



## HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

### Mechanical Service Manual 96-0283 RevH English January 2010

- 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.**

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**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.**

**Haas Automation Inc.**

# **Mill and Lathe Service Manual**

## **Mechanical Components**

### **January 2010**

**96-0283 rev H**



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## GENERAL MACHINE TROUBLESHOOTING

### 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.

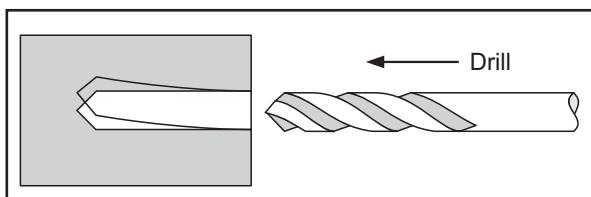
### Boring depth inaccurate.

- 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

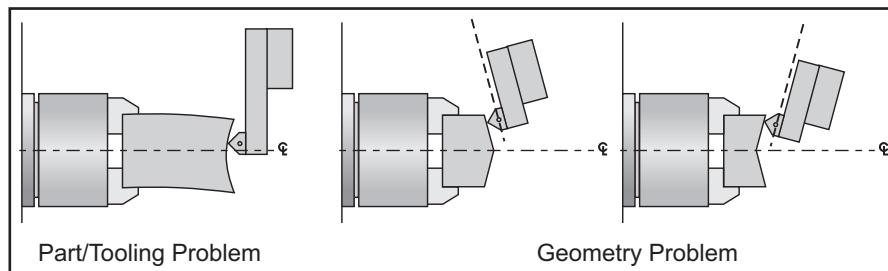
- Ensure the tool probe is set up correctly (settings, etc.).
- Ensure tool offsets are correct. Note that the coordinate system (FANUC, YASNAC, HAAS) must be selected before setting tools.
- Ensure Parameter 254, Spindle Center, is set correctly.
- Check for thermal growth of the X-axis ballscrew (see “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).

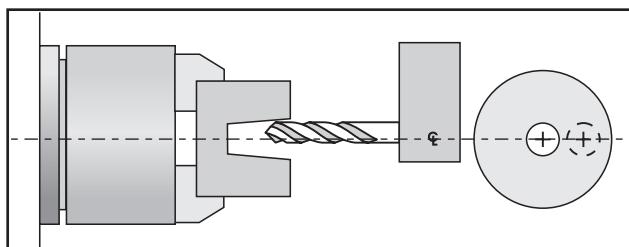
### Part faces are conical

- 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).



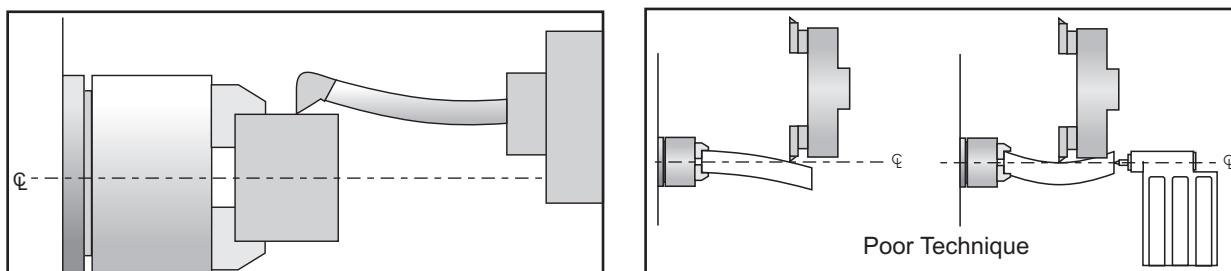
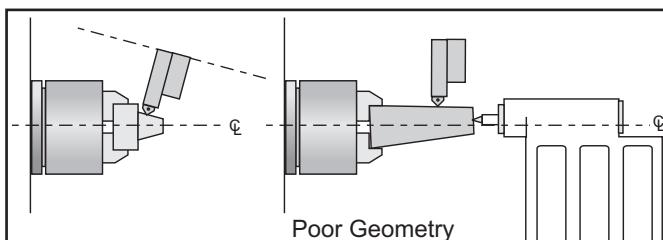
#### Bores are tapered

- 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.



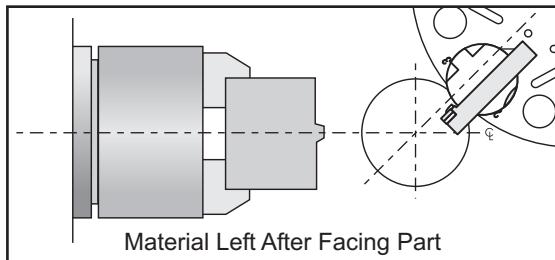
#### Outside diameter (O.D.) is tapered

- 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.



## FINISH

### Machining yields a poor finish

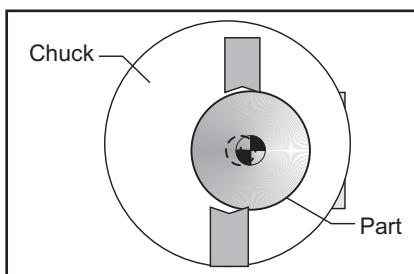
- Check for backlash ("Ball Screw Removal and Installation" section).
- Check the condition of the tooling and the spindle.

### 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.

<b>DIAMETER</b>	<b>TORQUE</b>
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



## MACHINE SPECIFICATIONS

### LUBRICATION CHART

System	Lubricant	Quantity
<b>Way Lube &amp; Pneumatics</b>		
Vertical/Horizontal Mills	Mobil Vactra #2*	2-2.5 qts
HS-3/4/6/7 incl R	Mobil DTE 25	2-2.5 qts
Lathes	Mobil Vactra #2	2-2.5 qts
<b>Transmission</b>		
Vertical Mills 40 Taper	Castrol AWS46	1.5 liters
Vertical Mills 50 Taper	Mobil SHC 625	1.0 liters
Horizontal Mills 50 Taper	Mobil SHC 625	2.5 liters
Lathes	Mobil SHC 625	2.5 liters
<b>Rotary Table</b>		
SHS210	Mobil SHC 634 Mobil SHC 634	Cover sight glass 1/4 full on sight glass
<b>Axes</b>		
A & B Axis (VR-Series)	Mobil SHC 634	A-axis 5qts, B-axis 4qts
4th & 5th Axis		
EC/HS Series	Mobil SHC 630	
Rotary Tables	Mobil SHC 634	
C-Axis (Lathe)	Vactra #2	1 drop every 10 engages
<b>Hydraulic Brake</b>		
EC-1600/2000/3000 & HS-3/4/6/7 incl R	Mobil DTE 25	Between Min/Max marks on brake booster
<b>HRT110/TR110</b>		
	Mobil DTE 25	1/4" to 1/2" below reservoir cap
<b>Hydraulic Power Unit (HPU)</b>		
	Mobil DTE 25	8 gal (26.4L) 10 gal. (37.9L) for SL-30B and larger
<b>High Pressure Coolant (HPC)</b>		
	5-30W Synthetic	Reservoir 25% full
<b>Toolchangers (SMTC)</b>		
Standard	Castrol Alpha SP 320	Top of sight glass (Vertical: 6 quarts, EC: 8 quarts)
Super Speed and EC-300/400/ES-5	Mobil SHC 630	Top of sight glass (Vertical: 6 quarts, EC: 8 quarts)
EC-630	Mobile SHC 634	
EC-1600/2000/3000	Castrol Alpha SP 320	
<b>Counterbalance System</b>		
<b>Machine Tank Size Tank Height</b>		
40 cubic feet	23"	2 Mobil DTE 25 per tank
80 cubic feet	36"	3 Mobil DTE 25 per tank
110 cubic feet	42"	3 Mobil DTE 25 per tank
		<b># of Pump Strokes</b>
		93
		140
		140

\* All 50-Taper Machines, 30,000 RPM 40-taper spindles and 15,000 RPM spindles in GR-Series mills use DTE 25.



#### SPINDLE AIR PRESSURE

System	Pressure
40/50 Taper & 10K	17 psi.
12/15K 40 Taper	20 psi
15K 30 Taper	20 psi
Horizontal Mills & 30K 30 Taper	25 psi
SL-Series/TL-15/25	10-12 psi
TL-15/25 Subspindle	10-12 psi
SR-100 Spindle Taper Constant Air	54 psi
Office Mill	4 psi
MiniMill	25 psi
Grease Pack (GR and TM Series)	3 psi

#### TOOL RELEASE PISTON PRECHARGE AIR PRESSURE

System	Pressure
Vertical Super Speed (SS)	30 psi
EC-300/400/500	30 psi
30 Taper Mills	35 psi
30K Machines	45 psi
SR-100	100 psi

#### PRECHARGE AIR PRESSURE

System	Pressure
Vertical 40 Taper	4.1 psi
Vertical Super Speed (SS)	30 psi
EC-300/400/500	30 psi
MDC-500	4.1 psi

#### COUNTERBALANCE AIR PRESSURE

System	Pressure
EC-630/1600/2000/3000	800 psi
VR-8/9/11	1025 psi
VF-3YT/50	1100 psi
VF-5/50	1100 psi
VF-6/7/10 50 Taper	1150 psi
HS Series	1250 psi
VS Series	1250 psi
VF-8/9/11 50 Taper	1550 psi

#### CLAMPING PRESSURE

**Drawbar - Measured by gauge on tool in spindle**

30K Machines	700-800 ft-lbs pull force
MM/SMM	900-1300 ft-lbs pull force
VF/HS/XHC 40 Taper	1750-2100 ft-lbs pull force
50 Taper Mills	3700-4200 ft-lbs pull force

#### Pallet

Clamp	100 psi
Unclamp	100 psi

A-Axis	100 psi
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#### **HYDRAULIC POWER UNIT (HPU)**

HPU (Lathe) 120 psi minimum

#### **HYDRAULIC BRAKE PRESSURE BOOSTER**

##### **EC-400**

Low Side 20 psi  
High Side 5-10 psi

##### **EC-630/1600**

Booster Pressure 970-1030 psi

#### **ROTARY HYDRAULIC BRAKE PRESSURE**

<b>HRT 110/TR 110</b>	35-50 psi
<b>HRT 450</b>	1000 psi
<b>HRT 600/VR</b>	1100 psi

#### **TABLE (4X)**

<b>System-EC-630/1600</b>	<b>Pressure</b>
Clamp Ring	250 psi
Fill Ring Inlet Air	25 psi
Fill Ring Hydraulic Pressure	1000 psi

#### **TABLE (5DEG)**

<b>System-EC-630/1600</b>	<b>Pressure</b>
Hydraulic Clamp	
Black Clamp Regulator	1500 psi
Red Lift Regulator	1000 psi



## 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°.

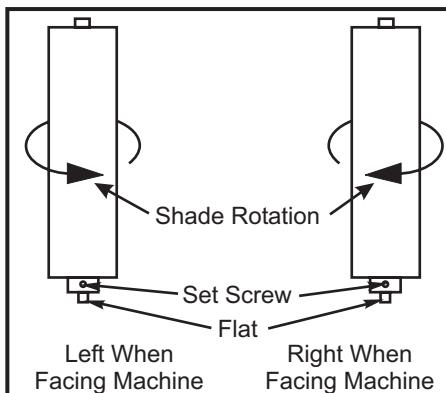
Power off the machine and remove the way cover bolts from each side of the cover.

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.

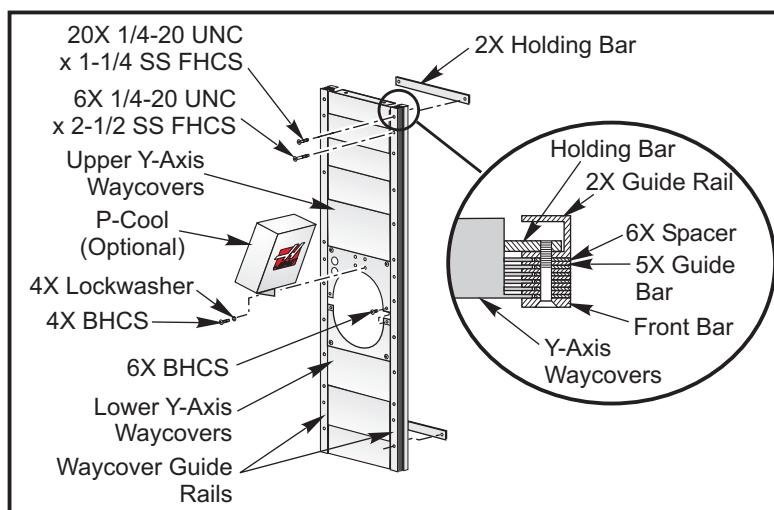


1. Clamp the shaft at the flat with clamping pliers or other such clamping device to hold the shaft when adjusting of the spring tension.
2. Loosen the set screw so that the spring tension may be adjusted.
3. Rotate the shaft one complete revolution against the force of the spring (counterclockwise for 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 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 way cover down until 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

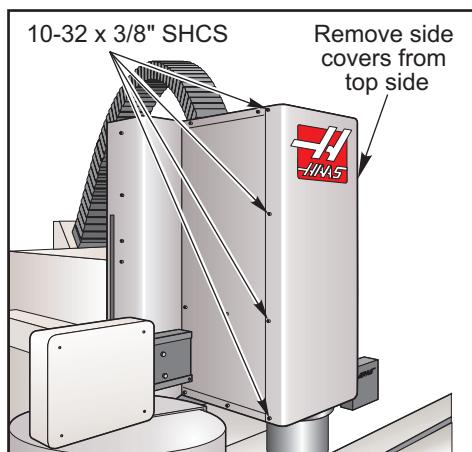
1. Install the four SHCS at the bottom of the way cover, and tighten evenly.
2. Slide the bottom of the way cover up and down to ensure it moves freely.
3. Slide the top flange of the way cover under the spindle head cover plate and fasten it to the spindle head cover and upper way cover using four BHCS.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

Two switches located on the tool release piston assembly 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

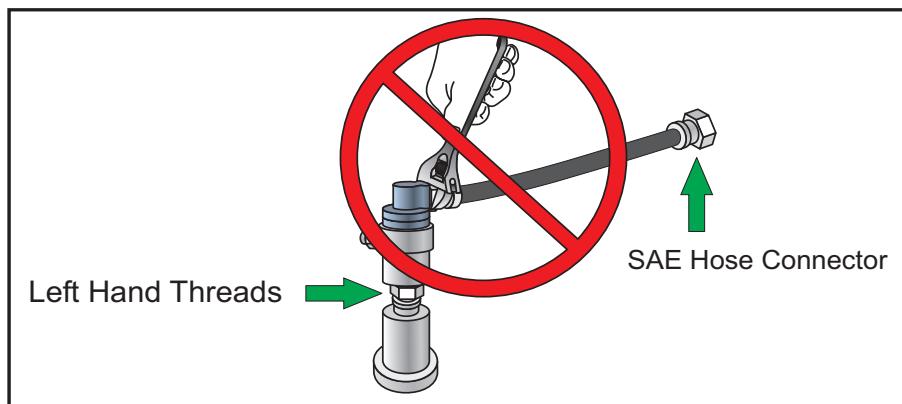
The Remote Tool Unclamp switch is mounted on the side of the cover to the spindle head. It operates the same as the button on the keyboard. It must be held for  $\frac{1}{2}$  second before the tool will be released and the tool will remain released for  $\frac{1}{2}$  second after the button is released.



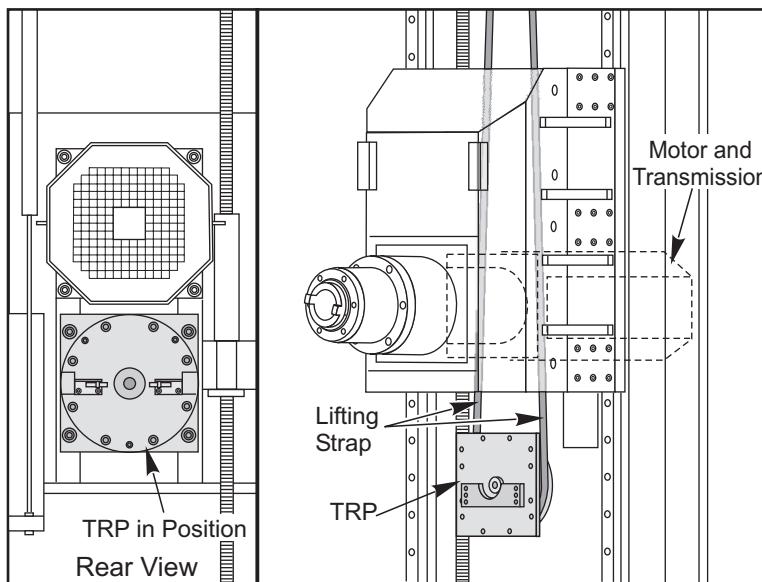
## TOOL RELEASE PISTON REMOVAL

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. **Horiz:** 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.



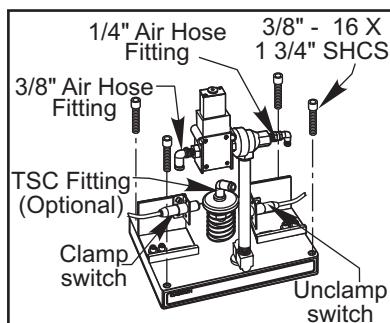
*Horizontal Mill Tool Release Piston*

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

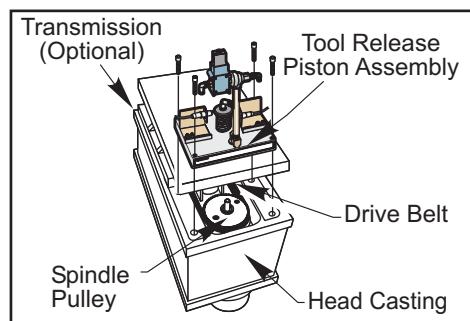
**NOTE:** Steps 9 and 10 apply only to machines with TSC.

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*

#### TOOL RELEASE PISTON INSTALLATION

**The following sections must be completed after installation:**

##### 40 Taper

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

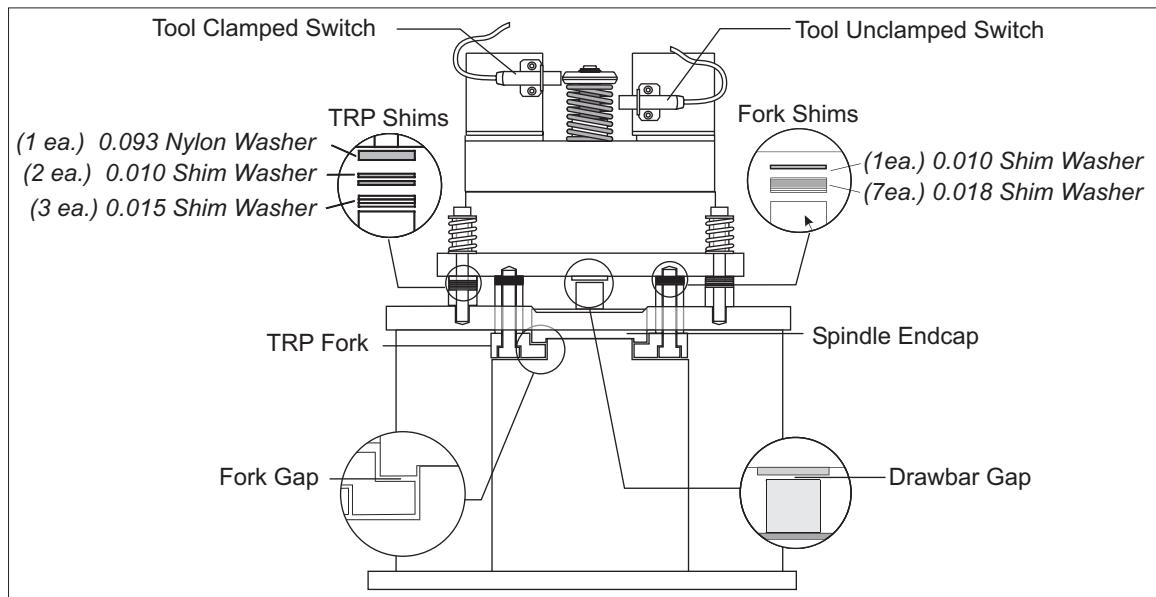
##### 50 Taper

- 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.

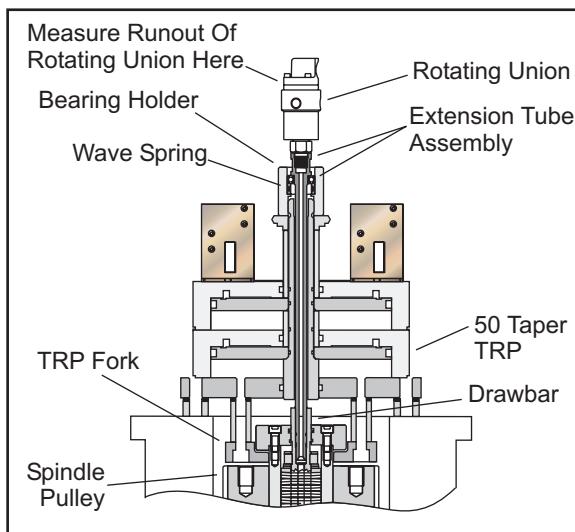
	<b>Part No.</b>	<b>Description</b>	<b>30-0013A (New)</b>	<b>30-0013 (Old Style)</b>
Fork:	(45-0014)	0.010 Shim Washer	1 ea.	None
	(45-0015)	0.018 Shim Washer	7 ea.	5 ea.
TRP:	(45-0019)	0.093 Nylon Washer	1 ea.	1 ea.
Spacers:	(45-0017)	0.010 Shim Washer	2 ea.	2 ea.
	(45-0018)	0.015 Shim Washer	3 ea.	2 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** - If 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 removable thread locking compound 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 thread locking compound on the threads.
    - 1) Thread the coolant union onto the end of the extension tube (it has left hand threads). Do not use thread locking compound. 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 thread locking compound on the screws). The drain line connector should point toward the rear of the machine.

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**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. Perform adjustments in “Precharge Regulator Adjustment” section.**

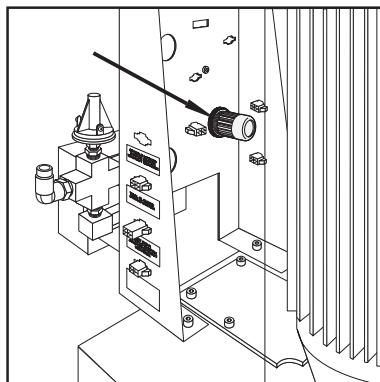
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**NOTE:** Set the air pressure regulator to 30 PSI on Super Speed machines with an in-line drive and do not set a precharge on 50 Taper machines. For a standard 40 Taper machine (without TSC), use the procedures in step 4.

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.

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**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 air pressure regulator  $\frac{1}{2}$  turn in. Execute tool change and listen for banging noise described in step 3. If it is heard, repeat 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.

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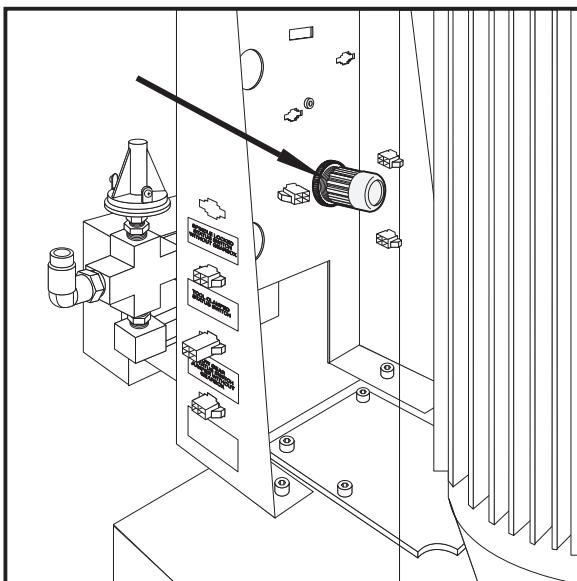
5. Replace the head covers.



## TRP SWITCH ADJUSTMENT

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

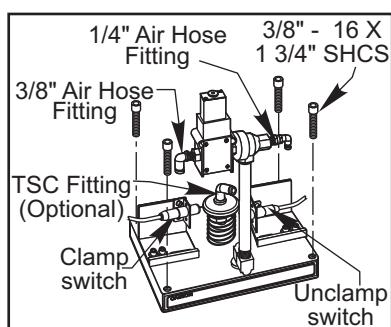
1. Install an inline pressure gauge between the regulator and the check valve.
2. Remove the toolholder from the spindle.
3. Rotate the regulator adjusting knob to the fully out position (turn counter-clockwise).



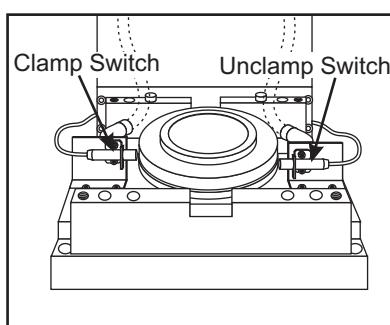
4. Press MDI.
5. Enter #1120=1, and press Cycle Start.
6. Adjust the pressure regulator to 30 PSI and press Reset.
7. Press Cycle Start again to verify that the regulator is set to 30 PSI, then press Reset.
8. Lock the regulator adjusting knob, by pressing it in and remove the inline gauge.

### Adjustment Procedure

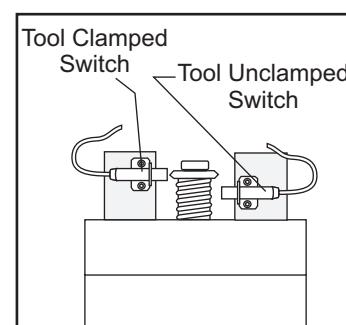
Upon completion of the Tool Release Piston switch adjustment procedure, the switches should indicate that the tool is released from the spindle taper with the tool **0.060"** out of the taper and that the tool is **not** released with the tool **0.050"** out of the taper.



Conventional Spindle Switches



Inline Spindle Drawbar Switches

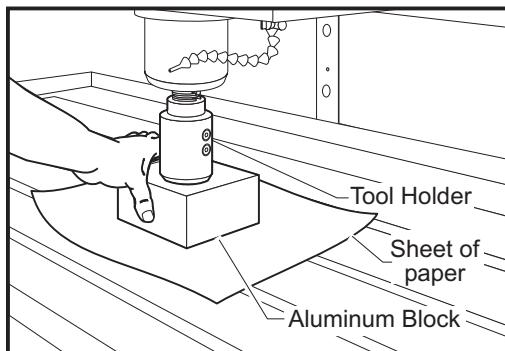


50 Taper Tool Clamp/Unclamp Switches

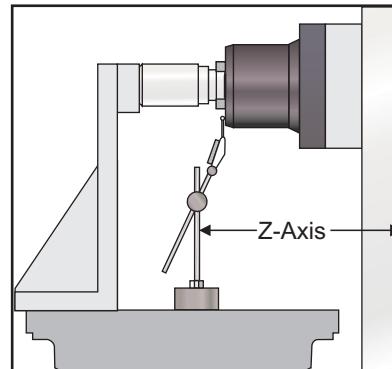
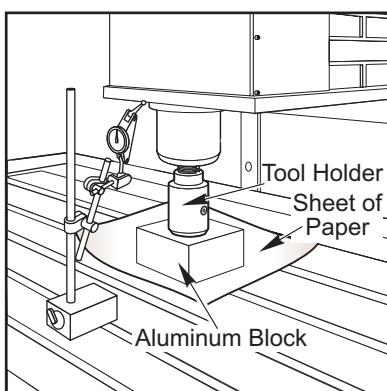


### Lower (Unclamp) Switch

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.

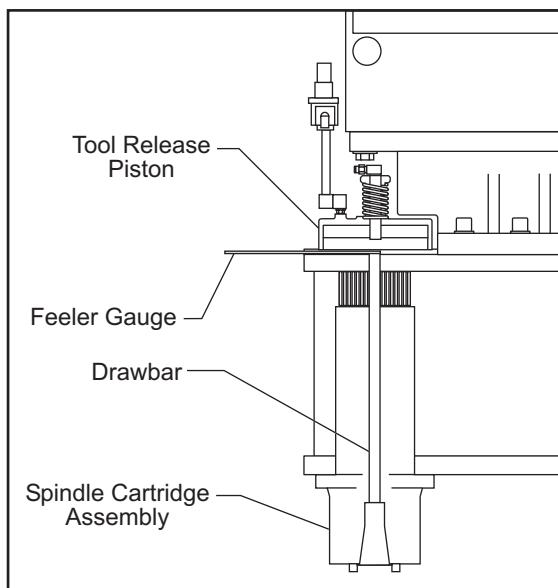
15. Set the pressure regulator back to 85 PSI and set Parameter 76 to 1500.

#### Upper (Clamp) Switch

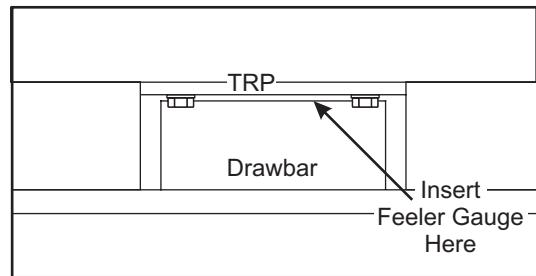
1. Remove the tool holder from the spindle.

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.

7. Repeat steps 4-6, 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.

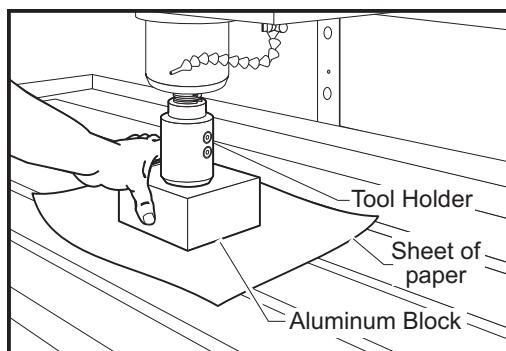


## SETTING TRP HEIGHT

**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

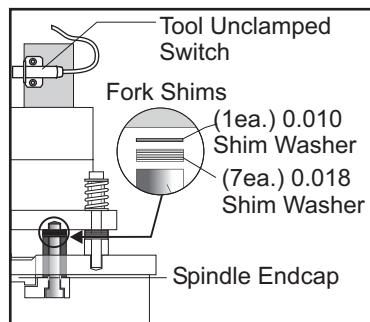
3. Hold the Tool Release button down, grasp the aluminum block and try to move it. The block should be tight.
4. Jog the Z-axis in the positive (+) direction 0.110".
5. Hold the Tool Release button down, grasp the aluminum block and try to move it. The block should be loose.

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

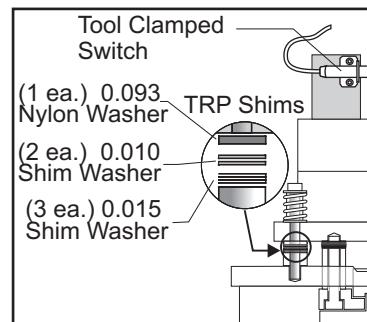
6. If the block moves at 0.100", jog the Z-axis in the negative (-) direction one increment at a time. Check for movement of the block between increments until the block is tight. Each increment is equal to one piece of shim stock.
7. The increments jogged in the Z negative (-) direction are the amount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

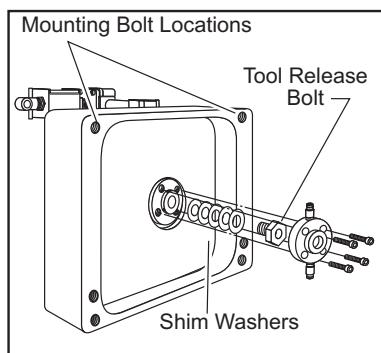
10. The tool push out adjustment is  $0.060" \pm 0.010"$ . Add or remove shims from the tool release fork to make adjustments. The shims come in  $0.010"$  and  $0.018"$  thicknesses. Jog away from the plate (upward for Vert)  $0.060$ . Press and hold the Tool Release button, and feel for movement in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

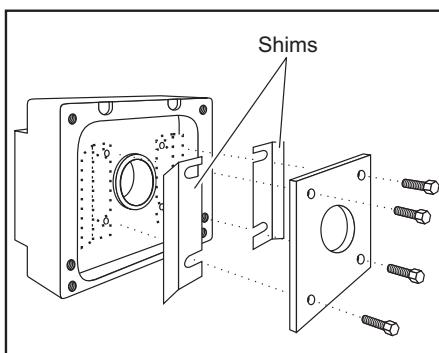
11. If shims were added to the TRP fork, add half that amount to the spacers supporting the TRP. This will keep the two clearance gaps between the TRP and the rotating spindle equal (approximately  $0.095"$  each). If shims were removed from the TRP fork, remove half that number of shims from the spacers.

12. Apply red grease to the shoulder bolts used to mount the TRP when shim adjustments are complete. Use removable thread locking compound on the threads.

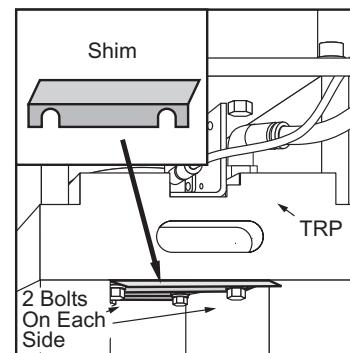
## Shims



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 removable thread locking compound on the bolt threads. If replacing the TSC coolant tip, put a drop of thread locking compound 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.

## DT-1 TOOL CLAMP SYSTEM

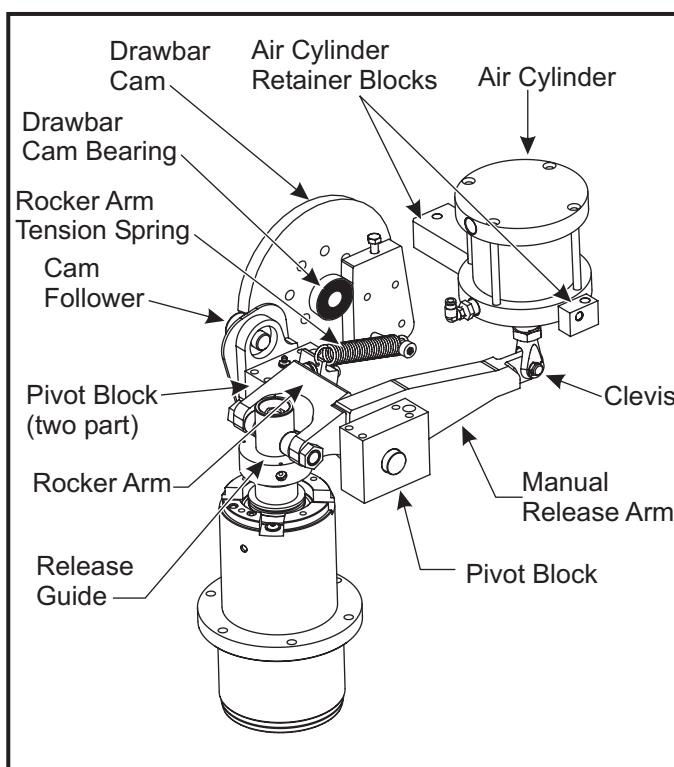
### Introduction

This document describes removal and replacement procedures for the three spindle clamp components of the DT-1 toolchanging system: The external cam from the toolchanger cambox, the rocker arm assembly, and the air cylinder.

These components control drawbar clamping during tool changes. The DT-1 does not use a TRP; instead, tool clamping/unclamping action is controlled by a cam (during tool changes) or an air cylinder (during manual tool loading) that acts on a rocker arm, which in turn controls the clamp/unclamp action of the drawbar.

### Assemblies

The basic assemblies are shown in the following illustration, with all surrounding parts removed for clarity:



*Basic Tool Clamp/Unclamp Assembly*

To access components for all of these procedures, remove both panels of the spindle head cover. It may be necessary to remove the inner part of the tool changer carousel cover to reach some of the sheetmetal fasteners on the left-hand panel. There is a chip shield inside the left-hand panel that covers the drawbar cam bearing through Z-axis travel that must also be removed.

### Rocker Arm

#### Removal

1. Jog the Z-Axis down to the bottom of travel. If there is a tool in the spindle, remove it.
2. Remove the C-clip from the clevis pin through the access hole. Pull the clevis pin out from the other side.

**NOTE:** Some early assemblies may not include the access hole. In this case, use a dental pick or similar tool to reach in and work the C-clip off of the pin.



Air Cylinder Clevis Access Example

3. Unhook the tension spring from the rocker arm.
4. Remove the four fasteners from each of the pivot blocks at the front of the rocker arm assembly. Use a 1/4-20 screw to remove the dowel from each block. If the dowel is difficult to remove, use some washers to space the screw out from the surface of the pivot block, then tighten the bolt to loosen the dowel.
5. At this point, the entire rocker arm assembly is loose, and can be worked out of the spindle head casting. Take care to prevent the right-side pivot block from dropping—the block and manual release arm can be disassembled from the shaft to ease removal.

#### Reinstallation

1. Assemble the left-hand, two-part pivot block to the rocker arm shaft with the front two screws in the block (there is insufficient clearance to install them when the block is in place). Work this assembly into place and secure the pivot block.
2. Slide the manual release arm onto the shaft and into its notch in the rocker arm.
3. Install the wave washer to the shaft. Slide the right-hand pivot block onto the shaft with the front two screws in the block (there is insufficient clearance to install them when the block is in place).

**NOTE:** The right-hand pivot block has a specific top and bottom; do not install it upside down. Identify the top of the block by the larger dowel pin locator hole that allows the dowel to enter easily. The lower hole is close-fitting to the dowel.

4. Secure both pivot blocks with four screws each, then install the dowel pins, making sure the pins are threaded-end up.
5. Reinstall the tension spring.
6. Reconnect the manual release arm to the air cylinder clevis. Replace the clevis pin and C-clip.
7. With the rocker arm reinstalled, automatic push-out, manual push-out, and rocker arm/release guide clearance must be checked and adjusted. Refer to the "Adjustments" section.

**NOTE:** If the rocker arm cam follower roller has been replaced with a larger roller as part of this service, it may be necessary to grind a path on the outside of the tool changer cambox to provide clearance. Carefully verify clearance along Z-axis travel. Interference with the cam follower during operation may lead to dropped tools and spindle damage.

## Air Cylinder

### Removal

1. Remove the clevis pin from the end of the air cylinder shaft. Access the pin and its retaining C-clips through the hole in the spindle head casting (see photo in the previous section).

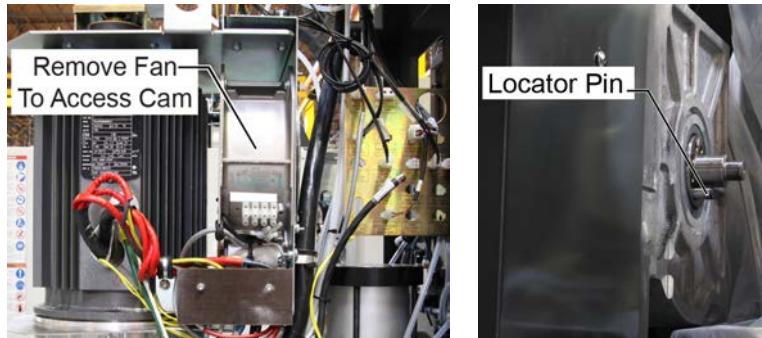


2. Remove the retainer block from each side of the air cylinder, then remove the air cylinder from the assembly.

### Replacement

Install the air cylinder following the removal instructions in reverse order. Once the cylinder is in place, it must be adjusted for correct operation. See the “Adjustments” section for details.

### Drawbar Cam



### Removal

1. Jog the Z-axis to put the spindle motor fan in line with the cam, then press Emergency Stop.
2. Remove the spindle motor fan. The cam is accessible through this opening.
3. Remove the screws holding the cam, then carefully remove the cam from the shaft. You can use (4) 1/4-20 screws as jacking bolts to ease removal.

### Replacement

1. Lightly grease the cam shaft.
2. Line up the locator pin on the cambox with the locator hole in the cam and carefully press the cam onto the shaft. Secure with (7) 3/8-16 x 0.75" screws torqued to 30 ft-lbs.

### Adjustments

Tools Required



Also required: magnetic base, feeler gauges

#### Manual Push-Out Adjustment

1. Place the split tool in the spindle.
2. Indicate the ground surface of the split tool and zero the indicator.
3. Push up on the split tool to keep it from dropping and press Tool Release. The drawbar will push the split tool out of the spindle.



4. Check the indicator. The tool should be pushed out 0.030". If the pushout varies from this value, adjust the air cylinder clevis position in or out until the correct pushout is achieved.

---

**NOTE:** Each 180° rotation of the clevis adjusts pushout by approximately 0.010". If an exact pushout of 0.030" cannot be achieved, adjust pushout to the closest possible value **over** 0.030". For example, if pushout can only be adjusted to 0.025" or 0.035", adjust it to 0.035"

#### Automatic Push-Out Adjustment

This adjusts tool push-out when tool release is controlled by the drawbar cam during tool changes.

1. Place the split tool in the spindle.
2. Set rapids to 5% and press ATC FWD to bring the spindle to tool change position. Press Emergency Stop as soon as the spindle orients to tool change position and the carousel stops moving.
3. Indicate the ground face of the split tool and zero the indicator. Carefully move the indicator and base away from the split tool (without disturbing the current indicator setting).
4. Make the tool changer axis visible (Parameter 462 bit 18), then jog it in the negative direction until the split tool is fully released.



*Measuring tool push-out*



*Rocker Arm Shim Placement*

5. Try to insert the split tool back into the spindle taper. Hold the tool in place while sliding the dial indicator back under the split tool and measure push-out. This should be 0.030"; if it is not, correct pushout by adding or removing shims.
6. To add or remove shims, loosen the connecting bolt in the rocker arm assembly (see photo above). Add or remove shims as needed. Shims provide pushout adjustment at a 1:2 ratio; that is, adding a 0.010" shim will increase pushout by 0.020".

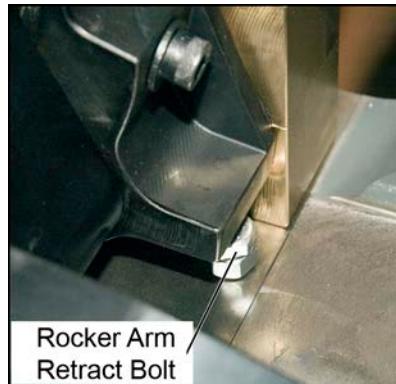
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**NOTE:** Install shims forward of the spherical washers in the assembly. Shims should not interfere with the washers nesting.

7. Retighten the connecting bolt and recheck tool pushout. If still not correct, repeat the shimming procedure to add or remove shims until push-out is equal to 0.030".
8. Reset the tool changer axis to invisible.



## Adjusting Rocker Arm / Release Guide Gap



1. Use a feeler gauge or shim to check the gap between the rocker arm cam followers (two rollers) and the release guide. This distance should be 0.040".
2. To correct this distance, adjust the rocker arm retract bolt (found on the rear of the rocker arm, under the shim retention bolt) up or down and secure with the jam nut.
3. Recheck the gap and make adjustments as necessary until the gap measures 0.040".

### TESTING

Beginning at 5% rapids, command and observe a tool change. If the change completes successfully, repeat the test at 25%, then 50%, then 100% rapids, checking each time that the tool is transferred smoothly between the pocket and spindle.

### BELT REPLACEMENT & TENSIONING

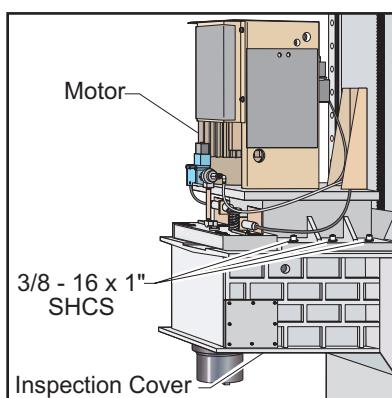
**Please read this section in its entirety before attempting to replace the Spindle drive belt.**

#### DRIVE BELT REPLACEMENT (VERT & EC-SERIES)

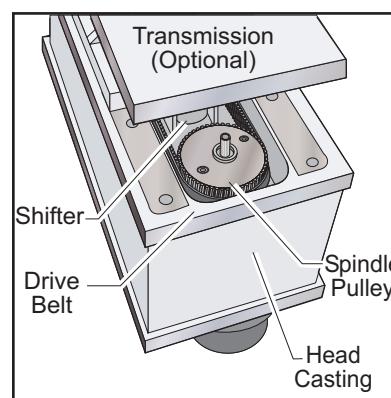
##### Removal

**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 ( $\frac{1}{2}$ " to  $\frac{3}{4}$ " 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.

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**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.

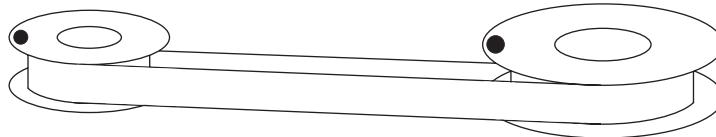
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**NOTE:** Do not bend or kink the belt in any way; damage to the fibers in the belt may result, and the belt will fail soon after installation.

## Installation

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**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).

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



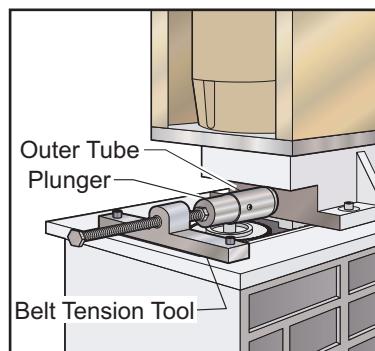
5. Double-check the spindle sweep to assure that nothing has moved during the previous steps. If sweep is within tolerance, continue; if not, sweep must be readjusted.

**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 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 three types of belts (3 rib, 4 rib and cogged) 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<sub>f</sub> (pounds force)/Hz tension readings. Cogged belt tension must be measured in lb<sub>f</sub>.

Belt	New Belt		Used Belt	
	Minimum	Maximum	Minimum	Maximum
3 Rib	53.7 lb <sub>f</sub>	57.6 lb <sub>f</sub>	46.2 lb <sub>f</sub>	50.1 lb <sub>f</sub>
	174 Hz	180 Hz	161 Hz	167 Hz
4 Rib	60.8 lb <sub>f</sub>	64.8 lb <sub>f</sub>	52.0 lb <sub>f</sub>	56.4 lb <sub>f</sub>
	159 Hz	165 Hz	148 Hz	154 Hz
Cogged	50 lb <sub>f</sub>	58 lb <sub>f</sub>		

**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

Setting for cogged belt: Weight 4.1, Width 25, Span 209

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

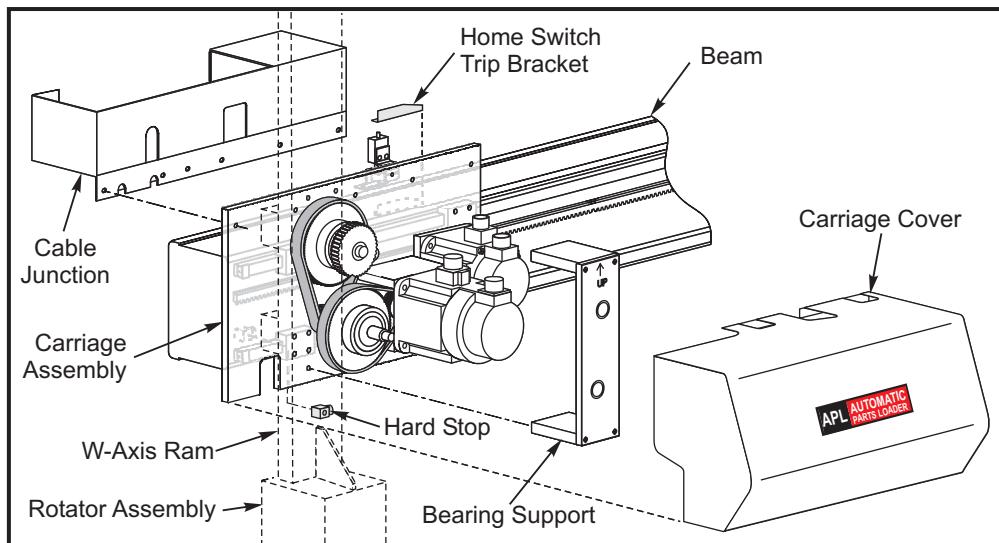
The spindle belt tension is measured using a Gates Sonic Tension Meter, model number 505C or 507C.

1. Set the Gates Sonic Tension Meter so that it is reading Hertz (Hz).
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. Take belt tension measurements at 6 locations through one revolution of the motor pulley by rotating the spindle shaft one half turn, 5 times (the starting point is the 6<sup>th</sup>). Take 2 readings at each point.
4. Adjust the assembly until the belt tension is between 160 and 180 Hz.
5. 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.

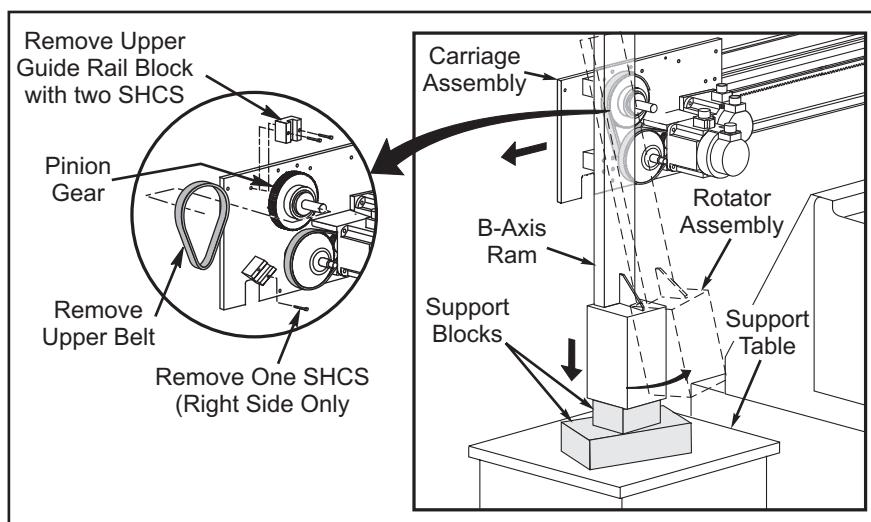


### Replacing the Belt(s)

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 the carriage 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.

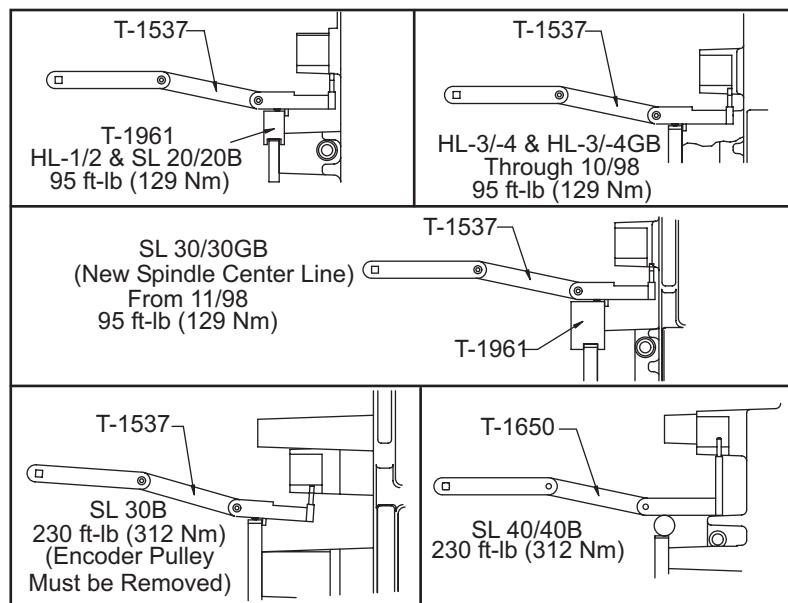




5. Remove the top linear rail guide block (2 bolts) which will drop down to the bottom block. **Only remove the inside bolt on the bottom linear guide block.** The remaining bolt (outside) on the bottom guide block should only be loose.
6. Remove the bearing support bracket and position the ram outwards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



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



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

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3. Mount the encoder onto the spindle housing below the spindle shaft with four mounting bolts and plug in the encoder.
4. Place the 3/8" timing belt on the spindle pulley, with the other end on the encoder pulley.
5. 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".
6. Slide the hydraulic cylinder into spindle shaft. Insert and snug the mounting bolts.
7. Install the anti-rotation bracket.
8. Attach and clamp the oil drain hose and coolant drain hose onto hydraulic cylinder. Attach and screw in clamp and unclamp hoses.
9. 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 and drawbar pull force (machine specifications); 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 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 tool-holder 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 and mill drawbar pull force (machine specifications).
- 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 mill drawbar pull force (machine specifications).
- 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 an 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 supplies 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 for vertical mills, or 25 PSI for horizontal mills.
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 for vertical mills, or 25 PSI for horizontal mills.
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 PURGE AIR**

The spindle air purge system is designed to keep contaminants from entering the spindle housing and possible damaging the bearings. Spindle purge air is only used on grease packed spindles. An air pressure to the spindle purge is adjusted using the regulator on the back of the machine.

Set the air pressure between 3-4psi, except for an Office mill. Office mills are set between 5-6psi.

#### **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.

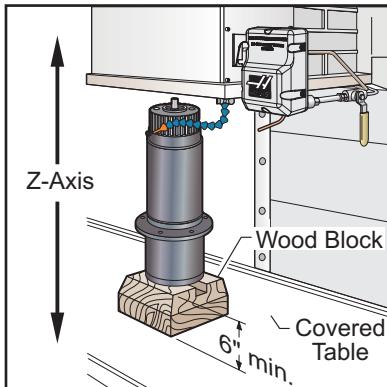
##### **Removal**

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.



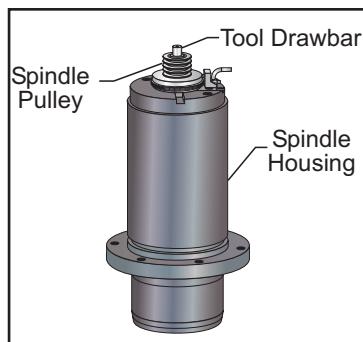
6. Ensure oil plug is inserted into oil injection port of spindle before removing spindle, or oil may spill into the spindle cartridge. The plug should fit flush with the spindle sides, if not, use tape to cover the hole.
7. **In-line drive and 30K spindles:** Remove the hose and oil fitting on the spindle 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.



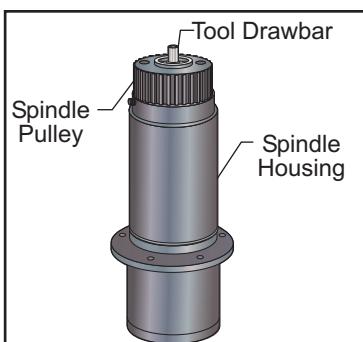
Position Wood Block Under Spindle

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.
11. Remove the 6 bolts from the spindle.
12. **Vert:** Jog the Z-axis up slowly until 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.

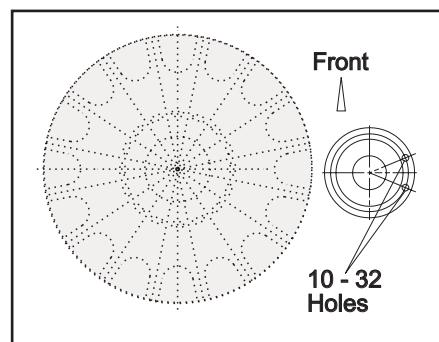
## Installation



30K Spindle Cartridge



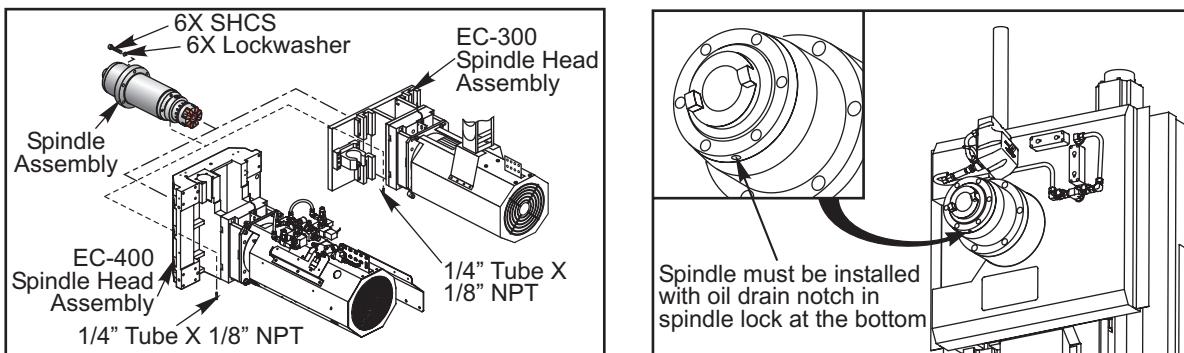
Vertical Spindle Cartridge



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.

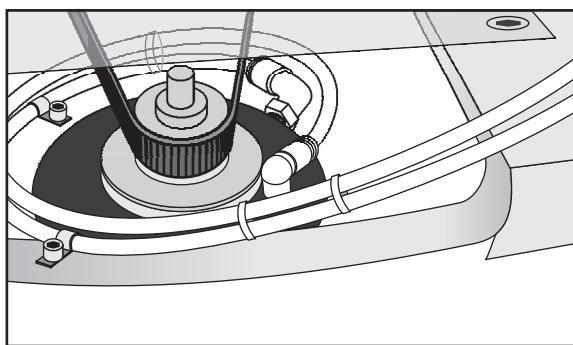
**HORIZ only:** Refer to "Spindle Troubleshooting - Overheating" and use the spindle run-in program. Verify that the spindle temperatures are acceptable.

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.

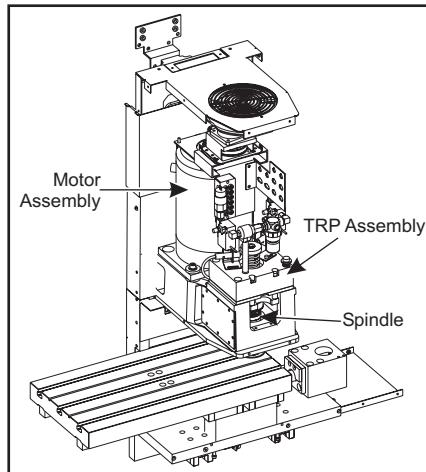
b. **Vert:** Check for correct amount of lubrication to the spindle bearings (0.5-1.0cc every two hours) in an air mist-lubricated spindle.

- 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.

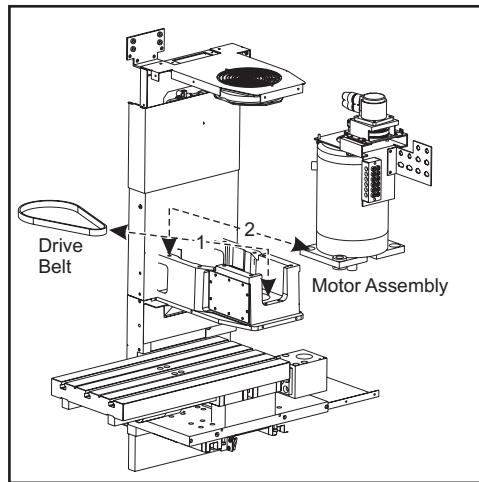
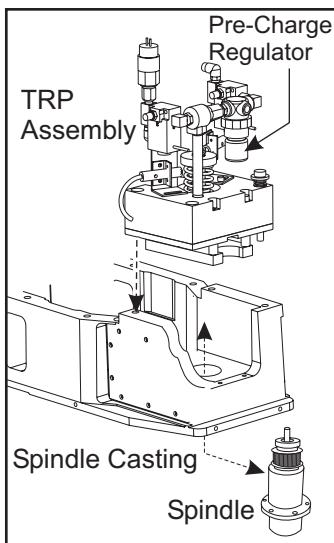
14. **In-line drive:** Check drawbar and adjust the tool clamp/unclamp limit switches.

**OFFICE MILL SPINDLE REPLACEMENT / UPGRADE**



*OM2A Spindle Assembly*

1. Remove the spindle head cover. Jog the Z-axis to the top of travel. Turn off machine and unplug power cord.
2. Loosen the spindle motor and slide it forward to release the spindle drive belt.
3. Disconnect the air purge tube and fitting from the front of the spindle. Wrap tape over the end of the tube to keep it clean. Install a 4-40 setscrew in the air purge port to keep it clean. Make sure the drive belt is off the spindle and remove the spindle through the bottom of the casting.



4. Remove the four shoulder bolt assemblies holding the tool release piston (TRP) assembly. Disconnect the tool clamp/unclamp sensor cables and solenoid wiring at the spindle connector bracket. Disconnect the air supply hose from the precharge solenoid at the right rear of the TRP. Disconnect the ground wire from the motor chassis and remove the TRP assembly.
5. Label the location of each of the spindle motor control wires in the terminal block at the front of the spindle motor. Loosen the screw holding each wire in place and pull the wire out.
6. Disconnect the encoder cables at the spindle connector bracket. Disconnect the ground from cable 650 at the top of the encoder. Unscrew the encoder cable from the rear of the encoder assembly.
7. Tilt the motor forward and lift it out of the machine.
8. Replace the old drive belt in the bottom of the casting with the new drive belt. Be careful not to bend or kink the belt in any way, as damage to the belt fibers may result, causing belt failure.
9. Put the new motor in place and reattach the encoder cable, taking care not to cross-thread the connector. Reconnect wires to the terminal block as noted previously and replace ground wires. Once these wires are connected, the machine can be powered on.
10. Reconnect the motor control wires as labeled on the spindle connector bracket.
11. Loop the drive belt around the motor gear. Put the motor mounting bolts in place but leave them loose.
12. Make sure the mating surfaces of the spindle and spindle-head casting are clean. Install the new spindle from the bottom of the casting. Make sure the small air purge port in the spindle body faces forward and loop the drive belt around the spindle while installing. Secure the spindle with six screws. Remove the setscrew from the air purge port and install the air fitting, using a 1/8" nut driver (Reference McMaster-Carr 7278A35). Attach the air purge tube to the air fitting at the front of the spindle.
13. Push the motor back to tension the drive belt. Use a Gates Sonic Tension Meter to set the belt tension of the spindle drive belt. Follow the steps below to achieve accurate readings:
  - a. Push the "HZ" button on the meter to set it to the proper units.
  - b. Take belt tension measurements at 6 locations through one revolution of the motor pulley by rotating the spindle shaft one half turn, 5 times (the starting point is the 6<sup>th</sup>). Take 2 readings at each point.
  - c. Take meter readings by placing the sensor of the meter within 3/8" of the belt and plucking the belt like a guitar string. Make sure the sensor does not touch the belt.
  - d. The belt tension should be set at 160-180Hz. The belt tension reading after breaking in should still measure between 160-180Hz. Adjustment may be required, as the belt may stretch during break-in.



14. Reinstall the TRP assembly. The top of the pulley must sit flush with the top of the TRP sub plate. If the TRP subplate is below the spindle, add .010" shims as necessary. Temporarily install an air pressure gauge to the TRP Pre-Charge pressure regulator. Enter #1120=1 to the control in MDI. Press Cycle Start and adjust the air pressure regulator until the pressure is 6 psi. Observe the TRP piston and verify it has contacted the top of the drawbar. Verify that the TRP subplate has lifted up and stopped against the pulley flange.

This is tested by manually pushing up on the TRP assembly. If it does not move it has stopped against the pulley flange. If it does move the TRP subplate is not against the pulley flange and the pre-charge pressure must be increased 1 psi and the test repeated. Press Reset to stop the program.

Once the subplate lifts and stops correctly (against the pulley flange), remove the pressure gauge, seat the TRP, and tighten the TRP mounting fasteners. Once the TRP fasteners are tight, the TRP must return to its original position.

15. Draw bar adjustment: Place an empty tool holder in the spindle. Place a machined aluminum block on the machine table and jog the Z-axis until the tool holder is approximately .03" above the block. Jog the Z-axis in .001" increments, press Tool Release and feel for movement on the tool holder. Repeat until no movement is felt. This is the zero point. In .01" mode, jog the Z-axis to .100" above the block. Press and hold Tool Release, and try to move the block. Try again at .110" above the block. The block should be tight at .100" and loose at .110". 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. The number of increments jogged up or down is the number of shims to add or remove. If the block was tight at .110", remove shims, if it was loose at .100", add shims.

To add or subtract shims, first remove the TRP assembly. Check the condition of the draw bar and tool release tip, and replace if damaged. Remove the tool release bolt add or remove the required number of shims. Reassemble the tool release bolt. Reinstall the TRP assembly and recheck alignment. Adjust as necessary.

16. 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. Establish a reference point (indicator zero), sweep the three remaining points and record the reading. Shim the spindle, if necessary, to correct the spindle sweep to specifications. Recheck sweep after adding shims. Sweep must be within .0005 in both X/Z and Y/Z planes, as stated in the inspection report supplied with the mill.

17. Make the following parameter changes:

Parameter	Description	Was	Is
57	OILER ON / OFF	1	1 (verify setting)
117	LUBE CYCLE TIME	0	108000*
208	SPIN. FAN OFF DELAY	15000	15000 (5 Minutes)
734	LOW LUBE PRESS.	1	0

\*Note: The pump is powered only when the spindle moves. Pump cycles every 30 minutes throughout the oil line.

18. Install the head cover and any other enclosure panels that were removed.

19. Run program O02025 (Spindle Run-in) to break in the spindle. This program will take approximately six hours to complete.

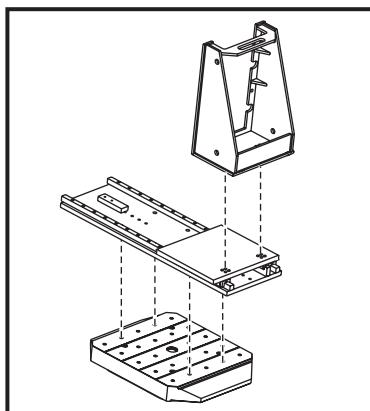


## EC-630 GEARED HEAD SERVICE

### Service Methods

#### Load Station Fixture

This fixture is used to remove the EC-630 geared head from a machine where the pallet load station door is available for use (e.g., no FMS or Pallet Pool installed). It consists of a slide fixture, spindle removal bracket, and a lifting bracket.



1. Secure the slide fixture to an empty pallet in the load station. Install the spindle removal bracket to the slide.
2. Orient the slide assembly so that it is parallel to the load station door (Perpendicular to the spindle center-line).
3. Command a pallet change to bring the service fixture to the machining station. Continue to step 1 in the next section.

#### Operator Door Fixture

This fixture allows the EC-630 geared head to be removed through the operator door if the load station door is not available due to a pallet pool or FMS system. It consists of the load station door fixture parts described previously, plus a rail assembly with a second slide that carries the geared head out through the operator door.

1. Secure the slide fixture to an empty pallet in the machining station. Install the spindle removal bracket to the slide.
2. Continue to step 1 in the next section.

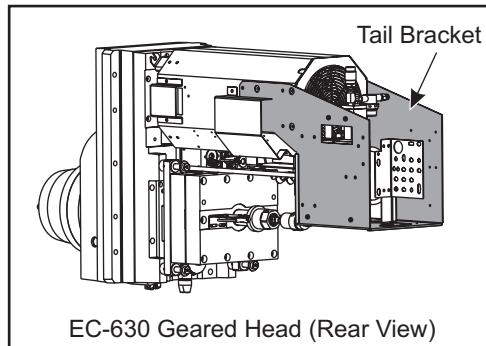
#### Removing the Geared Head From the Column

This procedure is the same for both service fixtures.

1. 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.
2. 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 4" X 4" piece of wood to allow removal of the spindle cover screws. Remove the spindle cover.
3. 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.



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

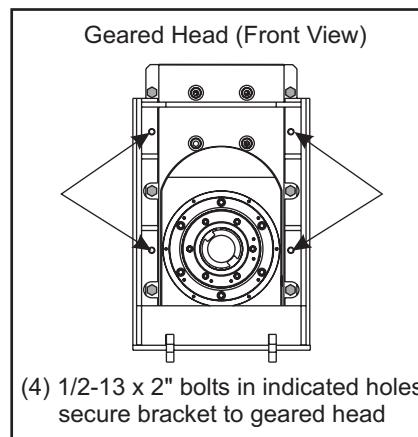


5. At the rear of the spindle assembly, remove the tail bracket and disconnect all lines (electrical, air, lubricant, coolant) that run from the tail bracket to the spindle assembly. Label cables and lines if necessary for reconnection to the new spindle. Plug the 3/4" air line. Put an insulating cover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

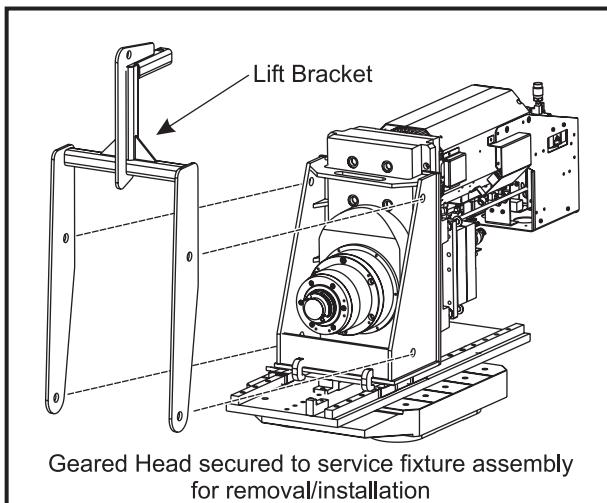
6. On the I/O board inside the control cabinet, remove the connector on P3 and replace with a tool changer jumper (33-8521). Remove the connector on P15 and replace with a spindle status jumper (33-8668A). install an encoder jumper, TRP unclamp jumper, motor overheat jumper, and disable GB in Parameter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

7. 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.

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



9. 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.



10. 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.

### Geared Head Removal from the Mill

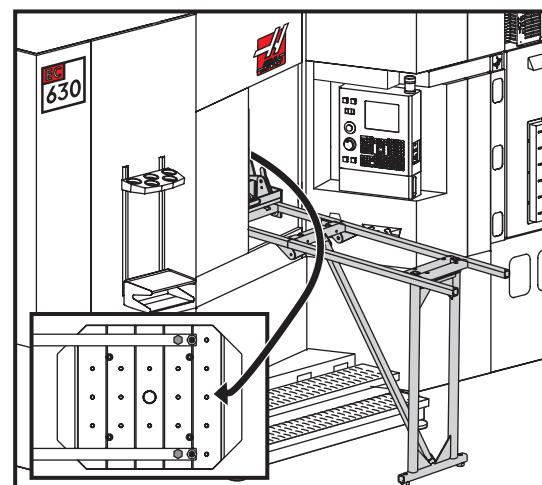
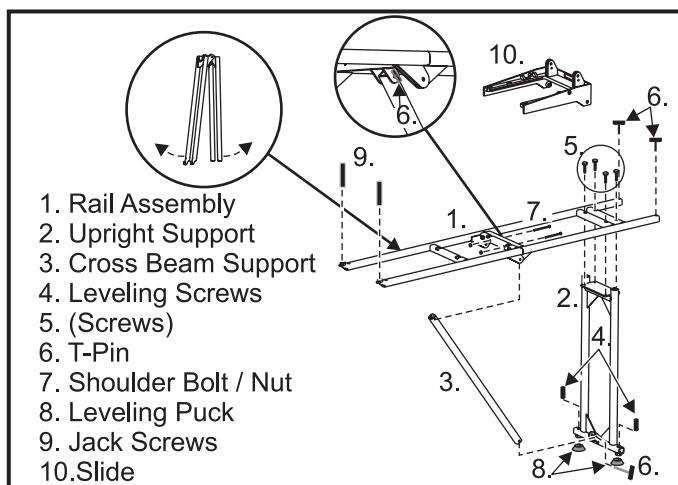
The procedure to remove the geared head from the EC-630 once it is secured in the removal bracket / slide assembly varies according to the method being used.

#### Load Station Fixture

1. 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.
2. Remove the four screws 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 on which the service fixture was shipped, and secure it to the pallet using four 1/2-13 x 1" bolts. Remove the lifting bracket.

#### Operator Door Fixture

1. Jog the A-Axis to point the end of the slide assembly toward the operator door. Adjust the A-axis and Z-axis positions as needed to ensure sufficient clearance for the geared head / slide assembly.



Rail Fixture Assembly

Rail Fixture to Pallet



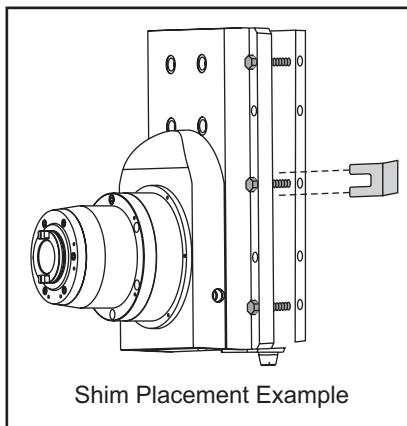
2. Assemble the rail fixture as shown. Push the pallet end into the machine and adjust level at the leveling screws. When a close level has been achieved, secure the rail fixture to the pallet as shown.
3. Install the slide to the rail and move it into the machine. Install the two T-pins to the outside ends of the rails.
4. Remove the four screws holding the geared head bracket to the pallet slide fixture. Use the jack screws to lift the head / bracket assembly sufficiently to allow the rail slide underneath, then lower the head / bracket assembly onto the rail slide. Rotate the two latch clamps on the rail slide to secure the slide to the head / bracket assembly. Secure the latches with T-pins.
5. Carefully pull the slide assembly along the rail and out of the machine.
6. Attach the lift bracket to the geared head bracket, then secure the entire assembly to a forklift or crane. Release the latch clamps, then lift the geared head and set it down on the pallet that the service fixture was shipped in. Secure it to the pallet using four 1/2-13 x 1" bolts. Remove the lifting bracket.

### **EC-630 GEARED HEAD INSTALLATION**

1. While the new geared head is out of the mill, 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.
- 2a. (**Load Station Method**) 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.
- 2b. (**Operator Door Method**) Attach the lifting bracket to the new geared head. Lift the assembly onto the rail slide, then secure it to the slide using the latch clamps. Secure the latch clamps with T-pins.
- 3a. (**Load Station Method**) 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.
- 3b. (**Operator Door Method**) Push the new geared head assembly to the pallet slide assembly. Using the jack screws on the rail assembly, lift the geared head enough to remove the rail slide, then secure the geared head bracket to the pallet slide. Jog the A and Z axes to slide the geared head into the column, align the 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.

4. 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.
5. 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.



6. Perform a spindle sweep using a precision test bar and a .0005" indicator. Shim geared head if necessary.
7. Reinstall sheetmetal spindle cover, way covers, coolant fittings and coolant lines at front of the spindle.
8. Remove all service fixtures.

#### 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 loosely 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 is tight at .060", remove shim washers. If the block is loose at .050", add shim washers. See "TRP Switch Adjustment" section.

#### 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.

### 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 transportation). Failure to run this program can result in spindle over heating and 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. Remove the necessary covers to access the spindle.
2. Place an empty toolholder in the spindle.

**In-line:** Remove motor.



3. Remove the TRP. **In-line:** Remove the key or pins from the drawbar and remove from spindle.
4. Remove the spiral (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.

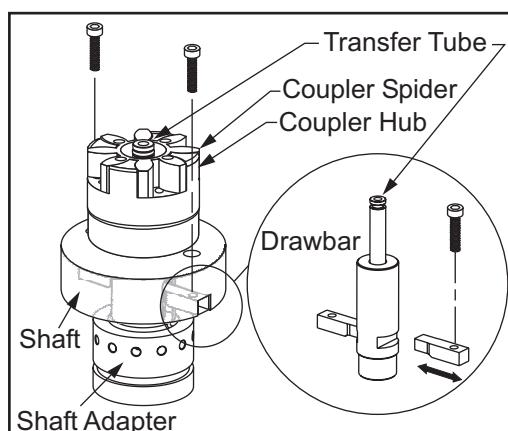
**NOTE:** Direct drive machines do not require movement of the drive assembly to access/remove the drawbar.

### 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 pins or 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.



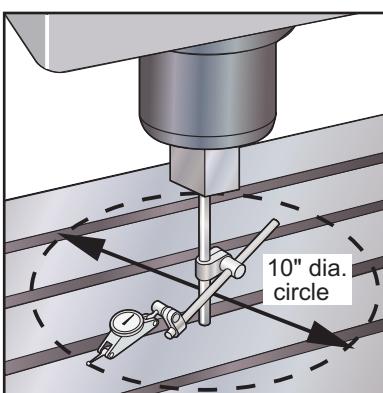
11. Set the drawbar height, and clamp/unclamp switches as previously described. Install the drawbar and re-install the tool release piston.
12. Check the drawbar pull force (machine specifications).
13. Reinstall the sheetmetal.
14. Test-run the machine and perform necessary tool changer adjustments. 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.



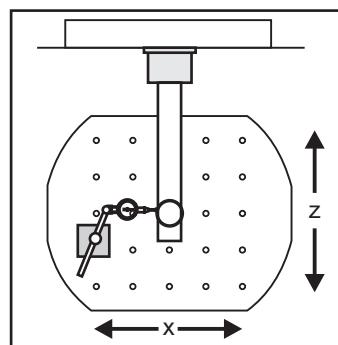
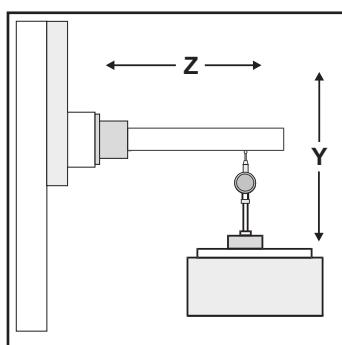
*Spindle Sweep Area*

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 Offset", 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 trammimg 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 ASSEMBLY

## LATHE SPINDLE REMOVAL

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

**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.

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.

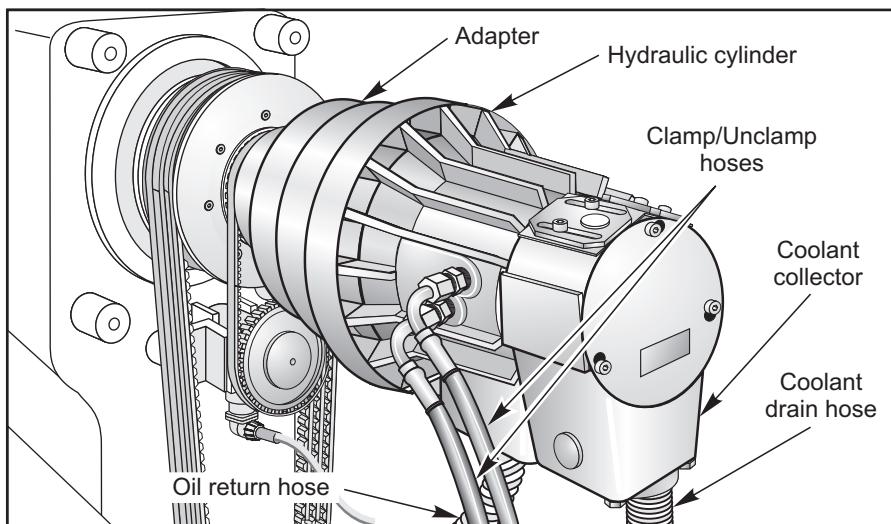


**TL:** Remove the belt from the spindle pulley. To do this loosen the three bolts on the motor mounting plate (see the spindle motor removal section). Use a bottle jack to lift the motor mounting plate. This will gain slack in the belt so it can be removed from the pulley.

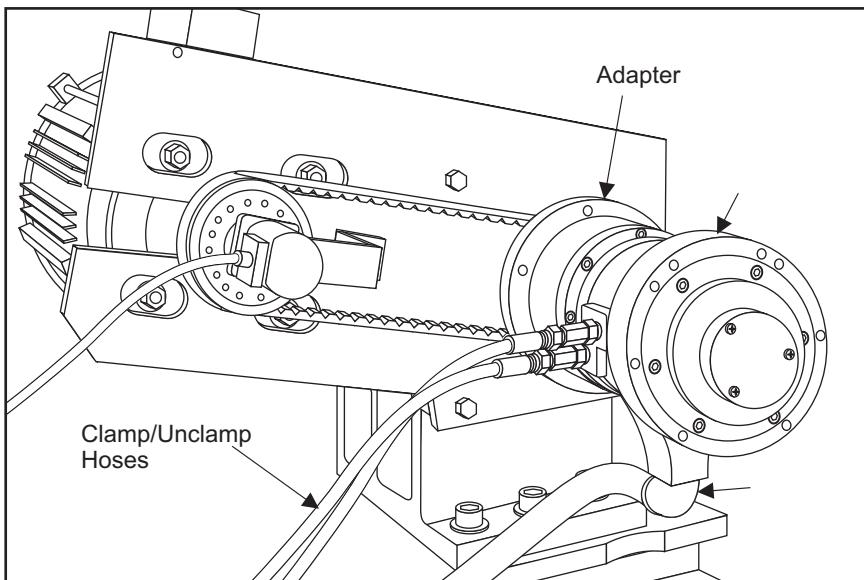
**ML:** Remove the belt from the drive pulley. Attach a hydraulic puller to the drive sprocket.

**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, and disconnect the anti-rotation bracket.
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.



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.

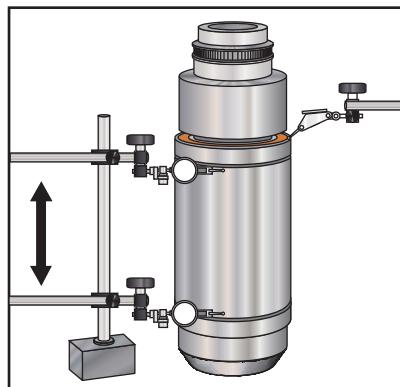


SL-10 Hydraulic Cylinder (Coolant Collector not Shown)

### SPINDLE INSTALLATION

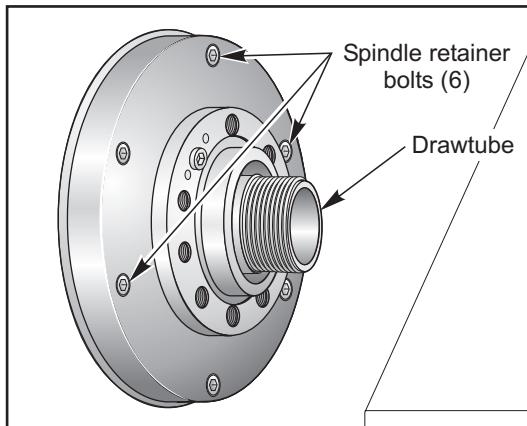
**Tools Required:** Removable thread locking compound, 1/2" Torque Wrench (Up to 250 ft-lb), Haas Belt Tensioning Tool P/N 93-8143 (SL 20), P/N T1537 (SL 30 and 40)

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; this should not exceed .003". Also verify the axial runout on the face of the bearing, which should not exceed .0004".

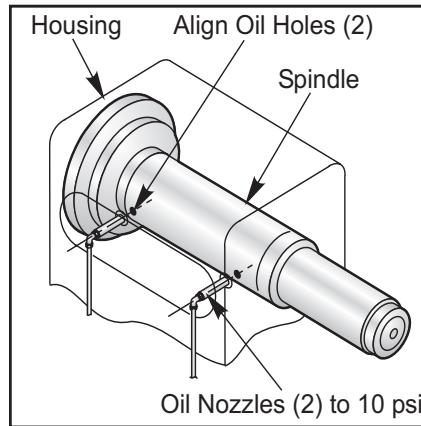


2. Install spindle into housing. Check location of oil holes for proper alignment.
3. Place the retainer ring on the spindle with the o-ring toward the spindle. Ensure that the drain holes are at the bottom of the retainer ring and that the o-ring remains in place.
4. Apply removable thread locking compound 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*

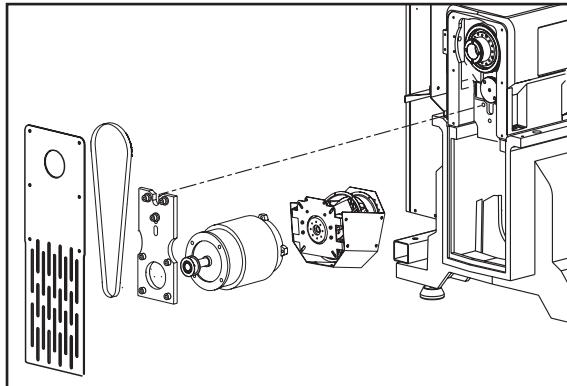


*Alignment of Oil Mist Holes*

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.

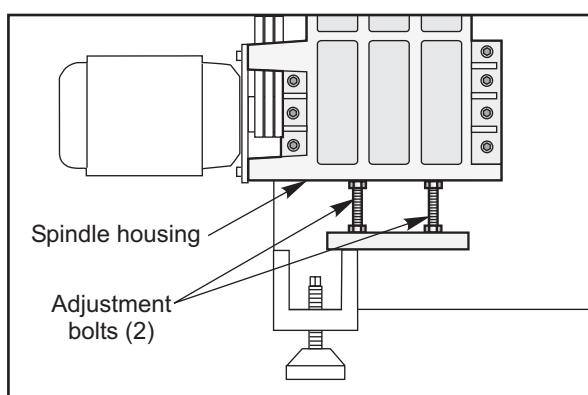
1. Attach the motor mount plate to the motor using the four SHCS, and torque the SHCS to 70 ft-lb. Attach the fan to the motor using the four SHCS.
2. Lift the mounting plate, motor and fan into place and fasten the plate to the casting using the three SHCS. Do not tighten the bolts, they should be snug 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

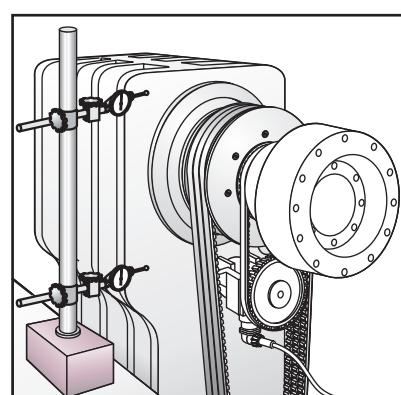
### TOOLS REQUIRED: Dual Indicator Stand

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 toward 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

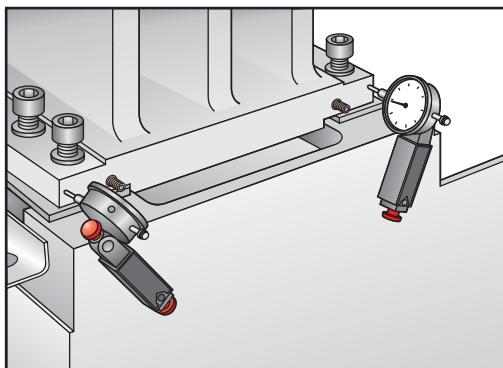
8. Next, zero the spindle alignment at the top and bottom of the turret pocket by sweeping the indicator at those positions and adjusting the jack screws equally.
9. Rotate the spindle 180° and adjust the jackscrews until the indicator reads within a .001” at the top and bottom of pocket. Repeat Steps 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.



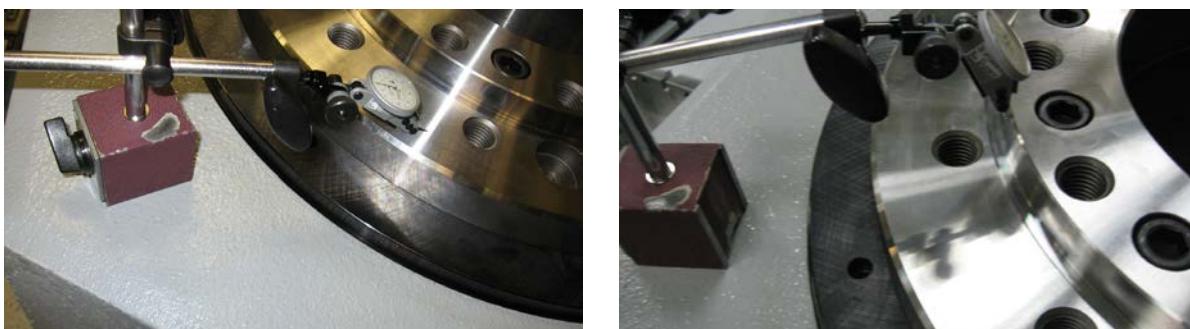
7. Attach a 0.0001" dial indicator into the end of the alignment bar.
8. Install a boring bar toolholder into tool position #1. Ensure the bore of the toolholder is clean and free of any burrs, chips, or other contaminants. The toolholder must be seated completely against the turret.
9. Jog the X-axis 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.

#### TL-4 SPINDLE CAP ALIGNMENT

If the TL-4 spindle cap is removed for service, or in the event of a machine crash, it must be realigned to prevent rubbing against the oil seal ring. The seal ring must also be aligned.

**Note:** Do not loosen or remove any of the screws from the bearing ring face located under the spindle cap (two rows of 36 screws each on the ring face). Doing so will cause the roller bearings and cages to fall out behind the face plate. This condition cannot be repaired in the field and the entire spindle/head casting assembly will have to be replaced.

1. Install the spindle cap and test runout by indicating the cap face and the side of the taper as shown. Taper runout should not exceed .0005" TIR, and face runout should not exceed .001" TIR.





2. Install the spindle cap using 12 3/4-10x4" SHCS, roughly aligning the cap and leaving the screws hand tight.
3. Indicate the face and taper as in step 1, making adjustments with a rubber mallet.
4. Tighten the screws in a cross pattern in 25-ft-lb. increments, indicating the face and taper after each tightening. At 100 ft-lbs. check alignment once more.
5. Clean the seal ring with alcohol and compressed air, and check the ring for debris or damage. Sand smooth any minor dings or rough finish, then clean the ring again.
6. Install the O-ring into the seal ring using lithium grease. Carefully install the seal ring into position around the spindle cap, with the oil drain hole facing down.
7. Turn the seal ring screws until they are snug, then back away 1/4 turn. Use a piece of .002" shim stock to test clearance between the ID of the seal ring and the OD of the spindle cap (see illustration), around the entire inner circumference of the seal ring. If the shim binds in places, gently tap the ring to allow the shim to clear.



8. When the shim indicates proper clearance around the entire circumference of the seal ring, tighten all seal ring screws to 20 ft-lbs. and check clearance again. Torque the screws to 30 ft-lbs. and verify clearance once more.

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#### TL-SERIES SUB SPINDLE

#### SPINDLE MOTOR REPLACEMENT

1. Remove the sheet metal covering the sub spindle motor and the union.
2. Cut all plastic ties to the motor wiring. Disconnect the wiring from the motor.
3. **Remove the encoder:** Loosen the set screw that holds the encoder to the motor shaft. Remove the screw that holds the encoder bracket to the motor.
4. Remove the four (4) bolts that mount the motor to the spindle head.

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**CAUTION!** You may need to use a hoist to lift the sub spindle motor as it weights approx. 90 lbs.

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5. Install the replacement motor in reverse steps for removal. Make sure the wiring is fed beneath the belt.

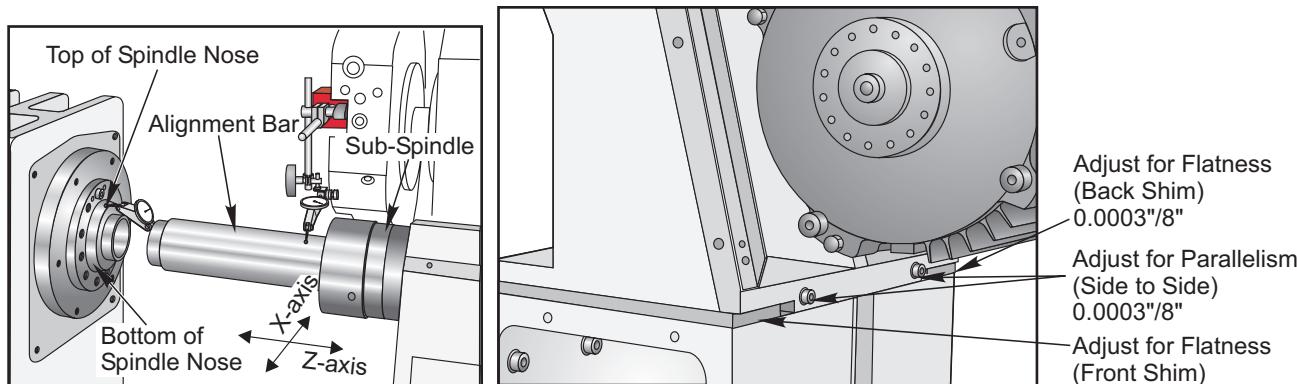


## Sub Spindle Head Alignment

1. Insure that the main spindle is aligned. Follow alignment procedures for Lathe Spindle Assembly.
2. Mount the spindle alignment bar (T-2113) to sub spindle face. Before installing the test bar, insure that both mating surfaces are cleaned thoroughly.
3. Mount a magnetic base and a .0001" indicator on the turret face. Rest the indicator tip on the top surface nearest the sub-spindle face and manually rotate the sub-spindle. Tap on the alignment bar flange and indicate it to zero runout. Jog the indicator in the Z-axis direction to the end of the alignment bar and set the indicator to read zero. Rotate the sub spindle to check runout. runout should not exceed .0002. If the runout exceeds .0002, then use different tension on the test bar mount bolts to adjust.

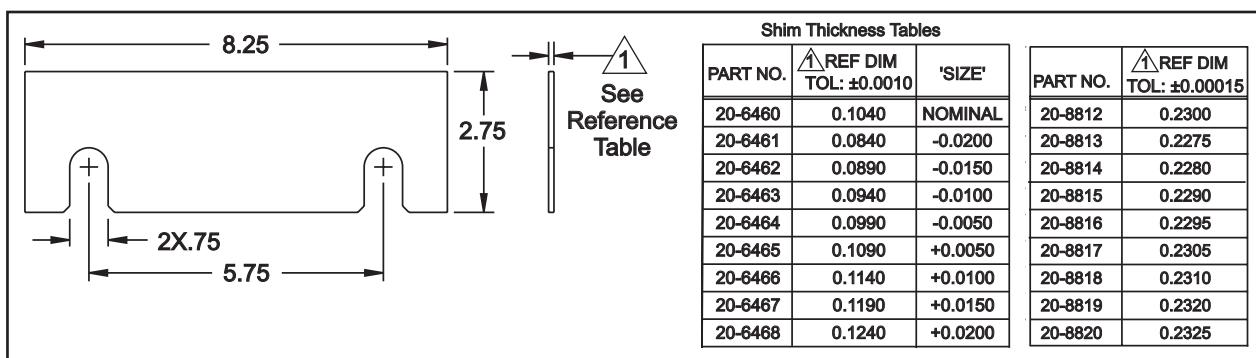
**NOTE:** Test bar should be indicated to .0 runout before checking alignment of sub-spindle

4. Rest indicator tip on the top surface. Using the "Z" axis jog the indicator tip over eight inches of the test bar to check spindle flatness, max tolerance is .0003"/8".



Shim Stock Location

5. If the sub-spindle is out of tolerance then shimming is necessary. See the following figure for shim stock information and the previous figure for the location of where the shim stock will be inserted.



Shim Stock Information

**Repeat steps 4 and 5 until the flatness is within specifications.**

6. With the indicator on the nose of the test bar, place the indicator tip on the top of the beveled lip of the main spindle and set it to zero.
7. Rotate the bar 360° and check the concentricity of the sub spindle to the main spindle. The tolerance is .002" TIR.



8. If the height is out of tolerance you need to change the front and back sub-spindles shims by the amount of correction necessary, and still maintain flatness.
  9. Repeat steps 5 - 9 until the **Flatness** and Top to Bottom **Centerline** tolerance are within specifications.
  10. Rest the indicator tip that is riding on the top of the test bar to run along the side of the test bar. Use the Z-axis to jog the indicator tip over eight inches of the test bar to check the sub-spindle parallelism, max tolerance is .0003"/8".
  11. If the sub-spindle is out of tolerance adjust the parallelism adjusting screws to bring it in.
- Repeat steps 10 and 11 until parallelism is within specifications.**
12. With the indicator on the nose of the test bar place the indicator tip on the side (90° position) of the beveled lip of the main spindle and zero.
  13. Rotate the bar 360° and check the concentricity of the sub to main spindle. The tolerance is .002" TIR.

## GEARBOX, TRANSMISSION, AND SPINDLE MOTOR

### 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".



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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.

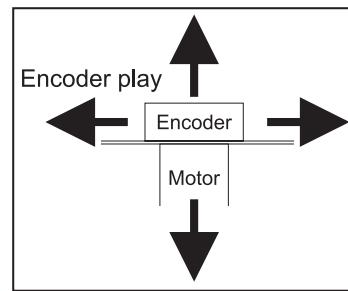
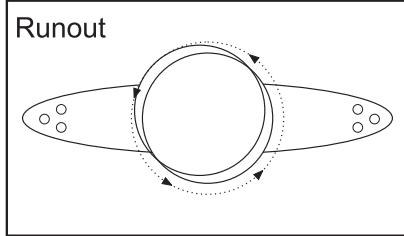
High gear and low gear are selected by programming an M41 (Low Gear) or M42 (High Gear). **The transmission will not change automatically.** The spindle will come to a complete stop when changing gears.



## TROUBLESHOOTING

**Noise** - There are many things that can result in excessive or unusual noise coming from the gearbox, transmission, and/or spindle motor. Most noise issues do not require that a gearbox/transmission assembly be replaced. The following must be investigated before a complete gearbox or transmission replacement is considered:

- Check for low transmission/gearbox oil supply. Insufficient oil supply will cause excessive transmission/gearbox noise. Be aware that transmission oil can be low and not generate a machine alarm. **Always verify oil level by using the sight glass located on the gearbox/transmission assembly.** Double check that correct oil is being used and that oil is not contaminated.
- Verify the correct spindle motor, spindle and motor encoders, and gearbox parameters for the machine. Use the most current 'parameter checker' program located at the Haas website.
- Check for proper drive belt tensioning. Adjust drive belt tension as noted in "Belt Replacement and Tensioning" section of the Mill/Lathe Mechanical Components Service Manual.
- Lathe belts may need replacing. Lathe belts are a matched set and should be replaced as a set, not individually. The belts (V-belts and toothed belts) must face the same direction; use the belt label as a reference. Toothed belts must have all the labels in a line.
- Check for a damaged or worn-out encoder pulley. Damage or excessive wear gives the same result as a loose belt.
- Check for proper operation of the spindle encoder. Insure that encoder belt is in good condition and that it is correctly tensioned. Encoder belt tension is critical; do not create an excessive amount of tension. The maximum radial load (side load) for the encoder is 13.5 lbs (60N). **Excessive belt load will result in premature encoder failure. Low belt tension will result in excessive transmission/gearbox noise.** Some machines are equipped with an automatic belt-tensioning bracket. Allow the bracket springs to properly tension the belt and tighten the screw.
- **"Hubbed"** style encoders - Check for run-out or play within the encoder and between the encoder and motor shaft ("hubbed" style encoders mount directly to the gearbox or spindle motor). See the illustrations. Excessive encoder play and/or run-out can cause noise.



- If all mechanical checks are acceptable, parameter 177 (Sp P Gain) may be lowered in steps of 500 while not going below 2000. This adjustment can reduce or eliminate some noises. Note that by reducing the value of this parameter, a lower spindle response is normal and will not affect the cut or finish of the material.
- Poor electrical connection. A bad connection at the Wye/Delta contactor can cause transmission noise. Check the contactor construction for improper assembly; it may need replacing. Check the termination of the cables at the contactor. Check the termination of the cables at the motor and at the vector drive.
- Run **VIBRATION ANALYZER** plots. Specific instructions for generating vibration plots as well as information for interpolating vibration plots are available in the Service section of the Haas website ([www.Haascnc.com](http://www.Haascnc.com)). Allow the vibration analyzer to help determine if the noise in question is problematic.



## 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 the 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.

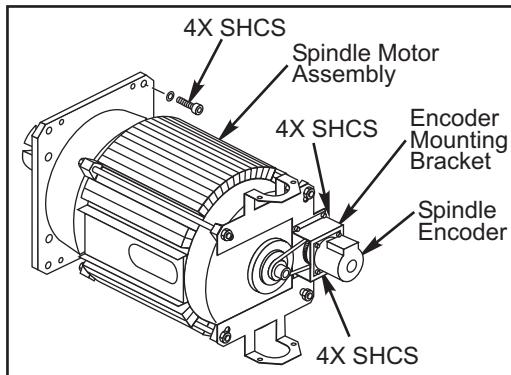
### Motor Removal

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).

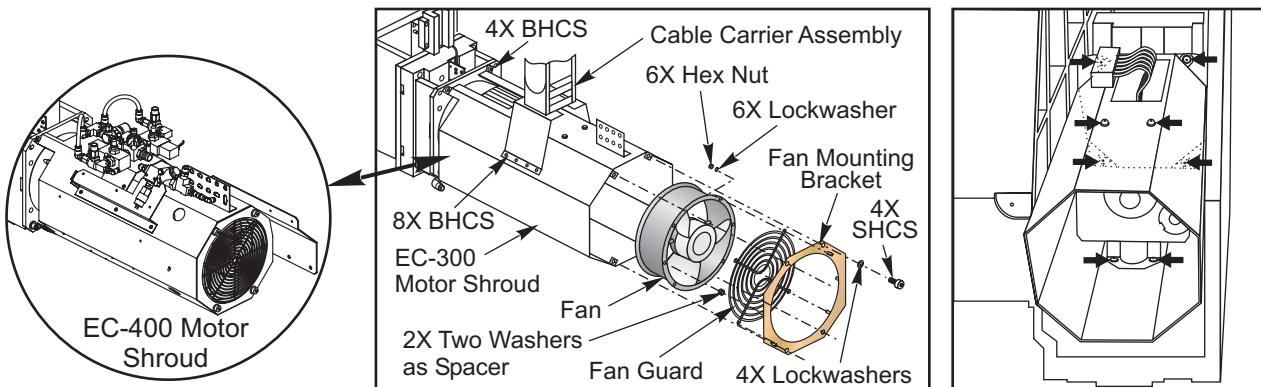


b. **Horiz:** Disconnect the electrical cable to the fan.

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 air supply and remove 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.

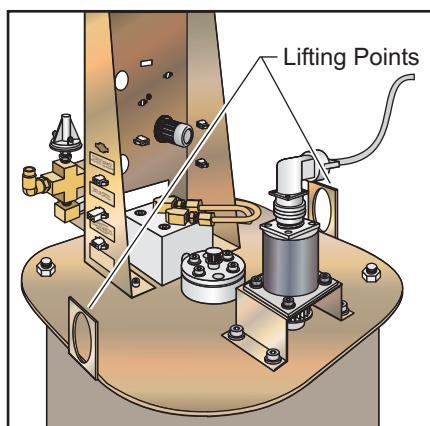


**EC-400:** Remove the motor shroud, which is held on with four (4) BHCS. Disconnect the encoder cable, spindle air blast, and TSC coolant union, if equipped.



**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)**

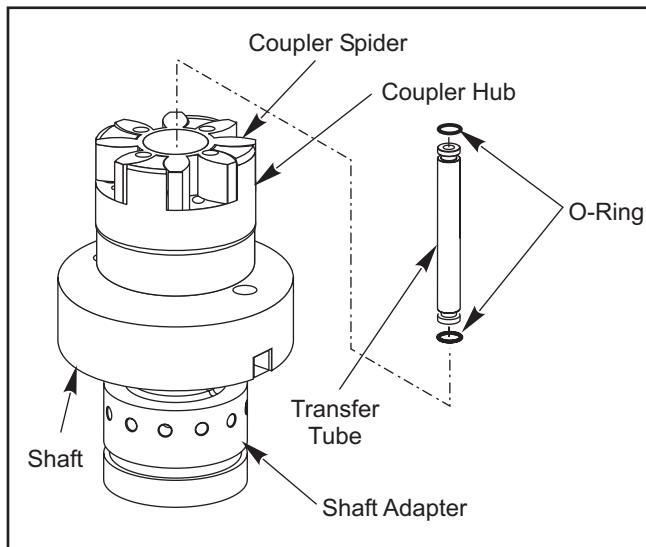
1. Sweep the spindle before the motor installation is started.
2. Check the condition of the coupler hub on top of the spindle, and the condition of the coupler spider. Lift the motor up and position it just above the TRP using a forklift or hoist. Check the condition of the coupler hub on the motor, 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.

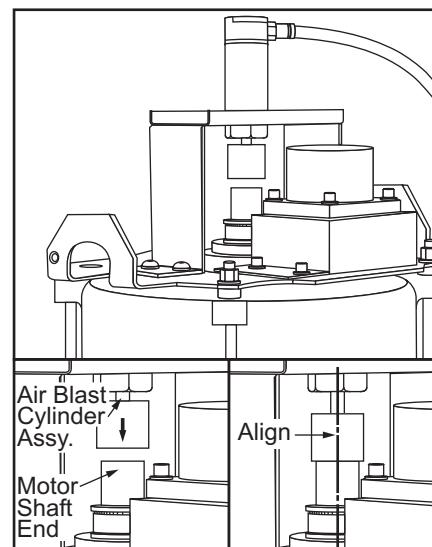
3. Lower/bring the motor toward the TRP. The couplers should engage with very little interference. It may be necessary to rotate/move the spindle back and forth slightly to line up the coupler hubs or rock the motor housing to square the assemblies. Do this by hand on the spindle dogs, at the spindle nose.
4. Once the coupler hubs are mated, insert the bolts that hold the motor to the spacer blocks; leave them loose. Join all 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 and HS 3-7 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.

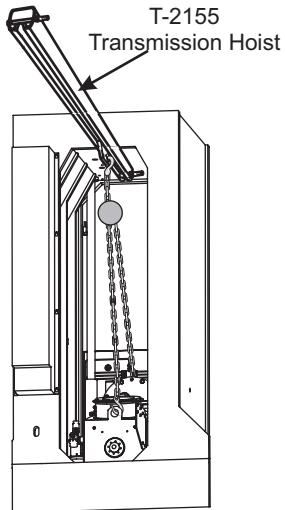
7. Remove the three cables from the Encoder Assembly.
8. Remove the Encoder Assembly (take the belt off first by loosening the encoder screws).



---

**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 of the transmission assembly. A rear lifting eye is there as part of the assembly, but the fan must be removed and set 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 of the transmission assembly. A rear lifting eye is there as part of the assembly, but the fan must be removed and set 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 spindle to seat the belt into the notches on the transmission gear, and ensure 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.

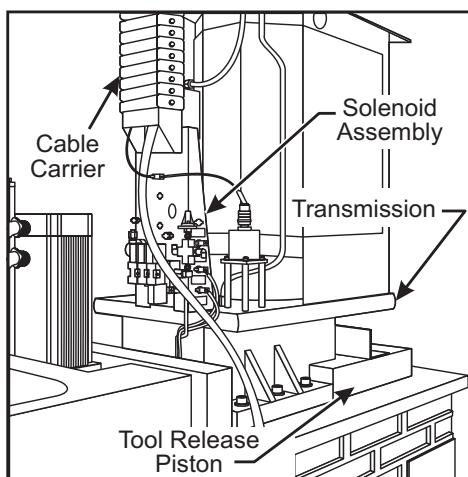
7. Remove the tool release piston assembly ("Tool Release Piston Assembly" section).

**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.



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**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.

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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.

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

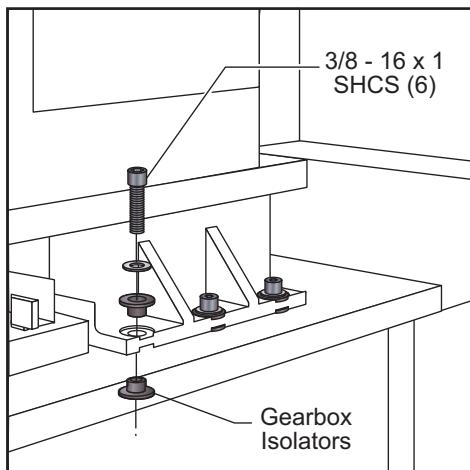
**50 taper:** Connect the power wires and attach the electrical plug panel to the rear of the motor. Reattach any Molex plugs to the panel, if removed during the previous procedure.

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 timing 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 the appropriate oil. See the Maintenance section of the operator's manual.

**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

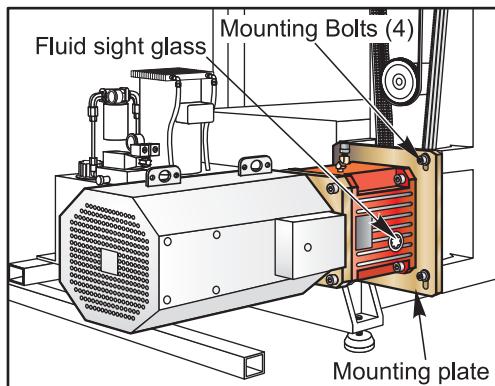
1. Power off the machine.
2. Remove the left side panel to access the spindle motor and transmission assembly.

**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.

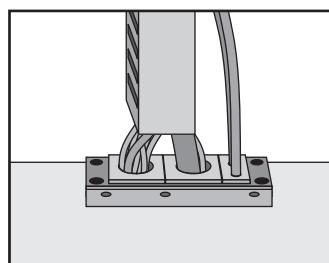
3. Insert the four bolts that secure the transmission mounting plate to the spindle head.



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.



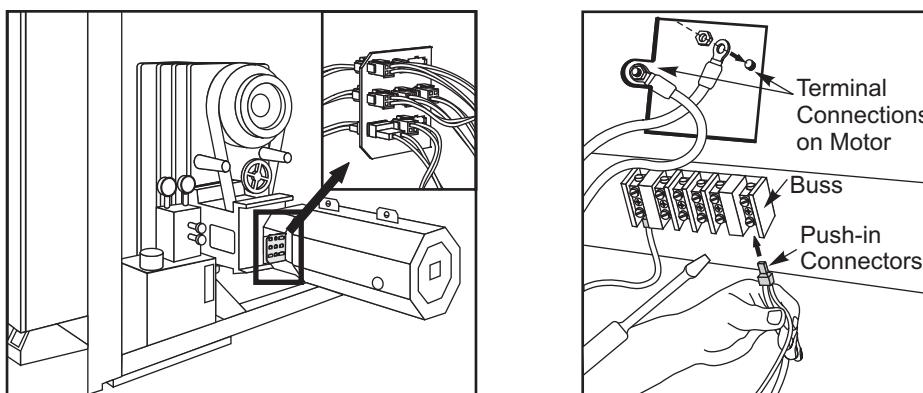
*Bottom-Exit Control Cabinet*

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 be 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.

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**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.

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

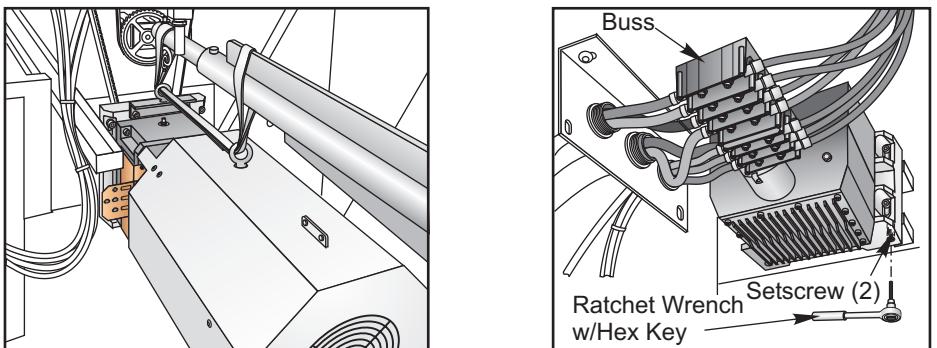
4. Use lifting eyes to support the motor/transmission assembly. There is a provision for a lifting eye close to the center of the motor cover and another at the pulley end. Use a lifting strap between the two lifting eyes and secure the strap to the lifting equipment.
5. Support the motor/transmission 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 oil as needed. **Use only the type of oil already used in the transmission; do not mix oil types.**

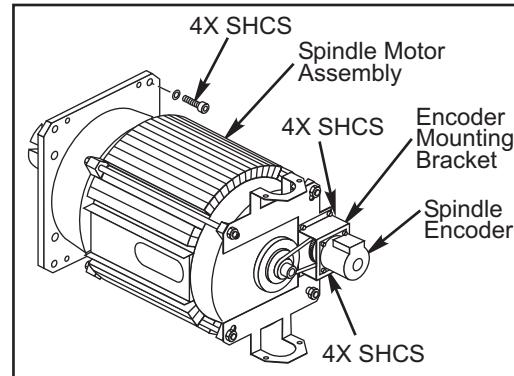
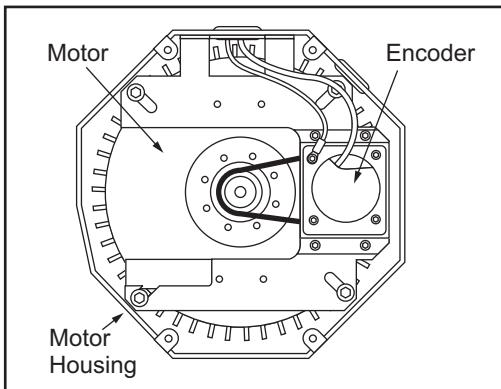
#### SPINDLE MOTOR ENCODER REPLACEMENT

#### OPTICAL ENCODER

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

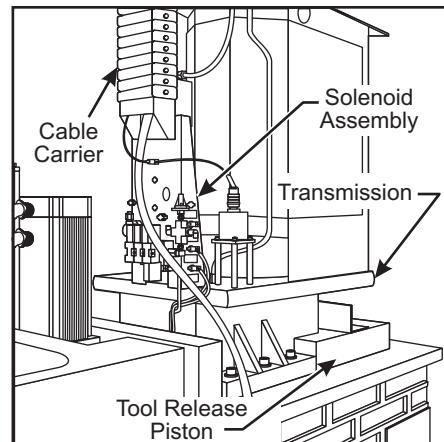
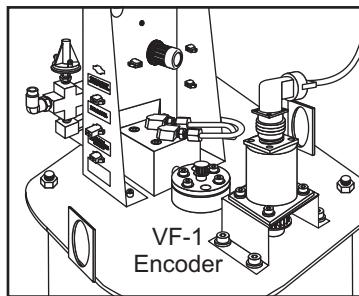
#### Removal

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)*

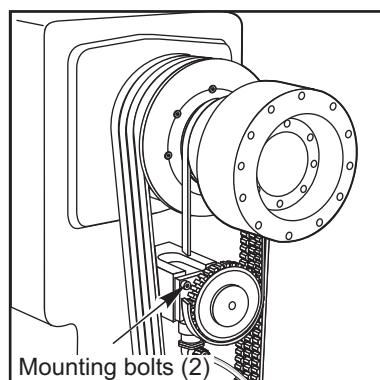
*Encoder Installation for Direct Drive Machines*

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 thread locking compound, 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.

### MAGNETIC ENCODER

Spindle Motor magnetic encoder replacement requires mechanical and electrical installation at the spindle encoder. An encoder failure may cause alarms in any of the following areas:

Spindle Orientation

Motor Z Faults

Z Channel Missing

Spindle not Turning

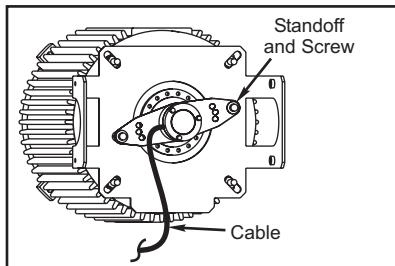
Cable Faults

Phasing Errors

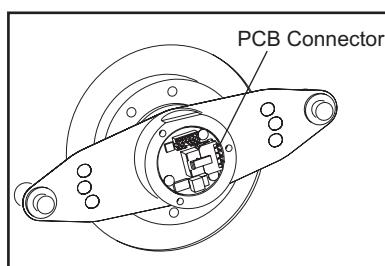
Transition Faults

### Replacement Kit

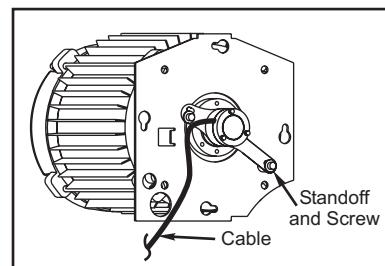
Note: There is a small amount of Three Set Screw Encoders in the field. If one of these needs replacing, do so using kit number 30-30330.



SL-20 Motor Magnetic Encoder



Encoder PCB



TM-1 Motor Magnetic Encoder

### Removal of Hub encoder

1. Remove the three screws on the lid of the encoder and remove the cable from the encoder PCB connector as shown in the Encoder PCB illustration.

2. Loosen the clamp on the collar. Note, if the screw(s) are loose/missing or if the encoder is slipping on the shaft, the encoder will not function properly.

3. Remove the screw(s) and standoff(s) holding the wing(s) in place and remove encoder from shaft.

### Installation of Hub encoder

1. Place replacement encoder onto motor shaft and press down until encoder bottoms out on the shaft.

2. Apply thread locking compound to the standoff screw(s) and secure the wing(s) with the standoff(s) and screw(s).

3. Connect the cable to the encoder PCB connector.

4. Replace encoder lid, ensuring the cable is routed through the groove in the side. Tighten the three screws.

**Replacement of a shafted encoder is the same as an optical encoder replacement. The removal of the encoder lid is still necessary to access and disconnect the encoder cable.**



**Replacement of a shafted encoder is the same as an optical encoder replacement. The removal of the encoder lid is still necessary to access and disconnect the encoder cable.**

When replacing an optical encoder with a magnetic encoder, refer to Haas document ES-0650. This document covers the replacement of an optical encoder with a shafted, magnetic encode. In most cases, it is NOT recommended to replace an optical encoder with a hub encoder; use a shafted, magnetic encoder.

### **HS 3-7 mills**

The spindle encoder is on the back of the spindle. To access the encoder the tool release piston (TRP) must be removed. See the TRP section for instructions.

Once the TRP is removed, remove the encoder mounting bolts and replace the encoder. Reinstall the TRP as described in its section.

#### **Encoder belt**

The transmission must be moved to replace the encoder belt. Remove the TRP as described in the TRP section. Replace each transmission mounting bolt with a longer one. This will allow the transmission to slide toward the back of the machine; it is not necessary to completely remove it. Once the transmission is slid back, a new belt can be installed. Properly tension the encoder belt. Slide the transmission toward the spindle and replace each of the long bolts with the original mounting bolt.

## **COOLANT SYSTEM OPERATION**

### **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.

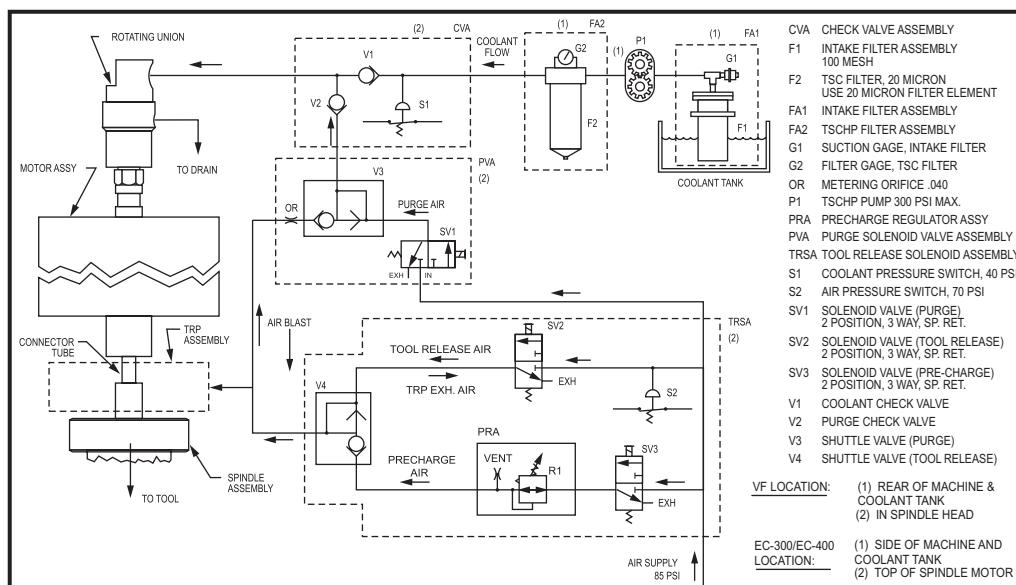
The coolant pump is electric and can be turned on and off both by the operator at the front panel and under program control. There are codes that the CNC programmer puts into the CNC program to turn on and to turn off the coolant. The machine can be operated normally without this coolant.

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.

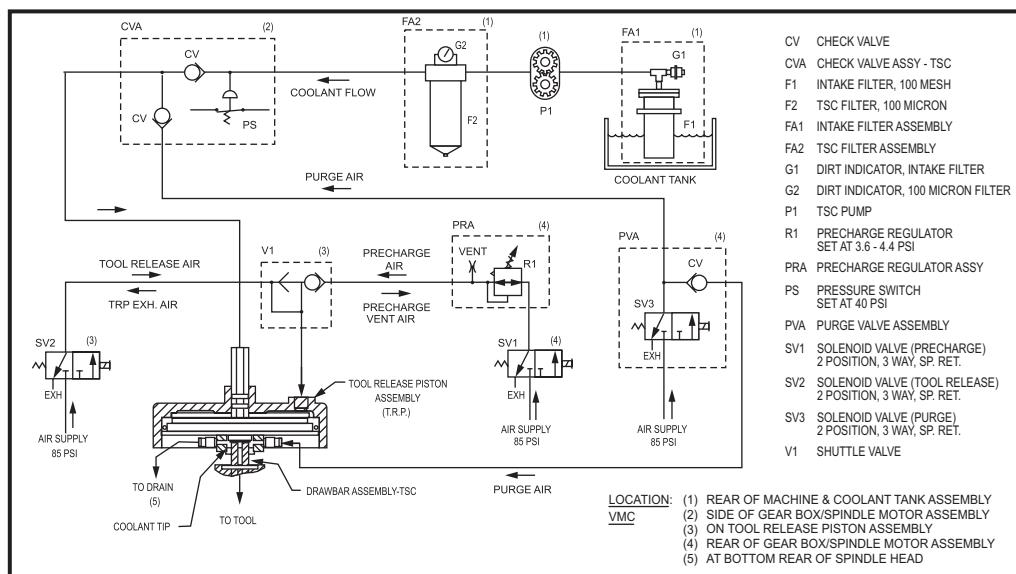
There is an optional "thru-the-spindle-coolant" system that can be installed on most machines. It consists of a second pump that can also be turned on from the CNC program and supply lines that bring the coolant down the center of the spindle or thru the tool. It provides no cooling functions to the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



## In-Line Drive (TSC)

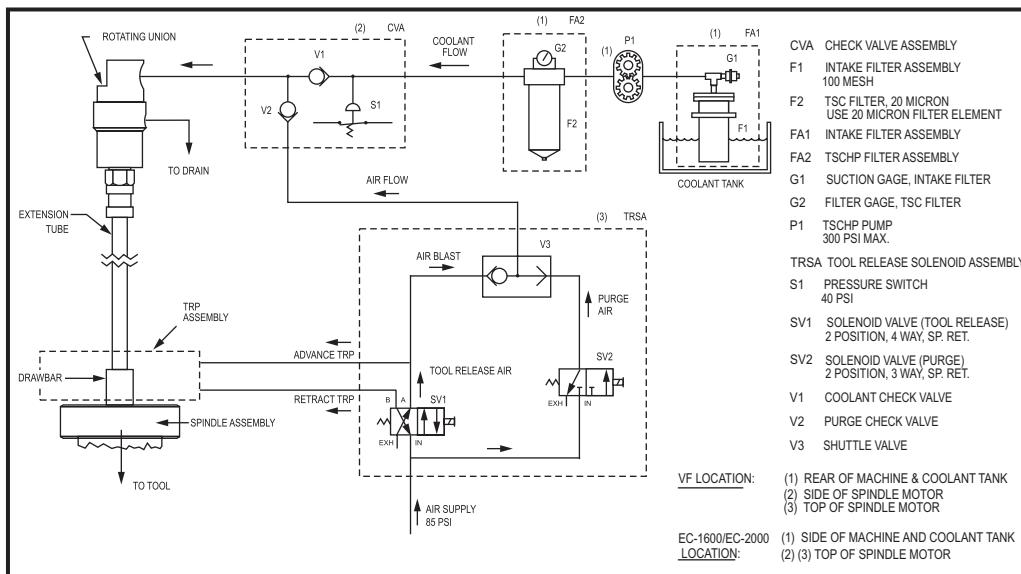


## 40 Taper (TSC)





## 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 coolant drain and purge lines connected to seal housing are intact. Replace 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 breaker has not tripped and pump is turning. Check cable continuity.
- 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:** Applies to the TSC system only. It 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 ( $\pm 0.4$  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.

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

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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.

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**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.

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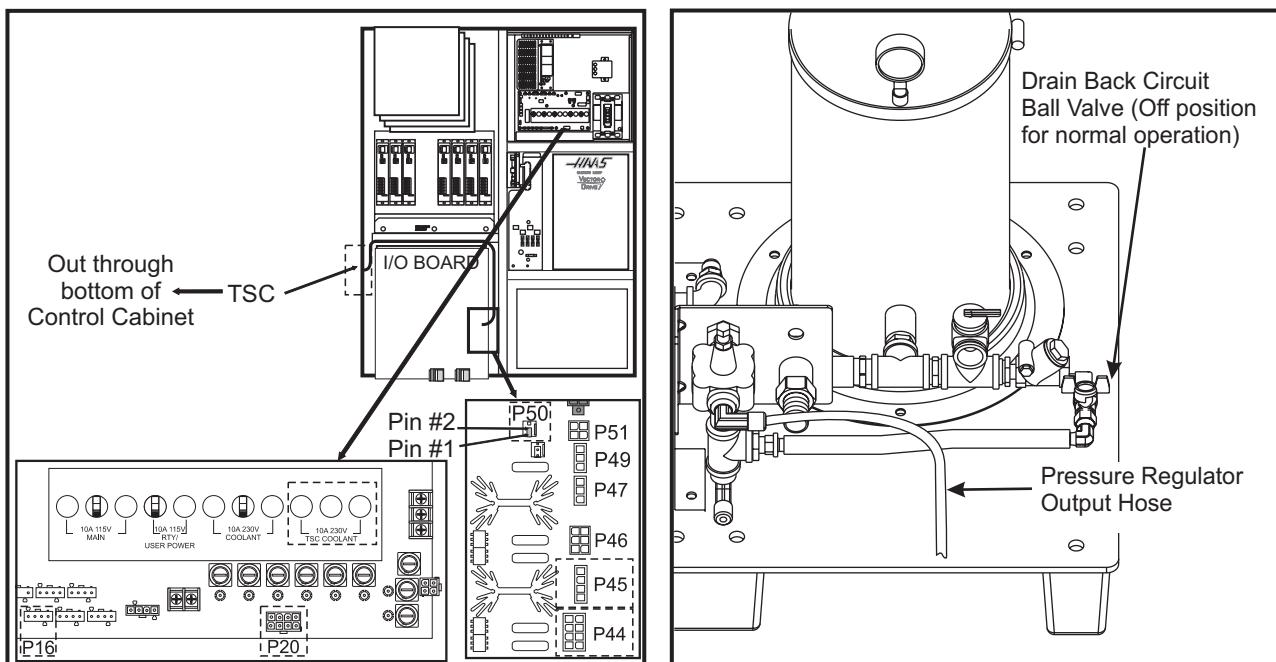
**NOTE:** This will cause coolant leakage under pressure. Wrap a rag around the fitting before loosening.



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.

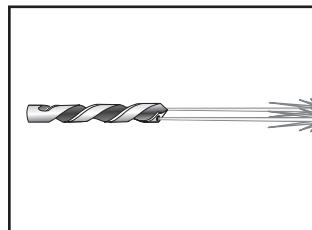
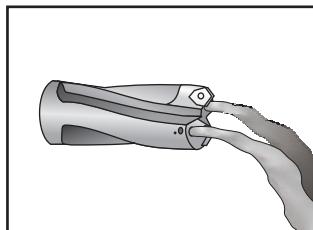


*TSC 1000 Control / Electrical Connections*

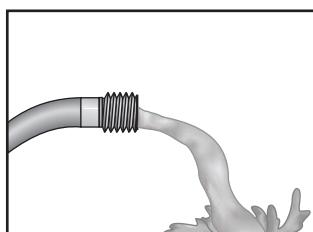


## TSC Pressure Effects

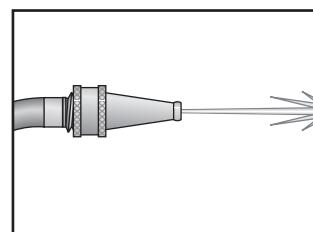
On machines using TSC during cutting operations, tooling size will have to be taken into consideration. As shown below, proper TSC system operation will deliver different pressures at the orifice of the tool; this depends on the diameter and number of coolant passages in the tool.



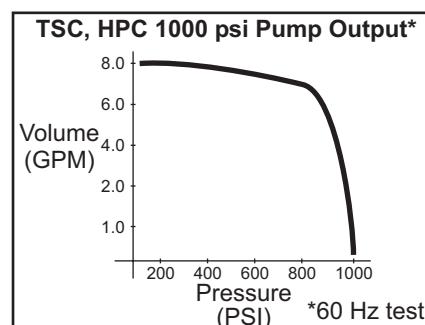
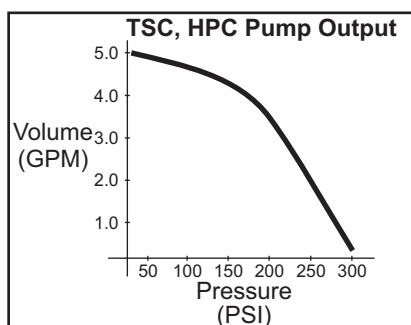
Larger tooling has larger diameter coolant passages. Smaller tooling has smaller diameter coolant passages.



*Coolant flow is higher at lower pressures*



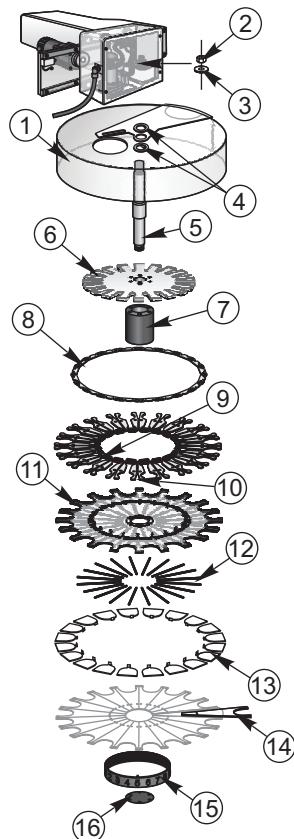
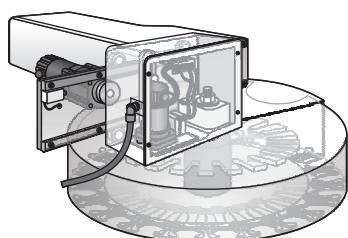
*This produces higher pressures at lower flow.*





## AUTOMATIC TOOL CHANGER (ATC)

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 1/4" 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.

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**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.

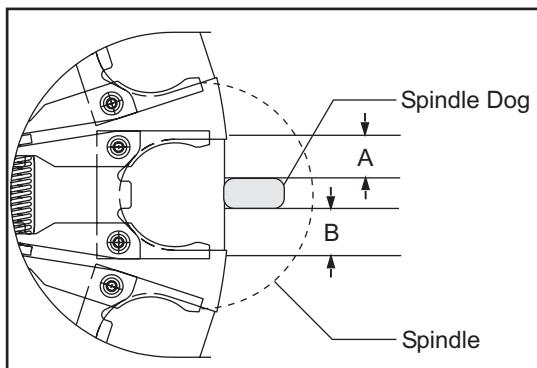
**CAUTION!** Ensure the ATC is securely supported, otherwise it may fall when an upper roller bolt is removed.

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*

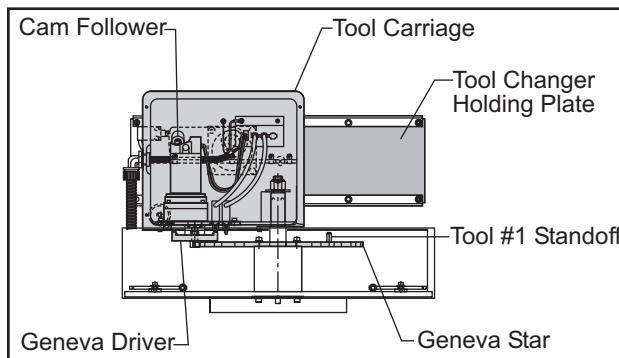
4. Move entire tool changer until the tool alignment key lines up with the spindle dog. Tighten the four HHB.

**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)*

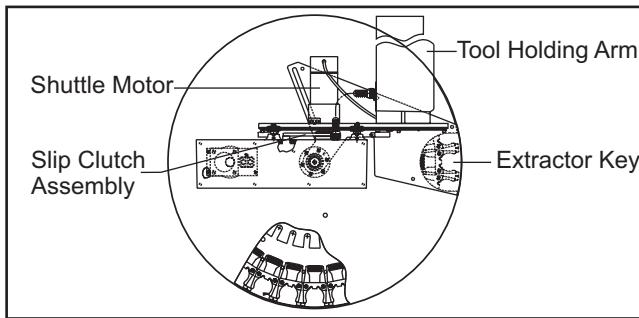
#### EXTRACTOR FORK REPLACEMENT

**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 removable thread locking compound 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**

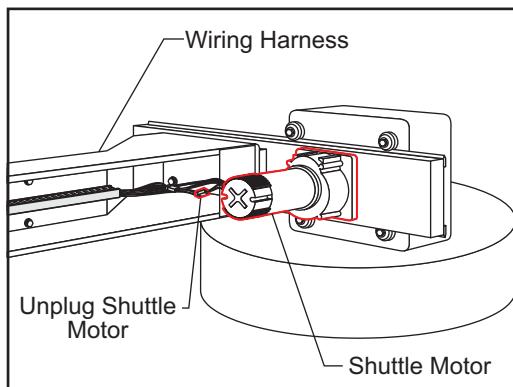
A motor moves the tool changer assembly (shuttle) towards and away from the spindle. The motor is geared to a low RPM and then connected to an arm that rotates through 180° and pushes the shuttle in and out.

#### **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.

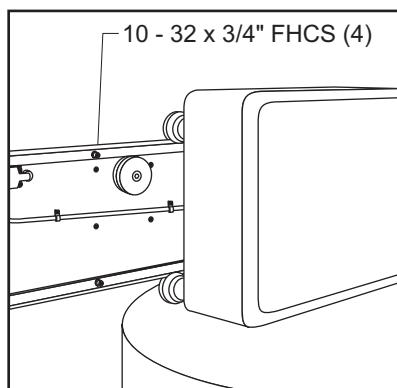


*Wiring Harness for Shuttle Motor*

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 removable thread locking compound 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 permanent thread locking compound 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 removable thread locking compound 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.

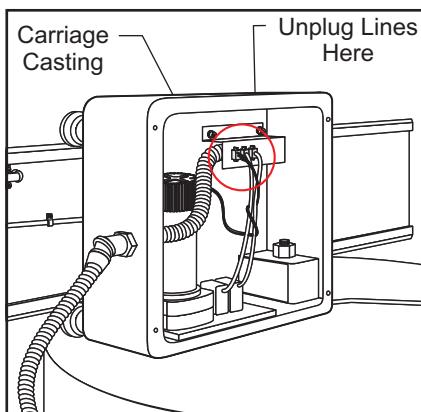


## CAROUSEL ROTATION MOTOR

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.

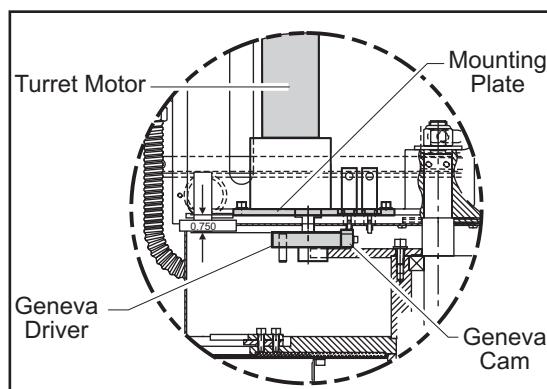
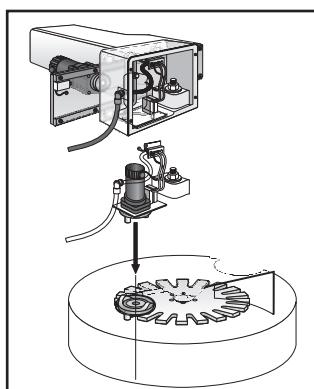


*Carriage Casting with Cover Removed*

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".

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**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

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**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.

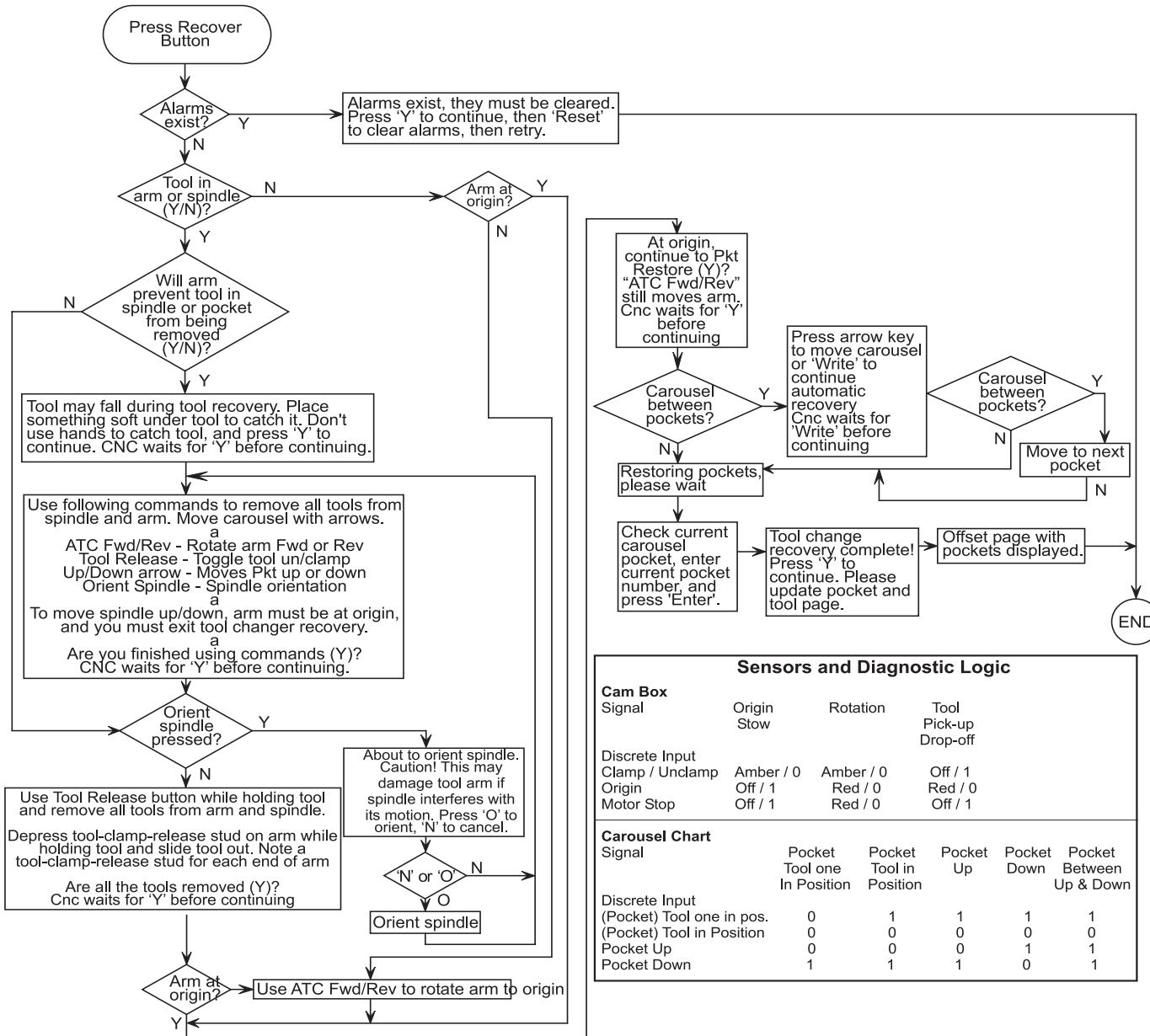


## SIDE MOUNT TOOL CHANGER (SMTC)

The tool changer is driven by a single axis control mounted inside the cabinet.

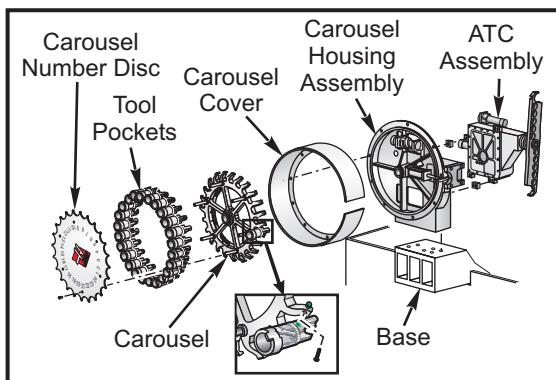
### TROUBLE SHOOTING

#### Side Mount Tool Changer Recovery Flow Chart

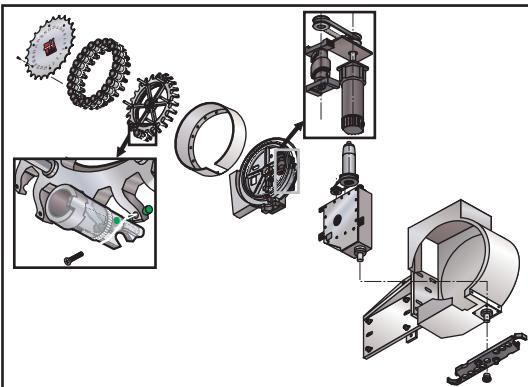




## 40 TAPER CAROUSEL REMOVAL AND INSTALLATION



SMTCH (Horiz)

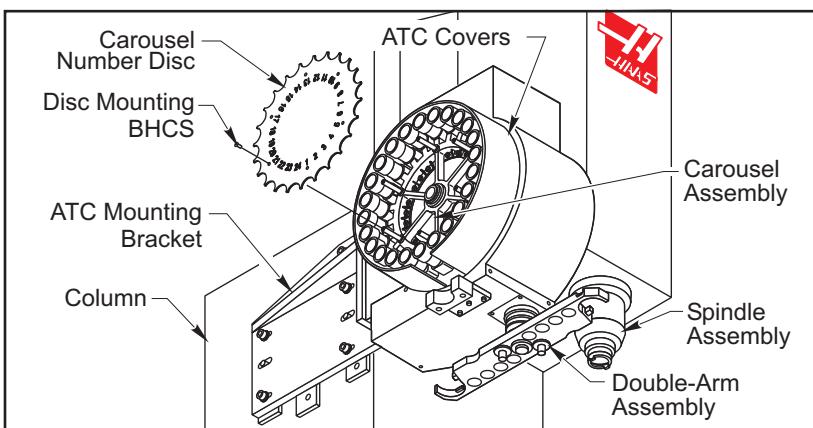


SMTCV (Vert)

**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.



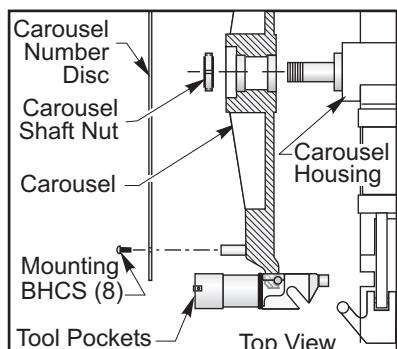
3. Using a spanner wrench, remove nut on the center shaft of the carousel.
4. Carefully pull the carousel assembly from the ATC center shaft. Lift carousel away from the machine and carefully avoid hitting the sheet metal covers. Place assembly in service area.

**CAUTION!** Be careful not to bend the tool pocket orientation tabs when storing the carousel assembly.

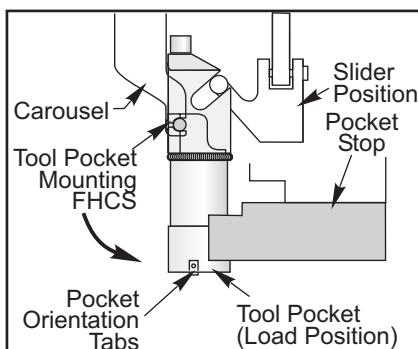
5. Unscrew the FHCS for each tool pocket. Remove the tool pocket holders from carousel as shown below.

### Installation

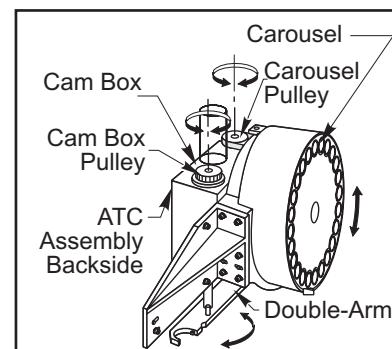
1. Carefully lift and place carousel onto the center shaft.
2. Install new carousel retaining nut onto the ATC center shaft and torque to 85 ft-lbs (place the locking portion of the nut toward the end of the shaft). Remove the pocket stop and slider.



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 removable thread locking compound 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

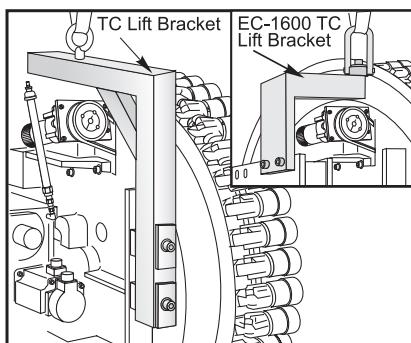
**Special Tools Required:** Lifting Device (3000lb Capacity), Lifting Bracket/Bar

### Removal

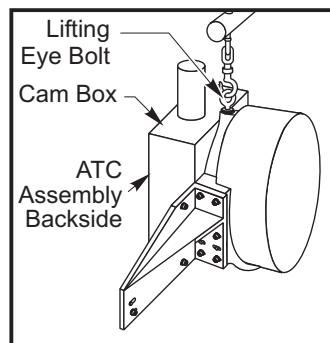
1. Power off machine.
2. Remove all ATC assembly sheet metal covers and fasteners.



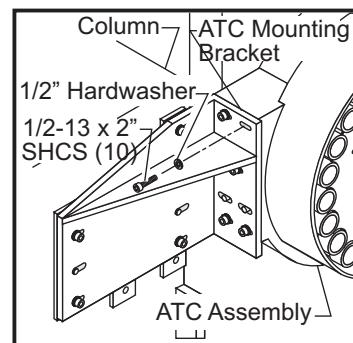
3. Remove the tool changer amphenol connection at the control box and tool pocket air line at the top of the carousel. Wrap and tie the amphenol connector to the top of the carousel cam box.
4. Insert an eyebolt into the threaded 1/2-13 hole at the top of the carousel housing. Note that 60-, 70-pocket 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.



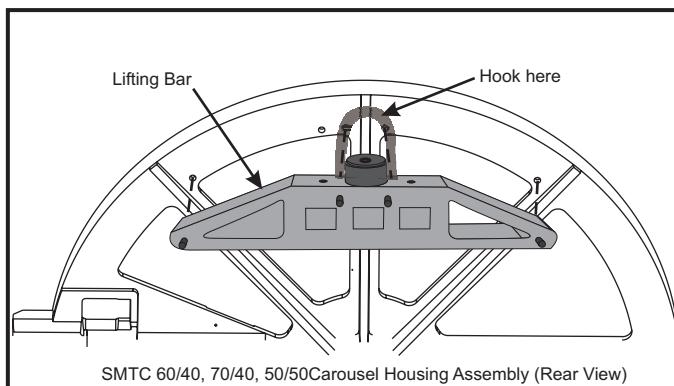
Horizontal ATC Assembly Lifting Position



Vertical ATC Assembly Lifting Position



Vertical ATC Mounting Bracket

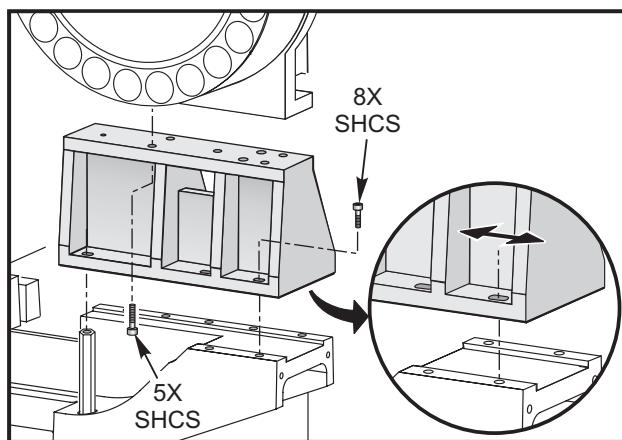


Lifting Bar Mount Location

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 removable thread locking compound 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, EC-630, EC-550, 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-400/500/550/630:** The X- and Y-axis, and the spindle orientation, are set by parameters. The Z-axis is adjusted by physically moving the SMTA.

**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 SMTA.

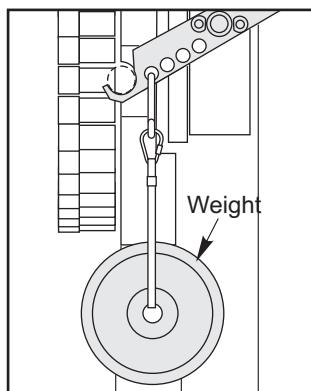
#### **Horizontal Machine Double Arm to Tool Pocket Alignment**

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.

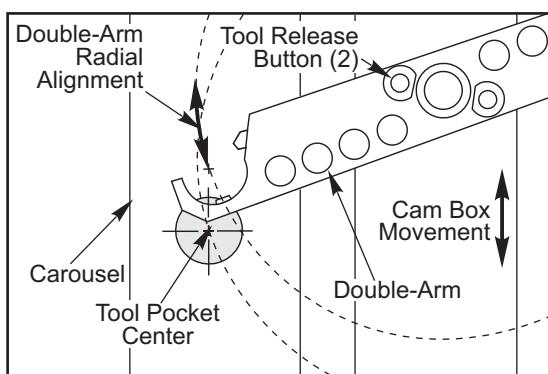


6. Install second half of the split tool into end of the double arm in front of pocket. It is necessary to manually press the tool lock plunger (near center of shaft as shown in following section) for split tool to be inserted.
7. Using T/C Recovery in the reverse direction, move the double arm back 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.

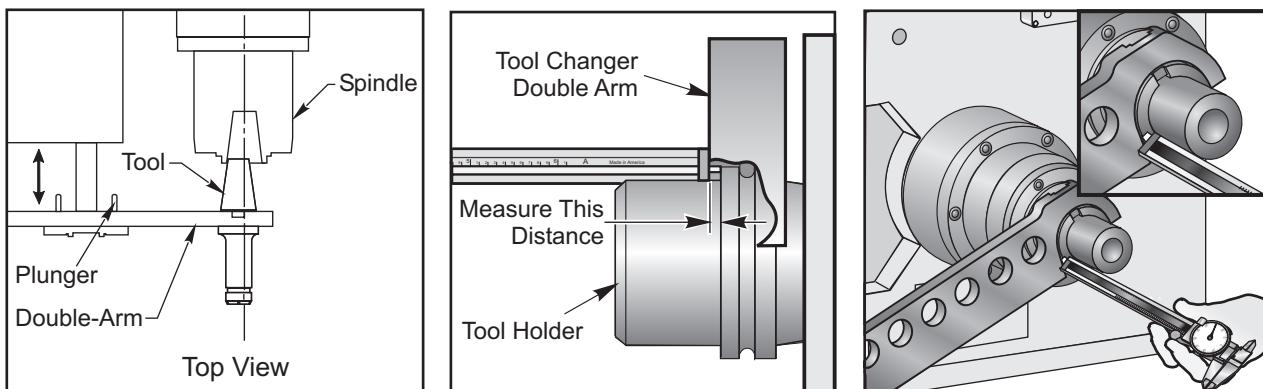


*Cam Box/Double Arm Alignment, Front View*

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*

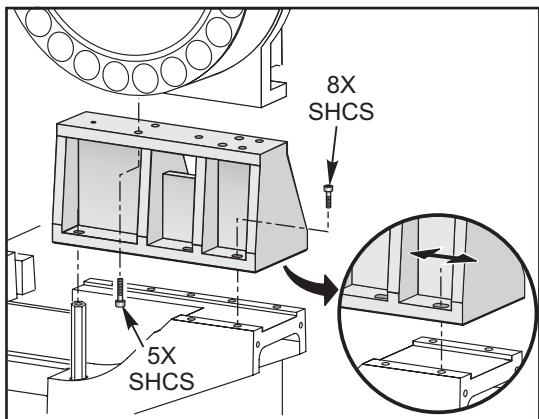
19. Measure the distance from the front of the double arm to the front face of the toolholder and record it.
20. Press the plunger to unlock the tool and remove the tool from the double arm.
21. Using Tool Change Recovery, return the double arm to the origin (Home) position.
22. Install the same toolholder, 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**

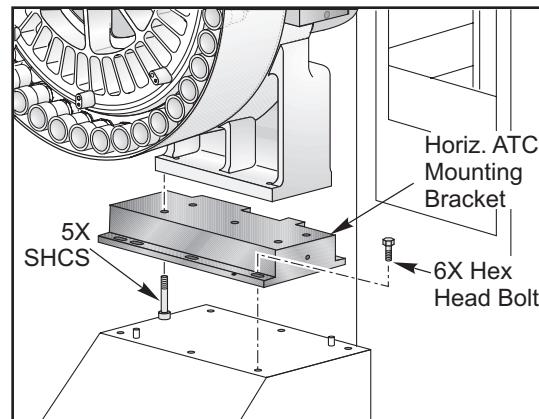
1. Double arm to carousel pocket alignment must be correct before setting double arm to spindle alignment.
2. With no tools in the machine, command a tool change. Press E-Stop before the double arm reaches the spindle. This causes the machine to move the axes into tool change position. Reset the E-Stop 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".



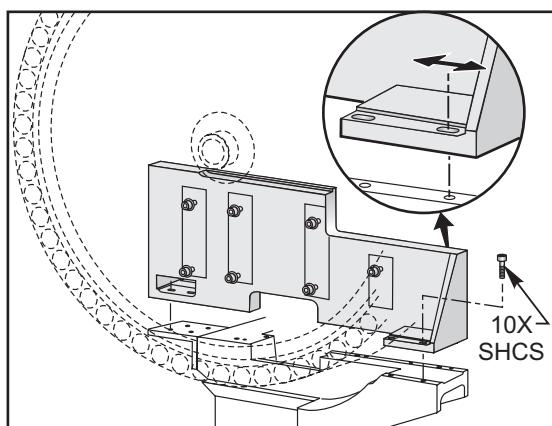
6. Continue moving the double arm in the forward direction until the arm extends approximately 4" (100mm) for the 40-taper spindle, or 6" (150mm) for the 50-taper spindle, in front of the spindle.
7. Using the dowel pin as a handle, install the tapered half of the split tool into the spindle. Be careful 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



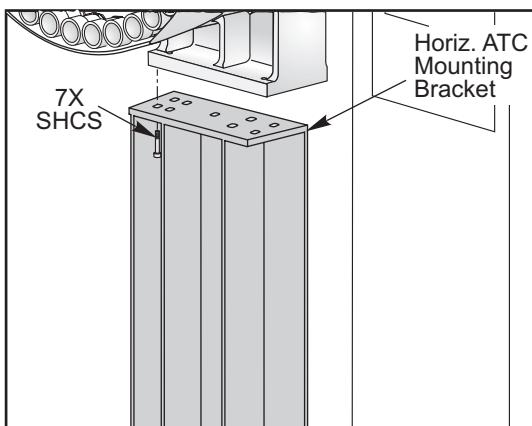
EC-400 40-Pocket Mount



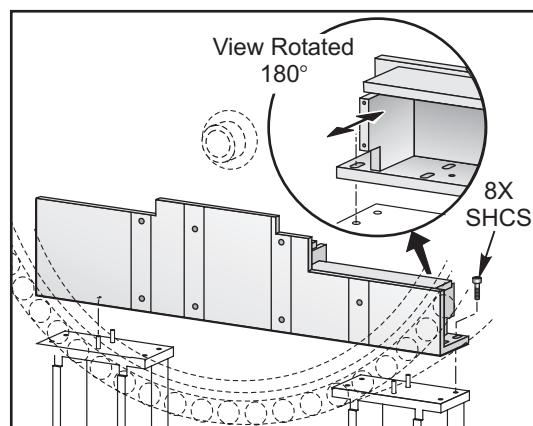
EC-400 60 and 70-Pocket Mount

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 SMTA as required, retorque the SHCS to 80 ft-lb, and recheck alignment.



EC-1600 Standard Mount

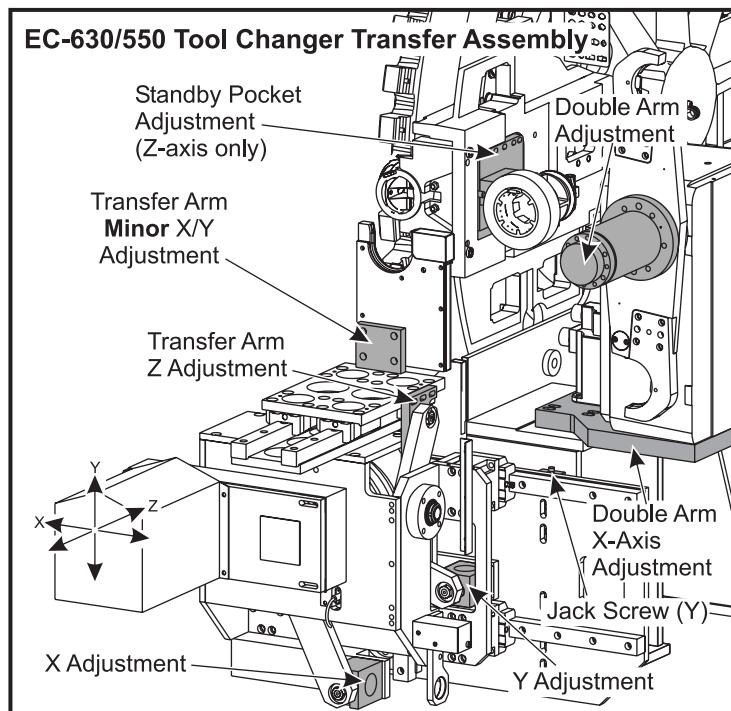


EC-1600 50-Pocket Mount



## EC-550/630 ATC ALIGNMENT

EC-550 and EC-630 tool changers utilize a transfer mechanism which delivers a tool from its carousel pocket to the standby pocket from which it is then delivered to the spindle by the double arm. All components must be correctly aligned for proper tool changer function. This procedure requires split tool P/N T-2088 for BT tooling or T-2089 for CT.



ATC transfer mechanism (EC-550/630)

### Transfer Arm to Carousel Pocket Alignment

1. Using Manual Tool Changer Restore in debug mode, move the transfer arm into position (use the PG UP and PG DOWN keys to move the arm) in front of the carousel pocket and out until it extends approximately 6" from of the carousel pocket.
2. Using the dowel pin as a handle, install the tapered half of the split tool into the carousel pocket. Be careful to not place your hands in the pinch point between the tool and the pocket.
3. Install the second half of the split tool into the transfer arm.
4. Using T/C Recovery in the reverse direction, move the transfer arm back until the halves of the split tool are approximately 1" (25 mm) apart.
5. Continue to move the arm toward the pocket. Watch the transfer 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.
6. Check the X and Y alignment of the transfer arm to the pocket by inserting the alignment dowel through both halves of the split tool. The dowel pin 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.
7. If the dowel pin does not slide freely, adjust alignment of the split tool to the transfer arm as follows:



Minor X/Y-axis adjustments are made at the base of the transfer arm (four screws). Major X/Y adjustments can be made at the block at the bottom front of the tool changer assembly (see illustration). Loosen the bolts holding the block to be moved and tap the block into its new position. When adjustment is complete, re-torque the bolts to 50 ft-lbs.

8. Make any necessary adjustments until the dowel pin slides freely, then torque mounting bolts to 35 ft-lbs. and re-check alignment.

9. Remove the split tool parts. Install a solid tool holder into the carousel pocket. Using Tool Chager Recovery, bump the transfer arm so that it picks up the tool holder. Continue to move the tool holder out until it is 2-3" out of the pocket. Reverse the transfer arm and watch the tool holder as the transfer arm moves down. If the tool holder moves in as the transfer arm moves down, then transfer arm Z alignment is not correct. Adjust Z at the transfer arm base so that the tool holder does not move when this step is repeated.

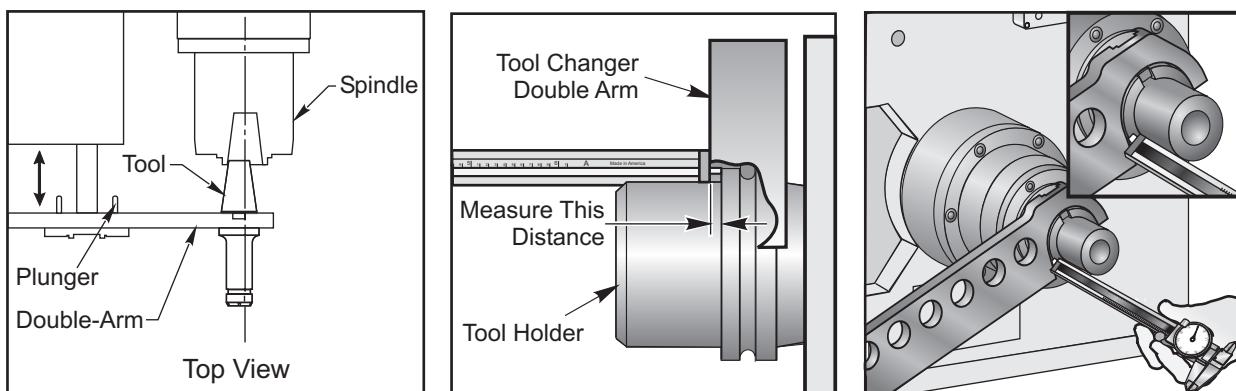
**IMPORTANT!** When returning the transfer arm to its home position, use the F1 "Home" command to do so. This will allow the tool changer software to account for any tool that may be in the standby pocket and return it to the carousel. Returning the transfer arm manually will not allow the software to account for any tools in the standby pocket and could cause a tool changer crash.

### Standby Pocket to Transfer Arm Alignment

**NOTE:** This procedure is to ensure that the transfer arm is square to the standby pocket. The distance between the carousel and standby pockets is set by the mechanism and is **not** adjustable.

1. Place the tapered half of the split tool into the standby pocket, and the other half in the transfer arm.
2. Using the Tool Changer Recovery commands in debug mode, move the transfer arm forward to the standby pocket, until the two halves of the split tool are within 1/8" (3mm) of each other.
3. Check alignment using the dowel pin, as before. Misalignment in the X and Y axes should be minimal; correct any found by loosening the transfer arm mounting bolts and moving the arm as needed. If Z-axis adjustment is required, loosen the standby pocket mounting bolts and slide the pocket as needed. Re-torque the bolts to 35 ft-lbs. when complete.

### Double Arm to Standby Pocket Alignment



*Tool to Spindle Alignment Shown. Tool to Pocket Alignment is Done the Same Way*

1. 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 6" (150 mm) in front of the pocket.
2. 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.
3. Install the second half of the split tool into the end of the double arm in front of the pocket. It will be necessary to manually press the tool lock plunger to allow the split tool to be inserted.



4. 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.
5. Hang a 40 lb. weight on the double arm to push it in the counterclockwise direction to remove backlash in the drive assembly.
6. 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.
7. Check the X alignment of the double arm to the pocket by inserting the alignment dowel through both halves of the split tool.
8. If the double arm is not aligned in the X-axis with the centerline of the split tool, loosen the four SHCS at the cam box base. Tap the base in the necessary direction until the double arm is aligned in the X-axis, then re-torque the cam box base screws to 80 ft-lbs.
9. Adjust radial alignment of the split tool to the double arm, loosen the lock ring SHCS on the double arm cap. Rotate the double arm to align it with the standby pocket, then tighten the lock ring SHCS to secure the arm.
10. Complete alignment by installing a solid tool holder in the staging pocket. Using recovery, rotate the shaft until it is in the clamp position. Rotate the arm to grasp the tool holder. Pull the tool holder out and place it back. If there is movement in the Z direction, the double arm must be adjusted in Z. Loosen the lock ring SHCS and slide the double arm on the shaft until the double arm is in the correct Z position. Make sure that radial alignment is still correct, and then tighten the lock ring screws.

### **Spindle to Double Arm Alignment**

**NOTE:** Double arm to standby pocket alignment must be correct before setting double arm to spindle alignment.

1. 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.
2. Orient the spindle; use the command in Tool Changer Recovery.
3. 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.
4. 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".
5. Continue moving the double arm in the forward direction until the arm extends approximately 6" (150mm) in front of the spindle.
6. 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.
7. 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.
8. 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.
9. Push the double arm in a counterclockwise direction to remove backlash.
10. 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.



11. 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.

12. If misalignment is present:

- 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) If Z-axis adjustment is necessary, loosen the ATC mounting SHCS, move the ATC in the Z-axis 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.

#### **Carousel Alignment (72-Pocket servo-driven carousel only)**

1. If carousel pockets are misaligned or binding in the load/unload position, align the carousel to correct the issue.

2. The carousel is operated on an invisible axis; "B" in the case of an EC-630 without a pallet pool, and "U" when a pallet pool is equipped. To correct binding and misalignment, the corresponding axis must be made visible, and the appropriate parameters must be adjusted. Refer to the table below for the proper parameters to adjust for the tool changer axis:

	Visibility	Grid Offset	Tool Change Offset
<b>B Axis</b>	151 bit 18	170	213
<b>U Axis</b>	354 bit 18	373	379

3. If starting with a new motor / encoder assembly, reset the grid offset before proceeding. Zero return the carousel axis, then record the encoder count value for the axis indicated in POS RAW DAT in debug mode. Enter this value into the appropriate parameter as indicated above.

4. Zero return the carousel axis, then jog the axis to correct any pocket misalignment or binding. Refer to the encoder count value indicated in POS RAW DAT in debug mode and enter this value into the appropriate parameter.

5. When complete, reset the carousel axis to invisible for proper tool changer function.

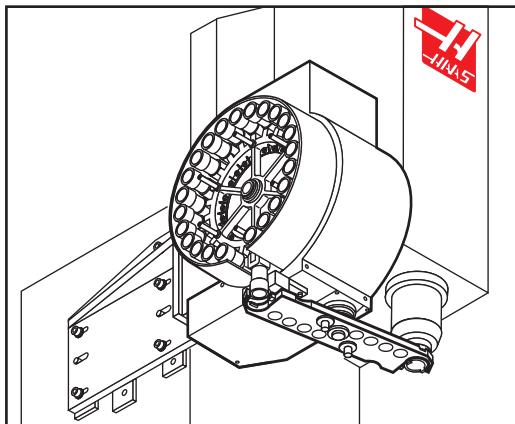


## ATC ALIGNMENT (VERT)

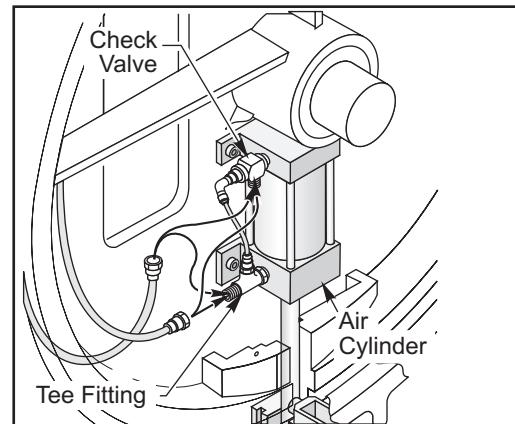
For Vertical machines, the servo tool changer, like those used on super speed machines, must have the grid offset and tool change offset set before starting the alignment procedure.

### 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).

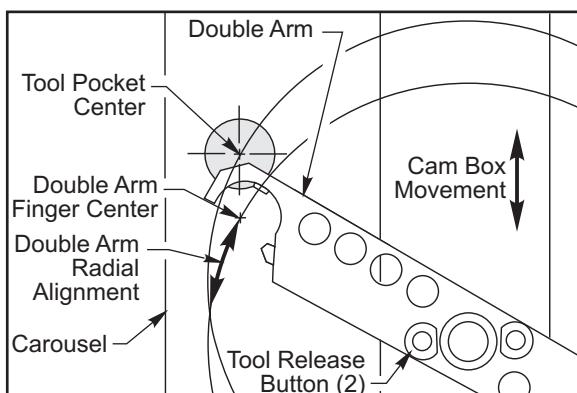


Double Arm Alignment



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°.
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**

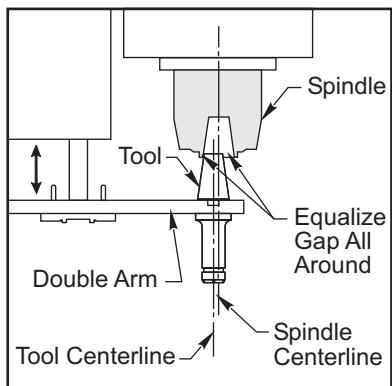
13. Rotate the cam box pulley clockwise to lower the double arm. Remove the split tool from the double arm.
14. Rotate the cam box pulley counter-clockwise to raise the double arm back to its home position.
15. Remove the air supply line from the rear of the machine. **Switch the inlet and outlet airlines 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°.
20. Remove the split tool from the double arm. Return the double arm to the home position.

### **Setting the Double Arm Height**

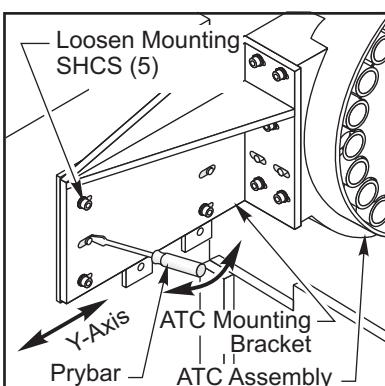
21. Press the Down Arrow to command the tool pocket down. Place the split tool **with** the pull stud into the tool pocket. In TCR mode, rotate the double arm near the tool pocket.
22. Visually check the height alignment of the double arm to the V-groove on the split tool. If necessary, loosen the lock 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**

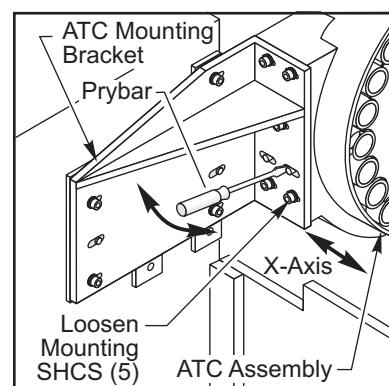
1. Zero Return the Z-axis.
2. In TCR mode, lower the double arm and re-insert the split tool into the double arm. Orient the spindle dogs for a tool change. (If the orientation has changed reset Parameter 257. Refer to section on setting spindle orientation). If spindle dogs are not aligned with the 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*



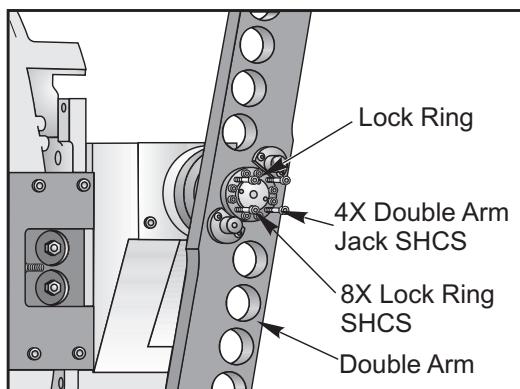
*ATC Assembly Y-Axis Alignment*

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 removable thread locking compound to the fasteners and tighten.

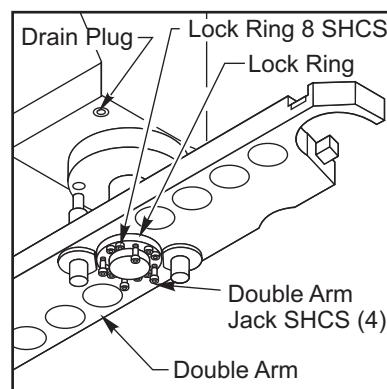
## DOUBLE ARM REPLACEMENT

### 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.



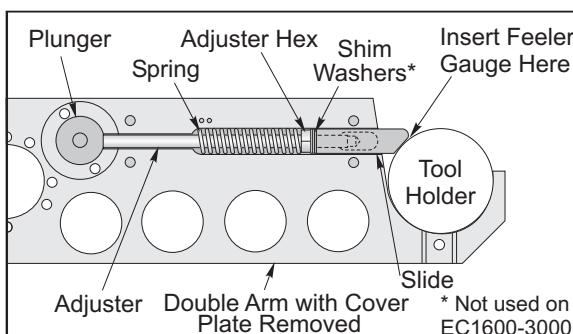
Double-Arm Removal (Horiz)



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.



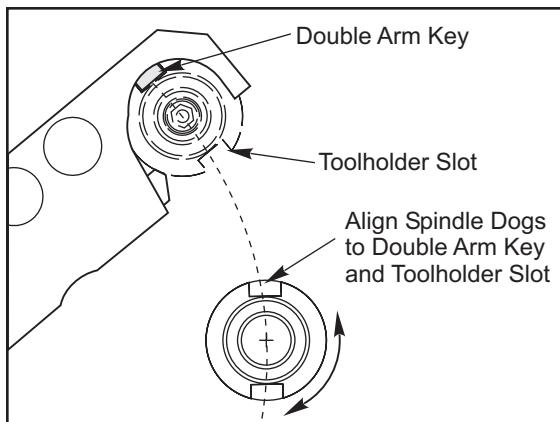
- b. The plunger will not return reliably to the fully raised locked position when the tool is inserted if there is insufficient clearance. The split tool will be excessively loose in the double arm if there is too much clearance. Either condition can cause dropped tools.
  - c. To adjust the clearance, 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 (SMTc)

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*

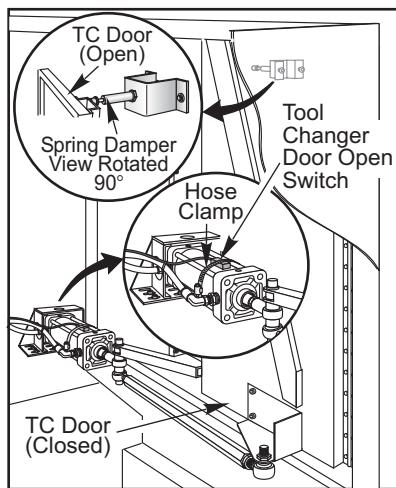
#### **SETTING SPINDLE ORIENTATION (UMBRELLA STYLE T/C)**

1. Enter debug mode. Make sure there is no tool in the spindle.
2. Change Parameter 257 to 0.
3. Press the Spindle Orient key, then press Reset.
4. Go to the POS RAW DAT page (press Posit, then select the VAR header tab, then RAW DATA) and check the value indicated at SPINDLE POS. Rotate the spindle by hand to decrement the value until you can align the spindle dogs roughly parallel to the X axis with the smallest possible positive spindle position value.
5. Set up a magnetic base and .0005" indicator on the machine table.
6. Indicate one spindle dog, then jog the X axis to indicate the other. Manually adjust the spindle until the dogs are parallel to the X axis within 0.30" TIR.
7. Return to the POS RAW DAT page and record the value indicated at SPINDLE POS. Input this value to Parameter 257.
8. Press Spindle Orient and indicate the spindle dogs once more to verify parallelism with the X axis.

#### **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.

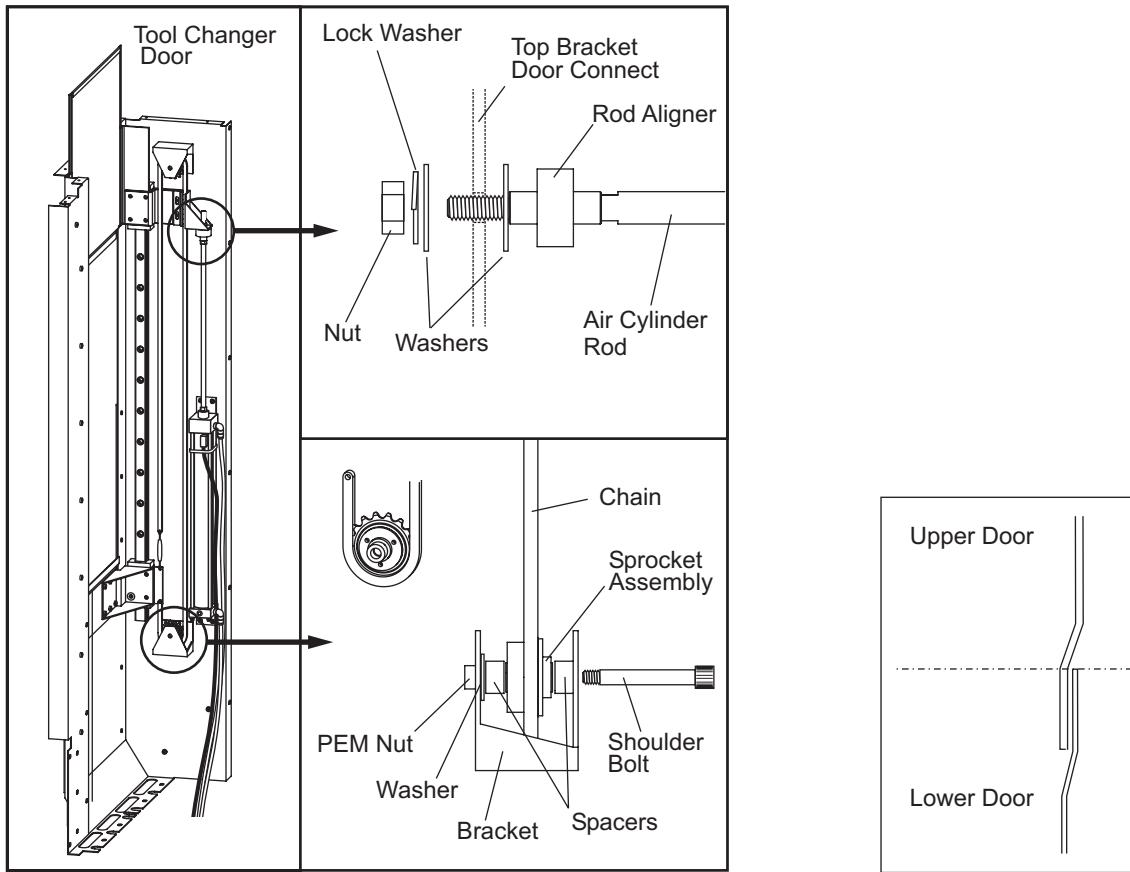
#### **EC-400 TOOL CHANGER DOOR REPLACEMENT**

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

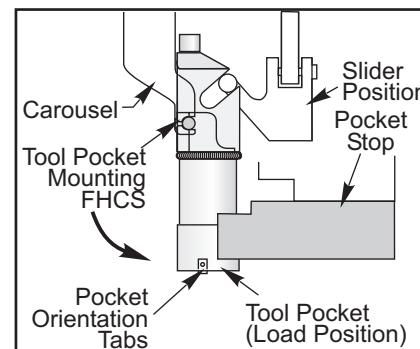
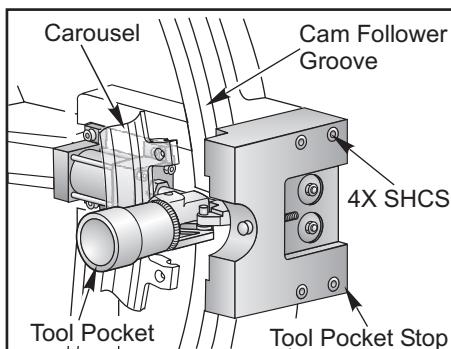
### Removal

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.

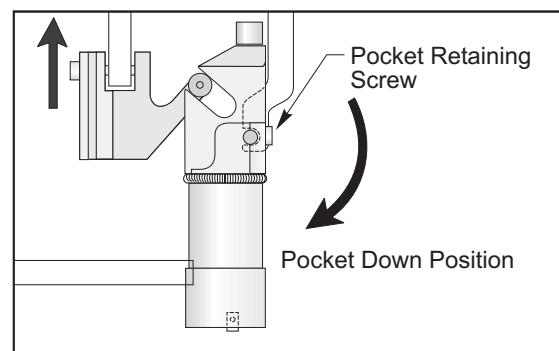
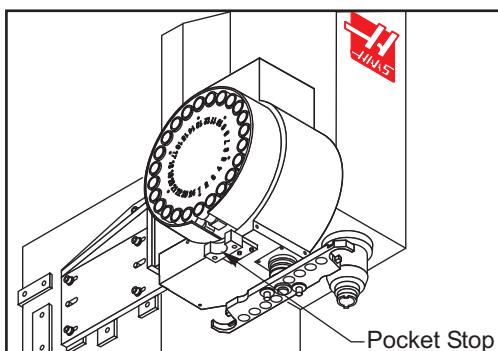
2. Press Tool Changer Restore. Press Y three times.

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*



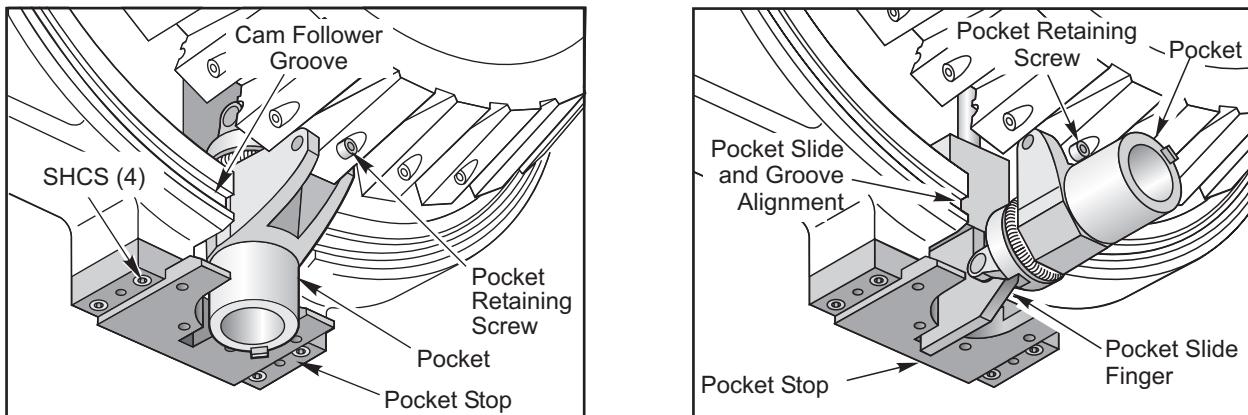
**NOTE:** The machine must be in Tool Changer Recovery Mode to perform the next step.

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 removable thread locking compound 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.

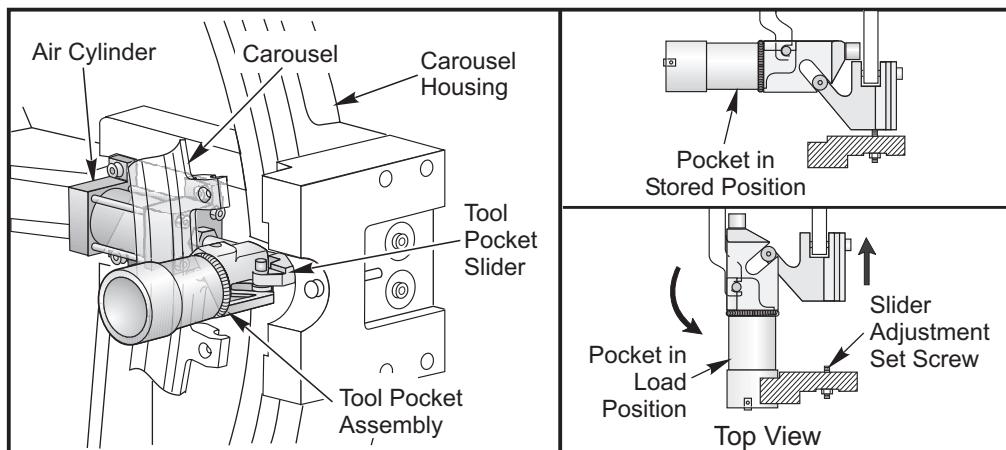


4. Restore the machine to automatic mode and perform a tool change by pressing **MDI** and then **ATC Fwd**. Check for any binding or interference of installed parts.

### 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.



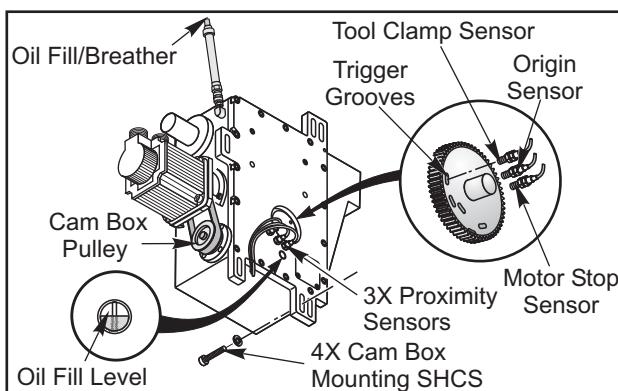
Tool Pocket Orientation/Set Screw Adjustment

**NOTE:** To replace the air cylinder the carousel must be removed

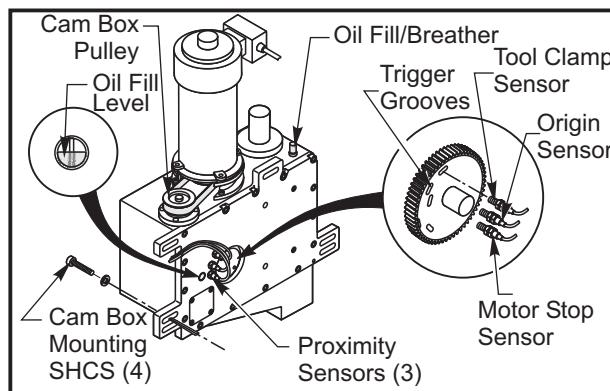
### PROXIMITY SWITCH REMOVAL/INSTALLATION

#### 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

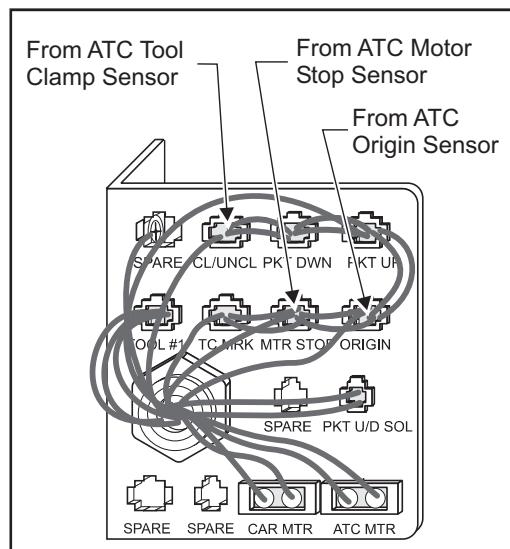


Vertical Machine Proximity Sensor Switch Location

#### 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.

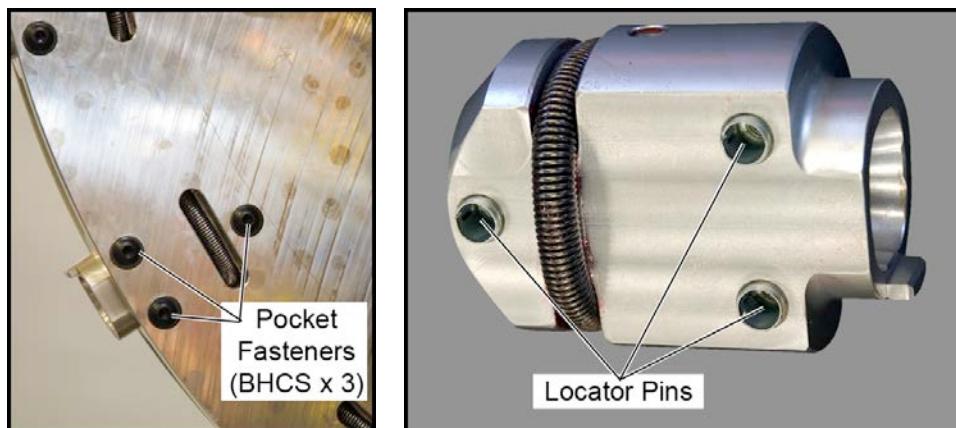


*Proximity Switch Connection Bracket.*

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 removable thread locking compound to the fasteners and tighten.

#### **DT-1 TOOL POCKET REMOVAL / REPLACEMENT**

1. Remove the tool changer cover.
2. Make the V axis visible (Parameter 390 bit 18).
3. Jog the V axis to rotate the machine carousel to position the pocket for removal.
4. Remove the two BHCS on the number disc side from the pocket to be removed and each pocket on either side of it.
5. Remove the three BHCS securing the pocket to the carousel plate.





6. Gently pry the number disc away from the pocket, far enough to allow the pocket locator pins to clear the carousel plate. Remove the tool pocket.
7. Install the replacement pocket, making sure to fully seat the locator pins in the carousel plate. Reinstall the three BHCS and torque to 30 ft-lbs (40.67 Nm).
8. Reinstall all BHCS to the front of the number disc.
9. Make the V-Axis invisible, and run several tool changes to verify proper function.

#### SETTING PARAMETER 64

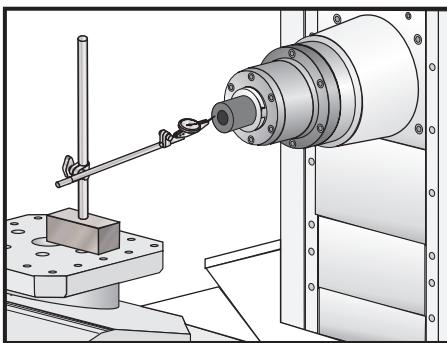
**CAUTION!** The EC-400 Z-axis can crash into the pallet changer actuator if Parameter 64 is not set correctly.

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

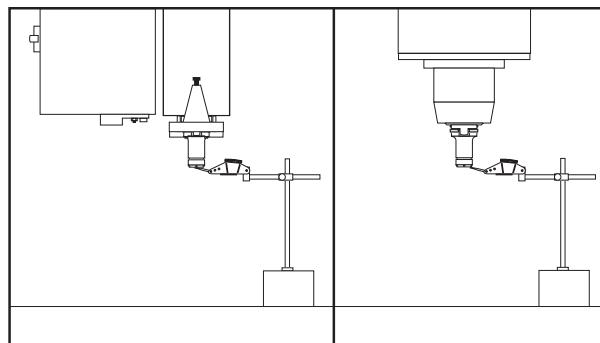
**Example:** .625 x 138718 = 861699

To reset Parameter 64 (Z-axis tool change position) if an ATC assembly has been replaced or realigned:

1. Enter debug mode.
2. Set up a .0005" indicator with an extended arm base on the machine table.
3. Place a tool holder in the double arm (side-mount toolchanger) or pocket #1 (umbrella-style toolchanger).



*Setting Parameter 64 for Horizontal Machines*



*Setting Parameter 64 for Vertical Machines (SMTC method shown)*

4. Indicate the bottom of the tool holder and zero the indicator.
5. Jog the indicator away from the tool holder. Remove the tool from the double arm (or pocket #1) and place it in the spindle.
6. Change the value for Parameter 64 to a smaller value (for example, if parameter 64 is currently 23012, change it to 10000).
7. Press ZERO RET, Z, SINGL.
8. Press 5% RAPID.
9. Press Z, and then HOME G28.
10. Place the indicator under the tool holder and jog the Z-axis down to the zero point on the indicator.
11. Go to the POS RAW DAT screen. Take the value from Z ACTUAL and add it (ignoring any minus sign) to the current Parameter 64 value (set in step 6). The sum is the new Parameter 64 value.
12. Perform a tool change and observe for misalignment. Adjust the Parameter 64 setting if necessary.



## SERVO TOOL CHANGER OFFSETS

### 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 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 (Mill version 16 software, press POSIT, then Zero Ret to place focus on the posit pane), 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 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.



## TURRETS

### 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/Cntrs, 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.

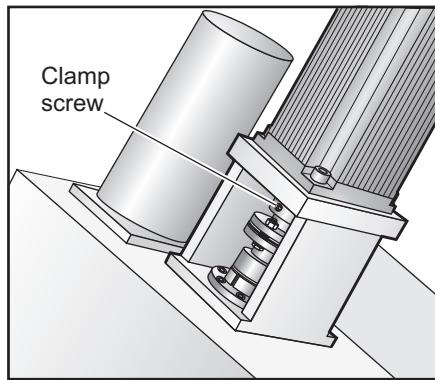
**NOTE:** If alarms 111 or 164 occur it may be necessary to adjust the turret motor coupling.

**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 top turret cover. Confirm 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 is more common on the original style cams, which do 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.

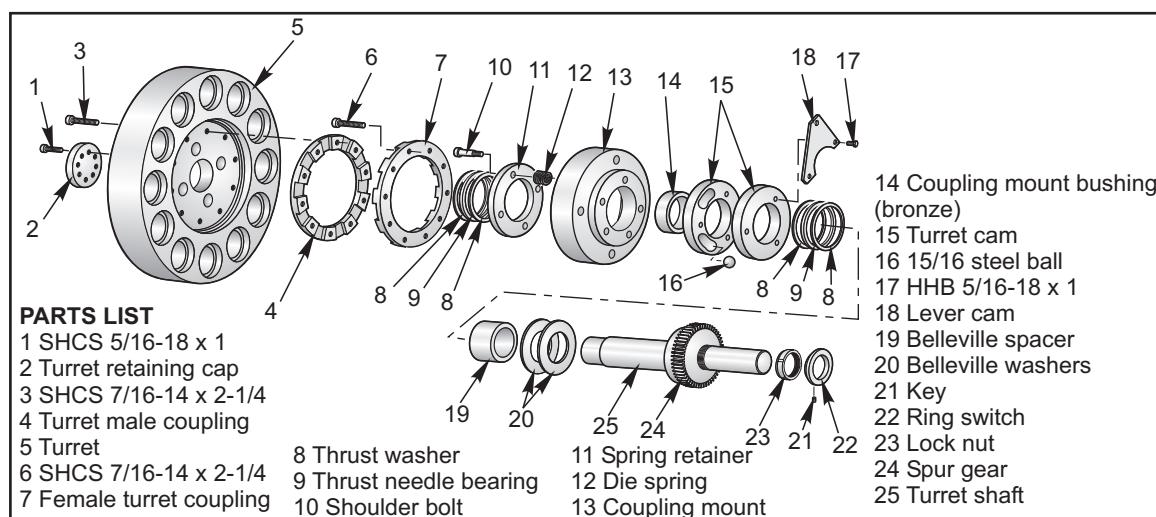
1) Reed style switches- these types of clamp/unclamp switches are mounted on the air cylinder to detect the clamp and unclamp position of the turret. The air cylinder has a magnetic piston, which activates the switch when the magnetic piston is under it. This style detects the movement of the piston, 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 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.

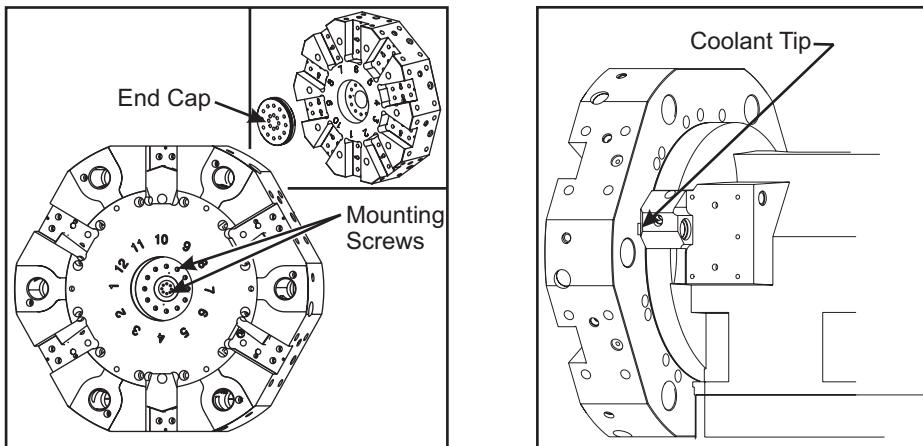
### **Hydraulic Turret**

#### **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.

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 un-clamping the turret.

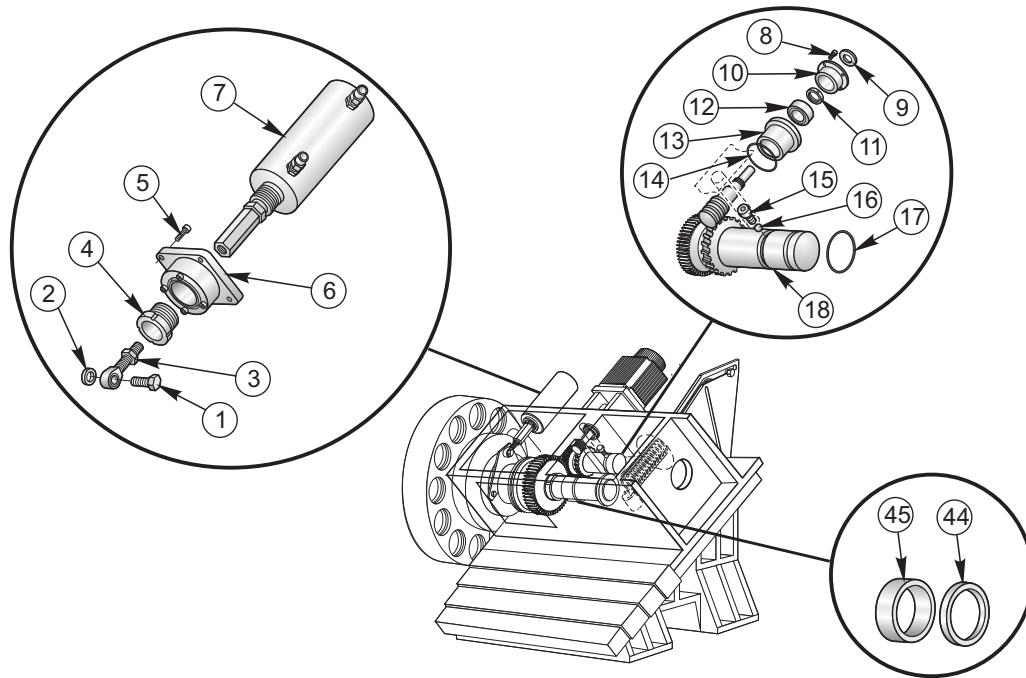
### TURRET CLAMP ADJUSTMENT (HYDRAULIC TURRET)

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 AND REPLACEMENT



#### 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.

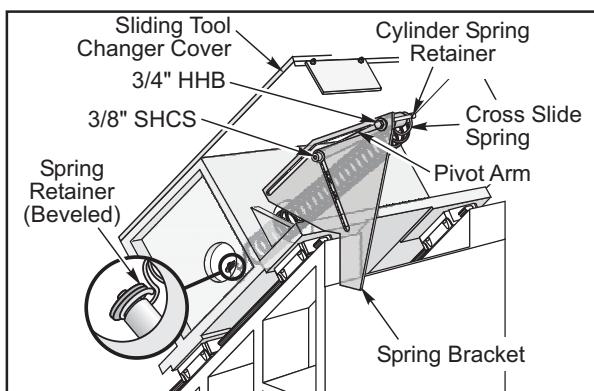
**Turret motor coupling adjustment procedure must be completed for proper alignment.**

### 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.

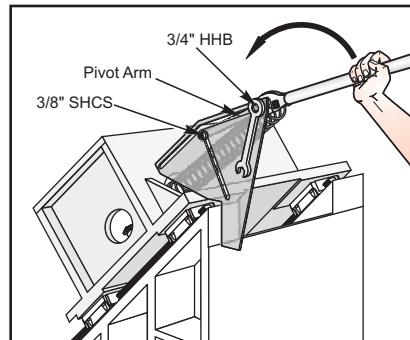
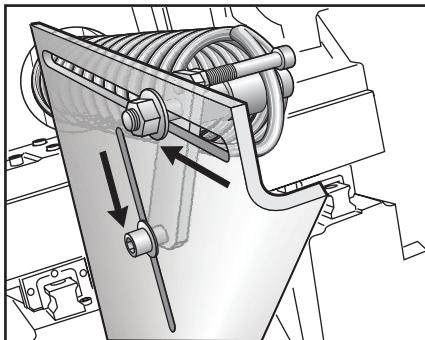


*Cross-Slide Spring Components*

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.

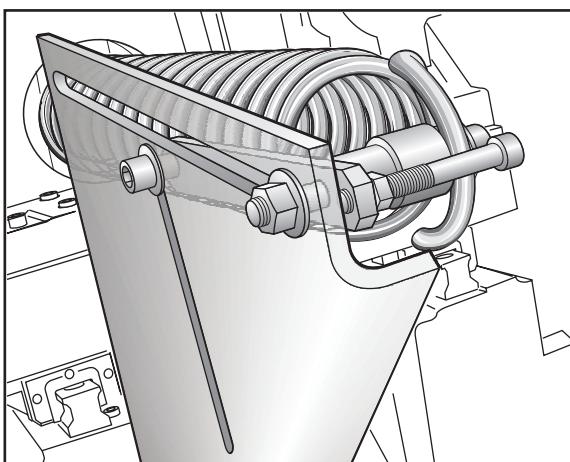
6. Remove cross slide spring and remove spring retainer located inside turret housing. Use access hole located on the opposite side of turret to remove spring retainer. Replace used spring retainer with new beveled spring retainer.

**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).

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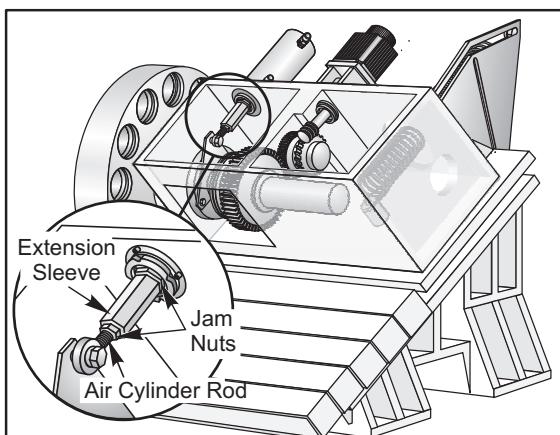
**NOTE:** While holding coupler at maximum rotational movement release pressure and note the backlash reading falls to lesser value. By experimenting, you will find a "spongy" area. This area is the end play in the worm and cluster gear.

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**NOTE:** Excessive backlash can come from the coupler or bearing retainer.

**Turret motor coupling adjustment procedure must be completed for proper alignment.**

## TURRET IN/OUT ADJUSTMENT



*Turret Travel Adjustment Components*

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**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.

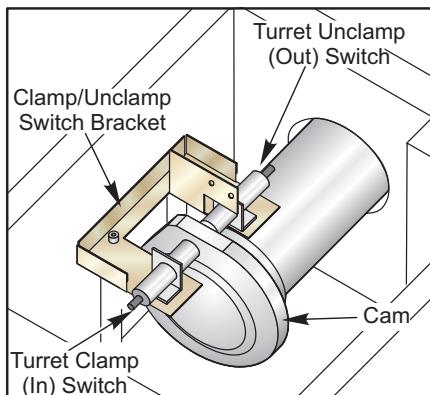


For the following procedures follow:

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.

**NOTE:** For turret replacement, loosen and adjust the inner coupling.

### 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.

**NOTE:** For turret replacement, loosen and adjust the inner coupling.

### 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.

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**CAUTION:** Have a bucket ready to catch oil draining from the housing.

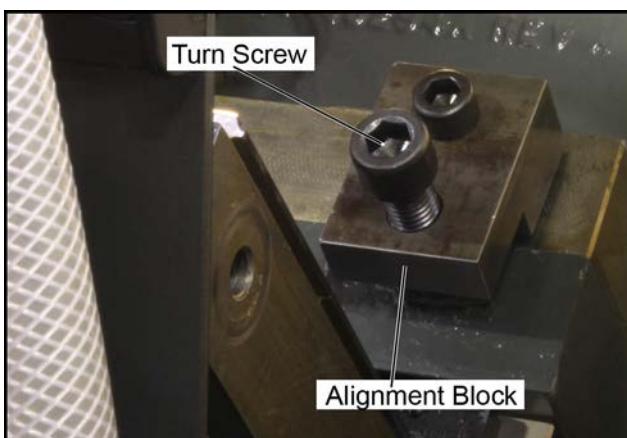
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5. Loosen all turret housing mounting bolts except for the front left bolt nearest the turret.

6. Clamp the turret (M44) and jog to the center of the X-travel.

7. **SL Lathes:** Tap on the turret casting in order to bring the face of the turret into alignment.

**ST Lathes (Standard Turret only):** Use an alignment block on either side of the top of the turret to pull the turret into alignment. Refer to the following illustration.



---

**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 thread locking compound 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)".

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**NOTE:** All alignments done could change spindle centerline. Verify and enter new spindle centerline position in Parameter 254.

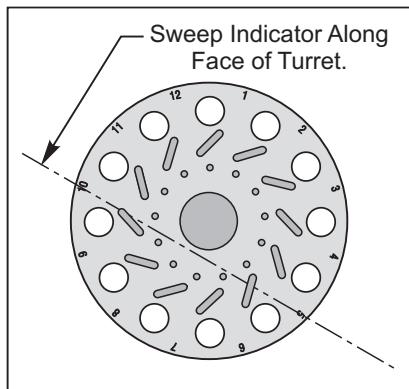
### TURRET ALIGNMENT VERIFICATION (X-Axis)

**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.

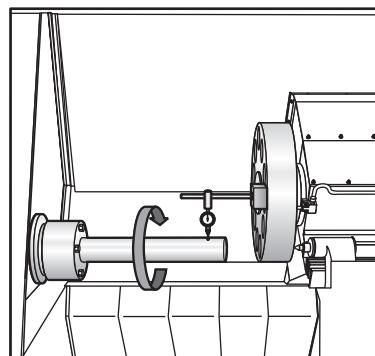


*Turret Alignment Verification (X-Axis)*

#### 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.**

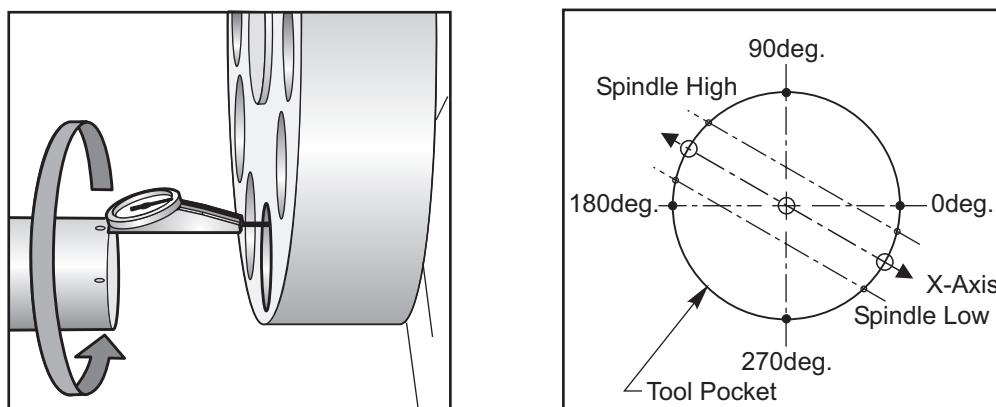
**Tools Required:** Spindle Alignment Tool, Dial Indicator (0.0005" or less resolution)

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.

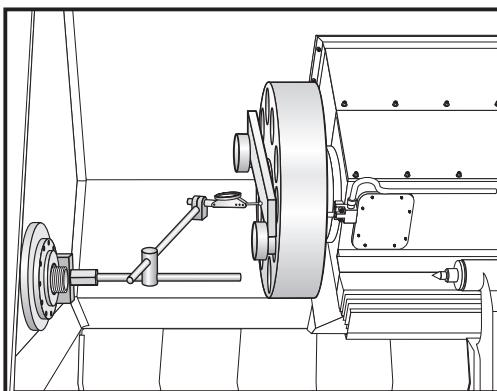


3. Press Posit, and Page Up until you see the debug screen Pos-Raw Dat 1.
4. Observe X-axis Command position. This is encoder steps. Ignore the negative sign and the decimal point.
5. Copy this number to Parameter 254 as a positive number with no decimal point.
6. Press Alarms, enter "Debug" and press 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.

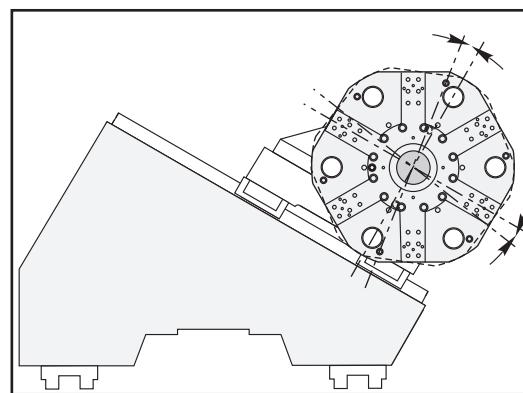
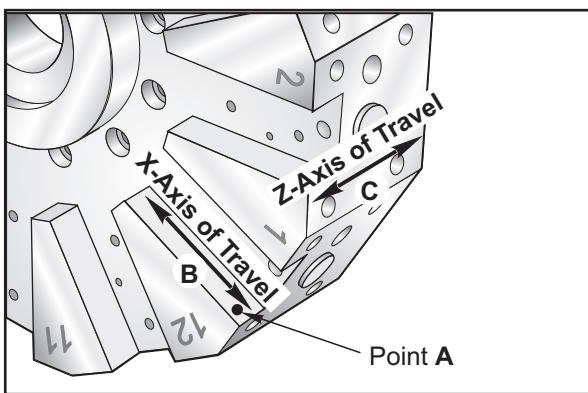
10. Rotate the turret 180° and check for .0003" TIR or less with the indicator.
11. Tap on the turret until the readings are within tolerance.
12. Retighten all (ten) turret bolts.

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

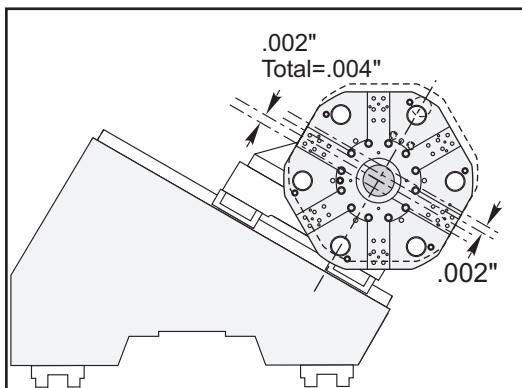
1. Clean the turret thoroughly before beginning alignment.
2. Index tool position #1 into the cutting position.
3. If the machine has a tailstock, move the turret and tailstock head next to each other and use the tailstock head as a secure mounting point for the indicator. If there is no tailstock, move the turret as close to 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 be as close to zero as possible.



Hybrid Turret Shown

The previous illustrations show 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 within 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

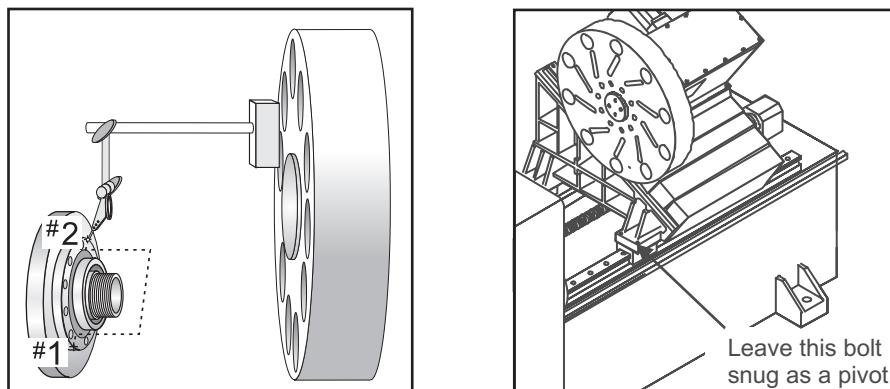
Using the data from the "Service Lathe Alignment" report as this procedure is followed. It is important that the form is filled out in its entirety before any adjustments of the wedge are attempted.



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 high voltages are present on the amplifiers, even when power is off. The high voltage comes from the vector drive, which has 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.

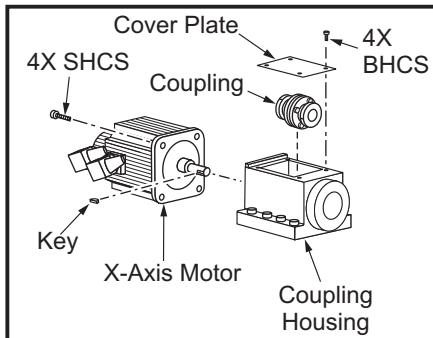


## WARNING! MILLS WITHOUT A COUNTERBALANCE

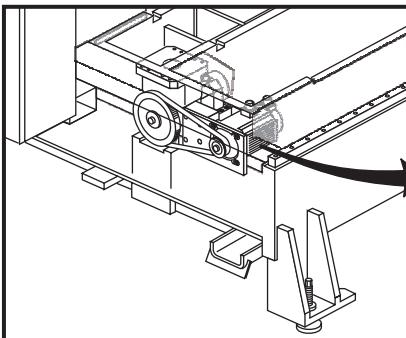
If debug is on and a vertical axis is disabled, the spindle head will fall. This is extremely dangerous and must be avoided.

**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.

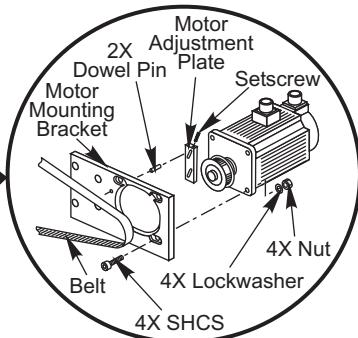
### Axis Motor Replacement



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.

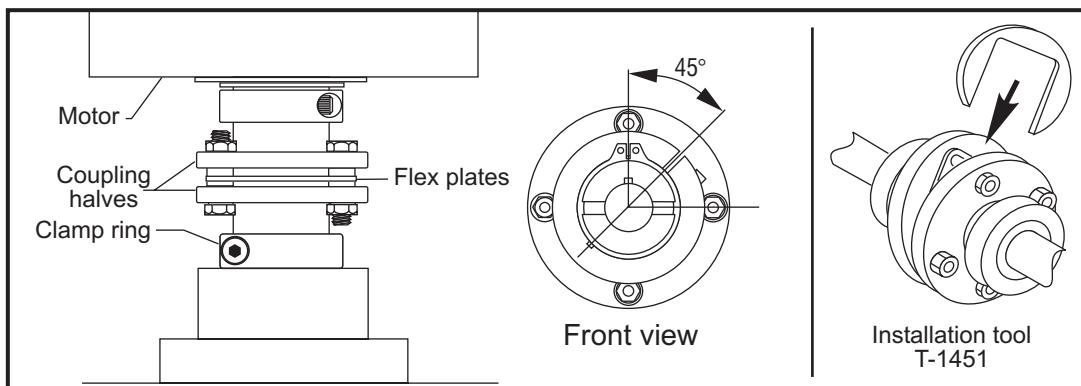


## COUPLING REPLACEMENT

**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

Note: Use the installation tool to avoid damaging the coupler.

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  $45^{\circ}$  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 removable thread locking compound 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)

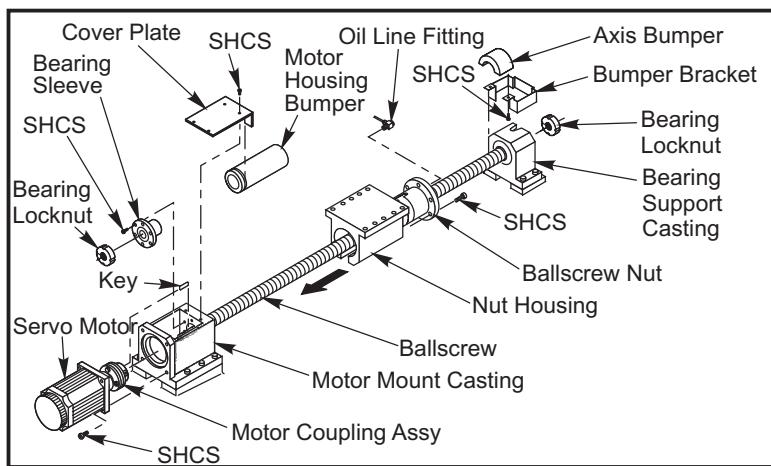
**NOTE:** For machines equipped with 40 or 50 mm ballscrews, the ballscrew must be removed in order to remove the bearing sleeve. Refer to the "Ballscrew Removal/Installation" section for instructions.

**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!

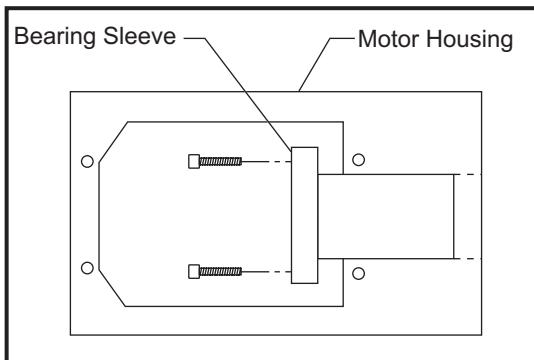
5. Remove the axis motor ("Axis Motor Removal/Installation" section).
6. Remove the motor coupling.
7. Loosen the SHCS on the locknut at the motor end of the ballscrew, and remove the locknut.
8. Loosen the SHCS and remove the bearing sleeve from the coupling housing. Push on the opposite end of the 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 removable thread locking compound on each of the SHCS before inserting.)

---

**CAUTION!** Do not use more than one drop of thread locking compound . 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  $\frac{1}{4}$ -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 thread locking compound , 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 REMOVAL AND INSTALLATION

## 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 servo motor from ballscrew and rotate motor by hand. If noise persists, replace 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 ballscrew noise complaints may not indicate a bad screw. Screws from different manufacturers produce varying noise levels. Often machines are built with 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.
- Ballscrew misalignment tends to cause the ballscrew to tighten up and make excessive noise at both ends of travel. The ball nut may get hot. Misalignment radially at the yoke where the ball nut mounts heats the ball nut on the ballscrew, and causes 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

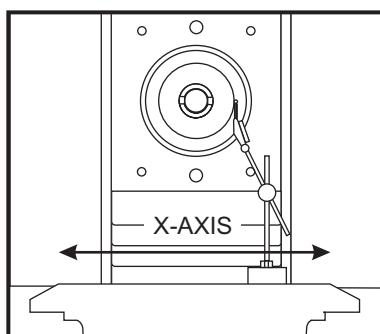
- Check parameters for that axis. Check the parameter values with the paperwork shipped with the machine.
- Check for backlash in the ballscrew as described in the following section.

### Initial Preparation

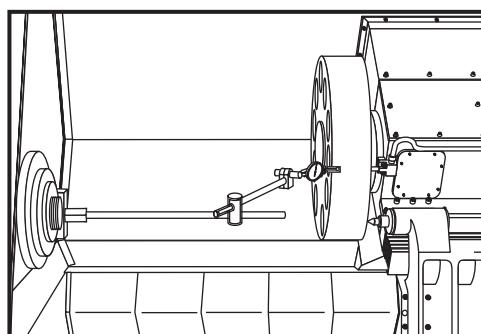
1. Turn the machine On and zero return the machine.
2. Center all the axes. (For Horizontal mills move the Z-axis so the spindle and the table are the closest to the end of travel toward the table.)

### Checking X-axis

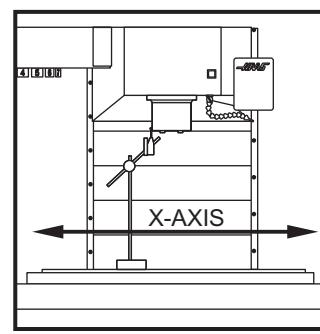
1. Set up a dial indicator and base as shown in the following figures.



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)  $\pm$  .0001.

4. Repeat Step 3 in the negative (-) direction. Total deviation between the dial indicator and the control panel display should not exceed .0002.

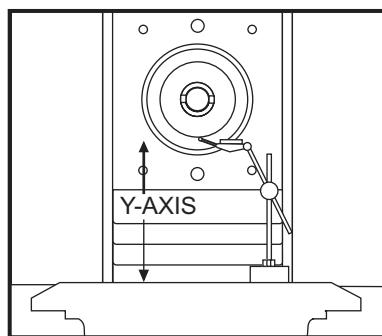
An alternate method for checking X-axis backlash is to place the dial indicator as previously shown and manually push the X-axis in both directions. The dial indicator should return to zero after releasing the axis. The axis motors must be on to check backlash by this method. Do not press E-Stop.

5. If backlash is found, refer to "Backlash - Possible Causes" in this section.

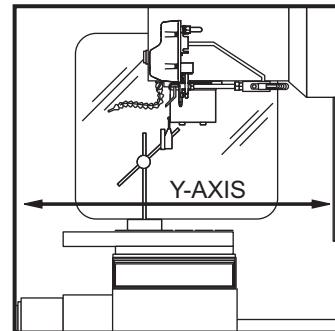


## Checking Y-axis

1. Set up a dial indicator and base on the mill table as shown in the following figures.



Horizontal Y-axis



Vertical Y-axis

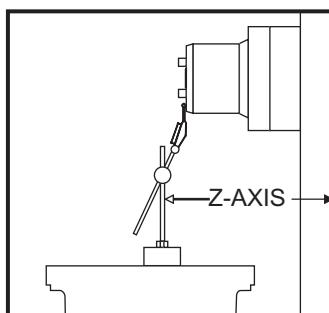
2. Follow the same procedure used for checking the X-axis.

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.

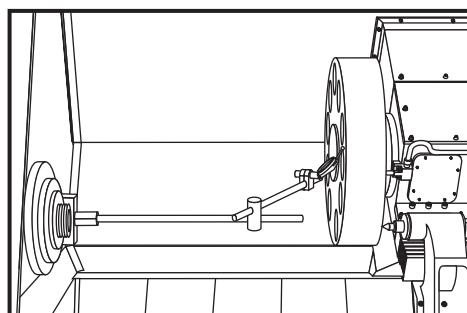
3. If backlash is found, refer to "Backlash - Possible Causes" in this section.

## Checking Z-axis

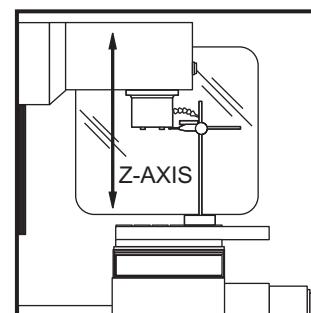
1. Set up a dial indicator and base as shown in the following figures.



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 indentations 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.

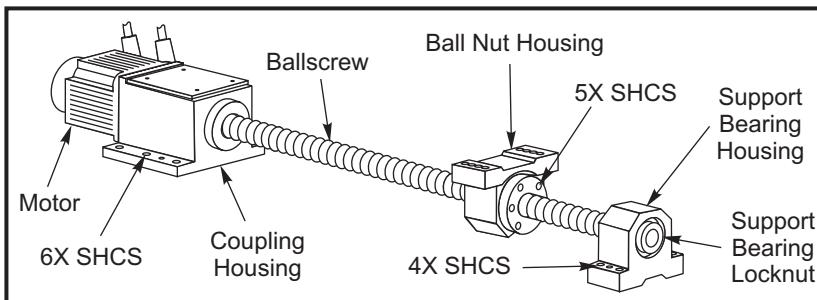
3. Jog ball nut to other end of travel. If metal flakes are present on screw threads, you may have wear issues.
4. Re-lubricate screw threads before returning the machine to service.

## 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 $\frac{1}{2}$ " 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 1/2" 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 1/2" 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 removable thread locking compound 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. Lower into place, rotating the ballscrew into position, being careful not to bump or scratch it. Gently push the ballscrew bearing support end 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.

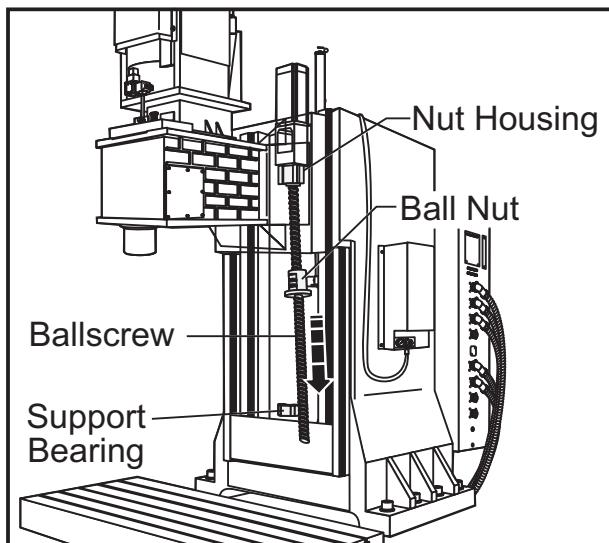
17. Zero return the axis and set grid offset.



## 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 1/2" 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 1/2" SHCS and remove the locknut on the ballscrew in the motor housing.
10. **For 32 mm ballscrews:**



- Loosen the six 1/4-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the opposite end of the ballscrew to loosen.

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**CAUTION!** Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, or ballscrew will result.

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- 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.

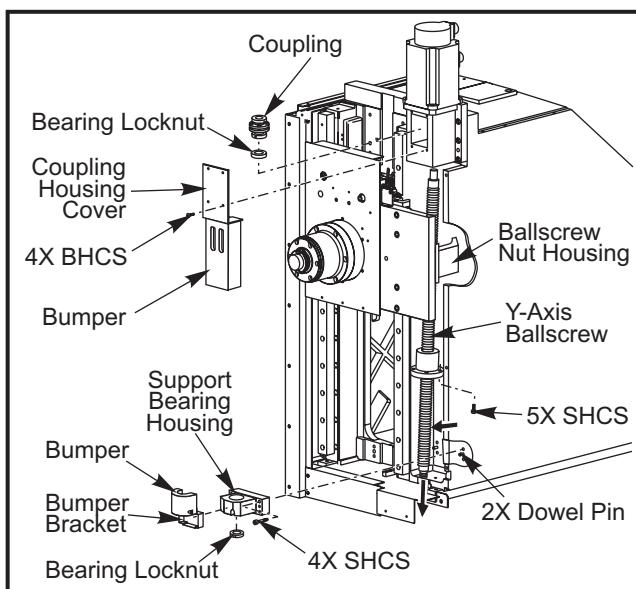
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**NOTE:** Only when the machine is powered Off, can the motor cables be removed so that the entire ballscrew assembly can be disconnected from the machine.

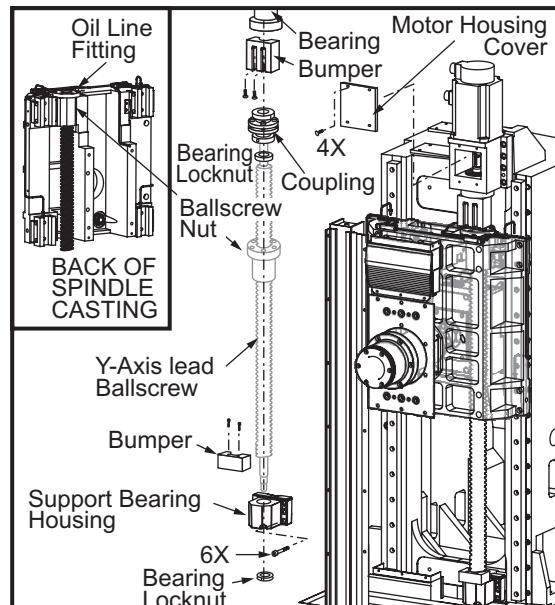
If the MDC-500 has to be turned on with the ballscrew disconnected, the corresponding Parameter bit has to be changed to disable that axis. In Parameter 29, change the bit from 0 to 1 to disable the Z-axis only if needed. When the ballscrew is in place, change the bit back to enable the axis.



## Installation



EC-300 Ballscrew Assembly



EC-400 Ballscrew Assembly

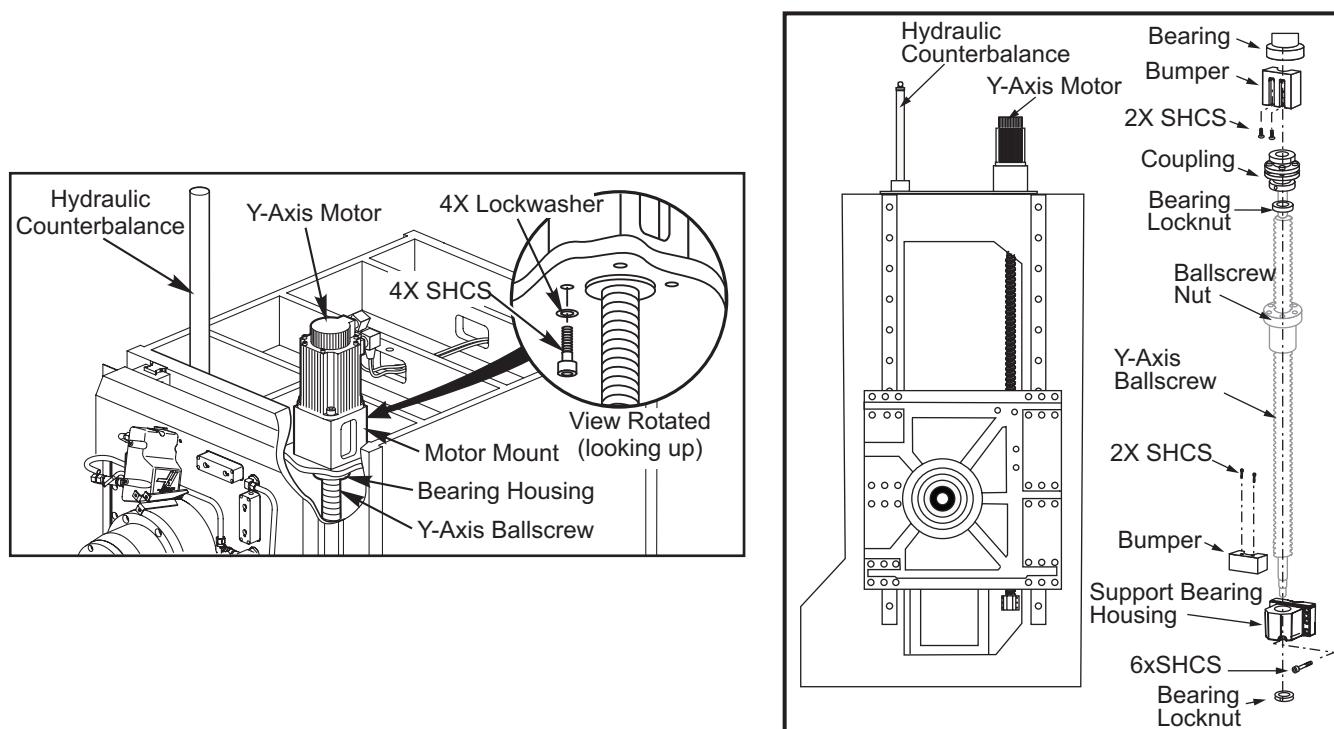
1. Ensure all mating surfaces on the bearing sleeve, motor housing, nut housing, and ball nut are free of dirt, burrs, grease, or other contaminants.

**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  $\frac{1}{4}$ -20 x 1" SHCS attaching the bearing sleeve to the motor housing (Place a drop of removable thread locking compound on each of the SHCS before inserting).

**CAUTION!** Do not use more than one drop of thread locking compound. 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  $\frac{1}{4}$ -20 x 1" (or  $\frac{1}{4}$ -20 x  $\frac{3}{4}$ ") SHCS attaching the ball nut to the nut housing. (Place a drop of removable thread locking compound 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.



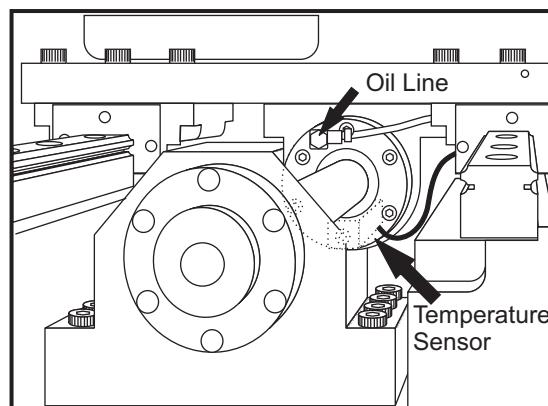
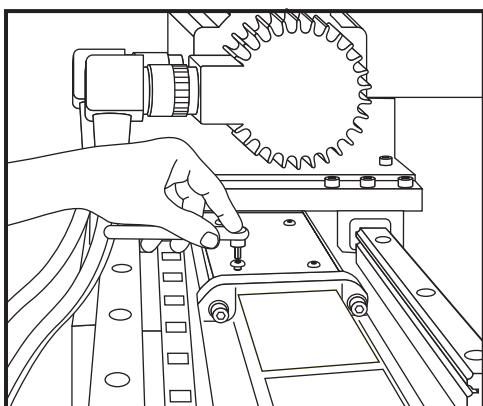
- Remove the shaft lock.
- Torque support mounting bolts to proper specifications.
- Loosen the locknut screw and locknut at the bearing support end and tighten to 4 in-lb (32 mm ballscrews) against the bearing (10 in-lb for EC-400 and EC-1600). Retighten the locknut.

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

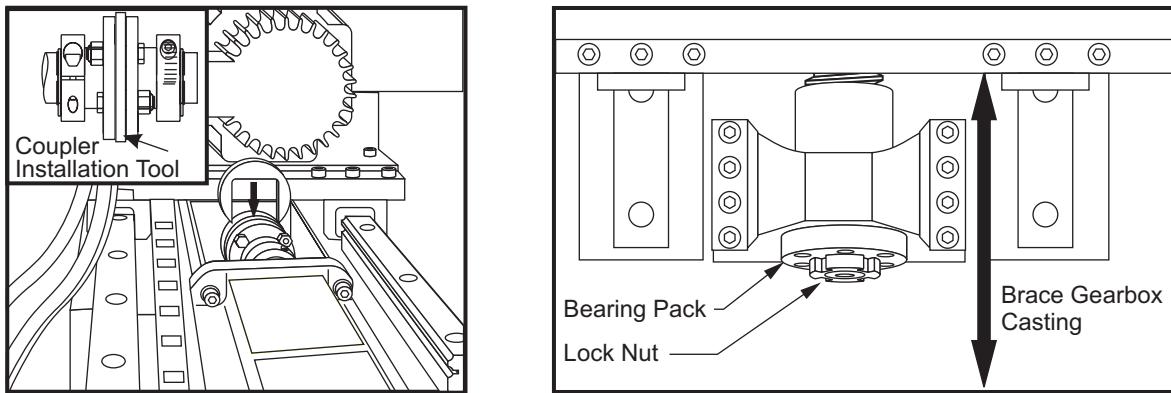
1. Turn the machine on. Zero Return all axes and put the machine in Handle Jog mode.
2. Remove all sheet metal necessary to gain access to the X-axis ballscrew, servo motor, and coupler. Remove the way cover.
3. Handle jog the turret down the X-axis until there is access to the motor housing cover.



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.

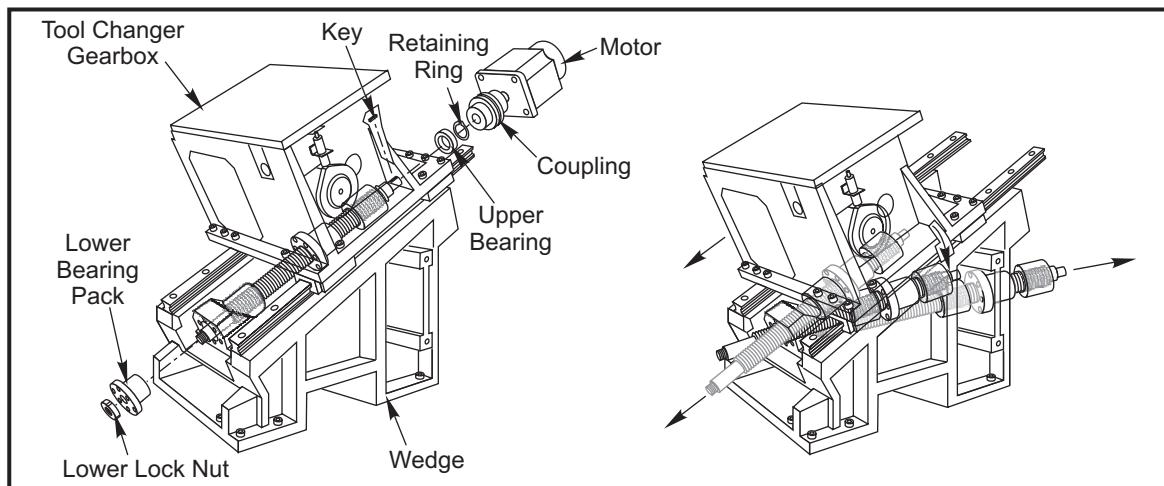
9. Disconnect motor cables. Remove the four (4) SHCS securing the axis motor to the motor housing. Pull the motor away from the casting, sliding the coupler off the ballscrew, leaving it attached to the motor output shaft.

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):

- Remove the last SHCS from the ball nut.
- Slide the ballscrew down through the bearing support casting.
- Thread the ball nut up the ballscrew toward the motor end, as you feed the ballscrew down through the bearing support casting.
- Thread the nut up the ballscrew until the ballscrew can be swung down through the opening in the wedge casting.
- Remove the ballscrew through the back side of the wedge casting.
- 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

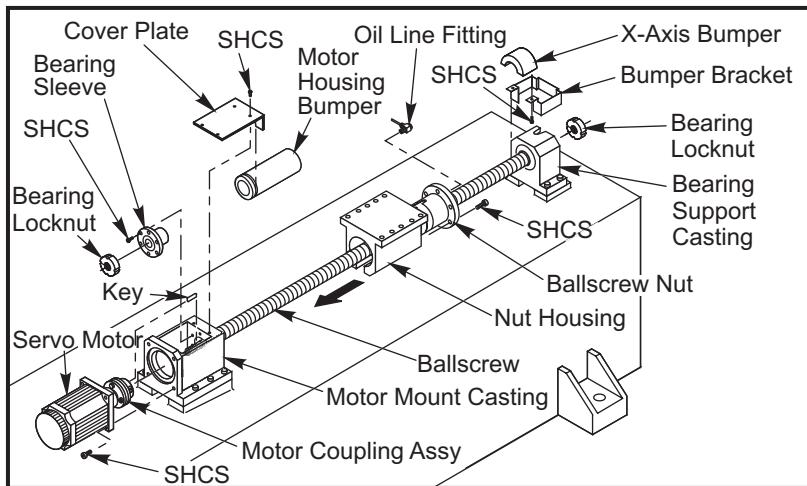
## Installation

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.

## LATHE BALLSCREW REPLACEMENT - Z-AXIS

### 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 1/4-20 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 1/4-20 x 1" SHCS. Place a drop of removable thread locking compound on each of the SHCS before inserting. Torque the bearing sleeve SHCS to 10 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 thread locking compound.

**CAUTION!** Do not use more than one drop of thread locking compound. An excessive amount causes a film between the sleeve and housing which could result in backlash.

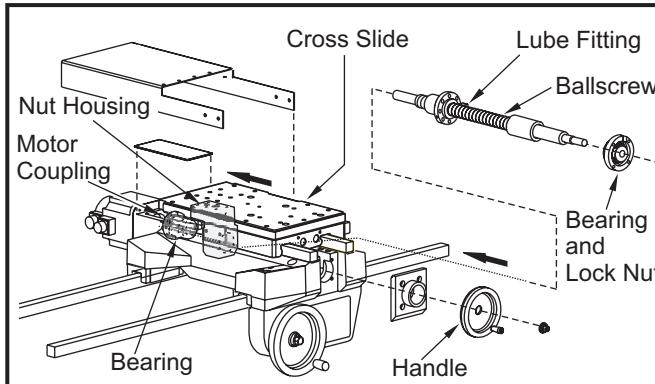
3. The following sequence is important to ensure proper installation of the ballscrew:
  - a. On the bearing support end, install the locknut 1/8" away from the bearing. Tighten the locknut screw. Install the shaft lock onto the bearing support end of the ballscrew.  
**CAUTION!** Do not attach bearing 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.



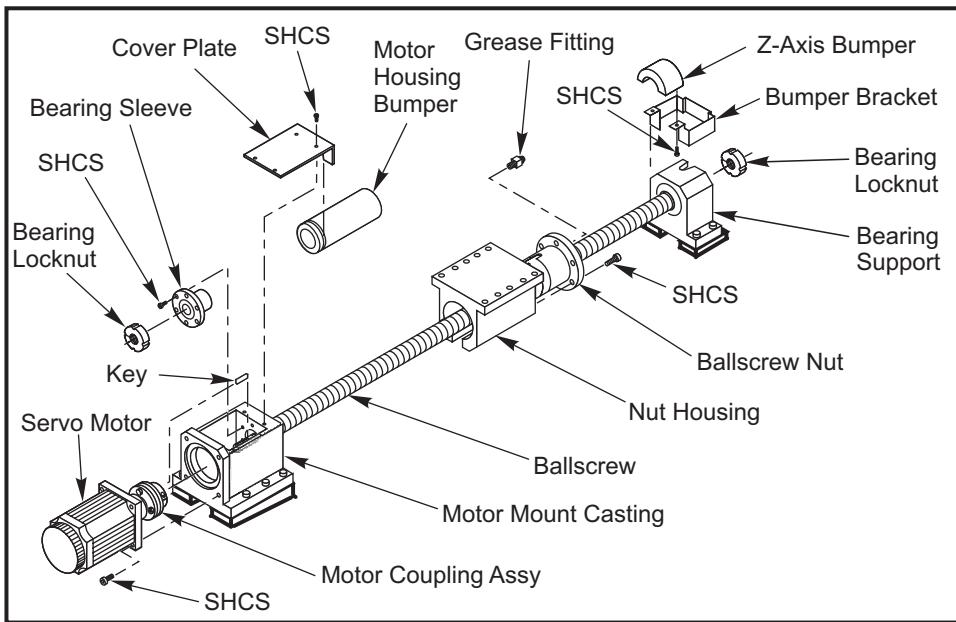
- d. At the bearing support end, remove the shaft lock.
  - e. **32mm**: Loosen the clamp nut screw. Tighten the lock nut against the bearing to 4 in-lb. Retighten the clamp nut screw and mark with paint.
  - f. Align the ballscrew nut to the nut housing on the wedge, and check the oil line fitting is in the correct position. Apply a drop of removable thread locking compound 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 10 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.

### TOOLROOM LATHE BALLSCREW REPLACEMENT

#### 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.

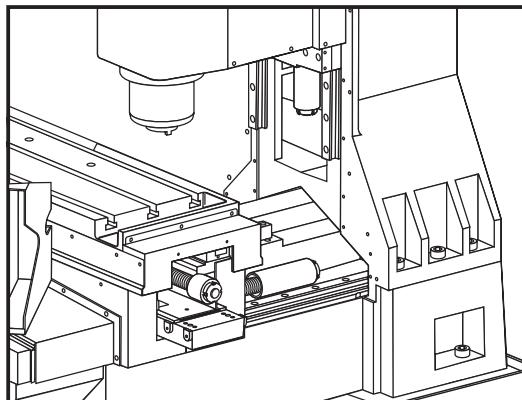
### MINI MILL BALLSCREW REPLACEMENT

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 simplifying 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.



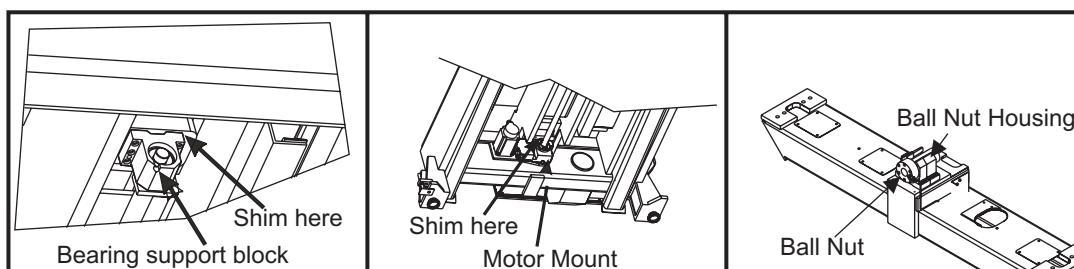
2. Remove the fastener from the support bearing assembly to allow it to float on its support surface. Position the ballscrew nut toward the motor end to allow it to self-align to the motor housing bearing assembly.
3. Tightening the five screws to the nut housing.
4. Install the ballscrew bumpers.
5. 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 10 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. Ensure 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 X- and Z-axes are 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°. 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 measurements are out of tolerance from top to bottom (0° and 180°), proceed to the Tailstock Leveling Procedure. If this measurement is out of tolerance from side to side (90° and 270°), 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.**

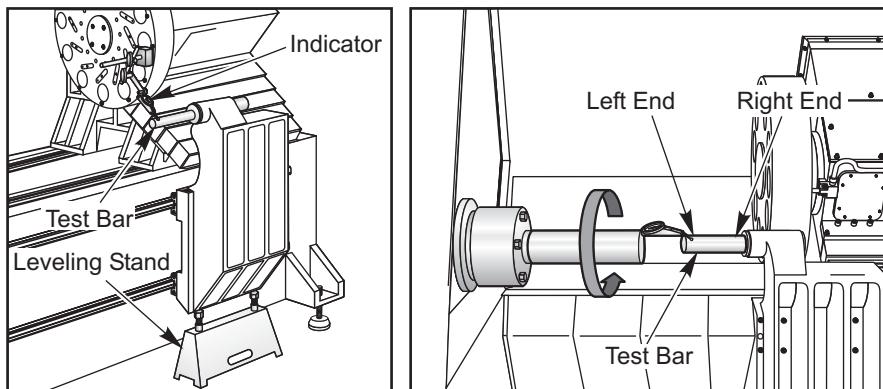
**Tools Required:** Tenths Indicator, Tailstock Alignment Tool (Test Bar P/N T-1416), Tailstock Leveling Assembly (Leveling Stand P/N 93-6001), Spindle Alignment Test Bar (P/N T-1312)

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.

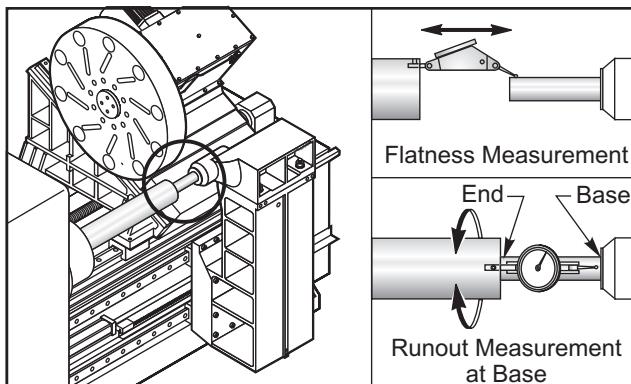
5. Check for tailstock level change. Adjust by setting the indicator to zero at the right end of the test bar and jog the indicator over to left end of bar. Snug bolts in upper left corner and loosen the others. Adjust the right-hand jack bolt only and bring the indicator to within .001".

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**

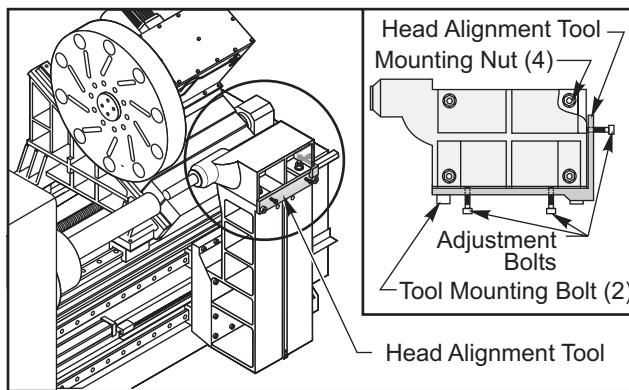
1. Using a spindle alignment tool and a Morse taper tool, indicate from spindle to tailstock. Measure flatness and TIR (total indicated runout). Determine in which direction the tailstock is out of alignment.



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.



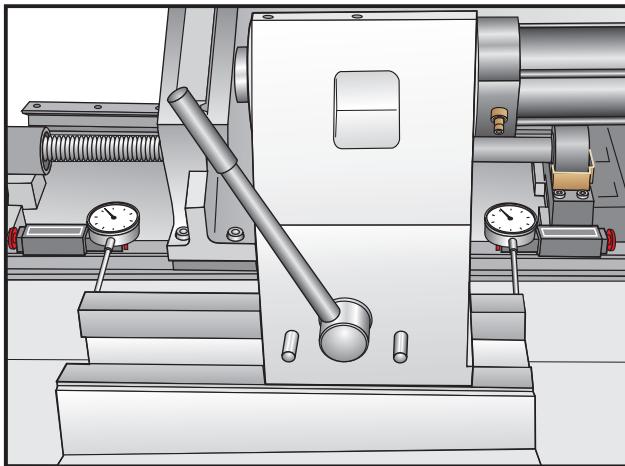
3. Check the top surface of the tailstock base for parallelism to the Z-axis. Check for dents and lightly stone the top mating surface of the tailstock. Indicate from the turret to the top of the tailstock base. Readings must be no more than +/- .0004" for 10 inches of travel.
4. Install the shims, lightly 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.

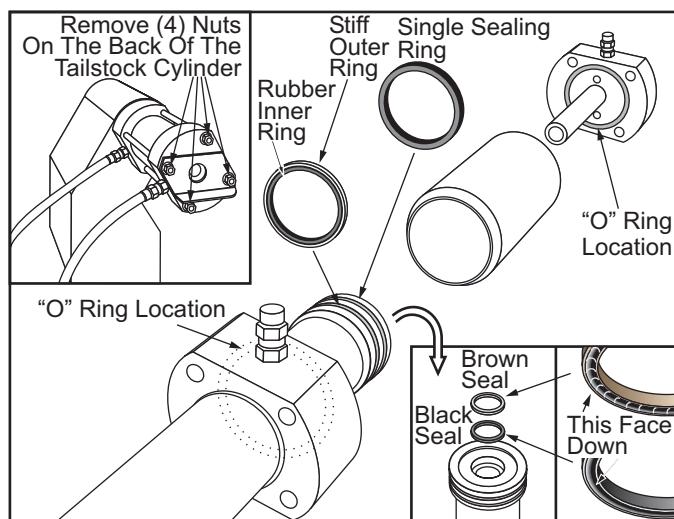


7. Measure the side to side runout of the concentricity of the spindle to the tailstock quill. The total side to side runout cannot exceed 0.0005".
8. Using the set screws in the tailstock base, move the entire tailstock assembly until the total side to side runout does not exceed 0.0005". Maintain the 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

Blow torch

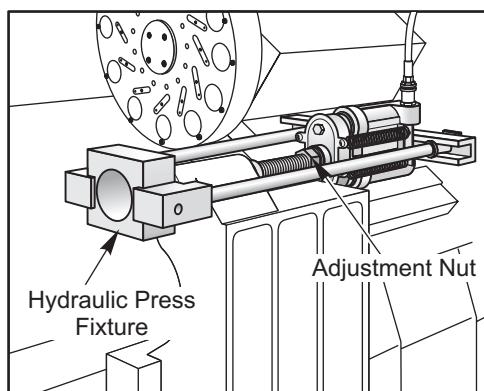
Spindle Alignment Test Bar (P/N T-1312)

Devcon liquid steel (P/N 99-4530)

Tailstock Taper Alignment Bar (P/N T-1416)

### 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.

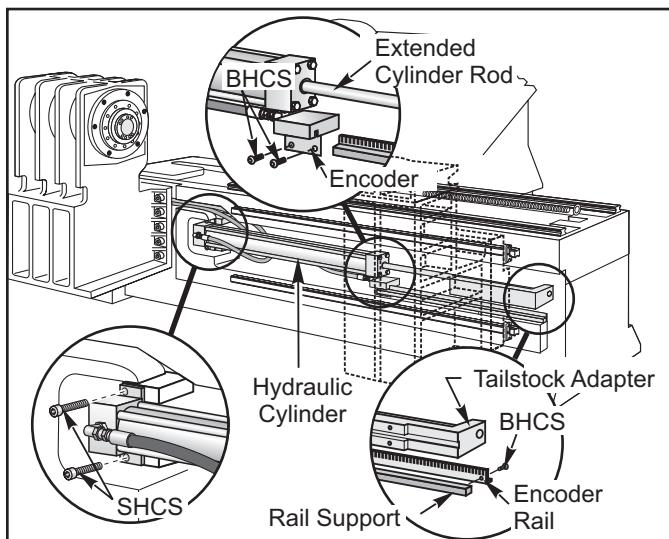
### **HYDRAULIC TAILSTOCK CYLINDER**

#### **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 end block from cylinder. Collapse hydraulic cylinder, then push the tailstock to the rear of travel.



7. Pull the hydraulic cylinder out from the front side of the tailstock.

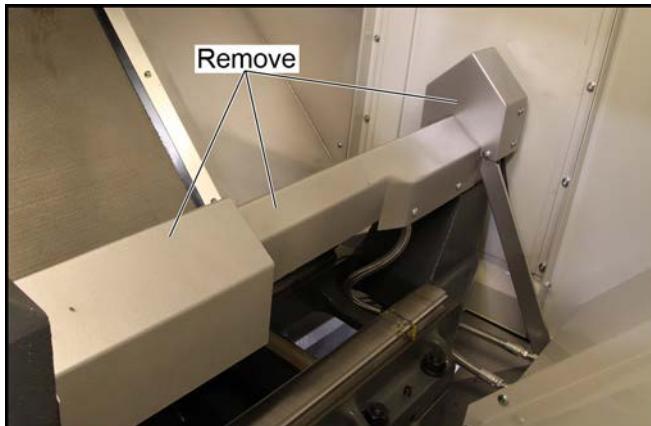
### Installation

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.

### ST SERIES HYDRAULIC TAILSTOCK BLEEDING

The hydraulic tailstock cylinder must be bled after any service procedure in which the system has been opened, or if a new cylinder is installed.

1. Remove the front right enclosure panel.
2. Remove the sheetmetal covering the tailstock cylinder components.
3. Remove the front nut and string encoder bracket screws from the front of the tailstock body.

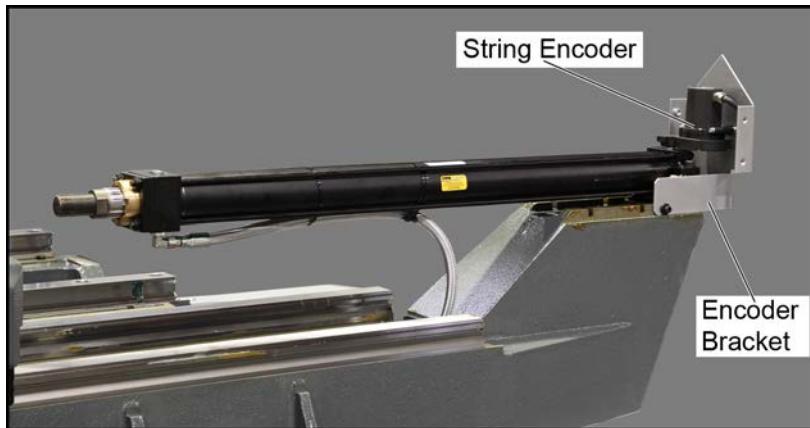


Tailstock Sheetmetal Covers



Tailstock Front Nut

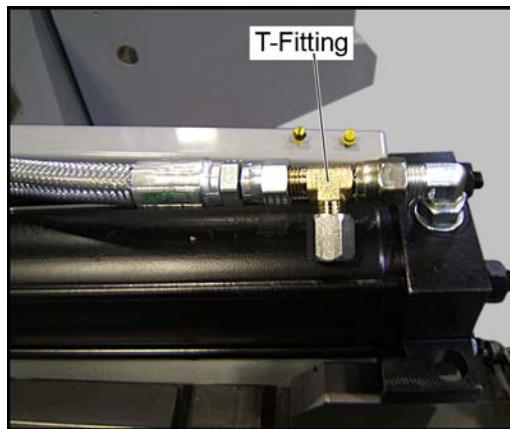
4. Set tailstock pressure to 450-500 psi.
5. With macros enabled (Parameter 57 bit 22), enter the following in MDI mode: **#1121=1 (CYLINDER IN)**. This brings the hydraulic rod into the cylinder.
6. Reach into the tailstock body and push the string encoder bracket out the front. To prevent damage to the string encoder, keep hold on the encoder string as you remove the 10-32 bolt that secures the string to the bracket and carefully allow the string to retract slowly into the encoder.



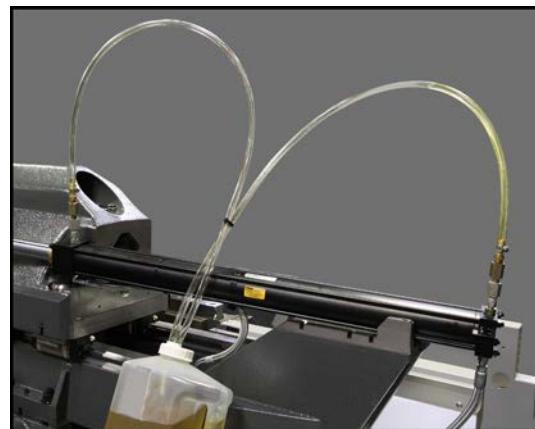
7. Remove the encoder and bracket from the end of the hydraulic cylinder. Remove the two 3/8-16 bolts that secure the cylinder to the tailstock base.

8. Press Emergency Stop to stop the HPU.

9. Examine the cylinder to determine the appropriate bleed procedure. Earlier cylinders require a T-fitting installed between each cylinder inlet and the hose to create an inline bleed port (see photograph for fitting position) the port created by this fitting should point up for the bleeding procedure. Later or replacement cylinders have a bleed port on the top of each end.



*T-Fitting Installed (Shown plugged and laid down)*



*Cylinder Bleed Setup (With Bleed Ports)*

10. Install the clear hose assemblies to the T-fittings or bleed ports. Insert the loose ends of the hoses into a container.

11. Enter the following program in MDI:

```
G103 P1;  
#1122=1 (CYLINDER OUT);  
G04 P60.;  
#1122=0;  
G04 P3.  
;  
G103 P1;  
#1121=1 (CYLINDER IN)  
G04 P60;  
#1121=0;  
G04 P3.;  
M30;
```



12. Run the program a minimum of four times. As the program runs, watch for air bubbles in the clear hose. Repeat the cycle until all air is purged.
13. Run the cylinder all the way in and remove the clear hose assembly from the rear port. Install a plug to the port. If using a T-fitting, loosen the fittings and lay the T-fitting down into operating position as shown in the photograph. The T-fitting will remain on the hose.
14. Run the cylinder all the way out and remove the clear hose assembly from the front port. Install a plug to the port. If using a T-fitting, loosen the fittings and lay the T-fitting down into operating position as shown in the photograph. The T-fitting will remain on the hose.
15. Make sure the rear hose is centered along the cylinder to prevent interference between the hose and tailstock body when the tailstock is zero returned.
16. Reassemble the tailstock in reverse order.



## EC-300/MDC PALLET CHANGER

### 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.

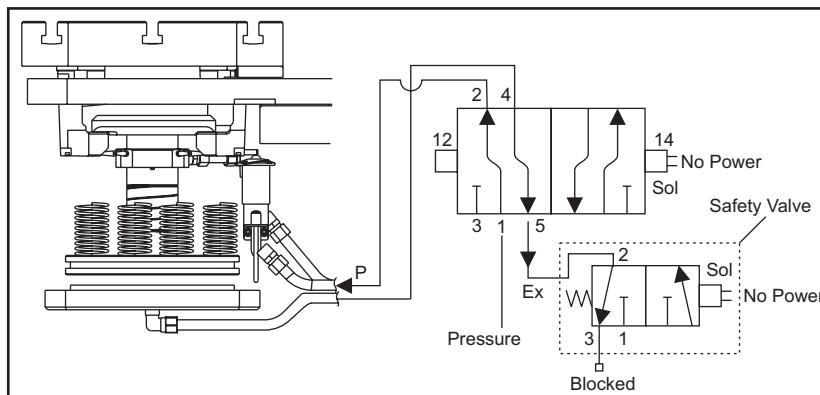
**Air Supply Lines** - The lifting cylinder has one large air supply line for lifting pallets and their loads. No return line is required because the cylinder is vented to the atmosphere and the assembly weight and load causes the cylinder to lower. The rotation cylinder is double-acting and has two smaller air supply lines for clockwise and counterclockwise rotation. The air blast system has one large air supply line, connected to the lube tube adapter. Each of the four air supply lines are routed to the solenoid mounting bracket (at the mill rear). 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

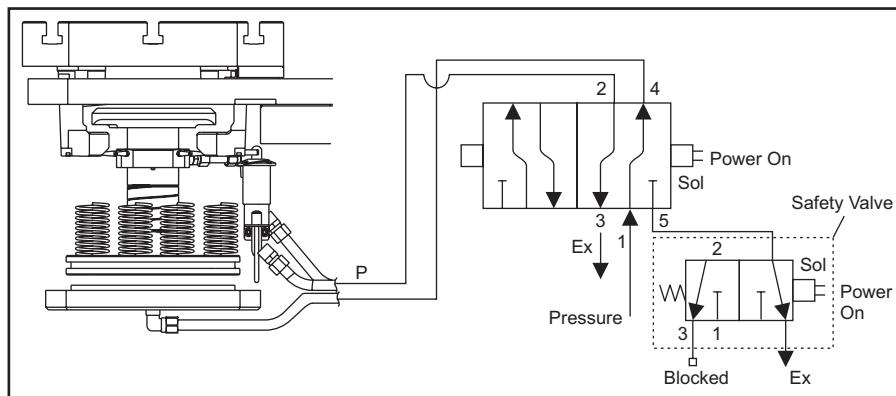
#### Table Clamp Status Under Different Conditions

A. Condition is clamped when machine is normally powered off, first powered on or table index is complete.

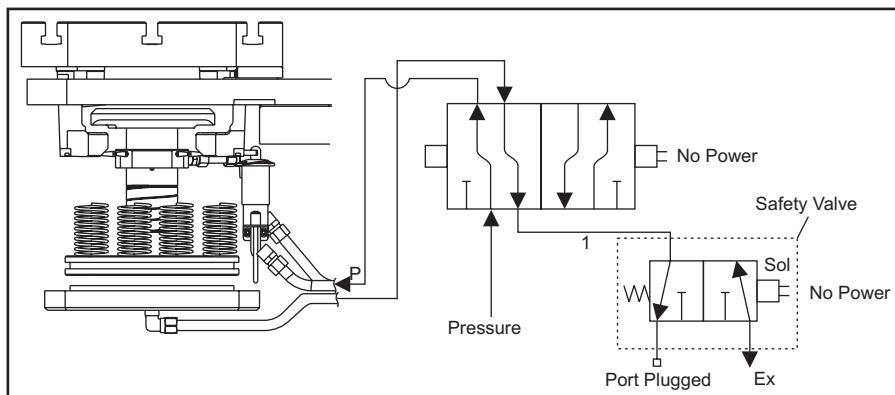




B. Condition when machine is unclamped. Note that the same condition applies if table is unclamped and the machine is emergency stopped in the middle of a table index. The table remains unclamped.



C. Condition when the table is unclamped and then power is lost.



- Main valve shuttles to clamp table but safety valve also loses power and blocks exhaust port on clamp side of piston. This prevents clamp plate from clamping immediately. The clamp plate slowly moves to its clamp position.

## TROUBLESHOOTING

- 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.
- 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.
- 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.



4. **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.

5. **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.

6. **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.**

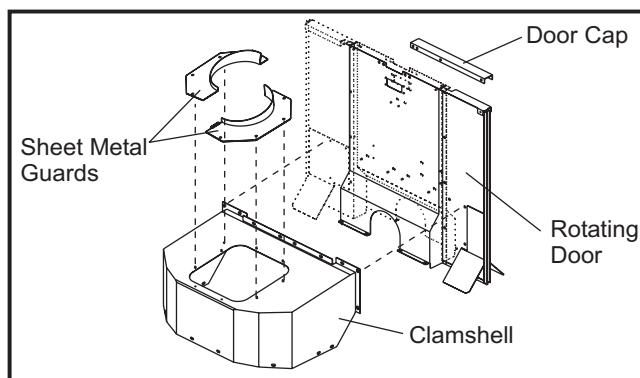
1. Enter M-17 in MDI mode and press Cycle Start to unclamp the pallet (recommend 25% rapid). Wait until the assembly has fully risen to its highest point and begins to rotate and press Emergency Stop. Rotate the pallet as required to remove the components.

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!** Remove clamshell by simply lifting it up and over rotary table once sheet metal guards are removed. **Do not** remove or adjust pallet on 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".

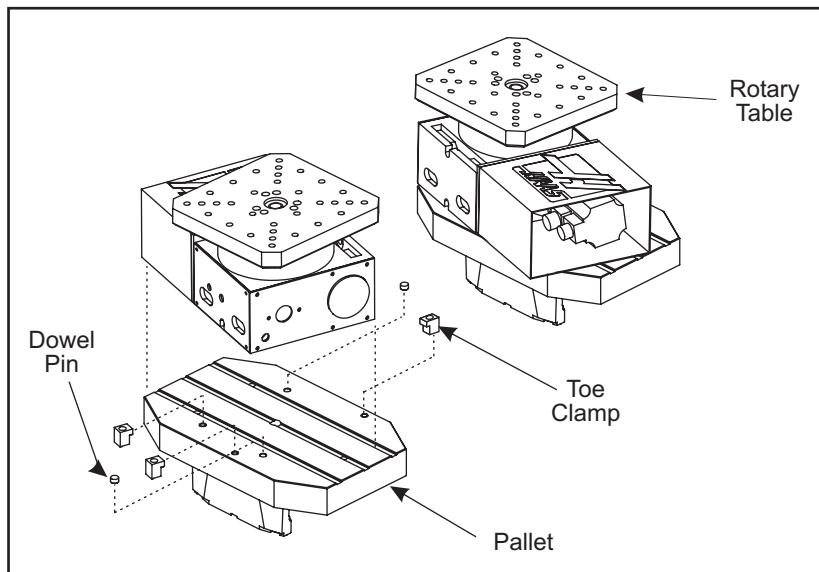
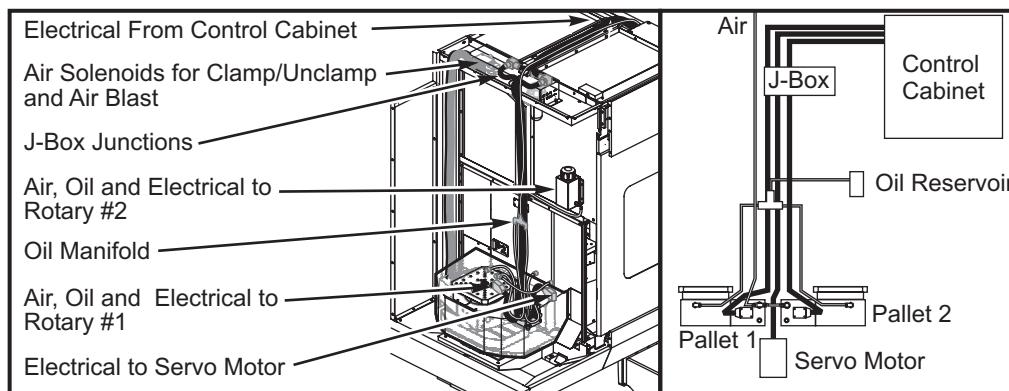
**NOTE:** Power off before disconnecting anything (and unscrew the power cables for the rotary tables from J-box for EC-300).

### 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.

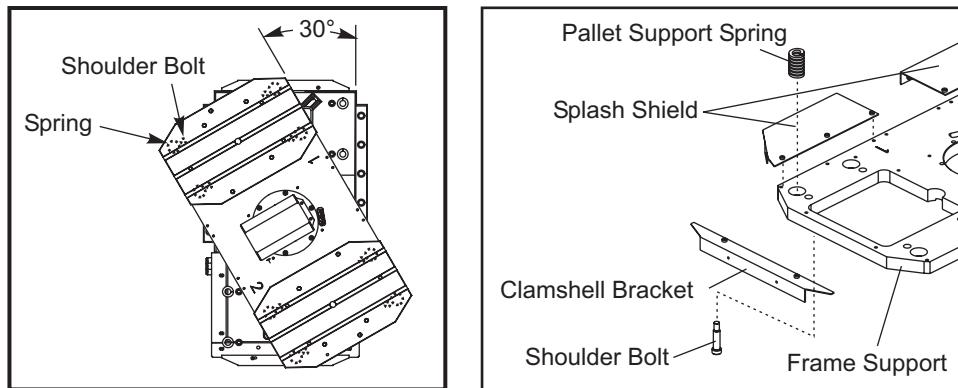
Remove the cable cover on the rotating door and pull the cables through. Disconnect the power cables from the J-box, remove the lubrication line and disconnect and crimp air lines leading to the rotary tables with a zip tie. There is a silk screen on the outside of the J-box that illustrates wire routing.



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  $\frac{1}{2}$ " 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 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.

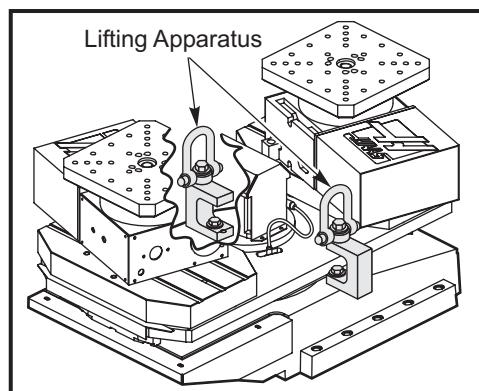
**NOTE:** Air pressure must stay connected throughout this process. **Do not** initiate a pallet change under any circumstance and only rotate assembly by hand.

**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.

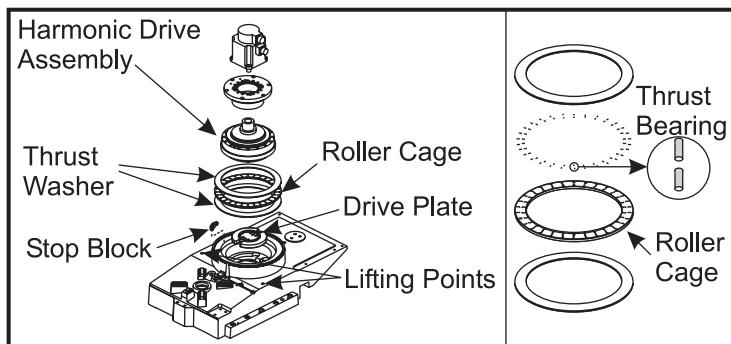
3. Disconnect the pallet clamp switch and remove the ten 5/8 –16 socket head bolts holding the pallet changer base to the main base casting.



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.

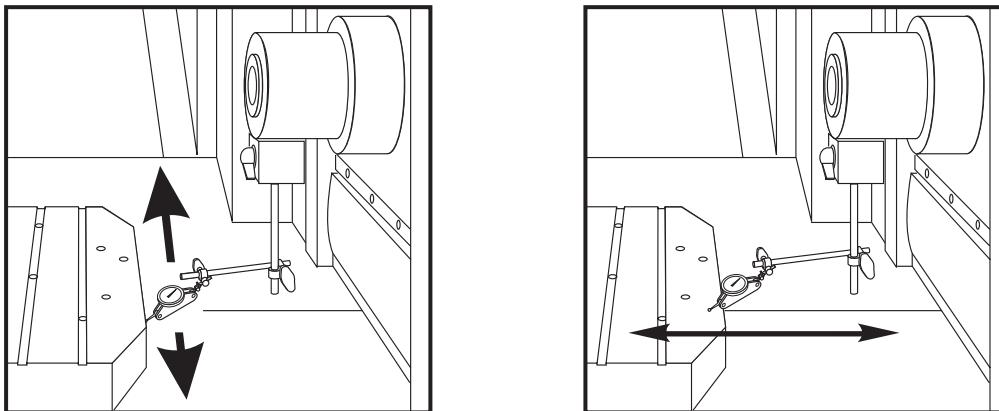
### Re-assembly

#### 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 pallet is within specification.
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 remained within specification.

## 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.

#### EC-400 PALLET CHANGER

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<sup>th</sup> 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.

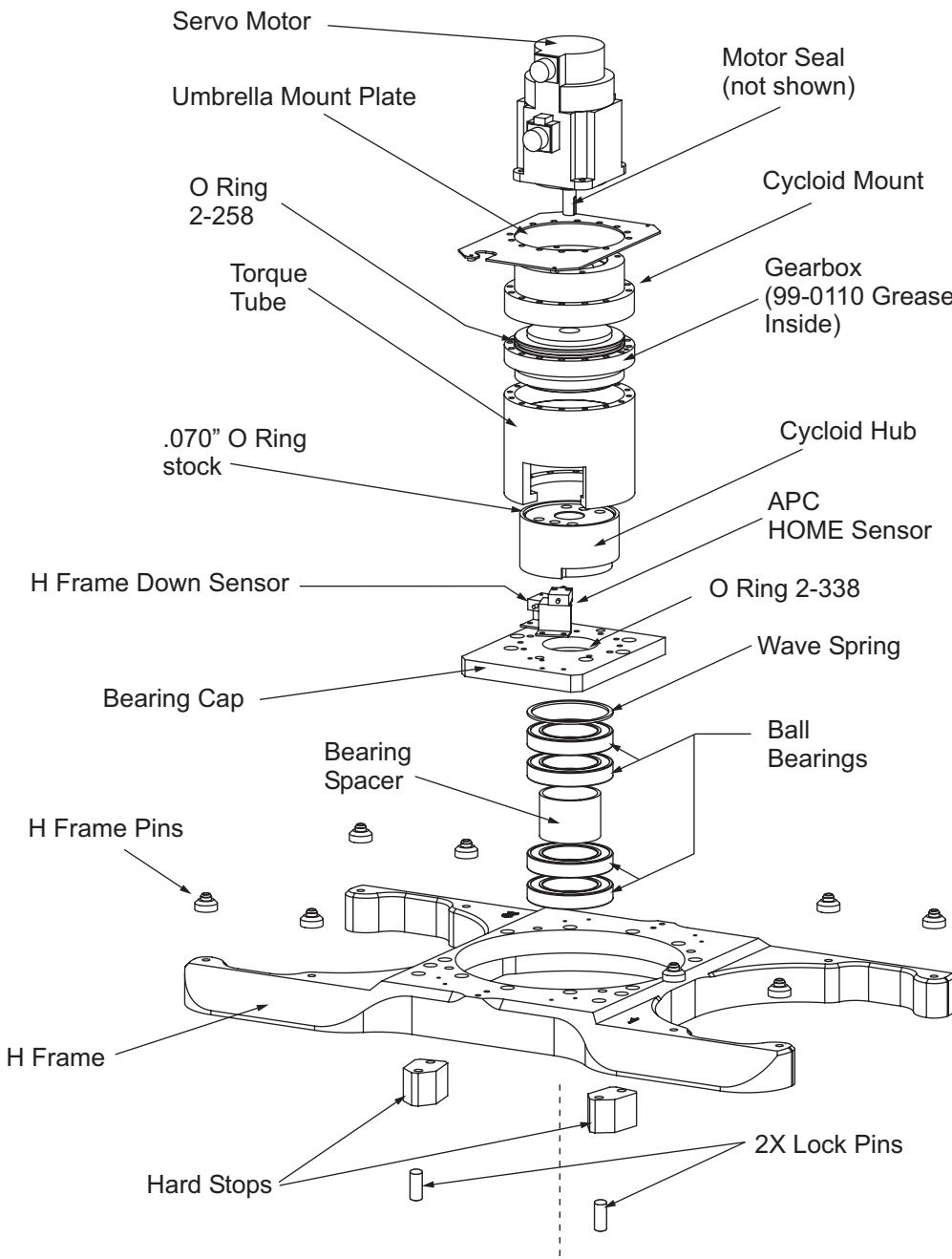


12. The H-frame down solenoid and safety solenoid turn off.
13. The H-frame up solenoid turns on.
14. Air pressure in air cylinder rotates top cam, by rotating seal housing. The bottom cam does not rotate.
15. The cage and three balls rotate at half the speed of the cam, forcing the cams to separate.
16. The top cam raises the H-frame by lifting the hub upward, 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 H-frame and pallets 180°, by driving through gearbox, torque tube, and hub, while 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 troubleshooting by removing either half of the door. APC disassembly requires removing the door. Disassembly is a top down process.

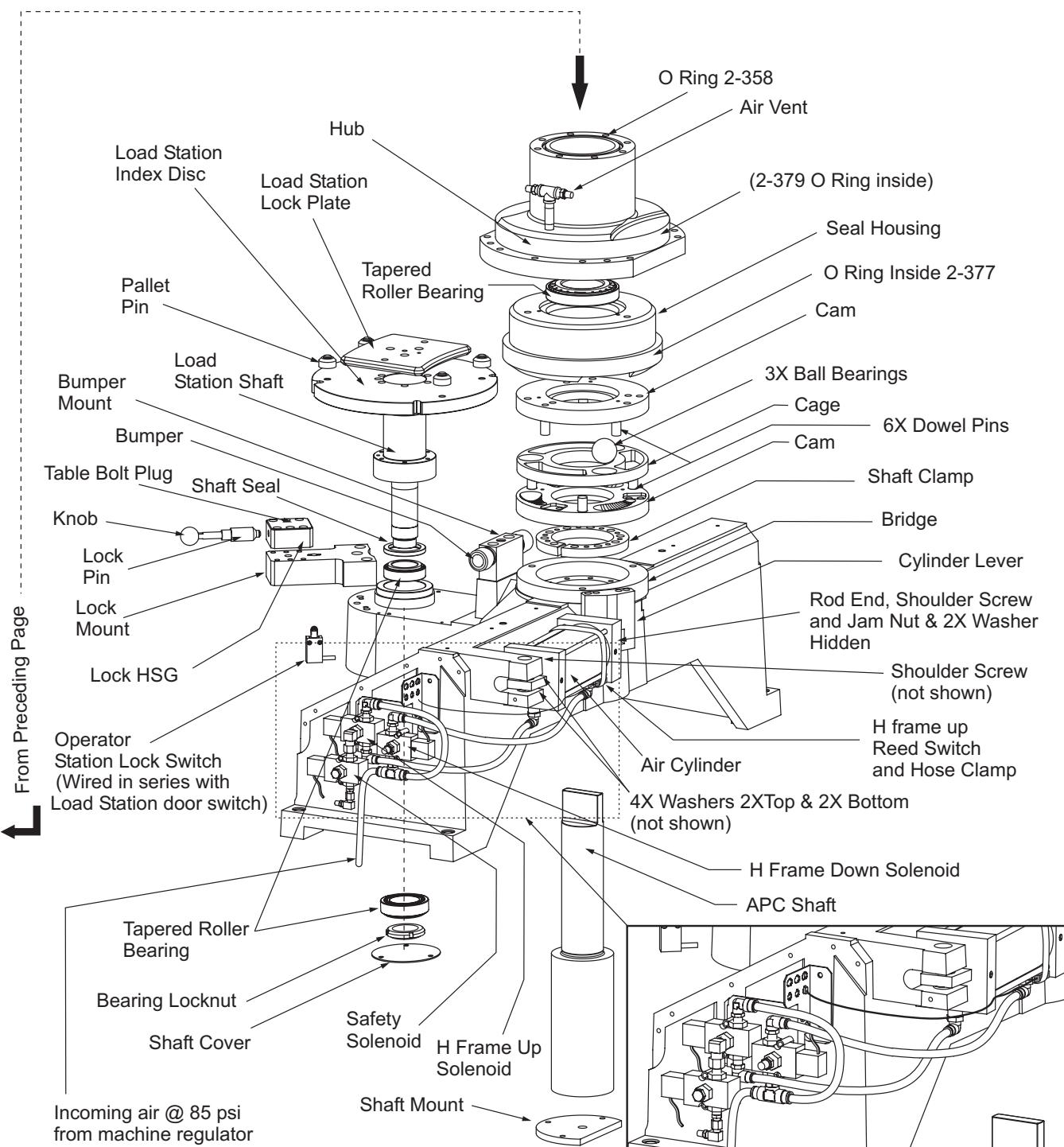


## EC-400 Pallet Changer Exploded View





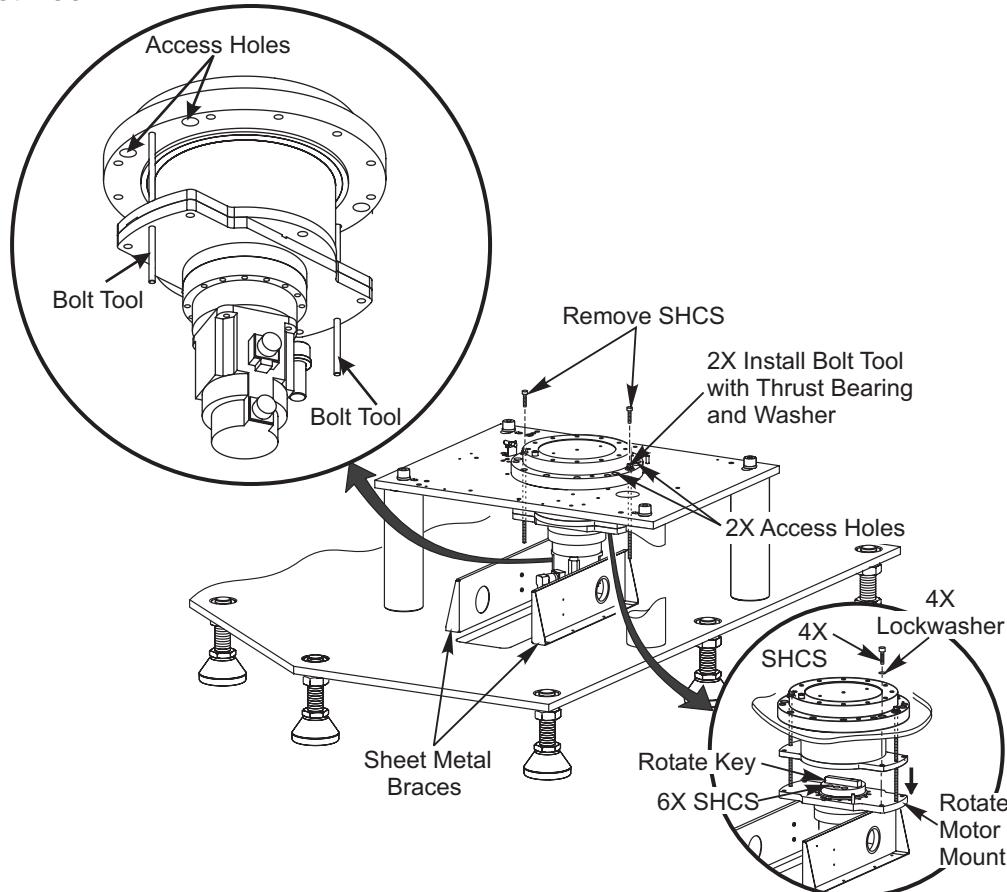
From Preceding Page



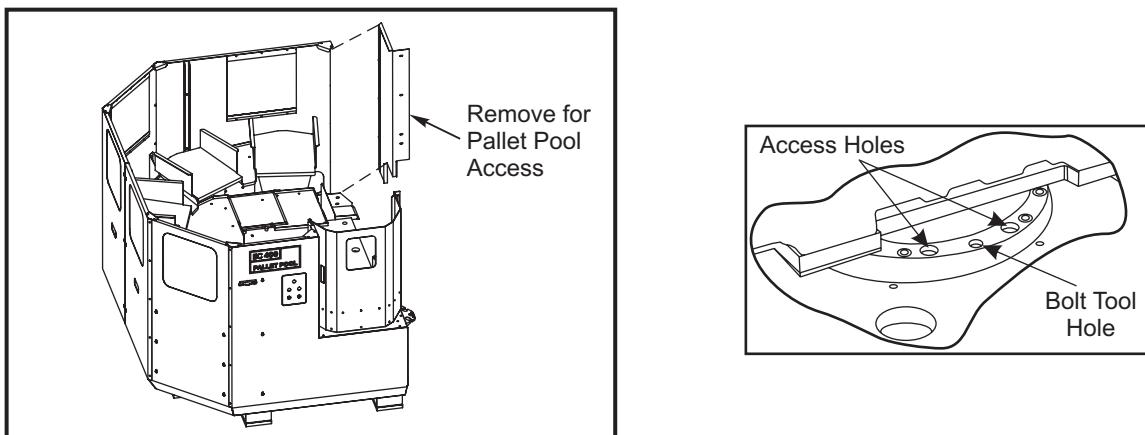


## PALLET POOL MOTOR REPLACEMENT

Pallet Pool Motor Replacement is accomplished from beneath the Rotator/Slider of the EC-400 Pallet Pool



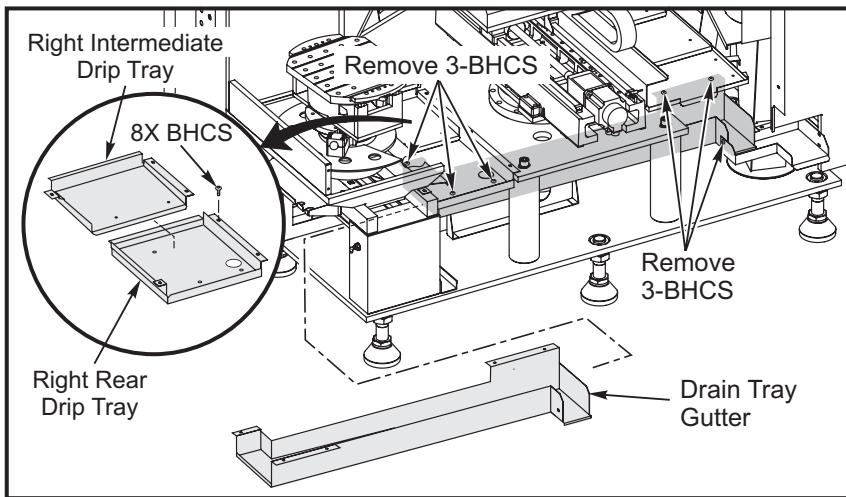
1. Enter M17 in MDI mode and press Cycle Start to unclamp load station pallet (recommend 25% rapid). Wait until assembly has fully risen to its highest point and begins to rotate, then press Emergency Stop.
2. Remove sheet metal attaching the Pallet Pool to the EC-400 to gain access to the interior.



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.



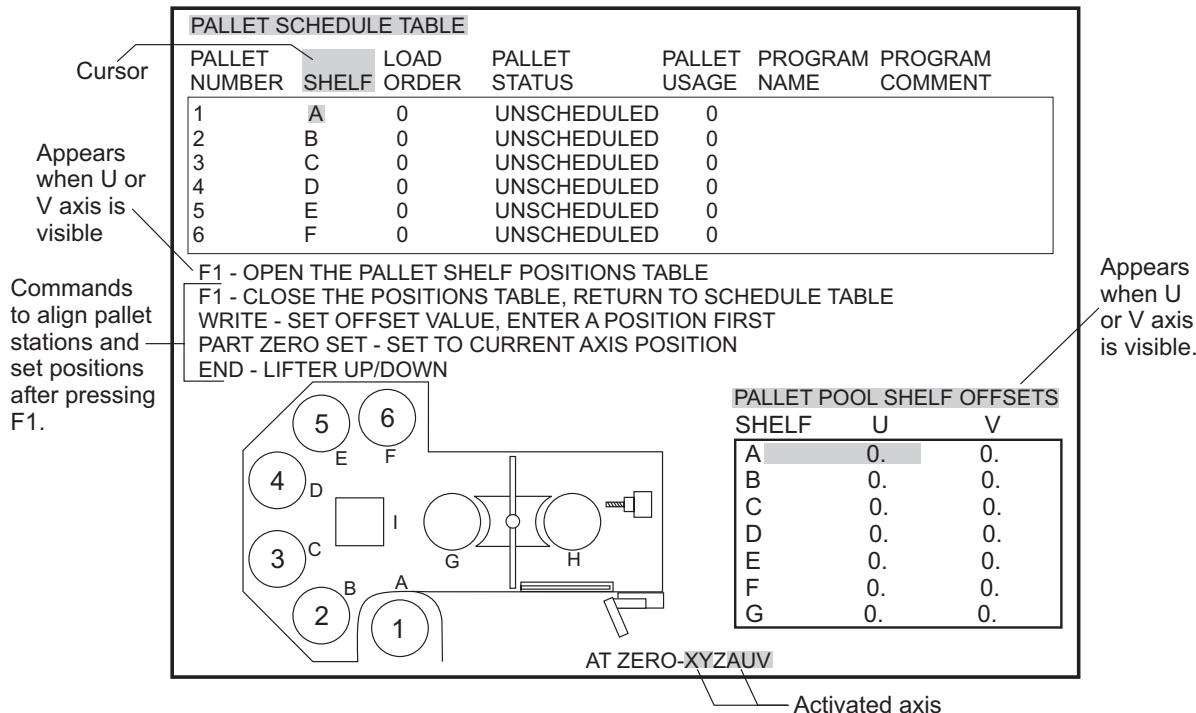
9. Enter the open area at the left side of the pallet pool by crawling into it, make your way to the motor, and disconnect any cables and wires holding the motor to the rotator/slider.
10. To remove the motor, slide it down to the end of the sheet metal braces and lift it up and out through the space 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 POOL SETUP MODE



This mode is used to reset pallet positions in the Pallet Pool.

1. Go into debug or make the pallet pool slider axis (U) or rotator axis (V) visible.
2. Move the cursor to the “SHELF” column, then press F1 to enter setup mode.
3. Jog the U and V axes to align the lifter with one of the shelf positions, the load station, or the ready position.
4. Ensure that the lifter is correctly aligned with the shelf by pressing the END key to lower the lift.
5. Press PART ZERO SET to enter the current U or V axis coordinate (depending on the column selected in the Pallet Pool Shelf Offsets table). Move the cursor to the next column to enter the coordinate for the other axis.
6. When finished setting pallet positions, press F1 or RESET to exit setup mode.
7. Exit debug mode, and make sure the U and V axes are reset to invisible.

## 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**

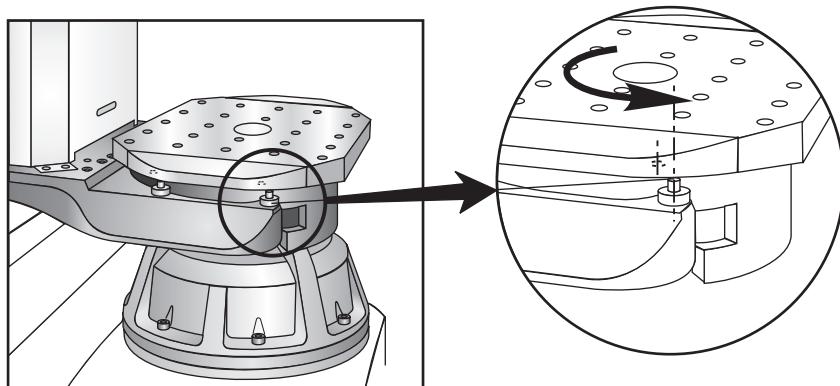
1. At the APC recovery page, confirm that the H-frame is commanded down.



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. 9999999999), 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.

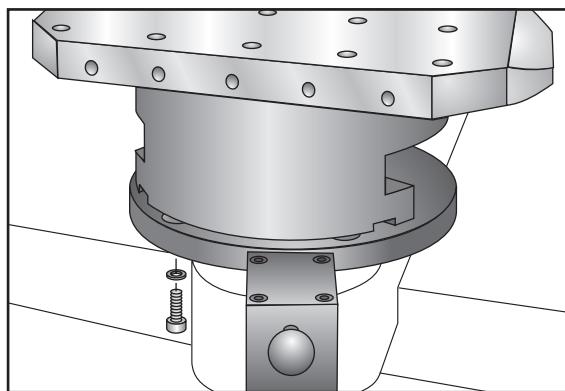


4. Enter Pallet Changer Restore (press Tool Changer Restore and select the Pallet Changer Restore option).
5. Home the Z-axis and verify the pallet to H-frame alignment.
6. Unclamp the pallet and turn down the main air pressure regulator to approximately 10 PSI.
7. Press the key to raise the pallet. 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 returned to home before automatic pallet changes can occur.



## EC-400 ROTARY REPLACEMENT

### Warning

The indexer will crash if the following procedures are not followed. Read all material before proceeding.

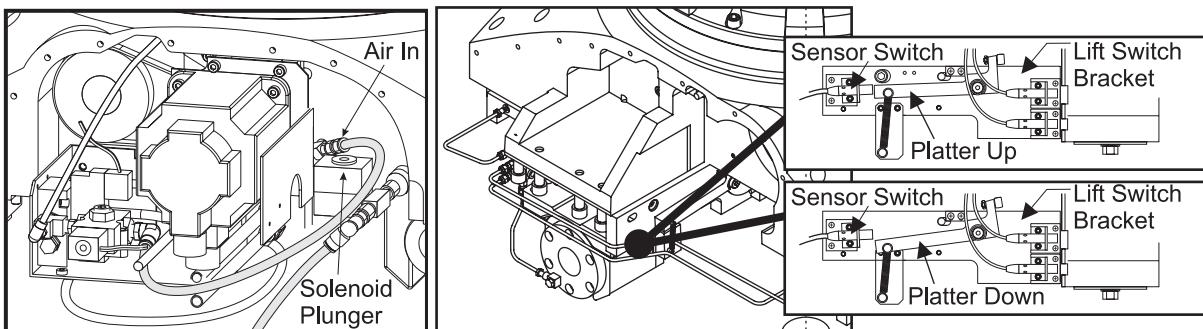
**When the Indexer is replaced in the EC-400, it must have the lift switch adjusted and Parameter 212 set to zero before any other machine movement is attempted!** Misalignment of the facegear at the home position will cause malfunction. Make sure that software version 12.08 or later is loaded and the 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 platter up state is at 0 when up and 1 when down. Adjust switch position so the platter lift state becomes 0 at .052" above the down position.
9. Tighten the switch mounting screws when this height is achieved.

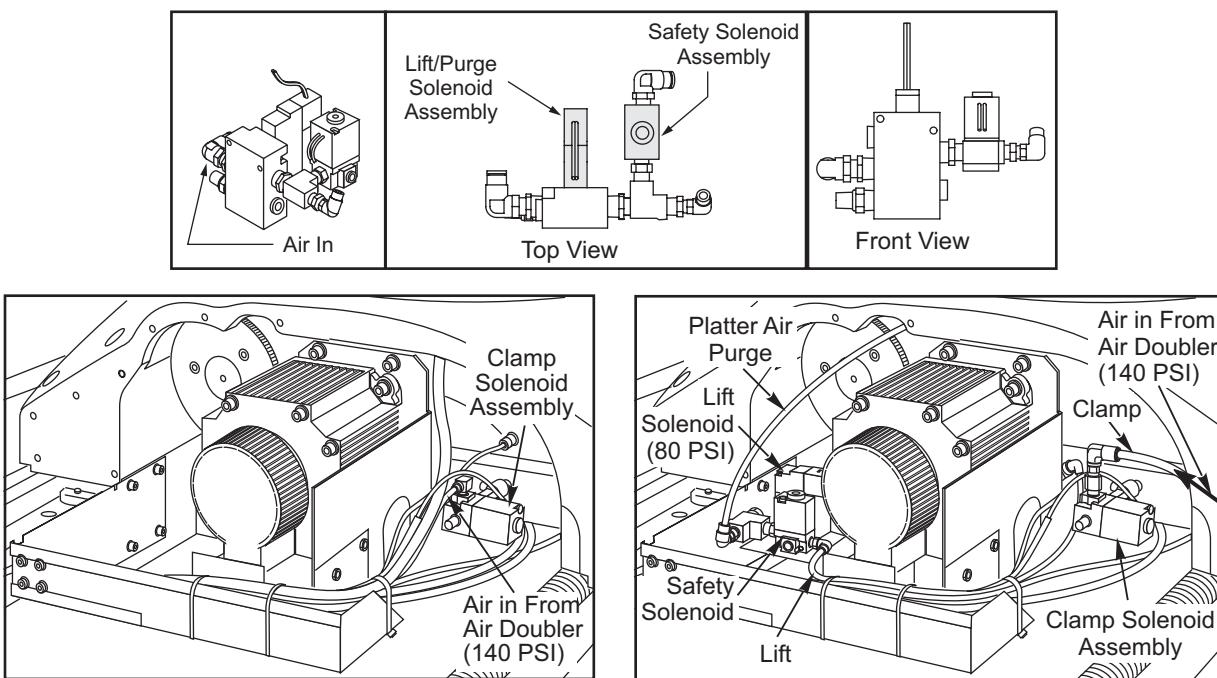
### SETTING PARAMETERS 212 AND 128 (INDEXER A AXIS OFFSET)

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.

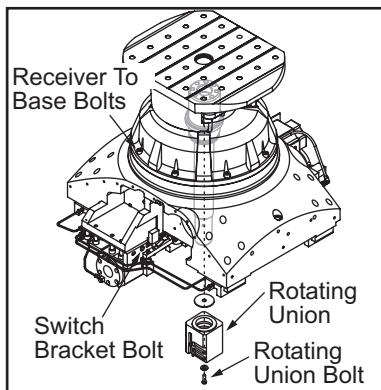
**Indicate the receiver runout** by indicating the top of the locating pads on the receiver. On machines with 1 or 45° indexers, move off the pad in Z-axis, rotate A-axis 90° to next pad and come back in to the same Z-axis position and note the indicator reading. For a full 4th rotary it is not necessary 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 single bolt securing switch plate assembly and remove 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 bottom of rotating union. The rotary union is now loose and is pulled straight down to remove. Note there are shim washers between large fender washer and the bottom of the receiver shaft.

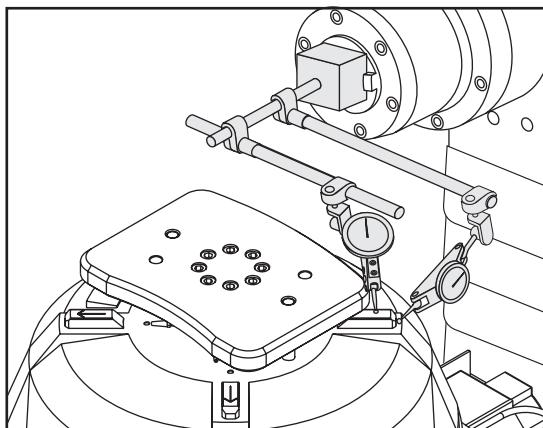


7. Remove the eight bolts securing the receiver to the rotary platter. The receiver is now ready to be removed from the machine.
8. Working through the operator door, use lifting equipment to remove the receiver. The receiver clamp plate has 1/2-13 tapped holes in it so that lifting eyes can be installed, 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 magnetic 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.

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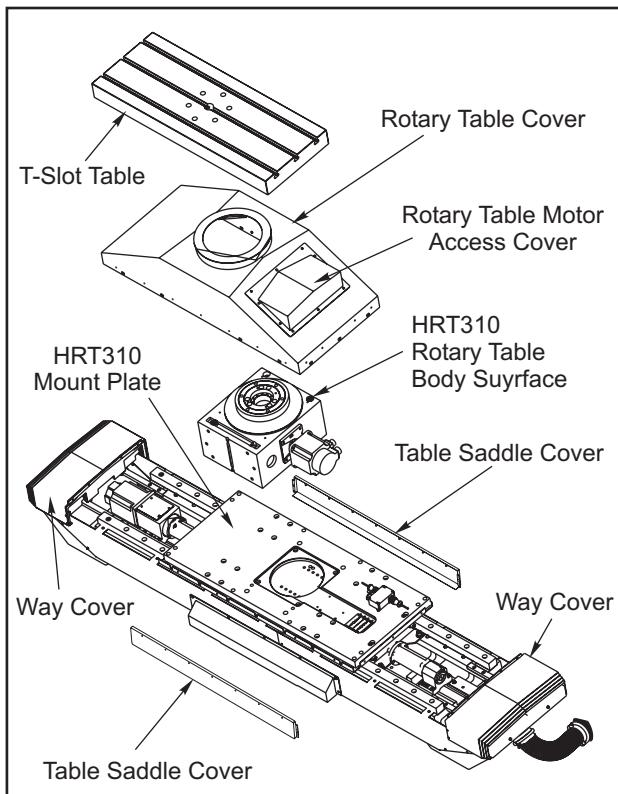
**NOTE:** Check both pallets before making any adjustments. The pallets should be within .0005" of each other.

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.

#### ES-5 HRT310 ROTARY TABLE REPLACEMENT



1. Remove the 6 bolts securing the T-Slot table to the rotary table and remove the T-slot table.
2. Remove the fasteners securing the two table saddle covers to the rotary table cover and remove the table saddle covers.
3. Remove the fasteners securing the waycovers to the rotary table cover, slide the waycovers back and remove the rotary table cover.
4. Disconnect the cables, lubrication lines, and air lines from the HRT310 rotary table.
5. Remove the 4 bolts securing the HRT310 to the mount plate and remove the HRT310.
6. Install the Oil Tank Assembly and route the oil tank hoses to the HRT310 as described in the Oil Tank Assembly Hose Routing section.



7. Clean and stone surfaces, set the new HRT310 rotary table in place and replace the 4 bolts securing it to the mount plate.

8. Align the HRT310 table.

a. Indicate the top of the mount plate in the X and Z axes. If necessary, adjust shims under the mount plate to align the mount plate as close as possible to .0004" in the Z-axis and .0002" in the X-axis.

b. Indicate the top of the rotary table in the X and Z axes. If necessary, adjust shims under the rotary table to align the rotary axis not to exceed .0004" in the Z-axis and .0002" in the X-axis.

9. Connect the cables, lubrication and air lines to the rotary table and ensure that the oil reservoir is filled with Mobil SHC 630 Synthetic Gear Oil.

10. Replace the rotary table cover and secure the two table saddle covers to it with the previously removed fasteners.

11. Slide the waycovers forward and reattach the fasteners securing the waycovers to the rotary table cover.

12. Reinstall the T-slot table and the 6 bolts securing it to the rotary table.

13. Align the T-slot table.

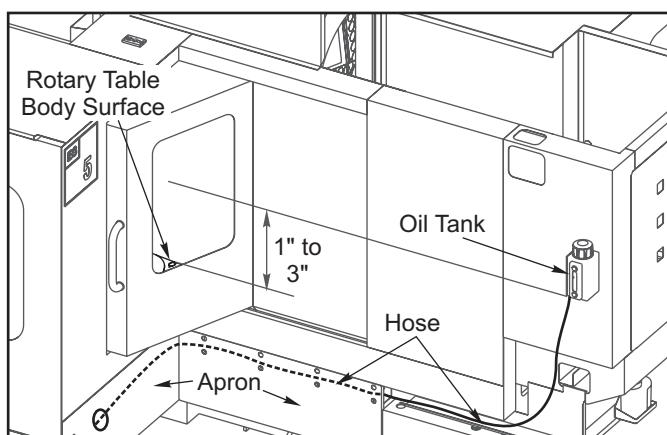
a. Indicate across the T-slot table surface along the X and the Z axes. If necessary, adjust shims under the T-slot table to align the rotary axis not to exceed 0.0001" in the Z-axis and .0015" in the X-axis.

b. Set the A-axis Home grid offset to 0.

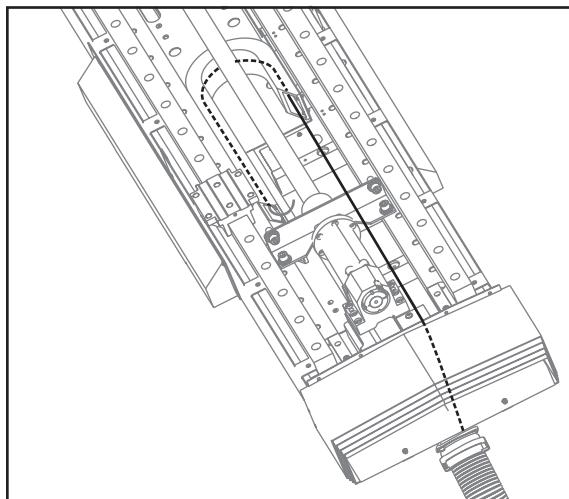
#### OIL TANK ASSEMBLY HOSE ROUTING

The Oil Tank Assembly (30-6747) consists of the oil tank, hoses and possibly a bracket. It is attached to sheet metal on the ES-5 and is used to fill the HRT310. The hoses are routed from the oil tank to the HRT310 table.

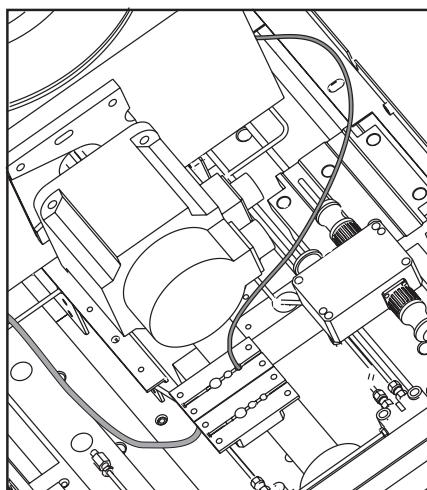
A bracket has been provided (if necessary) upon which to mount the oil tank. The bracket should be mounted at a height of approximately 60". Remove the machine aprons to reveal the cabling trough, connect the fitting on one end of the hose to the oil tank, and route the hose down the sheetmetal and into the trough, along with other hoses and cabling. Route the hose into the gore tube at the end of the trough and into the interior of the machine, and replace the machine aprons.



Route the oil hose out from the gore tube and into the cable carrier. Route the oil hose through the cable carrier and out the other end.



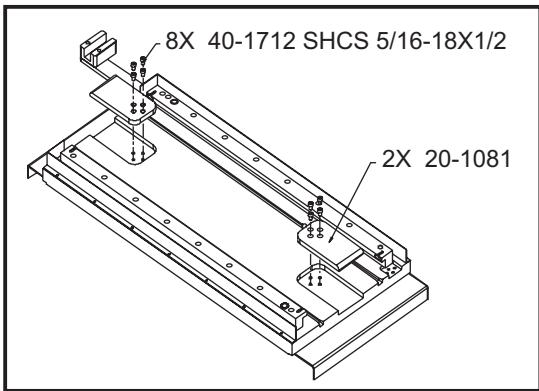
Route the oil hose out from the cable carrier and up through the strain relief conduit to the fitting on the side of the HRT310. Connect the hose to the fitting.



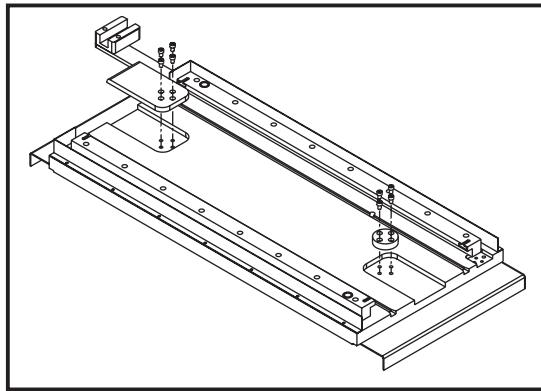
## AUTOMATIC PALLET CHANGER (APC) (VERTICAL MACHINES)

### 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 1/2 ( 4 ). Torque to 35 ft-lb. Bolts for Location Stub are 40-16385 SHCS 5/16-18 X 3/4 (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 12.5mm) above the receiver base.
- If alignment pins are out of receiver body, check depth of hole. Depth should be .510" to .550" (13 to 14mm).

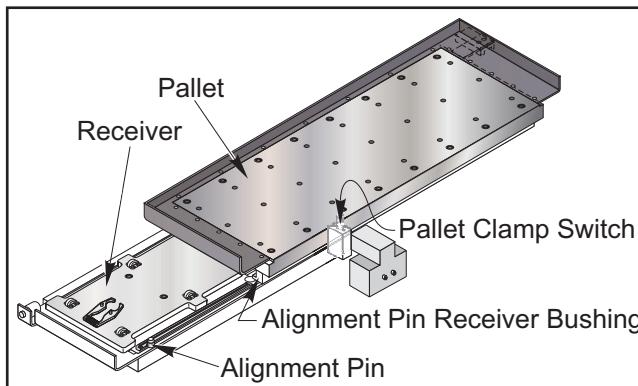
#### **Sticking Pallet**

- 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**

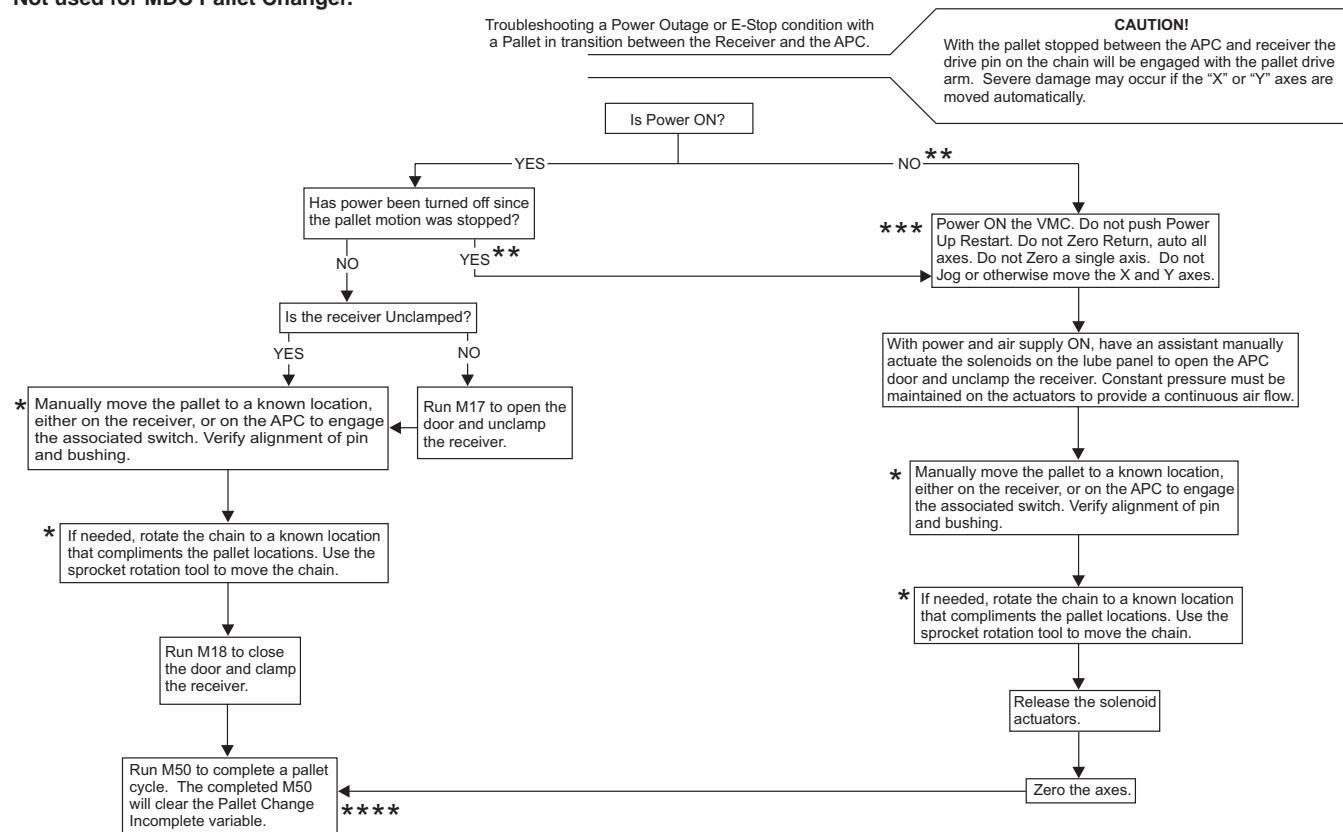
- If the APC does not run, but the mill does, check the APC control cable.
- Be sure the E-Stop jumper is removed and the APC control cable is plugged tightly into the 5th axis port.

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

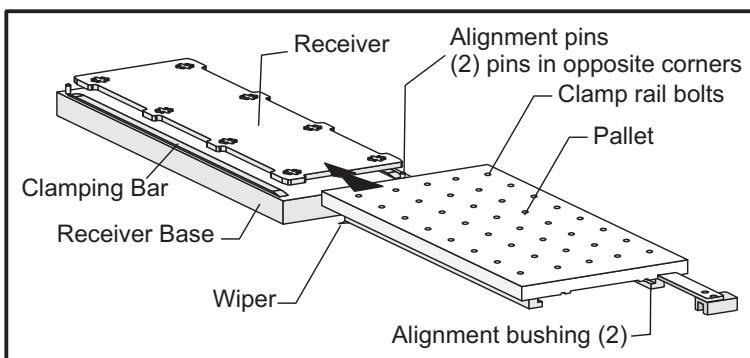
Disconnect the APC motor wire on the **left** side of the Quad APC mills. The pallets will be difficult to manually move if this is not done. The motor cable is located under the APC base.

**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.



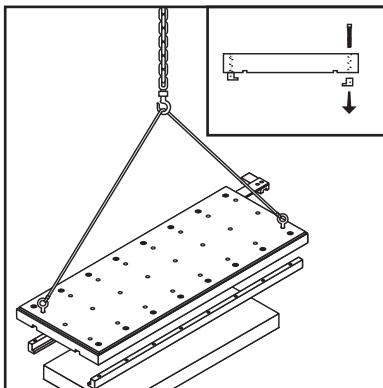
*Pallet Replacement*

### 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.

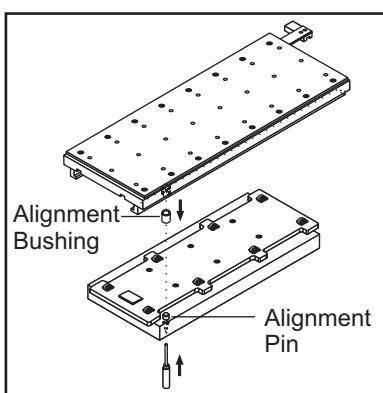
#### ALIGNMENT PIN REPLACEMENT

**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.

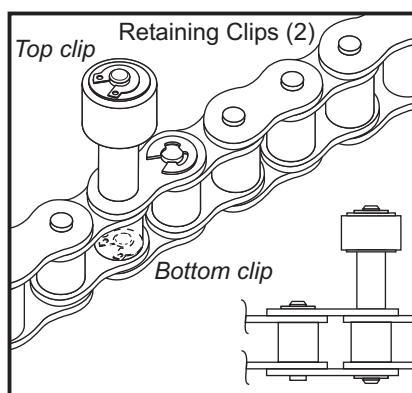
**NOTE:** Because the receiver has been removed from the mill, any tooling on the pallets must be re-aligned.

#### 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.

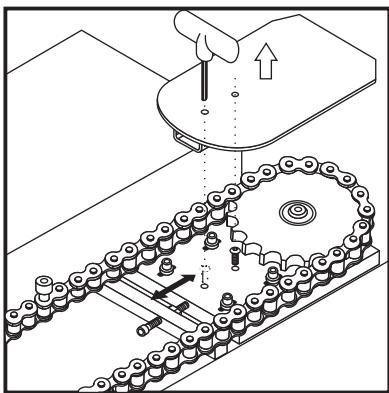


*Drive Pin Assembly*

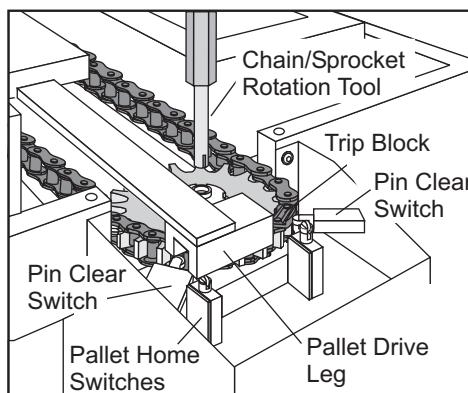
3. Remove 5/16" washer.
4. The cam follower is lightly pressed onto the pin. The spacer should slide off easily.

#### 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 GRID OFFSET**

#### **Setting the Offset Using the Grid Feature**

**Must have software version 11.17 (mill) or 4.21 (lathe) or later.**

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; manually calculate the offset for these types of axes.

1. Turn the machine off and back on. This will un-zero all the axes.
2. Select the Alarms screen and enter Debug mode (Setting #7 Parameter Lock must be off to enter Debug).
3. Set the grid offset to zero (Parameter 125,126, 127, 128, or 170, depending on the axis being set.)
4. 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.)
5. 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.

The Grid feature can be used on each axis independently by entering "Grid" a space and then the axis later, for example to set the grid offset on the x-axis enter, Grid X.

6. Perform Auto All Axes and verify that the Dist to Go value for each of the selected axes is now close to 0.0787". 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**

**Machines with software version earlier than 11.17 (mill) or 4.21 (lathe).**

Please read this section in its entirety before attempting to set the grid offset.



### Guidelines

The encoder Z channel signal will occur close to 2 mm (.0787") from where the home switch is released. If Distance to Go is less than .75 mm (.0295") or greater than 5.2 mm (.2065"), 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". 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 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.

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**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:**

- 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.

- 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.

- Does spindle head drift down from top of travel upon E-Stop?

1) **Yes:** Replace the switch.

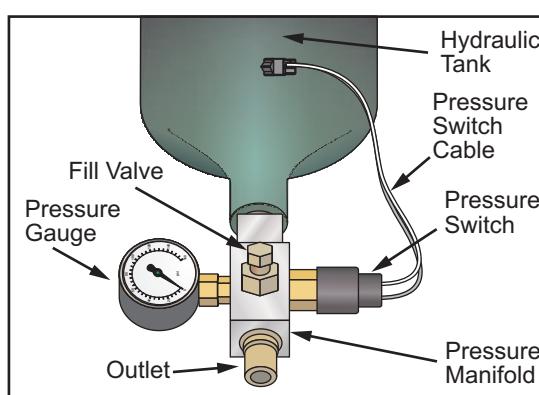
2) **No:** Replace the pressure gauge.

**Tools Required:** (1) 4 x 4 x 14" head support block.

Hydraulic counterbalance service kit, consisting of:

Pressure tank with manifold assembly, pre-filled 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  $\frac{3}{4}$ " 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

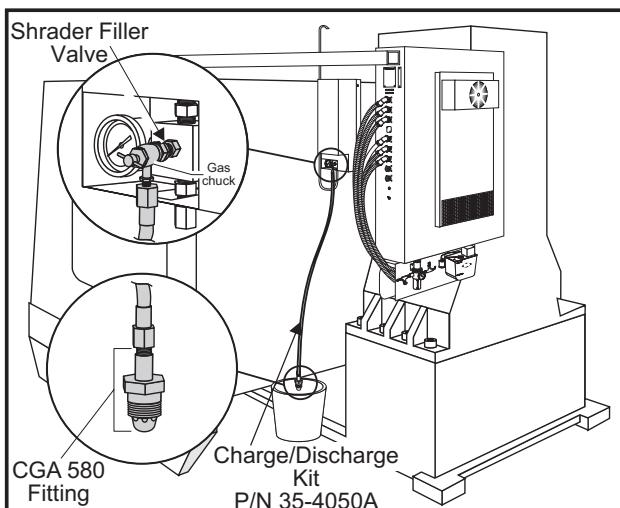
### Removal

**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 and 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 tank assembly to column with the tank mount and four SHCS. Ensure hydraulic hose is not twisted.
3. Connect the two-pin end of the pressure sensor cable(s) to the pressure sensor(s) and 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.

4. Attach the CGA 580 fitting end of the charge/discharge kit to source pressure. Turn T-handle of gas chuck 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.

**NOTE:** For machines with two counterbalances, 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.

Machine	Tank Pressure at Top of Travel
VF-3/4	1150 psi
VF-3YT/50	1100 psi
VF-5/40	875 psi
VF-5/50	1100 psi
VF-6/7/10 50T	1150 psi
VF-8/9/11 50T	1550 psi
VR	1025 psi
VS	1250 psi
HS	1250 psi
EC-630/1600/2000/3000	800 psi

*Tank Pressure Requirements*

5. 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.

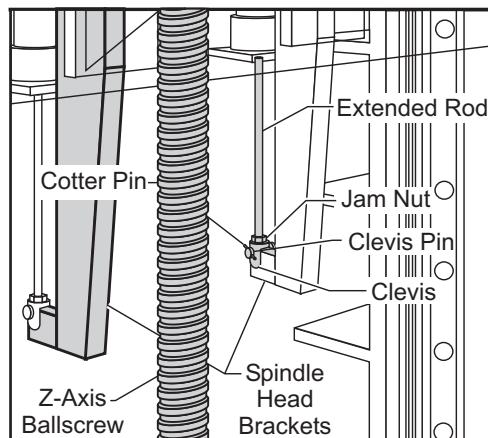
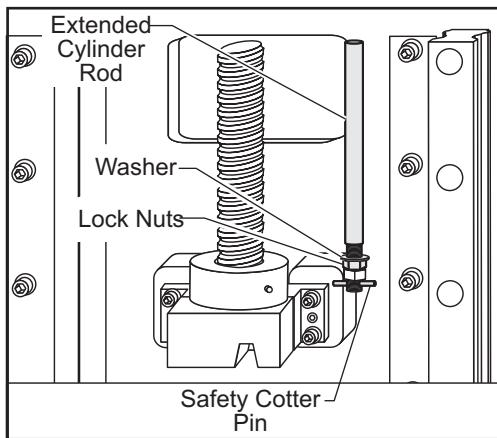
**NOTE:** If there is an E-Stop alarm that will not reset, check for correct system pressure and the correct tank assembly.



## HYDRAULIC CYLINDER REPLACEMENT

### Removal

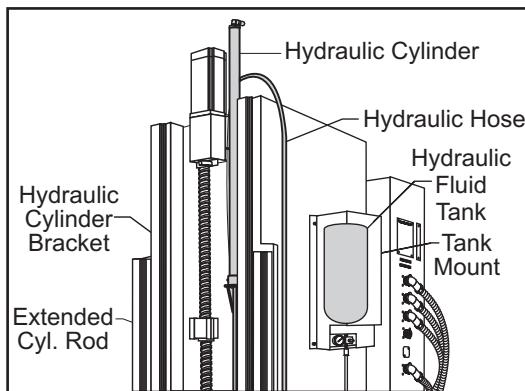
1. Remove the hydraulic tank as described in previous section.
2. To gain access to the cylinder rod, remove the three SHCS holding Z-axis way cover to spindle head.
3. Remove the cotter pin and lock nuts from the threaded end of the cylinder rod.



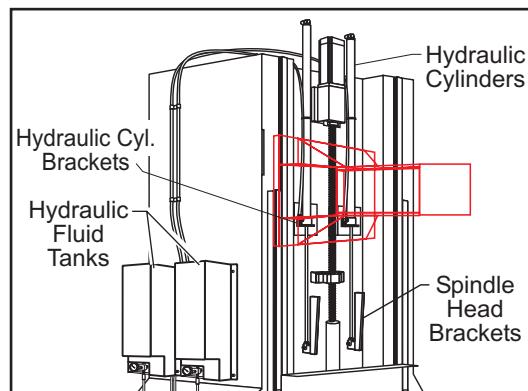
Hydraulic Cylinder Rod Installation for VF-1 through 4 and (VF-6/8)

**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.

5. 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.

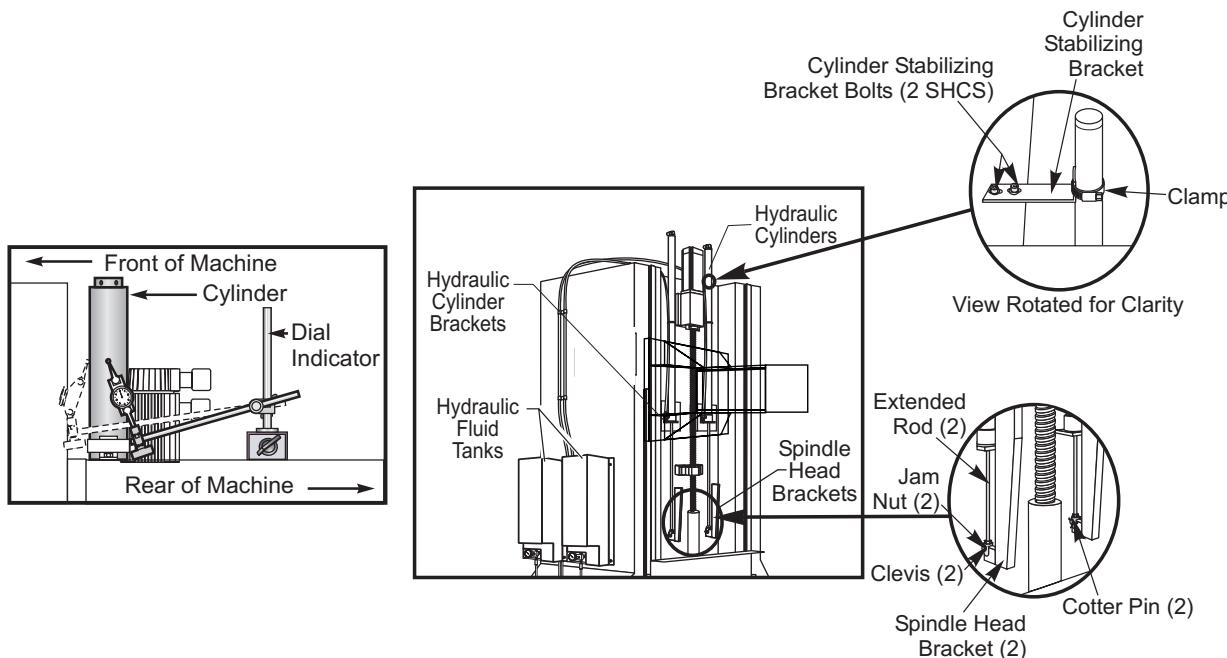


**NOTE:** For VF-6/8, orient cylinder bodies with hydraulic hose facing the ballscrew.

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 spindle head brackets have been moved from the original location it will be necessary to check for side to side alignment. Place a dial indicator 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. Cylinder shift should not exceed .015 in.
9. When the side to side alignment of the cylinder is correct, tighten 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.



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**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**

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**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**

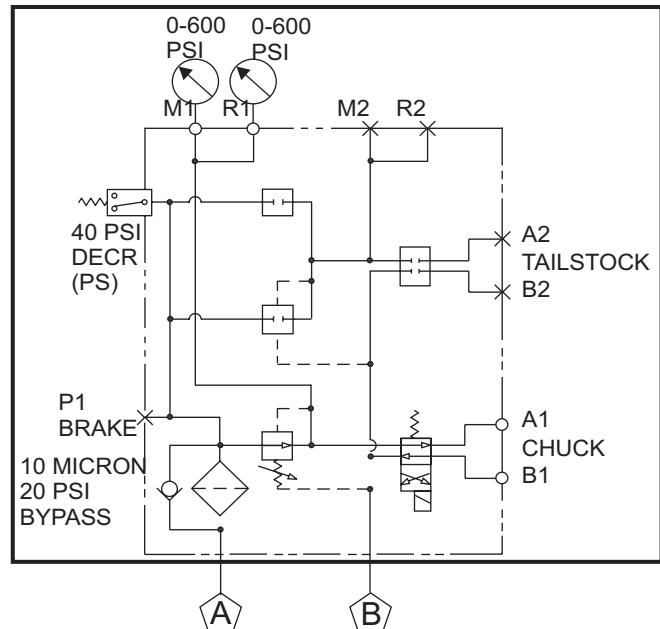
1. Position the HPU in place, and secure with four mounting bolts.
2. Connect pump motor, pressure switch, and solenoid valve cables
3. Replace the hydraulic hoses.
4. Fill the HPU with DTE25 to the top of the sight glass.



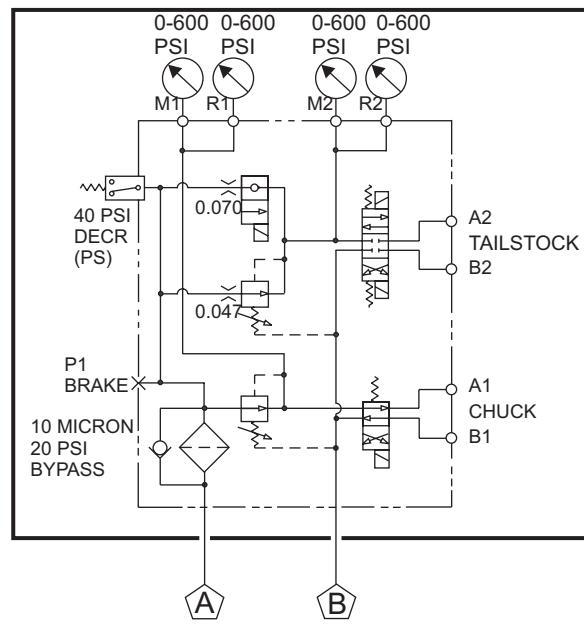
5. Replace any panels that were removed to access the HPU.

### SL-SERIES HYDRAULIC SCHEMATICS

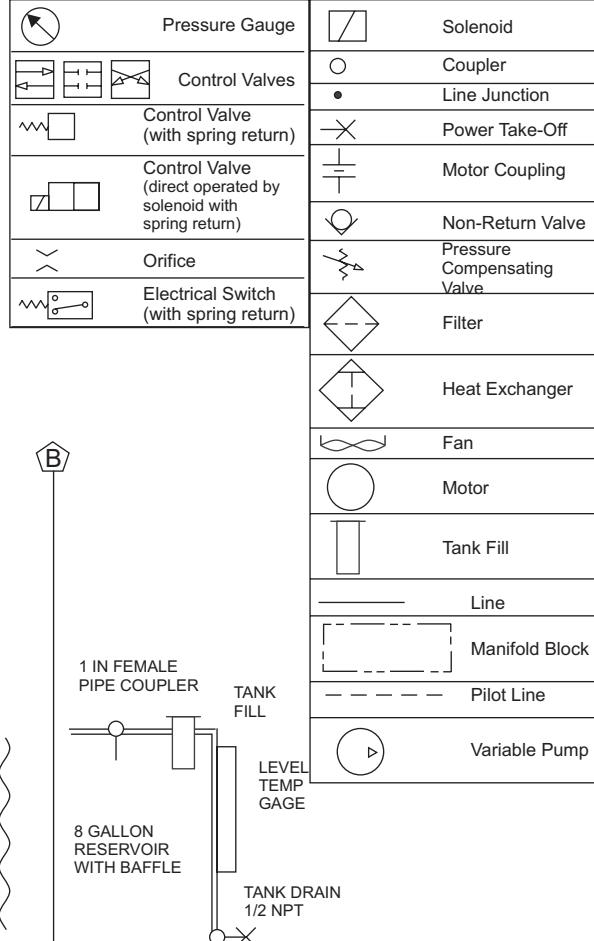
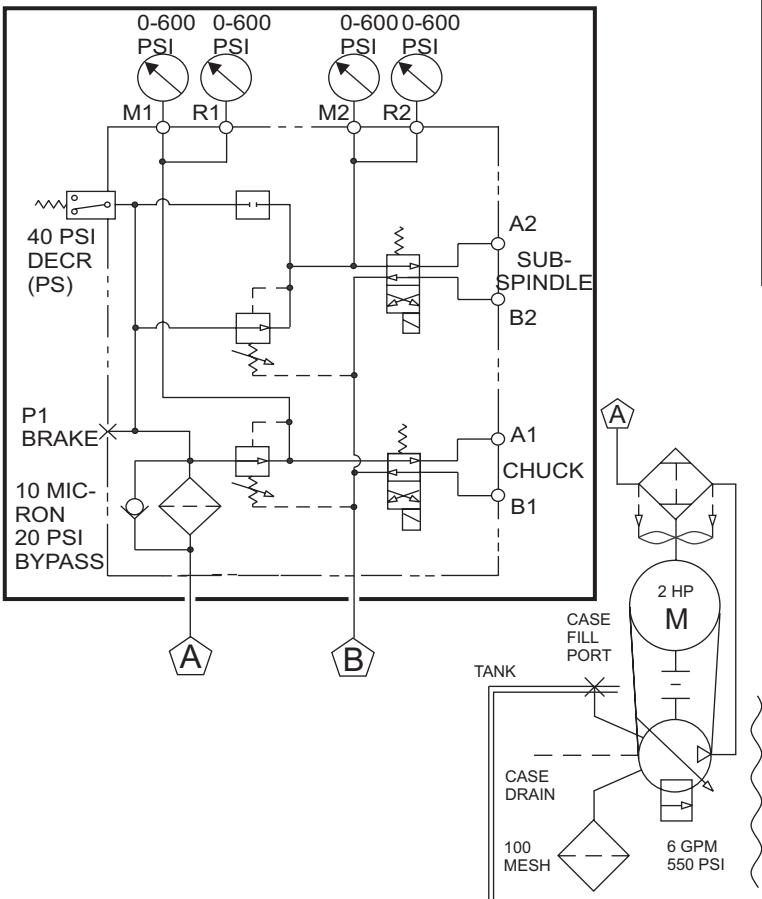
#### Chuck Only 6GPM



#### Chuck and Tailstock 6GPM

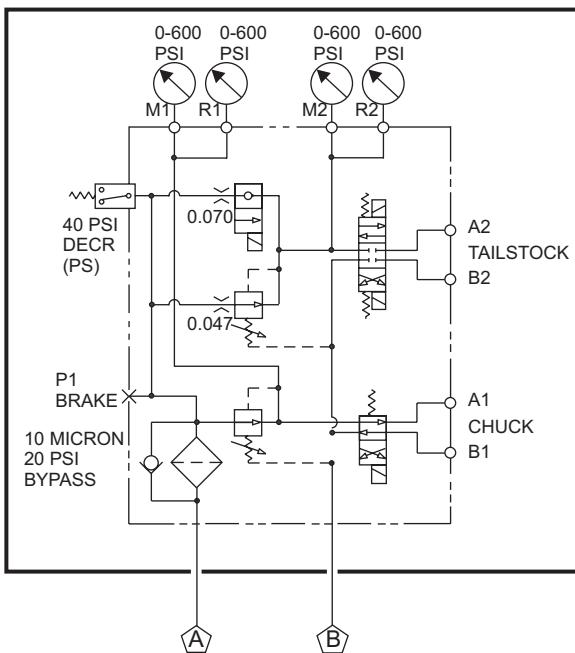


#### Chuck and Subspindle 6GPM

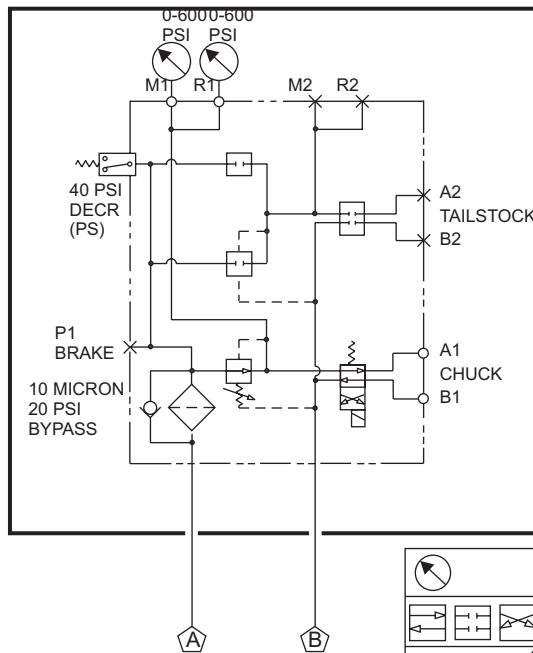




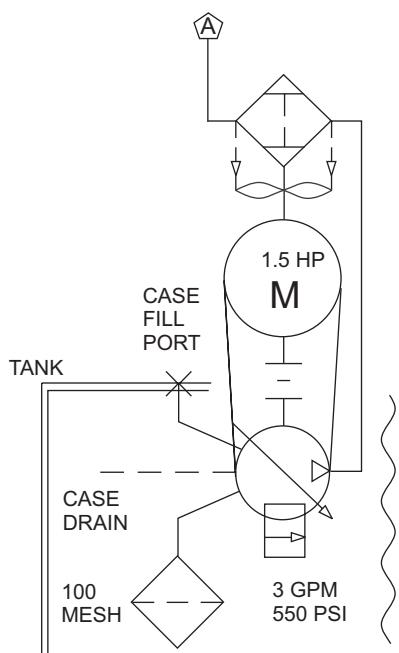
### Chuck and Tailstock 3GPM



### Chuck Only 3GPM



	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 contaminants.
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 thread locking compound 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 cross-threading 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.

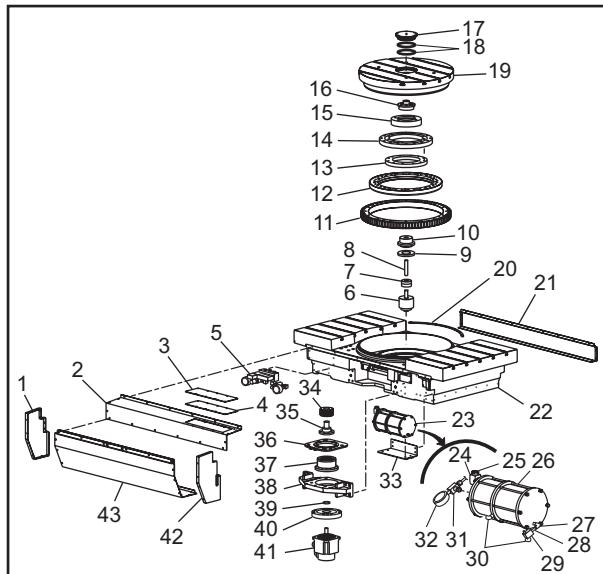
## BLEEDING THE HYDRAULIC BRAKE

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 clamp ring, forcing air and air bubbles out of oil through the bleed valve. Re-pressurize every five minutes for about 10 - 12 cycles or until oil is **completely clear** of any air bubbles. Re-tighten 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 through 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 thread locking compound 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.

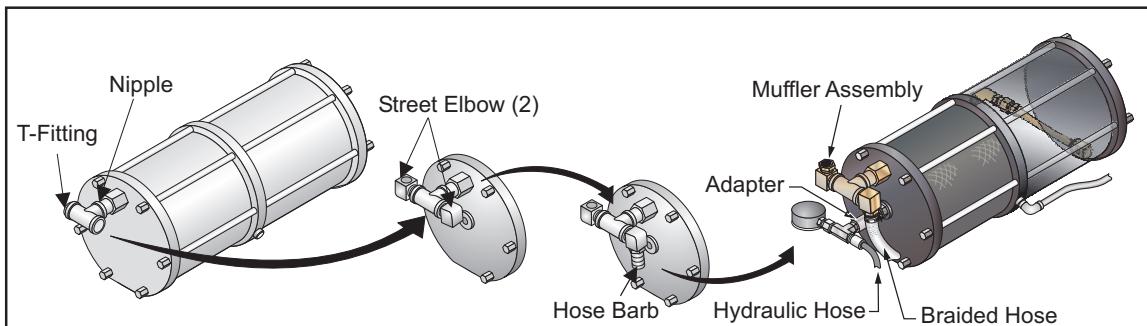
1. Identify the low and high pressure tubing lines coming from the pressure booster. Connect them to the respective low and high pressure ports on the air valve assembly regulator.
2. Attach an air supply line (45 PSI) to the air valve assembly. Supplied air is preset to 45 PSI.
3. Using appropriate 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.

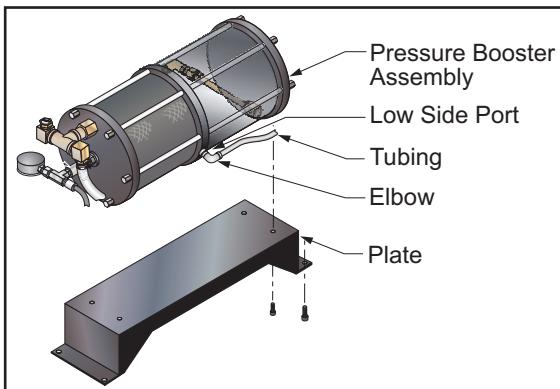
1. The pressure booster is shipped full of hydraulic oil. Tilt the pressure booster on end before removing the plug from the container.
2. Thread the adapter into the pressure booster and tighten.
3. Thread the nipple (new part) into the adapter.
4. Thread the T-fitting onto the nipple and tighten so 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.

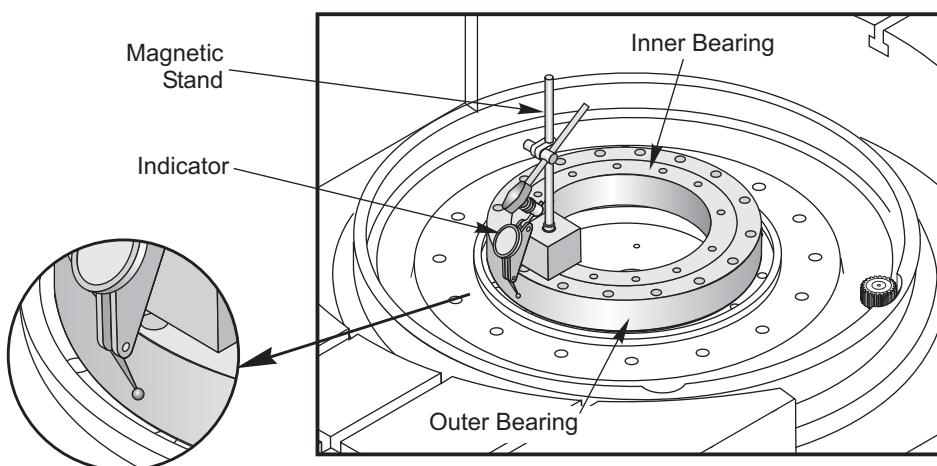


## BEARING INSTALLATION

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.

#### **ROTARY TABLE PLATTER REMOVAL AND INSTALLATION**

##### **Removal**

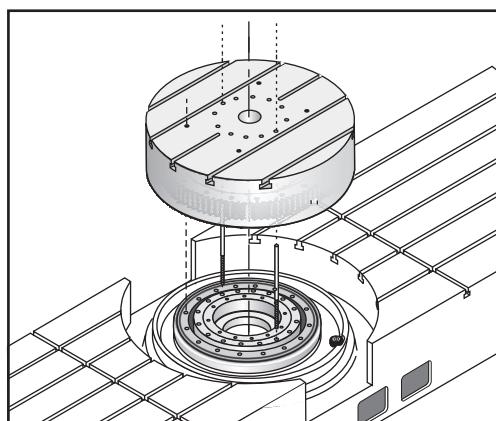
1. Command A-axis brake to disengage. Enter MDI and command an M11. Do not disconnect air to machine.
2. Remove the encoder cover plate. Remove the encoder shaft plate. **Important:** There are two set screws in the encoder shaft plate.
3. Remove the plastic bolt cover plugs and the bolts that secure 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.

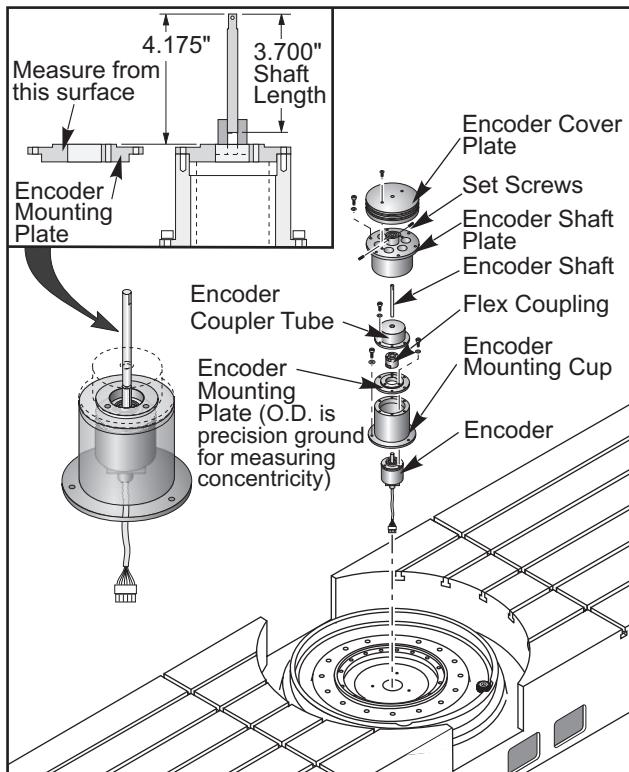
14. Replace the encoder cover plate.

## ENCODER INSTALLATION

### Pre-assembly Verification

Before assembling the encoder mounting parts, perform the following checks:

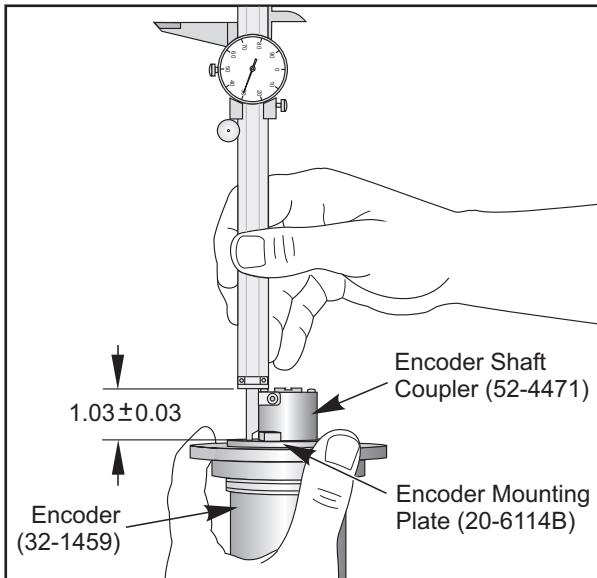
1. Verify the encoder mounting plate inserts into the encoder mounting cup without binding. The contacting surfaces must be burr-free.
2. Verify the encoder shaft has no detectable side-to-side play. Perform this test by hand.
3. Verify the encoder boss inserts into the encoder mounting plate without 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 receiver 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)**

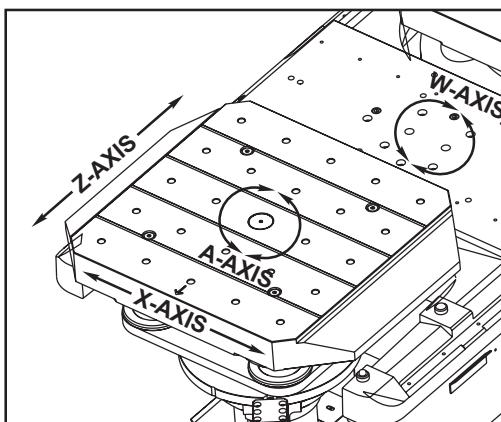
1. In Debug mode (Pos-Raw Dat screen), go to Parameter 212 (224 for EC-630/1600/2000/3000), enter "0" and press Write/Enter.
2. Zero the A-axis only by pressing the Zero Ret key, then the A key, then the Zero Singl Axis key.
3. Go to debug mode and type "GRID" followed by a space and then "A".
4. Jog 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).



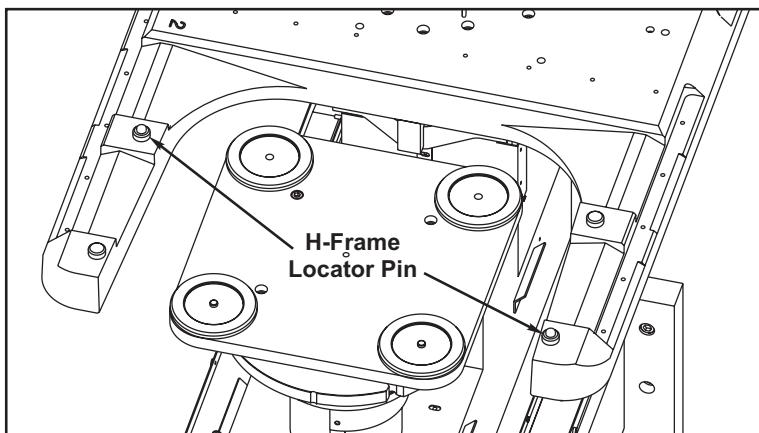
## H-FRAME PALLET ALIGNMENT (EC-630)

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.



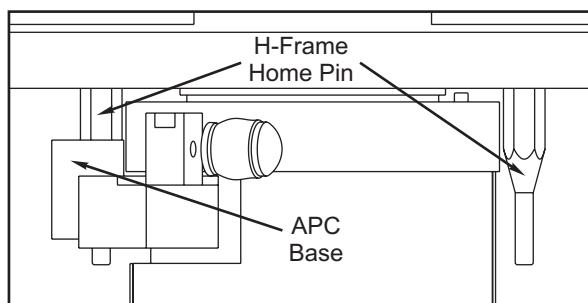
- When the value begins to increase, stop and back up until the fuse value stays constant and record the A-Axis actual encoder count.
- Add the two readings, divide by two, and subtract or add as required to the value in Parameter 224.
- Repeat the handle jogging until the difference between encoder 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 the encoder count into the Tool Changer Offset parameter for the Z-axis (always 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.

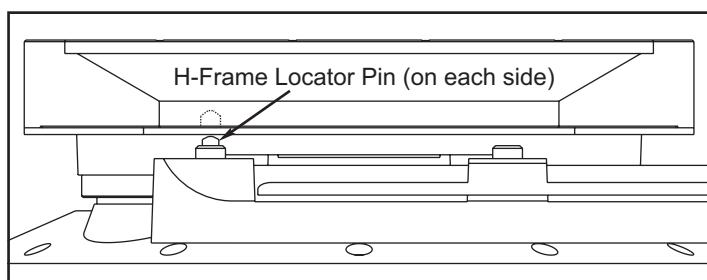
Calculate the number midway between these two values and enter it as the tool change offset parameter.

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.

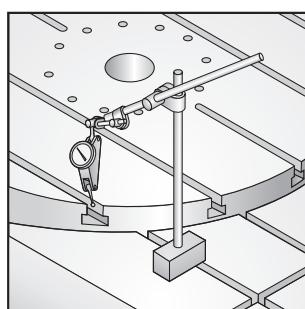
13. Before attempting a pallet change, verify all four (4) H-Frame pins (2 per pallet) are aligned with holes in the bottom of the pallet. Small adjustments in both Z- and W-axis may be necessary to complete this alignment. It is critical that all four (4) pins are aligned to safely lift the pallets. 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).

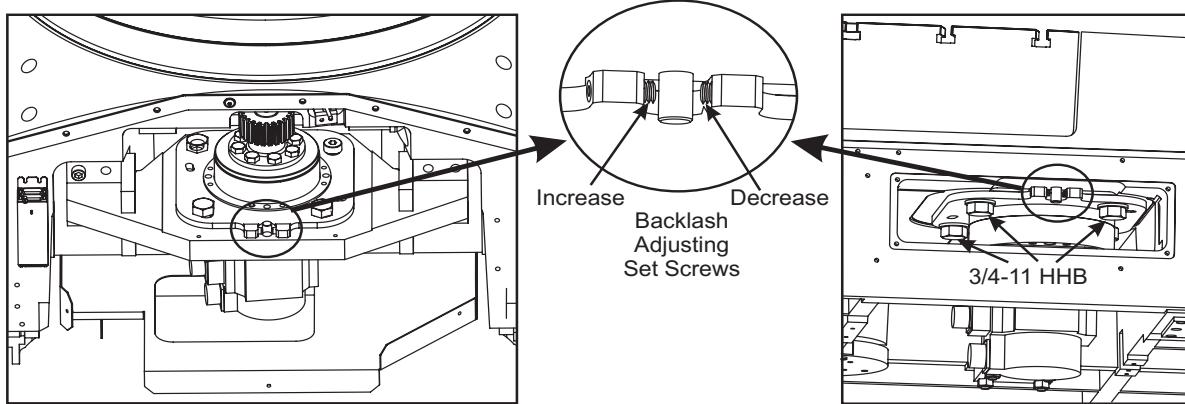




5. Manually rotate the platter back and forth. At times additional force is required to overcome the friction. Use platter lifting plates or a fixture on the platter with a bar between them, if necessary, to move the platter.
6. Take readings from the indicator every  $10^\circ$  for  $360^\circ$ . Reposition 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.



EC-630

EC-1600/2000/3000

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  $10^\circ$  for  $360^\circ$ . 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.

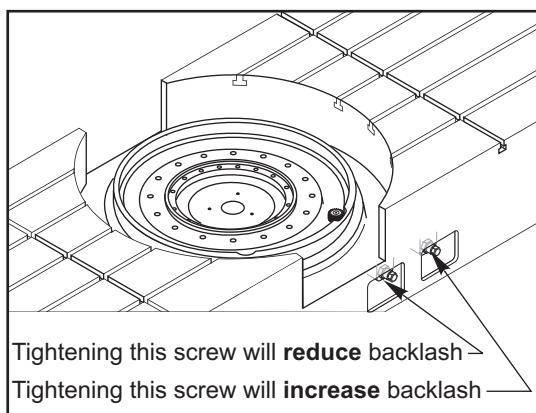
**NOTE:** Be sure that each set screw is tightened snugly against the pin.

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.



### A-axis Backlash adjustment (HS 3R-7R)

1. Command the A-axis brake to disengage. To do this enter MDI and command an M11. Do not disconnect the air to the machine.
2. Disable the A-axis encoder by setting the parameter 43 bit 3 to 1. Note: 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 2 SHCS that bolt through the plate are shoulder bolts and do not need to be loosened.
4. Loosen the backlash adjusting screw lock nuts on both of the adjusting screws. See the following figure. Loosen the left adjusting bolt and thread it back away from the plate. Tighten the right bolt three turns. This will increase the backlash between the drive and ring gear. Note: As this bolt is driven in it may start to bind. If this happens back the bolt off slightly and then continue tightening.



*Backlash Adjusting Screws*

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 cheater bar between them, if necessary, to move the platter within the allowable backlash.
6. Back the right bolt 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. See figure.
8. Begin tightening the left adjusting bolt and check the backlash. Using the cheater bar between the lifting plates or fixtures, nudge the table CW and CCW. Take readings from the indicator. Once the readings come close to .003", rotate the table and take readings every 10° for 360°. Find the tightest of these spots and set the indicator up as in the previous step.
9. Tighten the left adjusting bolt until the backlash is between .0005" and .0007"
10. Snug the right adjusting bolt against the bracket.
11. Tighten the 3/4-11 hex bolts that mount the cam backlash adjuster (motor plate).
12. Tighten the adjusting screw lock nuts.
13. Recheck the backlash. If adjustment is necessary, loosen the plate's hex bolts and adjusting screw's lock nuts before making adjustments.



## 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°).

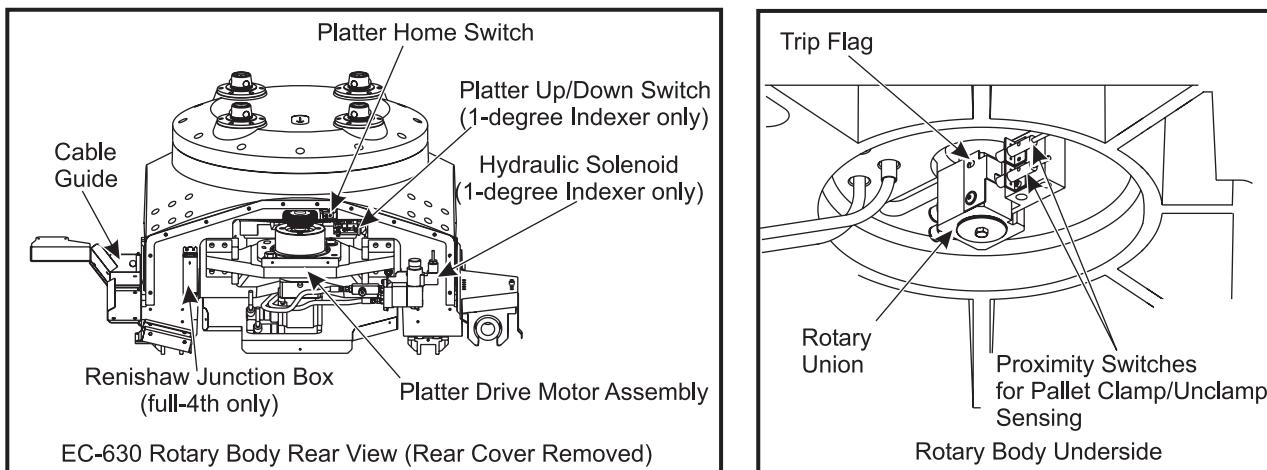
3. Remove 10-32 BHCS that retain worm housing cover. Place drip pan beneath black bearing housing cover to catch any gear oil (keep in place for step 4). Remove bearing housing cover. It may be necessary to use channel lock pliers on the bearing housing to remove it; if this is necessary, use a rag to 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



### Motor Assembly Removal

1. Command a pallet change and remove the pallet 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 4<sup>th</sup> 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.

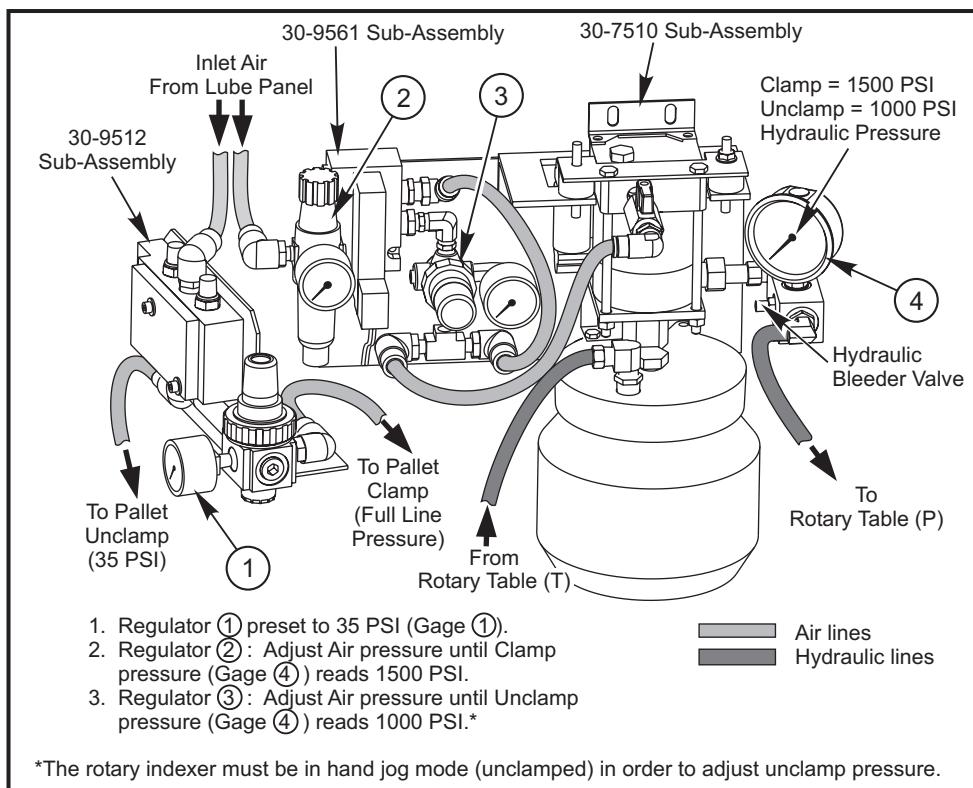
When replacing switches, make sure that the clamped (lower) and unclamped (upper) switches are in the appropriate positions, and that they are plugged into their appropriate locations at the control.



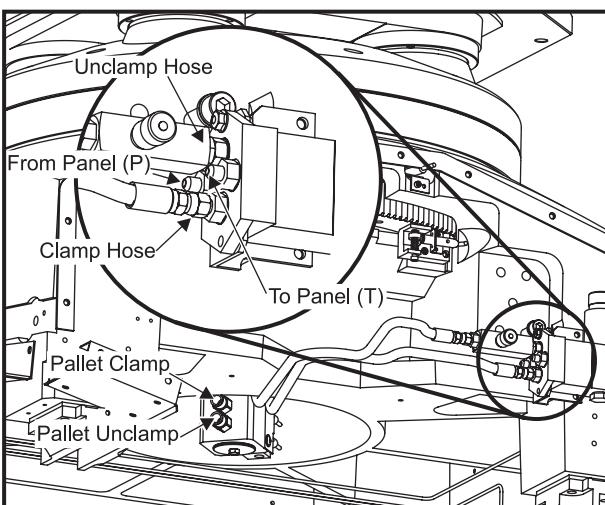
## HYDRAULIC / PNEUMATIC CONNECTIONS

The EC-630 rotary body is controlled by a pneumatic/hydraulic panel, located behind the enclosure directly underneath the pallet load station. A-Axis alarms such as 946 (APC Pallet Clamp Timeout) and 947 (APC Pallet Unclamp Timeout) may indicate that panel regulators or solenoids need to be adjusted or replaced. If parts of these panels are serviced or replaced, it is important that the hydraulic and pneumatic lines are correctly reconnected; refer to the appropriate illustration.

### 1-Degree Indexer



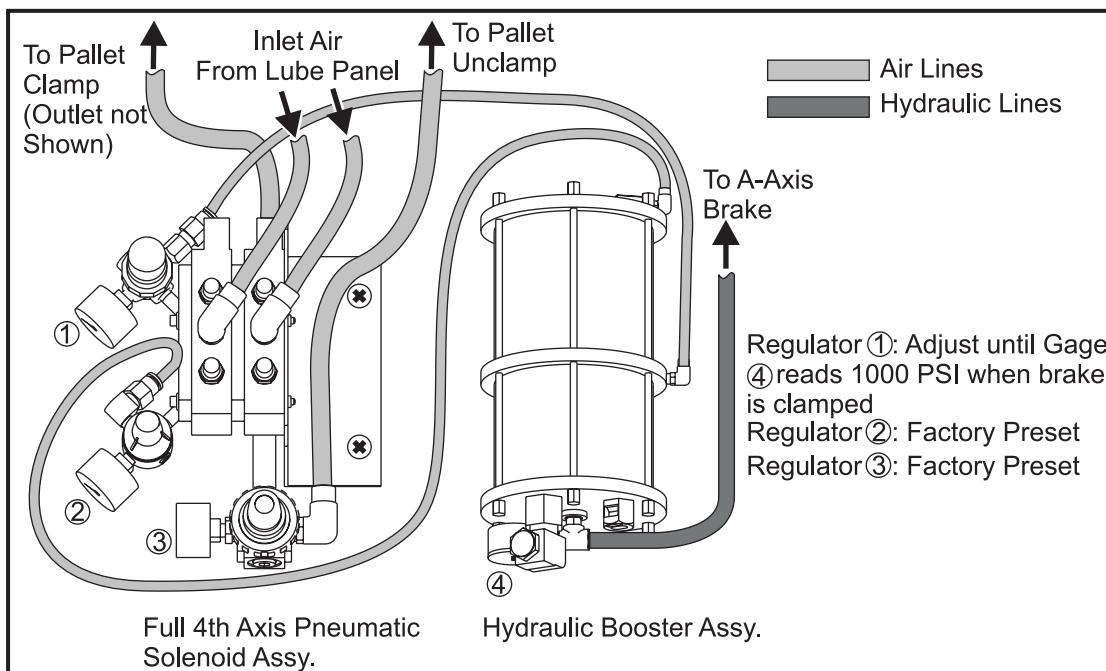
The 1-degree indexer panel consists of three discrete assemblies: A clamp/unclamp solenoid valve assembly (30-9512), an air solenoid assembly (30-9561), and a liquid pump assembly (30-7510). Reconnect hoses to the rotary body according to the following illustration. Ensure that hydraulic lines are properly bled.



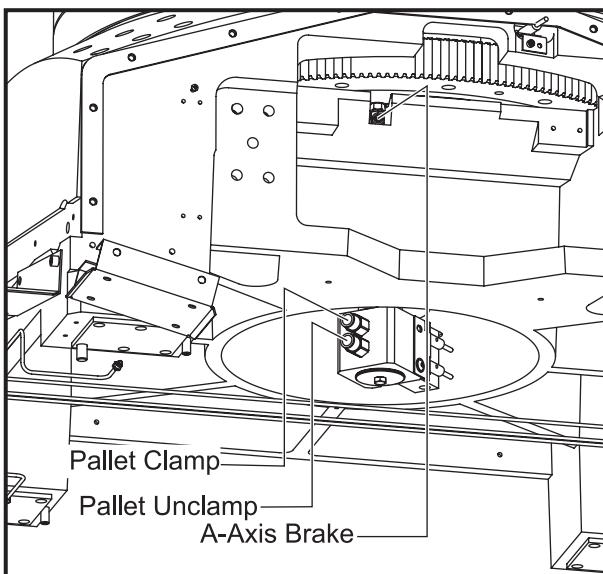


## Full 4th Axis

The EC-630 full 4th axis uses an air solenoid assembly to clamp/unclamp the pallet and a hydraulic booster to power the A-Axis brake:



Connect full 4th hoses to the rotary body as shown. Ensure that hydraulic lines are properly bled.





## 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, requiring no maintenance.

The Harmonic Drive Assembly is made up of the following components:

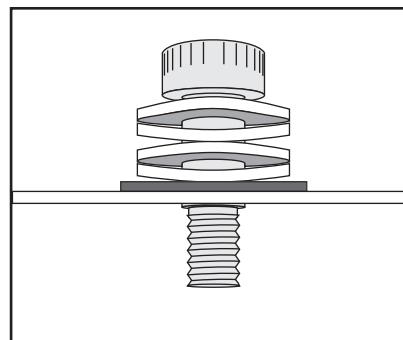
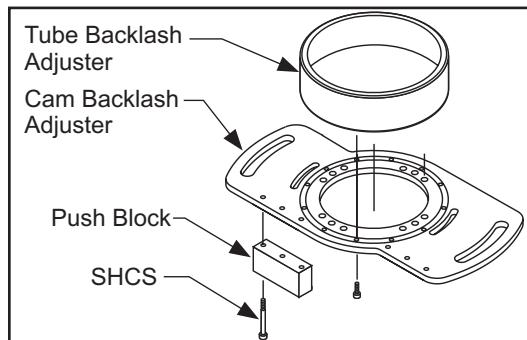
Housed Harmonic Wave Generator	DriveGearbox Adapter Cam Backlash Adjuster	O-Ring Pack	Pinion Gear, 22 Tooth Yaskawa Sigma Motor
--------------------------------	--	-------------	---

### 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

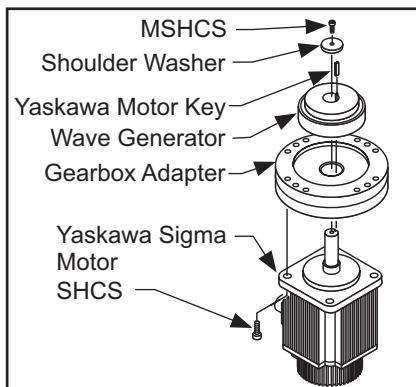
1. Sweat pinion gear (positioned so groove is away from flange) over shaft of sigma adapter and set aside.
2. Examine the spindle of your Yaskawa sigma motor. If your motor has the motor shaft spacer already sweated onto the shaft, skip to step 4.
3. Sweat the motor shaft spacer over the shaft of the 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 wave generator over motor shaft. Align keyway in wave generator with 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 thread locking compound , insert the MSHCS and tighten.

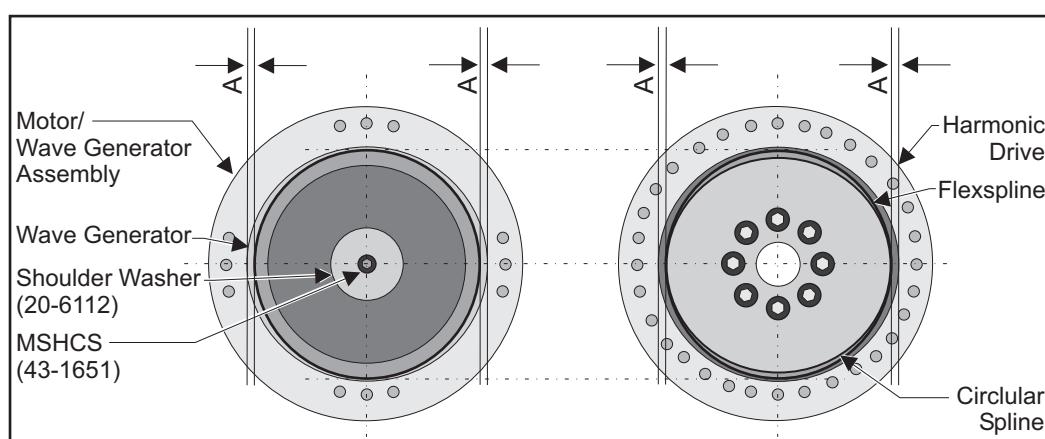


#### HARMONIC DRIVE ASSEMBLY

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, it is essential that the wave generator ring be concentric with the harmonic drive ring. The wave generator and harmonic drive rings are ellipses; not circular. Incorrect assembly results 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.

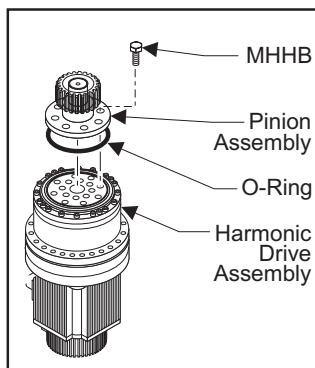
5. Bolt gearbox adapter to harmonic drive by inserting four SHCS into countersunk holes in gearbox adapter.

**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 contaminants. 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.

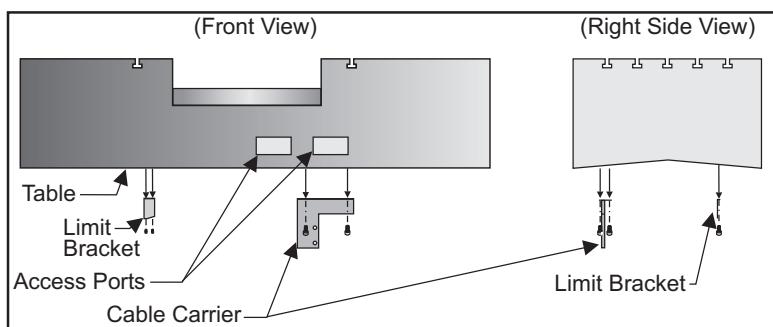


## Installation

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.

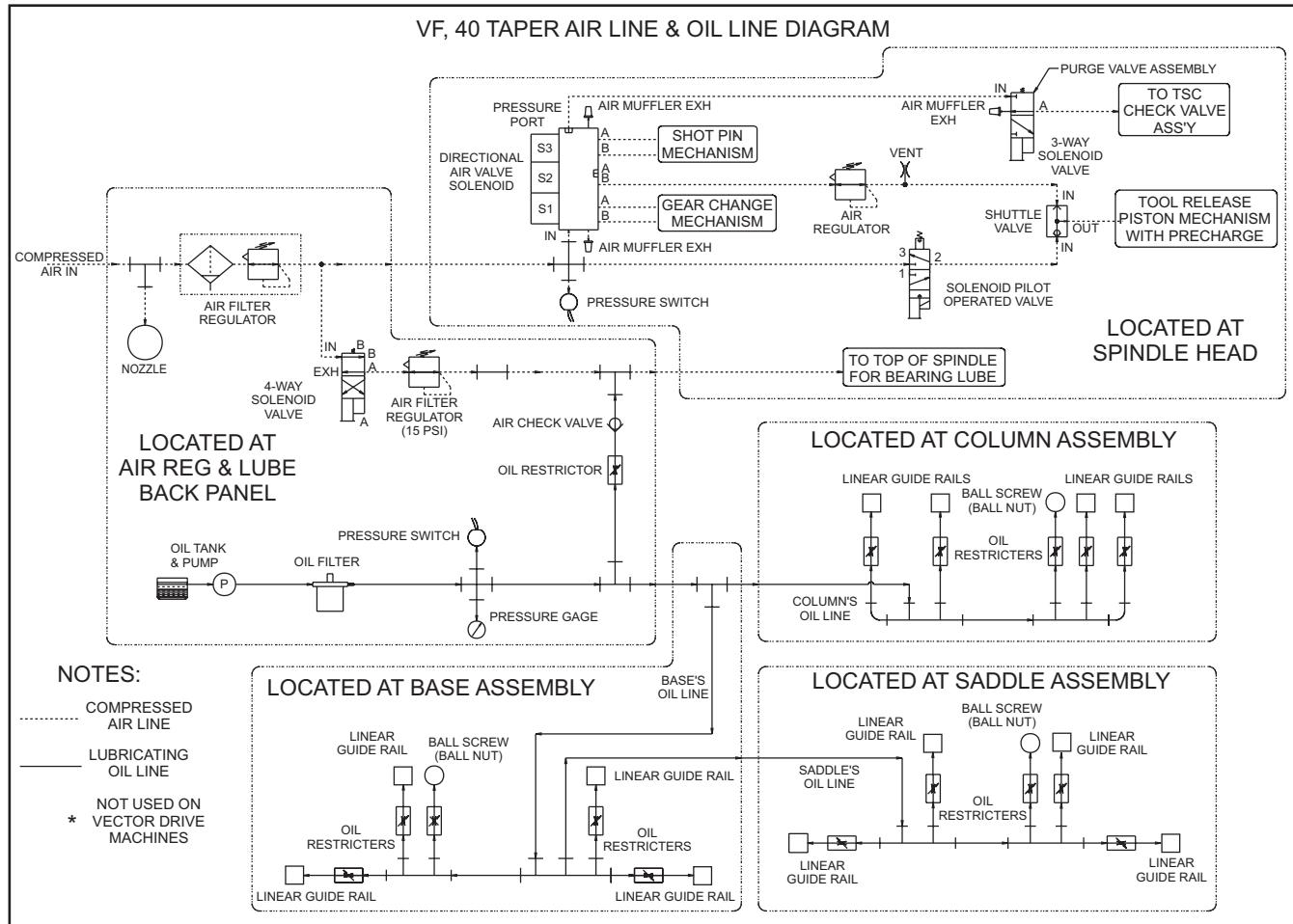
#### CABLE BOX ENCODER INSTALLATION

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.



## LUBRICATION SYSTEM

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 an 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.



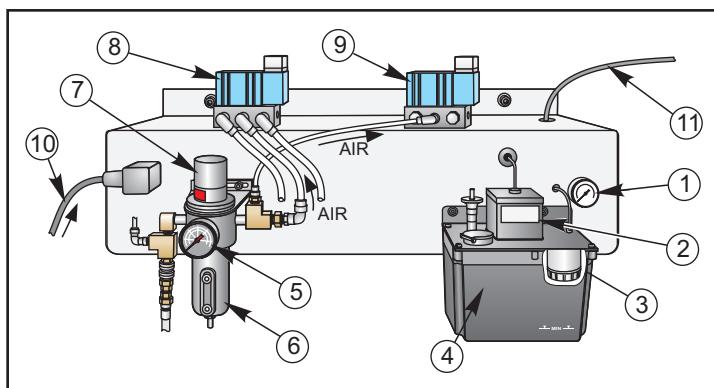
## Air Supply Lines

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 counterclockwise 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.

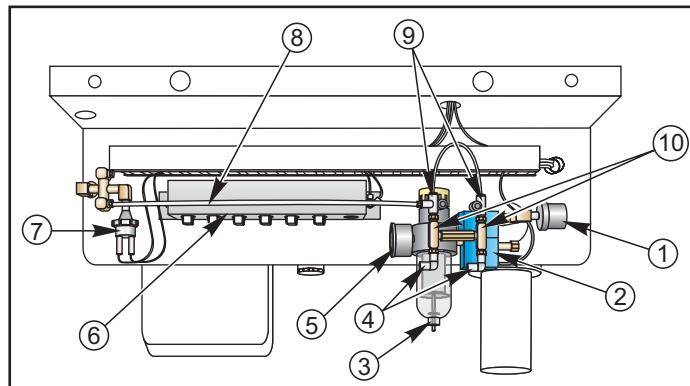
### COMPONENT



*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 35 PSI). This quantity of oil is fully disbursed throughout the lube system in 8 to 10 minutes.
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. Lathe only.
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.



## AIR REGULATOR SERVICING

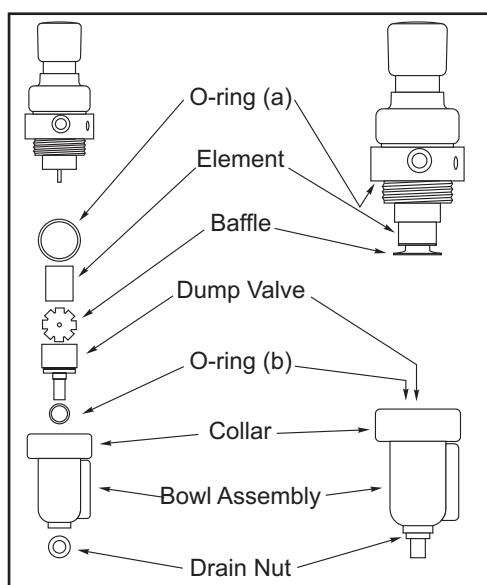
**CAUTION!** Disconnect or shut off air supply and exhaust the primary and secondary pressure before servicing unit. Turning the adjustment knob counterclockwise **does not** vent downstream pressure. Downstream pressure must be vented before servicing the regulator.

**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

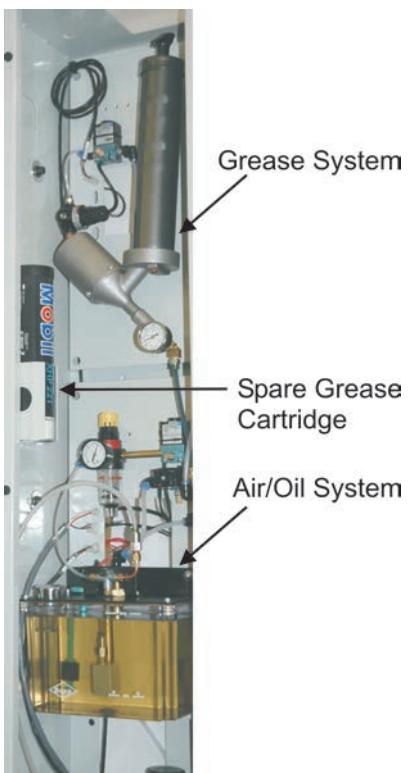
1. Unscrew the bottom threaded collar and remove the bowl assembly. Use care as not to lose the o-ring.
2. Unscrew the baffle and then remove the element.
3. Clean the internal parts and bowl assembly before reassembling. To clean the bowl assembly use mild soap and water only! Do not blow with air as 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  $\frac{1}{4}$  turn





## MINIMUM LUBRICATION SYSTEM

The Minimal Lube System consists of two parts, an axis lube system which supplies grease to the linear guides and ballscrews and a spindle oiling system.



These systems look at RPMs and travel distance as opposed to machine-on time before delivering lube to an assembly. Having the linear guides and ballscrews independent of the spindle means keeping better control of the lubrication.

### Technical Reference

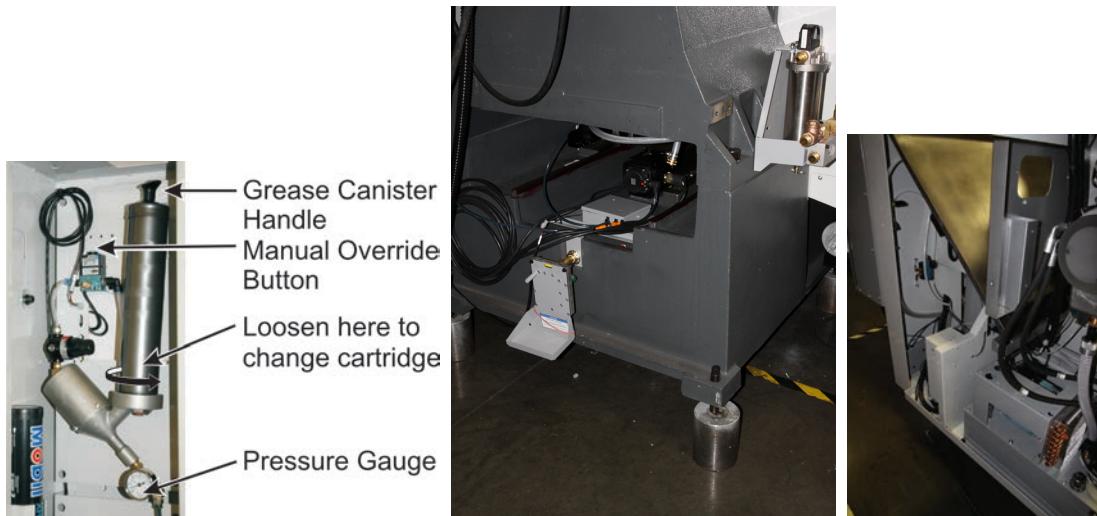
#### Axis Grease System

Grease system components and maintenance:

The grease gun consists of two major operating parts.

(1) The grease canister which contains the grease cartridge. When the grease cartridge is properly installed in the canister it will be under a low pressure resulting from a spring loaded piston. The canister handle is provided to retract the spring loaded piston and the locking tab is provided to prevent the piston from moving when the handle is pulled out of the canister.

(2) The grease pump which is pneumatically operated by the solenoid operated air valve. The air regulator is located after the air solenoid, ensuring that the grease system pressure is not excessive. A pressure switch monitors the operation of the axis lube system. If the system software does not detect a change in status of the pressure switch after a command to provide lubrication, a message will be displayed to notify the operator. The pressure switch is not continuously monitored. The grease system cannot work without an air pressure supply to the machine.



*Grease System Assembly*

Distribution blocks and pressure switch  
Vertical Mill - Under column      Lathe - Back left

This is a balanced system, which means that all grease tubes are the same length. The grease is pushed to a distribution block, the equal-length tubes then deliver the grease to each of the ballscrews and linear guides. **Do not change the length of the grease tubes.** Changing the length of one tube will negatively affect grease flow and pressure to all lubrication points. If a tube is cracked or broken the entire length must be replaced with the same size and length of hose. The broken part cannot be simply cut out.

### Spindle Air/Oil System Components

The oil system consists of two major operating parts.



*Spindle Air/Oil Assembly*

(1) The tank assembly and oil pump. The spindle oiling system cannot work without an air pressure supply to the machine. The tank assembly includes a low level float sensor that is monitored continuously. The oil pump is operated by a pressurized column of air applied to the surface of the oil in the pump body. The oil is forced through a known restrictor for a known time period to dispense the correct amount of oil to the air/oil mixer. A solenoid operated air valve is used to control the application of air to the pump, and is activated only during a software controlled lubrication cycle.

(2) The air/oil mixer exists outside the tank assembly. A solenoid operated air valve is activated any time the spindle is turning, mixing the bearing lubrication oil with the air that provides a positive air pressure to the spindle. An air regulator is installed in the system to provide a controlled flow of air to the spindle. The air pressure should be set at 15 psi for VMC, 25 psi for HMC, and 15 psi for Lathes.



## Axis Grease-Based Lubrication System

The grease based lubrication system lubricates all the axes when any axis travel in meters is reached, as determined by a parameter value. Since lubrication is based on the meters traveled, it lubricates all the axes as needed. Due to minimum lubrication requirements, a grease canister can last up to a year before needing replacement.

Grease Type: Mobil XHP-221

The Haas control generates Alarm 803 or 804 to warn users to replace an empty canister or repair a broken unit. The current values of parameters for amount of lubrication are calculated based on the current lubrication system. These parameters values enable a more efficient use of grease.

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**NOTE:** Be sure to run Parameter Checker on your machine to verify parameter and setting values.

### Mechanical Specifications

Grease system timing is based on 0.075cc per lube point (for 15 points) per 1000 meters, which is 1.125cc/lube cycle. There are about 450cc/tube of grease, so about 400 lube cycles/tube.

### Electrical Specifications

**Output relay** - The axis grease lube system cable is connected from the PC board output for Parameter 816, AX LUBE OUTPUT to the lube solenoid.

**Input high pressure signal** - The high pressure sensor cable is connected from the lube system to the PC boards input for Parameter 815, AX PRESSURE INPUT.

### Grease Parameters

**810 - Axis Lube Type** - Grease axis lube system selection. Set to 2 for the Minimal Lube system.

**811 - Ax Intrvl Meters** - Lubricates all axes when any single axis reaches the travel distance in meters. The default is 1000; the units are meters.

**812 - Ax Lube On Time** - This is the duration the grease system is ON at each lube cycle and discharges grease during this time. Units are in milliseconds.

**813 - Ax Pressure Time** - Minimum stable high pressure detection time, during grease discharge. LOW LUBE message is displayed if pressure stays on less than this time. Units are in milliseconds.

**814 - Ax Pressure Timeout** - If high pressure is not detected for time duration per Parameter 813, within the time per Parameter 814, LOW LUBE message displayed. Units are in milliseconds.

**815 - Ax Pressure Input** - I/O board input for grease lube pressure switch. Set to 25

**816 - Ax Lube Output** - Output relay number. Output relay for grease lube pump solenoid. Set to 52.

### Software Timing Requirements

The CNC software monitors all axes simultaneously for the meters traveled, and if any axis travel exceeds the Parameter 811, AX INTRVL METERS value, the following grease lubrication process is initiated:

1. Output relay turns ON per Parameter 816, AX LUBE OUTPUT value.
2. Output relay is ON for the time in milliseconds per Parameter 812 AX LUBE ON TIME value.
3. Once the output relay is turned ON, input pressures must constantly stay high and stable for the minimum time, in milliseconds, per Parameter 813, AX PRESSURE TIME value.
4. The lubrication amount is controlled by the Parameter 812, AX LUBE ON TIME value.



5. If stable high input pressure is not detected any time between the output relay turning ON, and the timeout period (Parameter 814, AX PRESSURE TIMEOUT), the control generates a LOW LUBE message. The software will not stop running the program, but keeps displaying the LOW LUBE message. Once the running program stops, it displays one of the following two alarms:

**Alarm 803** for the first four consecutive 5-minute interval low pressure faults of the lube system.

**Alarm 804** for the next two consecutive 5-minute interval low pressure faults. The main software will then reset the alarm pointer to Alarm 803.

### Alarms

**803, LOW WAY LUBE** - The control received four consecutive low pressure faults. The lubrication grease supply is low or empty, or has lost pressure. Check the grease canister for low supply and replace it if necessary. If the grease canister is not empty, check for leaks in the lines. Also check the lubrication pressure switch and wires for disconnect or damage. Machine damage will occur if the problem is not corrected.

**804, GREASE CANISTER IS EMPTY** - The lubrication grease supply is empty or the system has lost pressure. Replace the grease canister or check if there are any leaks in the lines. Machine damage will occur if the problem is not corrected.

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**NOTE:** Rarely will a line be clogged; more likely there is a leak at a fitting, or a split in the line. Tighten/replace the fitting or replace the line. The line must **not** be reduced in length.

### Spindle Drive Oil-Based Lubrication System

The spindle lubrication system lubricates the spindle based on both thousands of spindle revolutions and by the spindle-on time. The system is controlled by parameter values. The amount of lubrication can be changed by parameters, since product-to-product lubrication amount requirements may be different. One to two drops of oil are dispensed at each lube cycle; delivered by air pressure.

The CNC control generates Alarm 805 when the oil system needs refilling. The alarms warn users to check the oil level or repair the system. The oil system has a sight glass, so the level of oil can be observed.

Current values of parameters for the amount of required lubrication are calculated based upon the current lubrication system. These parameter values enable a more efficient use of lube oil.

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**NOTE:** Be sure to run Parameter Checker on your machine to verify parameter and setting values.

### Mechanical Specifications

**Revolutions based spindle lubrication** - Spindle oiling time is based on 0.24cc/hour at maximum speed. For example, 7500 RPM = every 112,000 spindle revolutions = every 15 minutes at max speed.

**Time based spindle lubrication** - Every 30 minutes of spindle run time if 112,000 revolutions are not reached, which means that for speeds of less than 3750 RPM there are fewer revolutions between injections.

### Electrical Specifications

**Output relay** - Connect the cable from the I/O card output (P36A for oil, P40 for air) for Parameter 822, SPINDLE LUBE OUTPUT to the lube system solenoid.

**Input high pressure signal** - Connect the lube pressure sensor input cable from the I/O card input (P71) for Parameter 821, SP LEVEL INPUT.

### Oil Parameters

**817 Spindle Lube Type** - Minimum Oil spindle lube system selection. Set to a value of 2.

**818 Sp Rotation Intrv** - Number of spindle revolutions (times 1000), between lubrication cycles. No lubrication done if machine not running. Units are thousands of revolutions.

**819 Sp Lube Time Intrvl** - If spindle does not travel revolutions per Parameter 818, within time interval per Parameter 819, lube occurs per Parameter 819. No lubrication done if machine not running. Set to a value of 30. Units are in minutes



**820 Sp Lube Time** - Duration that spindle lube system is ON at each lube cycle and discharges oil during this time. Set to a value of 4500. Units are in milliseconds.

**821 Sp Level Input** - Input relay number for spindle oil lube pressure detection. Set to a value of 12

**822 Spindle Lube Output** - Output relay number for spindle oil lube system solenoid. Set to a value of 28.

### Software Timing Requirements

The CNC software monitors the spindle and tracks both the number of spindle revolutions and spindle on-time. Once the value of parameter 818, Sp Rotation Intrv or 819, Sp Lube Time Intrvl is exceeded, the following lubrication process is initiated:

1. The output relay is turned ON for the time per Parameter 820, SP LUBE TIME, then turns OFF.
2. After turning the output relay ON, the main software monitors for the high oil pressure input signal (Parameter 821, SP LEVEL INPUT).
3. The CNC software monitors the oil level input signal.
4. The main software does not stop running the program, but it keeps displaying the LOW LUBE message. Once the running program stops, it displays the alarms:

**Alarm 805** for two consecutive low pressure detections of the lubrication system pressure.

### Alarms

**Alarm 805, LOW SPINDLE LUBRICATION** - Spindle lubrication oil reservoir is low or empty. Service spindle lubrication reservoir. If reservoir level is acceptable, check level sensor and wires for damage or disconnect.

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**NOTE:** The lubrication system continues to run when an alarm is generated.

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**NOTE:** Rarely will a line be clogged; more likely there is a leak at a fitting, or a split in the line. Tighten/replace the fitting or replace the line. The line must **not** be reduced in length.

### Axis Lube Test (Grease)

The following test verifies that the control generates a Low Lube message when it detects a low pressure fault from the grease axis lube system. The control does not generate an alarm while in a "Low Lube" message condition but generates an alarm after Reset is pressed.

1. Change Parameter 811 to 50.
2. Run the following program:  
G00 X-6. (adjust X value for safe unobstructed full machine travel);  
G28 X0.;  
M99;
3. Run the above program and go to the back of the machine and verify that it activates its solenoid after the X-axis finishes a travel of 50 meters.
4. Unplug P71 LOW GREASE SNSR (cable 500) output from the I/O PCB, this is the cable for the grease axis lube system that senses the pressure.



5. Run the program again and verify that the control generates a Lube Message after a few minutes.
6. Press Reset and verify that the control generates Alarm 803, Low Way Lube or Alarm 804, Grease Canister is Empty.
7. Run the following program:  
G00 X-6.0 (adjust X value for safe unobstructed full machine travel);  
M30;
8. Verify that the control generates a Low Lube message as well as Alarm 803 or 804 after M30.
9. Change Parameter 811 to 1000.
10. Plug P71 (Cable 500) back into the I/O PCB.

### Spindle Lube Tests (Oil)

The following test verifies lubrication by time. The control continues operation while displaying a Low Lube message, until RESET is pressed. The low lube message will be displayed if the oil level sensor is disconnected or if the oil level is low.

1. Change Parameter 819 to 3 minutes.
2. Run the following program:  
S1500 M03;
3. Verify that the spindle lube system activates its solenoid in about 3 minutes and that a very small drop of oil forms at the end of the copper tube inside the poly tube.
4. Unplug P13 (LOW SP OIL LVL) output from the I/O PCB (this is the signal from the oil level switch) and run the previous program (step 2).
5. Verify that the control generates a Low Lube message. Press Reset.
6. Verify that the control generates Alarm 805, Low Spindle Lubrication or Alarm 806, Low Spindle Lubrication - Action Needed.

The following verifies M30, and generates a Low Lube Alarm 805 or 806 when Low Lube is displayed.

7. Run the following program:  
S1500 M03;  
G4 P240.;  
M30;
8. Verify that the control generates a Low Lube message.
9. Verify that the control generates Alarm 805, Low Spindle Lubrication or Alarm 806, Low Spindle Lubrication - Action Needed after M30.



10. Change Parameter 819 to 30.

The following verifies alarms when lubricating by revolutions. The control continues operation while displaying a Low Lube message, until M30.

11. Change Parameter 818 to 2.

12. Run the following program:

S1500 M03:

G4 P240.

M30:

13. Verify that the spindle lube system generates a Low Lube message after four minutes.

14. Verify control generates Alarm 805, Low Spindle Lubrication or Alarm 806, Low Spindle Lubrication - Action Needed after M30.

15. Plug P13 (Cable 960) back into the I/O PCB.

The following verifies lubricating per spindle revolutions in a normal condition.

16. Run the following program:

S1500 M03:

17. Verify that the spindle lube system activates its solenoid after it finishes 2,000 revolutions.

18. Change Parameter 818 to 112.

## PARTS CATCHER (LATHE)

### 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.

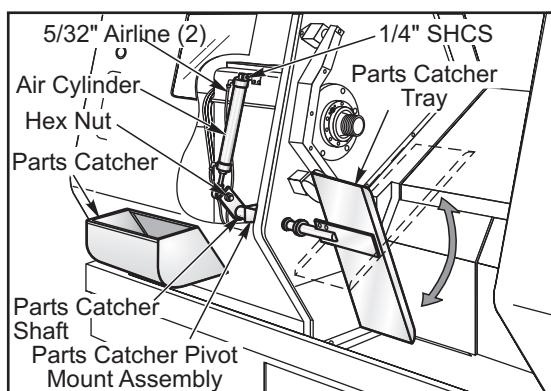
3. Unclamp outer retaining ring that retains the shaft collar on the outer shaft, remove shaft collar and inner retaining ring. Remove rubber seal from outer shaft.

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, performing 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).

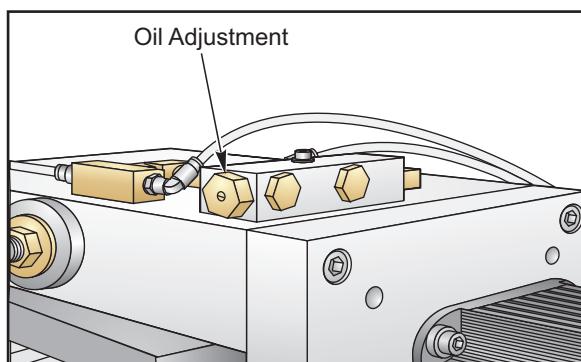


2. Jog away in Z direction and lower the tool presetter. Jog to probe the ID tool in the X+ direction using the 0.0001 feed rate.
3. Record the X Distance to Go number (e.g. 1.4809). Add this number to the measured diameter (e.g. 2.125 + 1.4809 = 3.2309). The sum should equal the number in Setting 60 (**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.

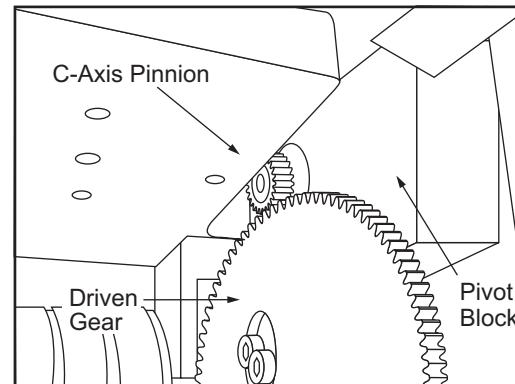
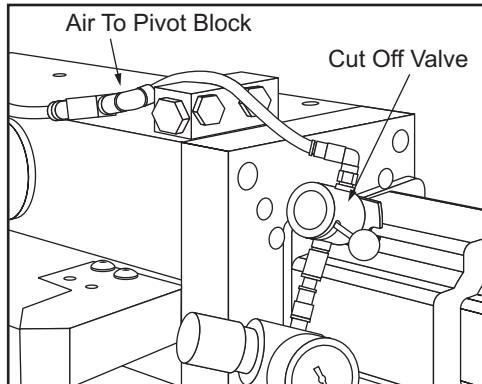


### SETTING GRID OFFSET

**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.



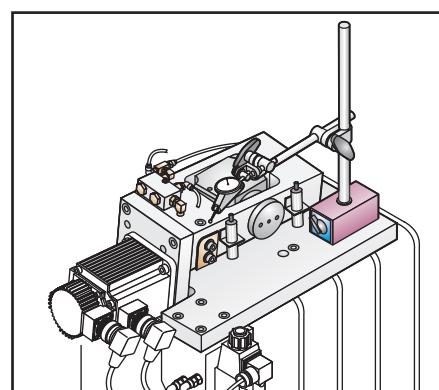
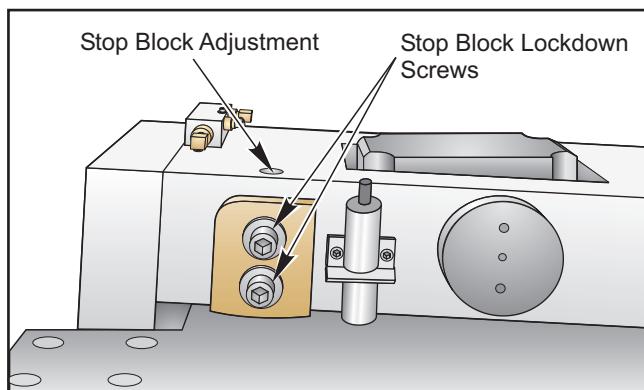
2. Press Setng/Graph and turn Setting #7 Off. Press Alarm/Mesgs, type Debug, and press Write/Enter. Change Parameter 517 to zero.
3. Press Zero Return, type "C" and press Zero Single Axis.



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 2000.
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 thread locking compound to the threads.



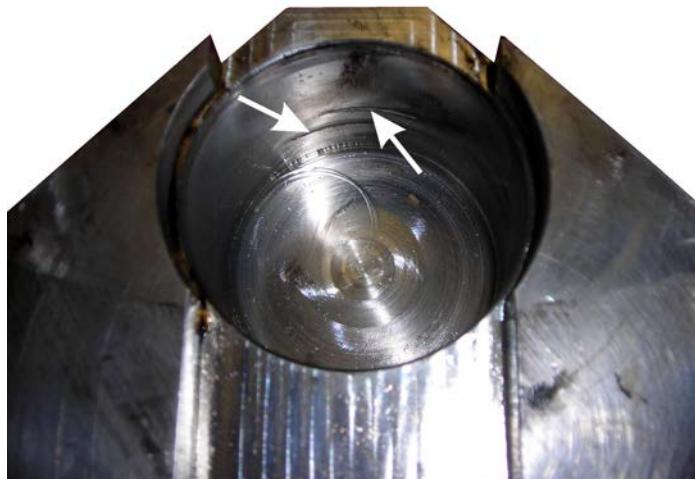
3. Install the set screw, but do not put pressure on the stop block. Place a magnetic base indicator on top of the spindle head and rest the indicator finger on top of the pivot block.



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.

#### C-AXIS BRAKE REBUILD

This procedure will guide the user when a rebuild of the C-Axis brake assembly is needed. Before rebuilding a Haas C-Axis brake assembly, an inspection of the cylinder bore in the caliper must be performed. Excessive wear or gouges on the bore will require replacement of the entire assembly.



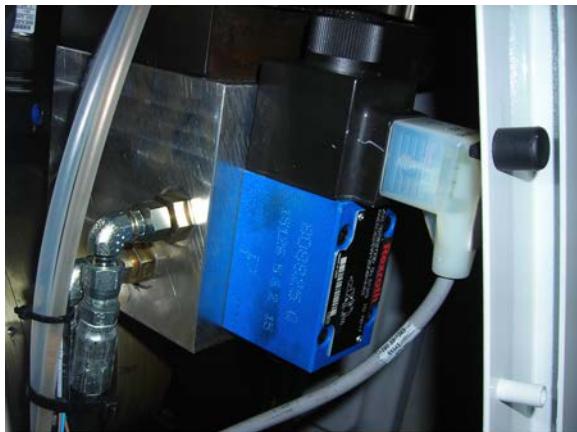
Brake caliper with damaged cylinder bore

#### C-Axis Brake Service Kit Part Numbers

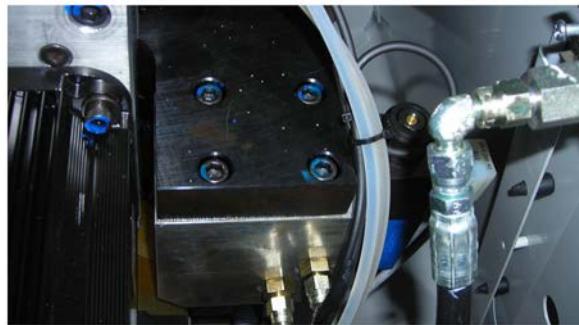
HAAS P/N	DESCRIPTION	QTY.
20-0199	FINGER BRAKE LT	1 EACH
40-16341	FHCS 10-32 X ¾	2 EACH
40-16372	SHCS 3/8-16 X 1 ½	3 EACH
40-16385	SHCS 5/16-18 X ¾	3 EACH
40-1700	SHCS 10-32 X 2	4 EACH
40-1703	FHCS 10-32 X ½	2 EACH
57-0045	PAD WILWOOD 150-1251	2 EACH
57-4120	O-RING 2-226 VITON	2 EACH

#### 1. Removal of the C-axis Brake Assembly:

- A. Turn off the machine power and put a lockout tag on the machine's main breaker. The C-Axis brake can be removed through the access door on the front of the machine; however, it might be necessary to remove the machine's left side panel for greater access to the unit.



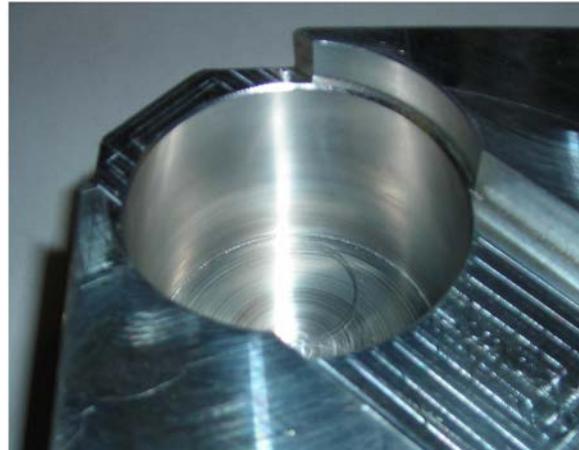
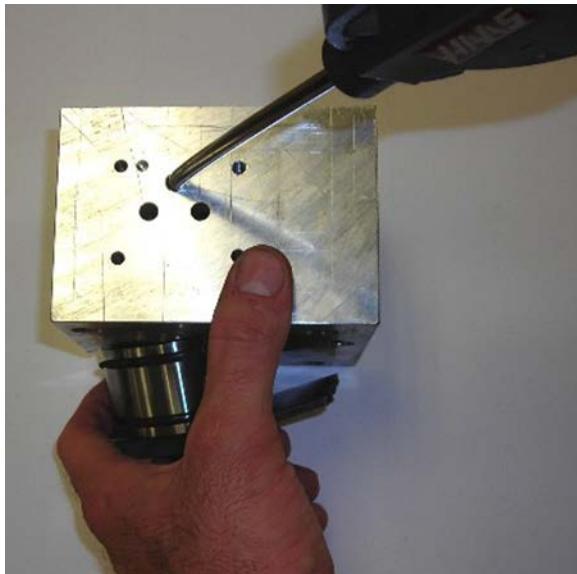
Brake assembly viewed through access door



Four mounting bolts (SL-20 shown)

- B. Before disconnecting the two hydraulic hoses from the brake caliper, label or mark them to ensure they do not get reversed during re-assembly. On most machines, the two hoses can be seen through the access door. On SL-30B machines, these hoses are on the opposite side.
- C. Remove the cable from the solenoid with a Phillips screwdriver. This cable is very close to the sheetmetal on some machines, so removal of the solenoid from the caliper may be necessary at this time.
- D. Remove the four bolts, which secure the brake assembly to the top plate.

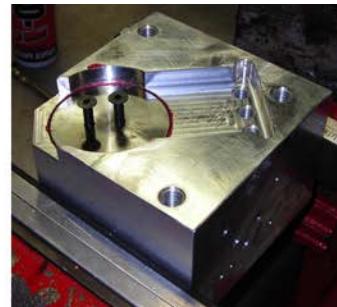
2. Remove all parts from the caliper and back-plate. Use care when removing the solenoid to prevent losing the solenoid O-rings. The piston can be removed by applying compressed air to the solenoid inlet port.





3. Lightly use a de-burring stone on all mating surfaces. Thoroughly clean the cylinder bore and piston. Use compressed air to remove debris from all ports in the caliper.

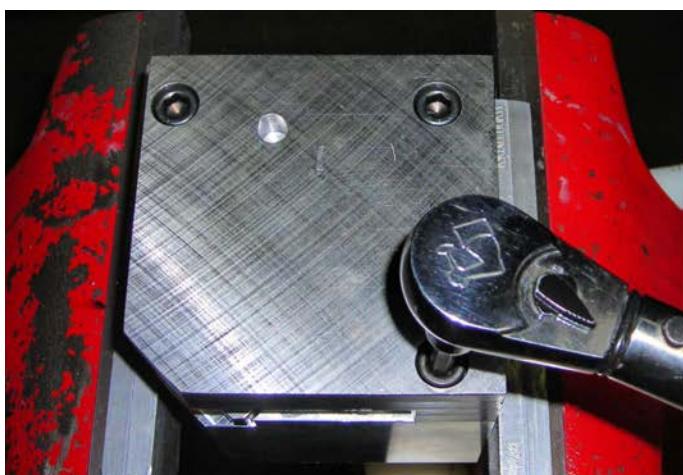
4. Install the two new O-rings onto the brake piston. Apply grease to the inside of the caliper bore and the outside of the piston. Note that one end of the piston has a pin machined into it. This pin identifies the topside of the piston. Carefully push the piston with O-rings into the caliper bore, topside first. Orient the piston using the two 10-32 X  $\frac{3}{4}$  FHCS, so the screw holes on the bottom side will line up with the brake finger and pad.



5. Attach the new brake finger and pad to the piston with the two FHCS (Over-tightening the screws will damage the brake pad). Fasten the new brake finger to the caliper using the three 5/16-18 X  $\frac{3}{4}$  SHCS supplied. Torque the bolts to 20 ft lbs. Install the second new brake pad to the back-plate using the two 10-32 X  $\frac{1}{2}$  FHCS.



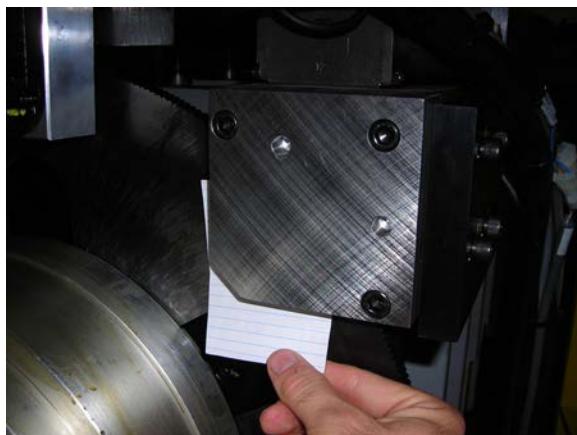
6. Assemble the back-plate and caliper using the three 3-16 X 1  $\frac{1}{2}$  bolts. Tighten to 35ft lbs. Re-install the hydraulic valve to the caliper.





## 7. Installation of Brake Caliper Assembly:

- A. Reconnect the hydraulic hoses and solenoid cable. Use cable ties to route hoses and cable away from rotating parts.
- B. Before tightening the mounting bolts, the caliper must be aligned so that there is equal clearance of the brake pads on either side of the brake disk. Sliding a piece of paper or shim stock between the pads and the brake disk can test the clearance (SL30B shown).



When installing the brake caliper on an SL30B, lift the unit up against the screws that secure it to the mounting plate to ensure that there is adequate clearance for the spindle drive belts. Rotate the spindle by hand to ensure that the caliper is not rubbing against the belts.

- C. Turn the machine on and press RESET to turn on the hydraulic power unit. Check the brake assembly for oil leaks. The C-Axis brake does not require bleeding.
- D. Zero-return the machine and use M14 in MDI to apply brake pressure and M15 to release. This step may need to be repeated a few times to allow air in system to escape. Continue to check for leaks. The spindle should rotate freely by hand when brake is released and not rotate when brake pressure is applied.

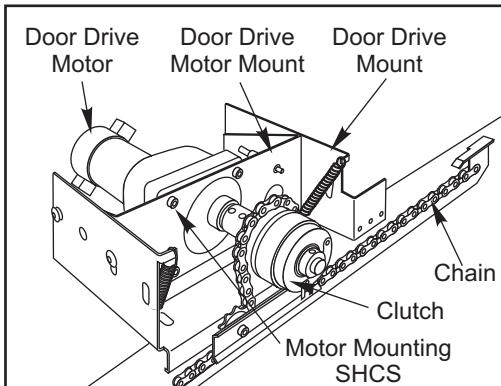
## AUTO DOOR REMOVAL AND REPLACEMENT (LATHE & VERT.)

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.

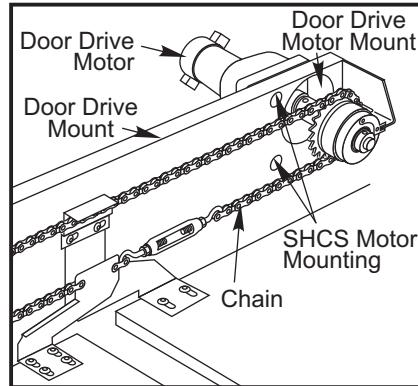
### MOTOR REPLACEMENT

#### 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

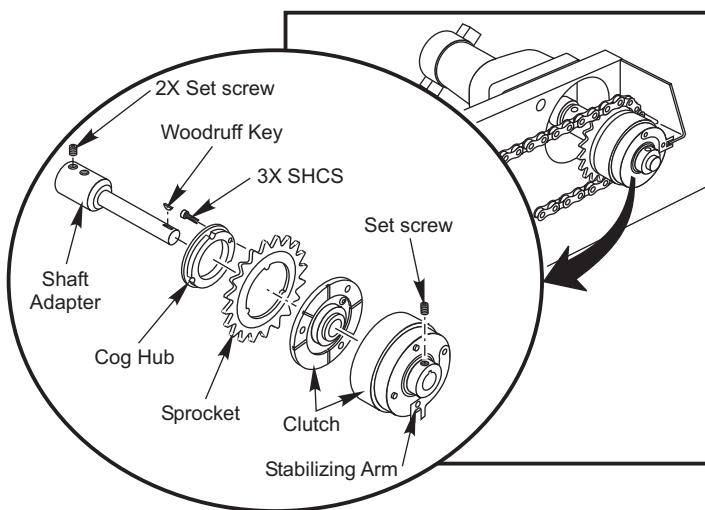
### **Motor Replacement**

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.).

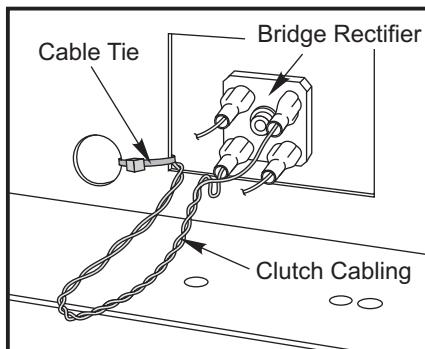
### **CLUTCH REPLACEMENT**

#### **Clutch Removal**

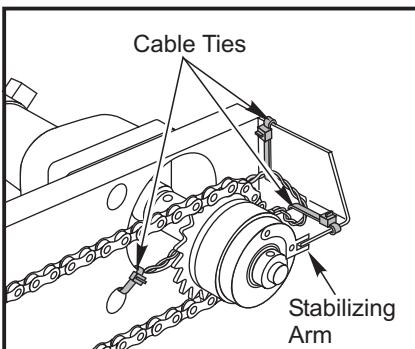
1. Turn off power to machine. Unplug both of the clutch cables from the bridge rectifier on the motor mount.
2. **Lathe:** Loosen the front two FBHCS on the door drive mount. **Vert:** Turn the turn buckle. This will loosen the tension on the chain. Remove the chain from the sprocket on the clutch assembly.
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).



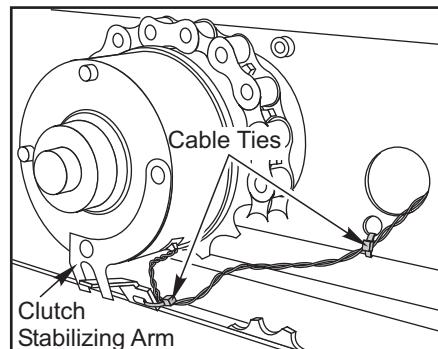
Vertical Machine Clutch Replacement



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.

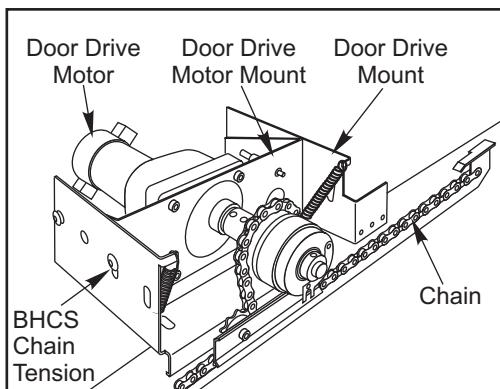
5. The clutch must be run-in after the clutch has been installed and the chain adjusted properly. To do so, manually open the door. While holding the door open command the door to close. This can be done by pushing a button on the side of the pendant or executing a program. Hold the door open until the machine alarms out. Repeat this three times; this will seat the clutch.



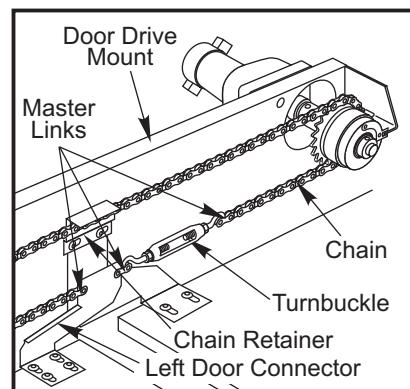
## CHAIN REPLACEMENT AND ADJUSTMENT

### 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

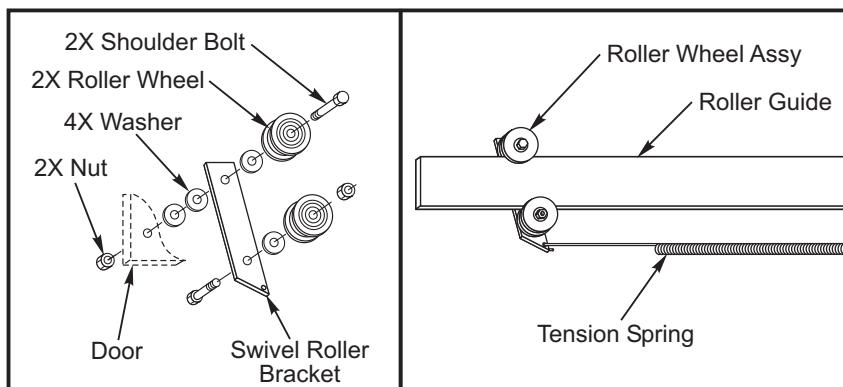
**CAUTION!** Doors are heavy; have two people performing this operation, if possible.

##### 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.

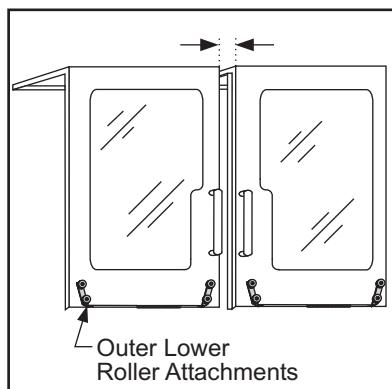


*Roller/Roller Guide Assembly*

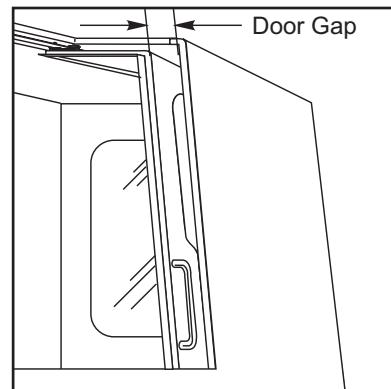


## Door Adjustments

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.



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2. Grip the tension bar and adjust in a counterclockwise direction so that the clamp will move closer to the base, creating more tension.

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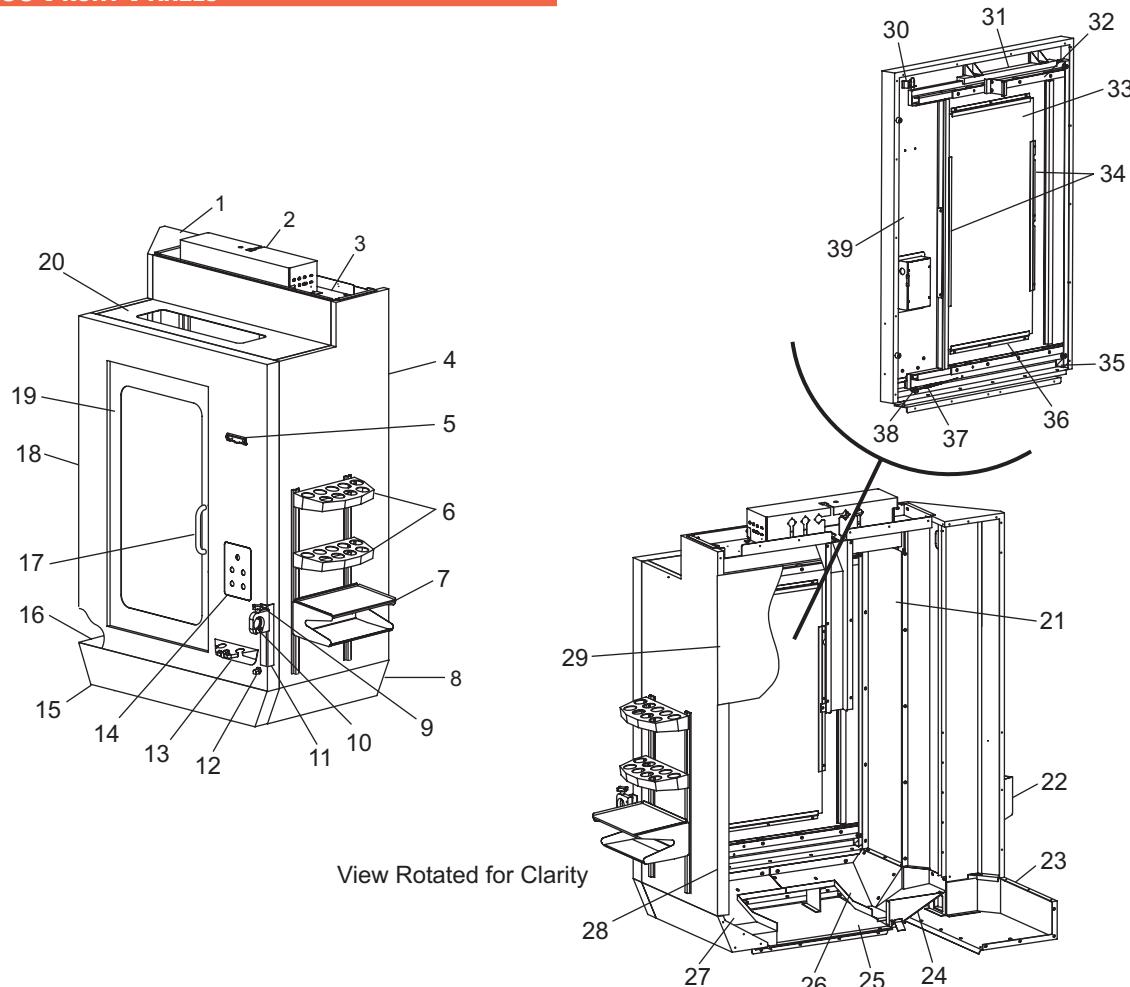
**NOTE:** Make sure that the tension bar is not so tight that the steady rest will still move in the unclamped position, but will properly lock in the clamped position.

3. Re-install the cap nut.



## HORIZONTAL MILL ASSEMBLY DRAWINGS AND PARTS LISTS

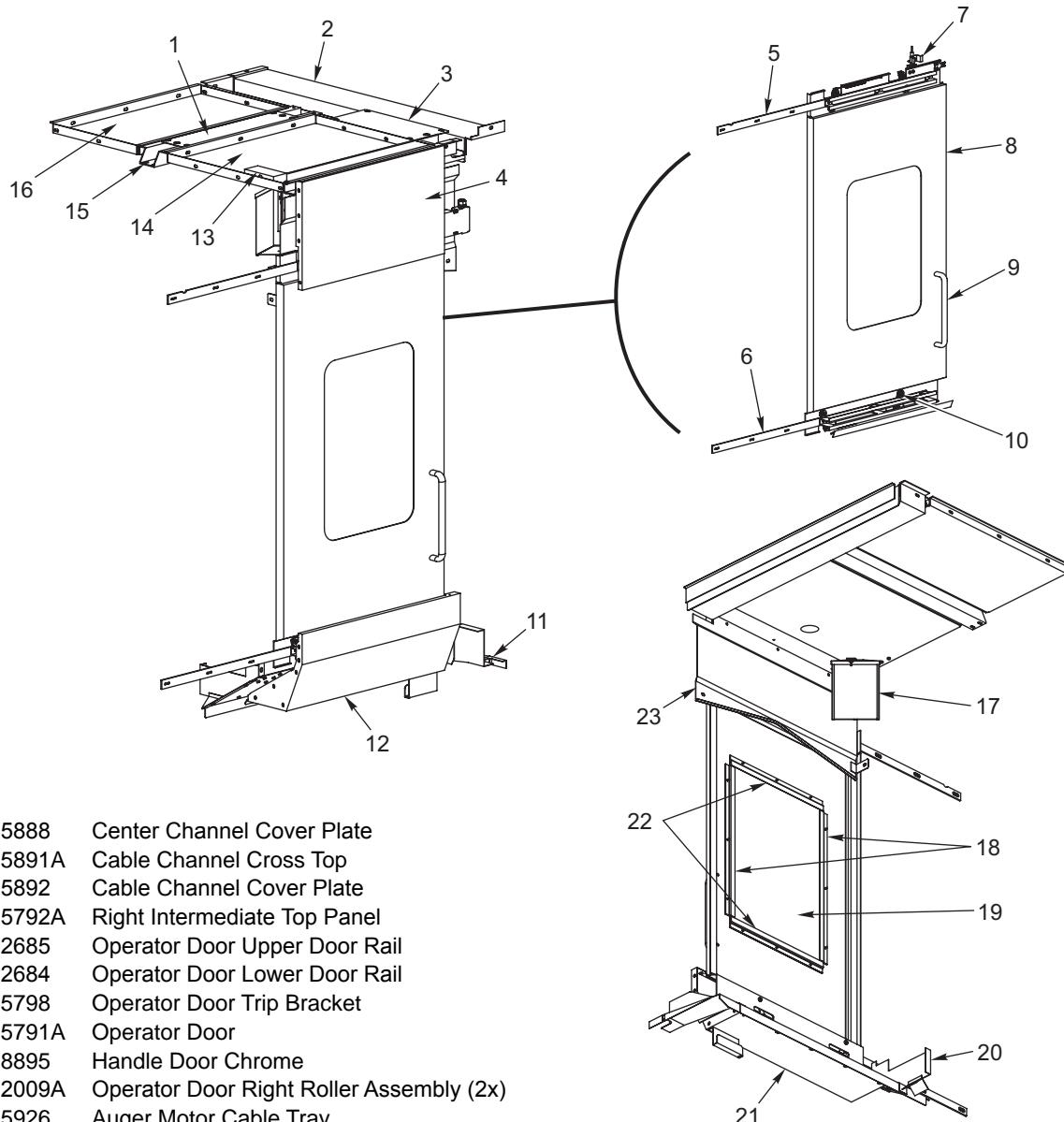
### EC-300 FRONT PANELS



- View Rotated for Clarity
- |   |   |
|---|---|
| 1. 25-5682A Tool Trays Panel                        | 22. 25-0563B Tool Box Assembly                  |
| 2. 25-5683C Intermediate J-Box Top Cover            | 23. 25-5738D Left Intermediate Pan              |
| 3. 25-5681A Intermediate Top Cover                  | 24. 25-5804C Left Chip Shield Pan               |
| 4. 25-5678B Front Right Panel                       | 25. 25-5742A Center Bottom Pan                  |
| 5. 59-0123 Sanders K 18 Wire Clip                   | 26. 25-5784C Front Left Chip Shield Pan         |
| 6. 25-0440A Tool Tray (2x)                          | 27. 25-5785C Front Right Chip Shield Pan        |
| 7. 25-6182D Front Table                             | 28. 25-5806A Operator Door Tunnel               |
| 8. 25-5740D Front Right Pan                         | 29. 25-5893B Panel Top Partition                |
| 9. 59-0278 Knob Head 3/8-16 x 1-1/4 Dog Point Screw | 30. 32-2300 Proximity Limit Switch -Door Open   |
| 10. 20-1341 Tool holder Block                       | 31. 20-2696 Front Door Guide Bar                |
| 11. 25-0798 Tool Holder Bracket                     | 32. 20-2317 Rail Load Station (2x)              |
| 12. 58-1671 Nipple 1/8 NPT x2                       | 33. 28-0165 Front Door Window                   |
| 58-3618 Street Elbow 1/4, 90 degree                 | 34. 25-0668 Side Window Retainer (2x)           |
| 13. 25-5412 Nozzle Holder Bracket                   | 35. 59-6400A Guide Wheel                        |
| 14. 25-1257A Front Panel Switch Box                 | 49-2015 PTHS 1/4-20 x 7/8                       |
| 15. 25-5741B Front Center Pan                       | 46-0015 Nut 1/4-20 Flange                       |
| 16. 25-5739 Front Left Pan                          | 45-16390 Washer 1/4 Flat                        |
| 17. 22-8895 Door Handle                             | 36. 25-0669 Top-Bottom Window Retainer (2x)     |
| 18. 25-5809B Center Front Panel                     | 37. 59-9743 Front Door Spring                   |
| 19. 30-8652 Front Door Assembly                     | 38. 30-2009A Lower Right Corner Roller Assembly |
| 20. 25-5680A Front Panel Top Cover                  | 39. 25-5810A Front Door                         |
| 21. 25-5679 Front Left Panel                        |   |



### EC-300 OPERATOR DOOR PANELS

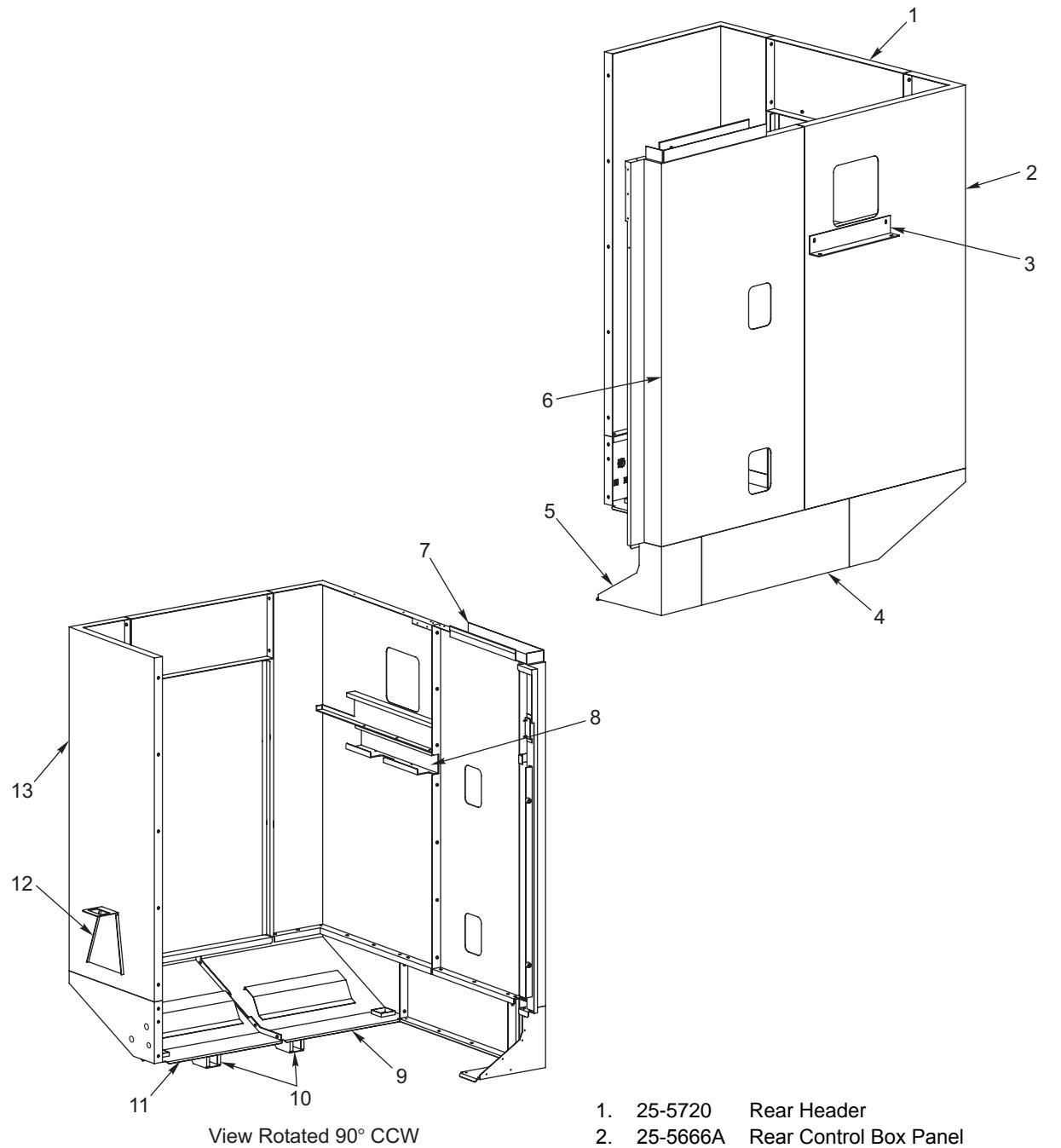


1. 25-5888 Center Channel Cover Plate
2. 25-5891A Cable Channel Cross Top
3. 25-5892 Cable Channel Cover Plate
4. 25-5792A Right Intermediate Top Panel
5. 20-2685 Operator Door Upper Door Rail
6. 25-2684 Operator Door Lower Door Rail
7. 25-5798 Operator Door Trip Bracket
8. 25-5791A Operator Door
9. 22-8895 Handle Door Chrome
10. 30-2009A Operator Door Right Roller Assembly (2x)
11. 25-5926 Auger Motor Cable Tray
12. 25-5788B Right Intermediate Pan
13. 25-4521A Cover Lamp Connector
14. 25-5889A Operator Side Top Cover
15. 25-5887 Top Center Channel
16. 25-5890 Tool Changer Side Top Cover
17. 32-0227 Mylar Reflector Lamp Assembly
- 25-4789A Adjust Work Light Bracket
18. 25-5793 Operator Door Side Z-Frame
19. 28-0151 Operator Door Side Window
20. 25-5785C Chip Shield Right Front Panel
21. 25-5789B Operator Side Lower Chip Shield
22. 25-5228 Door Window Z-Frame (2x)
23. 25-5800A Operator Side Top Chip Shield

View Rotated 180° (Looking Up)



## EC-300 REAR PANELS

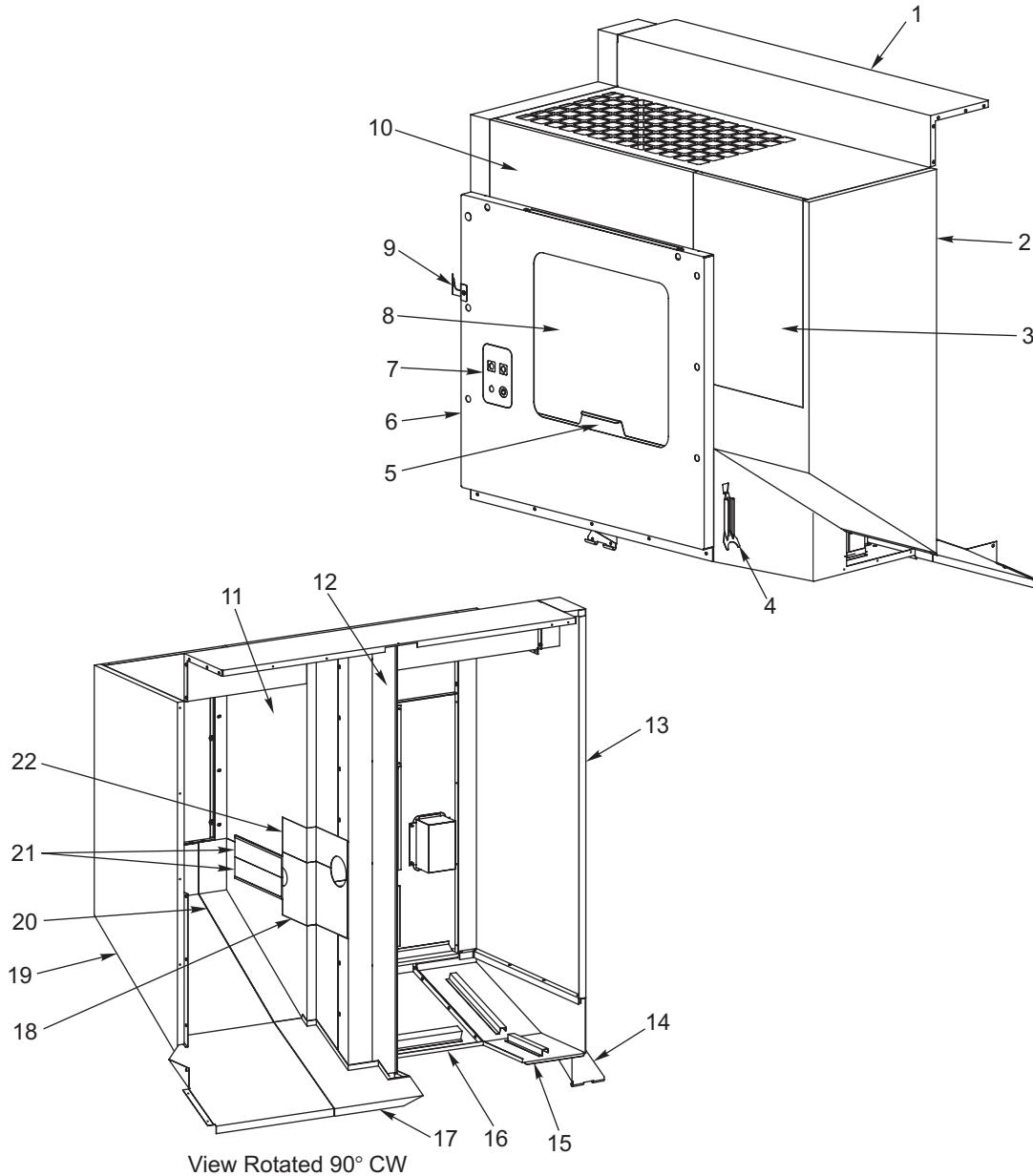


View Rotated 90° CCW

- |              |                                  |
|--------------|----------------------------------|
| 1. 25-5720   | Rear Header                      |
| 2. 25-5666A  | Rear Control Box Panel           |
| 3. 25-5722   | Control Support Mounting Bracket |
| 4. 25-5924   | Control Intermediate Pan         |
| 5. 25-5665C  | Front Control Pan                |
| 6. 25-5667A  | Front Control Box Panel          |
| 7. 25-5912   | Control Top Panel Tray           |
| 8. 25-5896   | Control Box Panel Tray           |
| 9. 25-5925B  | Rear Control Pan                 |
| 10. 25-5897  | Rear Panel Support Bracket (2x)  |
| 11. 25-5664C | Rear Left Pan                    |
| 12. 25-7726  | TSC Filter Bracket               |
| 13. 25-5718  | Rear Left Panel                  |



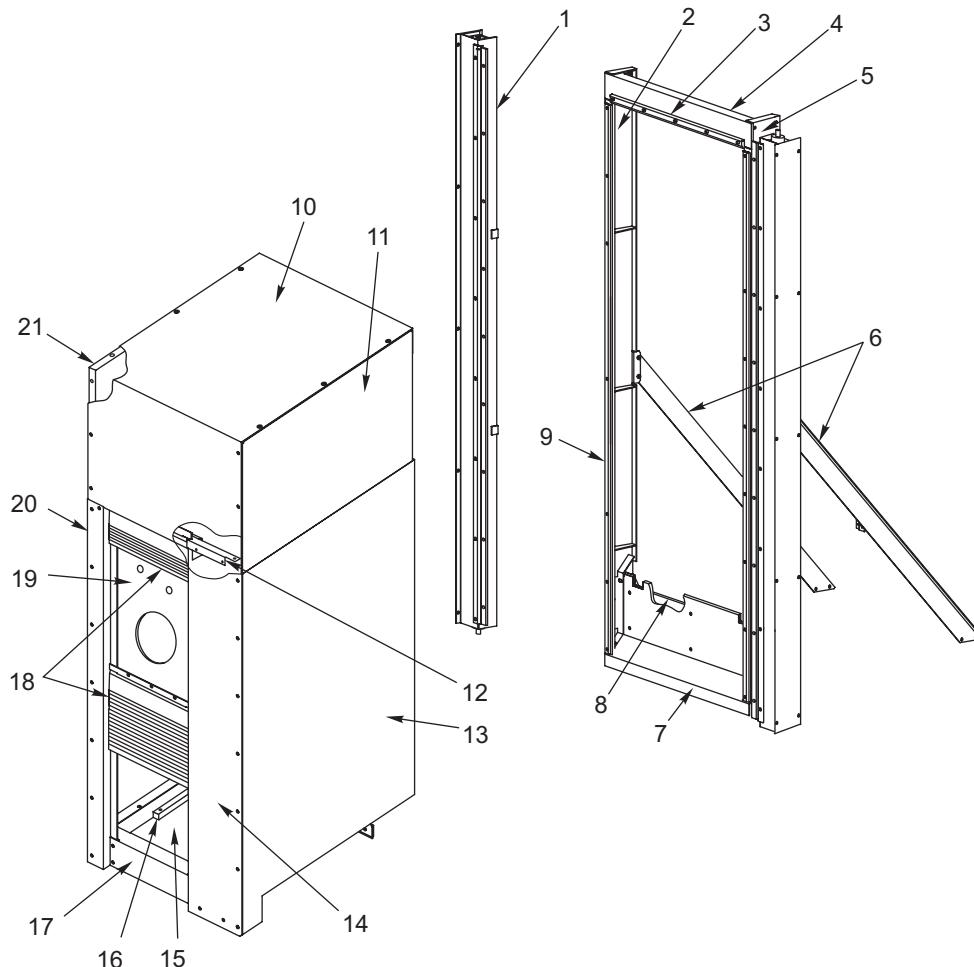
## EC-300 Tool Changer Panels



- |              |                             |              |                               |
|--------------|-----------------------------|--------------|-------------------------------|
| 1. 25-5881   | Tool Changer Top Cover      | 13. 25-5709  | T.C. Rear Panel               |
| 2. 25-5706A  | T.C. Front Panel            | 14. 25-6725B | Separator Return Line Bracket |
| 3. 25-5779B  | T.C. Side Panel             | 15. 25-5705A | T.C. Rear Pan                 |
| 4. 25-6682A  | Removal Tool 40T Holder     | 16. 25-5707D | T.C. Front Pan                |
| 5. 25-9248A  | Plate Window Handle         | 17. 25-5804C | T.C. Lower Chip Shield        |
| 6. 25-5885B  | T.C. Access Panel           | 18. 25-5957A | T.C. Access Bottom Bulkhead   |
| 7. 32-1107   | Remote Switch Box           | 19. 25-5706A | T.C. Front Panel              |
| 8. 28-0168   | T.C. Access Window          | 20. 25-5776A | Lower Bulkhead                |
| 9. 25-9262A  | Wash Handle Holding Bracket | 21. 26-0155  | Nylon Strip Brush (2x)        |
| 10. 25-5927A | T.C. Header Panel           | 22. 25-5956A | T.C. Access Top Bulkhead      |
| 11. 25-5777  | Top Bulkhead                |              |                               |
| 12. 25-5778  | Mounting Bulkhead           |              |                               |



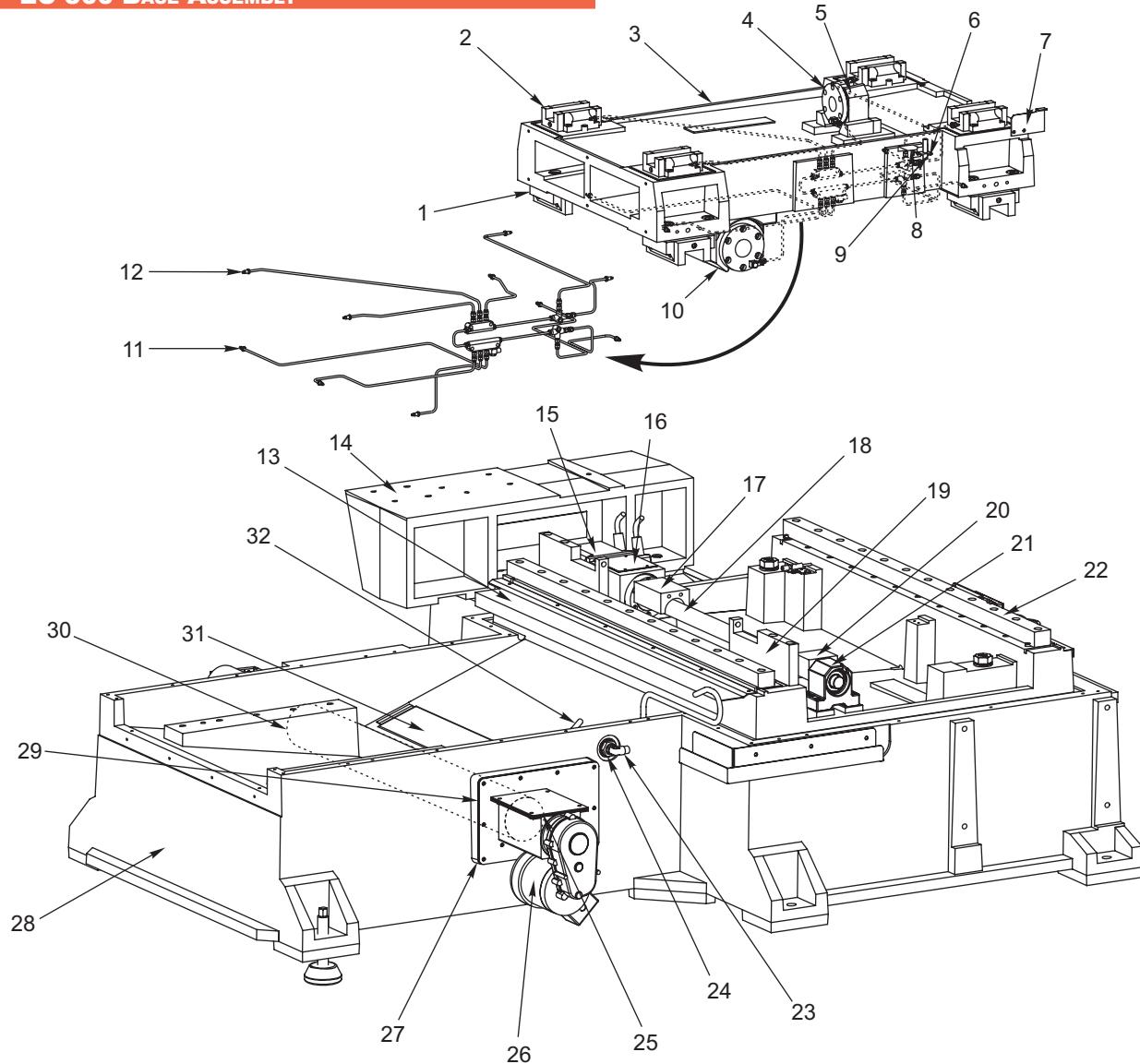
## EC-300 COLUMN AND FRAME PANELS



- |              |                                |             |                              |
|--------------|--------------------------------|-------------|------------------------------|
| 1. 59-0706   | Shade Roller- 70.5" x 21" (2x) | 13. 25-5823 | Column Right Cover           |
| 2. 25-5833A  | Shade Roller Left Frame        | 14. 25-5827 | Gordillo Right Guide         |
| 3. 25-5837   | Top Column Clamp Wiper         | 15. 25-5829 | Bottom Chip Cover Plate      |
| 26-0173      | Top Column Wiper Felt          | 16. 20-2615 | Bottom Plate Bar (2x)        |
| 4. 25-5834   | Shade Roller Top Frame         | 17. 25-5830 | Bottom Gordillo Cover        |
| 5. 25-5832A  | Shade Roller Right Frame       | 18. 59-0714 | Y-Axis Gordillo (2x)         |
| 6. 25-5773   | Shade Roller Frame Brace (2x)  | 19. 25-5911 | Y-Axis Waycover Center Cover |
| 7. 25-5765   | Saddle Cover Front Seal        | 20. 25-5828 | Gordillo Left Guide          |
| 8. 25-5766   | Wiper Backing Plate            | 21. 25-5824 | Column Left Cover            |
| 25-0169      | Saddle Wiper Felt              |             |                              |
| 9. 25-5836   | Column Felt Wiper Clamp (2x)   |             |                              |
| 26-0172      | Column Felt Wiper              |             |                              |
| 10. 25-5826  | Column Top Cover               |             |                              |
| 11. 25-5825  | Column Top Side Cover          |             |                              |
| 12. 25-5831A | Gordillo Top Bracket           |             |                              |



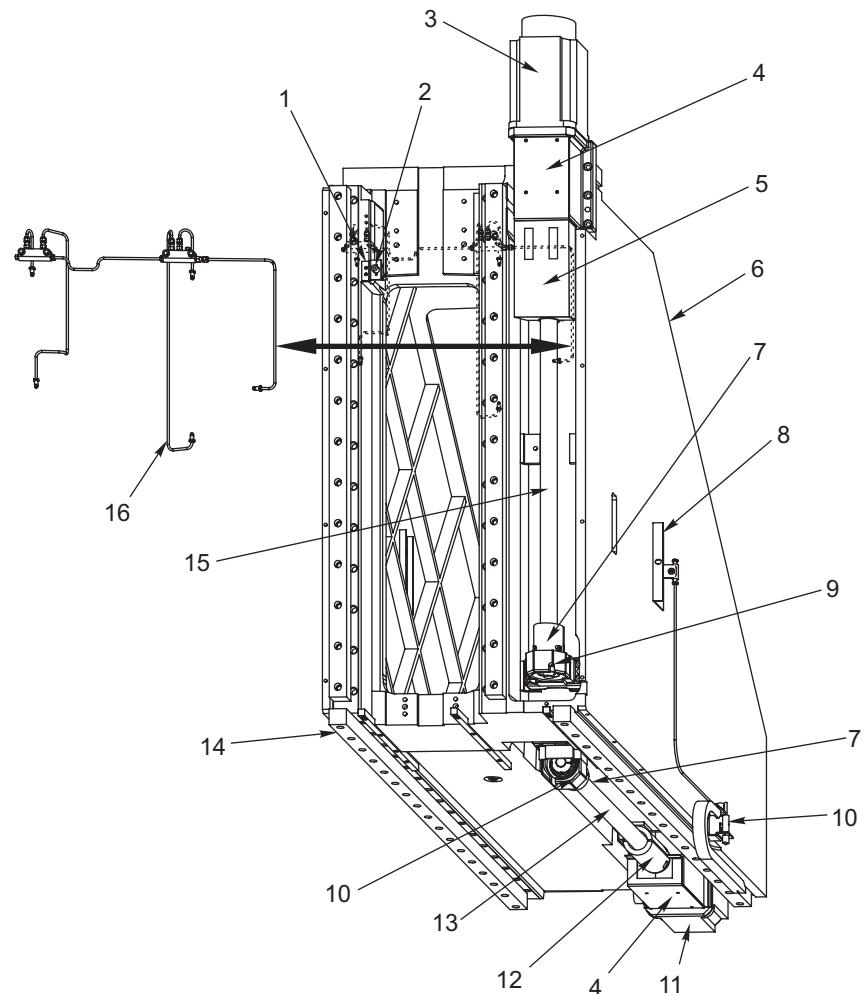
### EC-300 BASE ASSEMBLY



- |             |                           |              |                     |
|-------------|---------------------------|--------------|---------------------|
| 1. 50-9011  | Linear Guide (truck)      | 19. 20-2593  | X-Axis Ship Block   |
| 2. 50-0017  | Linear Guide (35mm truck) | 20. 28-0188  | Ballscrew Bumper    |
| 3. 20-2587A | Saddle Casting            | 21. 20-0152  | Bearing Housing     |
| 4. 58-3600  | 3/8" Nipple               | 22. 50-9011  | Linear Housing      |
| 5. 20-0150  | Nut Housing               | 23. 58-1680  | Parker Fitting      |
| 6. 25-7267  | Prox. Switch Bracket      | 24. 58-1691  | 90° Fitting         |
| 7. 25-5913  | Y-Axis Trip Bracket       | 25. 57-9265A | Chip Conv. Bracket  |
| 8. 25-5919  | Cable Carrier Bracket     | 26. 32-6626  | Chip Conv. Motor    |
| 9. 20-2593  | Prox. Switch              | 27. 57-0360  | Box Gasket          |
| 10. 20-0150 | Nut Housing               | 28. 20-2586D | Base Casting        |
| 11. 30-7140 | Base Lube Assembly        | 29. 57-9265A | Conveyor Gasket     |
| 12. 30-7138 | Saddle Lube Assembly      | 30. 20-2592B | Chip Auger          |
| 13. 25-5953 | Chip Shield               | 31. 25-5670  | Auger Box Cover     |
| 14. 20-2687 | ATC Mount                 | 32. 58-0807  | Coolant Nozzle Base |
| 15. 62-0014 | Servo Motor               |              |                     |
| 16. 25-9203 | Motor Mount Cover Plate   |              |                     |
| 17. 28-0184 | X-Axis Bumper             |              |                     |
| 18. 30-3107 | Ballscrew Assembly        |              |                     |



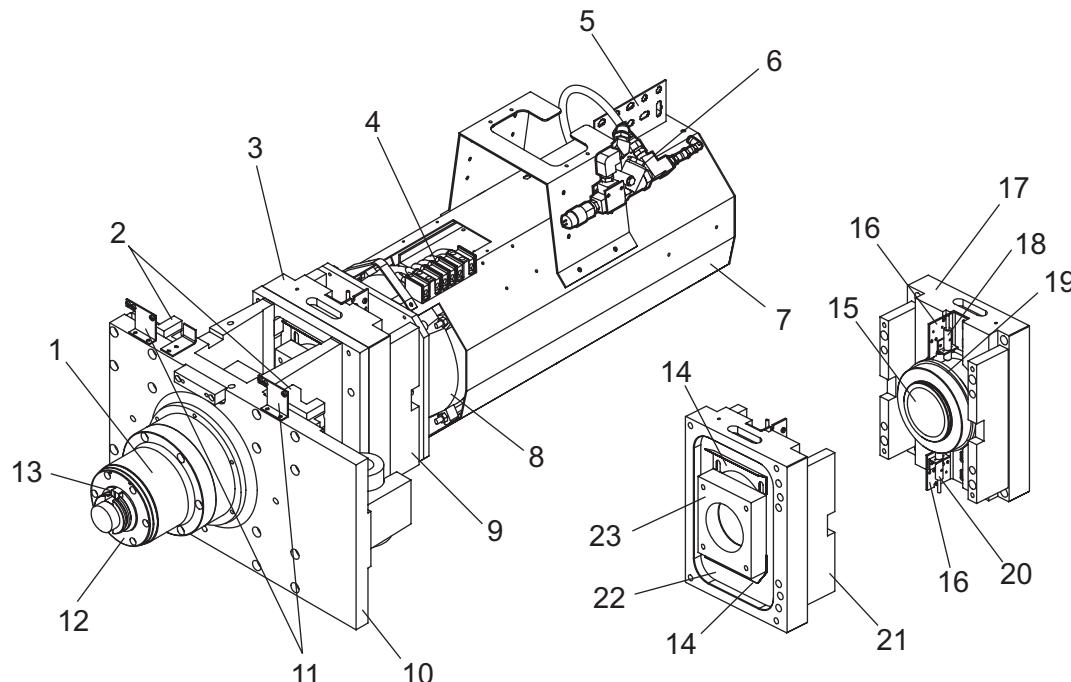
## EC-300 COLUMN ASSEMBLY



1. 25-7266 Mounting Bracket
2. 32-2130 Prox. Switch
3. 62-0035B Servo Motor
4. 25-7042 Cover Plate
5. 28-0188 Ballscrew Bumper
6. 20-2588A Column Casting
7. 28-0188 Y-Axis Bumper
8. 25-5732 Column Cover
9. 20-7009 Bearing Housing
10. 32-2132 Prox. Switch
11. 62-0036C Servo Motor
12. 28-0188 Bumper Cover
13. 24-0023 Ballscrew Assembly
14. 50-3400 Linear Guides
15. 24-0041 Ballscrew
16. 30-7356 Y-Axis Lube Line Assembly



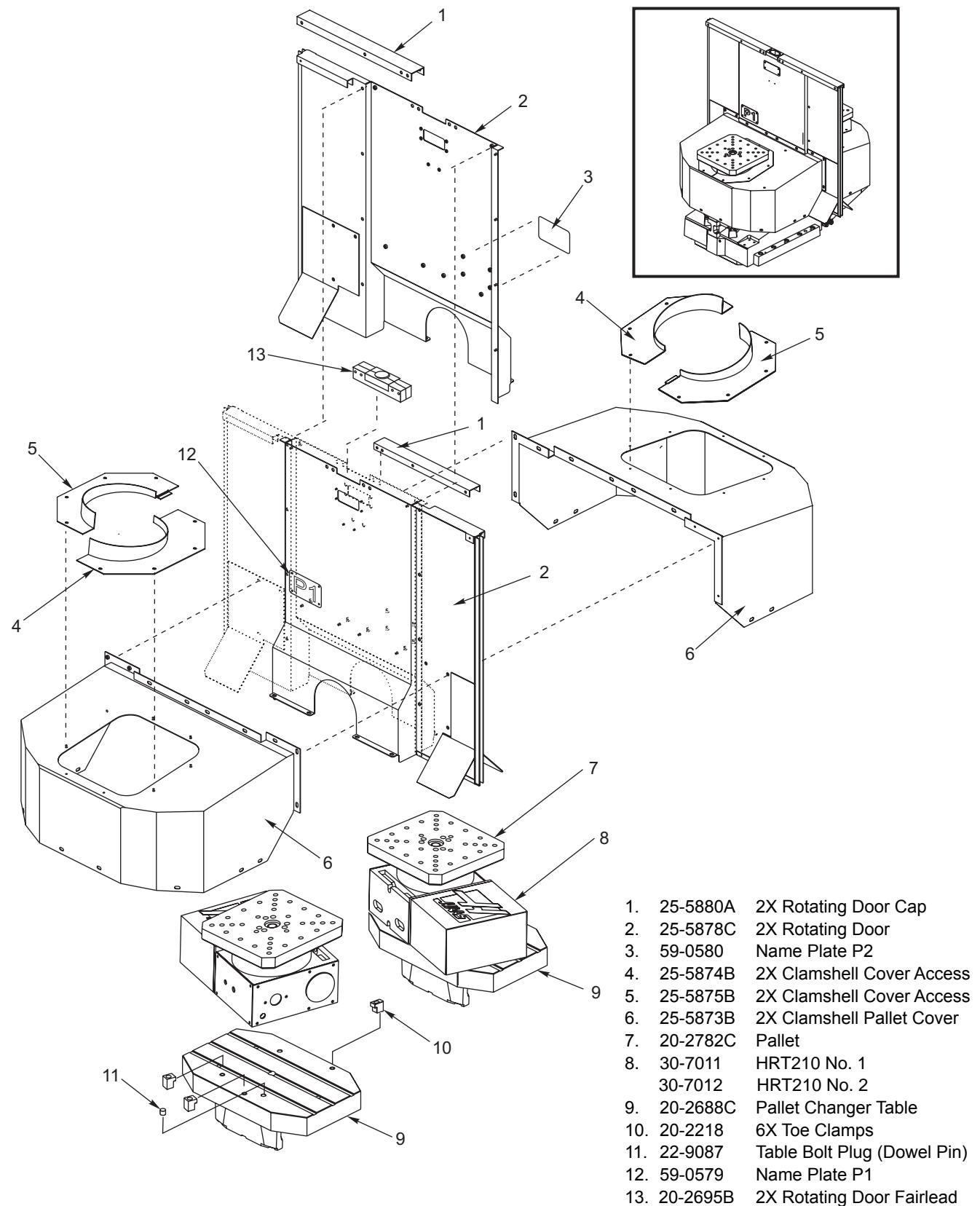
## EC-300 SPINDLE HEAD ASSEMBLY



- |              |                           |              |                         |
|--------------|---------------------------|--------------|-------------------------|
| 1. 20-7016C  | Spindle Housing           | 15. 20-1691  | Shaft Inline            |
| 2. 50-0017   | Linear Guide (35mm Truck) | 16. 25-4648B | Bracket Switch Mounting |
| 3. 30-7441   | TRP                       | 17. 20-4269  | Cylinder Inline         |
| 4. 73-3055   | Terminal Buss             | 18. 32-2200  | Prox. Switch "Unclamp"  |
| 5. 25-5242   | Shroud Bracket            | 19. 20-1696A | Spring Retain Inline    |
| 6. 30-6465   | TSC Fitting Assembly      | 20. 32-2233  | Prox. Switch "Clamp"    |
| 7. 25-6733   | Motor Shroud              | 21. 20-2520  | Standoff Inline         |
| 8. 62-3019   | Spindle Motor             | 22. 20-1692A | Piston Inline           |
| 9. 20-2520   | Stand Off                 | 23. 20-2521  | Striker Plate Inline    |
| 10. 20-2674A | Spindle Head              |              |                         |
| 11. 25-6592  | Junction Bracket          |              |                         |
| 12. 20-9763C | Spindle Lock              |              |                         |
| 13. 20-2512  | Inline Spindle Shaft      |              |                         |
| 14. 25-5970  | Shim                      |              |                         |



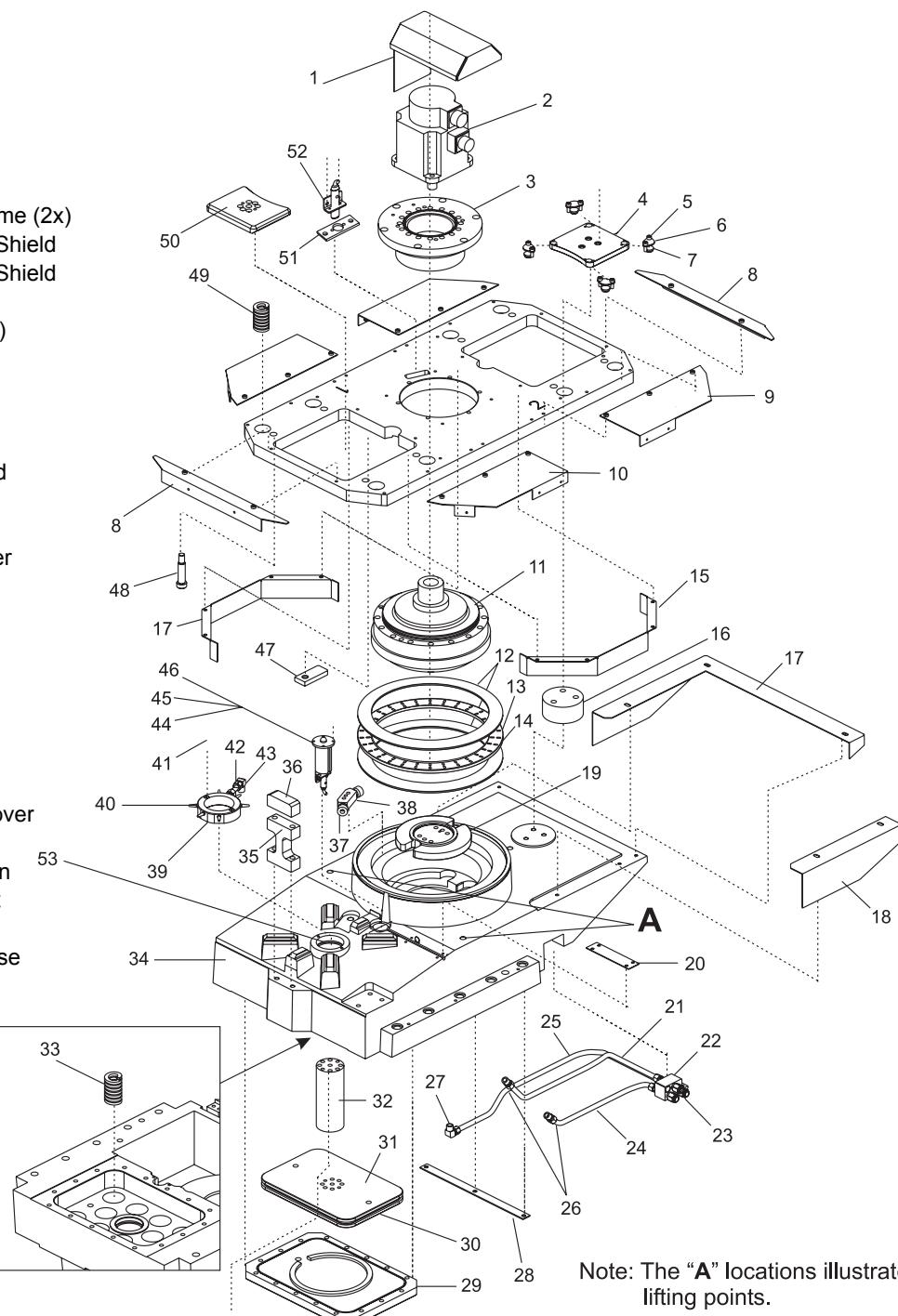
## EC-300 PALLET CHANGER





## 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 1/2
7. 20-2814 Stabilizer Button
8. 20-2729C Pallet Support Frame (2x)
9. 25-5876A Clamshell Splash Shield
10. 25-5877A 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. 58-0779A Air Blast Tube
22. 20-2726A Bulkhead
23. 58-1693 LBO Fitting
24. 58-0778A Clamp Tube
25. 58-0777A Unclamp Tube
26. 58-3087 Comp Fitting
27. 58-3052 90° Comp Fitting
28. 59-0485 APC Cable Strap
29. 20-2719 Clamp Cylinder Cover
30. 57-2986 Piston "O" Ring
31. 20-2700 Pallet Clamp Piston
32. 20-2716A Pallet Clamp Shaft
33. 59-0727 Die Spring
34. 20-2690B Pallet Changer Base

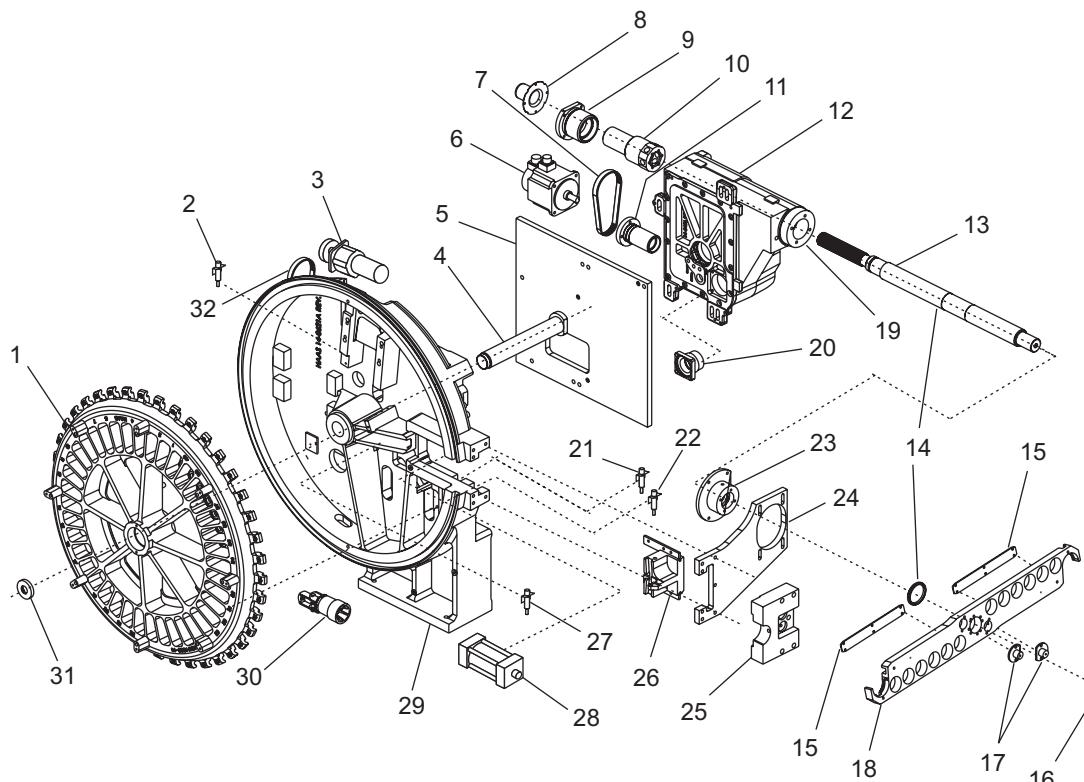


Note: The "A" locations illustrate lifting points.

- |              |                      |             |                            |
|--------------|----------------------|-------------|----------------------------|
| 35. 20-2785A | "H" Frame Pad        | 46. 32-2236 | Prox. Switch Unclamp       |
| 36. 20-2809  | Frame Button         | 47. 20-2698 | Pallet Flag                |
| 37. 59-0725  | Bumper               | 48. 49-0114 | Shoulder Bolt (2x)         |
| 38. 20-2728  | Stop Block           | 49. 59-0726 | Pallet Support Spring      |
| 39. 20-2727B | Air Blast Ring       | 50. 20-2715 | Pallet Clamp               |
| 40. 20-2582B | Air Blast Nozzle     | 51. 25-5903 | Prox. Pallet Mount         |
| 41. 40-1705  | FHCS                 | 52. 32-2130 | Prox. Home 1.5'            |
| 42. 58-2070  | Hex Fitting          | 53. 57-2157 | O-ring 2-333 Viton (qty 2) |
| 43. 58-0780A | Tube Input Air Blast |             |                            |
| 44. 20-2699B | Pallet Up Plunger    |             |                            |
| 45. 20-3073B | Clamp Switch Housing |             |                            |



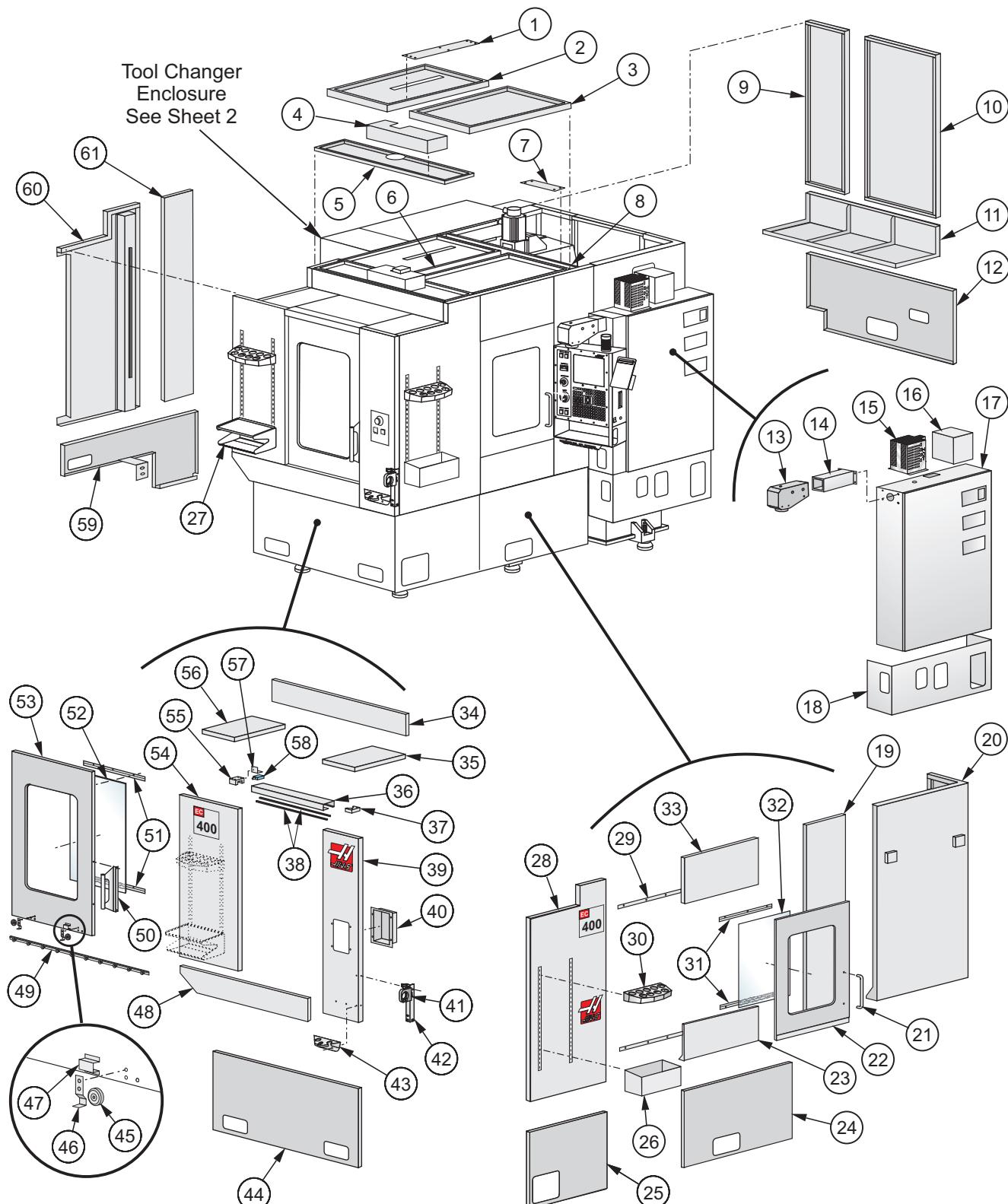
## EC-300 40-40 TOOL CHANGER



- |              |                      |              |                       |
|--------------|----------------------|--------------|-----------------------|
| 1. 20-0391B  | Carousel             | 20. 20-0226A | Bearing Housing       |
| 2. 32-2295   | Prox. Carousel Mark  | 21. 32-2251  | Prox. Pocket Down     |
| 3. 62-0030A  | Carousel Motor       | 22. 32-2252  | Prox. Pocket Up       |
| 4. 20-0387   | Carousel Shaft       | 23. 20-2732  | SMTC Shaft Support    |
| 5. 20-0487   | Mounting Plate       | 24. 20-2731  | SMTC Support Plate    |
| 6. 62-0035B  | Servo Motor          | 25. 20-2730  | Pocket Stop           |
| 7. 54-0036   | Drive Belt           | 26. 20-0807  | Tool Pocket Slide     |
| 8. 22-0001   | Output Shaft Cad     | 27. 32-2253  | Prox. Switch Tool One |
| 9. 20-0224   | Star Bearing Housing | 28. 59-0078  | Air Cylinder          |
| 10. 20-0223A | Star Gear            | 29. 20-2735  | ATC Housing           |
| 11. 20-0225  | Bearing Housing      | 30. 20-0458  | Tool Pocket           |
| 12. 30-4008A | Cam Box              | 31. 20-0392  | Carousel Washer       |
| 13. 20-2694  | Output Shaft         | 32. 54-0045  | Belt Drive            |
| 14. 57-0059  | Seal                 |              |                       |
| 15. 25-5805  | Cover Plate          |              |                       |
| 16. 20-0240  | Arm Hub              |              |                       |
| 17. 20-0245  | Arm Cap              |              |                       |
| 20-0246      | Arm Cap              |              |                       |
| 18. 30-7234  | Double Arm Assy.     |              |                       |
| 19. 20-0238B | Bearing Cap          |              |                       |



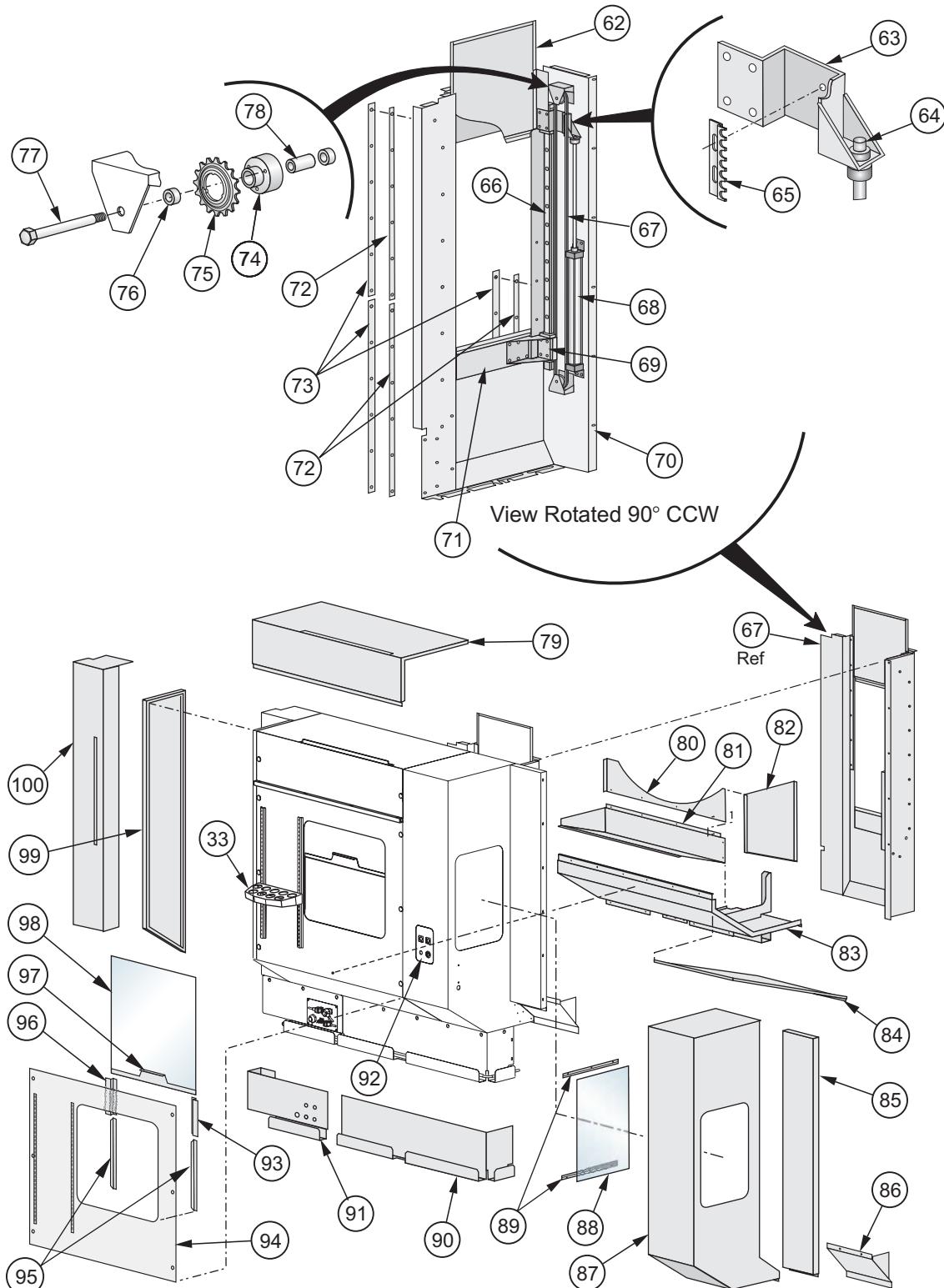
## EC-400 ENCLOSURE SHEET METAL



Sheet 1 of 2



**EC-400 ENCLOSURE SHEET METAL**



# Tool Changer Enclosure

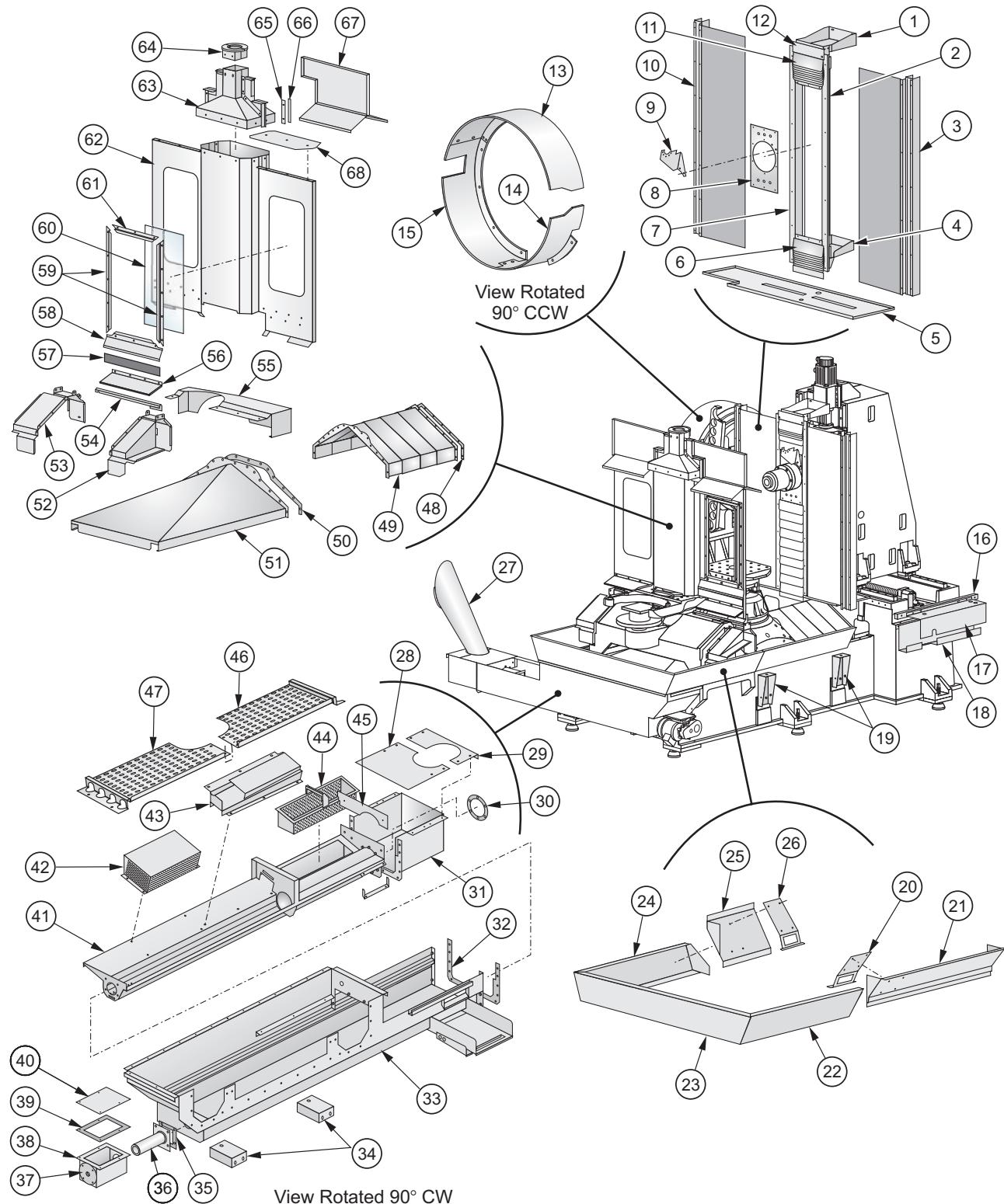
## Sheet 2 of 2

**EC-400 ENCLOSURE SHEET METAL**

1. 25-4984	Wire Channel Top Cover	45. 54-0030	2X Guide Wheel
2. 25-4965B	Left Top Cover	46. 25-5402A	2X Door Hook
3. 25-4964C	Right Top Cover	47. 25-4043	Door Stop
4. 25-4953B	J-Box Top Cover	48. 25-4950B	Front Upper Pan
5. 25-4952A	Front Top Cover	49. 20-1433	Door V-Track
6. 25-4980	Wire Channel Top Cover	50. 20-6016	Rail Spacer
7. 25-5253	Brace Top Cover	50. 22-8895	Front Door Handle
8. 25-4963A	Intermediate Top Brace	51. 25-5260	2X Front Door Window Z-Frame
9. 25-4957	Rear Center Panel	52. 28-0152	Front Door Window
10. 25-4977	Rear Panel Access Cover	53. 25-4997B	Front Door
11. 25-4958A	Rear Pan	54. 25-4947C	Front Left Panel
12. 25-5035A	Rear Apron	55. 20-2410	Door Guide Block
13. 25-6661A	Arm End Cap	56. 25-5420A	Left Panel Stiffener Bracket
14. 20-4137	Pendant Arm	57. 25-5415	Door Guide Bracket
15. 32-0042A	Regen Assy	58. 32-5074A	Front Door Close Switch
16. 25-4953B	J-Box	59. 25-4971B	Left Front Apron
17. 25-11310A	Control Box Assy	60. 25-4949B	Left Top Side Panel
18. 25-10649	Control Box Skirt	61. 25-4979	Left Intermediate Panel
19. 25-4956B	Right Intermediate Panel	62. 25-5030A	TC Top Door
25-5200A	Operator Door Rear chip Shield	63. 25-5032A	Top Connect Bracket
20. 25-4938	Right Rear Corner Panel	64. 59-0641	Rod Aligner
21. 22-8895	Door Handle	65. 25-0974	Chain Retainer
22. 25-4966	Operator Door	66. 50-0012A	Linear Guide
30-1958A	4X Door Roller Assy	67. 54-0072	Chain 96 in.
59-0604	Door Spring	68. 59-0612A	Air Cylinder
23. 25-5198	Operator Lower Panel	69. 25-5033	Bottom Connect Bracket
24. 25-4982A	Right Rear Apron	70. 25-5029	TC Internal Panel
25. 25-4970	Right Front Apron	71. 25-5031	TC Bottom Door
26. 25-0563B	Tool Box	72. 25-5034	3X Door Guide Spacer
27. 25-6182D	Tool Tray	73. 20-2087	3X Door Guide
28. 25-4948B	Right Side Panel	74. 20-3126	Idler Sprocket
29. 20-2036	Upper Operator Door Track	75. 54-0073	Master Link
20-2038	Lower Operator Door Track	76. 22-9673	4X Spacers
30. 25-0440A	Tool Crib	77. 20-10251	2X Shaft
31. 25-5228	2X Operator Door Window Z-Frame	78. 51-0075	2X Bearing
32. 28-0151	Operator Door Window	79. 25-4960B	TC Panel Header
33. 25-4954	Right Side Header	80. 25-5284A	Left Chip Shield
25-4973B	Header Chip Shield	81. 25-4976A	Coolant Drip Pan
32-2313	Door Close Switch	82. 25-5283A	TC Front Chip Shield
25-4990	Door Trip Bracket	83. 25-4961A	TC Pan
34. 25-4999A	Enclosure Header	84. 25-4985A	Chip Shield Lower Panel
35. 25-4951B	Front Corner Panel Stiffener Bracket	85. 25-4979	TC Intermediate Left Panel
36. 25-5456	Front Door Guide Rail	86. 25-4987	Lower Left Panel Chip Shield
37. 20-2411B	Door Stop Block	87. 25-4962C	TC Panel
38. 59-0053	2X Edge Trim	88. 28-0151	TC Window
39. 25-4946	Front Right Panel	89. 25-5228	2X TC Window Z-Frame
40. 25-1257A	Switch Box	90. 25-4972	Right Rear Apron
25-1258A	Switch Box Cover	91. 25-5247D	Left Rear Apron
57-0195A	Switch Box Cover Gasket	92. 32-1114A	TC Remote Switch Box
41. 20-1341	Tool Holder	25-6719	Switch Box Cover
59-0278	Knob and Screw	93. 25-4220C	Window Rest
42. 25-0798A	Tool Holder Mounting Bracket	94. 25-5991B	TC Side Panel
43. 25-5412	Nozzle Holding Bracket	95. 28-0167	TC Window Extrusion
44. 25-4969A	Front Apron	96. 25-4221C	Window Rest Opposite
		97. 25-9248A	Window Plate Handle
		98. 28-0168	TC Access Window
		99. 25-4978A	TC Rear Panel
		100. 25-4959E	Left Rear Corner Panel



## EC-400 INTERNAL SHEET METAL



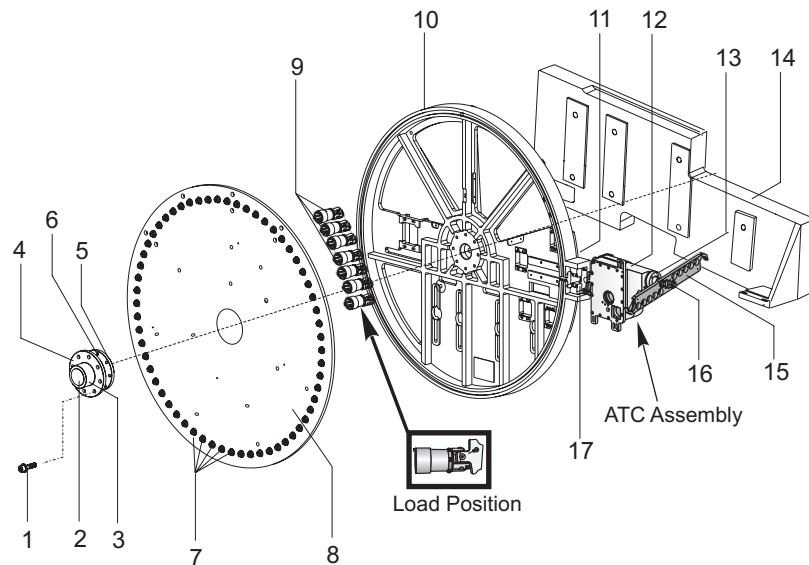


## EC-400 INTERNAL SHEET METAL

- |              |                                 |              |                                    |
|--------------|---------------------------------|--------------|------------------------------------|
| 1. 25-5007   | Y-Axis Frame Top Bracket        | 51. 25-5549  | Z-Axis Front Waycover              |
| 2. 25-5001B  | Y-Axis Right Guide              | 52. 25-5229A | Right Bridge Chip Shield           |
| 3. 59-0806   | Right Roll-up Waycover          | 53. 25-5230A | Left Bridge Chip Shield            |
| 4. 25-5008   | Y-Axis Frame Bottom Bracket     | 54. 25-5235  | 2X Rotating Door Right Step Shield |
| 5. 25-5006A  | X-Axis Bottom Shield            | 55. 25-5046  | APC Cylinder Shield                |
| 6. 59-0606   | Y-Axis Lower Waycover           | 56. 25-5237  | 4X Z-Axis Rotating Door Shade Seal |
| 7. 25-5000B  | Y-Axis Left Guide               | 57. 20-2283A | 2X Rotating DF Support Bar         |
| 8. 25-5002A  | Spindle Cover                   | 58. 25-5233A | 2X Rotating Door Z-Channel         |
| 9. 25-7858   | P-Cool Mounting Bracket         | 59. 25-1262  | 4X Partition Top z-Frame           |
| 10. 59-0805  | Left Roll-up Waycover           | 60. 28-0043  | 2X Window                          |
| 11. 59-0605  | Y-Axis Upper Waycover           | 61. 25-4149  | 4X Window Z-Frame                  |
| 12. 20-2319B | Y-Axis Frame Plate Filler       | 62. 25-5232C | Rotating Door Panel                |
| 13. 25-4152B | SMTC 40-40 Front Cover          | 63. 25-5234B | Rotating Door Cover                |
| 14. 25-0800C | SMTC 40-40 Corner Shroud        | 64. 20-2284  | 2X Rotating Door Cable Fairlead    |
| 15. 25-4153B | SMTC 40-40 Rear Cover           | 65. 25-5239A | 2X Rotating Door Retainer Seal     |
| 16. 20-2035  | Control Box Support Bar         | 66. 57-0330A | 2X Rotating Door Cover Seal        |
| 17. 30-6316A | Lube Panel Assy                 | 67. 25-4983C | 2X Rotating Door Splash Shield     |
| 18. 25-4942A | Wire Channel Panel              | 68. 25-5238A | 2X Rotating Door Top Shade         |
| 19. 25-4940A | 2X Panel Side Brace             |              |                                    |
| 20. 25-5360A | Auger Keeper Right Bracket      |              |                                    |
| 21. 25-4967A | lower right Front Chip Shield   |              |                                    |
| 22. 25-4994  | Right Front Pan                 |              |                                    |
| 23. 25-4981A | Lower Front Pan                 |              |                                    |
| 24. 25-4995  | Left Front Pan                  |              |                                    |
| 25. 25-4987  | Lower Left Panel Chip Shield    |              |                                    |
| 26. 25-5361A | Auger Keeper Left Bracket       |              |                                    |
| 27. 25-0548  | Auger Chute                     |              |                                    |
| 28. 25-5301  | Coolant Trough Extension Cover  |              |                                    |
| 29. 25-5300  | End Chute Cover                 |              |                                    |
| 30. 57-0048  | Auger Chute Gasket              |              |                                    |
| 31. 25-5025A | Coolant Trough Extension        |              |                                    |
| 32. 57-0334A | Coolant Trough Extension Gasket |              |                                    |
| 33. 25-5288B | Coolant Trough                  |              |                                    |
| 34. 25-4944  | 2X Auger Trough Brace           |              |                                    |
| 35. 57-0333  | Extension Box Gasket            |              |                                    |
| 36. 20-2322  | Auger Coupler Extension         |              |                                    |
| 37. 57-9265A | Conveyor Motor Gasket           |              |                                    |
| 38. 25-5289  | Auger Motor Extension Box       |              |                                    |
| 39. 57-0332  | Extension Box Top Gasket        |              |                                    |
| 40. 25-5290  | Extension Box Top               |              |                                    |
| 41. 25-5024A | Auger Trough                    |              |                                    |
| 42. 25-5299A | Auger Trough Screen             |              |                                    |
| 43. 25-5297A | Coolant Channel                 |              |                                    |
| 44. 25-5291B | Chip Basket                     |              |                                    |
| 45. 25-5521  | Rear Auger Trough Seal          |              |                                    |
| 46. 25-5256B | Front Left Auger Guard          |              |                                    |
| 47. 25-5255B | Front Right Auger Guard         |              |                                    |
| 48. 57-0304  | Bulkhead Waycover Gasket        |              |                                    |
| 49. 25-5011A | Bulkhead Waycover               |              |                                    |
| 50. 57-0327  | Waycover Gasket                 |              |                                    |



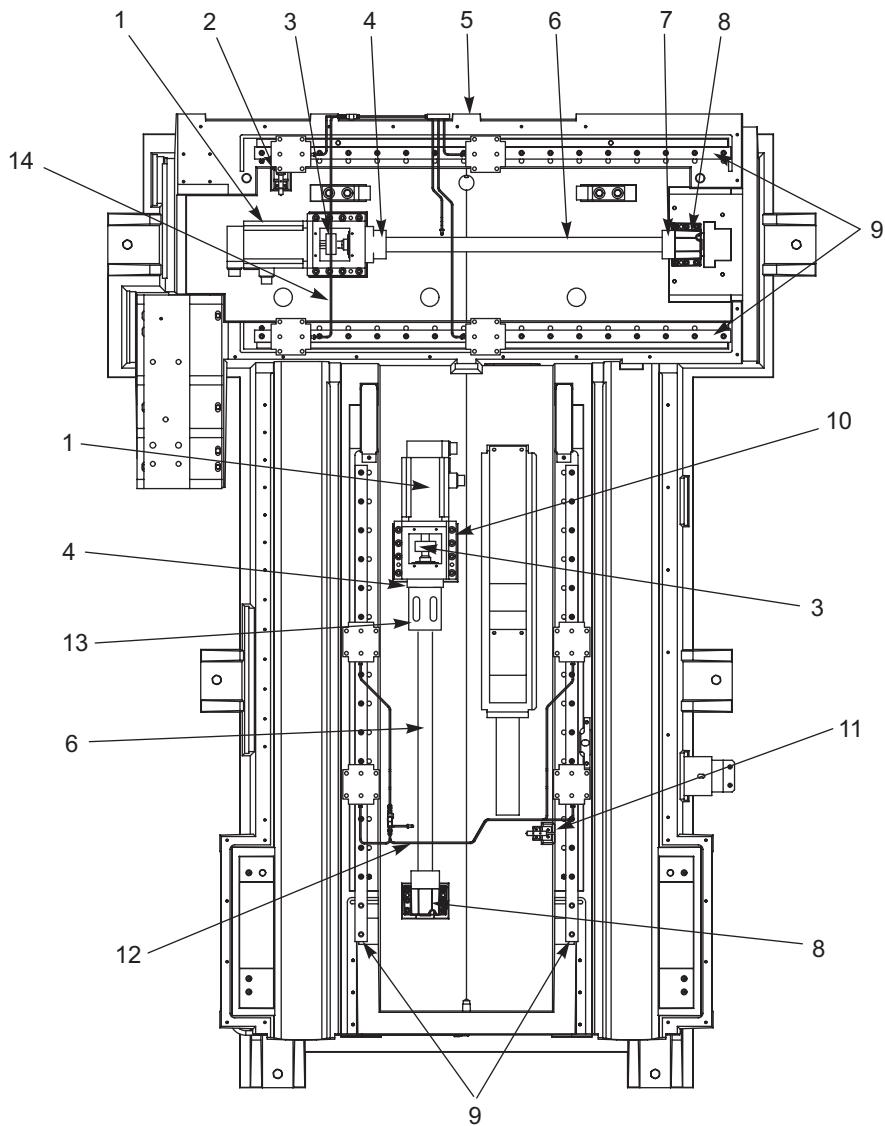
## EC-400 60-40 Tool Changer



1. 40-0226 SHCS  $\frac{3}{4}$ "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  $\frac{1}{2}$ "-13x $1\frac{3}{4}$ "
7. 51-0045 Cam Follower
8. 20-2022E Plate Index
9. 20-0458 Tool Pockets
10. 20-0457C Pocket Carousel
11. 30-0145A Cambox Assembly
12. 20-0455C ATC Cambox
13. 20-0238B Bearing Cap
14. 20-2825B Machining Mount
15. 20-2121 Double Arm
16. 20-0240 Hub Arm
17. 20-2867A Stop Pocket



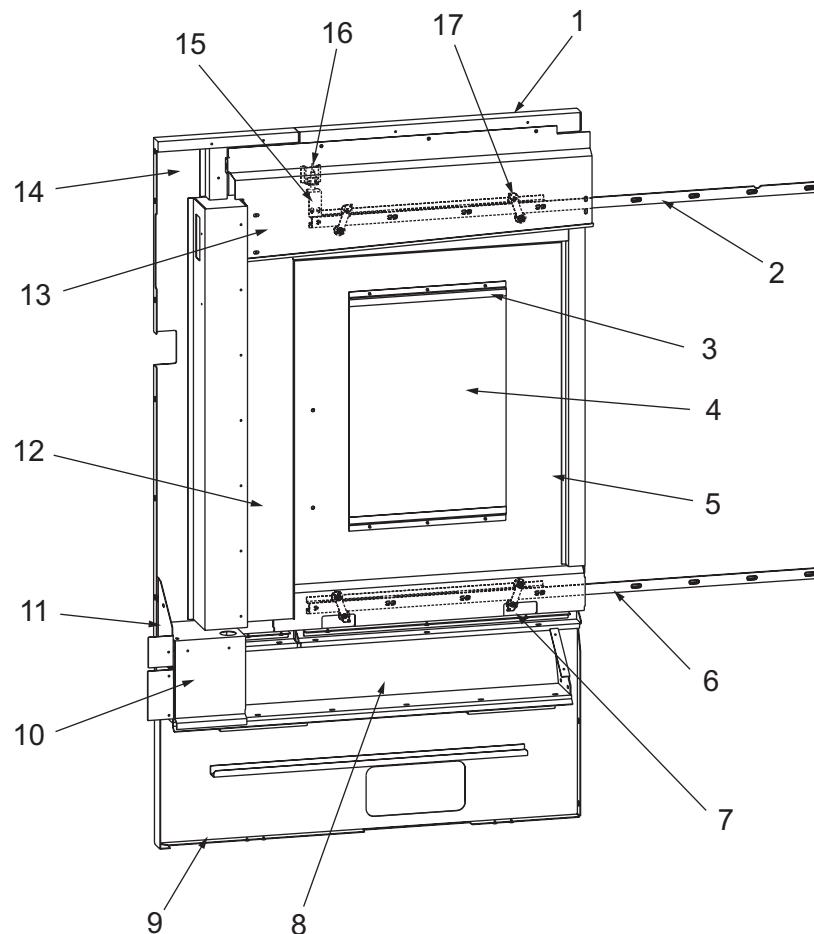
## EC-400 BASE CASTING



1. 62-0016 Motor
2. 32-2130 Limit Switch
3. 30-1225A Ball Screw Coupling
4. 20-9212 Bearing Housing
5. 20-2042G Casting
6. 24-0026A Ballscrew
7. 28-0206 Hard Stop X-Axis
8. 20-0152 Bearing Housing
9. 50-3400 Linear Guides
10. 20-0151A Motor Mount Assy.
11. 32-2134 Limit Switch
12. 30-6336 Z-Axis Lube Assy.
13. 28-0193 Bumper
14. 30-6337 X-Axis Lube Assy.



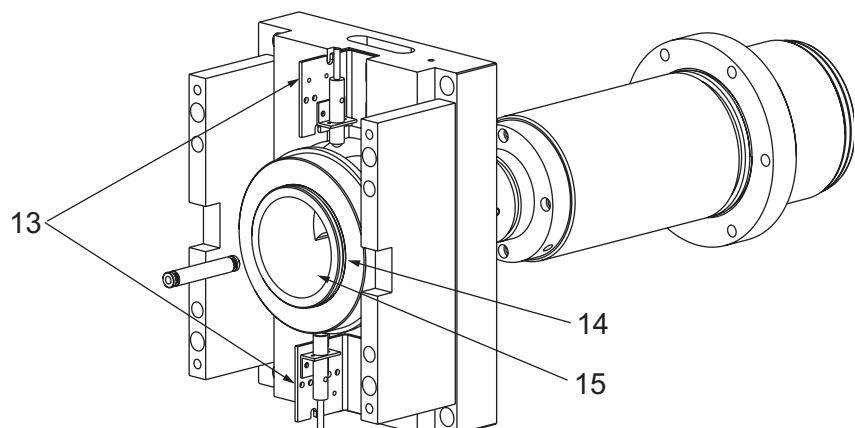
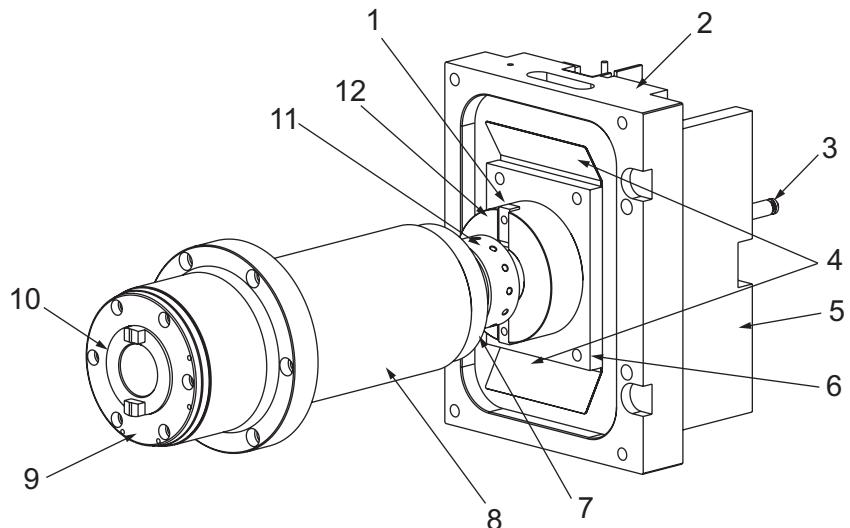
## EC-400 OPERATOR'S DOOR



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. 25-4982A Right Rear Apron
10. 25-5246 Chip Shield
11. 25-5245 Chip Shield Lower Operator Panel
12. 25-5200A Chip Shield Rear Operator Door
13. 25-4973B Chip Shield Header Operator Door
14. 25-4956B Right Intermediate Panel
15. 25-4990 Trip Bracket Operator Door
16. 32-2313 Operator Door Close Switch
17. 30-1958A Door Roller Assembly  
59-0604 Operator Door Spring



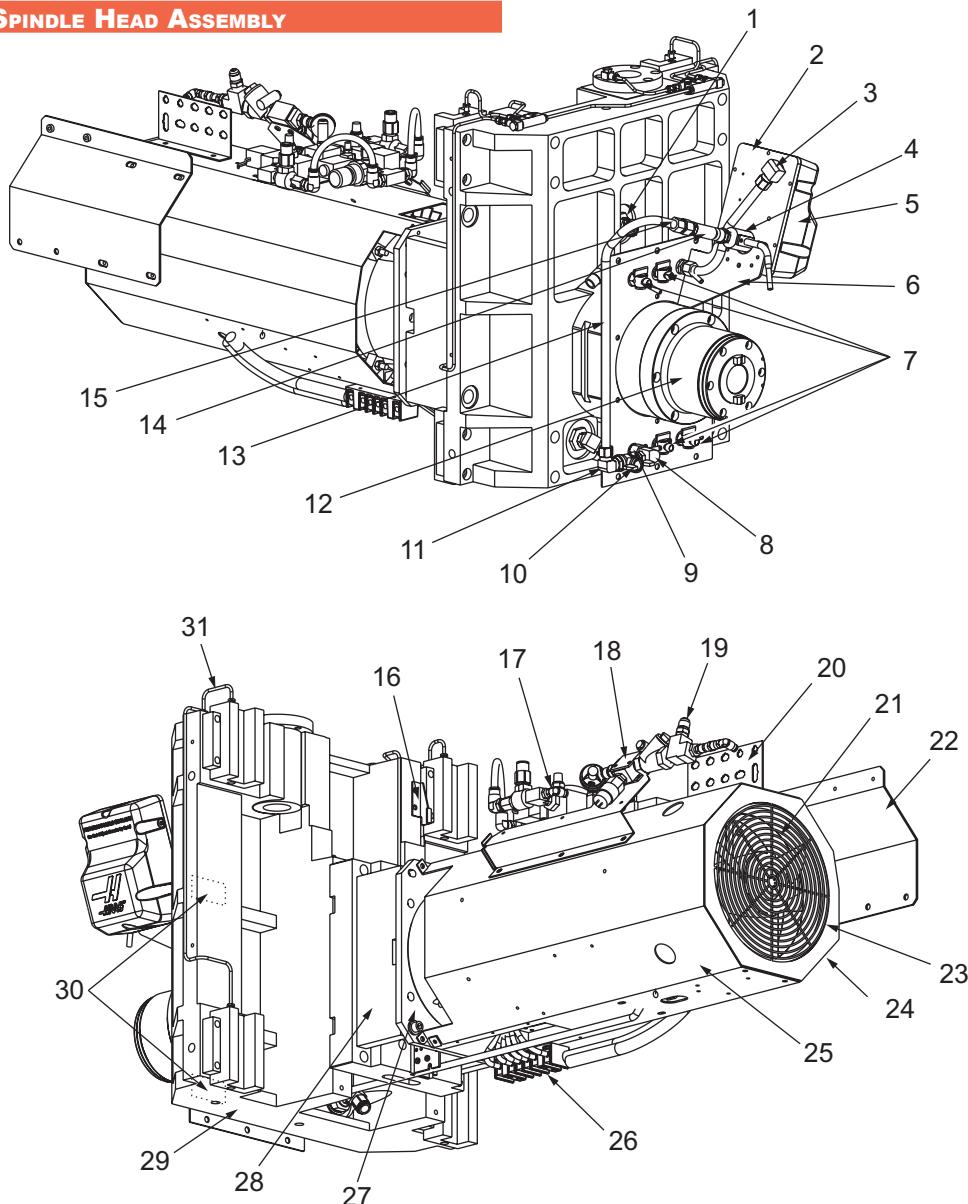
### EC-400 IN-LINE SPINDLE ASSEMBLY



- |             |                        |              |  |
|-------------|------------------------|--------------|--|
| 1. 20-2516  | Key Drawbar Inline     | 12. 25-4648B | 2X Bracket Switch Mounting In-line Spindle |
| 2. 20-4269  | TRP Cylinder In-Line   | 13. 20-1696A | TRP Spring Retain Inline                   |
| 3. 20-2519  | Transfer-Tube In-line  | 14. 20-1691  | TRP Shaft In-Line                          |
| 4. 25-5970  | 2X Shim TRP In-Line    | 15. 52-0155  | Shaft Coupling                             |
| 5. 20-2520  | Standoff Motor In-Line |              |  |
| 6. 20-2521  | Striker Plate Inline   |              |  |
| 7. 20-3823  | Oil Injector Cover     |              |  |
| 8. 20-7016C | Spindle Houseing 40T   |              |  |
| 9. 20-9763C | Spindle Lock Tapered   |              |  |
| 10. 20-2512 | Spindle Shaft 40T      |              |  |
| 11. 20-4242 | Guide Release In-line  |              |  |



### EC-400 SPINDLE HEAD ASSEMBLY

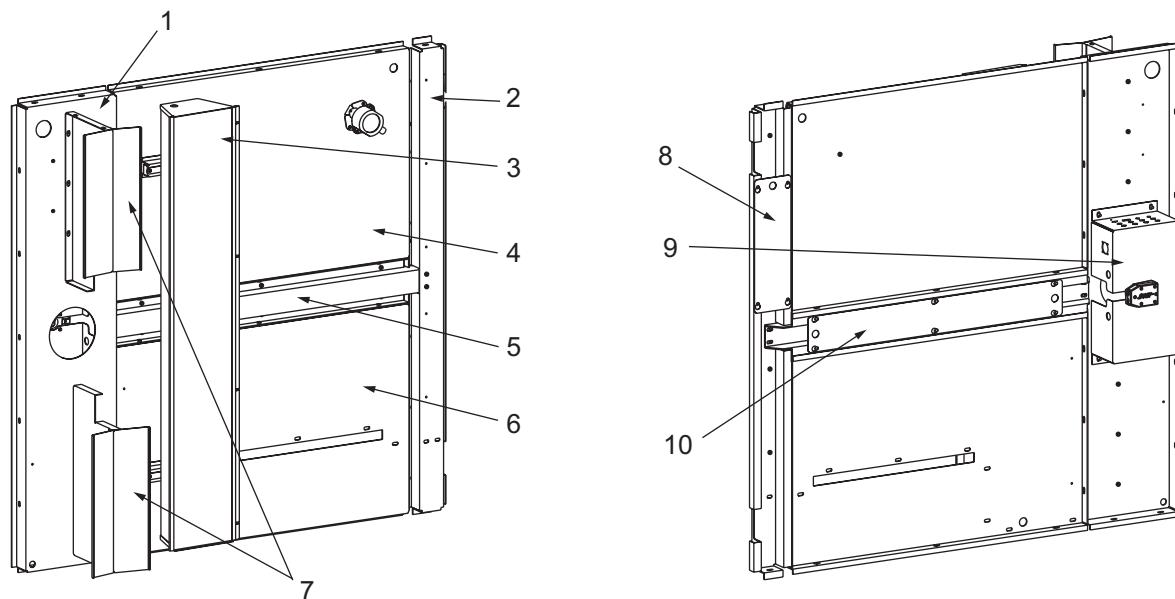


View Rotated 180° Looking Up

- |              |                                       |              |                             |
|--------------|---------------------------------------|--------------|-----------------------------|
| 1. 58-1680   | Fitting Bkhd NPT 1/2x1.125 Dia.       | 16. 25-5012  | Trip Bracket Y-axis         |
| 2. 20-3491   | Plate, Prog Coolant                   | 17. 30-4095A | TRP Solenoid Assembly       |
| 3. 25-8478   | Condit Assembly P-Cool                | 18. 25-7823  | Bracket Clamp TSC           |
| 4. 58-0961   | Nozzle Body                           | 19. 32-3002C | TSC Switch Assembly         |
| 5. 14-2149   | P-Cool Cover                          | 20. 25-5242  | Bracket Shroud              |
| 6. 25-7858   | P-Cool Mounting Bracket               | 21. 36-3035C | Fan Assembly Spindle        |
| 7. 58-3694   | 1/4 Valves Loc-Line                   | 22. 25-7825  | Brkt Cable Carrier Y-Axis   |
| 8. 58-1722   | Fitting NPT 3/8F x NPT 3/8M 90 Degree | 23. 59-0144  | Fan Guard 8.75 in.          |
| 9. 58-1686   | Fitting NPT 1/4M x NPT 3/8F           | 24. 25-7871  | Bracket Fan In-Line Spindle |
| 10. 58-0326  | 3/8 Full Pivot Ball Valve             | 25. 25-7820  | Shroud Motor In-Line        |
| 11. 58-3052  | Fitting Comp 1/2 x NPT 3/8M 90 Degree | 26. 73-3055  | Therm Blk 6-Pole            |
| 12. 30-6460A | Spindle Assmby 12K in-Line            | 27. 20-2248  | Plate Motor                 |
| 13. 58-0674  | Tube Coolant P-Cool                   | 28. 20-2520  | Stand Off Motor In-Line     |
| 14. 52-0035  | P-Cool Hose                           | 29. 20-2044B | Spindle Head Machined       |
| 15. 58-3049  | Fitting Comp 1/2xNPT 3/8 Str          | 30. 20-2063  | Coolant Block               |
|              |                                       | 31. 30-6338B | Oil Line Assembly Y-Axis    |



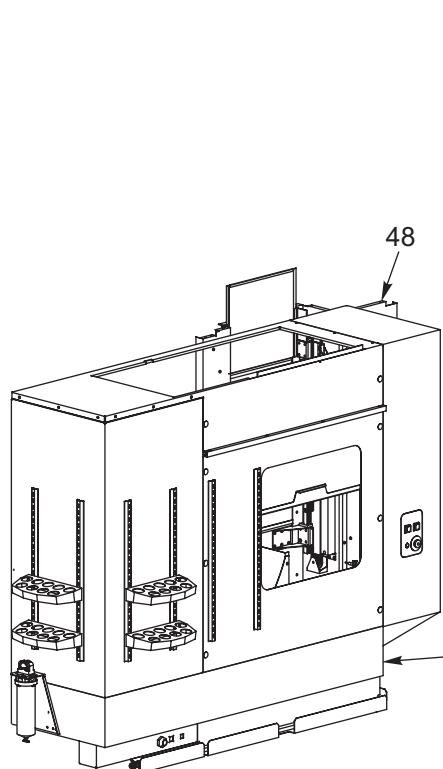
## EC-400 TOP COVER



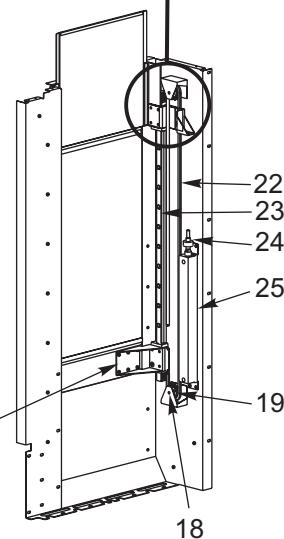
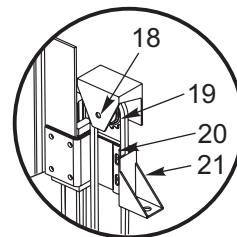
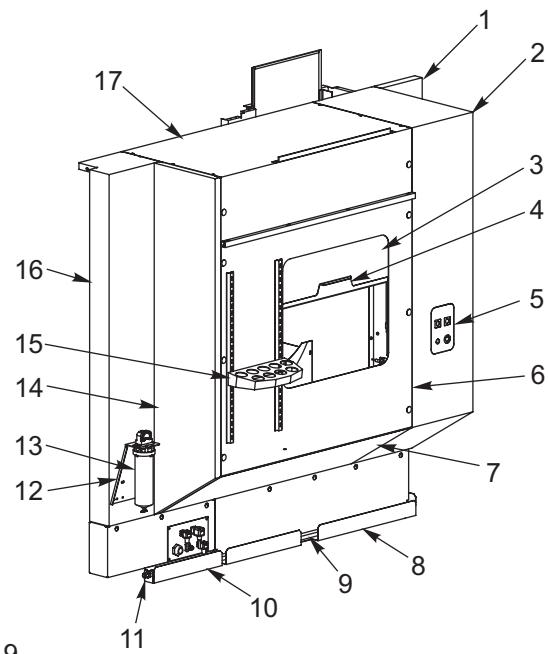
1. 25-4952A Top Cover Front
2. 25-4963A Brace Top Intermediate
3. 32-0196 Worklight Assembly
4. 25-4964C Top Cover Right
5. 25-4980 Wire Channel Top Cover
6. 25-4965B Top Cover Left
7. 25-4983C Splash Shield Rotating
8. 25-5253 Cover Brace Top
9. 25-4953B J-Box Top Cover
10. 25-4984 Cover Wire Channel Top



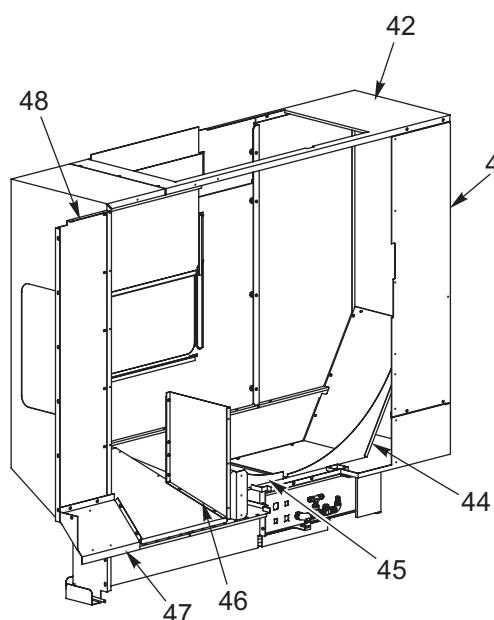
## EC-400 60 AND 70-TOOL TOOL CHANGER PANELS



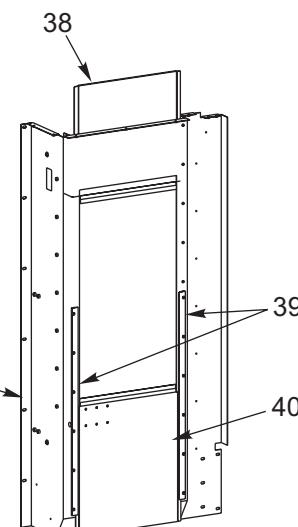
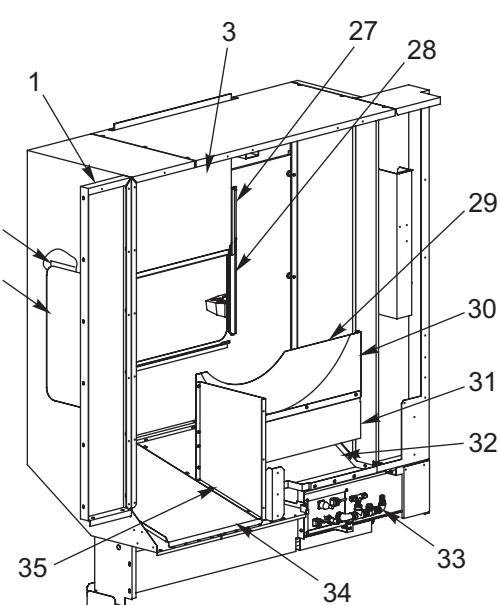
SMTC 60 Pocket Only



TC Door Assembly



SMTC 60 Pocket Only  
(View Rotated 180°)



TC Door Assembly  
(View Rotated 180°)

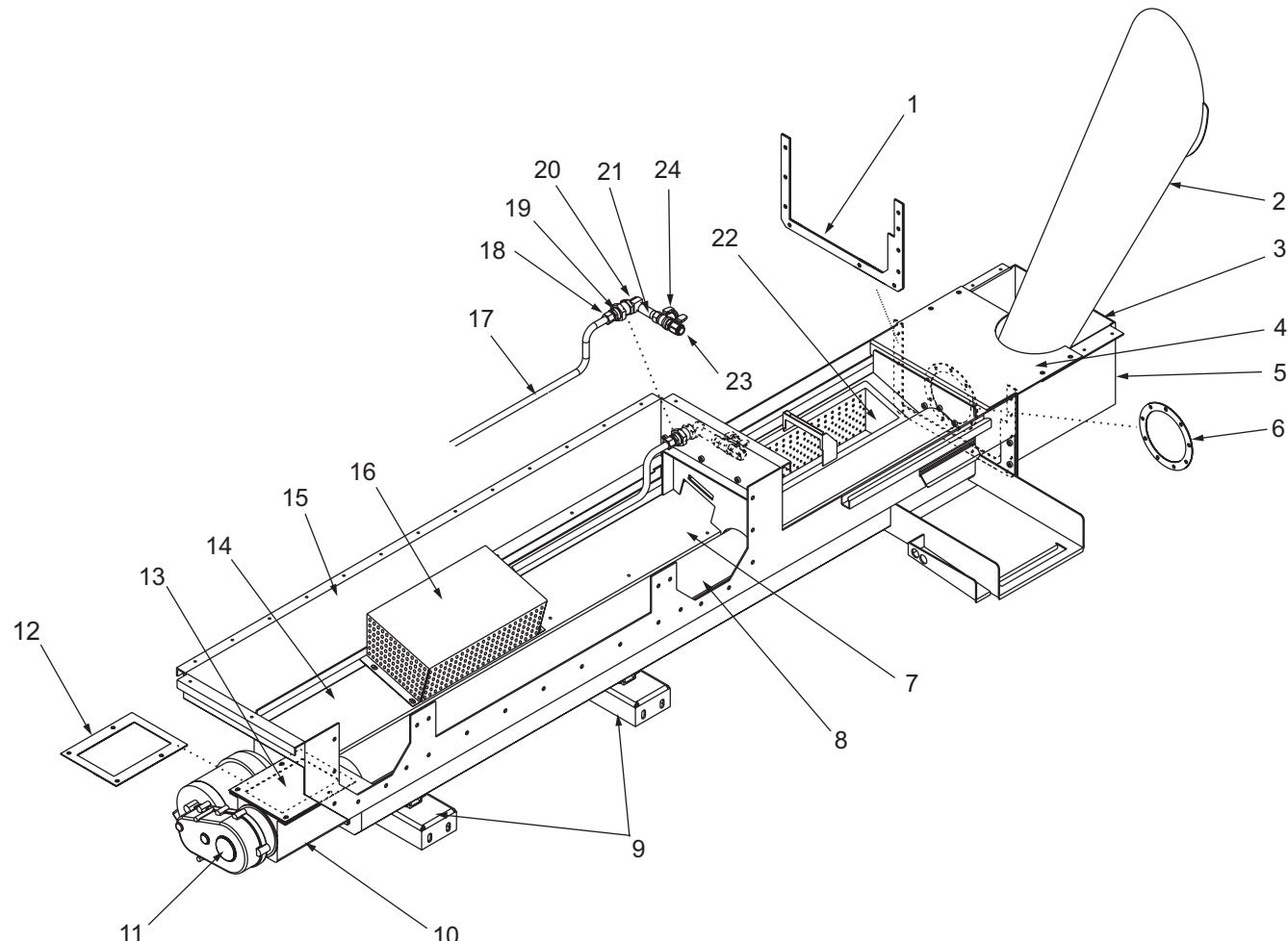


## EC-400 60- AND 70-TOOL TOOL CHANGER PANELS

1. 25-4979 Left intermediate panel
2. 25-4962C Tool changer panel
3. 28-0168 TC access window
4. 25-9248A Plate window handle
5. 25-6718A SMTc switch box
5. 25-6719 SMTc switch box cover
6. 25-5991B SMTc side panel
7. 25-4961A TC pan
8. 25-4972 Left rear apron
9. 58-0671 Coolant drain tube
10. 25-5247D TC panel rear apron
11. 58-1679 Bulkhead fitting
- 58-1693 LBO fitting (2)
12. 52-6042 TSC filter
13. 25-8951 TSC filter bracket
14. 25-4978A TC rear panel
15. 25-0440A Tool tray
16. 25-4959E Left rear panel
17. 25-4960B TC panel header
18. 22-9673 Spacer (2)
19. 30-8049 Idler sprocket assembly
20. 25-0974 Chain Retainer
21. 25-5032A TC door top connect bracket
22. 54-0072 Chain
23. 50-0012A Linear guide
24. 59-0641 Cylinder rod aligner
25. 59-0612A Air cylinder
26. 25-5033 TC door bottom connect bracket
27. 25-4221C Opposite window rest (2)
28. 28-0167 TC window extrusion (2)
29. 25-5284A TC left chip shield 24TL
30. 25-5295A TC left chip shield 40TL
31. 25-4976A TC coolant drip pan
32. 25-4961A TC pan
33. 30-6753C Coolant fitting assembly
34. 25-4985A TC panel lower chip shield
35. 25-5283A TC front chip shield
36. 28-0151 Window TC panel operator door
37. 25-5228 TC operator door window Z-frame
38. 25-5030A Top door
39. 20-2087 Door guide
- 25-5034 Door guide spacer
40. 25-5031 Bottom door
41. 25-5029 TC internal panel
42. 25-5992B SMTc60 top panel
43. 25-5994A SMTc70 rear panel
44. 25-5996A SMTc70 rear chip shield
45. 25-5995A 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



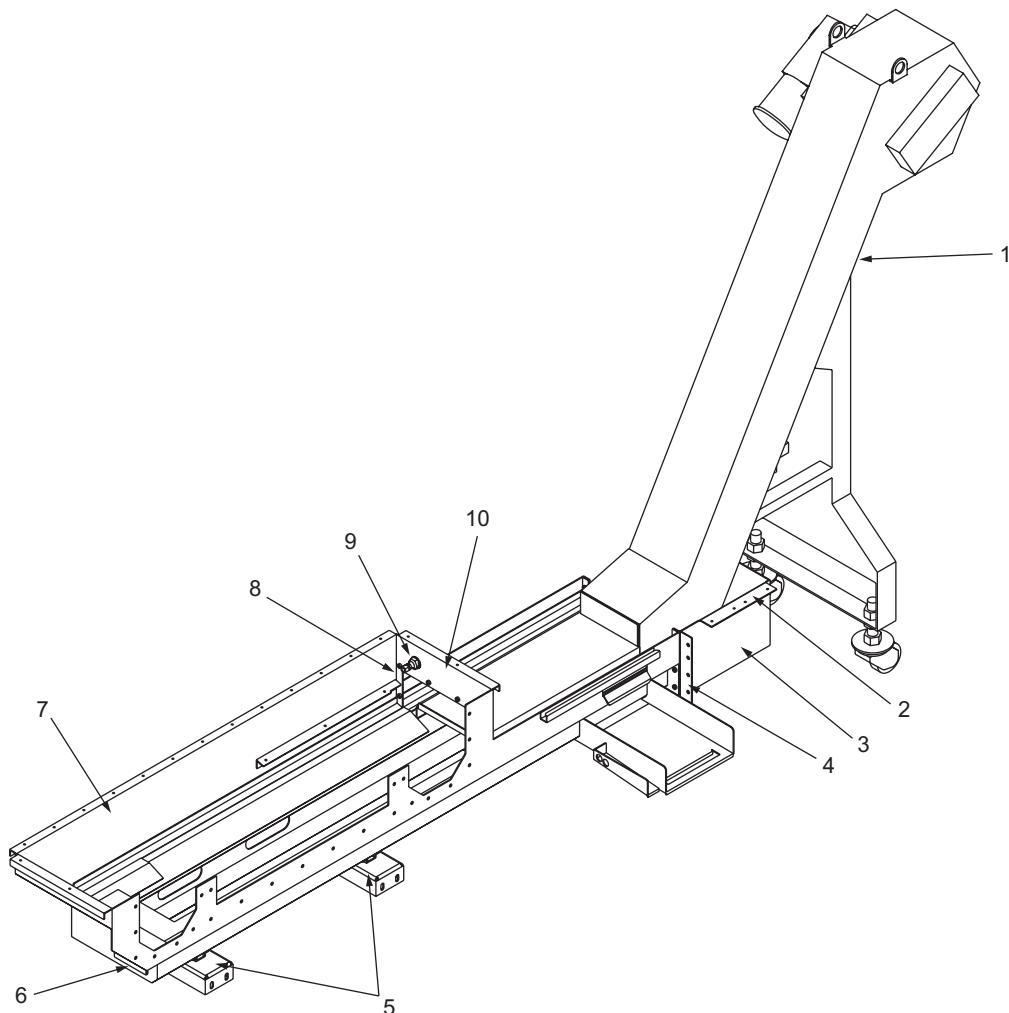
## EC-400 FRONT TROUGH ASSEMBLY (AUGER SYSTEM)



- |              |                                |              |                                      |
|--------------|--------------------------------|--------------|--------------------------------------|
| 1. 57-0334A  | Gasket Coolant Trough          | 17. 59-0661  | Nozzle Assembly Screen Washdown      |
| 2. 25-0548   | Chute Discharge                | 18. 58-2071  | Fitting Comp 1/2 x NPT 1/2M          |
| 3. 25-5300   | End Chute Cover                | 19. 58-1679  | Fitting BKHD NPT 3/8 x 1 Dia         |
| 4. 25-5301   | Coolant Trough Extension Cover | 20. 58-1722  | Fitting NPT 3/8F x NPT 3/8M 90 Brass |
| 5. 25-5025A  | Extension Box Front Trough     | 21. 58-3644  | Nipple 3/8 NPT x 2 1/2 Brass         |
| 6. 57-0048   | Gasket Discharge               | 22. 25-5291B | Chip Basket                          |
| 7. 25-5297A  | Coolant Channel                | 23. 58-1693  | Fitting LBO 1/2 NPT 3/8M STR         |
| 8. 20-2039A  | Auger Front                    | 24. 59-2229  | 1/2 NPT Swing Valve                  |
| 9. 25-4944   | (2X) Brace Auger Trough        |              |                                      |
| 10. 25-5289  | Extension Box Auger Motor      |              |                                      |
| 11. 62-0050A | 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. 25-5288B | Coolant Trough                 |              |                                      |
| 16. 25-5299A | Auger Trough Screen            |              |                                      |



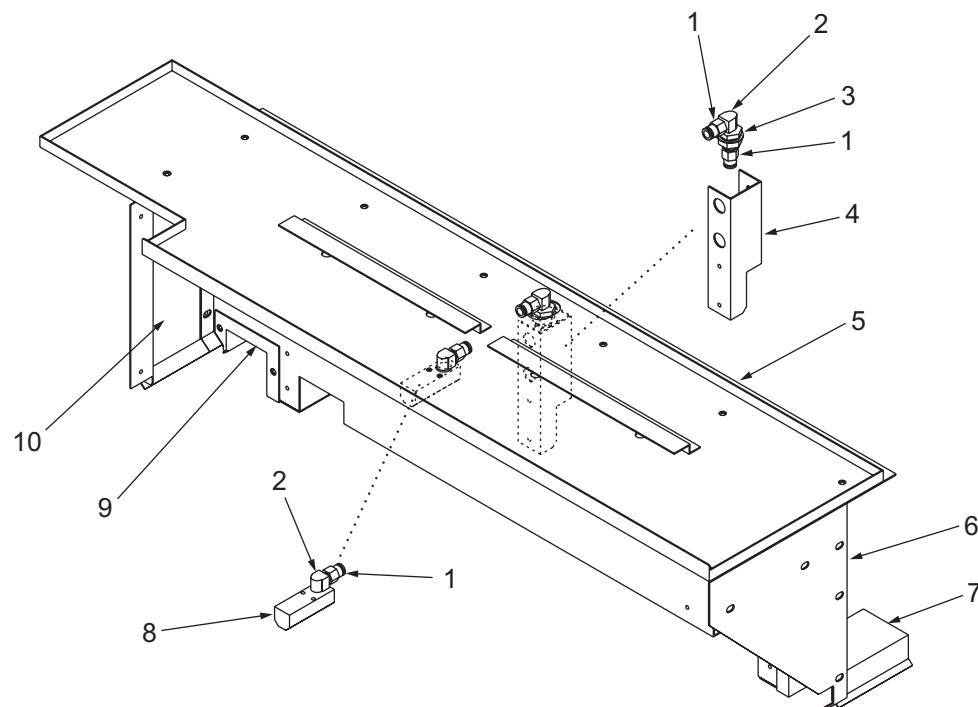
### EC-400 FRONT TROUGH ASSEMBLY (CHIP CONVEYOR SYSTEM)



1. 30-6477E 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
7. 57-0333 Extension Box Gasket
7. 25-5288B 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



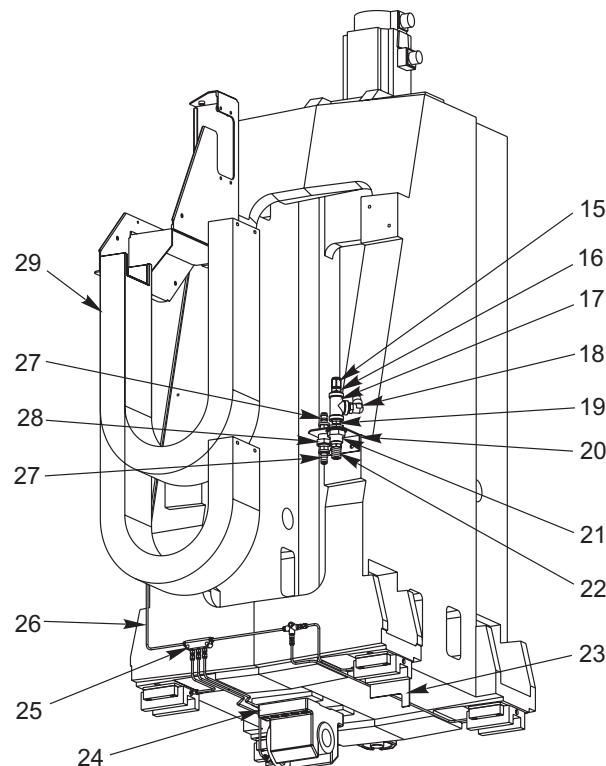
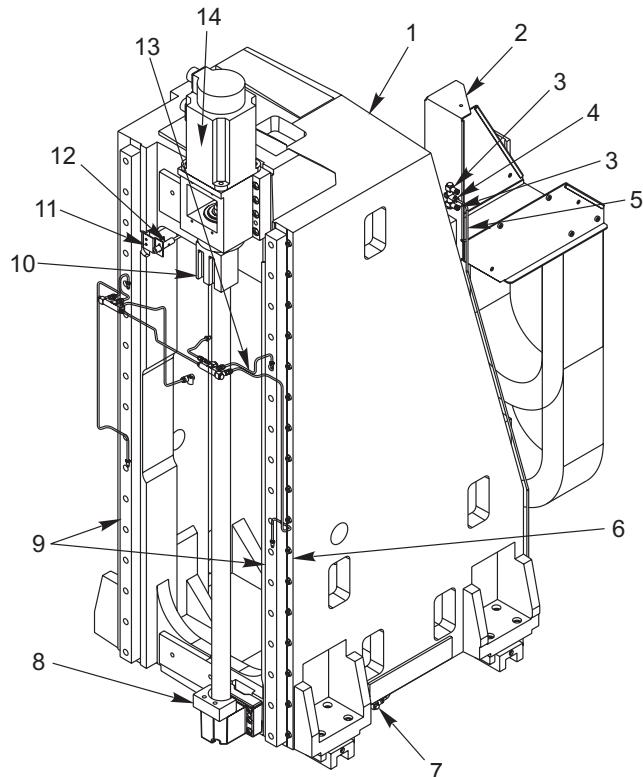
## EC-400 BULKHEAD



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. 25-5006A X-Axis Bottom Shield
6. 25-5003B Base Cover
7. 25-5004 Right Trough Cover
8. 20-6413 Manifold Washdown
9. 25-5005 Left Trough Cover
10. 25-5010 Left Base Cover Shield



## EC-400 COLUMN ASSEMBLY

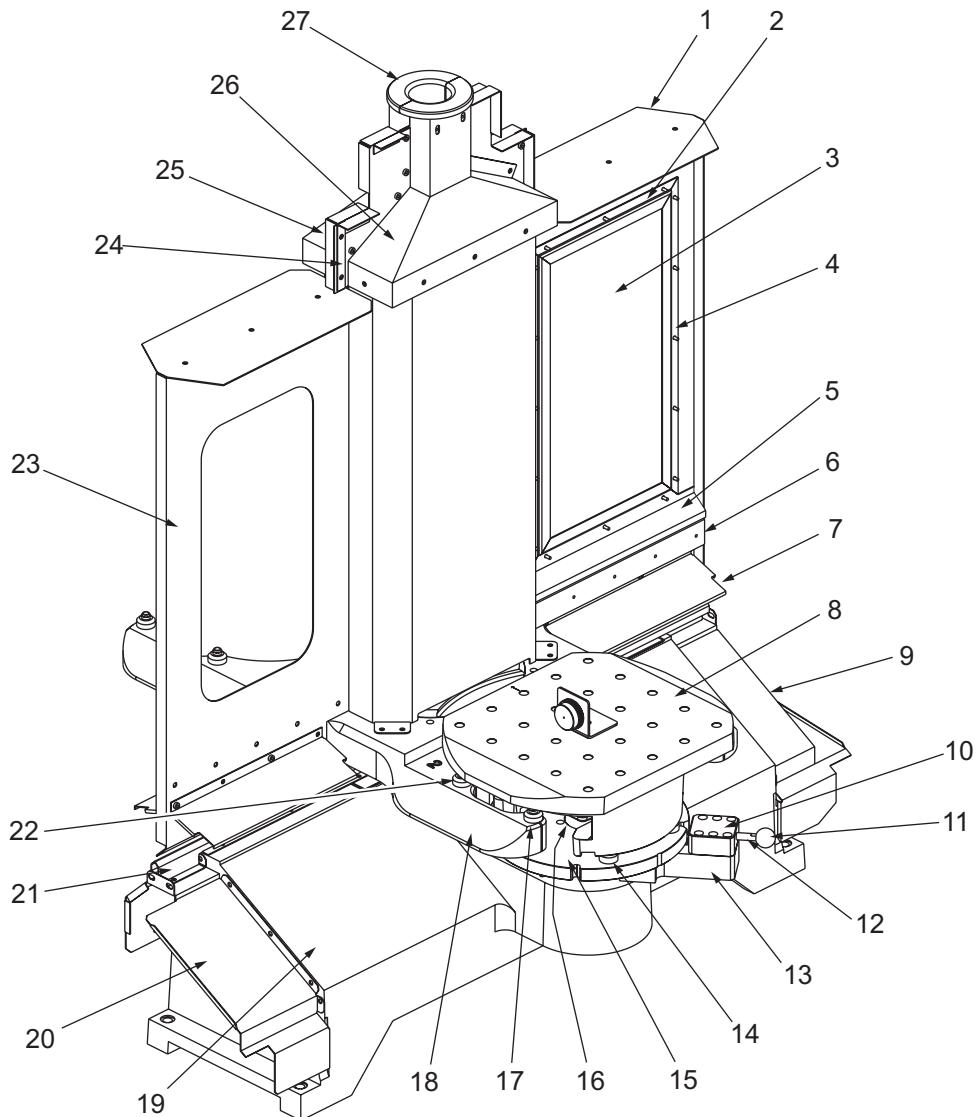


Back View (Looking Up)

- |              |                      |              |                          |
|--------------|----------------------|--------------|--------------------------|
| 1. 20-2043D  | Column Machined      | 21. 58-1680  | Fitg Bkhd                |
| 2. 25-4996A  | BRKT Carrier Column  | 22. 58-2067  | Fitg Hose Barb           |
| 3. 58-3031   | Lube Fitg Adaptor    | 23. 25-4937  | Trip Bracket X-Axis      |
| 4. 58-3031   | Lube Fitg Adaptor    | 24. 20-0150  | Nut Housing              |
| 5. 58-0634A  | Copper Tubing Column | 25. 30-6337  | Oil Line Assembly X-Axis |
| 6. 22-7458A  | Cam Linear Guide     | 26. 58-0634A | Copper Tubing Column     |
| 7. 58-3031   | Lube Fitg Adaptor    | 27. 58-0029  | Fitg Hose Barb           |
| 8. 28-0218   | Bumper               | 28. 58-1679  | Fitg Bkhd                |
| 9. 50-3400   | Linear Guide         | 29. 59-0640  | Cable Carrier Y-Axis     |
| 10. 28-0218  | Hardstop Y-axis      |              |                          |
| 11. 25-7267  | Mounting Bracket     |              |                          |
| 12. 32-2132  | Home Switch          |              |                          |
| 13. 30-6338B | Lube Line Assy.      |              |                          |
| 14. 62-0017  | Servomotor YASK 13   |              |                          |
| 15. 58-1693  | Fitg LBO             |              |                          |
| 16. 58-3625  | Fitg Reducer         |              |                          |
| 17. 58-3041  | Fitg                 |              |                          |
| 18. 58-0097  | Fitg LBO             |              |                          |
| 19. 58-3108  | Hex Nipple           |              |                          |
| 20. 25-5294A | Bracket TRP          |              |                          |



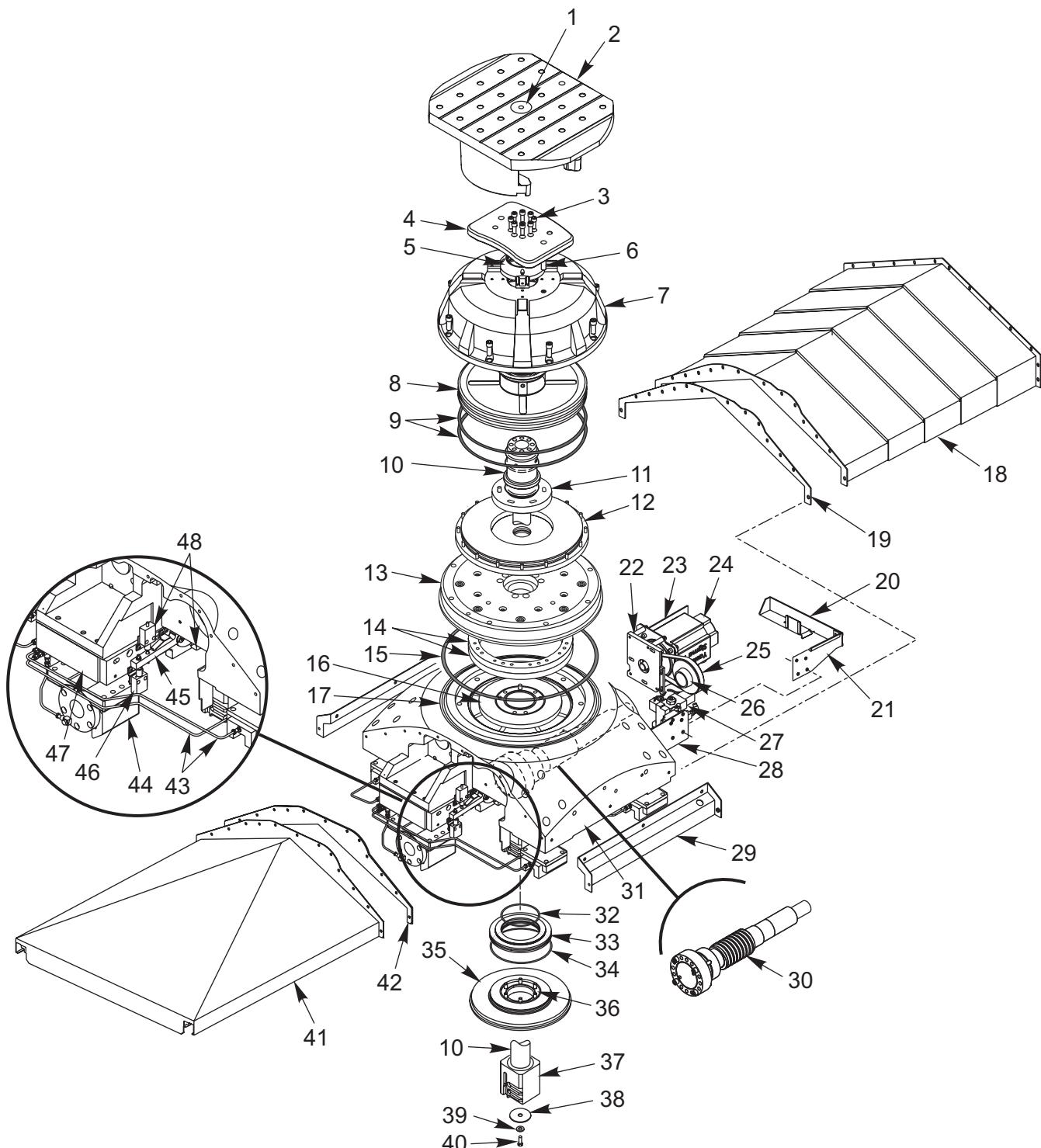
## EC-400 PALLET CHANGER ASSEMBLY



- |              |                                |              |                               |
|--------------|--------------------------------|--------------|-------------------------------|
| 1. 25-5238A  | Shade Rotating Door Top        | 14. 20-2249B | Load Station Pallet Pin       |
| 2. 25-4149   | Z-Frame Window SMTC            | 15. 20-2256B | Load Station Index Disc       |
| 3. 28-0043A  | Window Partition               | 16. 20-2258  | Load Station Shaft            |
| 4. 25-1262   | (2X) Z-Frame Partition Top     | 17. 20-2154B | APB H-Pin                     |
| 5. 25-5233A  | (2X) Z Channel Rotating Door   | 18. 20-2115D | H-Frame APC                   |
| 6. 20-2283A  | (2X) Support Bar Rotating Door | 19. 20-2046C | Bridge Machined               |
| 7. 25-5237   | (4X) Shade Rotating Door Seal  | 20. 25-5230A | Chip Shield Bridge Left       |
| 8. 20-2048F  | Pallet                         | 21. 25-5235  | Step Right Rotating Door Seal |
| 9. 25-5229A  | Chip Shield Bridge Right       | 22. 20-3208  | Pin Short APC H-Frame         |
| 10. 20-2254A | Load Station Lock Housing      | 23. 25-5232C | (2X) Panel Rotating Door      |
| 11. 59-6225  | Knob                           | 24. 25-5239A | Retainer Seal Rotating Door   |
| 12. 20-2255  | Load Station Lock Pin          | 25. 57-0330A | (2X) Seal Rotating Door Cover |
| 13. 20-2253  | Load Station Lock Mount        | 26. 25-5234B | Rotating Door Cover           |
|              |                                | 27. 20-2284  | (2X) Cable Rotating Door      |



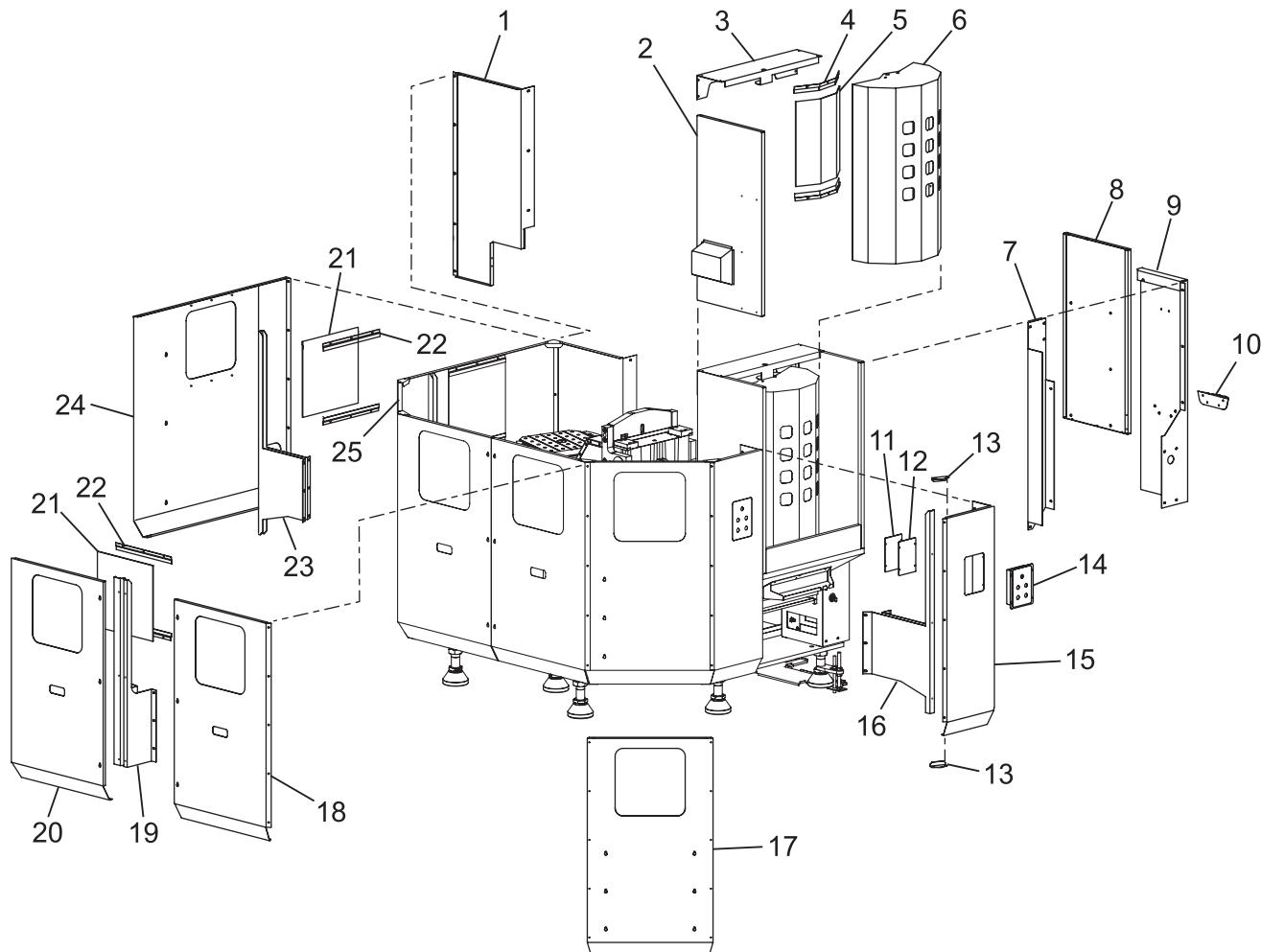
## EC-400 RECEIVER ASSEMBLY



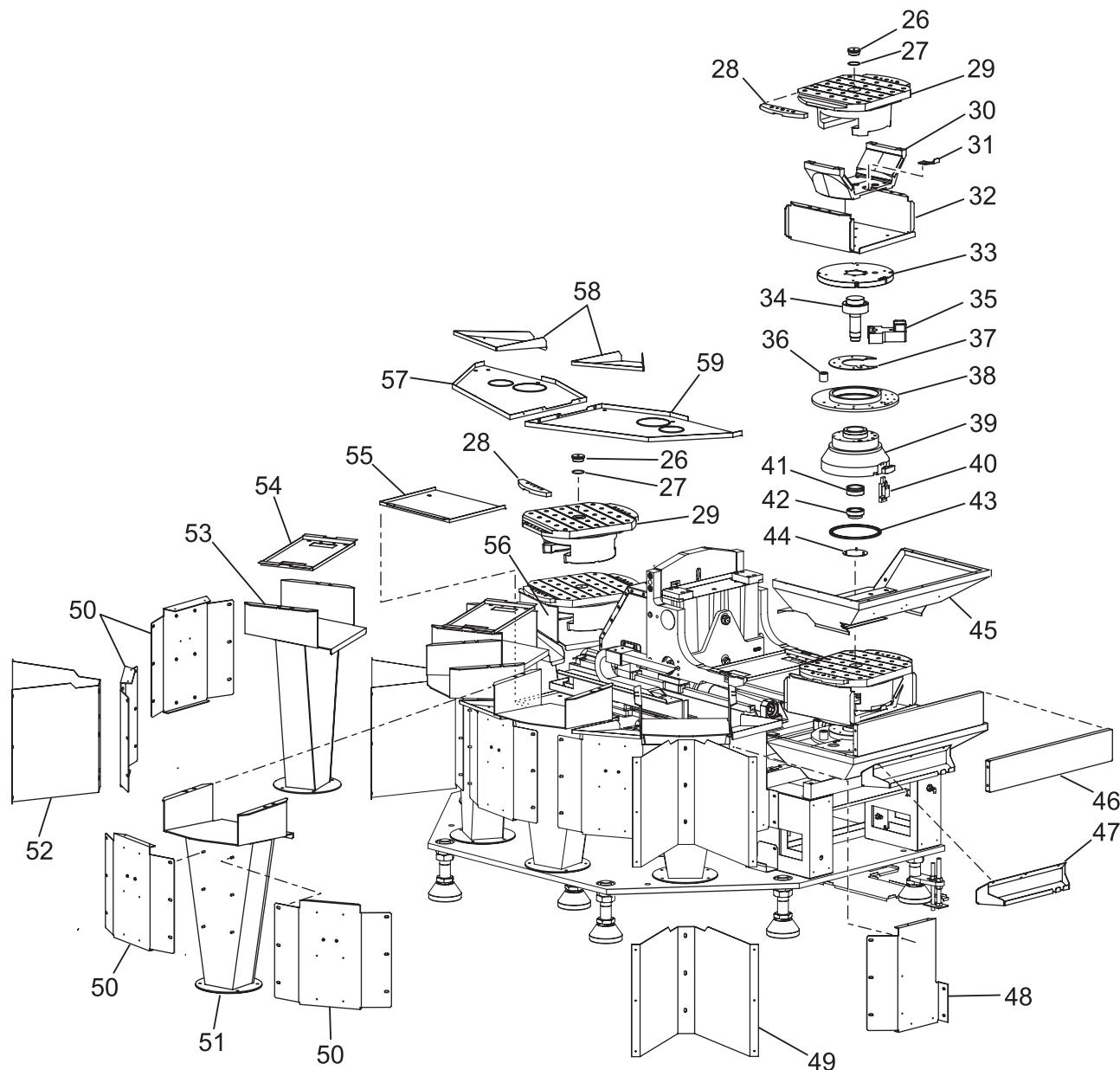


## EC-400 RECEIVER ASSEMBLY

1.	20-1123B	Pallet plug	36.	20-4236	Spindle spacer
	57-0041	Parker O-ring 2-135		40-1636	SHCS (6)
2.	20-2048F	Pallet machined	37.	20-1998C	Receiver rotary union
3.	40-1639	SHCS 3/8-16x1 (8)	38.	20-2344	Rotary union lower washer
4.	20-1995	Receiver clamp plate	39.	45-0075	Steel washer 5/16
5.	30-5005A	Air blast assembly	40.	43-7004	HHB 5/16-18 x 7/8 pltd
6.	48-1667	Dowel pin 1/2x3 1/2 (2)	41.	25-5549	Front way cover Z-axis
7.	20-2041E	Receiver body machined	42.	57-0327	Fixed way cover gasket
	57-0328	O-ring 2-339 viton (2)	43.	30-6336	Oil line assy Z-axis
	25-5252	Receiver wear surface (2)	44.	20-0150	Ballnut housing machined
	57-0337	V-ring seal	45.	20-2330C	Rotary axis switch arm
	40-16575	SHCS (8)	46.	20-2473	Bar-spring mount assy
8.	20-1994A	Receiver piston	47.	20-2023A	Ballnut spacer Z-axis
	25-5250	Piston wear surface	48.	69-1700	Proximity switch (2)
9.	57-0329	O-ring (2)			
10.	20-1996A	Receiver shaft			
	57-0328	O-ring (3)			
11.	20-1997	Receiver nut			
12.	20-1999A	Receiver seal plate			
	40-1500	SHCS (16)			
13.	20-2022E	Rotary table platter			
	40-1646	SHCS (8)			
	45-0038	Washer (8)			
14.	59-0778	Face Gear (2)			
15.	57-0337	V-ring Seal			
16.	35-4284B	Spindle gear assy			
	57-2121	O-ring 2-161			
17.	57-0337	V-ring Seal			
18.	25-5011A	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.	20-2071A	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.	30-6774B	Rotary index solenoid assy			
28.	25-5027A	Z-axis cable carrier bracket			
29.	25-4968A	Rotary table side chip shield			
30.	35-4210	Worm shaft assembly			
31.	20-2045F	Rotary table index machined			
32.	57-4282	O-ring 2-248			
33.	20-4286	Lift piston			
	51-4285	Thrust washer (2)			
	51-4286	Thrust bearing			
34.	57-0139	O-ring 2-263			
35.	20-4213	Disc brake			
	57-2144	O-ring 2-256			
	57-4288	Thrust bearing			

**EC-400 PALLET POOL EXTERNAL SHEET METAL**

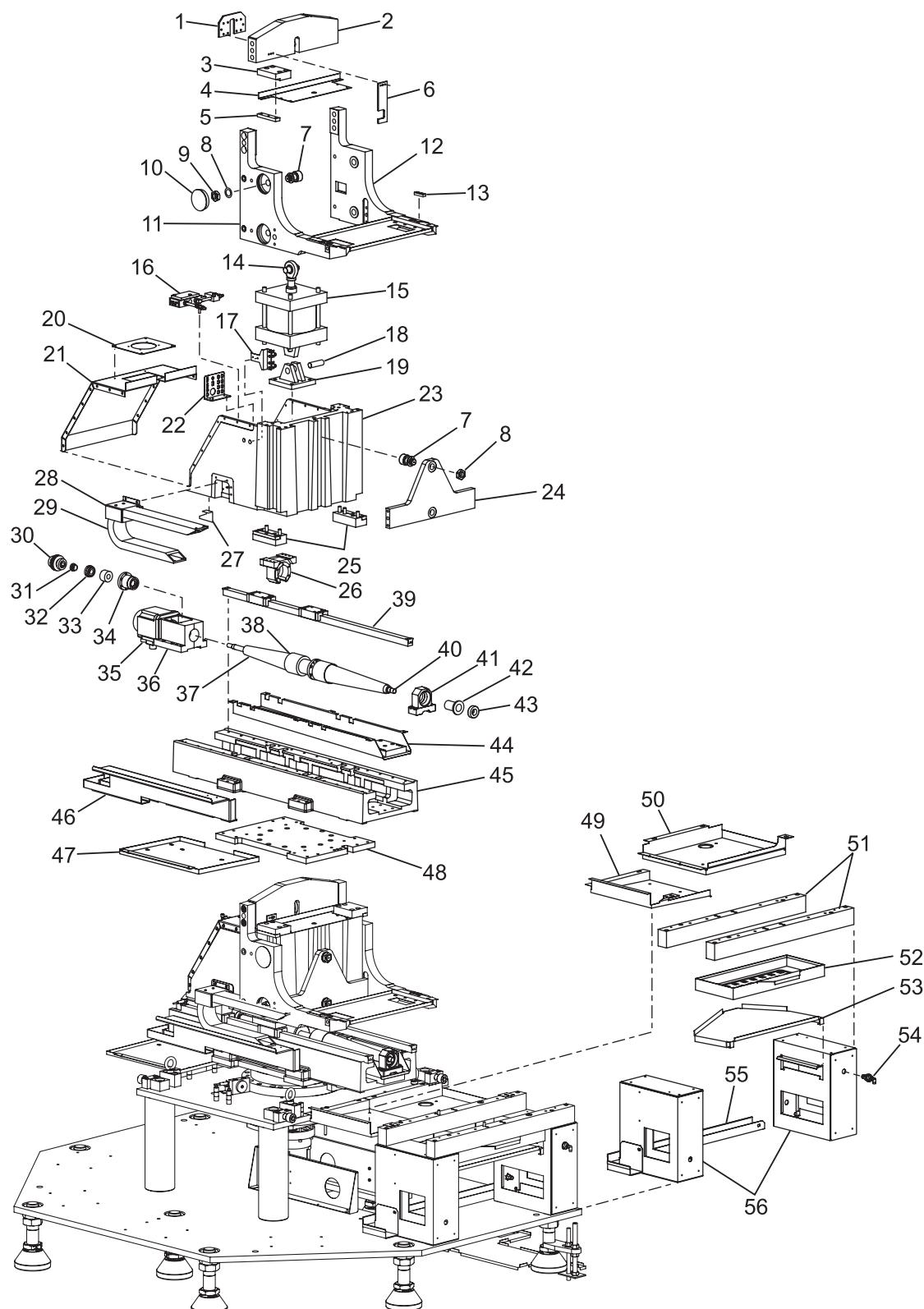
- |              |                                     |              |  |
|--------------|-------------------------------------|--------------|--|
| 1. 25-7528   | Enclosure Left Rear Panel           | 19. 25-7512  | Front Panel Mount Bracket              |
| 2. 25-7827   | Left Load Station Side Panel        | 20. 25-7523  | Left Front Pallet Pool Enclosure Panel |
| 3. 25-7475A  | Load Door Top Pivot                 | 21. 28-0183  | 5x Window 19" Sq.                      |
| 4. 25-8512   | 2x Load Door Station Window Z-Frame | 22. 25-5228  | 10x TC-OP Door Window Z-Frame          |
| 5. 28-0263   | 3x Load Station Door Window         | 23. 25-7524  | Corner Enclosure Panel                 |
| 6. 25-7489C  | Load Station Door                   | 24. 25-7526  | Left Enclosure Panel                   |
| 59-0901      | Chuck Guard handle                  | 25. 25-7524  | Corner Enclosure Panel                 |
| 7. 25-7768A  | Load Station Guard                  | 26. 20-1123B | 2x Pallet Plug                         |
| 8. 25-7474B  | Right Load Station Side Panel       | 27. 57-0041  | 2x O-Ring 2-135                        |
| 9. 25-7527B  | Enclosure Right Rear Panel          | 28. 20-3304B | 2x Pallet Lift Bar                     |
| 10. 25-5412  | Nozzle Holder Bracket               | 29. 20-3303A | 2x Pallet                              |
| 11. 25-1258A | Switch Box Cover                    | 30. 20-3550A | Load Station Pallet Support            |
| 12. 57-0195A | Remote J-Box Cover Gasket           | 31. 25-8484  | Load Station Pallet Guide Bracket      |
| 13. 25-7510  | 8x Corner Brace Bracket             | 32. 20-3550A | Load Station Pallet Support            |
| 14. 25-1257A | Switch Box Front Panel              | 33. 20-3286B | Load Station Index Plate               |
| 15. 25-7525A | Right Pallet Pool Enclosure Panel   | 34. 20-3285  | Load Station Shaft                     |
| 16. 25-7513  | Side Enclosure Support Frame        | 35. 30-8388  | Load Station Lock Pin Assembly         |
| 17. 25-7524  | Corner Enclosure Panel              | 36. 20-3440  | Load Station Door Hard Stop            |
| 18. 25-7522  | Right Front Enclosure Panel         | 37. 25-7480A | Load Door Retainer Plate               |

**EC-400 PALLET POOL EXTERNAL SHEET METAL (CONTINUED)**

- |              |                                |              |                               |
|--------------|--------------------------------|--------------|-------------------------------|
| 38. 20-3288B | Load Station Door Ring         | 49. 25-7520  | Right Panel Mount Bracket     |
| 39. 20-3284  | Load Station Bearing Block     | 50. 25-7515  | 4x Front Pallet Support Frame |
| 20-3293A     | Load Station Door Trip Bracket | 51. 25-7493  | 2x Front Pallet Station       |
| 40. 20-3292  | Load Station Switch Bracket    | 52. 25-7514  | Left Panel Mount Bracket      |
| 61-2125A     | Limit Switch                   | 53. 25-7494  | 2x Corner Pallet Station      |
| 41. 57-0034  | Seal 2.500" National           | 54. 25-7566  | Pallet Alignment Plate        |
| 42. 51-2043  | Bearing Locknut                | 55. 25-7530A | Left Intermediate Drip Tray   |
| 43. 20-3287A | Load Station Door Bearing      | 56. 25-7492  | Left Rear Pallet Station      |
| 44. 25-5177  | Load Station Shaft Cover       | 57. 25-7509B | Left Front Drip Tray          |
| 45. 25-7472A | Load Station Pan               | 58. 25-7539  | 4x Stations Support Drip Pan  |
| 46. 25-7477  | Load Station Front Stiffener   | 59. 25-7508B | Right Front Drip Tray         |
| 47. 25-7479  | Load Station Tool Tray         |              |                               |
| 48. 25-7516  | Pallet Support Side Frame      |              |                               |



### EC-400 PALLET POOL SLIDER-SADDLE-BASE ASSEMBLY



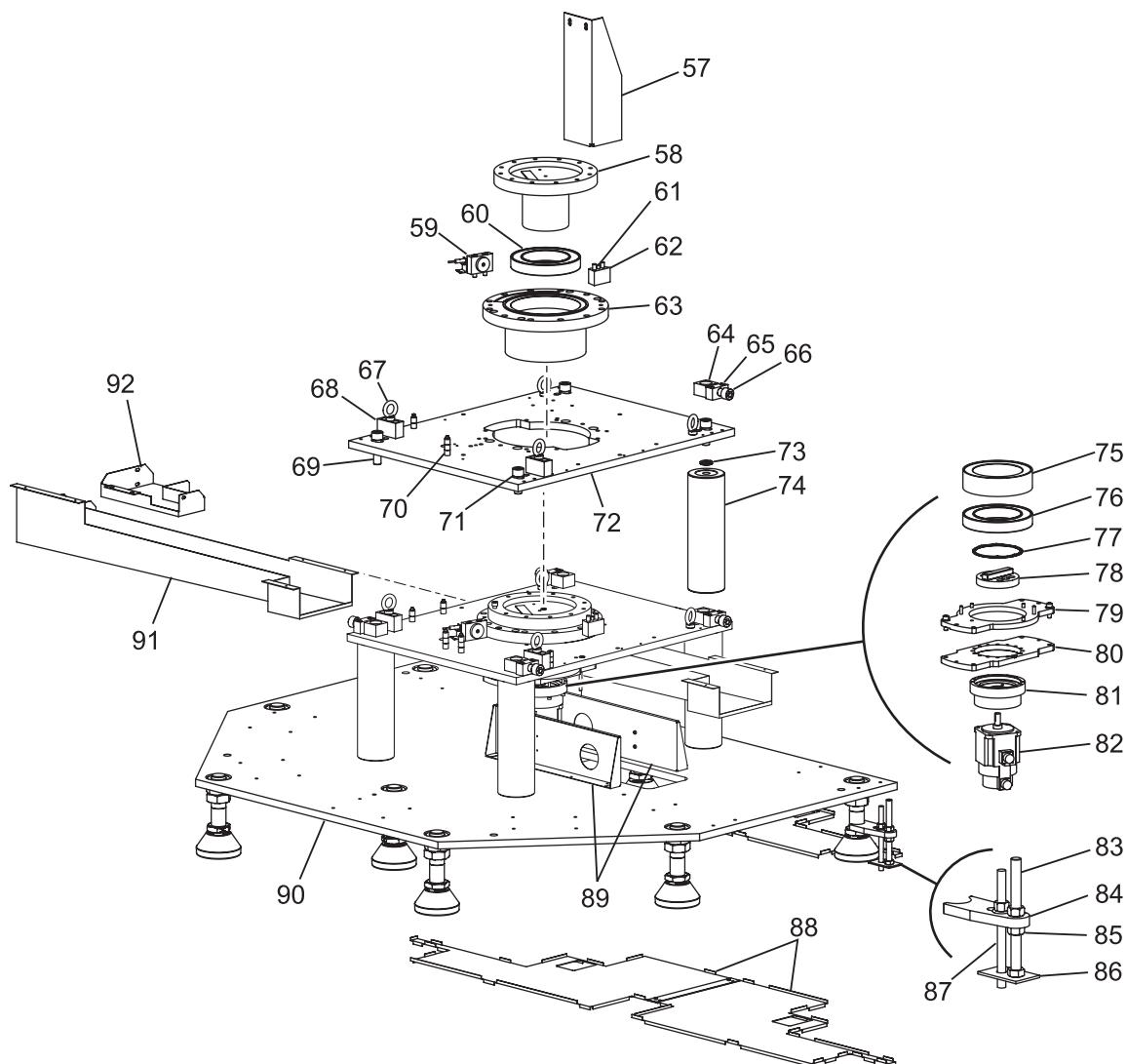


### EC-400 PALLET POOL SLIDER-SADDLE-BASE ASSEMBLY

1. 20-3319	Slider Assembly Retaining Plate	50. 25-7531B	Right Rear Drip Tray
2. 20-3315	Slider Assembly Cross Beam	51. 20-3282A	2x Load Station Beam
3. 20-3327	2x Upper Slider Stop Block	52. 25-7473	Load Station Drain Drawer
4. 25-7506	Top Slide Guide Block Cover	53. 25-7476	Load Station Drip Pan
5. 20-3326	2x Upper Delrin Slider Stop	54. 58-1677	2x Bulkhead Fitting NPT .25"x.750" dia.
6. 20-3329	Prox. Arm Position Flag	55. 25-7536	Auxiliary Switch Box Cable Tray
7. 51-0178	6x Cam Follower 1.75" Dia.	56. 25-7470A	2x Load Station Load Base
8. 45-1722	6x Split Lockwasher 1"		
9. 46-1670	6x Jam Nut 1-14		
10. 59-0737	4x Hole Plug 3.375" Black		
11. 20-3317A	Slider Assembly Left Arm		
12. 20-3316A	Slider Assembly Right Arm		
13. 20-3959	2x Pallet Locate Arm Pad		
14. 48-0109	Dowel Pin 1 x 2.75"		
15. 59-0823	Air Cylinder		
16. 30-8395	Slider Lift Assy. Solenoid Assy.		
17. 25-7507	Slider Lift Assy. Switch Bracket		
69-1705	2x Proximity Switch		
18. 59-0826	Mounting Pin		
19. 59-0825	Mounting Plate		
20. 25-7505	Slider Assy. Gortube Bracket		
21. 25-7502A	Slider Rear Cover		
22. 25-6448B	Cable Mounting Bracket		
23. 20-3960	Slider Assy. Base Machined		
24. 20-3318	Slider Assy. Support Cross Plate		
25. 20-3325	2x Slider Assy. Lower Stop Block		
26. 20-7008F	Nut Housing Machined		
27. 25-7503	Slider Assy. Home Switch Flag		
28. 25-7504A	Slider Assy. Cable Carrier Bracket		
29. 59-0822	Cable Carrier - 1 GUS 240-05-0 55 Links		
30. 30-1220A	Coupling Assy.		
31. 22-7417	Bearing Cartridge Spacer		
32. 20-7418	Lock Bearing Cartridge		
33. 51-1011U	Contact Ang Bearing		
34. 20-7416	Bearing Cartridge Housing		
35. 62-0014	Yaskawa 09 No Brake Servo Motor		
36. 20-7010B	Motor Mount Machined		
37. 59-0831	2x Ballscrew Cover		
38. 20-3355	2X Ballscrew Cover Retainer		
39. 50-0012A	2x Linear Guide 30 x 1170		
40. 24-0033	Ballscrew Assy. 32mm x 12mm		
41. 20-7009	Bearing Housing Machined		
42. 20-3436	Slider Bumper - Support End		
43. 51-2025	Radial Bearing		
44. 20-3310	Bearing Support Spacer		
45. 20-3308A	Saddle, Machined		
46. 25-7497A	Cable Carrier Tray		
47. 25-7532A	Left Rear Drip Tray		
48. 20-3301	Saddle Mount Plate		
49. 25-7529A	Right Intermediate Drip Tray		



**EC-400 PALLET POOL SLIDER-SADDLE-BASE ASSEMBLY (CONTINUED)**



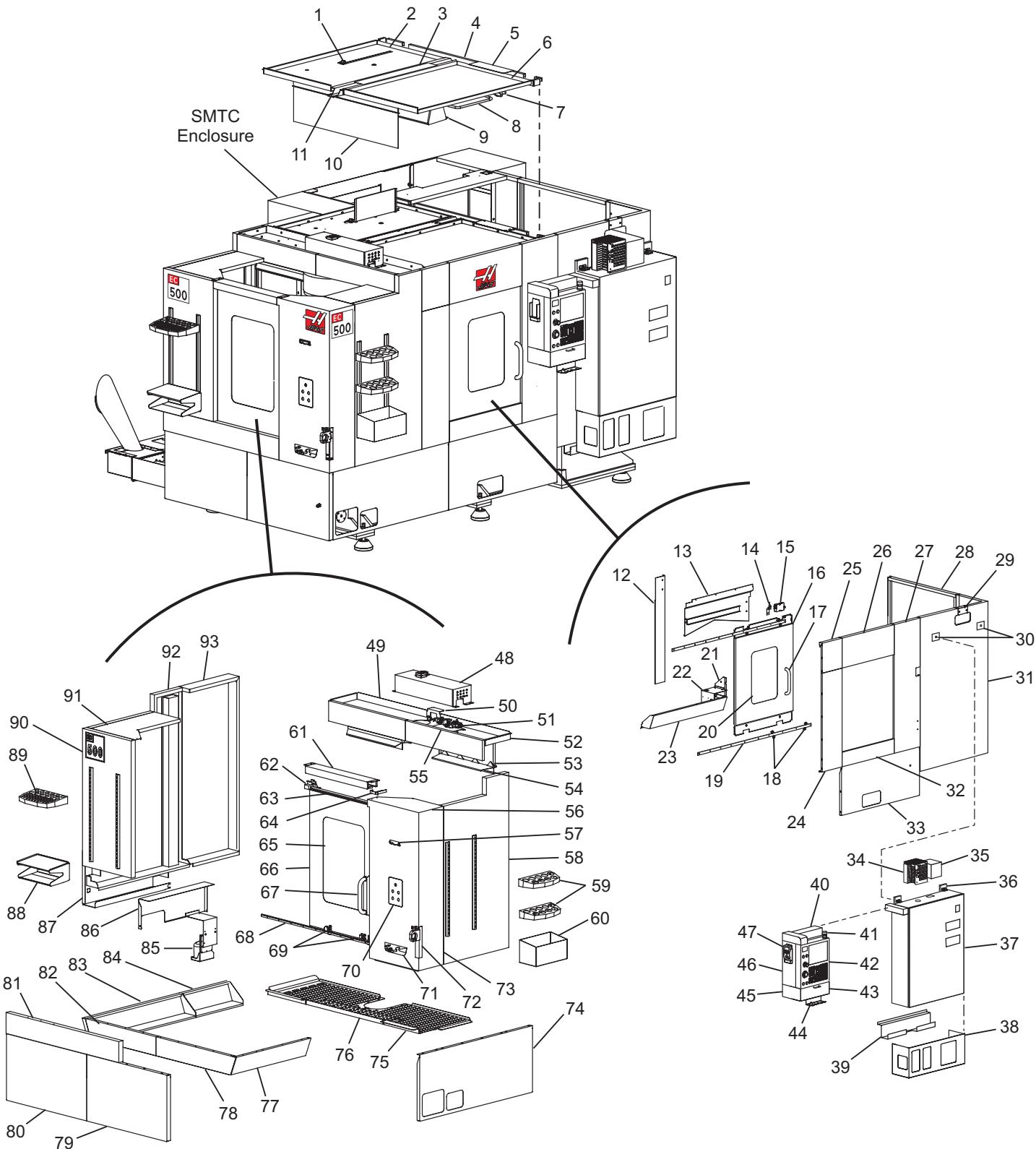


## EC-400 PALLET POOL SLIDER-SADDLE-BASE ASSEMBLY (CONTINUED)

57. 25-7576A Pallet Pool Shipping Bracket
58. 20-3278A Rotary Shaft Flange
59. 25-7496A Rotary Switch Bracket
- 32-2134 Home Switch 5.5 FT NC
- 20-3305A Fixed Rotary Stop Block
- 20-3306 2x Rotary Stop Bumper
60. 51-2037 Deep Groove Bearing
61. 48-0040 Dowel Pin .375 x 1 in.
62. 20-3307 Rotating Stop Block
63. 20-3277A Cylinder Rotary Drive Body Machined
64. 20-3449 4x Rotary Plate Alignment Block
65. 20-3450 4x Rotary Plate Alignment Adjustable Block
66. 40-0133 4x SHCS 1-8 x 2.50 in.
67. 49-0123 4x Eye Bolt 1-8 x 2 1/2 in.
68. 20-3361 2x Lift Eye Block
69. 40-1680 2x SHCS .25-20 x 2.75 in.
70. 20-3330 14 x Pallet Pool Drip Pan Spacer
- 45-16390 4x Flat Washer .25 in
- 40-1680 2x SHCS .25-20 x 2.75 in.
71. 40-0133 2x SHCS .125-8 x 2.50 in.
72. 20-3300B Rotary Mount Plate
73. 45-1722 4x Split Lock Washer 1 in.
74. 20-3299 4x Base Plate Standoff 5 in.
75. 20-3279 Rotate Assy. Bearing Spacer
76. 51-2037 Deep Groove Bearing
77. 56-0108 Retaining Ring - WS-629
- 59-0827 Wave Spring - 6.75 O.D. x 6.321 I.D. - 104 lbs.
78. 20-3280 Rotate Key
79. 20-3333 Rotate Serv Flange
- 48-0044 2x Dowel Pin - .375 x 11 in.
- 40-2030 2x SHCS .375 - 16 x .75 in.
80. 20-3281 Rotate Assy. Motor Mount
81. 20-2130 APC Cycloid Mount
82. 62-0027 Sigma 9 No Brake Motor
83. 43-0112 4x HHB .75-10 x 5 in.
- 46-1710 8x Hex Nut .75-10
84. 22-8898 4x Anchoring Strap
85. 46-1663 4x Jam Nut .75-16
86. 25-0123 4x Floor Plate
87. 49-0141 4X Stud .625-11 x 7.00 in.
- 46-1010 4x Hex Nut .625-11
- 45-0046 4x Flat Washer .625 in.
88. 25-7575A 2x Pallet Pool Alignment Plate
89. 25-7592 2x Rotary Motor Removal Skid
90. 20-3297A Pallet Pool Base Plate
91. 25-7533 Pallet Pool Gutter Drain Tray
92. 25-7534 Pallet Pool Drain Tray Front Trough



## EC-500 EXTERNAL SHEET METAL



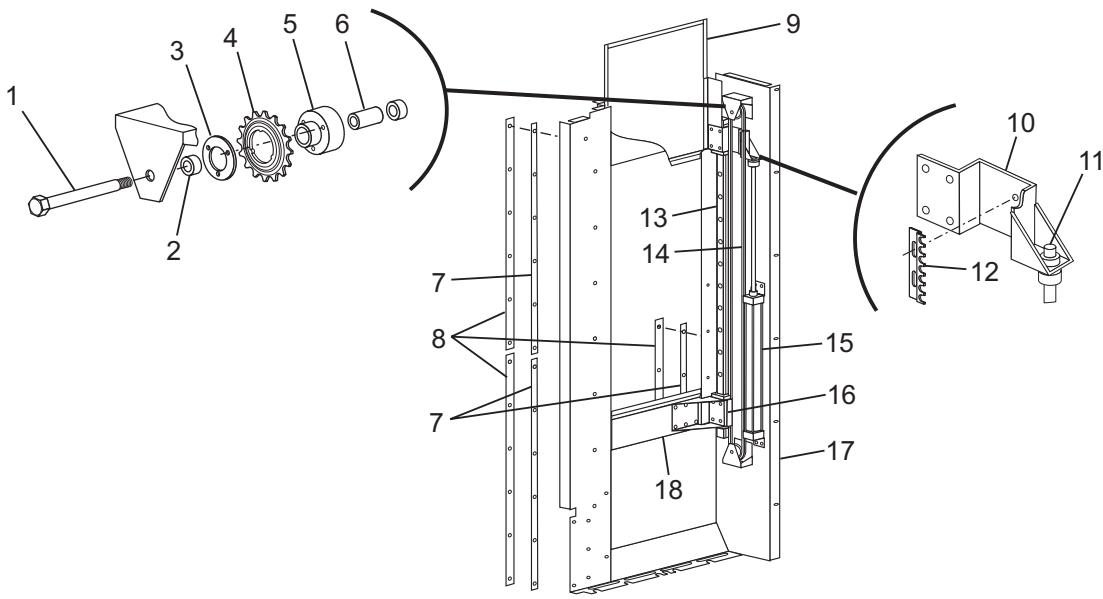


## EC-500 EXTERNAL SHEET METAL

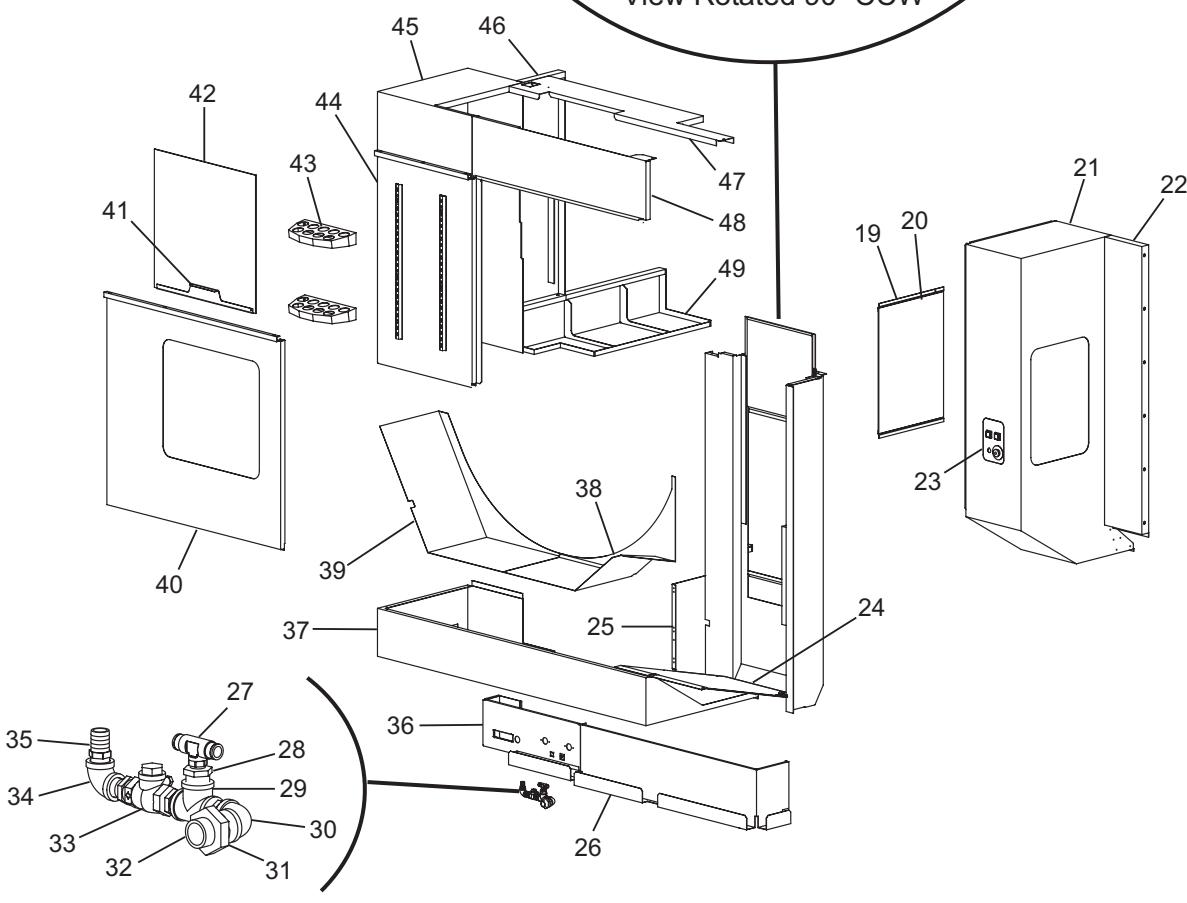
1. 69-1700 Proximity Switch  
25-7894 Proximity switch mounting bracket
2. 25-6991 Top cover, Tool changer side
3. 25-4984 Top cover, wire channel
4. 25-7004 Cover, roll-up chip shield
5. 25-5253 Top cover brace
6. 25-6990 Top cover, operator side
7. Omni unit
8. 30—8801 Niagara washdown assembly
9. 25-4160 Overhead light fixture  
25-4161 Light fixture reflector  
25-4162 Light fixture clamp bracket
10. 25-7406A Rotating door seal  
26-0204 Rotating door coolant seal  
25-7626 rotating door seal mounting plate
11. 25-6992 Top cover center brace
12. 25-5200A Rear operator door chip shield
13. 25-4973B Operator door header chip shield
14. 25-4990 Operator door trip bracket  
69-1770 Proximity limit switch
15. 61-0006A Interlock switch  
61-0007Flat key
16. 25-4966 Operator door
17. 22-8895 Door handle, chrome
18. 59-6440 4x Guide wheel assembly  
25-7288A 4x Swivel roller bracket
19. 20-3152 Top operator door rail
- 20-3153 Bottom operator door rail
20. 28-0151 Operator door window  
25-5228 2x Window retainer
21. 25-5245 Upper operator panel chip shield
22. 25-5246 Lower operator panel chip shield
23. 25-4967 Lower right front chip shield
24. 25-7020 Right intermediate lower panel
25. 25-7022 Right intermediate upper panel
26. 25-4954 Operator upper panel
27. 25-4956C Right intermediate panel
28. 25-6998 Rear panel access cover
29. 25-7026 Control panel spacer
30. 20-2034 2x control panel spacer
31. 25-6974 Rear panel control support
32. 25-5198 Operator lower panel
33. 25-4982A Apron right rear panel
34. Regen assembly
35. J-box
36. 25-4784B 4x control box mounting bracket
37. 25-4307 Electrical control box assembly
38. 28-5421A Lube rack cover
39. 25-4942A Bottom control wire channel
40. 25-10610 Front cover wire channel
41. 25-8120B Remote control cradle
42. Thin pendant assembly
43. 25-4953B J-box top cover
44. 25-6986 Front left top cover
45. 25-7362 Top cover stiffener bracket
46. 30-7442 APC solenoid assembly
47. 25-6985 Front right top cover
48. 25-7038 2x Rotating door upper seal  
26-0193 2x rotating door seal mounting bracket
49. 26-0186 2x Splash seal shield
50. 25-6088 APC solenoid assembly bracket
51. 25-4951B Corner panel stiffener bracket
52. 59-0123 Wire clip
53. 25-4948B Front side panel chip shield
54. 25-1293A 2x Tool crib
55. 25-0563 Tool Box
56. 25-5456 Front door guide rail
57. 20-2410 Door Guide block  
Trip limit switch
58. 59-0053 2x Edge trim
59. 20-2411B Door stop block
60. 25-4997A Front door
62. 25-7412 Door handle mount  
22-8895 Door handle
63. 20-14733 Door V-track
64. 25-5402A 2x Door hook  
2x Guide wheel
65. 25-1257A Switch box front  
25-1258A Switch box cover
66. 25-5412 Nozzle holder bracket
67. 25-0798 Tool holder vise bracket  
20-1341 Tool holder block bracket  
59-0278 Tool holder knob bracket
68. 25-6982 Front right panel  
25-7035 front right panel chip shield
69. 25-7001 Right front apron
70. 25-7009 Auger front right guard  
25-7010 Auger front left guard
71. 25-7021 Front guard chip shield
72. 25-7032 Right front pan
73. 25-7000 Front lower right arm
74. 25-6996 Front right apron
75. 25-6994 Front left apron
76. 25-6984 Front upper pan
77. 25-6999 Front lower left pan
78. 25-7033 Left front pan
79. 25-7017 Left intermediate pan
80. 30-6534 Oil coolant separator assembly
81. 25-6995 Left front apron
82. 25-6997 Left front intermediate apron
83. 25-6182 Front table
84. 25-1293 Collet tray
85. 25-4947C Front left panel
86. 25-6987 Left panel extension stiffener
87. 25-6983 Left front panel
88. 25-6988 Left intermediate panel  
25-7002 Left upper chip shield



### EC-500 SMTA EXTERNAL SHEET METAL



View Rotated 90° CCW



SMTA Enclosure

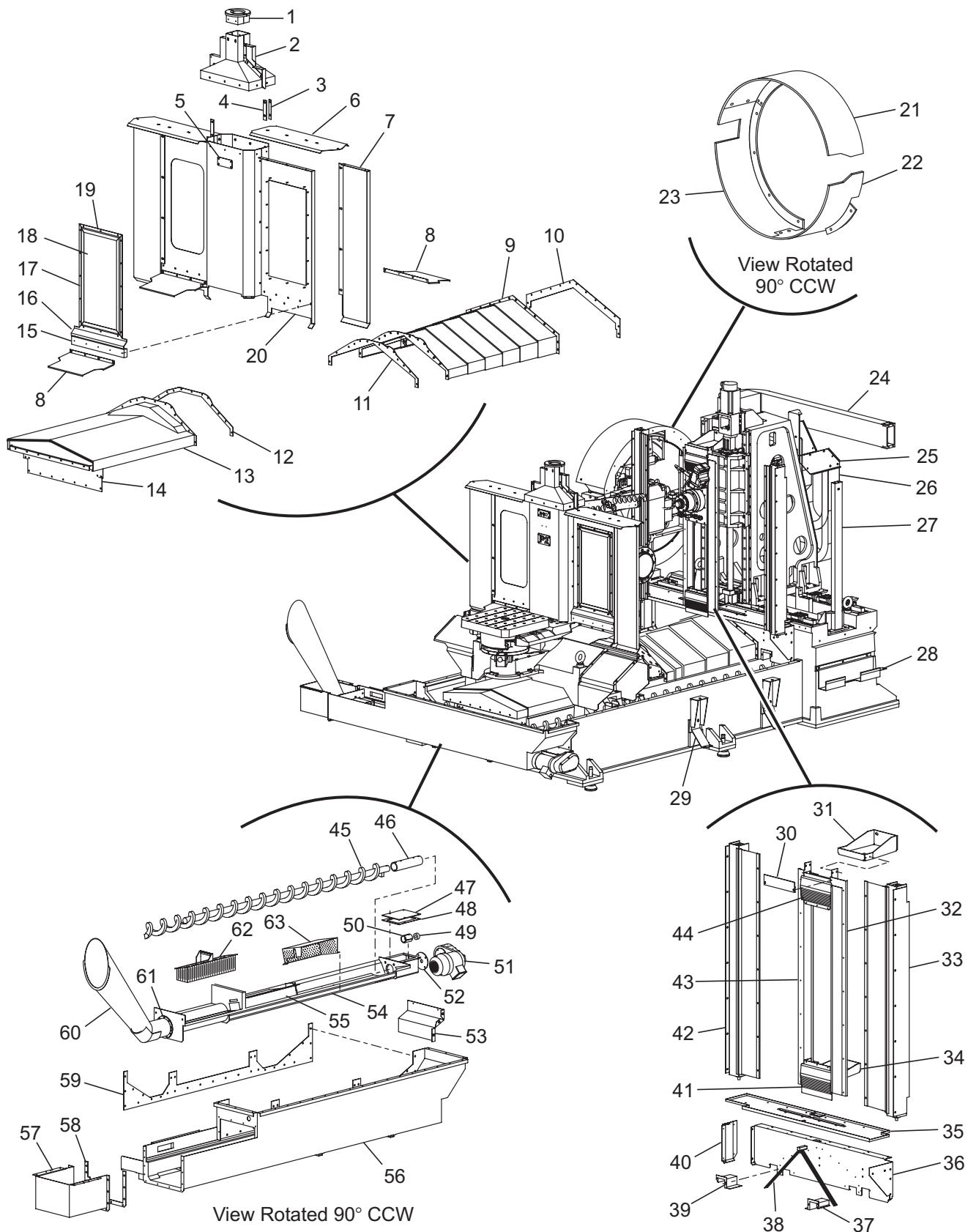


## EC-500 SMTc EXTERNAL SHEET METAL

1. 2x Shaft
2. 22-9673 4x Spacers
3. 20-0548 2x Cog hub
4. 54-0074 2x Chain cog 16T
5. 20-1005 2x Sprocket adaptor
6. 50-0075 2x Bearing
7. 25-5034 3x Door Guide Spacer
8. 20-2087 3x Door guide
9. 25-5030A TC top door
10. 25-5032A Top connect bracket
11. 59-0641 Rod aligner
12. 25-0974 Chain retainer
13. 50-0012A Linear Guide
14. 54-0072 Chain 96in.
15. 59-0612 Air cylinder
16. 25-5033 Bottom connect bracket
17. 25-5029 TC internal panel
18. 25-5031 TC bottom door
19. 25-5228 2x Window Z-frame
20. 28-0151 Window
21. 25-4962A TC left panel
22. 25-7002 TC left intermediate panel
23. 25-6718A SMTc switch box  
25-6719 SMTc switch box cover
24. 25-4985A TC panel lower chip shield
25. 25-5283A TC front chip shield
26. 25-4972 Left middle apron
27. 58-3041 Tee fitting LBO-1/2 x LBO-1/2 x NPT 3/8" M
28. 58-1709 Reducer fitting NPT-3/4M x NPT 3/8" F
29. 58-1708 Fitting NPT 3/4F x NPT 3/4" F  
58-0120 2x Nipple 3/4NPT x 1-1/4" brass
30. 58-1705 Elbow fitting NPT 3/4F x NPT 3/4" F
31. 58-1702 Pipe nut
32. 22-9418 Bulkhead coolant fitting
33. 58-1706 Swing check valve NPT3/4F x NPT 3/4" F  
58-1672 Nipple 1/2NPT close brass
34. 58-3054 Elbow fitting NPT 1/2F x NPT 1/2" F
35. 58-2066 Hose barb fitting 3/4 x NOT 1/2" M



## EC-500 INTERNAL SHEET METAL



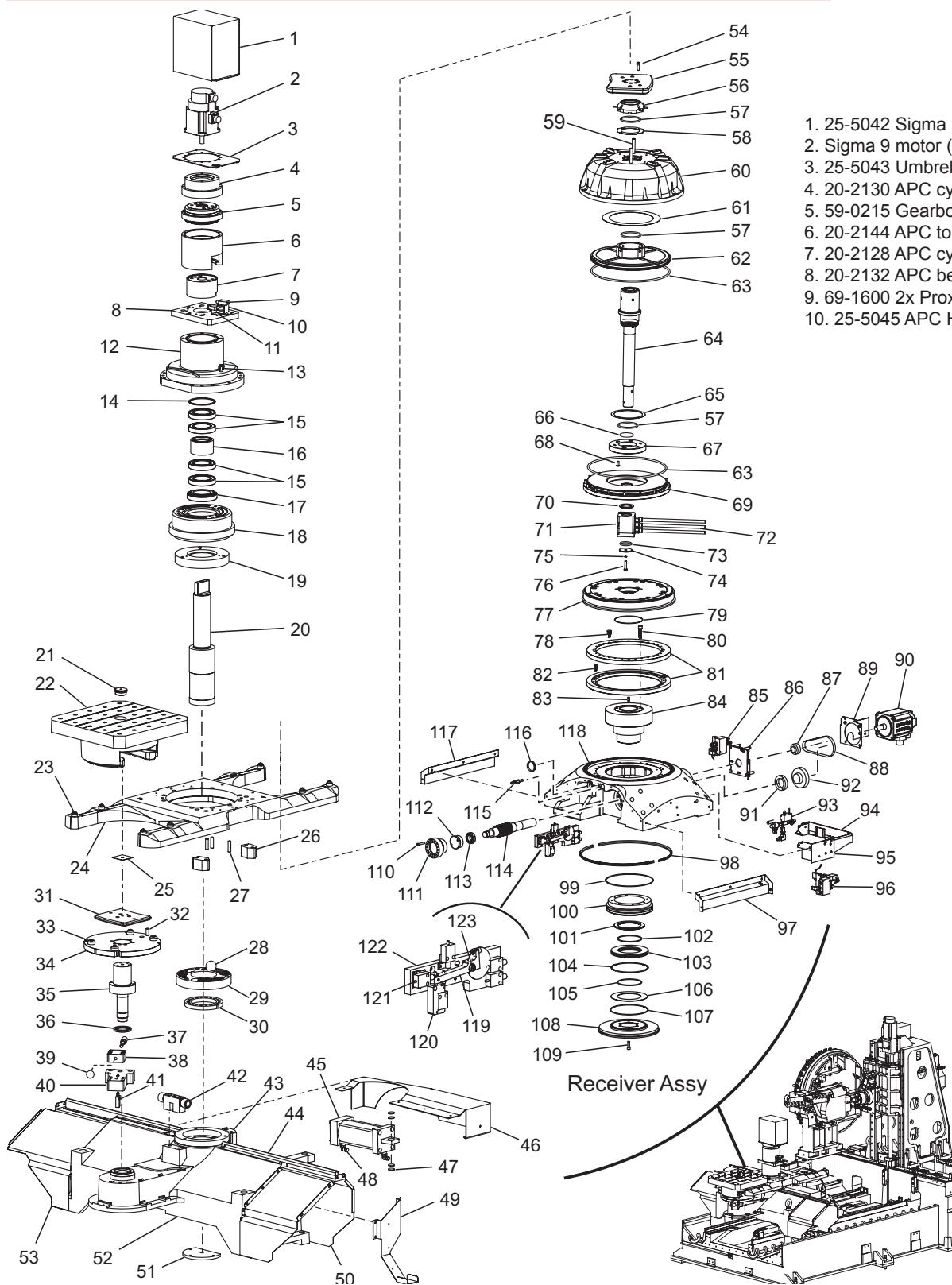


## EC-500 INTERNAL SHEET METAL

1. 20-2284 2x Rotating door cable fairlead
2. 25-5234B 2x Rotating door cover
3. 25-5239A 2x Rotating door seal retaining cover
4. 57-0330A 2x Rotating door cover seal
5. 25-5883 2x Rotating door access cover
6. 25-7023A 2x Rotating door seal shade
7. 25-7024A 2x Rotating door extension
8. 25-7008A 2x Rotating door bottom shade
9. 25-6980A Z-axis telescoping waycover
10. 57-0395 Z-axis telescoping waycover gasket
11. 57-0326 Z-axis telescoping waycover right gasket
12. 57-0327 Fixed waycover gasket
13. 25-6981 2x -axis front waycover
14. 25-5550 2x Telescoping waycover
15. 20-2283 2x Rotating door support bar
16. 25-5233A 2x Rotating door Z-channel
17. 25-1262 2x Right and left side window frame
18. 28-0043 2x Partition window
19. 25-4149 2x Top and bottom window Z-frame
20. 25-5232 2x Rotation door panel
21. 25-4152B SMTc front cover
22. 25-0800C SMTc corner shroud
23. 25-4153B SMTc rear cover
24. 59-0804 X-axis cable carrier (approx. 76")
25. 25-4996A Column carrier bracket
26. 59-0640 Y-axis cable carrier
27. 20-2035 Control box support
28. 25-4942A Control box wire channel
29. 25-4940A 2x Panel side brace
30. 20-2319B Y-axis frame filler plate
31. 25-5007 Y-axis Top frame bracket
32. 25-6976B Right toll up cover guide
33. 59-0806 Right roll up waycover
34. 25-5008 Y-axis bottom frame bracket
35. 25-6978 Bulkhead bottom shield
36. 25-6977 Bulkhead base cover
37. 25-5004 Right trough cover
38. 20-6413 Washdown manifold
39. 25-5005 Left trough cover
40. 25-5010 Left base cover shield
41. 59-0606 Y-axis lower bellows
42. 59-0805 Left roll up waycover
43. 25-5000B Y-axis left guide
44. 59-0605 Y-axis upper bellows
45. 22-8891A Chip auger
46. 20-2322 Auger extension coupler
47. 25-5290 Extension box top
48. 57-0332 Extension box top gasket
49. 20-9546 Chip conveyor spacer
50. 20-9150 Conveyor motor coupling
51. 62-0052 Auger motor 230VAC
52. 57-9265A conveyor gasket
53. 25-7013 Auger trough chip shield
54. 25-6972 Front auger trough
55. 25-5297A Coolant channel
56. 25-6973 Coolant trough
57. 25-5025 Front trough extension box
58. 57-0334A Coolant trough gasket
59. 57-0394 Front trough gasket
60. 25-0548 Discharge chute
61. 57-9846 Discharge chute gasket
62. 25-5291A Chip basket
63. 25-5299A Auger trough screen



## EC-500 APC ABD RECEIVER



1. 25-5042 Sigma 9 motor umbrella
2. Sigma 9 motor (no brake)
3. 25-5043 Umbrella mounting plate
4. 20-2130 APC cycloid mount
5. 59-0215 Gearbox – RV-40E 153:1
6. 20-2144 APC torque tube
7. 20-2128 APC cycloid hub
8. 20-2132 APC bearing cap
9. 69-1600 2x Proximity home switch
10. 25-5045 APC Home switch mount

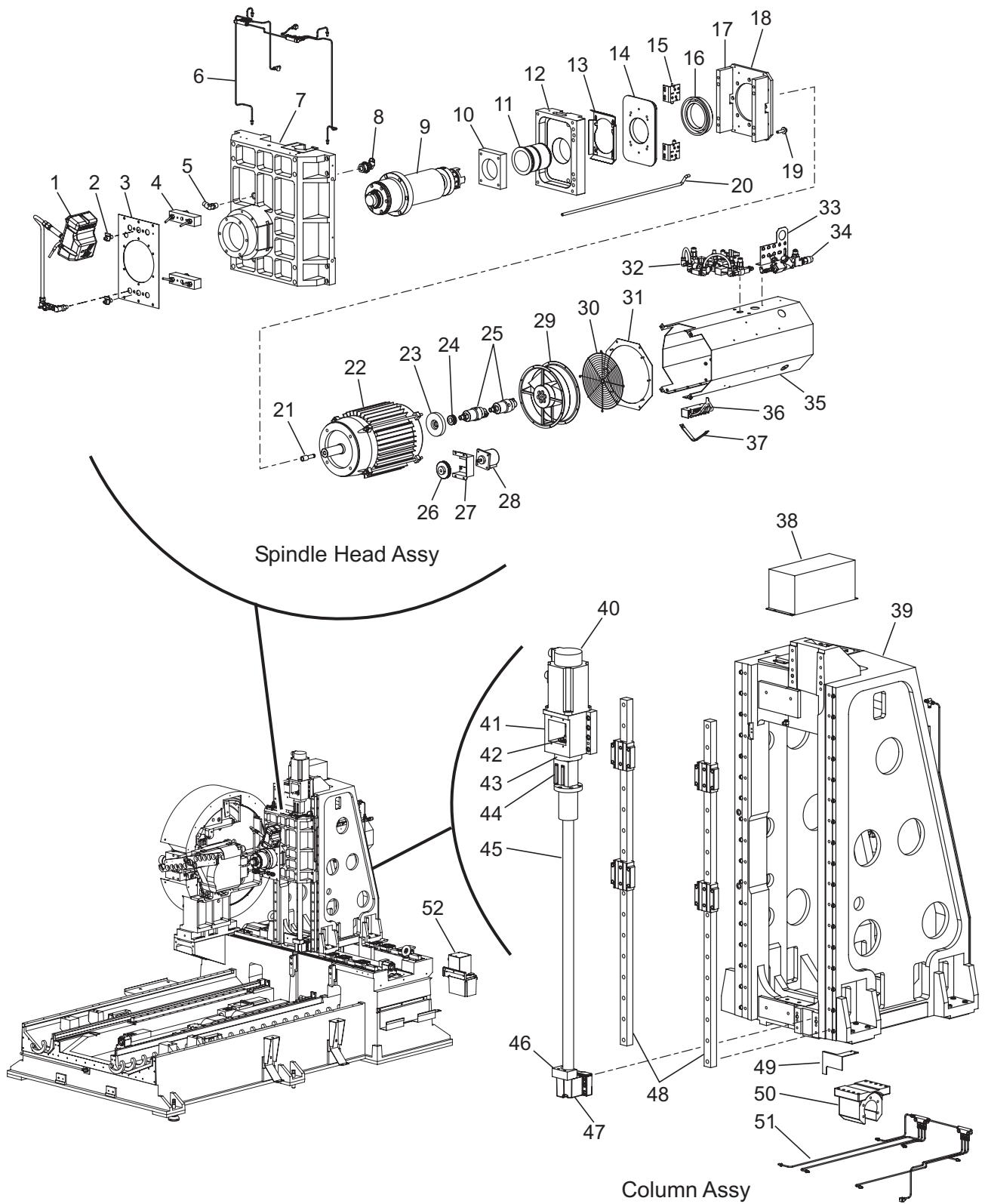


## EC-500 APC ABD RECEIVER

11. 25-5044 APC H-frame down proximity mount
12. 20-2139B APC hub
13. 58-1693 straight fitting  $\frac{1}{2}$  x  $\frac{3}{8}$ " NPT M
14. 59-0015 Ware spring – smallly SB-0492
15. 51-0054 4x Deep groove bearing
16. 20-2143A APC bearing spacer
17. 51-0152 Tapered roller bearing
18. 20-2131B APC seal housing
19. 20-2111A APC cage
20. 20-2122 APC shaft
21. 20-1123B 2x Pallet plug assembly
22. 20-3144B 2x Machined pallet 500mm
23. 20-2154B 8x APC H-frame pin
24. 20-3145A Machined H-frame
25. 57-0336 Pallet shipping bracket pad
26. 20-2153 2x APC hard stop
27. 48-1755 3x Dowel pin  $1\frac{1}{2}$  x 2"
28. 59-0616 APC ball 1-7/8in.
29. 20-2110A APC cam
30. 20-2145 APC shaft clamp
31. 20-2257 Load station lock plate
32. 48-1666 Dowel pin  $1\frac{1}{2}$  x 2-1/4"
33. 20-2249B 4x LD station pallet pin
34. 20-2256B Load station index disc
35. 20-2258 Load station shaft
36. Seal 2.500 national 473476-3.150in O.D.
37. 20-2255 Load station lock pin
38. 20-2254A Load station lock housing
39. 59-6225 Knob McMaster-Carr 6046K23
40. 20-2253 Load station lock mount
41. Trip limit switch
42. 20-2152A APC bumper mount
43. 20-2295 APC cylinder lever
44. 25-6993 Rotating door step seal
45. 59-0617 Air cylinder 4x7.55in.
46. 25-5046 Air cylinder shield
47. 45-0102 4x Washer 3/4in steel
48. 58-0018 2x Elbow fitting  $\frac{3}{8}$  x NPT 1/2 in. M 90
49. 25-7040 Air hose cable tray
50. 25-7006 APC bridge right chip shield
51. 20-2124 APC shaft mount
52. 20-3146 APC machined bridge casting
53. 25-7007 APC Bridge left chip shield
54. 40-1639 8x SHCS  $\frac{3}{8}$ -16x1in.
55. 20-195 Receiver clamp plate
56. 30-6551C Air blast ring
  - 9x Air blast nozzle
57. 57-0328 3x O-ring 2-339 Viton
58. 57-0358A Air blast ring gasket
59. 48-1667 2x Dowel pin  $1\frac{1}{2}$ x3-1/2in.
60. 20-2041E Machined receiver body
61. 25-5252 Receiver wear surface
62. 20-1994A Receiver piston
63. 57-0329 O-ring 2-456 Viton
64. 20-1996A Receiver shaft
65. 25-5250 Piston wear surface
66. 57-2148 O-ring 2-329 Viton
67. 20-1997 Receiver nut
68. 40-0030 BHCS 5/16-18x3/4in.
69. 20-1999A Receiver seal plate
70. 45-0104 Rotary union washer
71. Receiver Rotary union
72. 3x Air line 1000psi
73. 57-0095 O-ring 2-021 Buna
74. 20-2344 Rotary union lower washer
75. 45-0075 Washer 5-16in steel.
76. 43-0023 HHB 5/16-18x1-1/2in plated grade 8
77. 20-2022E platter indexer 17 dia.
78. 20-2493 Platter plug 8mm
  - 45-0038 Washer .312 hard .644 ID x .75in OD
  - 40-0047 SHCS M8 x 25 (Domestic only)
79. 57-2121 Piston head O-ring 2-161
80. 40-1661 6x SHCS .50-13x2 (Domestic only)
81. 59-0778 Face gear 1 deg17 (set of two pieces)
82. 40-0084 16x SHCS .312-18x1in.
83. 48-0035 Dowel pin .375 x .75in.
84. 20-4283A Spindle indexer
85. 30-4283 Solenoid assembly 310FG
86. 20-2071 Motor mounting plate
  - 20-4116 motor spacer
87. 20-4288 Drive pulley 32T
88. 54-4505 Drive belt PGGT 5M x 15
89. 25-5018A Receiver solenoid mount
90. 62-0016 Yaskawa servo motor 13 no brake
91. 20-4229 Driven pulley lockring
92. 20-4506 Driven pulley 310-64T
93. 30-6776 Indexer solenoid assembly clamp
  - 58-3690 Nipple .25NPT
  - 58-3056 Fitting .25F x .25F NPT
  - 58-3685 Elbow fitting .375 x NPT .25M
94. 25-6305 Z-axis cable tray
95. 25-5027A Z-axis cable carrier
96. 30-6774C Indexer solenoid assembly
97. 25-4968A Rotary side chip shield
98. 57-0337 2x V-ring seal CR404502
99. 57-4283 O-ring 2-272 Viton
100. 35-4284A Spindle/gear assembly
101. 51.4285 2x Thrust washer AS-120155
- 51-4286 Thrust Bearing AXK120155
102. 57-4282 O-ring 2-248 Viton
103. 20-4286 Lift piston 310FG
104. 57-0139 O-ring 2-263 Buna
105. 57-4282 O-ring 2-248 Viton
106. 57-4288 Thrust bearing nylon 6/6
107. 57-2144 O-ring 2-256
108. 20-4213 Disc brake HRT310
109. 40-1636 SHCS .375-16x1.25in.
110. 40-1716 4x SHCS .312-18x1.75in. (Domestic only)
111. 20-4216 Bearing housing 310mm
112. 20-4217 Nut housing 310mm
113. 51-0012 Bearing locknut BH-06
- 51-1021 Bearing ang contact 30TAC62BSU25-3
114. 20-4215 Worm shaft
115. 30-6778 Indexer breather assembly
116. 28-4126 Oil sight glass
117. 25-4968A Rotary side chip shield
118. 20-2045F Indexer rotary table
119. 20-2330C Switch lever arm
  - 51-0115 Cam follower .50 crowned
  - 46-16175 3x nut 10-32 hex
  - 44-0111 2x SSS 10-32x1.25in. sap pt.
120. 20-2473 Spring mount bar switch assembly
121. 69-1700 5x Proximity switch NC 2WR 1.0M
  - 25-5324A 3x Proximity switch bracket
122. 20-2329D Switch bracket
123. 49-0105 Shoulder screw .375 x 1.25in. self locking



### EC-500 SPINDLE HEAD AND COLUMN



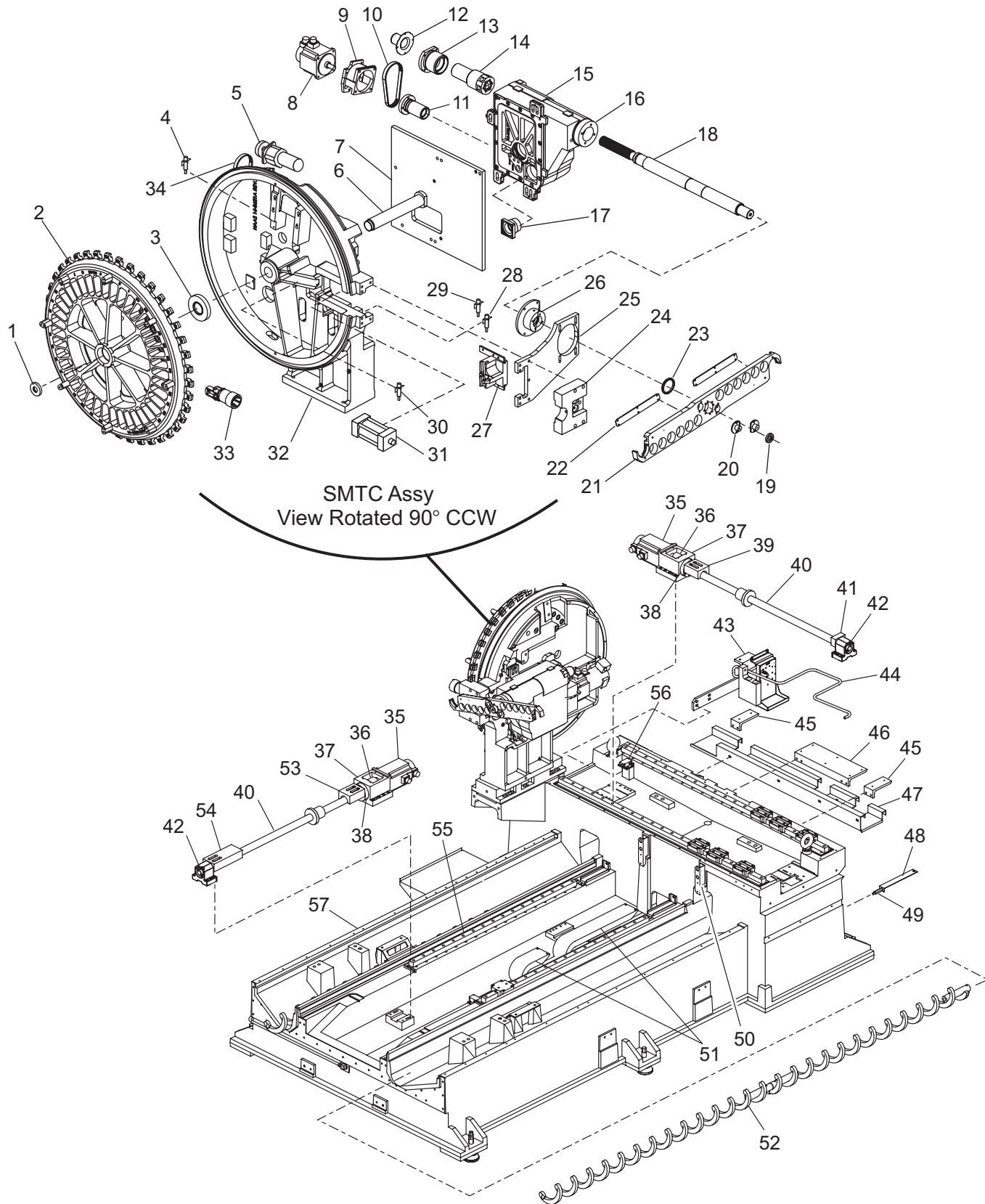


## EC-500 SPINDLE HEAD AND COLUMN

1. P-cool assembly  
20-7381B P-cool base plate
2. 58-3694 2x Locline valve
3. 25-5002A Spindle cover
4. 20-2063 2x Coolant block  
58-0658 4x Adj. coolant nozzle, 1/4NPT .15 orifice x 1.25in. L
5. 58-0097 2x Elbow fitting 1/2 x 1/2NPT M
6. 30-6338B Y-axis oil line assembly
7. 20-2044A Spindle head machined
8. 58-1680 2x Bulkhead fitting 1/2NPT x 1.125in. dia.
9. 30-6460 Spindle assembly 40T inline
10. 20-2521 TRP striker plate, inline
11. 20-1691 TRP shaft, inline
12. 20-1693 TRP cylinder, inline
13. 25-5548 (8) TRP shims 3.5 x gen  
25-5970 (8) TRP shims 3.5 x gen
14. 20-1692A TRP piston, inline
15. 25-4648B 2x Switch mounting bracket  
69-1700 2x Proximity switch assembly
16. 20-1696A TRP Spring retainer, inline
17. 20-2520 2x Standoff, inline
18. 20-2248 Motor plate
19. 40-16372 SHCS 3/8 x 1.5in.  
45-1730 Hard washer 3/8in.
20. 58-0654 TSC Drain tube
21. 20-2519 Transfer tube, inline
22. 62-3013A Spindle motor 12K, inline
23. 20-0278 Motor balancing hub
24. 20-0180 Timing pulley .750in. bore
25. 52-6200 TSC rotating union
26. 20-0179 Timing pulley .375in. bore
27. 25-1396A Encoder mounting box
28. 32-1457 Encoder
29. 36-3035 Spindle fan assembly 10in.
30. 59-0144 Fan guard
31. 25-6734 Fan bracket
32. 30-4032 Air solenoid assembly, inline
33. 25-5242 Shroud connector bracket
34. 30-6830A TSC pressure switch assembly
35. 25-6733 motor shroud
36. 73-3055 Terminal block
37. 25-5216 Motor lift strap
38. 25-4172 B Delta Y switch cover
39. 20-2043D Column, machined
40. 62-0016 Yaskawa sigma 13 no brake
41. 20-0151 Motor mount 40/50mm, machined
42. 20-9213 Spacer ring 40mm
43. 20-9211 Nut housing 40mm  
20-9212 Bearing housing 40mm
44. 20-2058A Y-axis bumper 3.75in. 40/50mm
45. 24-0101A Y-axis ballscrew 40-8-1412
46. 20-0166 Bumper 1.25 40/50mm
47. 20-0152 Bearing housing 40/50mm, machined
48. 50-3400 2x X-axis linear guide 35x1320in.
49. 25-4937 X-axis trip bracket
50. 20-0150 Nut housing machined, 40/50mm
51. 30-8093 X-axis oil line assembly
52. 30-8542 MOM reservoir assembly



## EC-500 BASE AND SMTC ASSEMBLY



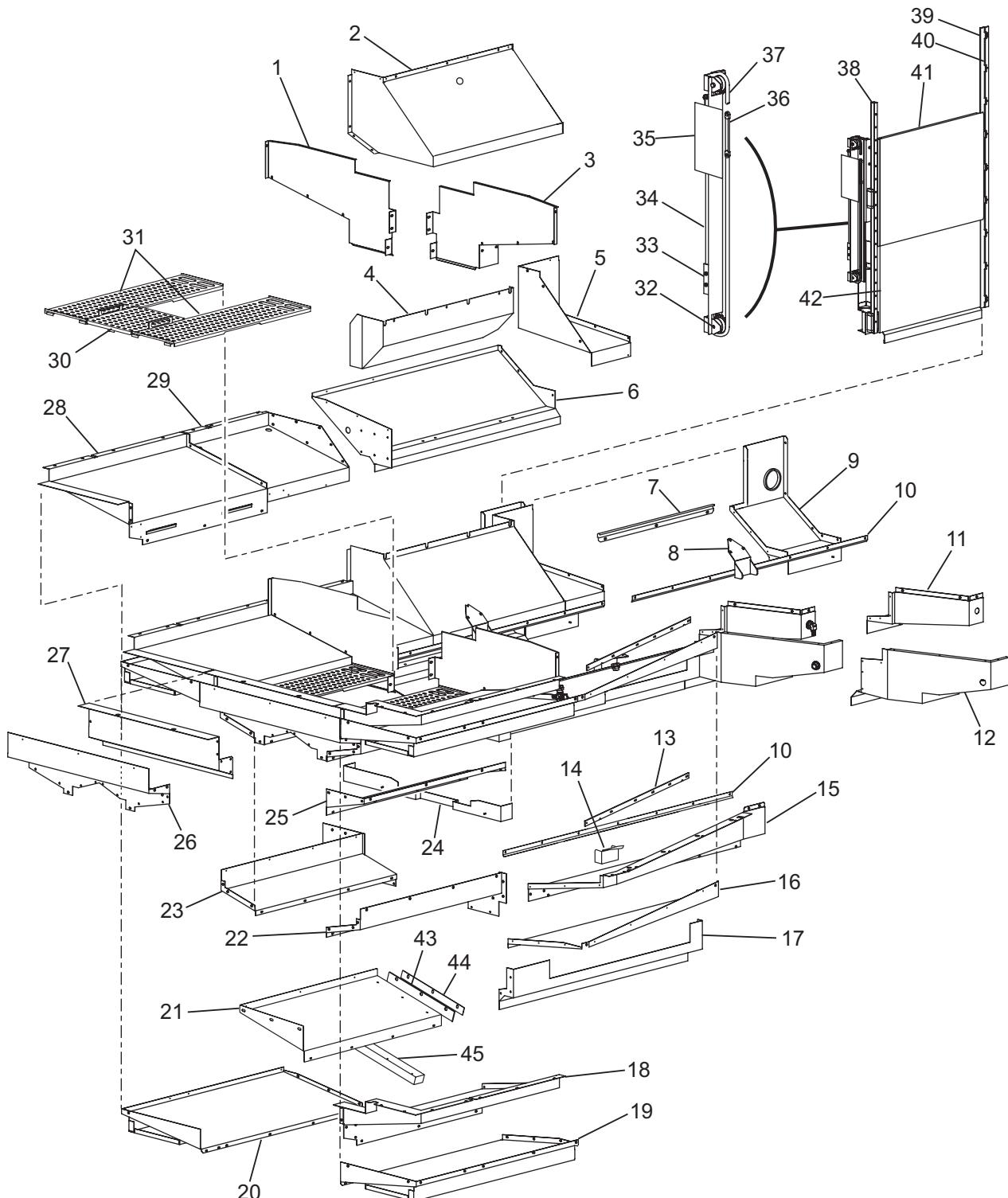


## EC-500 BASE AND SMTC ASSEMBLY

1. 20-0392 Carousel washer
2. 20-0731 Carousel
3. 59-0290 Locknut
4. 32-2295 Carousel mark proximity switch
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. 20-0225 Bearing housing
12. 22-0001 Output shaft cap
13. 20-0224 Star bearing housing
14. 20-0223 Star gear
15. 30-4008 Cam box
16. 20-0238 Bearing cap
17. 20-0226 Bearing housing
18. 20-2694 Output shaft
19. 20-0240 Arm hub
20. 20-0245 2x Arm cap
21. 30-7234 Double arm assembly
22. 25-5805 Cover plate
23. 57-0059 Seal
24. 20-2730 Pocket stop
25. 20-2731 SMTC Support plate
26. 20-2732 SMTC shaft support
27. 20-0807 Tool pocket slide
28. 32-2252 Proximity switch, pocket up
29. 32-2251 Proximity switch, pocket down
30. 32-2253 Proximity switch, tool one
31. 59-0078 Air cylinder
32. 20-2735 ATC housing
33. 20-0458 Tool pocket
34. 54-0045 Drive belt
35. 62-0016 Yaskawa motor sigma 13
36. 30-1215 2x Coupling
37. 20-0151 Motor mount
38. 20-9211 Nut housing 40mm  
20-9212 Bearing housing 40mm
39. 20-6540 Bumper
40. 24-00025 Ballscrew 40x1412
41. 20-2084 X-axis hardstop
42. 20-0152 Bearing housing machined 40/50mm  
51-0007 4x Deep groove bearing
43. Oil separator assembly rear drain
44. 58-0887 Base rear oil drain tube
45. 20-2899 2x Rear panel support short bracket
46. 20-2027 Rear support bracket
47. 25-4939 Rear wire channel
48. 25-5387 Rear apron support bracket
49. 20-2977 2x Motor plate standoff
50. 25-6979 2x Base cover bracket
51. 59-0803 Z-axis cable carrier
52. 22-6510 2x Chip auger
53. 20-0788 Y-axis bumper motor end
54. 20-0362 Bumper 9in. 40/50mm
55. 50-3400 2x X-axis linear guide 35x1320
56. 20-3958 Proximity switch mounting plate  
69-1700 Proximity switch assembly
57. 20-3143 Base casting, machined



## EC-630 INTERNAL SHEET METAL



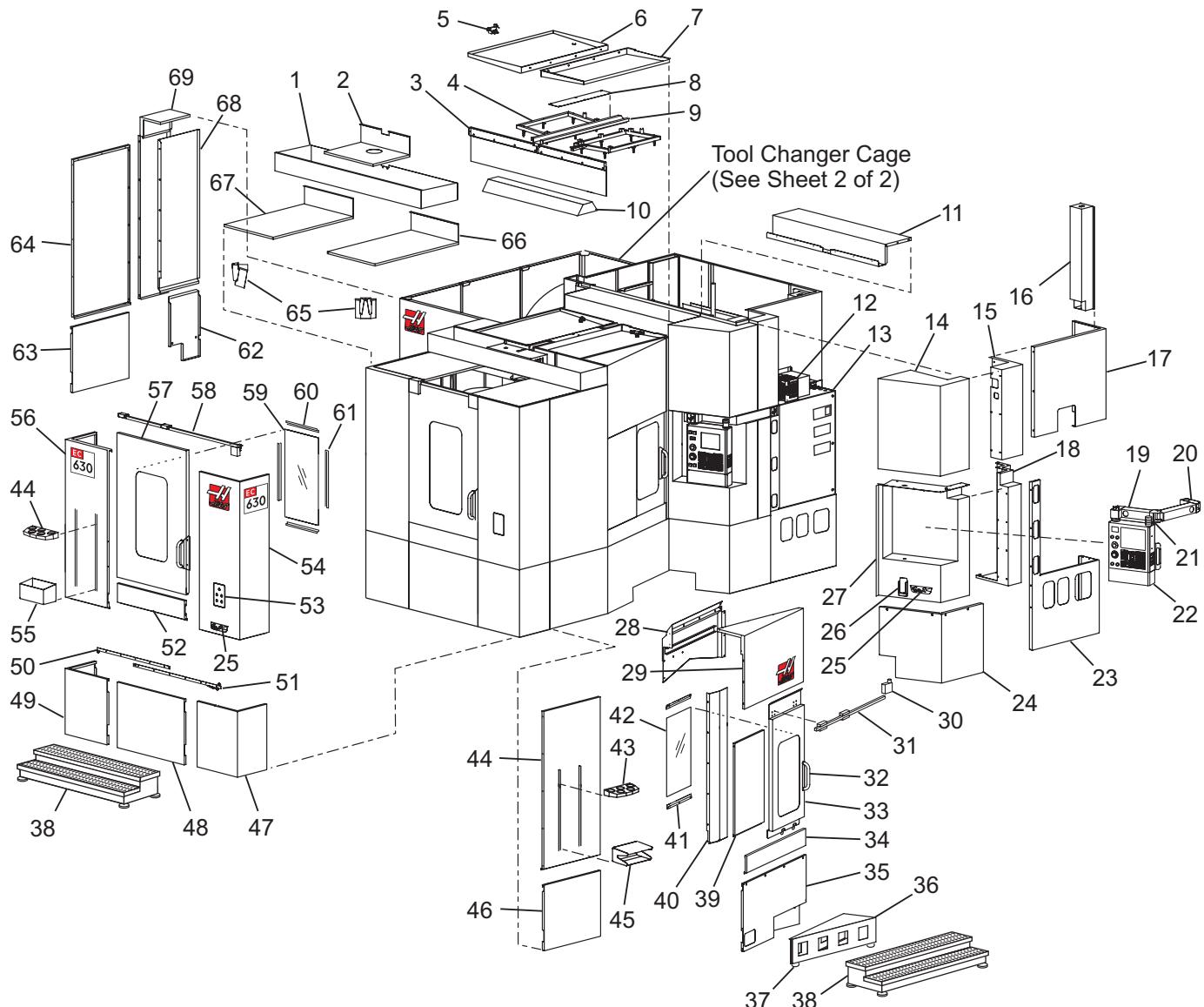


## EC-630 INTERNAL SHEET METAL

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 Operator Side Base Front Drip Pan
20. 25-8195 TC Side Base Front Drip Pan
21. 25-8227B TC Side Top Front Wiper
- 25-8228B Op 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
43. 26-10002 Z-Axis Waycover Felt Wiper (x2)
44. 25-11333 Z-Axis Waycover Cover Wiper (x2)
45. 20-10201 Z-Axis Waycover Aiper Delrin (x2)



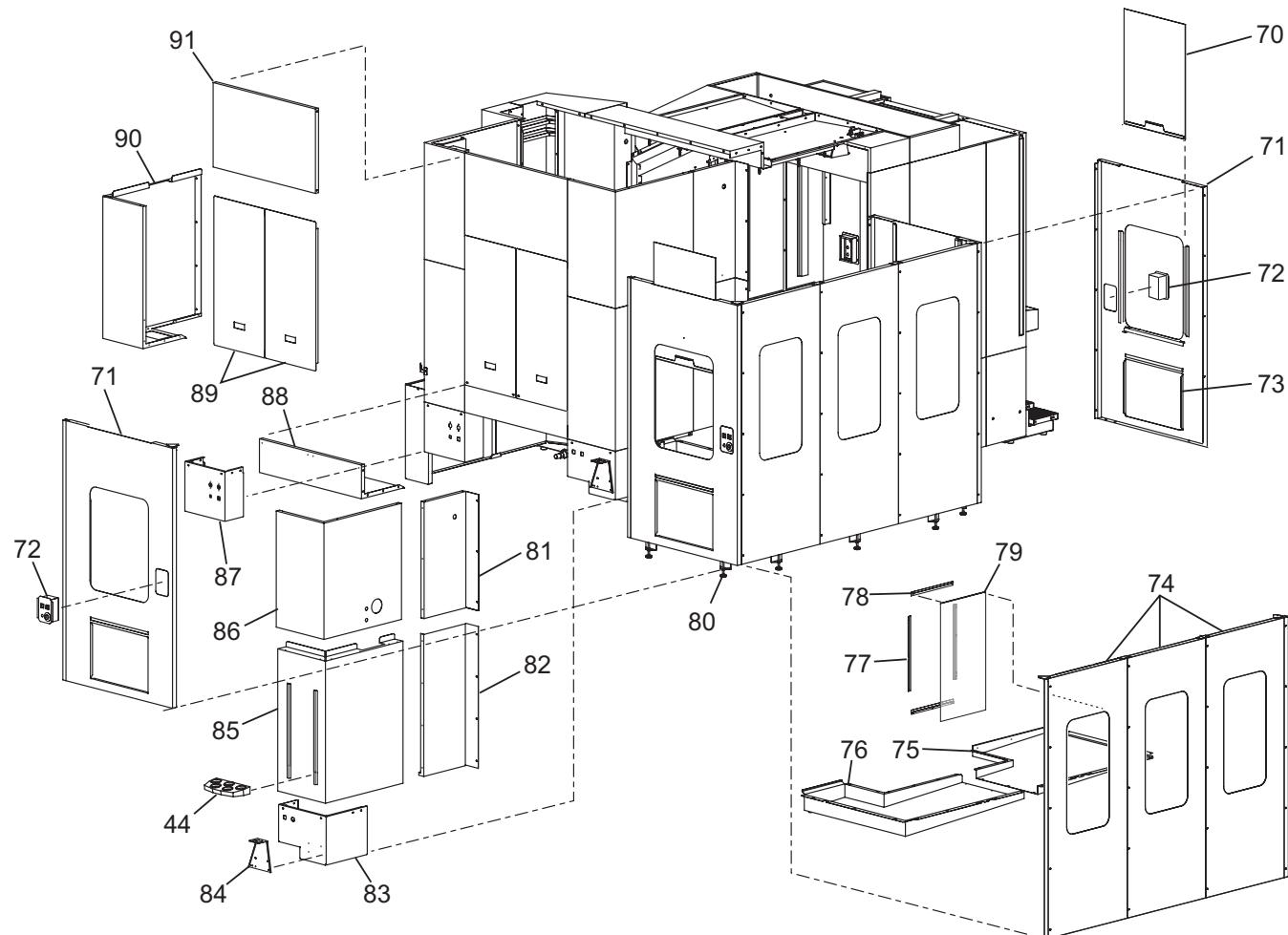
## EC-630 EXTERNAL SHEET METAL



Sheet 1 of 2



**EC-630 EXTERNAL SHEET METAL**



Sheet 2 of 2  
(View Rotated 180°)

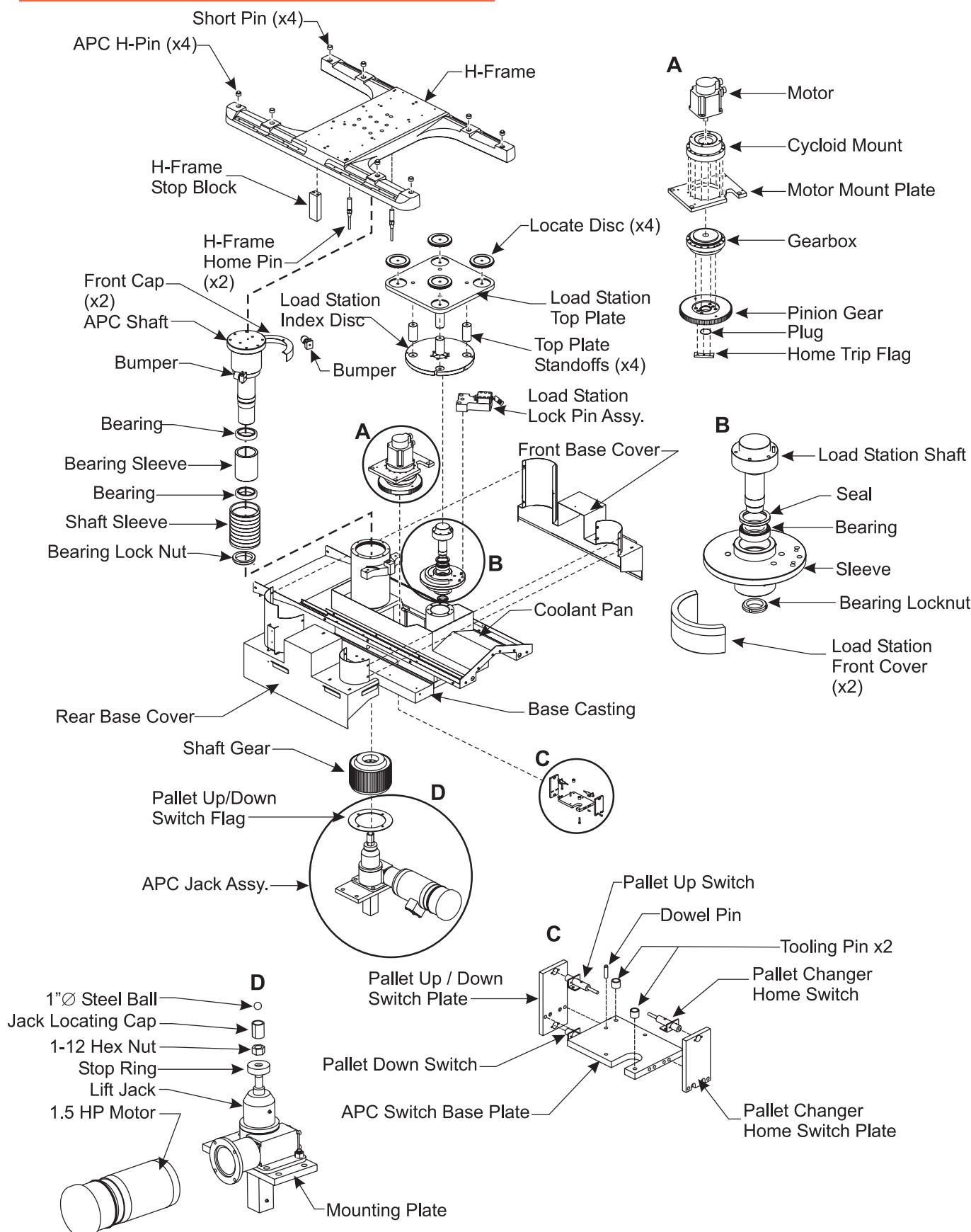


## EC-630 EXTERNAL SHEET METAL

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 Pendant 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 SMTA Switch Box
- 25-6719 2X SMTA 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

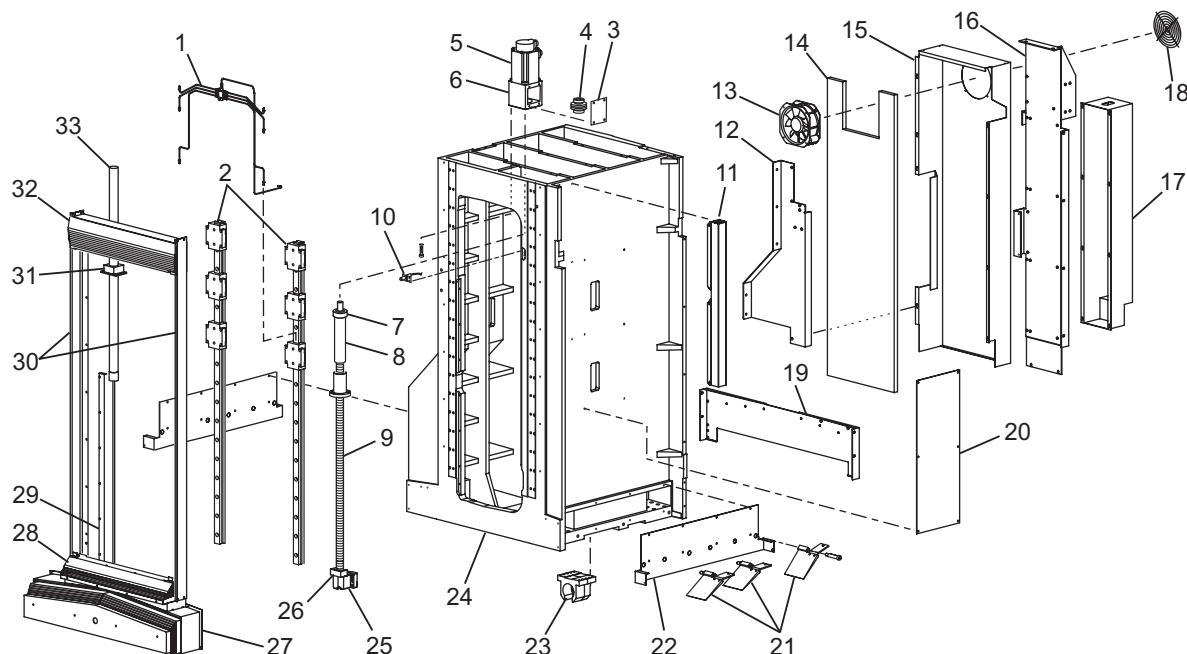


### EC-630 PALLET CHANGER ASSEMBLY





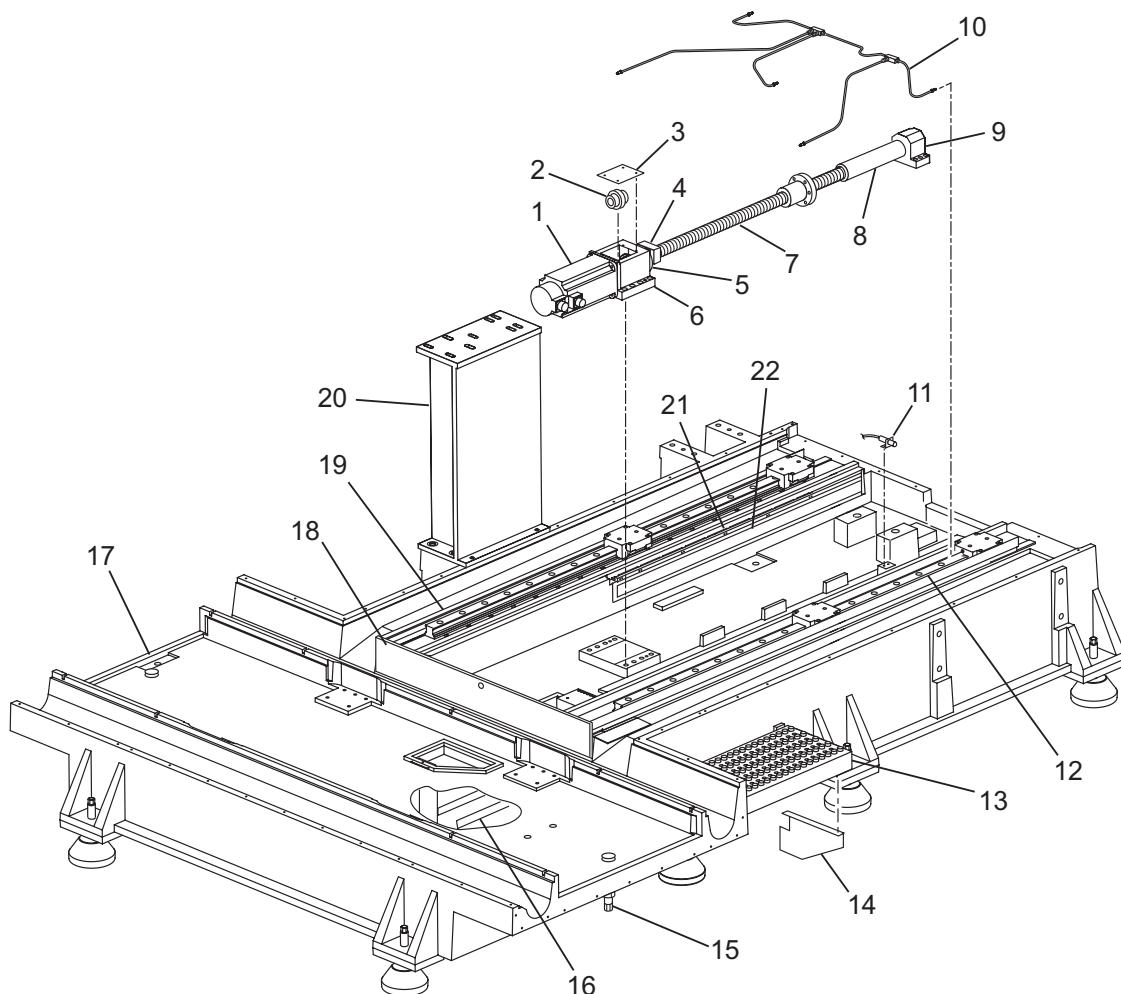
## EC-1600/2000/3000 COLUMN ASSEMBLY



- |                                      |   |
|--------------------------------------|---|
| 1. 30-6954 Lube Line Assy            | 21. 25-5631 6X Column Scraper (CE)          |
| 2. 50-9010 2X Linear Guide           | 25-6360 6X Scraper Counterweight (CE)       |
| 3. 25-9203 Motor Mount Cover         | 49-0119 6X Shoulder Bolt 3-1/4 x 3"         |
| 4. 30-3698 Coupling Assy             | 22. 25-5630A 2X Waycover Side Panel         |
| 5. 62-0037B Motor                    | 23. 20-0150 Nut Housing Machined            |
| 6. 20-6013 Motor Mount               | 24. 20-2995A Column Machined                |
| 7. 30-0764 Bearing Assy              | 25. 30-0472 Bearing Assy                    |
| 20-6253 Y-Axis Bearing Housing       | 20-0152 Bearing Housing                     |
| 51-0093 2X Bearing                   | 51-0007 3X Deep Groove Bearing              |
| 20-9211 Housing Nut                  | 26. 20-0195 Bumper (Support End)            |
| 8. 20-2677A Bumper (Motor End)       | 27. 25-5563B Z-Axis Front Waycover          |
| 9. 24-0003B Y-Axis Ballscrew         | 28. 59-0698 Y-Axis Lower Bellows            |
| 10. 69-1700 Proximity Sensor Assy    | 29. 60-0002C Linear Encoder Assy (Optional) |
| 11. 25-9439 Cable Cover              | 30. 25-5567 2X Bellows Guide                |
| 12. 25-5937B Coolant Hose Guide      | 31. 20-2959 Hydraulic Cylinder Plate        |
| 13. 66-1473A Fan                     | 32. 59-0697 Y-Axis Upper Bellows            |
| 14. 59-0796A Column Sound Foam       | 25-5566 Y-Axis Chip Guard                   |
| 15. 25-6959A Column Sound Shield     | 33. 52-0161A Hydraulic Cylinder             |
| 16. 25-6850C Tank – Carrier Bracket  |   |
| 17. 25-6035C Counterbalance Tank Box |   |
| 18. 59-0144 Fan Guard                |   |
| 19. 25-6849 Waycover Rear Mount      |   |
| 20. 25-6758 Column Panel Decal       |   |



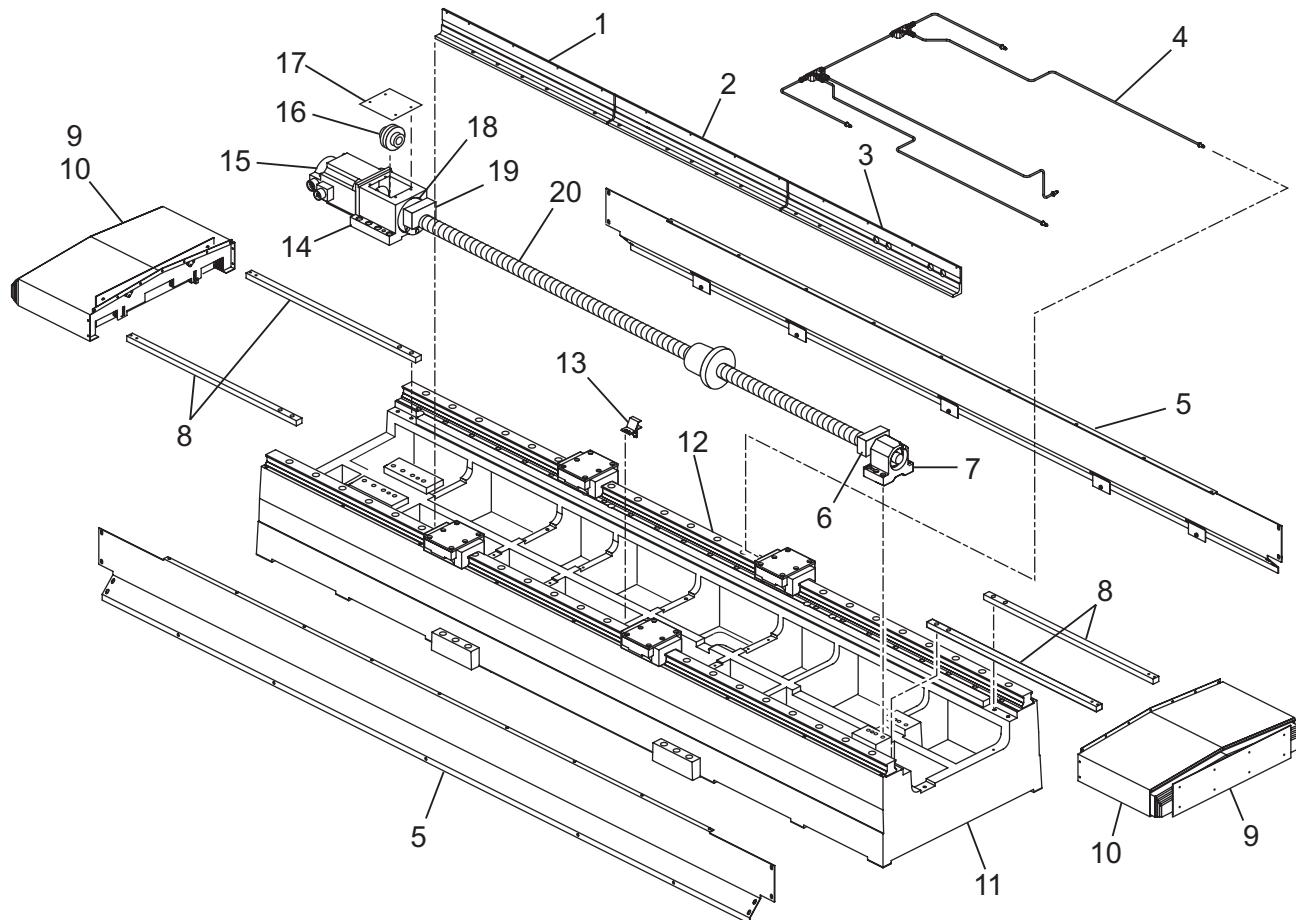
## EC-1600/2000/3000 BASE ASSEMBLY



- |             |                                |              |                                  |
|-------------|--------------------------------|--------------|----------------------------------|
| 1. 62-0038  | Serro Motor                    | 15. 20-3422  | 2X Pad Jack Screw (EC-1600/2000) |
| 2. 30-3698  | Coupling Assy                  | 44-0018      | 2X SSS 1-14 x 5 Flat Pt.         |
| 3. 25-9203  | Motor Mount Cover Plate        | 46-1670      | 2X Jam Nut                       |
| 4. 28-0236  | Y-Axis Motor End Bumper        | 16. 25-5553  | Base Cable Tray                  |
| 5. 30-1222  | Ballscrew Support Bearing Assy | 25-5554      | Base Cable Tray Support          |
| 6. 20-0151A | Motor Mount                    | 25-5552A     | Base Cable Strain Relief         |
| 7. 24-9960D | Y-Axis Ballscrew Assy          | 17. 20-2509D | Base Machined                    |
| 8. 28-0194  | Lead Screw Bumper              | 18. 20-2560  | Front Z-Axis Waycover Mount      |
| 9. 20-0152  | Support Bearing Housing        | 19. 25-5634A | 2X Z-Axis Truck Chip Guard       |
| 30-0472     | Support Bearing Assy           | 20. 20-2552A | Tool Changer Mount Machined      |
| 10. 30-6953 | Z-Axis Lube Line Assy          | 21. 20-9968A | Z-Axis Scale Mount (Optional)    |
| 11. 32-2134 | Home Switch 5.5 FT NC          | 22. 60-0002C | Linear Scale (Optional)          |
| 25-5391     | Z-Axis Proximity Switch Mount  | 23. 25-5391  | Z-Axis Proximity Switch Mount    |
| 12. 50-9010 | 2X Linear Guide                |              |                                  |
| 13. 22-7588 | Grating Step                   |              |                                  |
| 14. 25-5633 | Step Support Base              |              |                                  |



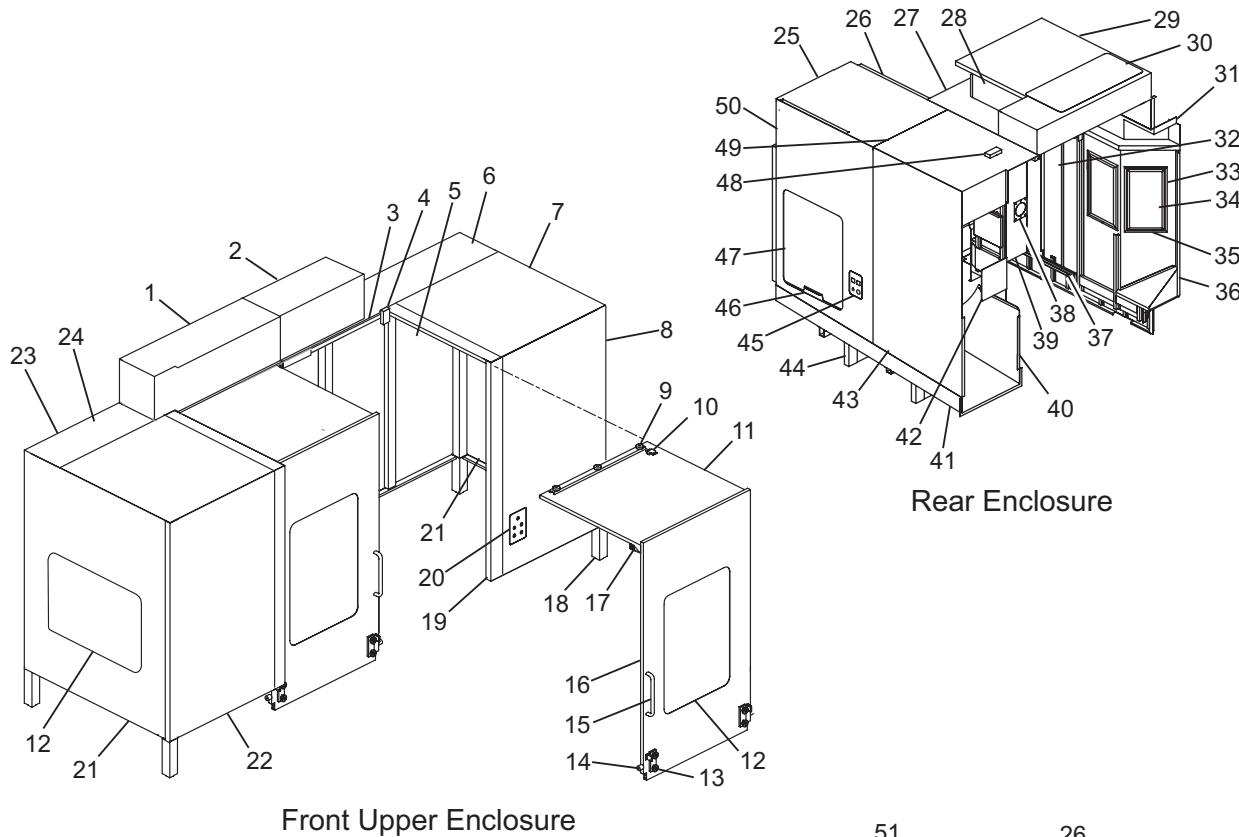
## EC-1600/2000/3000 SADDLE ASSEMBLY



- |             |                                    |              |  |
|-------------|------------------------------------|--------------|--|
| 1. 20-3013  | Scale Mount Section (Optional)     | 12. 50-9806  | 2X Linear Guide (EC-1600)              |
| 2. 20-3014  | Scale Mount Section (Optional)     | 50-9971      | 2X Linear Guide (EC-2000)              |
| 3. 20-3015  | Scale Mount Section (Optional)     | 50-0001B     | 2X Linear Guide (EC-3000)              |
| 4. 30-7410  | Lube Line Assy (EC-1600)           | 13. 32-2134  | Home Switch 5.5 FT NC (EC-1600/2000)   |
| 30-9200     | Lube Line Assy (EC-2000)           | 32-2142      | Home Switch 9.5 FT NC (EC-3000)        |
| 30-0036     | Oil Line Assembly X-Axis (EC-3000) | 25-7267      | Home Switch Mounting Bracket (EC-1600) |
| 5. 25-5620  | 2X Saddle Cover                    | 25-7049      | Home Switch Mounting Bracket (EC-2000) |
| 6. 28-0195  | Bumper (Support End) (EC-1600)     | 25-5344      | Home Switch Cover (EC-1600 Only)       |
| 28-0216     | Bumper (Support End) (EC-2000)     | 14. 20-0151A | Servo Motor Mount                      |
| 28-0194     | Bumper Leadscrew (EC-3000)         | 15. 62-0016  | Servo Motor                            |
| 7. 30-0472  | Bearing Assy                       | 16. 30-1225A | Coupling Assy                          |
| 20-0152     | Bearing Housing                    | 17. 25-9203  | Motor Mount Cover                      |
| 8. 20-9822  | 4X X-Axis Guide Bar (EC-1600/2000) | 18. 30-1222  | Bearing Assy                           |
| 25-0036     | Guide Bar X-Axis (EC-3000)         | 19. 28-0195  | Bumper (Motor End) (EC-1600)           |
| 9. 25-5632  | 2X X-Axis Waycover Bolt Plate      | 28-0215      | Bumper (Motor End) (EC-2000)           |
| 10. 25-9810 | 2X X-Axis Waycover (EC-1600)       | 28-0236      | Y-Axis Bumper Motor End (EC-3000)      |
| 25-9977     | 2X X-Axis Waycover (EC-2000)       | 20. 24-9961D | X-Axis Ballscrew (EC-1600)             |
| 11. 20-2536 | Saddle Machined (EC-1600)          | 24-0014      | X-Axis Ballscrew (EC-2000)             |
| 20-3174     | Saddle Machined (EC-2000)          | 24-0002C     | X-Axis Ballscrew (EC-3000)             |
| 20-3368     | Saddle Machined (EC-3000)          |              |  |

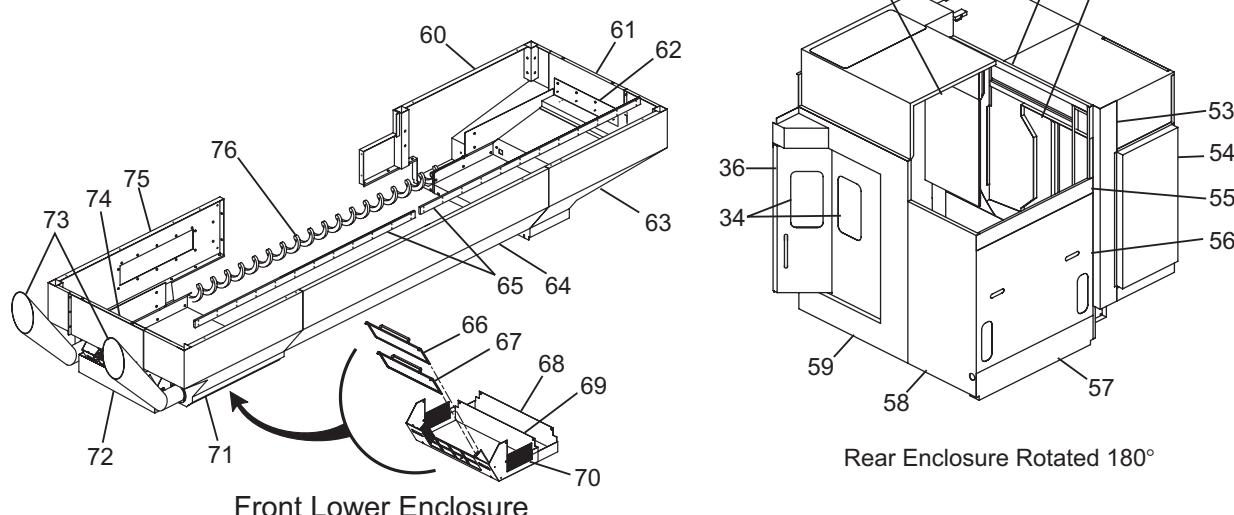


## EC-1600/2000/3000 ENCLOSURE ASSEMBLY



Front Upper Enclosure

Rear Enclosure



Front Lower Enclosure

Rear Enclosure Rotated 180°

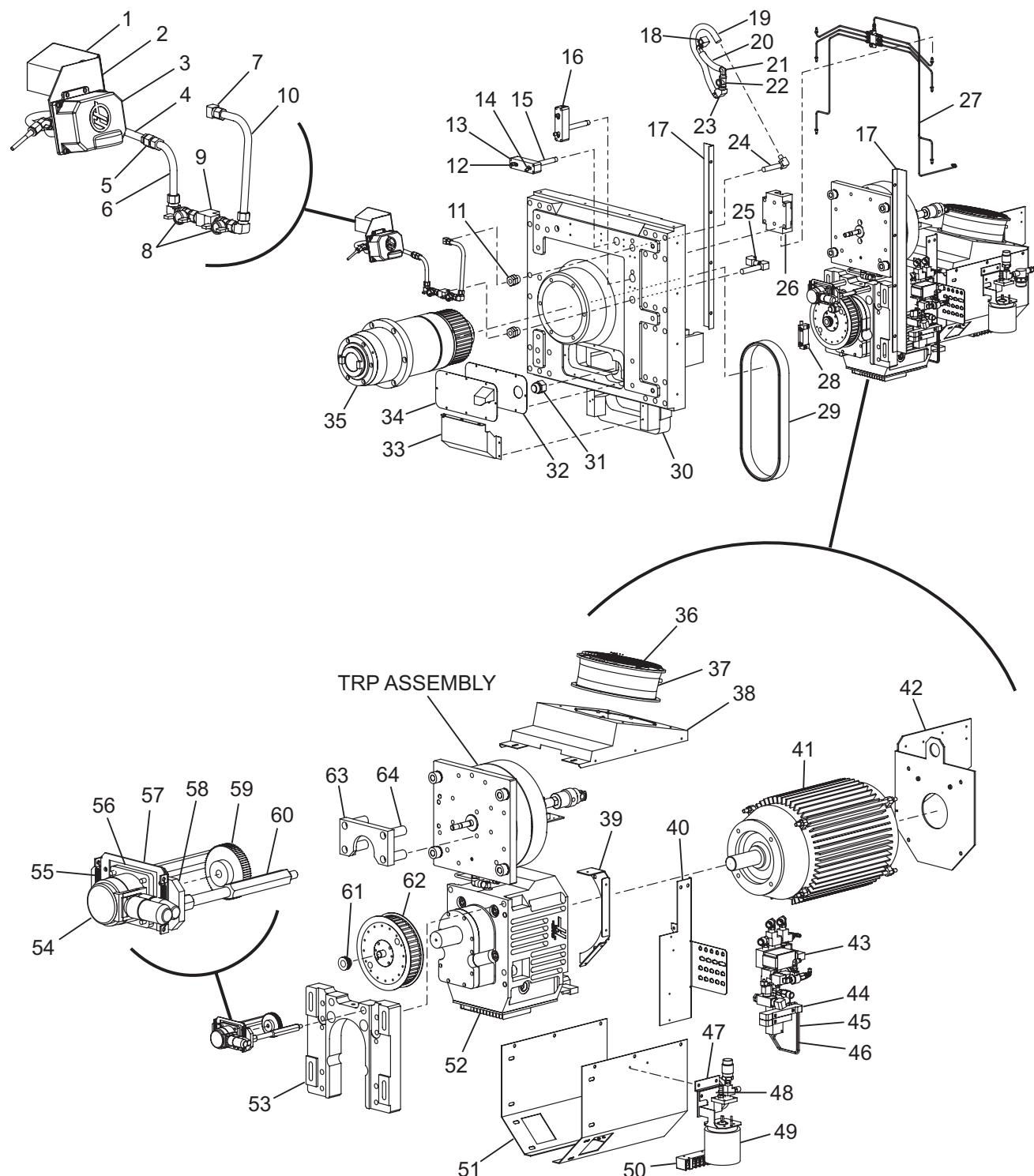
- |             |   |             |   |
|-------------|---|-------------|---|
| 1. 25-5625  | Enclosure Top Right Cover (EC-1600)           | 5. 25-5743  | Enclosure Right Rear Panel (EC-1600/3000) |
| 25-7059A    | Enclosure Middle Top Cover (EC-2000/3000)     | 25-7056     | Enclosure Right Rear Panel (EC-2000)      |
| 2. 25-5626  | Enclosure Top Left Cover (EC-1600)            | 6. 25-7062  | Top Right Rear Panel (EC-2000)            |
| 3. 25-5622A | 2X Enclosure Door Roller Track (EC-1600/2000) | 7. 25-5615B | 2X Top Right-Left Panel (EC-1600/3000)    |
| 25-7613     | Door Track Upper (EC-3000)                    | 8. 25-9324  | Front Right Panel (EC-1600/3000)          |
| 4. 25-6372  | 2X Switch Bracket                             | 25-5614     | 2X Front Right-Left Panel (EC-2000)       |
| 61-2125A    | 2X Limit Switch                               |             |   |



9.	20-6017	12X Door Offset Spacer	45.	25-6718A	Switch Box
	51-2020	6X Radial Bearing		25-6719	Switch Box Cover
	40-2001	6X SHCS 14-20 x 1 in,	46.	25-9248A	Window Plate Handle
10.	25-6366	2X Trip Ramp	47.	28-0036	Window Extrusion Side
11.	25-5618B	2X Enclosure Top Door Panel (EC-1600)		28-7472B	Left Rear Side Window
12.	28-0020	4X Door Window (EC-1600)	48.	25-4521A	Lamp Connector Cover
	28-0021	2X Door Window (EC-2000)	49.	25-7123B	Top Front Shroud
	25-0969	8X Door Frame Top-Bottom (EC-1600)	50.	25-9315	Left Rear Shroud (EC-1600/3000)
	25-0981	4X Door Frame Top-Bottom (EC-2000)		25-7119	Shroud Left Rear (EC-3000)
	25-0970	8X Door Frame Sides	51.	25-7163	Cambox Right Shroud
13.	30-7077	4X Wheel Guide Assy	52.	25-5601A	Left Side Rear Panel
	25-5653	4X V-Track Retainer	53.	25-7128	Right Rear Shroud
14.	59-1057	4X Door Bumper	54.	25-7146	Back Panel Shroud
15.	22-8895	3X Door Handle	55.	25-5588	Rear Upper Panel
16.	25-5619B	2X Front Door (EC-1600)	56.	25-5587	Rear Middle Panel
	25-7068	2X Front Door (EC-2000)	57.	25-5589B	Rear Lower Panel
	25-7618	2X Door Front (EC-3000)	58.	25-5592	Right Rear Side Panel
17.	61-0006A	2X Door Interlock	59.	25-5593C	Right Side Panel
	25-9254B	2X Interlock Switch Mounting Bracket	60.	25-5608A	Back Right Saddle (EC-1600/3000)
18.	25-5617	5X Enclosure Main Post		25-7051A	Back Right Saddle (EC-2000)
19.	25-7064	2X Front Panel (EC-2000)	61.	25-5638	Right Saddle End Cover (EC-1600)
20.	25-1257A	Front Panel Switch Box		25-7047A	Right Saddle End Cover (EC-2000/3000)
	25-1258A	Switch Box Cover	62.	25-5632	2X X-Axis Waycover Bolt Plate
21.	25-5616A	2X Left and Right Side Panel	63.	25-5610	Front Right Saddle (EC-1600)
22.	25-5614A	Front Left Panel (EC-1600)		25-7053	Front Right Saddle (EC-2000/3000)
23.	25-5598A	Rear Left Panel (Rear) (EC-1600/3000)	64.	25-5611A	Front Middle Saddle
	25-7055A	Rear Left Panel (Rear) (EC-2000)	65.	20-2573A	2X Front Door Track (EC-1600/2000)
24.	25-7063	Top Left Rear Panel (EC-2000)		20-2572	V-Track Operator Door (EC-3000)
25.	25-7124	Top Rear Shroud	20-2574	4X Front Door V-Rail (EC-1600/2000)	
26.	25-7127	Support Shroud	20-3366	V-Rail Front Door (EC-3000)	
27.	25-5594B	Enclosure Top Panel	68.	25-5639B	Plenum Drain (EC-1600)
28.	25-7147B	Cambox Top Shroud	69.	25-7065A	Plenum Drain (EC-2000/3000)
29.	25-5594B	Top Panel	70.	25-5643	2X Drain Cover
30.	25-9316A	Top Roof Access Cover		25-7807	2X Auger Chip Screen
31.	25-5592	Right Rear Side Panel	71.	25-5612B	Front Left Saddle (EC-1600)
32.	25-5593C	Right Side Panel		25-7054	Front Left Saddle (EC-2000/3000)
33.	25-4149	4X Window Z-Frame Top-Bottom	72.	25-10633	Trough Drain
34.	25-1262	4X Window Z-Frame Sides	73.	25-0548	2X Discharge Chute
35.	28-0043	2X Window		57-9846	2X Discharge Chute Gasket
36.	25-5591B	Operator Door	74.	25-5609A	Left Saddle End Cover (EC-1600)
37.	20-2570	Operator Door V-Track Plate		25-7047A	2X Saddle end Cover (EC-2000/3000)
	20-2572	2X Operator Door V-Track	75.	25-5613A	Left Back Saddle (EC-1600)
38.	25-0285A	2X C-Panel		25-7052A	Left Back Saddle (EC-2000/3000)
39.	25-7148A	Cambox Front Shroud	76.	22-6121A	Chip Auger 3.75 x 130.75 in. (EC-1600)
40.	25-7165A	Front Inside Shroud		22-9841A	Chip Auger 3.75 x 145.25 in. (EC-2000)
41.	25-7110	TC Drip Pan	22-8891A	Chip Auger 3.75 x 86 in. (EC-3000)	
42.	25-8946	TC Door	62-0050A	2X Auger Motor	
43.	25-7114	Left Front Shroud	20-9150	Motor Coupling	
44.	25-7109	2X Pan Support	57-9265A	Motor Gasket	



### EC-1600/2000/3000 SPINDLE ASSEMBLY

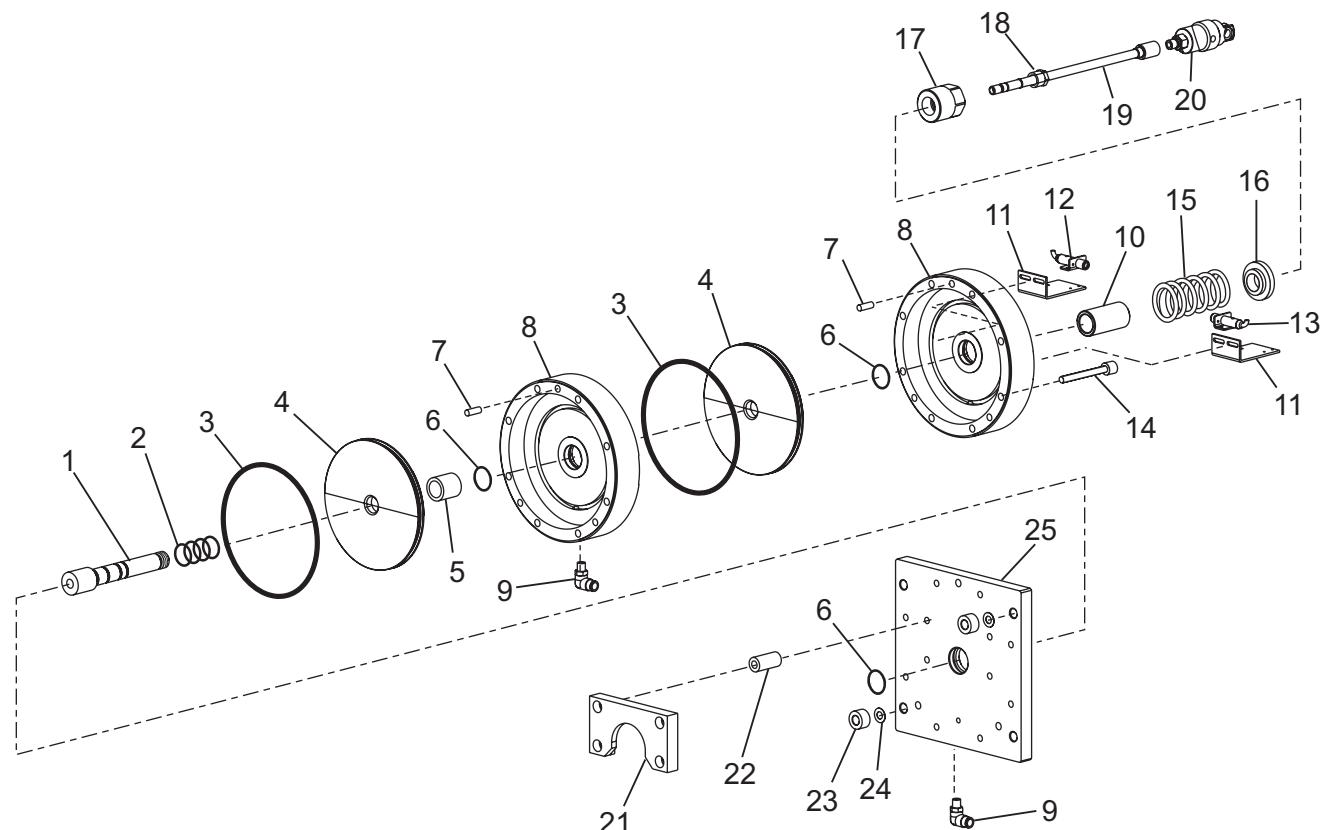




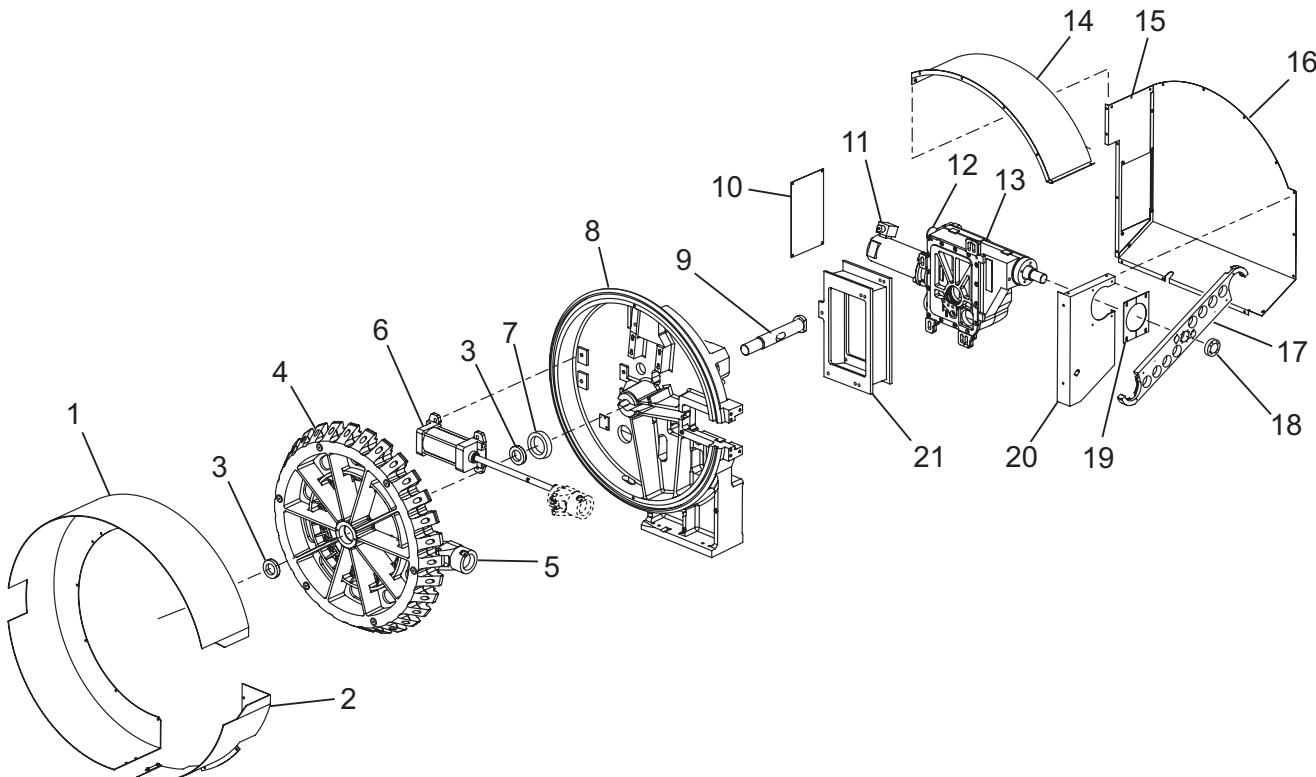
- |              |   |              |                            |
|--------------|---|--------------|----------------------------|
| 1. 25-8470   | Cable Cover                               | 41. 62-4025  | Spindle Motor 20HP         |
| 2. 25-7859   | PCool Bracket                             | 42. 25-5650A | Motor Backing Plate        |
| 3. PCOOL-E16 | PCool Assy                                | 43. 30-7280  | Solenoid Valve Assy        |
| 14-2149      | PCool Cover                               | 44. 32-0083  | Air Valve Solenoid Assy    |
| 4. 52-0026A  | Straight Swivel Hose                      | 45. 58-0499  | Low Gear Air Line          |
| 5. 58-3049   | Straight Fitting .50 x .375-F NPT         | 46. 58-0498  | High Gear Air Line         |
| 6. 58-0789A  | Tube                                      | 47. 25-5648  | Oil Pump Assy Bracket      |
| 7. 58-3052   | 3X 90 Degree Elbow .50 x .375-M NPT       | 48. 25-6843  | Oil Pump Bracket (25-6844) |
| 8. 58-0326   | 2X Ball Valve .375 NPT                    | 49. 30-3260C | Oil Gear Pump Assy         |
| 9. 58-3003   | Tee .375-M x .375-M x .375-F              | 50. 73-3055  | Terminal Block 6 Pole      |
| 58-3601      | Close Nipple .375 NPT                     | 51. 25-5647A | Spindle Motor Shroud       |
| 10. 58-0788  | Manifold Tube                             | 52. 20-1824C | Gearbox 7500_50T           |
| 11. 58-1679  | 2X Bulkhead Fitting .375 NPT x 1.000 Dia. | 20-1705      | Oil Pan                    |
| 12. 22-8739  | 2X Coolant Nozzle 45 Degree               | 53. 20-2549  | Transmission Plate         |
| 13. 20-6097A | 2X Coolant Manifold                       | 54. 30-30390 | Encoder Assy               |
| 22-8749      | 4X Nozzle Clamp Bushing                   | 30-9572A     | Encoder & Pulley Assy      |
| 57-0026      | 4X O-Ring 2-109                           | 55. 59-0742  | 2X Spring .290D x 1.5L     |
| 14. 22-8730  | 2X Coolant Nozzle                         | 56. 25-6299A | Encoder Spring Mount       |
| 15. 58-0790  | 2X Nipple .375 NPT x 5.00                 | 57. 25-6298  | Encoder Spring Mount Clamp |
| 16. 58-3105  | 2X Pipe plug .25-M NPT                    | 58. 20-2997  | Encoder Spring Mount Plate |
| 17. 25-5566  | 2X Y-Axis Chip Guard                      | 59. 20-0179  | Timing Pulley .375 Bore    |
| 18. 58-3062  | 4X Elbow 90 Degree .375-F x .375-F NPT    | 60. 20-2965B | 2X Encoder Standoff        |
| 19. 58-2050  | Hose 1                                    | 61. 20-4518  | Encoder Drive Pulley       |
| 20. 58-2050  | Hose 2                                    | 62. 20-1455A | Pulley 45 Tooth            |
| 21. 58-2060  | 3X Hose Barb Fitting .50 x .375-M NPT     | 20-0025      | 2X Pulley Flange           |
| 22. 58-1725  | Tee .375-F x .375-F x .375-F NPT          | 20-1454      | Encoder Pulley Mount       |
| 23. 58-1721  | Elbow 45 Degree .375-F x .375-M NPT       | 63. 20-0015  | Spindle Fork Lift          |
| 24. 58-1723  | 2X Nipple .375 NPT x 4.00                 | 64. 22-0013A | 4X Spindle Fork Spacer     |
| 25. 58-3641  | Nipple .375 NPT x 2.00                    |              |                            |
| 26. 50-9010  | 4X Linear Guide Truck                     |              |                            |
| 27. 30-6954  | Y-Axis Lube Line Assy                     |              |                            |
| 28. 20-2962  | Y-Axis Read Head Mount                    |              |                            |
| 60-0002C     | Lin Encoder                               |              |                            |
| 29. 54-0104  | Spindle Drive Belt 7.5K                   |              |                            |
| 54-0082      | Spindle Drive Belt 10K                    |              |                            |
| 30. 20-3472  | Spindle Head Machined                     |              |                            |
| 31. 32-1210C | TRP Button                                |              |                            |
| 32. 57-0372A | Encoder Cover Gasket                      |              |                            |
| 33. 25-6292A | Spindle Belt Sound Shield                 |              |                            |
| 34. 25-5565A | Encoder Cover                             |              |                            |
| 35. 30-8894  | Spindle Assy 50T                          |              |                            |
| 36. 59-0144  | Spindle Fan Guard 8.75 in.                |              |                            |
| 37. 66-1473A | Fan 10 in.                                |              |                            |
| 38. 25-5649A | Fan Mounting Shroud                       |              |                            |
| 39. 25-1415  | Motor Right Support Bracket               |              |                            |
| 25-1416      | Motor Left Support Bracket                |              |                            |
| 40. 25-5646  | Valve Mounting Bracket                    |              |                            |



## EC-1600/2000/3000 TOOL RELEASE PISTON



- |  |                                     |
|--|-------------------------------------|
| 1. 20-0018A Air Cylinder Shaft         | 21. 20-0015 Spindle Fork Lift       |
| 2. 57-0027 4X O-Ring 2-121             | 22. 22-0013A 4X Spindle Fork Spacer |
| 3. 57-0082 2X O-Ring 2-448             | 23. 22-0014 4X Spacer               |
| 4. 20-0019A 2X Air Cylinder Piston     | 24. 45-0014 Washer .010 in.         |
| 5. 20-0020A Lower Air Cylinder Spacer  | 45-0015 Washer .018 in.             |
| 6. 57-0095 3X O-Ring 2-327             | 25. 20-0017A Sub Plate              |
| 7. 48-1662 6X Dowel Pin                |                                     |
| 8. 20-0022A Air Cylinder Housing       |                                     |
| 9. 58-1695 3X 90 Degree Elbow          |                                     |
| 10. 20-0021B Upper Air Cylinder Spacer |                                     |
| 11. 25-0009A 2X Switch Bracket         |                                     |
| 12. 32-2204 Proximity Switch (Clamp)   |                                     |
| 13. 32-2203 Proximity Switch (Unclamp) |                                     |
| 14. 40-0006 8X SHCS .50-13 x 5in.      |                                     |
| 15. 59-0049 Compression Spring         |                                     |
| 16. 20-1657 Spring Retainer            |                                     |
| 17. 20-7655 Bearing Holder             |                                     |
| 18. 58-3665 Reducer                    |                                     |
| 19. 30-1242 Extension Tube Assy        |                                     |
| 20. 30-0068A Rotating Union Assy       |                                     |

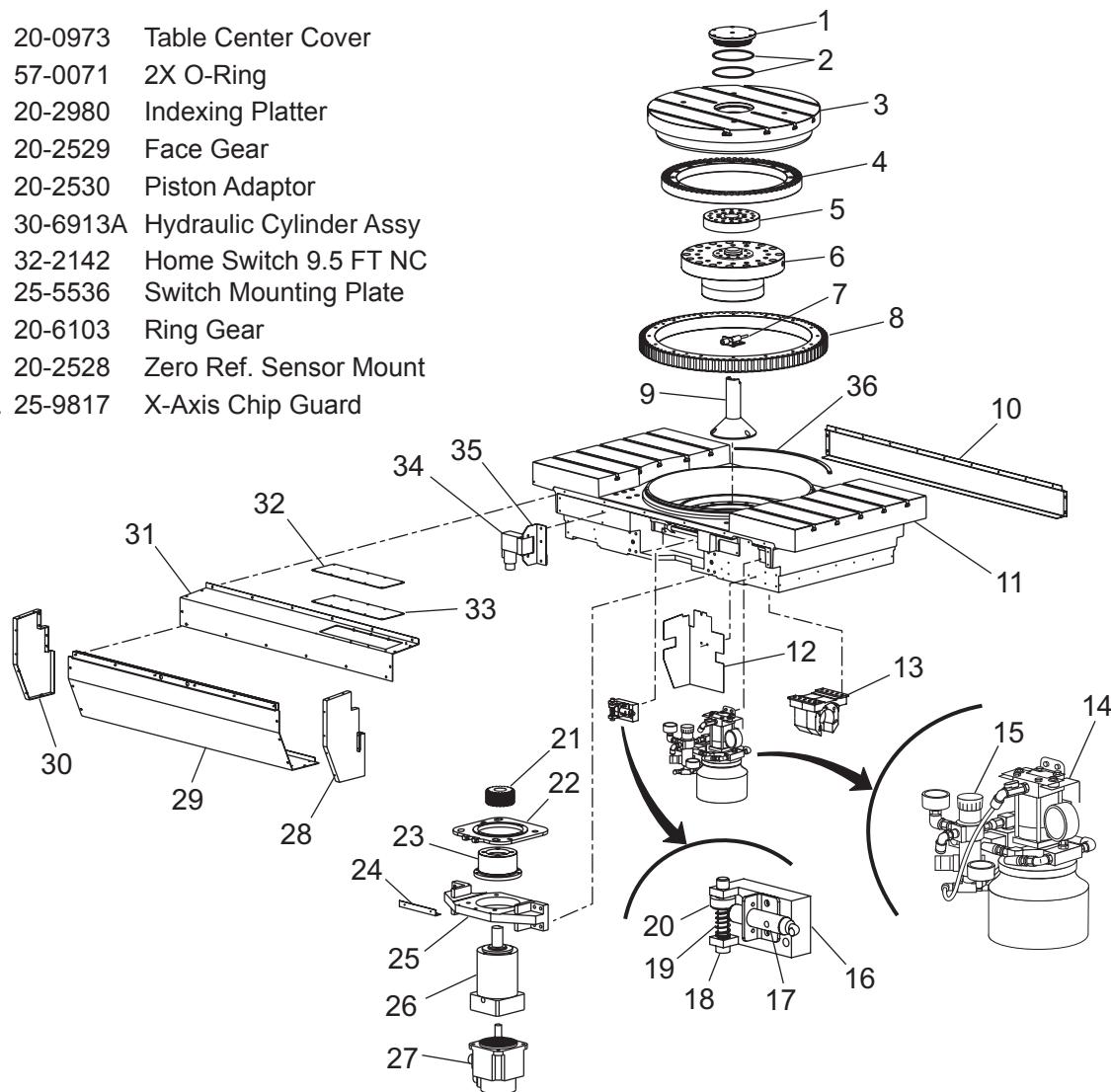
**EC-1600/2000/3000 SMTC50/30 POCKET**

1. 25-0286B SMTC50 Shroud
2. 25-0291B SMTC50 Corner Shroud
3. 51-0020 2X Deep Groove Bearing
4. 20-0438A Carousel
5. 30-9128 30X Tool Pocket Assy
6. 59-0116A Air Cylinder 200A2
7. 20-0392 Carousel Washer
8. 20-0621 Carousel Housing Machined
9. 20-0387 Carousel Shaft
10. 25-5572 Motor Cover (EC-1600)
11. 62-0030A Motor .50HP  
20-0272B Motor Mount Side Mount
12. 30-0148A Stargear Assy
13. 20-0455C Cambox machined  
20-0456 Cambox Cover
- 20-0028 Outer Lower Bearing Spacer
- 20-0225 Bearing Housing Wormshaft
14. 25-0290A SMTC50 Front Cover (EC-1600)  
25-5573 SMTC50 Front Cover (EC-2000/3000)
15. 25-5571 SMTC50 Top Plate (EC-1600/3000)  
25-0287A SMTC50 Top Plate (EC-2000)
16. 25-0289A SMTC50 Right Cover (EC-1600)  
25-5574 SMTC50 Right Cover (EC-2000/3000)
17. 20-2968A SMTC50 BT50  
20-2362A SMTC50 CT50
18. 20-0240 Arm Hub
19. 25-0285A 2X SMTC50 C-Panel
20. 25-0292A SMTC50 Bottom Cover (EC-1600)  
25-5570A SMTC50 Bottom Cover (EC-2000/3000)
21. 20-2075A Cambox Spacer



## EC-1600 5-DEGREE TABLE ASSEMBLY

1. 20-0973 Table Center Cover
2. 57-0071 2X O-Ring
3. 20-2980 Indexing Platter
4. 20-2529 Face Gear
5. 20-2530 Piston Adaptor
6. 30-6913A Hydraulic Cylinder Assy
7. 32-2142 Home Switch 9.5 FT NC
- 25-5536 Switch Mounting Plate
8. 20-6103 Ring Gear
9. 20-2528 Zero Ref. Sensor Mount
10. 25-9817 X-Axis Chip Guard

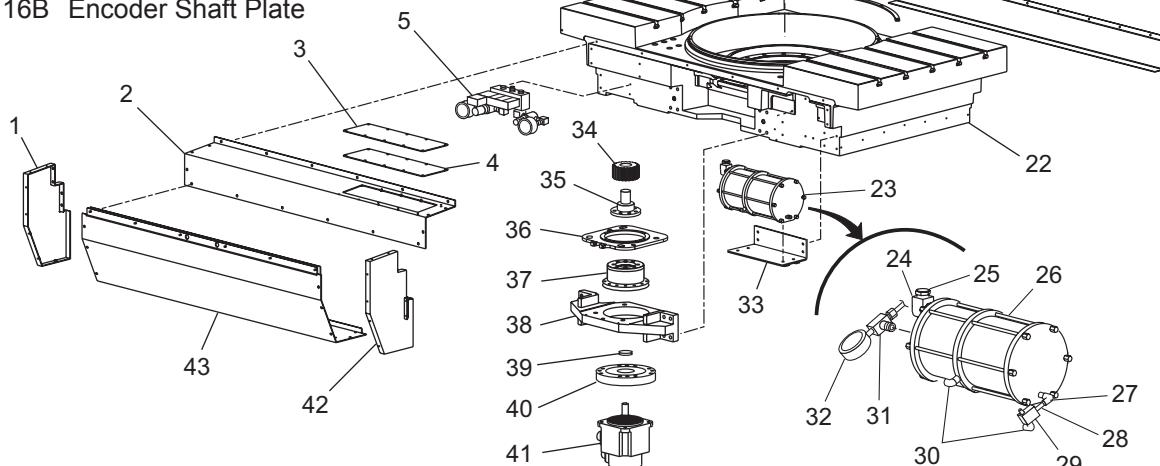


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|-------------------------------------|---------------------------------------|
| 11. 20-2508B Indexing Table         | 24. 25-5539 Shroud Support            |
| 12. 25-5545 Pump Sound Wall         | 25. 20-2531 Platter Drive Mount       |
| 13. 20-0150 Ballnut Housing         | 26. 59-0695 Gear Box Planetary 50:1   |
| 20-2979 2X Shim .220                | 27. 30-7531 Indexer Motor Assy        |
| 14. 30-7510 Haskel Pump Assy        | 28. 25-5540 Right Shroud              |
| 15. 30-7511 Air regulator Assy      | 29. 25-5543 Bottom Shroud             |
| 16. 20-2532 Switch Bracket          | 30. 25-5541 Left Shroud               |
| 17. 32-2130 Home Switch 1.5 FT NC   | 31. 25-5542 Top Shroud                |
| 18. 49-1019 Shoulder Screw          | 32. 25-5544 Pump Access Cover         |
| 19. 59-0763 Spring Compression      | 33. 57-0393 Pump Cover Gasket         |
| 20. 20-2533B Plunger Sensor Bracket | 34. 32-6929 Hydraulic Solenoid        |
| 21. 20-2527 Pinion 22T Indexer      | 35. 25-5546 Hydraulic Valve Bracket   |
| 22. 20-1400 Backlash Plate          | 36. 25-5558 4X Retaining Platter Seal |
| 23. 20-2526 Gear Box Mount          |                                       |



### EC-1600 TABLE ASSEMBLY (FULL-FOURTH INDEXER)

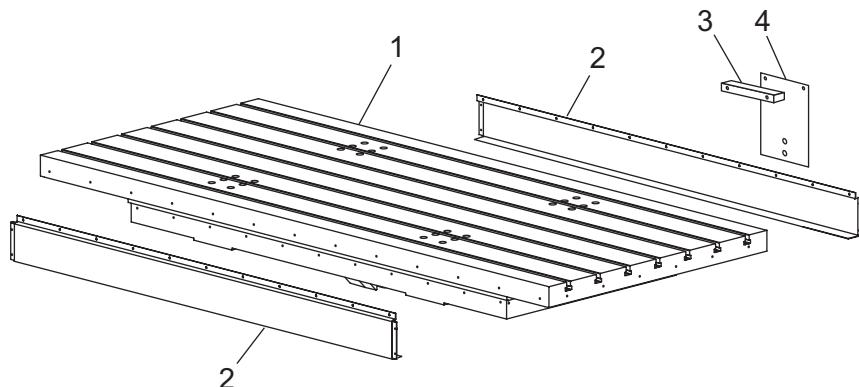
1. 25-5541 Left Shroud
2. 25-5542A Top Shroud
3. 25-5544 Pump Cover Access
4. 57-0373 Pump Cover Gasket
5. 30-7398A Hydraulic Solenoid Assembly
6. 32-1459 Encoder Assembly
7. 52-4471 Coupling
8. 20-6115A Encoder Shaft
9. 20-6114B Encoder Mounting Plate
10. 20-6027 Coupling Tube
11. 20-6103 Ring Gear
12. 30-7754 Hydraulic Brake Assembly
13. 20-6113 Bearing Retainer Ring
14. 51-2038 Cross Roller Bearing
15. 20-2534 Encoder Shaft Plate Adaptor
16. 20-6116B Encoder Shaft Plate



- |  |                                      |
|--|--------------------------------------|
| 17. 20-0973 Table Cover Center                     | 31. 58-0315 "T"                      |
| 18. 57-0071 2X O-Ring                              | 32. 52-0014 Pressure Gauge           |
| 19. 20-2510A 4 <sup>th</sup> Axis Platter Machined | 33. 25-5547 Booster Mounting Bracket |
| 20. 25-5538 4X Retainer Platter Seal               | 34. 20-6102 Pinion Gear              |
| 21. 25-9817 X-Axis Chip Guard                      | 35. 20-6108 Gearbox Adaptor          |
| 22. 20-2508B Table                                 | 36. 20-1400 Backlash Plate           |
| 23. 30-7881 Brake Boosted Assembly (with Sensor)   | 37. 59-2930 Harmonic Drive (50:1)    |
| 24. 58-1696 Elbow                                  | 38. 20-2531 Platter Drive Mount      |
| 25. 58-2267 Muffler                                | 39. 20-6110 Motor Shaft Spacer       |
| 58-0051 Connector                                  | 40. 20-6109 Motor Adaptor            |
| 26. 59-0216A Booster                               | 41. 30-6248 Yaskawa Mtr w/Seal       |
| 27. 58-16700 Elbow                                 | 42. 25-5540 Right Shroud             |
| 28. 58-1671 Nipple                                 | 43. 25-5543 Bottom Shroud            |
| 29. 59-0047 Quick Exhaust Valve                    |                                      |
| 30. 58-3658 2X Elbow                               |                                      |



## EC-1600/2000/3000 3-Axis TABLE

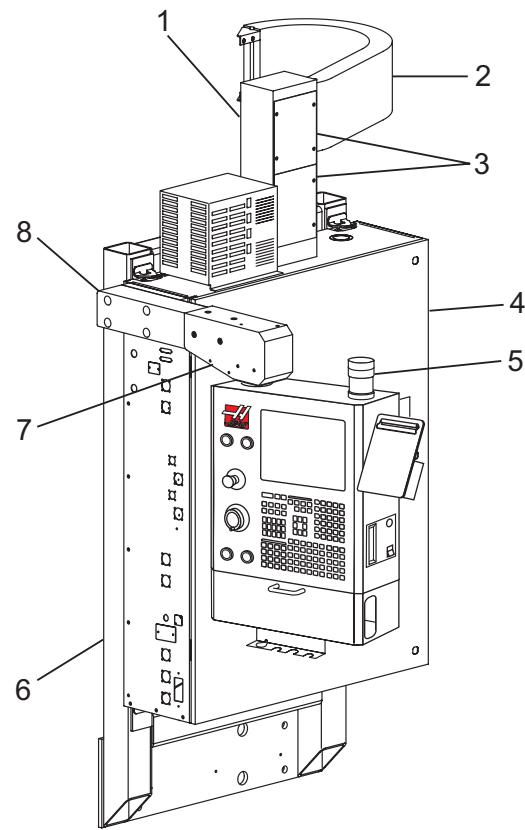


1. 20-2414 Table Machined (EC-1600)  
20-3175 Table Machined (EC-2000)  
20-3369A Table Machined (EC-3000)
2. 25-9817 2X X-Axis Chip Guard (EC-1600)  
25-9980 2X X-Axis Chip Guard (EC-2000)  
25-0032 2X X-Axis Chip Guard (EC-2000)
3. 20-2985A Ship Bracket Stand-Off Block
4. 20-2575 X-Axis Ship Bracket



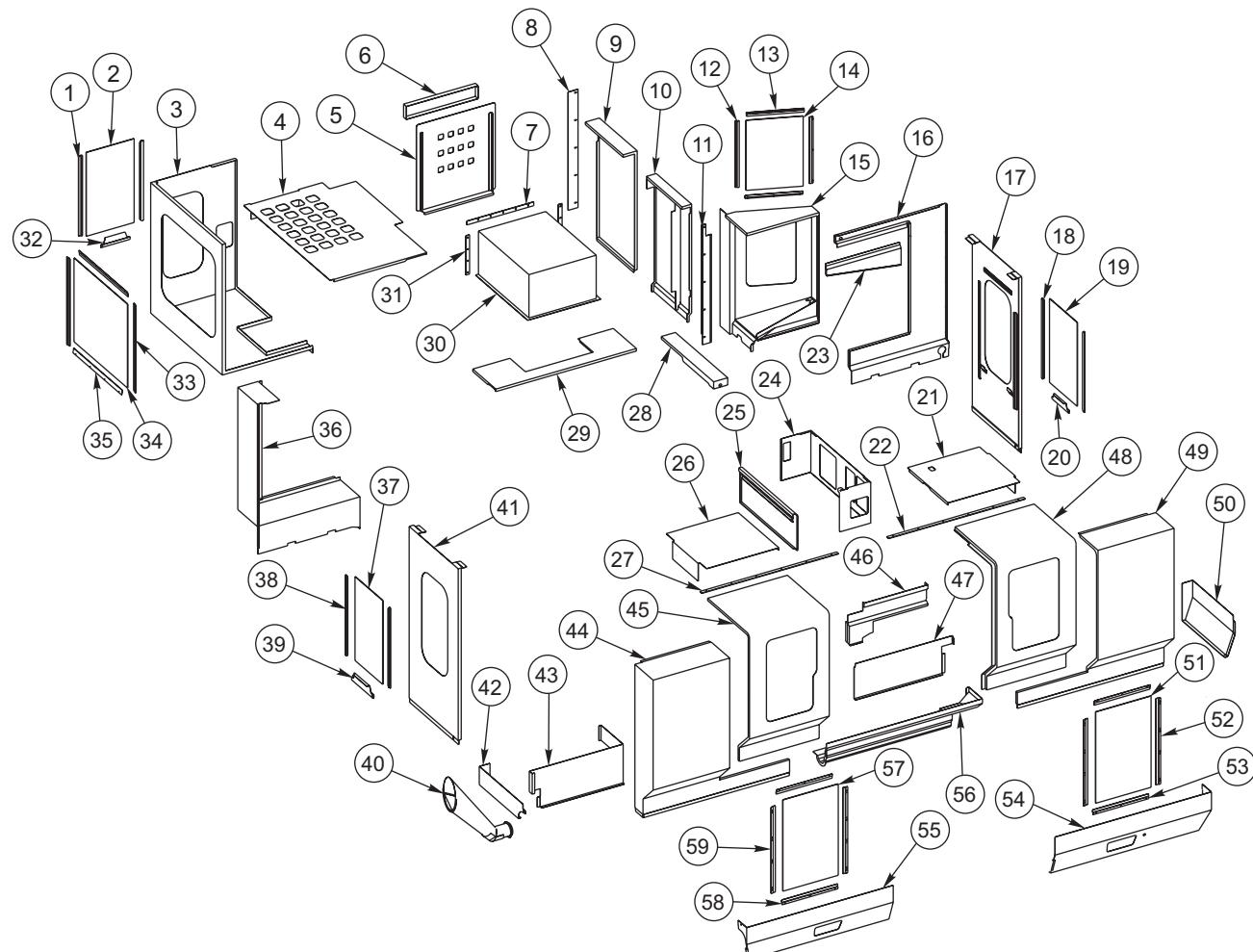
## EC-1600/2000/3000 CONTROL ASSEMBLY

1. 25-5568A Control Junction Box
2. 59-0702 Cable Carrier
3. 25-7198C 2X Junction Box Cover
4. 30-30296 Control Box
5. 28-1071 Top Beacon Light Molded  
28-1075C Beacon Base
6. 20-2551A Control Mount Machined
7. 25-6661A Arm End Cap
8. 25-6659A Mounting Plate Swivel
9. 20-2556 Pendant Arm





## ES-5 EXTERNAL SHEET METAL



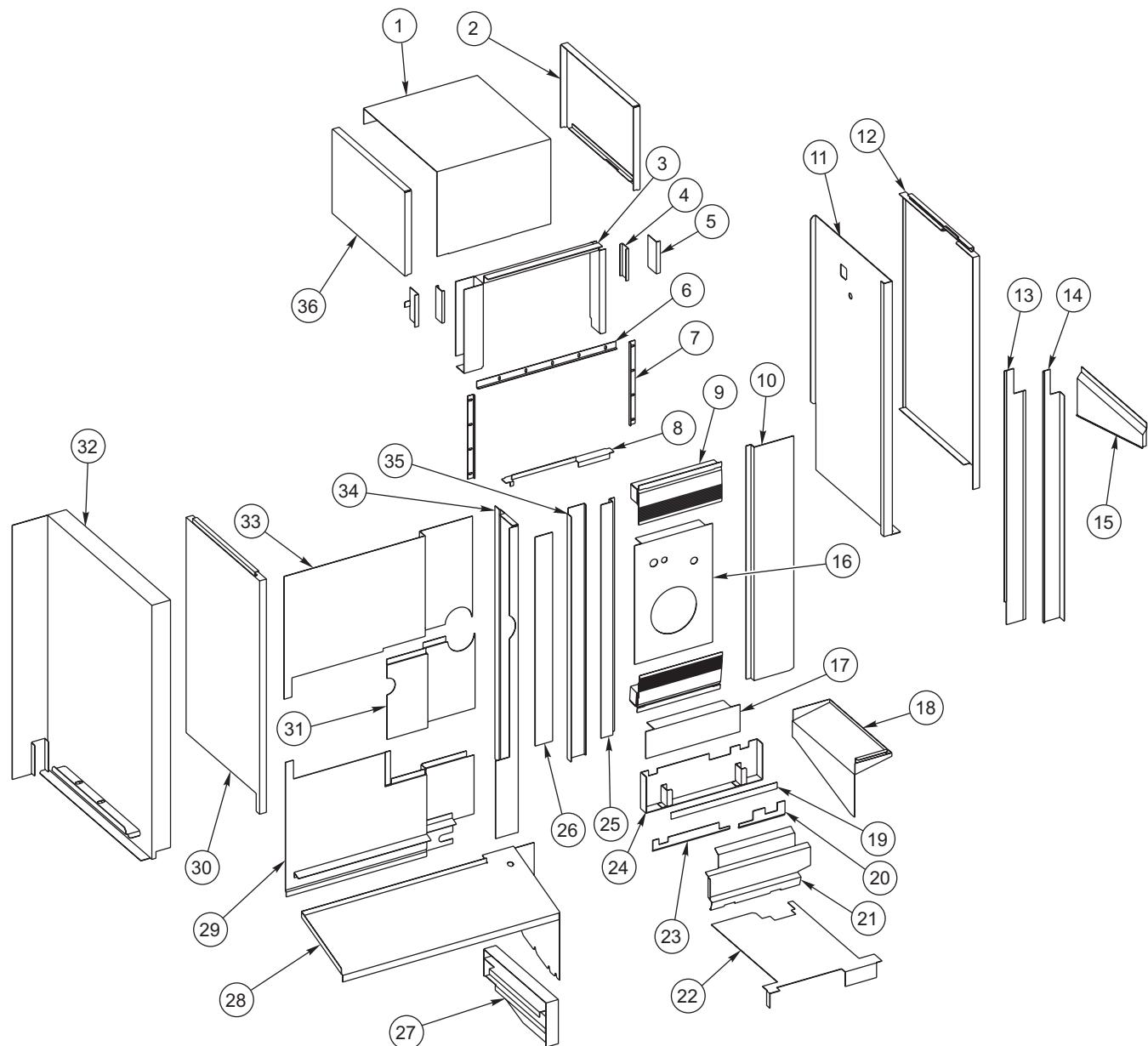


## ES-5 EXTERNAL SHEET METAL PARTS LIST

1. 28-0036	Side Window Extrusion (x2)	41. 25-9662	Side Panel Left Front
2. 28-0014	Window Door	42. 25-0705	Side Apron Left Front
3. 25-9633A	T/C Rear Panel	43. 25-9710A	Tray Cover Left Front Panel
4. 25-9637A	T/C Panel Top	44. 25-9656	Front Panel Left
5. 25-9711	Access Cover Rear Panels	45. 25-9670A	Front Door Left
6. 25-9684	Rear Top Panel Center	46. 25-9718A	Chip Shield Front Lower Operator Door
7. 26-0259	Felt Column Top	47. 25-9708A	Tray Cover Right Front Panel
8. 26-10000	Felt T/C Column Side	48. 25-9669A	Front Door Right
9. 25-9685	Intermediate Panel Operator Side	49. 25-9655	Front Panel Right
10. 25-9636A	Operator Door Rear	50. 25-9704A	Side Apron Right Front
11. 26-0257	Felt Column Operator Side	51. 28-0015	Window Door
12. 25-0668	Window Retainer Side (x2)	52. 25-0819	Door Frame Sides (x2)
13. 25-0669	Window Retainer Top/Bottom (x2)	53. 25-0818	Door Frame Top/Bottom (x2)
14. 28-0046	Window Top Cover	54. 25-9727	Apron Front Right
15. 25-9700C	Operator Door Front	55. 25-9608	Apron Front Left
16. 25-9672A	Front Panel Rear Operator	56. 25-0615	Front Trough Right
17. 25-9657	Side Panel Right Front	57. 28-0015	Window Door
18. 28-0036	Side Window Extrusion (x2)	58. 25-0818	Door Frame Top/Bottom (x2)
19. 28-0014	Window Door	59. 25-0819	Door Frame Sides (x2)
20. 25-9703	Handle Slide Window		
21. 25-9663A	Top Panel Right Front		
22. 22-9074	Upper Guide Rail Door		
23. 25-9717	Chip Shield Front Top Operator		
24. 25-10649	Skirt Control Box		
25. 25-9706A	Apron Right Operator Side		
26. 25-9668A	Top Panel Left Front		
27. 22-9074	Upper Guide Rail Door		
28. 25-9686A	Intermediate Panel Operator Side		
29. 25-9675A	Top Panel Center		
30. 25-9674	Center Top Cover		
31. 26-0258	Felt Column Side Top		
32. 25-9703	Handle Slide Window		
33. 25-0970	Door Frame Sides (x2)		
34. 28-0021	Window		
35. 25-0981	Door Frame Top/Bottom (x2)		
36. 25-9673A	Panel Rear Front T/C		
37. 28-0014	Window Door		
38. 28-0036	Side Window Extrusion (x2)		
39. 25-9703	Handle Slide Window		
40. 25-0548	Chute Discharge		



### ES-5 INTERNAL SHEET METAL



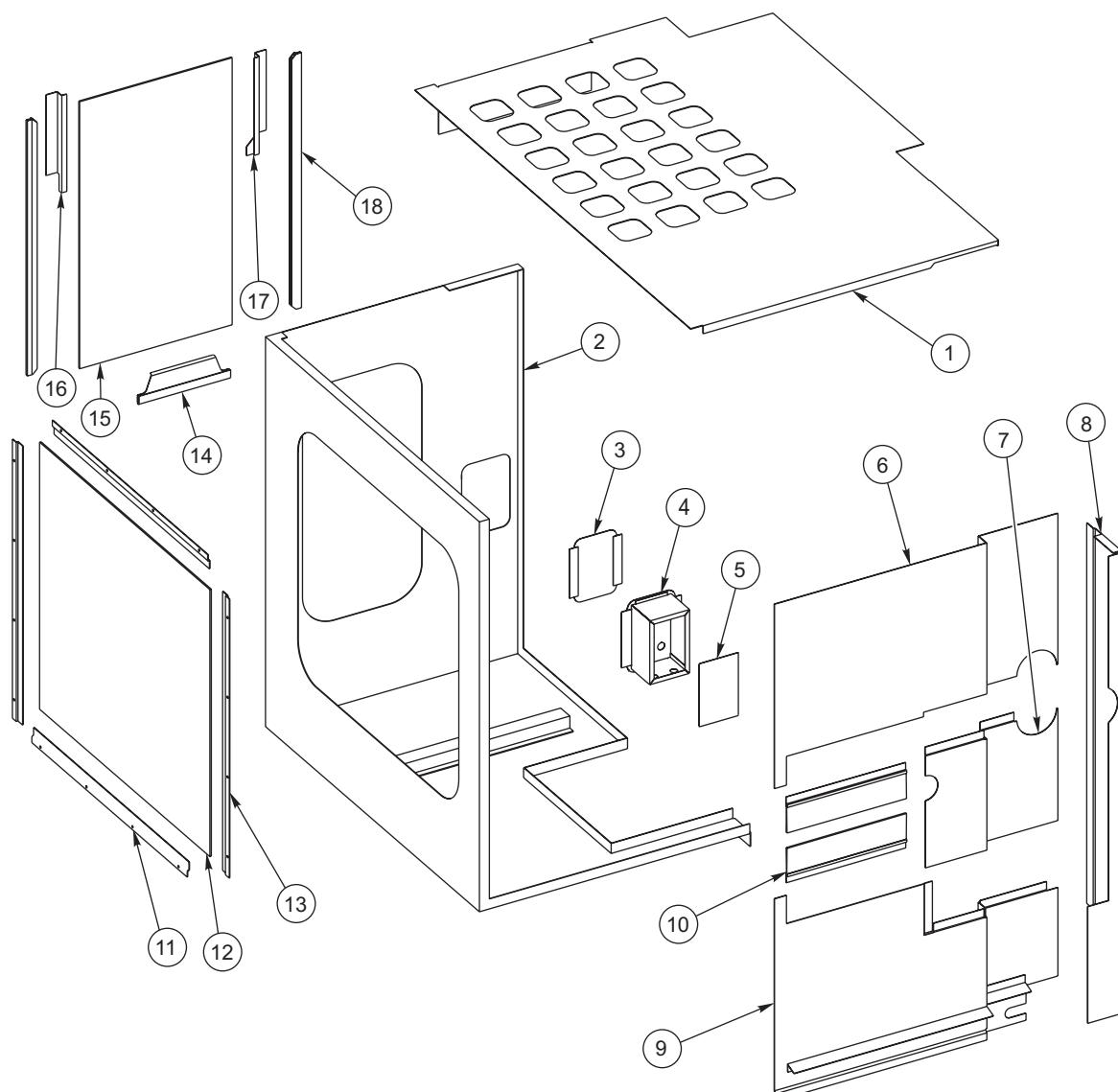


## ES-5 INTERNAL SHEET METAL PARTS LIST

1. 25-5826 Cover Top Column
2. 25-5825 Cover Top Column Side
3. 25-9698 Wiper Support Mounting Bracket Top
4. 25-5733 Nutplate - Column Cover Support (x2)
5. 25-5732 Support Column Cover (x2)
6. 25-9699 Wiper Mounting Bracket Top
7. 25-9638 Wiper Mounting Bracket Side Top (x2)
8. 25-5831A Top Bracket Gordillo
9. 59-0714 Gordillo Y-Axis (x2)
10. 25-5827 Guide Gordillo Right
11. 25-9688A Wiper Support Mounting Bracket Operator Side
12. 25-9715 Cover Column Right
13. 26-0257 Felt Column Operator Side
14. 25-9692 Wiper Mounting Bracket Operator Side
15. 25-9701 Chip Shield Top Operator Door
16. 25-9715 Cover Column Right
17. 25-5830 Cover Gordillo Bottom
18. 25-9623A Chip Shield Wiper Bracket Operator Side
19. 26-0260 Felt Column Bottom
20. 25-9734 Backing Plate Column Right Bottom
21. 25-9630A Wiper Seal Cover Center
22. 25-9731 Column Bottom Chip Cover
23. 25-9742 Backing Plate Column Left Bottom
24. 25-9730 Felt Wiper Mount Plate
25. 25-5828 Guide Gordillo Left
26. 26-10000 Felt T/C Column Side
27. 25-9776A Support Panel Base T/C
28. 25-9707A Chip Shield T/C Panel
29. 25-9654A T/C Panel Lower Interior
30. 25-9714 Cover Column Left
31. 25-11844 Bulkhead T/C Access Cover
32. 25-9693A Wiper Support Mounting Bracket T/C Side
33. 25-9640A T/C Panel Upper Interior
34. 25-9639A T/C Panel Wiper Interior
35. 25-9694A Wiper Mounting Bracket T/C Side
36. 25-5825 Cover Top Column Side



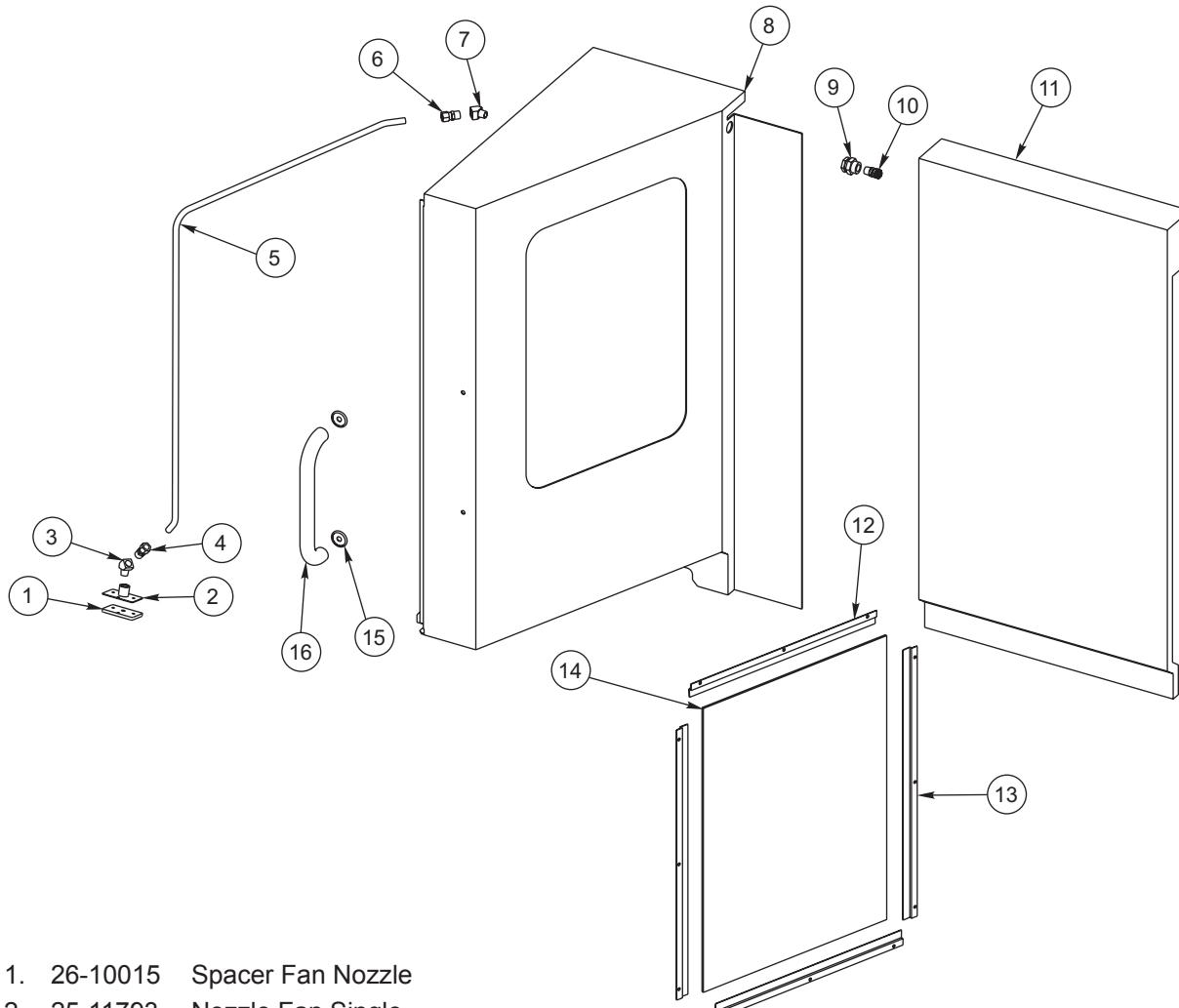
## ES-5 TOOL CHANGER PANELS



- |             |                                  |              |                            |
|-------------|----------------------------------|--------------|----------------------------|
| 1. 25-9637A | T/C Panel Top                    | 14. 25-9703  | Handle Slide Window        |
| 2. 25-9633A | T/C Rear Panel                   | 15. 28-0014  | Window Door                |
| 3. 25-6362  | T/C Panel Switch Box Cover       | 16. 25-4220C | Side Window Rest           |
| 4. 25-6718A | Switch Box SMTC40 (Option)       | 17. 25-4221C | Side Window Rest Opposite  |
| 5. 25-6719  | Cover Switch Box SMTC40 (Option) | 18. 28-0036  | Side Window Extrusion (x2) |
| 6. 25-9640A | T/C Panel Upper Interior         |              |                            |
| 7. 25-11844 | Bulkhead T/C Access Cover        |              |                            |
| 8. 25-9639A | T/C Panel Wiper Interior         |              |                            |
| 9. 25-9654A | T/C Panel Lower Interior         |              |                            |
| 10. 26-0155 | Nylon Strip Brush (x2)           |              |                            |
| 11. 25-0981 | Door Frame Top/Bottom (x2)       |              |                            |
| 12. 28-0021 | Window                           |              |                            |
| 13. 25-0970 | Door Frame Sides (x2)            |              |                            |



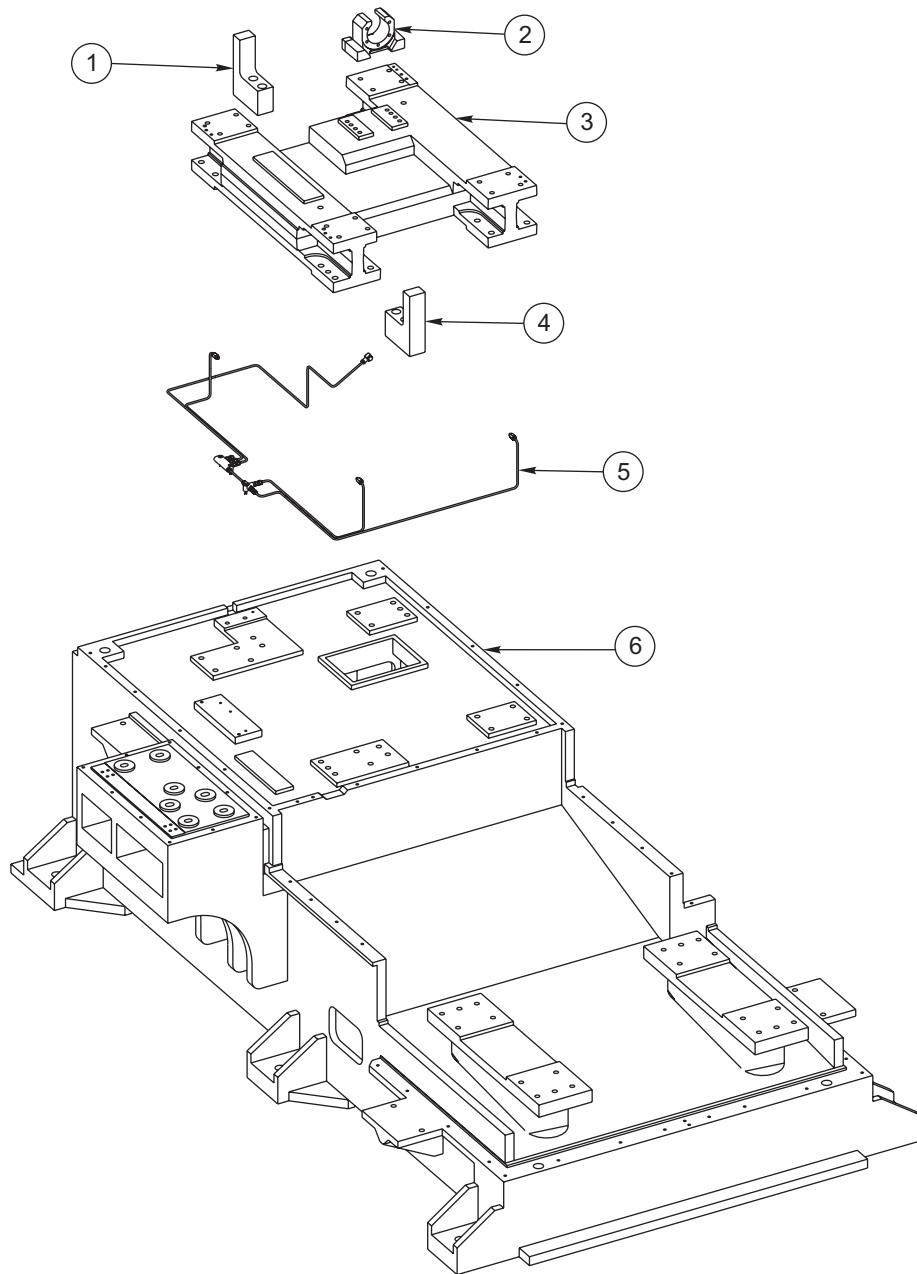
## ES-5 OPERATOR DOOR PANELS



1. 26-10015 Spacer Fan Nozzle
2. 25-11793 Nozzle Fan Single
3. 58-1721 Fitting NPT - 3/8-F x NPT - 3/8-M
4. 58-3087 Fitting Comp - 1/2 x NPT - 3/8-M STR
5. 58-10049A Washdown Tube Op Door
6. 58-3087 Fitting Comp - 1/2 x NPT - 3/8-M STR
7. 58-1721 Fitting NPT - 3/8-F x NPT - 3/8-M
8. 25-9700C Operator Door Front
9. 58-1679 Fitting Bulkhead NPT - 3/8 x 1.000 dia.
10. 58-0915 Fitting Comp - 1/2 Tube x 3/8 NPT-M
11. 25-9636A Operator Door Rear
12. 25-0669 Window Retainer Top/Bottom (x2)
13. 25-0668 Window Retainer Side (x2)
14. 28-0046 Window Top Cover
15. 28-0178 Ferrule Door Handle
16. 22-8895 Door Handle Chrome



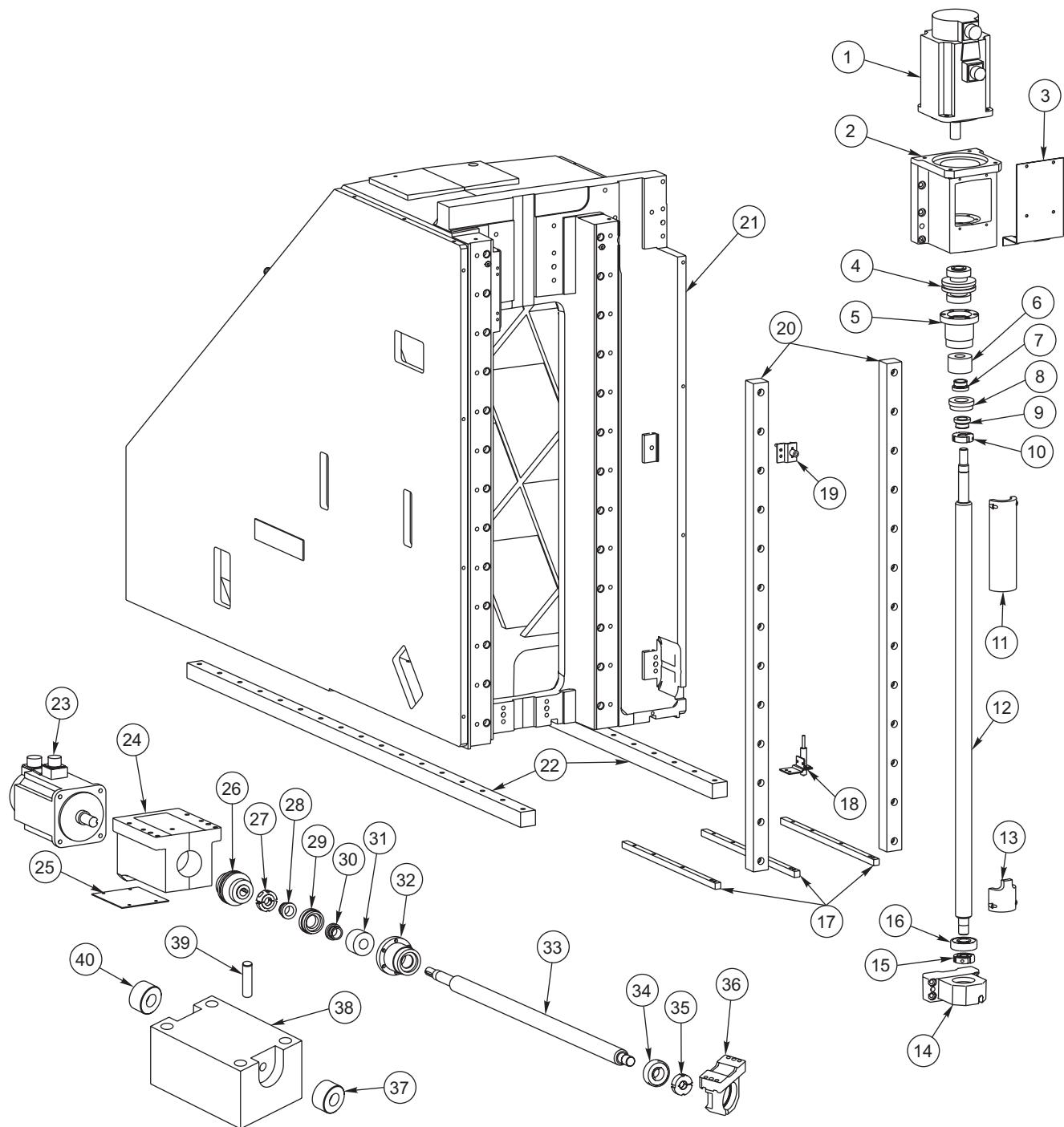
## ES-5 BASE ASSEMBLY



1. 20-4456A Hard Stop Z-Axis Base
2. 20-4466 Mod Nut Housing Z-Axis
3. 20-10260 Column Spacer Machining
4. 20-4456A Hard Stop Z-Axis Base
5. 30-10744A Oil Line Assembly Base Z-Axis
6. 20-4374A Machine Base Casting



## ES-5 COLUMN ASSEMBLY



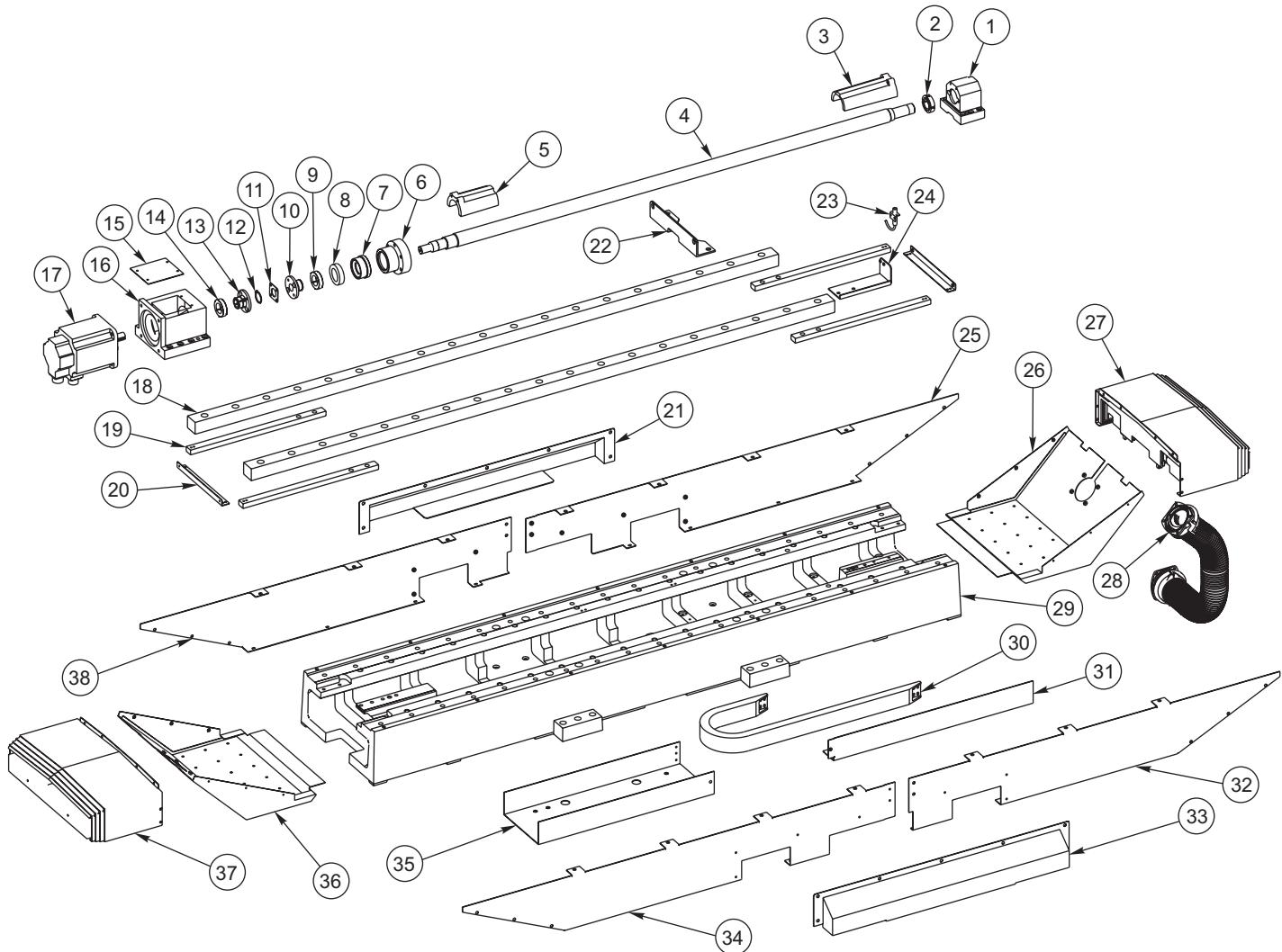


## ES-5 COLUMN ASSEMBLY PARTS LIST

1. 62-0017 Servomotor Yaskawa 13 w/Brake
2. 20-7010A BL Motor Mount Machined
3. 25-7042 Cover Plate Motor Mount
4. 30-1220A Coupling Assembly BL
5. 20-7416 Housing Bearing Cartridge
6. 51-1011U Bearing Angular Contact
7. 22-7417 Spacer Bearing Cartridge
8. 20-7418 Lock Bearing Cartridge
9. 22-7417 Spacer Bearing Cartridge
10. 51-2012 Bearing Locknut
11. 28-0186 Bumper Ballscrew
12. 24-0041 Ballscrew 32-10-993.6
13. 28-0220A Hardstop - Notched - 2.25
14. 20-7009 Bearing Housing Machined
15. 51-2012 Bearing Locknut
16. 51-2025 Bearing Radial 304PP
17. 20-2615 Bar Bottom Plate Mounting
18. 25-7267 Mounting Bracket  
69-1700 Proximity Switch
19. 25-7266 Bracket X-Axis Mounting  
69-1700 Proximity Switch
20. 50-3300 Linear Guide 35 x 1000 (x2)
21. 20-2588B Machined Casting Column
22. 50-3400 Linear Guide 35 x 1320 X-Axis (x2)
23. 62-0014 Servomotor Yaskawa 09 No Brake
24. 20-7010A BL Motor Mount Machined
25. 25-9203 Cover Plate Motor Mount
26. 30-1220A Coupling Assembly BL
27. 51-2012 Bearing Locknut
28. 22-7417 Spacer Bearing Cartridge
29. 20-7418 Lock Bearing Cartridge
30. 22-7417 Spacer Bearing Cartridge
31. 51-1011U Bearing Angular Contact
32. 20-7416 Housing Bearing Cartridge
33. 24-0023 Ballscrew 32-8-800 X/Y/Z Axis
34. 51-2025 Bearing Radial 304PP
35. 51-2012 Bearing Locknut
36. 20-4490 Modified Bearing Housing Machining
37. 20-4473 Shim Brace Operator Side
38. 20-4455A Hard Stop Z-Axis Column
39. 48-1755 Dowel Pin 1/2 x 2
40. 20-4473 Shim Brace Operator Side



## ES-5 SADDLE ASSEMBLY



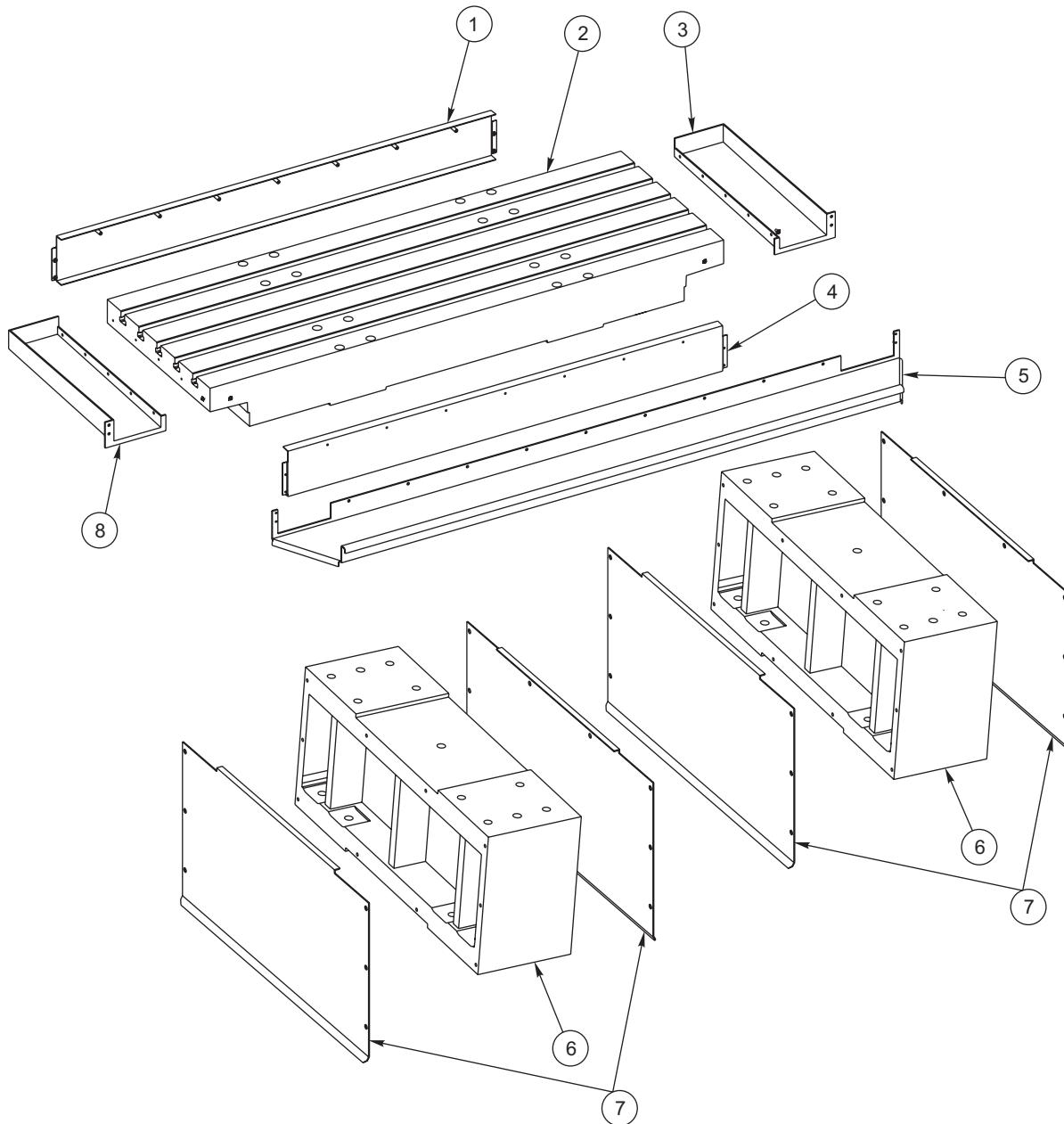


## ES-5 SADDLE ASSEMBLY PARTS LIST

1. 20-0152 Bearing Housing 40/50mm Ballscrew
2. 51-0008 Bearing Lock Nut
3. 28-0209 Bumper X-Axis Motor End
4. 24-0003B Ballscrew 40-6-1671 Z-Axis
5. 28-0184 Bumper X-Axis Motor End
6. 20-9212 Bearing Housing 40mm Ballscrew
7. 20-9211 Nut Housing 40mm Ballscrew
8. 51-0093 Bearing Angular Contact
9. 51-2019 Clamp Collar 1-1/4 Bore
10. 20-0105A Coupling Servo Brushless
11. 59-2060 Flexpak for AJ05
12. 56-0076 Retaining Ring 1.000 SH
13. 20-0105A Coupling Servo Brushless
14. 51-2019 Clamp Collar 1-1/4 Bore
15. 25-9203 Cover Plate Motor Mount
16. 20-0151A Machining Motor Mount 40 & 50mm Ballscrew
17. 62-0016 Servomotor Yaskawa 13 No Brake
18. 50-9305 Linear Guide 45 x 1980 (x2)
19. 20-4538B Guide Bar X-Axis Waycover (x4)
20. 25-11380 Waycover Extension Panel (x2)
21. 25-9613 Saddle Splash Shield Rear
22. 25-9603 Mounting Bracket Table Cover
23. 69-1700 Proximity Switch
24. 25-9770 Switch Mount Bracket Saddle
25. 25-9542A Saddle Cover Right
26. 25-9524A End Shield Saddle
27. 25-9309B X-Axis Waycover
28. 59-1102 Conduit Saddle Cable
29. 20-4672A Saddle Modified Trunnion
30. 59-0536 Cable Carrier X-Axis
31. 25-4668A Cable Tray External TR
32. 25-9541A Saddle Cover Left
33. 25-9612 Saddle Splash Shield Front
34. 25-9542A Saddle Cover Right
35. 25-4670A Cable Tray Base TR
36. 25-9524A End Shield Saddle
37. 25-9309B X-Axis Waycover
38. 25-9541A Saddle Cover Left



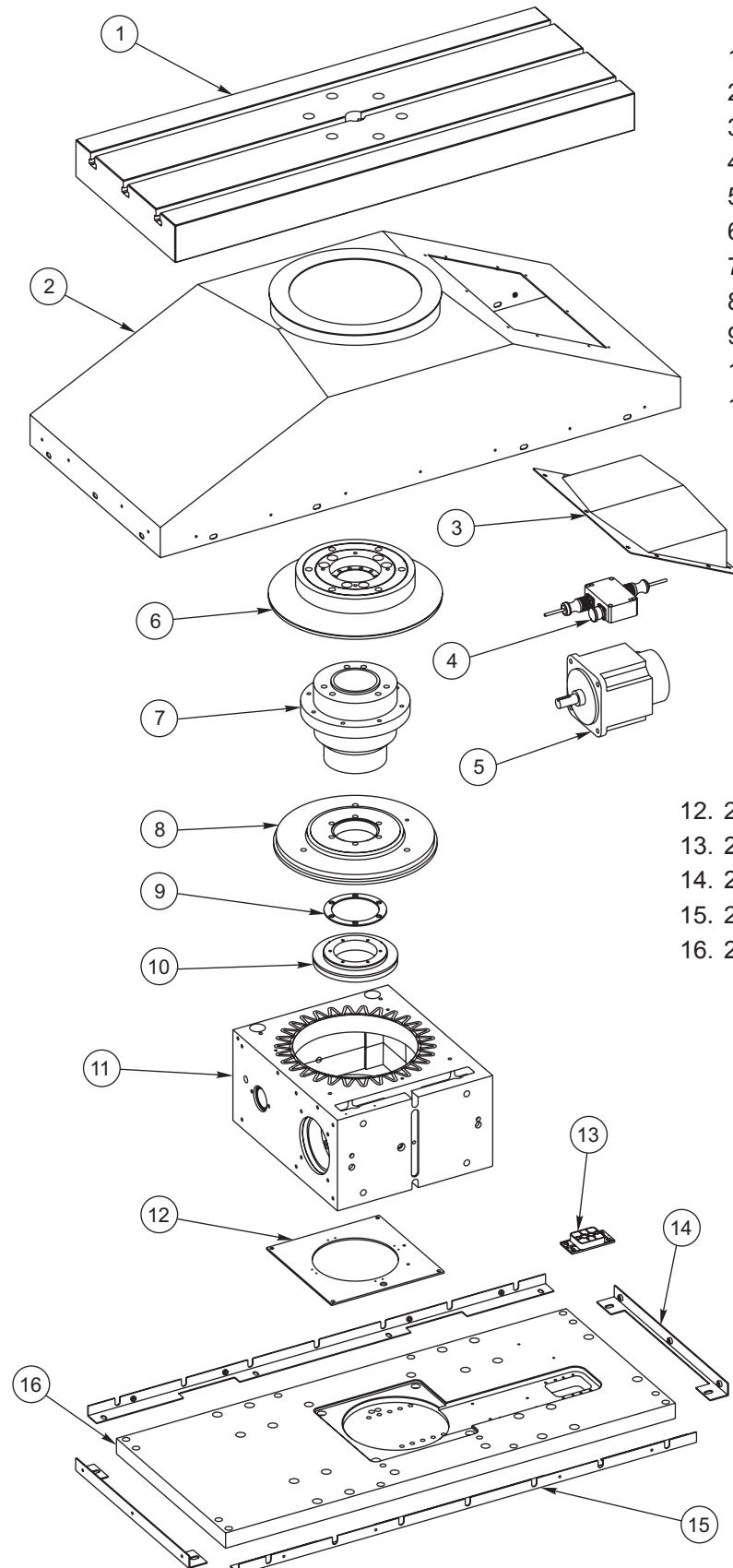
### ES-5-T TABLE



1. 25-9310 Table Cover
2. 20-9308D Table Machined
3. 25-6587 Table Gutter Right
4. 25-6720 Table Gutter Front
5. 25-9310 Table Cover
6. 20-10051 Saddle Spacer Machining 3-Axis Table
7. 25-10602A Saddle Spacer Cover 3-Axis Table
8. 25-6586 Table Gutter Left



### ES-5-4T TABLE

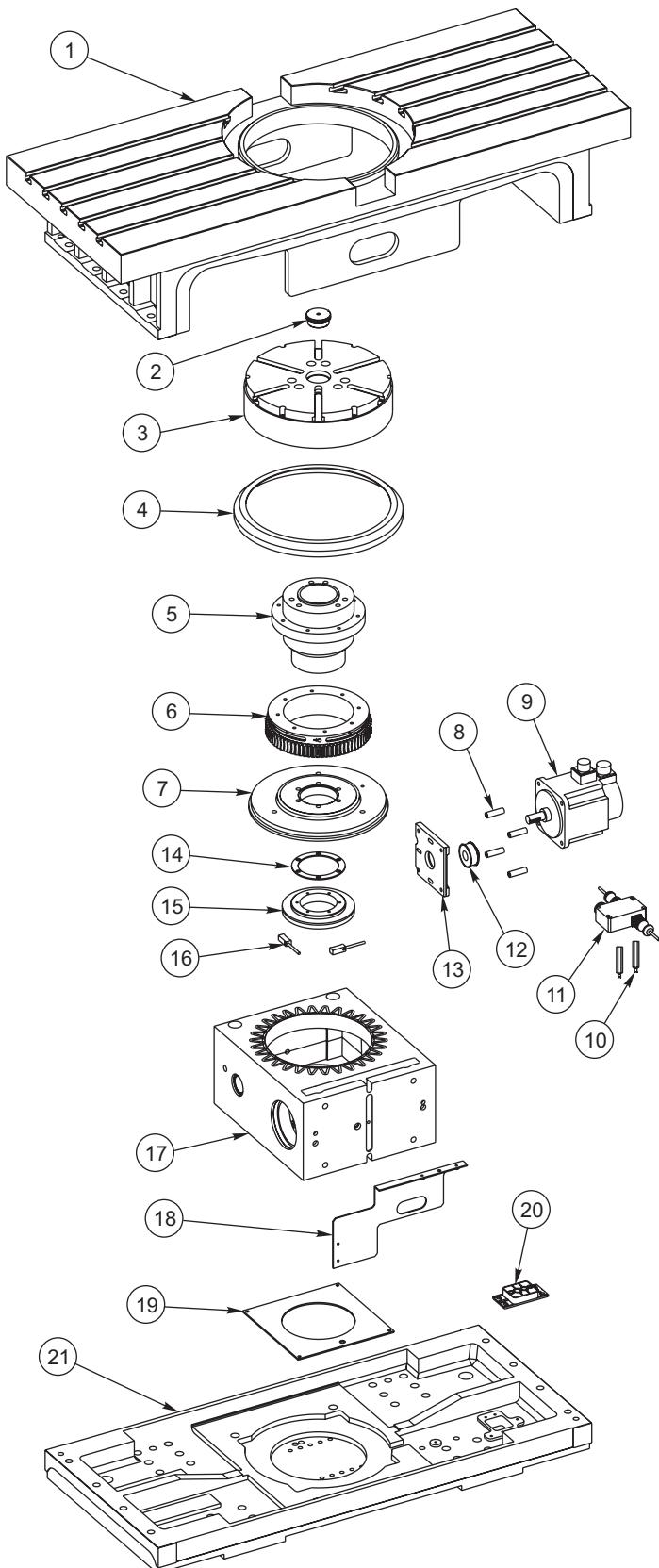


- |     |         |                            |
|-----|---------|----------------------------|
| 1.  | 20-4350 | Table T-Slot               |
| 2.  | 25-9606 | Rotary Table Cover         |
| 3.  | 25-9720 | Access Cover Table Motor   |
| 4.  | 32-8888 | Interpolation Box Assembly |
| 5.  | 62-0014 | Servomotor Yaskawa 09      |
| 6.  | 20-4349 | Platter                    |
| 7.  | 20-4212 | Spindle                    |
| 8.  | 20-4213 | Brake Disc                 |
| 9.  | 20-4236 | Spindle Spacer             |
| 10. | 20-4463 | Scale Mount Adaptor        |
| 11. | 20-4210 | Body Machined              |

- |     |          |                                |
|-----|----------|--------------------------------|
| 12. | 25-9712  | Bracket Encoder Head Mount     |
| 13. | 22-7456A | Cable Strain Relief            |
| 14. | 25-9604  | Mount Side Bracket Table Cover |
| 15. | 25-9603  | Mount Bracket Table Cover      |
| 16. | 20-4351  | Mount Plate HRT310             |



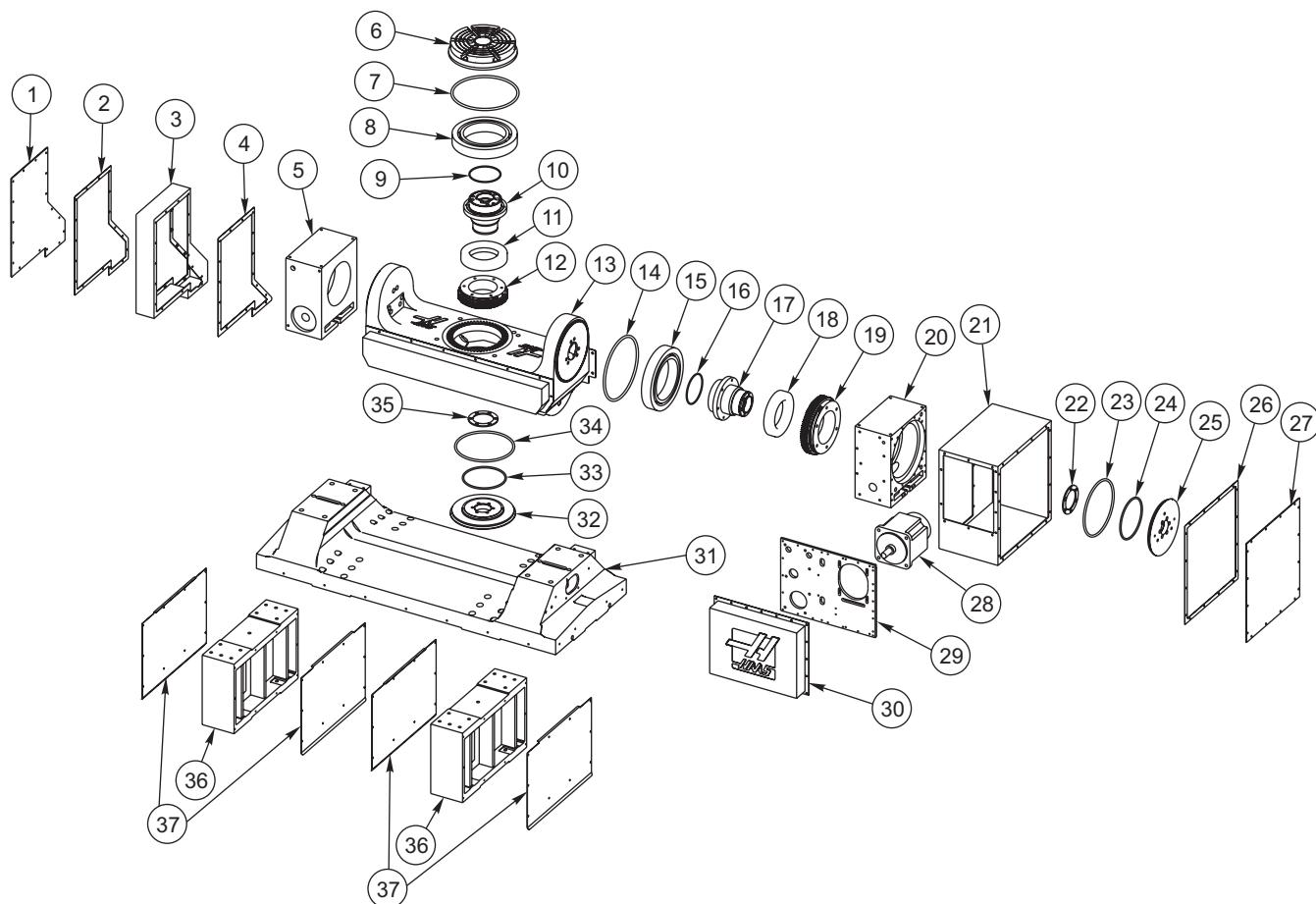
## ES-5-4AX TABLE



1. 20-10052 Machining Integrated Table
2. 20-1123B Plug Pallet
3. 20-10054 Platter
4. 20-10060 Platter Shield
5. 20-4212 Spindle
6. 20-4214 Worm Gear 310mm RT
7. 20-4213 Brake Disc
8. 20-4207 Standoff (x4)
9. 62-0014 Servomotor Yaskawa 09 No Brake
10. 63-0201 Standoff 3/8 x 1.812
11. 32-8888 AMO Interpolation Box Assembly
12. 20-4288 Pulley Drive 32T-13 Sigma
13. 20-4259 Motor Mounting Plate
14. 20-4236 Spindle Spacer
15. 20-4463 Scale Mount Adaptor
16. 60-0241 Read Head with 3M Cable
17. 20-4210 Body Machined
18. 25-10603 Bracket Cable Carrier Saddle Table
19. 25-9712 Bracket Encoder Head Mount
20. 22-7456A Cable Strain Relief
21. 20-10053 Machine Table Base Integrated



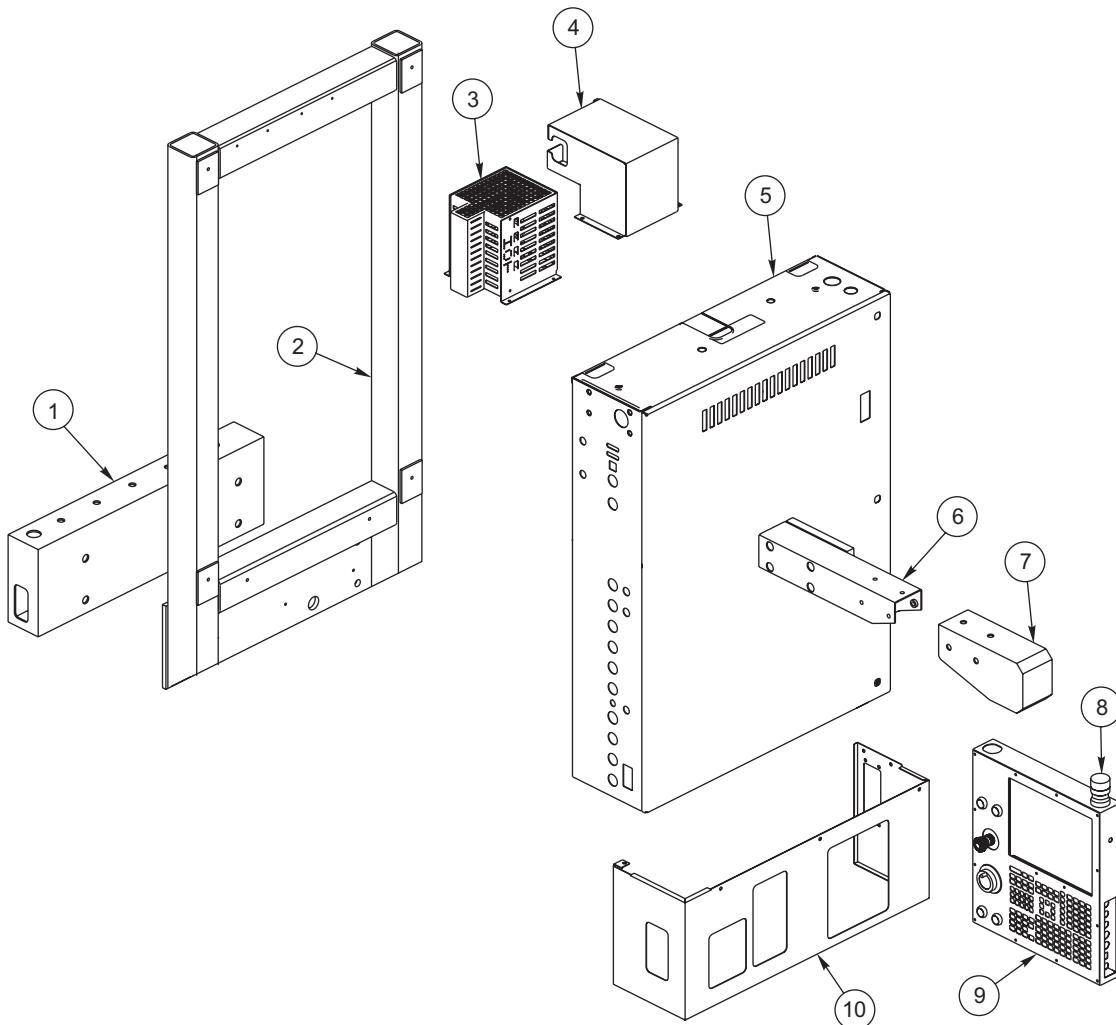
## ES-5-TR TABLE



1.	25-4674	Enclosure Cover Counterbalance	20.	20-4656	Body HRT210 Modified
2.	57-4674	Gasket Counterbalance Enclosure Cover	21.	25-4665	Motor Scale Enclosure
3.	25-4673	Enclosure Counterbalance	22.	20-4130	Spindle Spacer HRT210
4.	57-4673	Gasket Counterbalance Enclosure	23.	57-2222	O-Ring 2-369
5.	20-4656	Body HRT210 Modified	24.	57-2223	O-Ring 2-242
6.	20-4101	Platter HRT210	25.	20-4103A	Brake Disc HRT210
7.	57-2221	O-Ring 2-260	26.	57-4666	Gasket Motor Scale Enclosure
8.	51-2026	Bearing Deep Groove 6021	27.	25-4666	Cover Motor Scale Enclosure
9.	57-0054	O-Ring 2-044	28.	62-0014	Servomotor Yaskawa 09 No Brake
10.	20-4102	Spindle 210mm RT	29.	20-4653	Side Plate 210 Trunnion
11.	51-2027	Bearing Deep Groove 6016	30.	25-4805	Belt Enclosure
12.	20-4104	Worm Gear HRT210	31.	20-4650B	Table Trunnion
13.	20-4651	210 Trunnion Machining	32.	20-4103A	Brake Disc HRT210
14.	57-2221	O-Ring 2-260	33.	57-2223	O-Ring 2-242
15.	51-2026	Bearing Deep Groove 6021	34.	57-2222	O-Ring 2-369
16.	57-0054	O-Ring 2-044	35.	20-4130	Spindle Spacer HRT210
17.	20-4102	Spindle 210mm RT	36.	20-4474	Saddle Spacer Machining Trunnion
18.	51-2027	Bearing Deep Groove 6016	37.	25-9748A	Saddle Spacer Cover Side
19.	20-4104	Worm Gear HRT210			



## ES-5 CONTROL ASSEMBLY

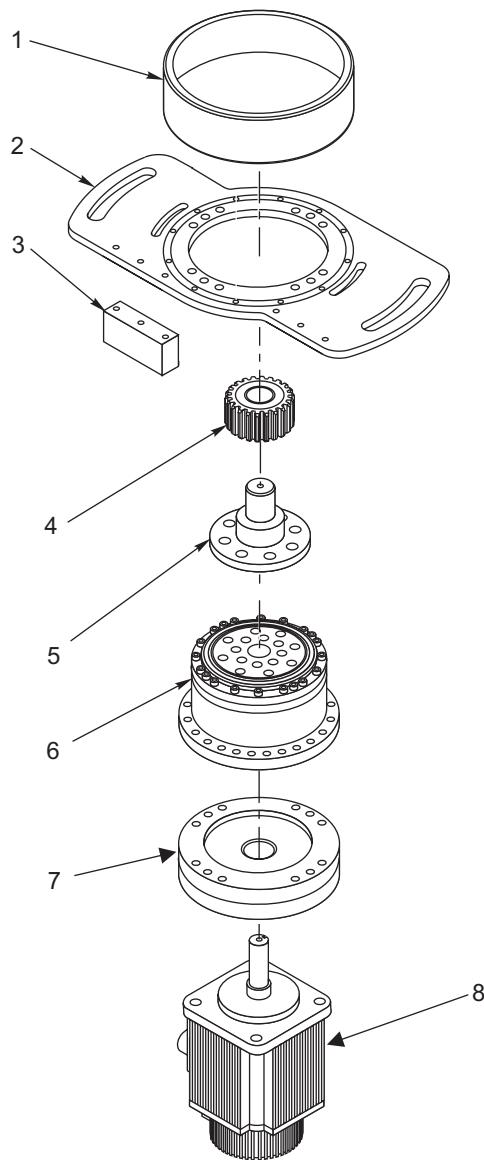


1. 25-9729 Control Stand Mounting Bracket
2. 20-2551B Control Mount Machine
3. 32-0042A Regen Assembly 5.6 ohm
4. 25-11348 Control Cable Exit Cover
5. 25-11310A Main Chassis CNC Control
6. 20-2556 Pendant Support Arm
7. 25-6661A Arm End Cap
8. 28-0267 2 LED Beacon
9. 32-9875 CNC Control
10. 25-10649 Skirt Control Box



## HS3-7R HARMONIC DRIVE ASSEMBLY

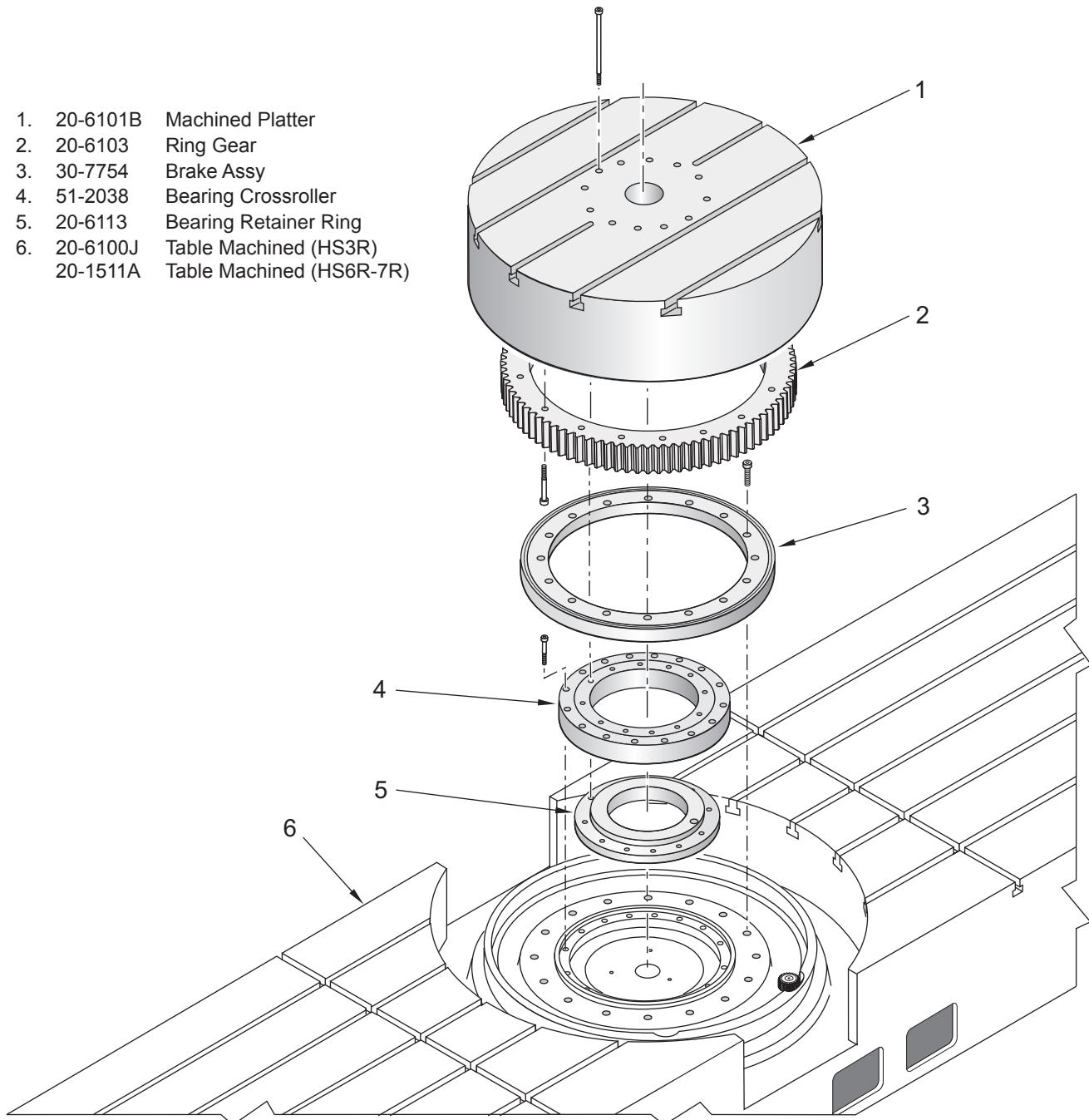
1. 20-6047A Tube Backlash Adjuster (HS3R)
2. 20-6048A Cam Backlash Adjuster (HS3R)
3. 20-6005 Push Block (HS3R)
4. 20-6102 Pinion Gear (HS3R)
5. 20-6108 Gearbox Adapter (HS3R)
6. 59-2930 Harmonic Drive
7. 20-6109 Sigma Adapter (HS3R)
8. 62-0014 Yaskawa Sigma Motor





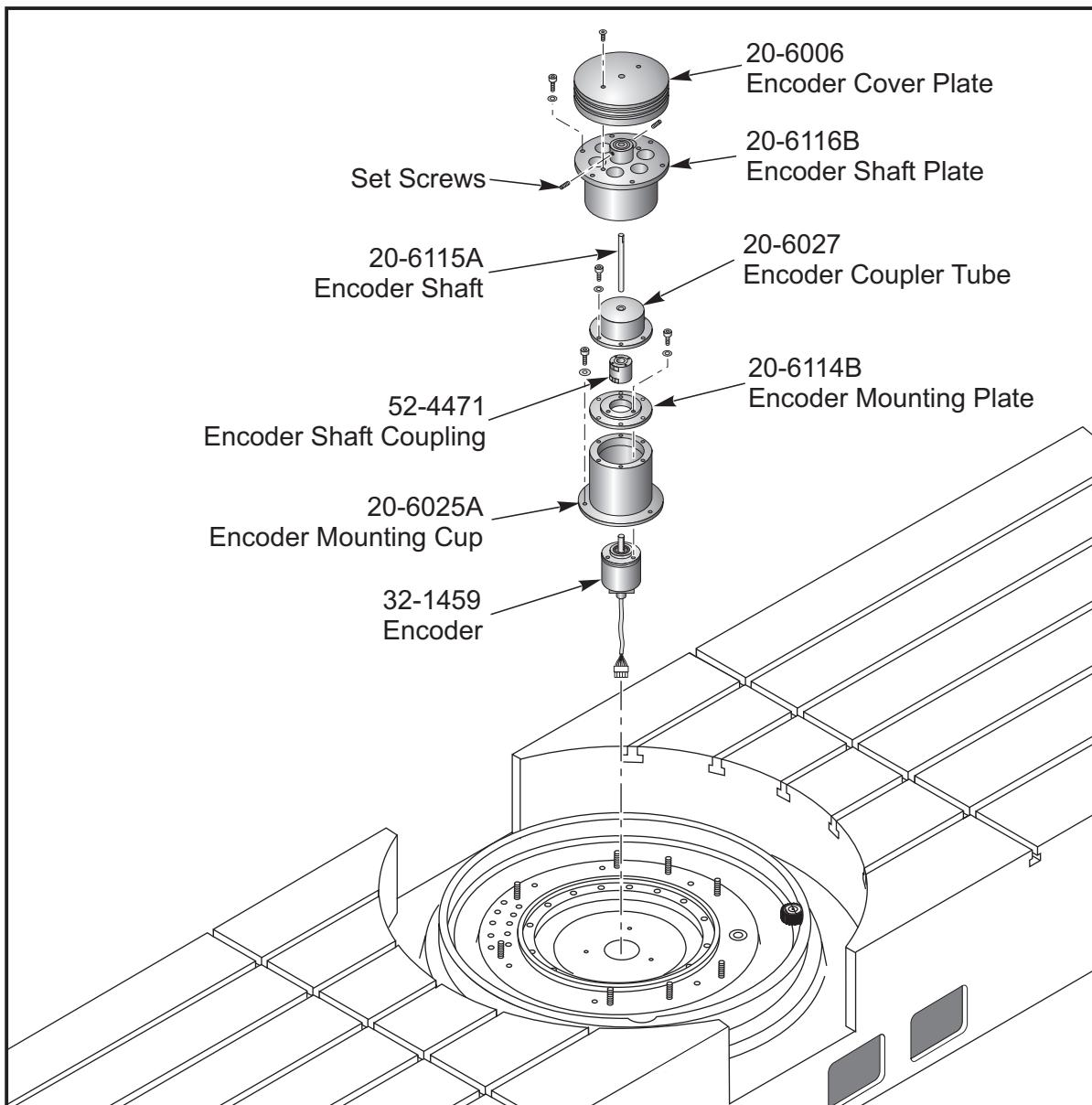
## HS3-7R TABLE ASSEMBLY

1. 20-6101B Machined Platter
2. 20-6103 Ring Gear
3. 30-7754 Brake Assy
4. 51-2038 Bearing Crossroller
5. 20-6113 Bearing Retainer Ring
6. 20-6100J Table Machined (HS3R)  
20-1511A Table Machined (HS6R-7R)



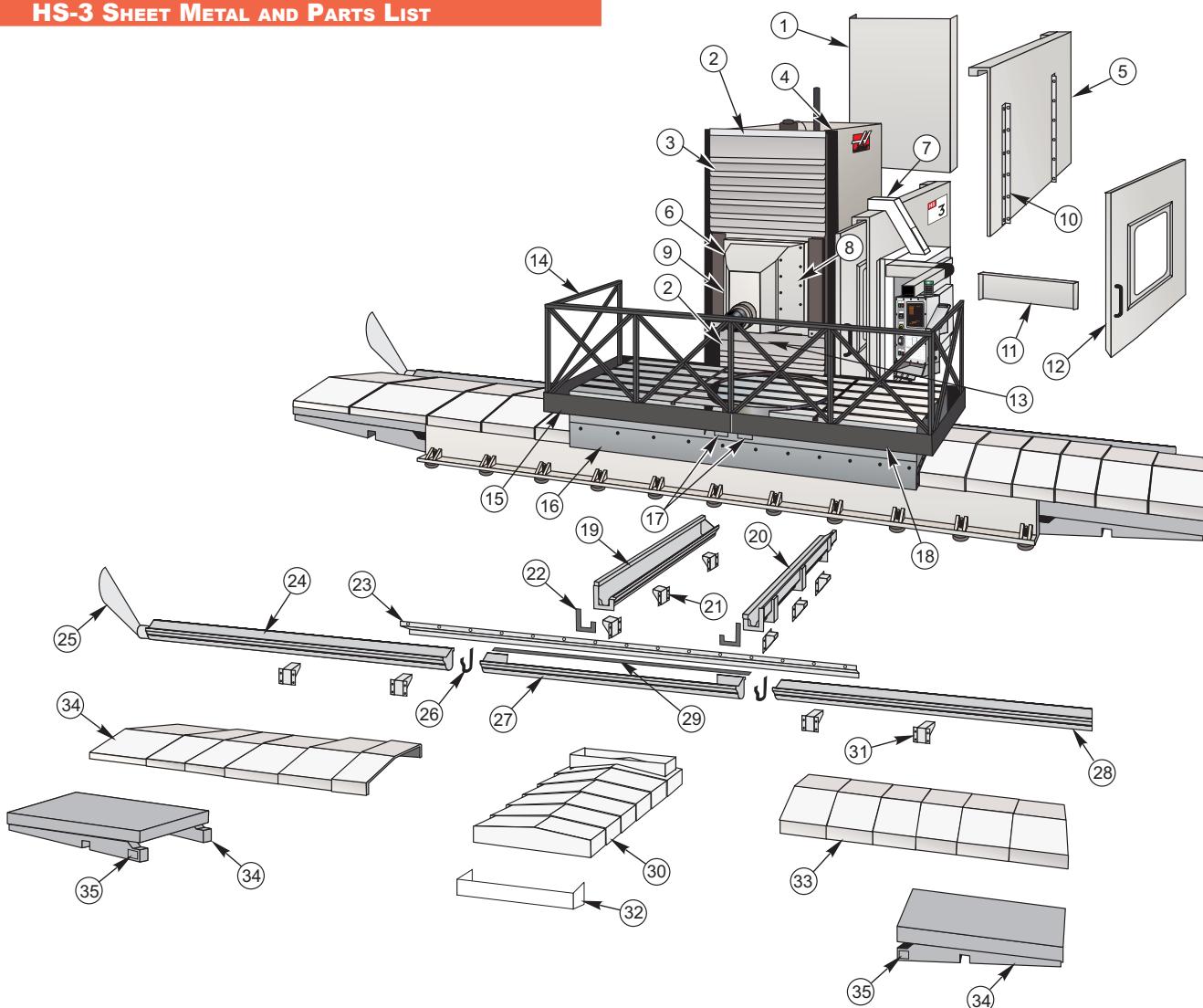


### HS3-7R ENCODER ASSEMBLY





### HS-3 SHEET METAL AND PARTS LIST

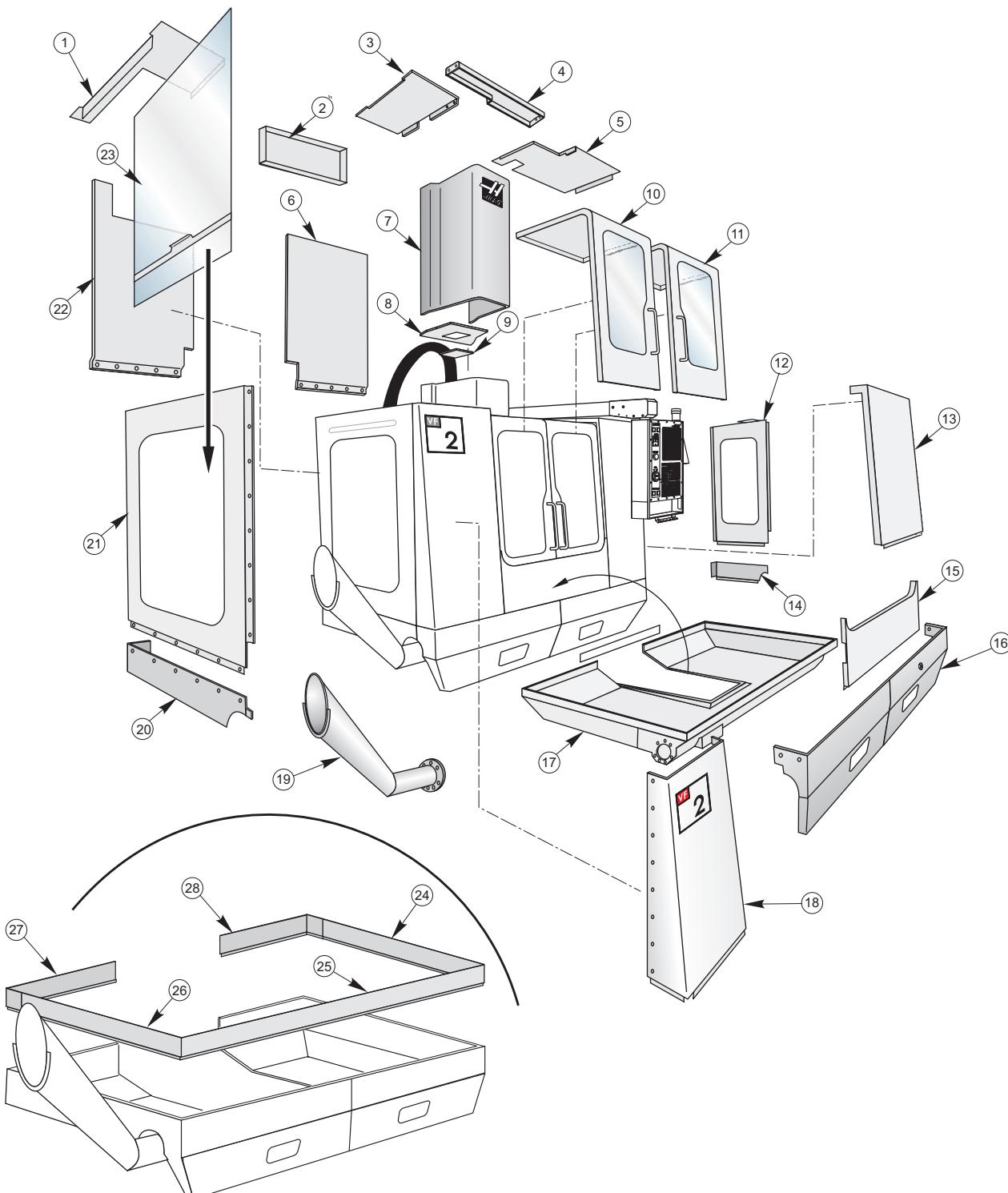


- |              |                               |              |                                      |
|--------------|-------------------------------|--------------|--------------------------------------|
| 1. 25-0528   | Back panel sheet metal        | 19. 25-0448  | Z-Axis chip conveyor tray, left      |
| 2. 25-0163   | Y-Axis bellows top edge cover | 20. 25-0449  | Z-Axis chip conveyor tray, right     |
| 3. 59-6016   | Y-Axis upper bellows          | 21. 25-6043  | Z-Axis chip conveyor brace (6)       |
| 4. 25-6017A  | Y-Axis left bellows guide     | 22. 57-0085A | Z-Axis chip conveyor tray gasket (2) |
| 5. 25-6051A  | Control box shield            | 23. 25-0632  | X-Axis chip deflector                |
| 6. 25-6027   | Chip guard                    | 24. 25-0450A | X-Axis chip conveyor tray, left      |
| 7. 22-9904   | Conduit enclosure             | 25. 25-0548  | Chip conveyor chute                  |
| 8. 25-6722   | Spindle head cover, bottom    | 26. 57-0086  | X-Axis chip conveyor tray gasket     |
| 9. 25-6721   | Spindle head cover            | 27. 25-0451A | X-Axis chip conveyor tray, middle    |
| 10. 25-6571  | "L" bracket                   | 28. 25-0452A | X-Axis chip conveyor tray, right     |
| 11. 25-0446A | Center bottom sheet metal     | 29. 57-0087  | Center Trough Gasket                 |
| 12. 25-6052  | Door                          | 30. 25-6008A | Z-Axis way covers                    |
| 13. 59-6015B | Y-Axis lower bellows          | 31. 25-6063  | X-Axis chip conveyor brace (4)       |
| 14. 22-6056A | Fence panel (6)               | 32. 25-0447A | Z-Axis way cover end support         |
| 15. 25-0626  | Left table gutter             | 33. 25-6007A | X-Axis way covers (2)                |
| 16. 25-0630  | Front table cover             | 34. 25-0645B | X-Axis extension                     |
| 17. 25-9258  | Access cover (2)              | 35. 25-0679  | X-Axis extension access cover        |
| 18. 25-0627  | Right table gutter            |              |                                      |



## VERTICAL MILL ASSEMBLY DRAWINGS AND PARTS LISTS

### VF EXTERIOR SHEET METAL



VF6 - 8 Extended Column - Riser Sheet Metal  
(Optional)

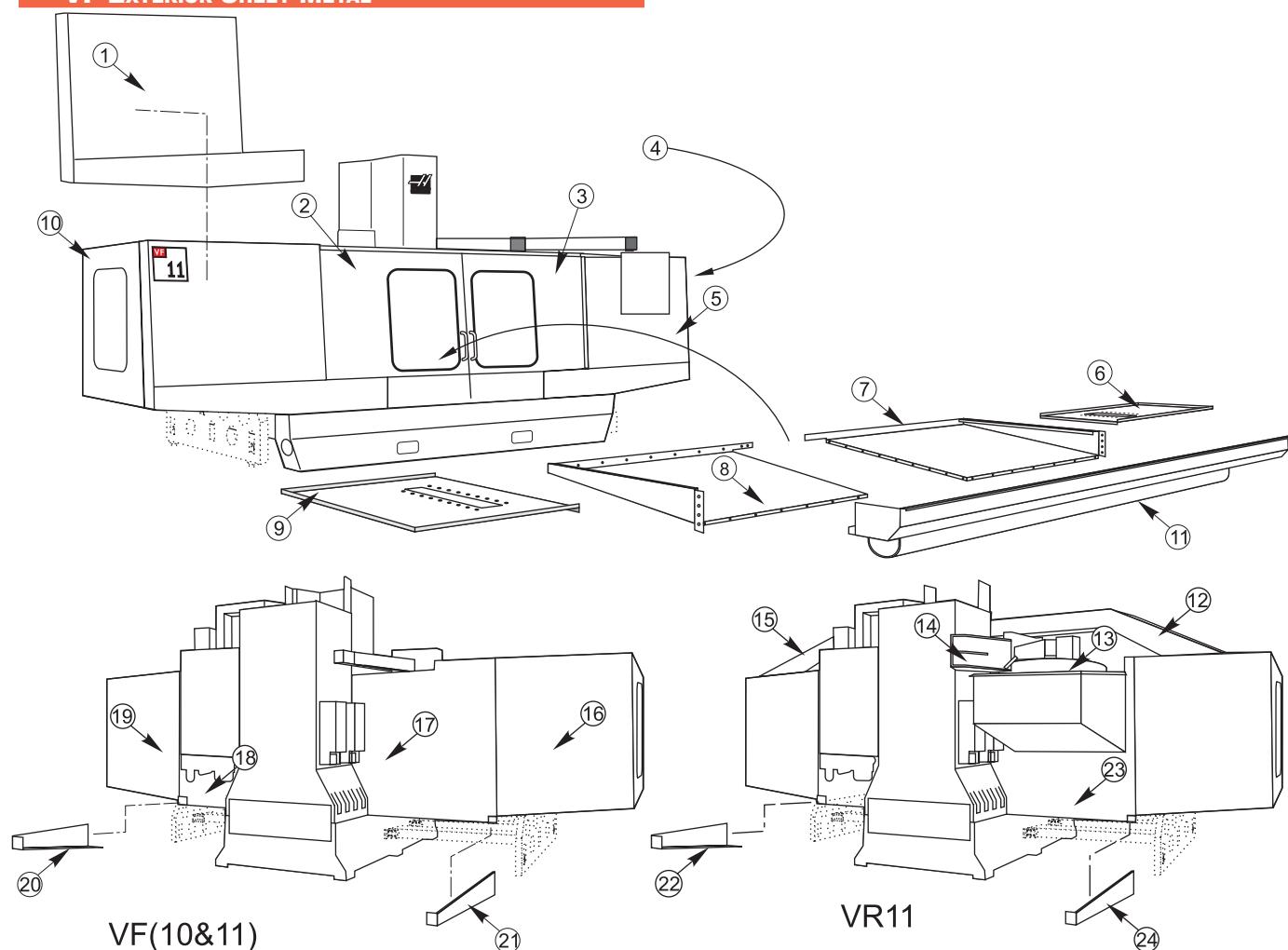


## VF EXTERIOR SHEET METAL

1. 25-9241D Plate, Top Left
2. 25-1042 Back Panel Spacer
3. 25-0741B Top Left Panel
4. 25-9243C Upper Door Brace
5. 25-9242H Plate, Top Right
6. 25-9233B Back Right Panel
7. 25-7600H Spindle Head Cover
8. 25-7096D Spindle Head Cover, Bottom
9. 25-7222 Chip Guard Spindle Head
10. 30-1633 Left Door Assembly
11. 30-1634 Right Door Assembly
12. 25-9235D Panel, Right Side
13. 25-11796 Panel, Front Right
14. 25-9247 Apron Extension, Right
15. 25-11796 Front Right Panel
16. 25-9236C Apron, Left
17. 25-9237B Apron, Right
18. 25-9230E Pan, Chip Enclosure
19. 25-9239E Front Left Panel
19. 25-0548 Chip Chute
20. 25-9246B Apron Extension, Left
21. 25-9234D Side Panel, Left
22. 25-9232C Back, Left Panel
23. 28-7472B Side Window (handle not included)
24. 25-4249 Spacer Right Side
25. 25-4256 Spacer Center
26. 25-4248 Spacer Left Side
27. 25-4246B Spacer Left Back
28. 25-4247A Spacer Right Back



### VF EXTERIOR SHEET METAL



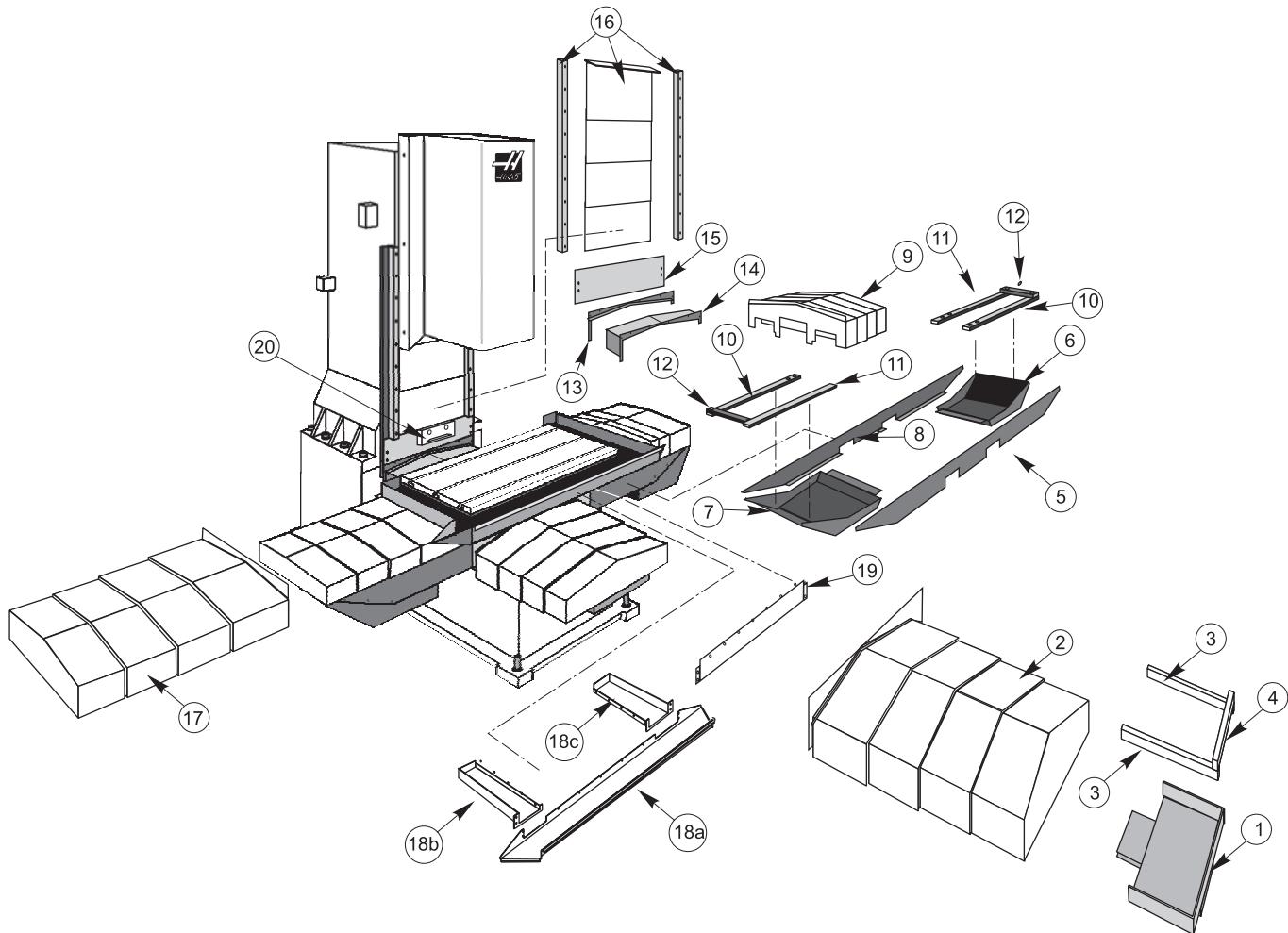
VF(10&11)

1. 25-0044A Front Left Panel (VF-10)  
25-1108C Front Left Panel (VF-11)
2. 25-0042C Left door (VF-10)  
25-1110B Left Door (VF-11)
3. 25-0043C Right door (VF-10)  
25-1115B Right door (VF-11)
4. 25-0052A Right panel (VF-10)  
25-1102A Right panel (VF-11)
5. 25-0045 Front Right Panel (VF-10)  
25-1109A Front Right Panel (VF-11)
6. 25-6639B Pan Right, Outrigger (VF-10)  
25-6643B Pan Right, Outrigger (VF-11)
7. 25-4771C Floor Pan Right (VF-10)  
25-4773C Floor Pan Right (VF-11)
8. 25-4772C Floor Pan Left (VF-10)  
25-4770C Floor Pan Left (VF-11)
9. 25-6638B Pan Left, Outrigger (VF-10)  
25-6642B Pan Left, Outrigger (VF-11)
10. 25-0052 Left pane (VF-10)  
25-1102A Right panel (VF-11)
11. 25-9850A Auger Trough

12. 25-1116 Support Beam (VF-11)
13. 25-6609B Tool Changer Cover (VF-10)  
25-4153B Tool Changer Cover (VF-11)
14. 25-7267 Tool Changer Bracket
15. 25-1116 Support Beam (VF-11)
16. 25-0050 Back Left Panel Extension
17. 25-0180 Inner Back Panel, Left
18. 25-9853A Inner Back Panel, Right
19. 25-0051 Back Right Panel Extension
20. 25-9867A Apron Extension Right (VF-10)  
25-9940A Apron Extension Right (VF-11)
21. 25-9868A Apron Extension Left (VF-10)  
25-9939A Apron Extension Left (VF-11)
22. 25-9867A Apron Extension Right (VF-10)  
25-9940A Apron Extension Right (VF-11)
23. 25-0180 Back Panel Left (VF-10)  
25-9449 Back Panel Left (VF-11)
24. 25-9868A Apron Extension Left (VF-10)  
25-9939A Apron Extension Left (VF-11)



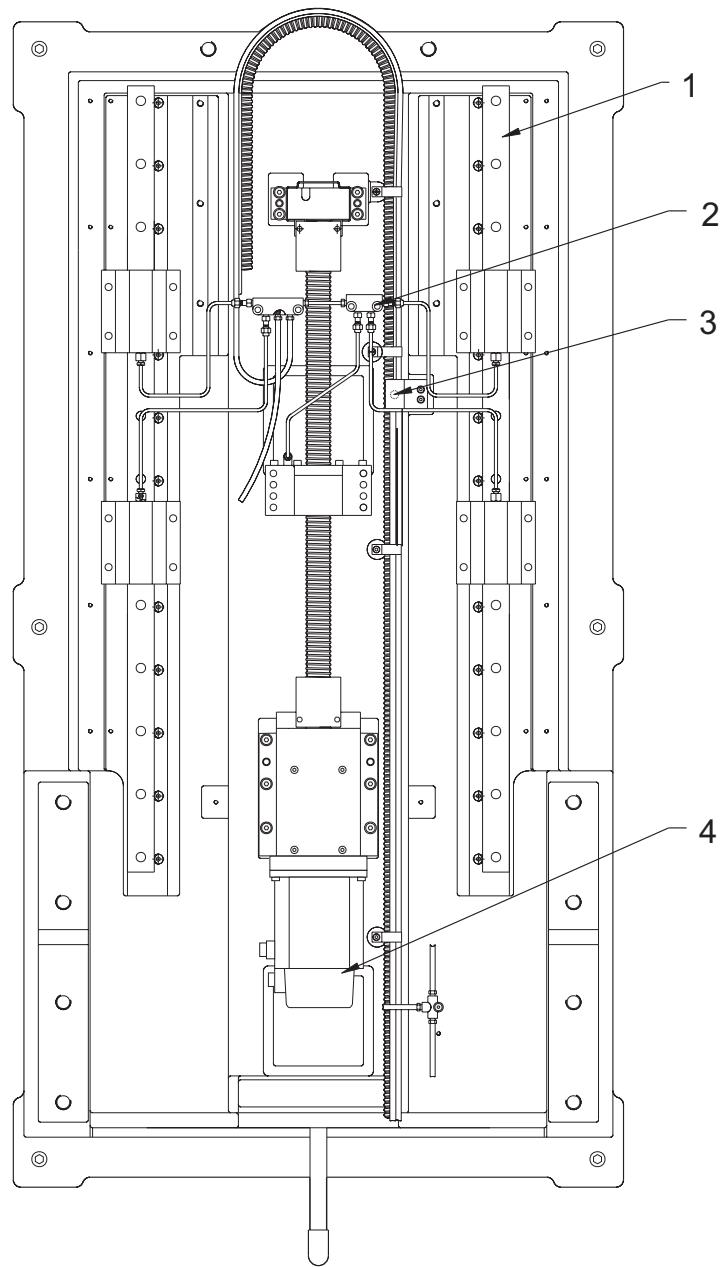
## VF INTERIOR REPLACEABLE PARTS



1. Y-axis Gutter
2. Y-axis Waycover
3. Y-axis Guide Rails
4. Way Cover Bracket
5. Saddle Cover, Front
6. End Shield Saddle Cover, Right
7. End Shield Saddle Cover, Left
8. Saddle Cover, Back
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 Waycover
17. X-axis Waycover
- 18a. Table Gutter Front
- 18b. Table Gutter Left
- 18c. Table Gutter Right
19. X-axis Chip Guard
20. Nozzle Fan Single (25-11793)  
Spacer Fan Nozzle (26-10015)



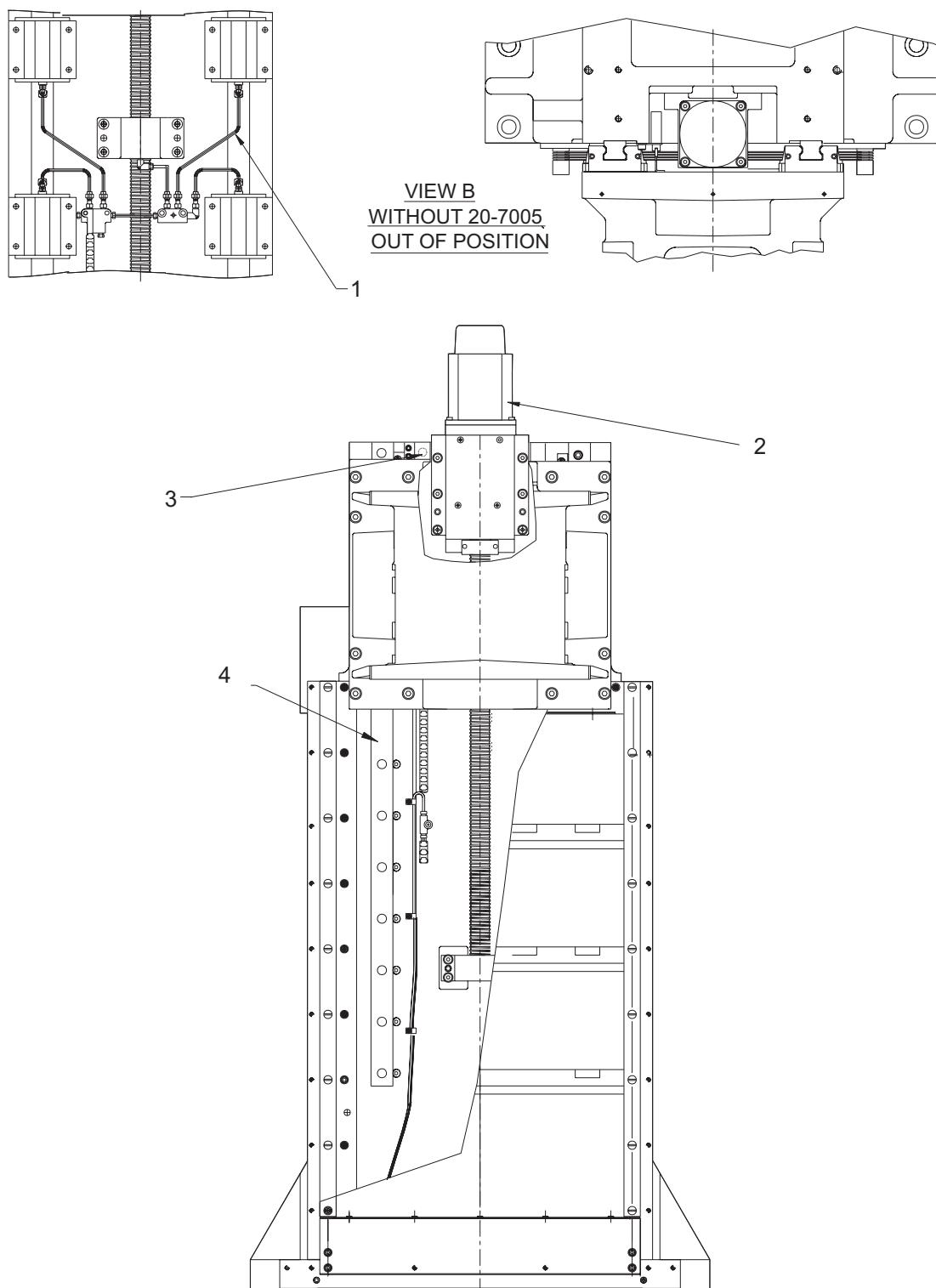
## VF-1 BASE



1. 50-3300 Linear guide
2. 30-30535 Oil line assembly
3. 32-2132 Switch assembly
4. 62-0035B Motor (except XRT)



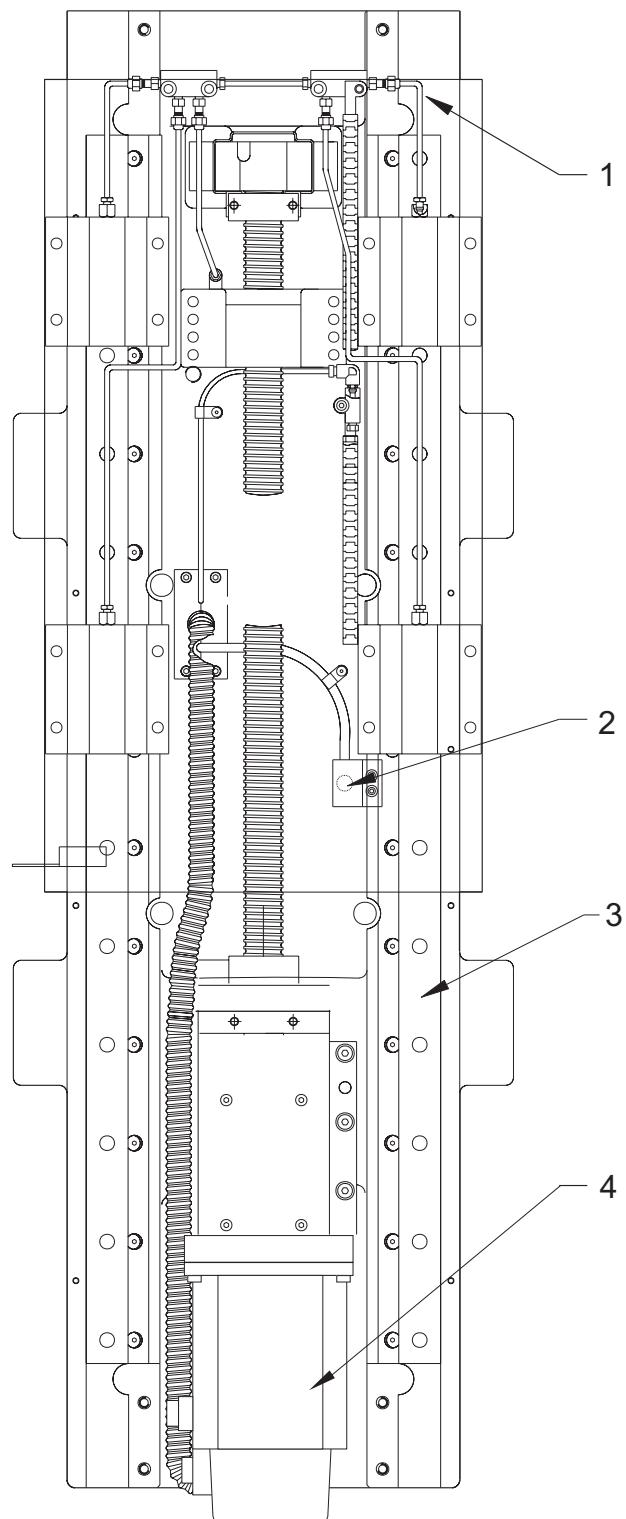
### VF-1 COLUMN



1. 30-0170 Oil line assembly
2. 62-0017 Motor (except XRT)
3. 32-2130 Switch assembly
4. 50-3300 Linear guide



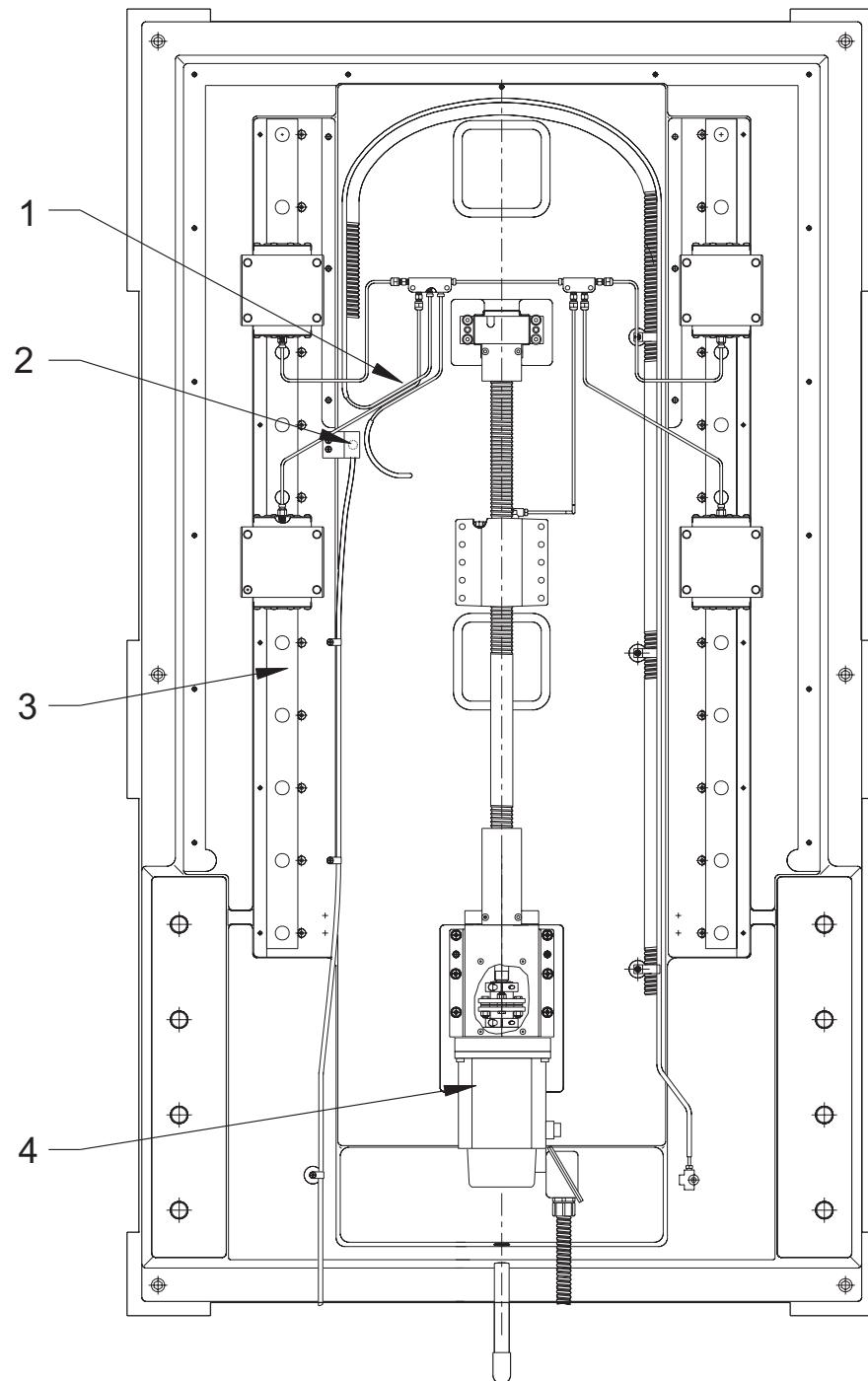
## VF-1 SADDLE



1. 30-0173 Oil line assembly
2. 32-2132 Switch
3. 50-3300 Linear guide
4. 62-0035B Motor (except XRT)



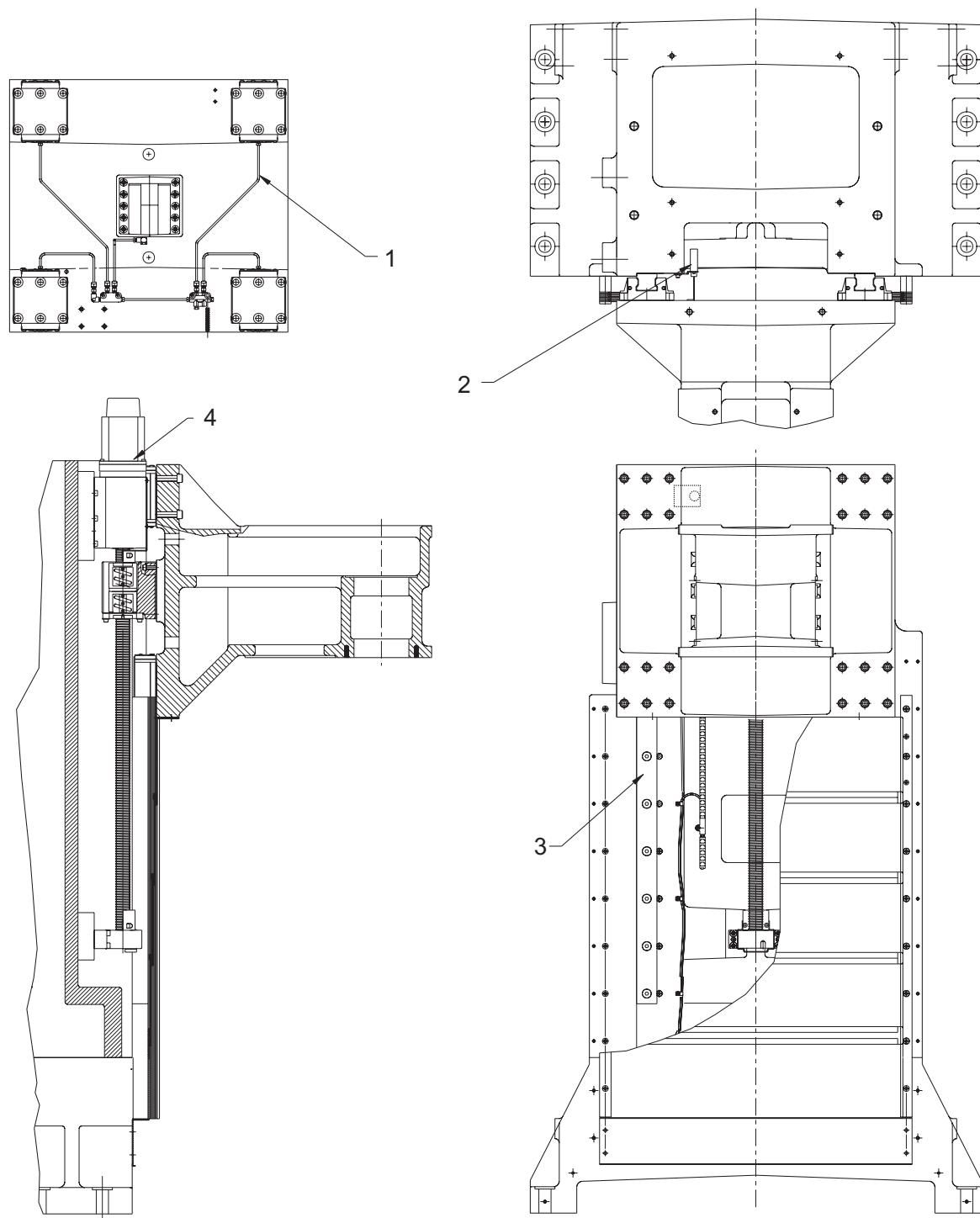
### VF-3 BASE



1. 30-0221 Oil line assembly
2. 32-2134 Switch assembly
3. 50-9011 Linear guide
4. 62-0035B Motor assembly (except XRT)



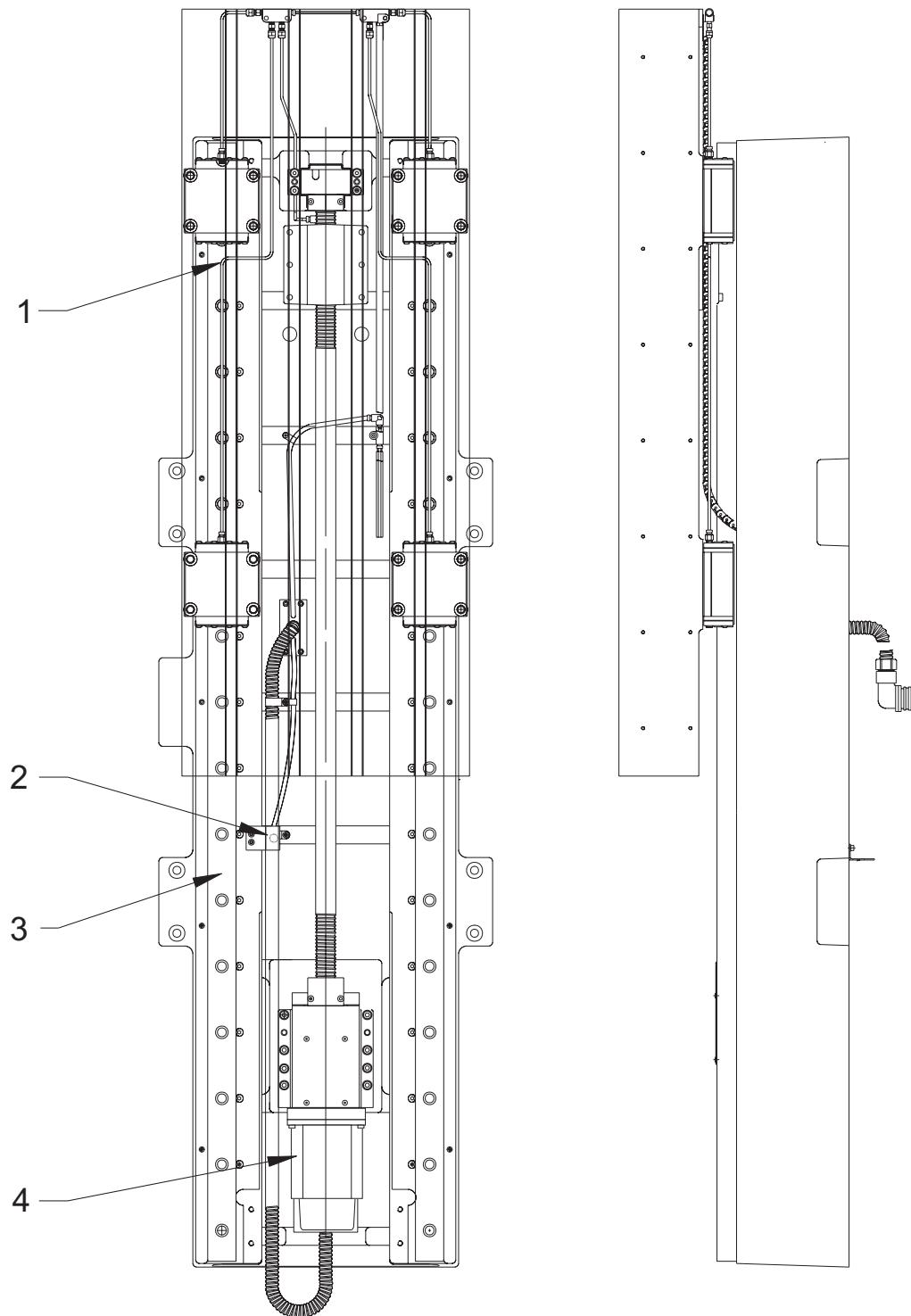
## VF-3 COLUMN



1. 30-0687 Oil line assembly
2. 32-2130 Switch assembly
3. 50-9011 Linear guide
4. 62-0017 Motor (except XRT)



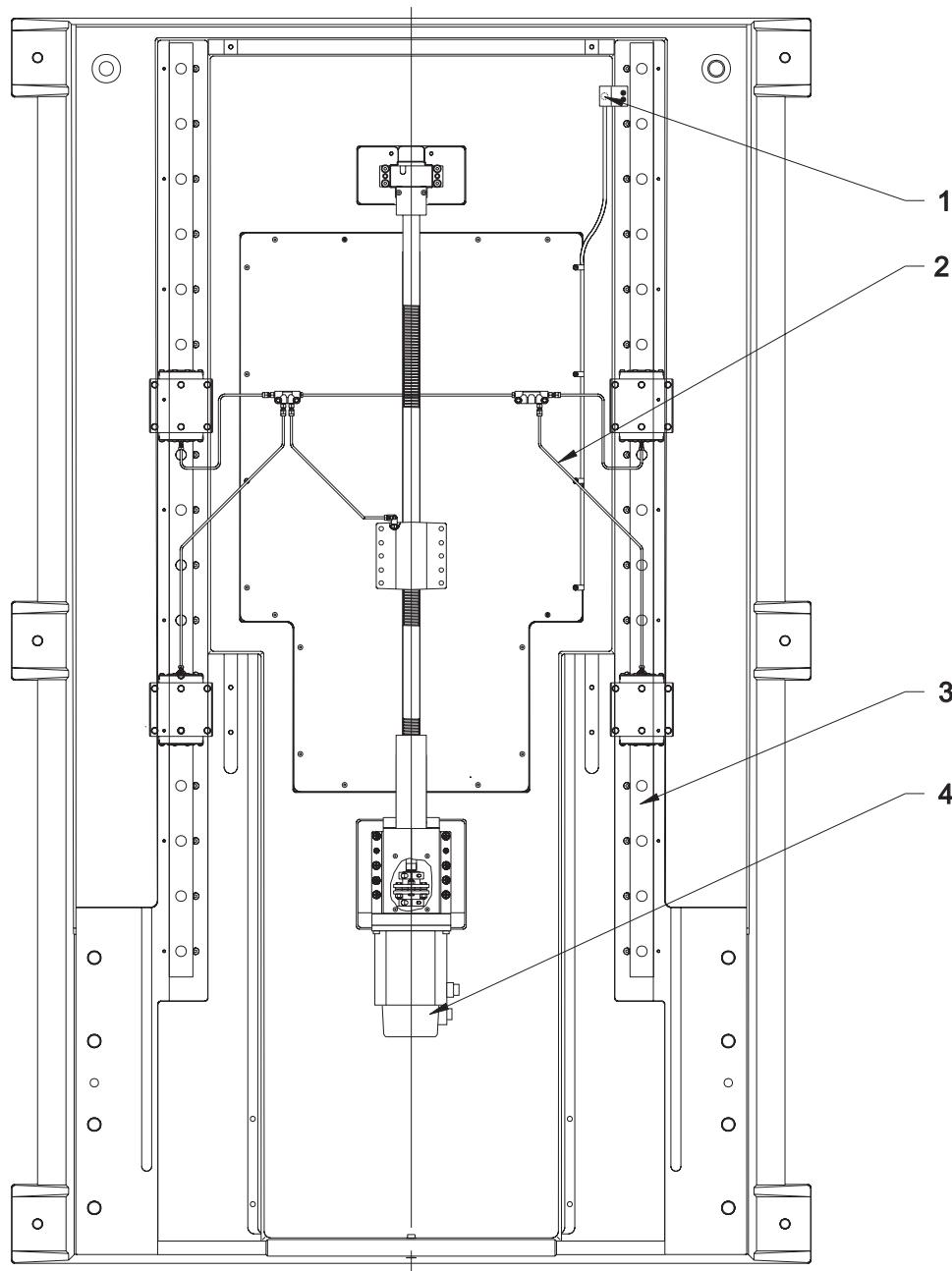
### VF-3 SADDLE



1. 30-0223 Oil line assembly
2. 32-2132 Switch assembly
3. 50-9010 Linear guide
4. 62-0035B Motor (except XRT)



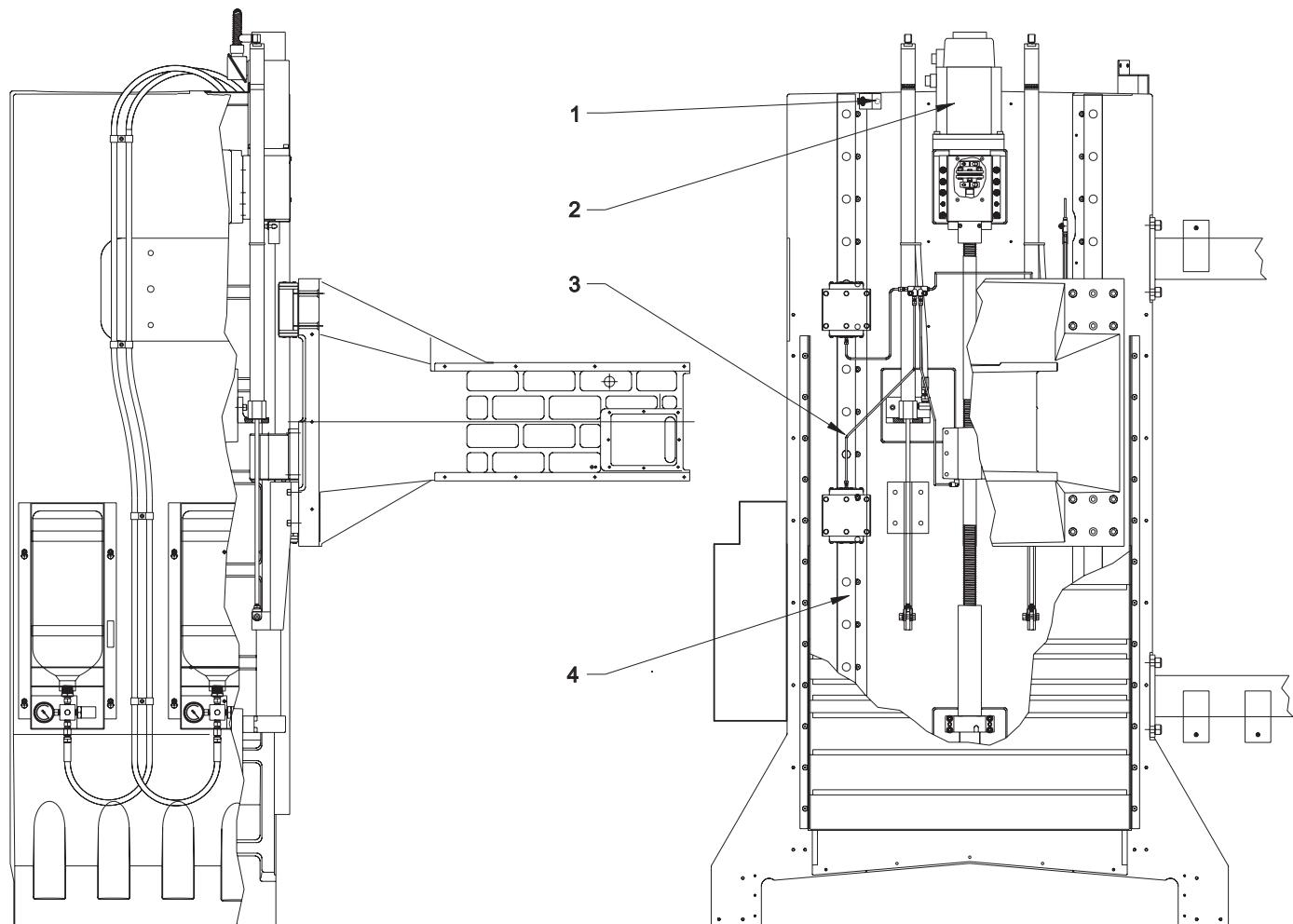
## VF-6 BASE



1. 32-2142 Limit switch assembly
2. 30-0461 Oil line assembly
3. 50-9010 Linear guide
4. 62-0035B Motor (except XRT)



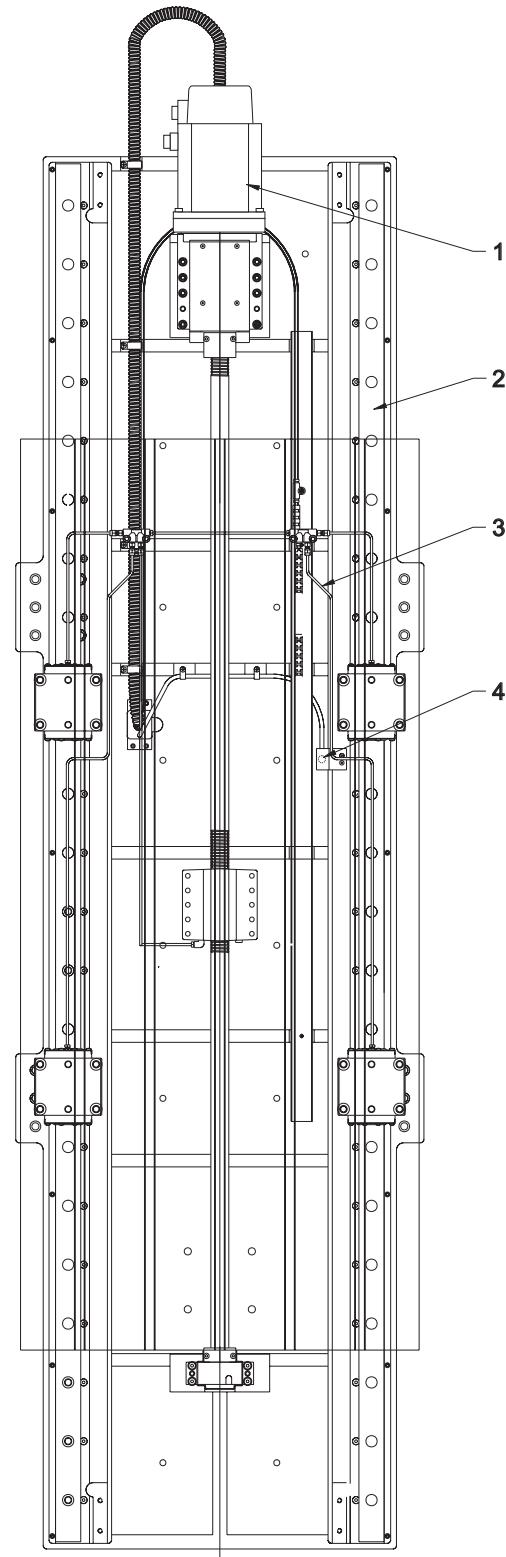
## VF-6 COLUMN



1. 32-2130 Limit switch assembly
2. 62-0037B Motor (except XRT)
3. 30-0464 Oil line assembly
4. 50-9010 Linear guide



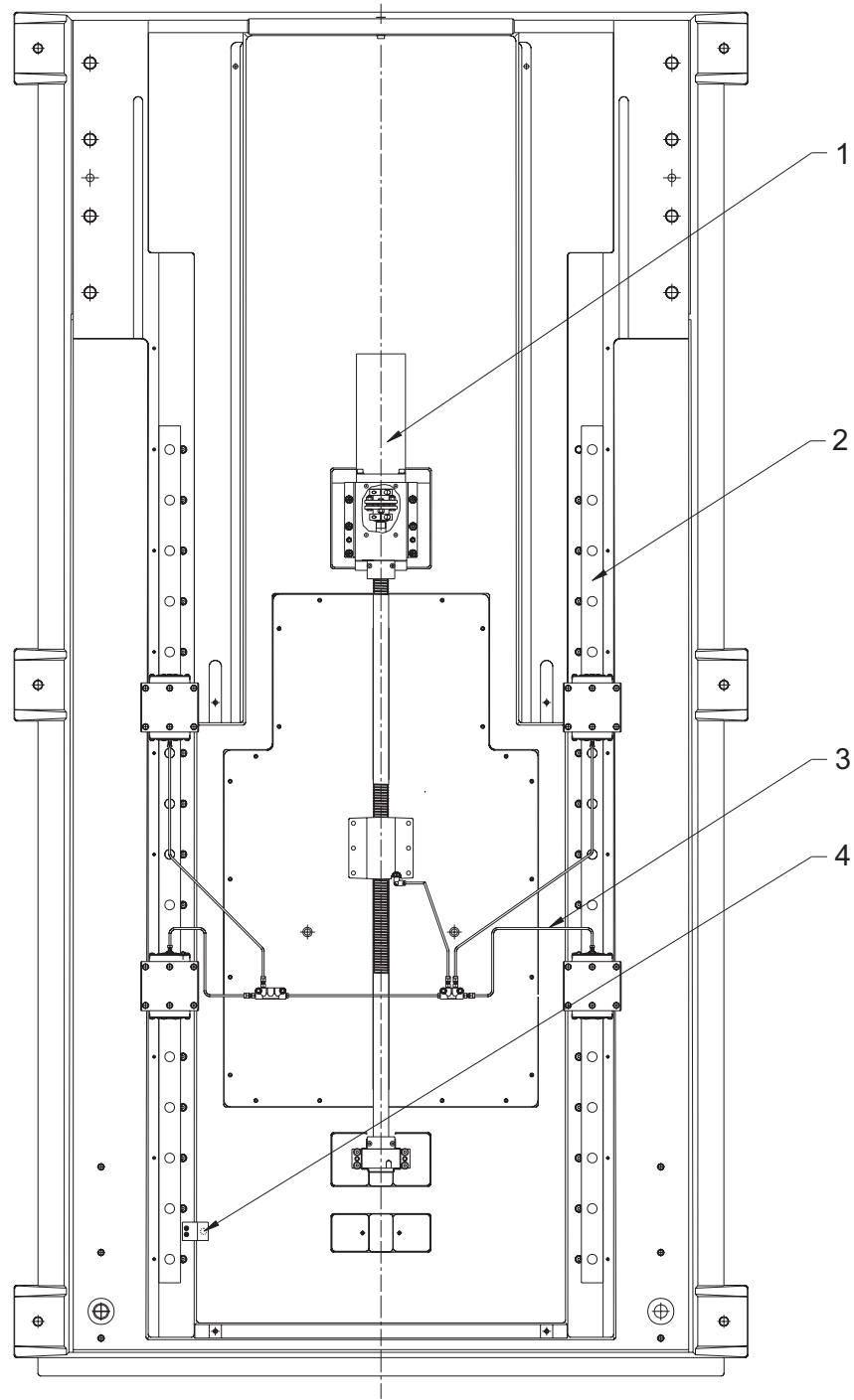
## VF-6 SADDLE



1. 62-0035B Motor (except XRT)
2. 50-9806 Linear guide
3. 30-0463 Oil line assembly
4. 32-2134 Limit switch assembly



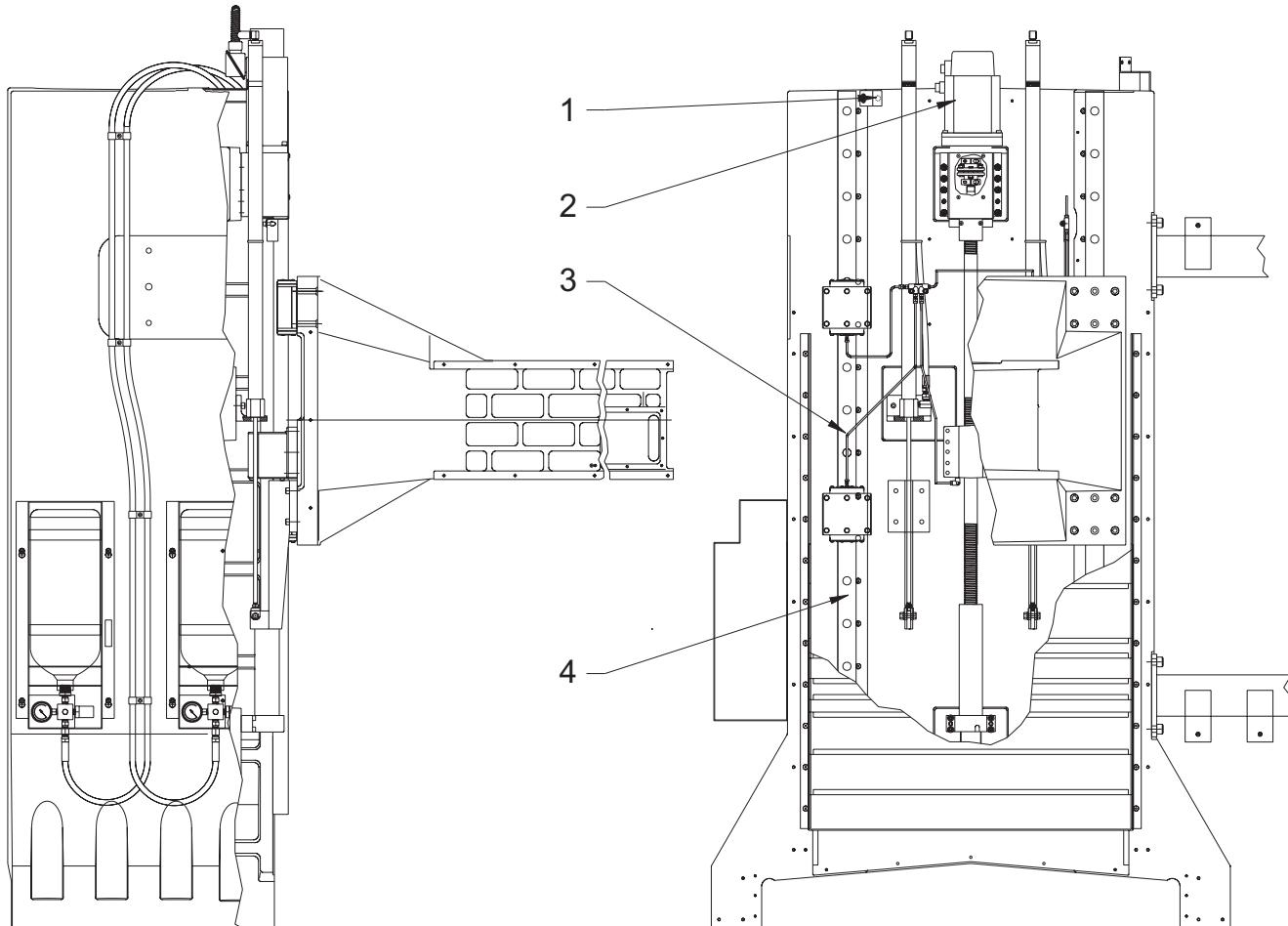
## VF-8 BASE



1. 62-0035B Motor (except XRT)
2. 50-9010 Linear guide
3. 30-0461 Oil line assembly
4. 32-2142 Limit switch assembly



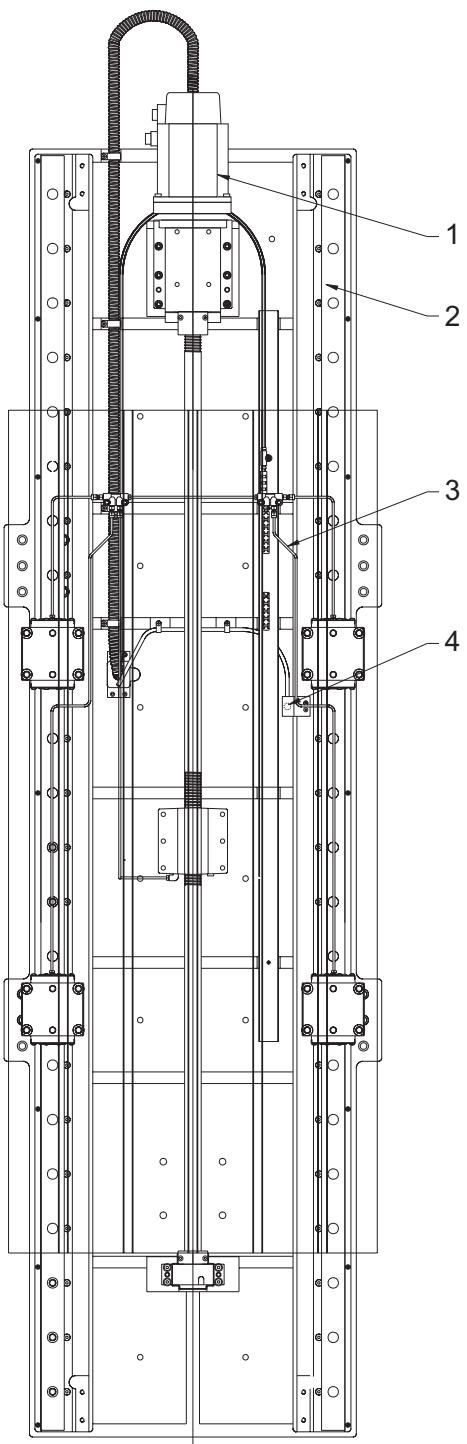
## VF-8 COLUMN



1. 32-2130 Limit switch assembly
2. 62-0037B Motor (except XRT)
3. 30-0464 Oil line assembly
4. 50-9010 Linear guide



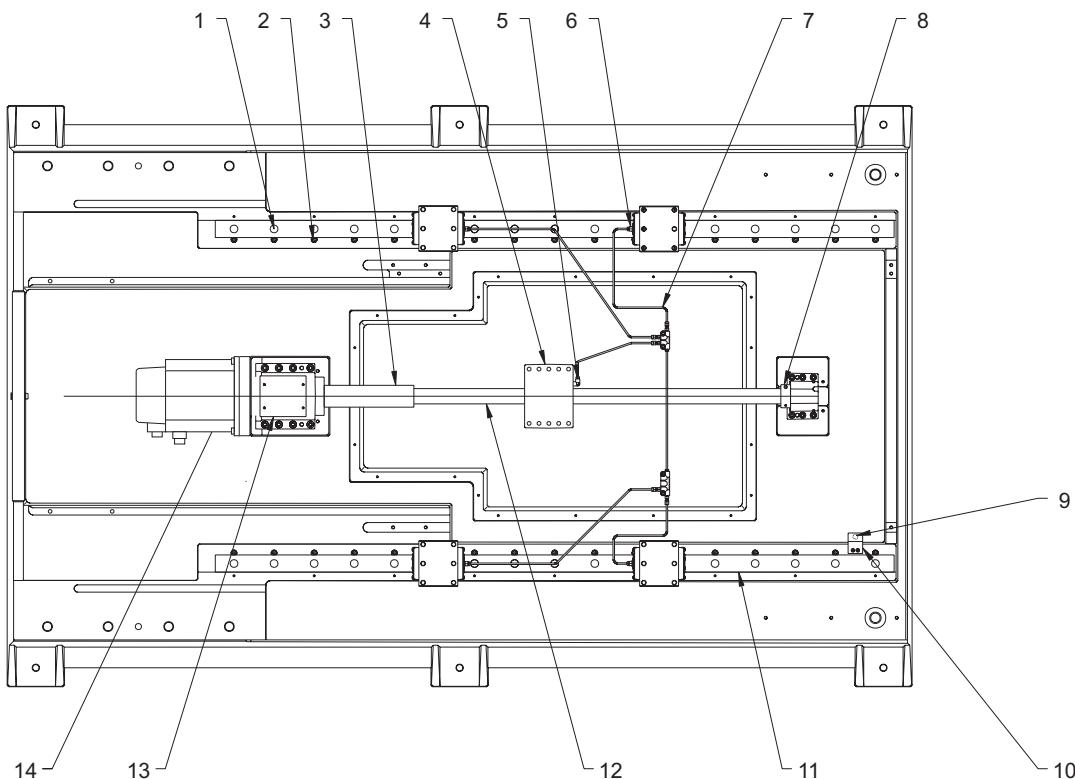
## VF-8 SADDLE



1. 62-0035B Motor (except XRT)
2. 50-9806 Linear guide
3. 30-0463 Oil line assembly
4. 32-2134 Limit switch assembly



## VF-10 BASE

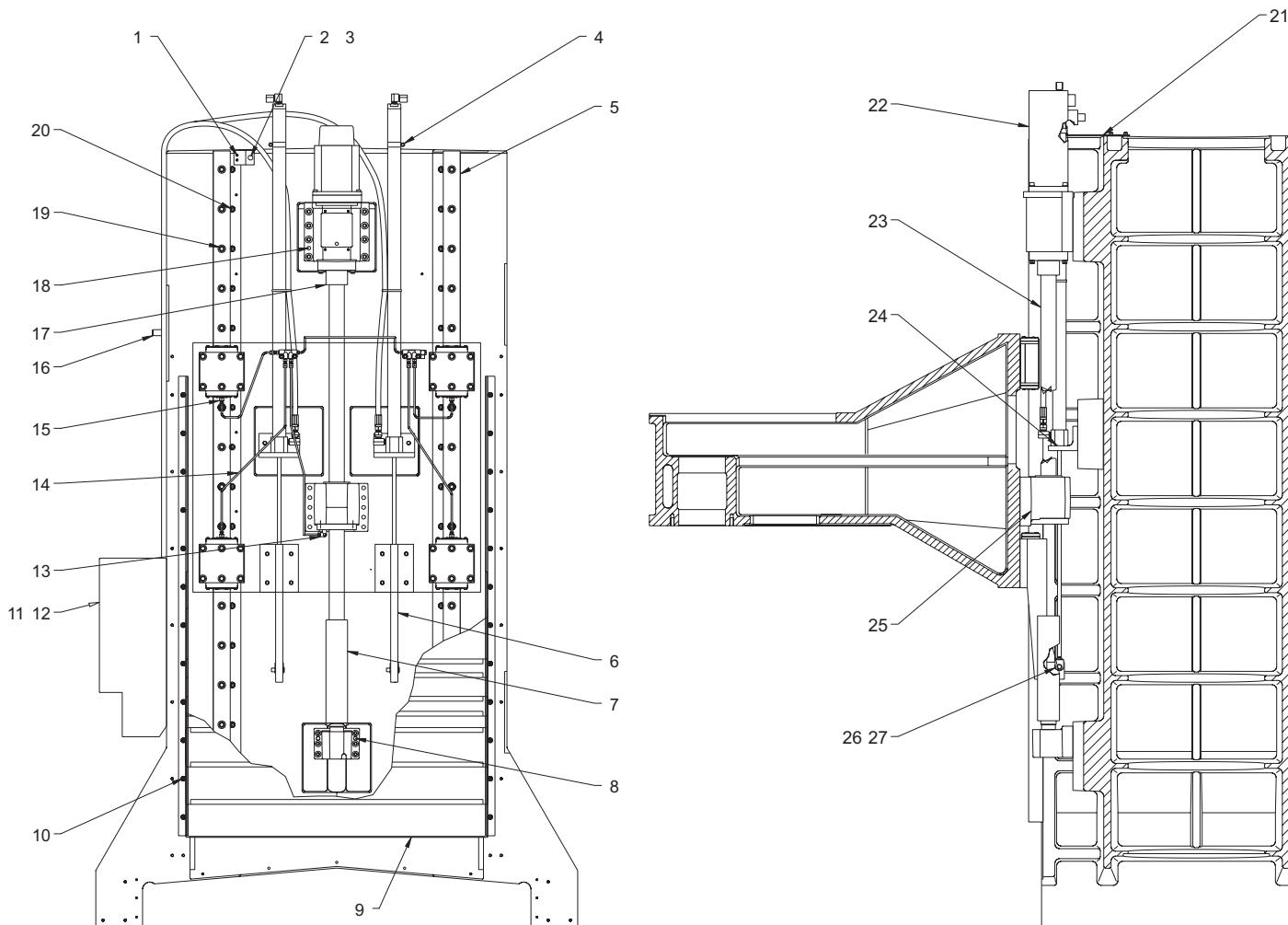


1. 59-6655 Rubber plug guide rail
2. 22-7458 Cam, linear guide
3. 28-0236 Y-axis bumper, motor end
4. 20-0150 Nut housing
5. 58-3031 Banjo elbow 5/16 female x M6 male
6. 58-1560 Adapter 1/8m (NSK and THK Linear guides) 59-0001 (Star linear guides)
7. 30-0461 Oil line assembly
8. 28-0194 Bumper for 40 and 50 mm ballscrews
9. 32-2142 Limit switch assembly
10. 25-7267 Bracket mounting Y-axis
11. 50-9010 Linear guide
12. 24-9960D 40mm ballscrew (except XRT)
13. 25-9203 Cover plate motor mount
14. 62-0035B Servo motor (40 taper) 62-0016 servo motor (50 taper)\*

\*Except XRT



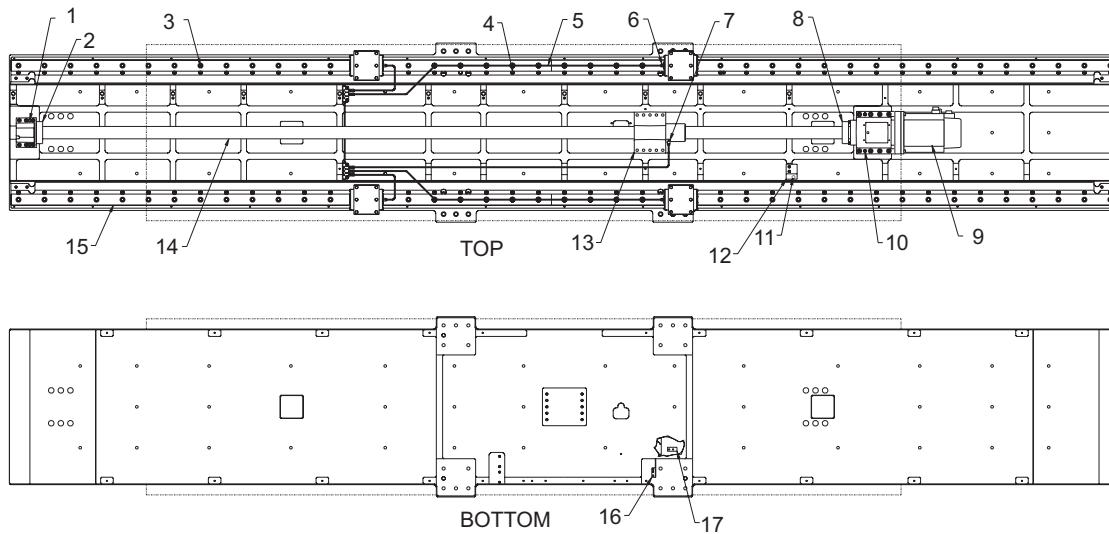
## VF-10 COLUMN



- |              |                                    |              |                                     |
|--------------|------------------------------------|--------------|-------------------------------------|
| 1. 25-7267   | Bracket mounting Y-axis            | 18. 48-0045  | Dowel pin 3/8 x 1 1/2               |
| 2. 25-9929A  | Stabilizer bracket hyd. cyl. (50T) | 19. 59-6655  | Rubber plug                         |
| 3. 32-2130   | Limit switch Z-axis                | 20. 22-7458  | Cam                                 |
| 4. 59-4002   | Hose clamp 13/16 x 1 3/4 (50T)     | 21. 25-9929A | Stabilizer bracket (50T)            |
| 5. 50-9010   | Linear guide                       | 22. 20-0365  | Clevis counterbalance (50T)         |
| 6. 22-9826A  | Counterweight head bracket (50T)   | 23. 48-0017  | Clevis pin 3/8 dia. x 1 1/4 (VR-11) |
| 7. 28-0211   | Z-axis bumper, support end         | 49-0026      | Cotter pin 1/8 x 1 1/4 (VR-11)      |
| 8. 48-0045   | Dowel pin 3/8 x 1 1/2 pull         | 24. 20-0150  | Nut housing                         |
| 9. 25-9813B  | Z-axis waycover                    | 25. 22-9927  | Bracket cylinder counter (50T)      |
| 10. 40-2021  | FHCS 1/4-20 x 3                    | 26. 24-9960D | 40mm ballscrew (except XRT)         |
| 11. 25-9550C | Mount hydraulic fluid tank         | 27. 62-0037B | Motor (except XRT)                  |
| 12. 30-1421  | Counterbalance tank assembly (50T) |              |                                     |
| 13. 58-3031  | Banjo elbow 5/16 F x M6 M (50T)    |              |                                     |
| 14. 30-0464  | Oil line assembly                  |              |                                     |
| 15. 58-1560  | Linear guide adapter 1/8m          |              |                                     |
| 16. 48-1699  | Dowel pin 5/8 x 2 1/4              |              |                                     |
| 17. 28-0231  | Z-axis bumper, motor end           |              |                                     |



## VF-10 SADDLE

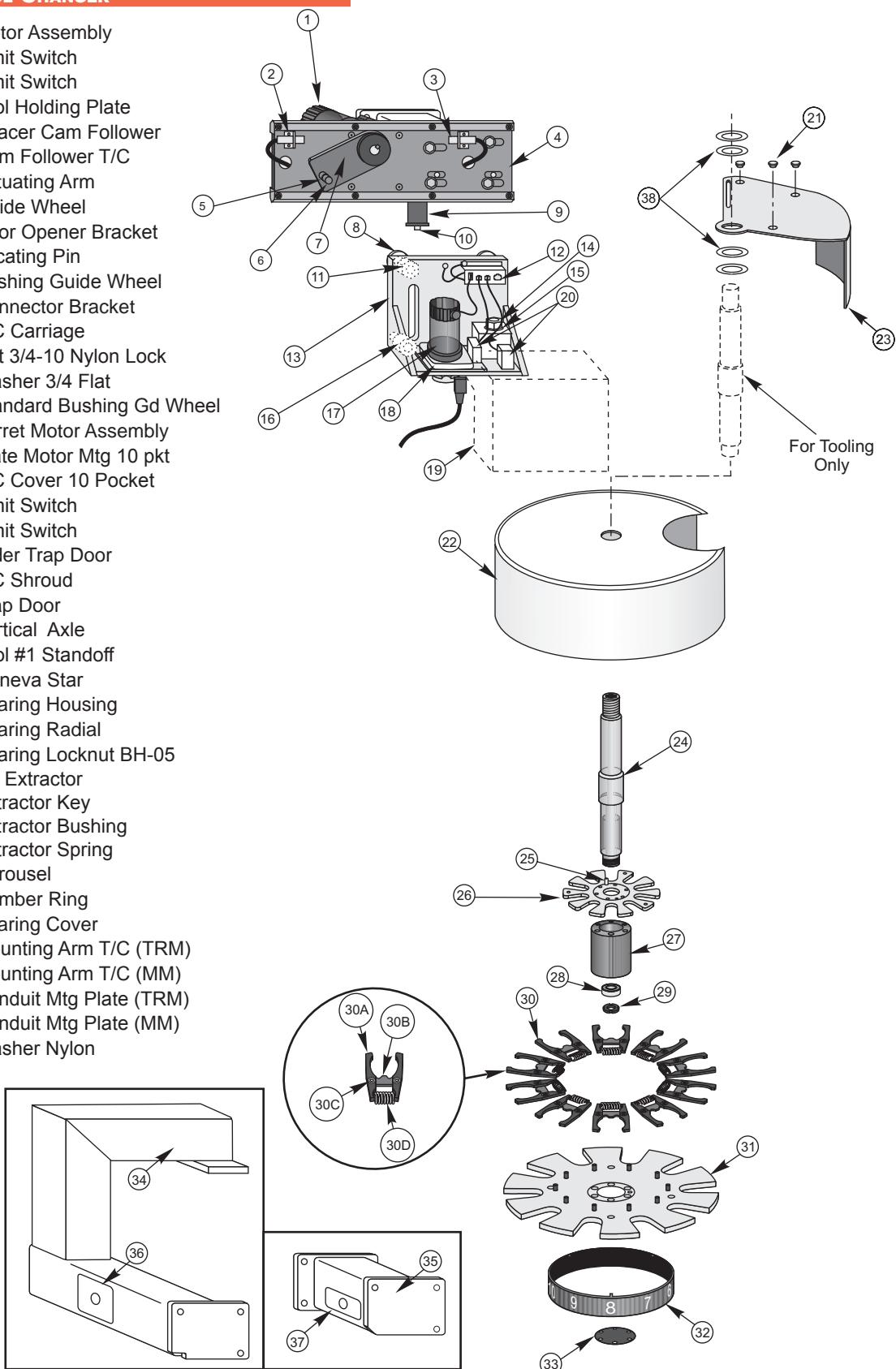


1. 20-0152 Bearing housing 40mm and 50mm ballscrew
2. 20-0194 Bumper
3. 59-6655 Rubber plug
4. 22-7458 Cam, linear guide
5. 30-0534 Oil line assembly
6. 58-1560 Linear guide adapter 1/8m
7. 58-3031 Banjo elbow 5/16 F x M6 M (50T)
8. 20-0194 Bumper 40 and 50mm ballscrews
9. 62-0016 Motor (except XRT)
10. 48-0045 Dowel pin 3/8 x 1 1/2 pull
11. 32-2132 X-axis limit switch
12. 25-9219 Bracket, limit switch
13. 20-0150 Nut housing
14. 24-0002C Ballscrew 50mm (except XRT)
15. 50-0001B Linear guide
16. 25-5322 Bracket trip table
17. 25-9219 Bracket, trip X-axis



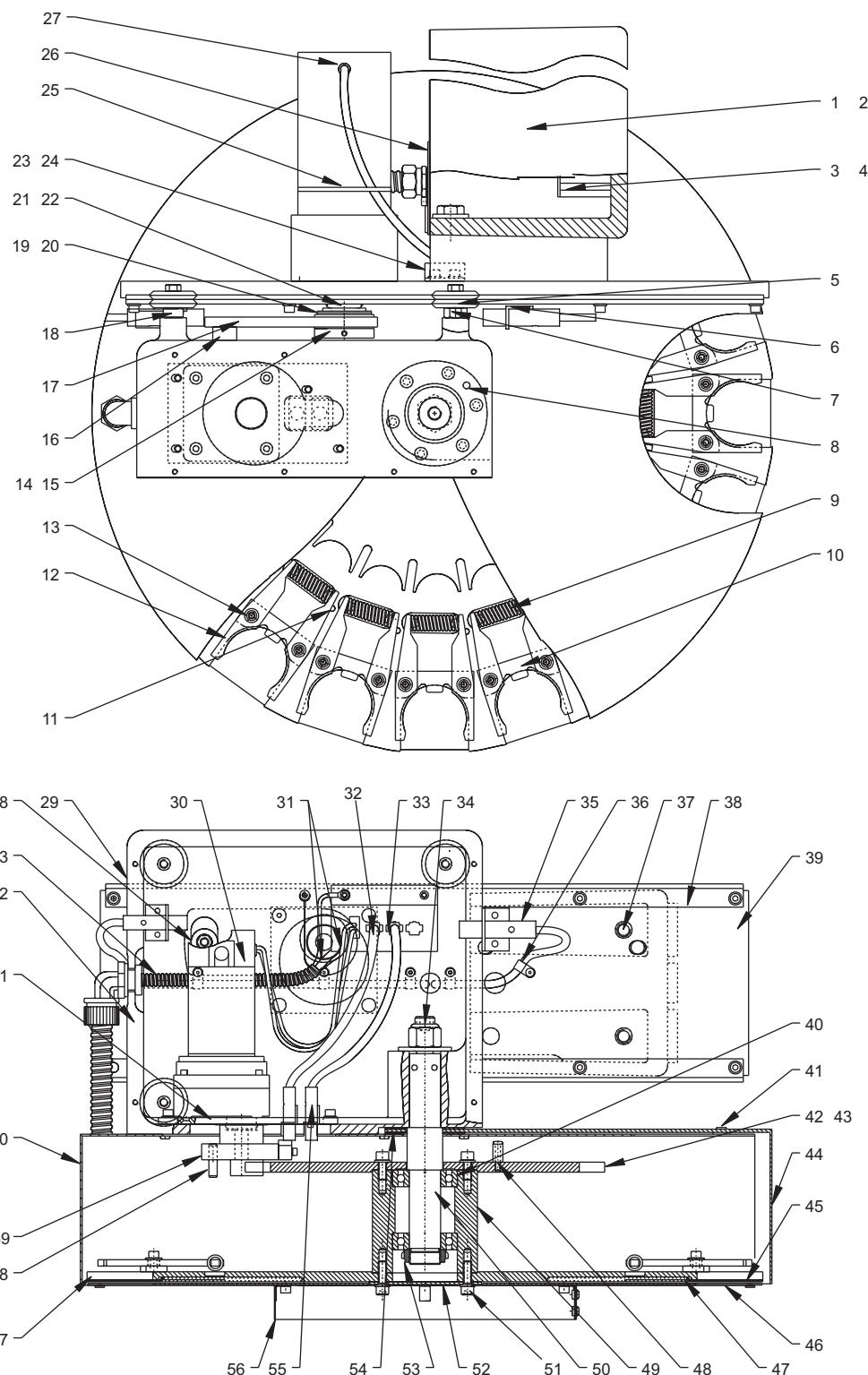
### 10 POCKET TOOL CHANGER

- |                |                           |
|----------------|---------------------------|
| 1. 32-1875     | Motor Assembly            |
| 2. 32-2207     | Limit Switch              |
| 3. 32-2208     | Limit Switch              |
| 4. 20-0682     | Tool Holding Plate        |
| 5. 22-10057    | Spacer Cam Follower       |
| 6. 54-0010     | Cam Follower T/C          |
| 7. 30-30061    | Actuating Arm             |
| 8. 54-0030     | Guide Wheel               |
| 9. 25-0466     | Door Opener Bracket       |
| 10. 22-2065    | Locating Pin              |
| 11. 54-0020    | Bushing Guide Wheel       |
| 12. 25-10621   | Connector Bracket         |
| 13. 20-1354C   | T/C Carriage              |
| 14. 46-1705    | Nut 3/4-10 Nylon Lock     |
| 15. 45-1725    | Washer 3/4 Flat           |
| 16. 54-0040    | Standard Bushing Gd Wheel |
| 17. 30-1679A   | Turret Motor Assembly     |
| 18. 20-0680A   | Plate Motor Mtg 10 pkt    |
| 19. 25-1025B   | T/C Cover 10 Pocket       |
| 20. 32-2205    | Limit Switch              |
| 21. 32-2206    | Limit Switch              |
| 22. 22-7163    | Rider Trap Door           |
| 23. 25-0633    | T/C Shroud                |
| 24. 25-0636A   | Trap Door                 |
| 25. 20-0681    | Vertical Axle             |
| 26. 22-7255A   | Tool #1 Standoff          |
| 27. 20-0678    | Geneva Star               |
| 28. 20-0679    | Bearing Housing           |
| 29. 51-2022    | Bearing Radial            |
| 30. 51-2041    | Bearing Locknut BH-05     |
| 31. A 22-9574A | CT Extractor              |
| B 22-7067F     | Extractor Key             |
| C 22-9256      | Extractor Bushing         |
| D 24-9257      | Extractor Spring          |
| 32. 93-0403    | Carousel                  |
| 33. 25-0638    | Number Ring               |
| 34. 25-0635    | Bearing Cover             |
| 35. 20-1118D   | Mounting Arm T/C (TRM)    |
| 36. 20-1263A   | Mounting Arm T/C (MM)     |
| 37. 25-9912A   | Conduit Mtg Plate (TRM)   |
| 38. 25-7906    | Conduit Mtg Plate (MM)    |
| 39. 45-2020    | Washer Nylon              |





## 20 POCKET TOOL CHANGER



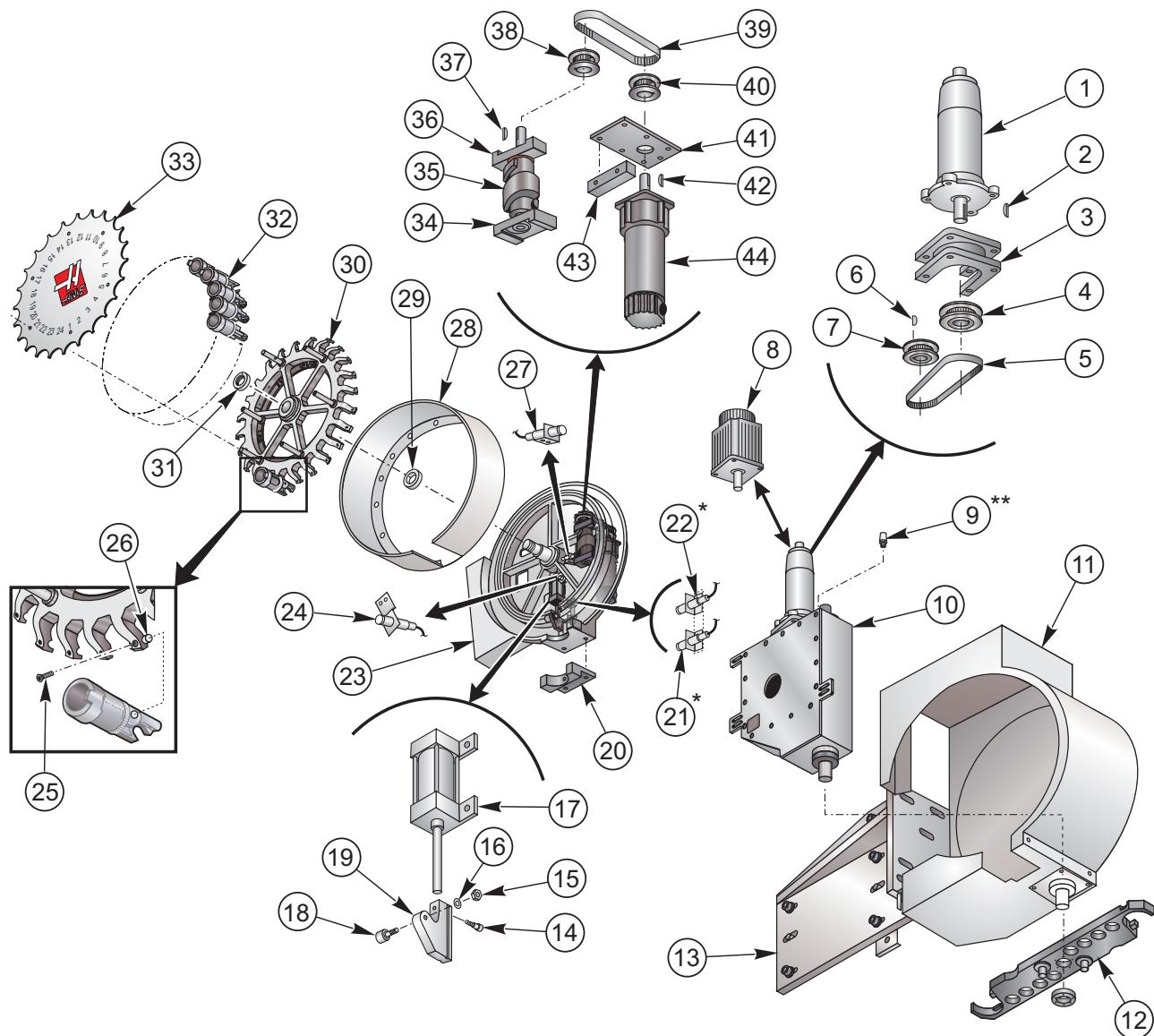


## 20 POCKET TOOL CHANGER

1. 20-7029C	Holding arm	50. 20-7035G	Vertical axle
2. 57-7379	Tool holding arm gasket	51. 54-0040	Standard bushing guide wheel
3. 79-0014	Wire channel 1in. x 2in.	52. 25-7036	Cap, tool changer
4. 79-0015	Cover wire channel 1"	53. 51-0012	Bearing locknut BH-06
5. 54-0030	Guide wheel	54. 26-7239	Spacer ring
6. 22-7263	Block switch mounting	55. 32-2205	Prox NC TC mark
7. 54-0020	Bushing guide wheel	56. 25-7570	Number ring
8. 48-0019	Dowel pin 1/4 x 5/8	57. 20-7352B	20 tool carousel
9. 24-9257	Spring, extractor	20-1524	20 Tool carousel BT
10. 22-7067F	Key extractor spring	58. 51-0051	Bearing 3/4 cam follower
11. 48-0002	Roll pin 7/32 x 7/8	59. 20-9332	Driver geneva 2 pin
12. 22-9574A	CT extractor spring load	60. 25-7237C	20 pocket T/C cover
22-7166A	BT Extractor	61. 20-7236A	Motor mounting plate
13. 22-9256	Bushing extractor	62. 57-7378	Tool Carriage gasket (VF6-10)
14. 20-7476	Hub slip clutch	63. 78-1996	Split flex tubing 1/2 I.D.
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. 25-0466	Bracket, door opener		
25. 70-0050	PLT4S-M cable ties		
26. 25-9253A	Conduit mounting plate		
27. 32-1875	Shuttle motor assembly		
28. 54-0010	Cam follower T/C		
29. 20-7030F	Tool carriage		
30. 32-1900A	Turret motor assembly		
31. 32-7620A	TL carriage cable		
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. 32-2219	Limit switch shuttle In		
32-2208	Limit switch shuttle Out		
36. 63-1031	Cable clamp 1/4		
37. 48-1750	Dowel pin 1/2 x 1 1/2		
38. 22-7106	V track		
39. 20-7033F	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		



## SIDE MOUNT TOOL CHANGER ASSEMBLY



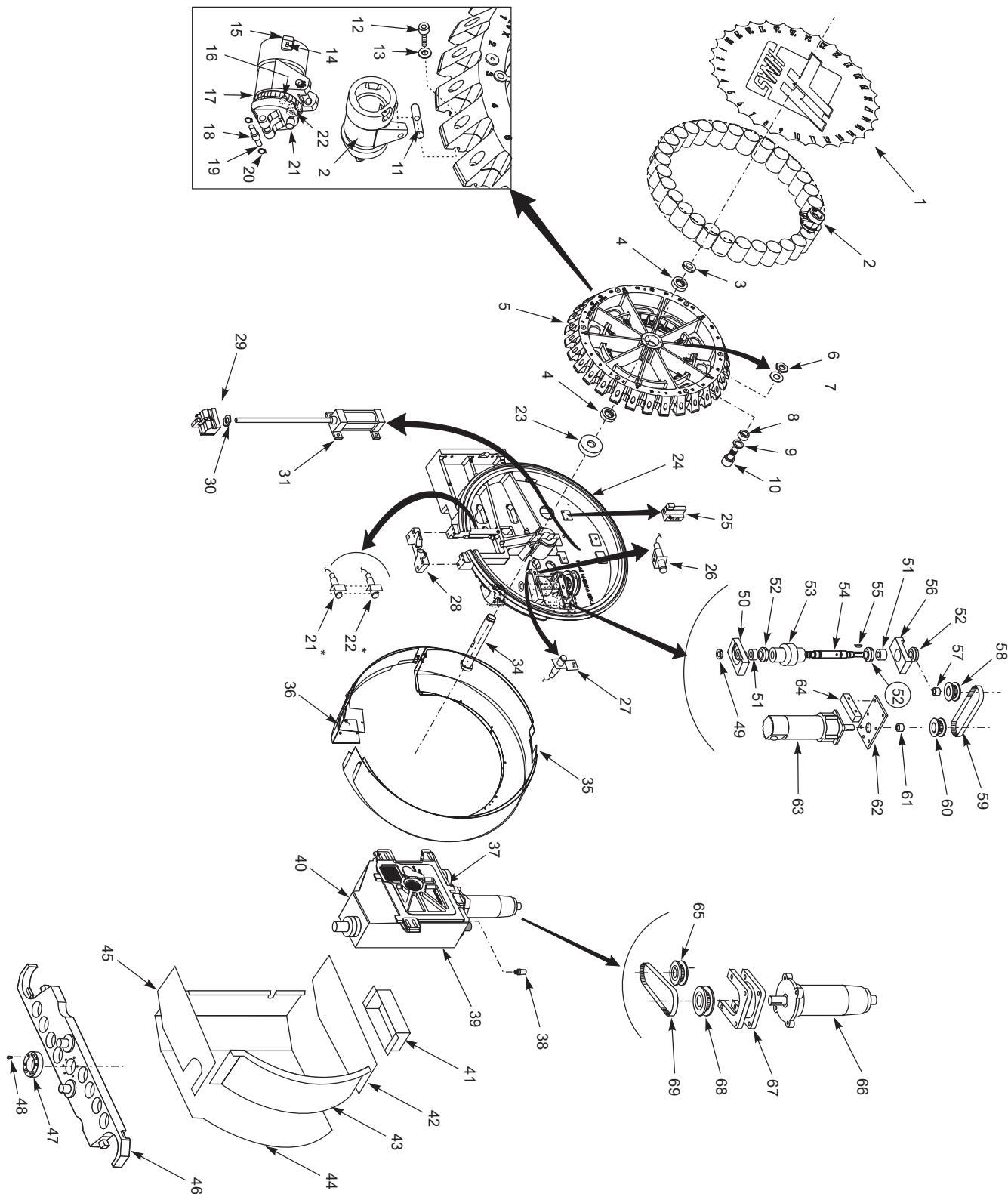


## SIDE MOUNT TOOL CHANGER ASSEMBLY

- \* 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



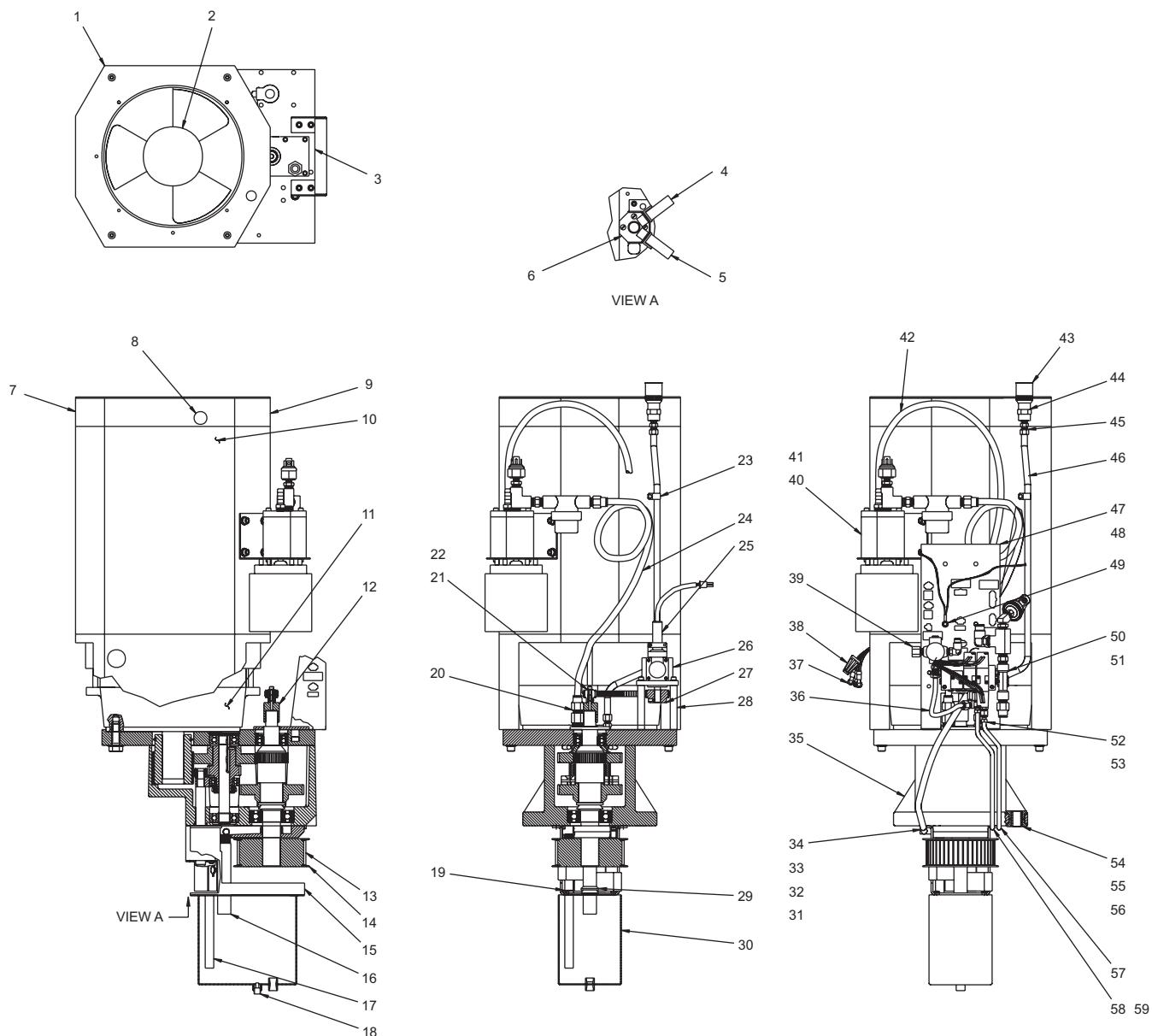


## 50 TAPER SIDE MOUNT TOOL CHANGER ASSEMBLY

1. 25-0284A	Carousel Cover	54. 20-0231	Carousel Shaft
2. 20-0490A	Tool Pocket 50T	55. 22-2629	Key Stub
3. 51-2043	Bearing Lock Nut	56. 20-7239	Carousel Cam Top Support
4. 51-0020	Bearing	57. 54-0017	Bushing
5. 20-0438A	Carousel 50T	58. 54-0044	Pulley
6. 46-1663	Jam Nut	59. 54-0045	Belt
7. 45-0068	Flat Washer	60. 54-0043	Pulley
8. 20-1239A	Tapered Bushing	61. 54-0017	Bushing
9. 45-0070	Washer	62. 20-0272B	Motor Mount Plate
10. 51-0045	Cam Follower	63. 32-1875	Motor Assy.
11. 20-0385	Pocket Roller Shaft	64. 20-0273	Motor Mount Block
12. 56-0020	Retaining Clip	65. 54-0043	Pulley
13. 40-1715	SHCS	66. 32-1880B	Motor Assy.
14. 45-1739	Washer	67. 20-0772	Motor Mounting Base
15. 40-1919	Screw	68. 54-0037	Pulley
16. 20-0384	Arm Key	69. 54-0036	Belt
17. 20-0382	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. 20-0621	ATC Housing		
25. 32-0039	Solenoid Assy.		
26. 32-2295	Prox. Switch		
27. 32-2253	Prox. Switch		
28. 20-0390A	Pocket Slide		
29. 20-0393B	Pocket Stop		
30. 46-1663	¾-16 Jam Nut		
31. 59-0116A	Air Cylinder		
32. 32-2252	Prox. Switch		
33. 32-2251	Prox. Switch		
34. 20-0387	T/C Shaft		
35. 25-0286B	Shroud		
36. 25-0291B	Corner Shroud		
37. 20-0456	Cam Box Cover		
38. 58-3069	Muffler		
39. 20-0455C	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		



## VF 1-11 GEARBOX ASSEMBLY 15 HP



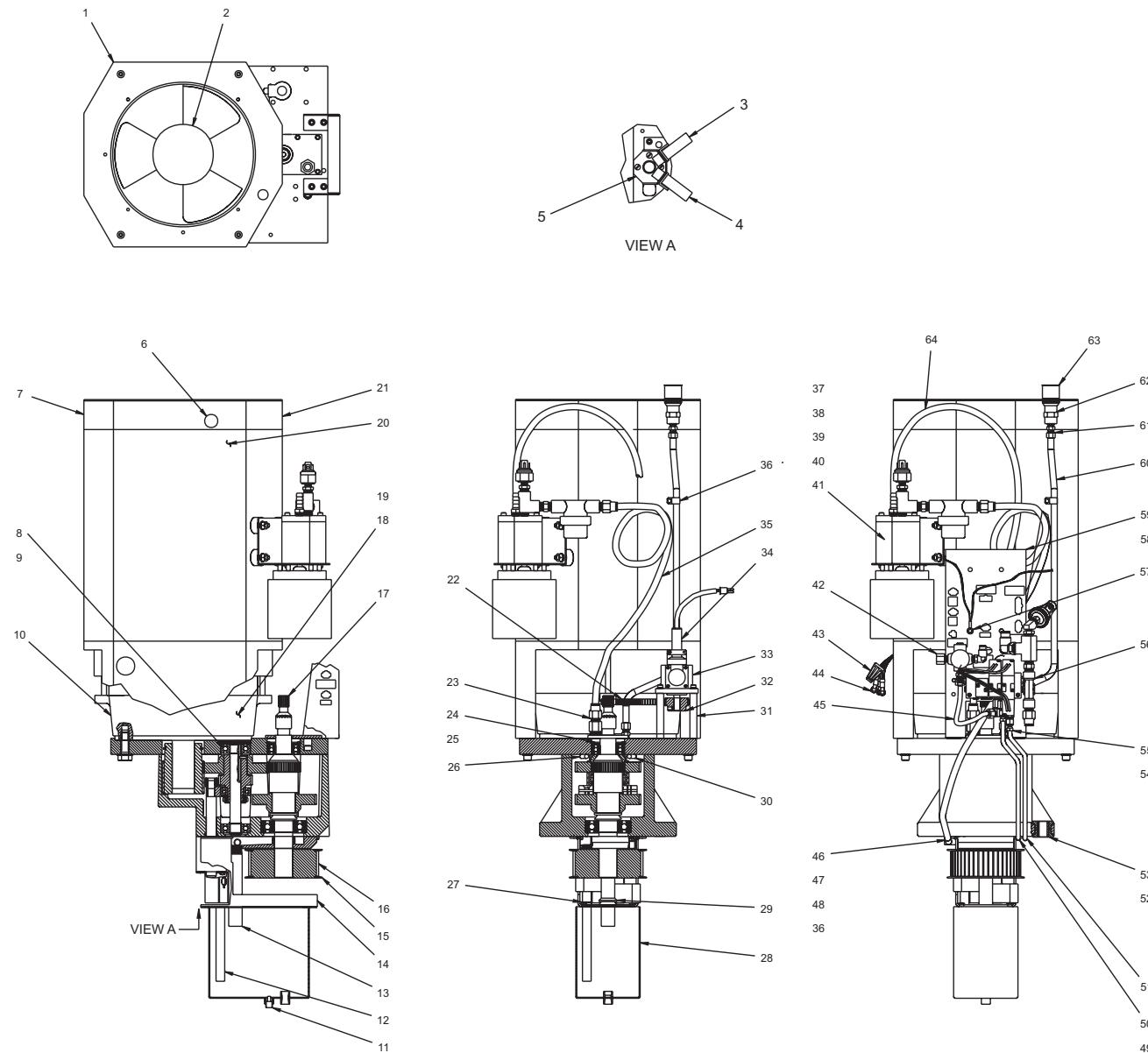


## VF 1-11 GEARBOX ASSEMBLY 15 HP

- |              |                                   |              |                           |
|--------------|-----------------------------------|--------------|---------------------------|
| 1. 25-0108   | Fan bracket motor shroud          | 53. 58-2110  | Sleeve nuts lube assembly |
| 2. 36-3035   | Spindle fan assembly              | 54. 22-7520A | Isolater trans            |
| 3. 59-7130   | Protective strip                  | 55. 22-7521A | Spacer trans              |
| 4. 32-2259A  | Prox NO 2WR                       | 56. N/A      |                           |
| 5. 32-2214A  | Prox NC 2WR                       | 57. 58-7636  | High gear tube VF-3       |
| 6. 25-7264   | Switch mounting bracket           | 58. 58-7635  | Low gear tube VF-3        |
| 7. 29-0022   | Shroud caution decal              | 59. 63-0001  | Nylon cable clamp 1/2     |
| 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              |              |                           |



## VF 1-11 GEARBOX ASSEMBLY HT10K



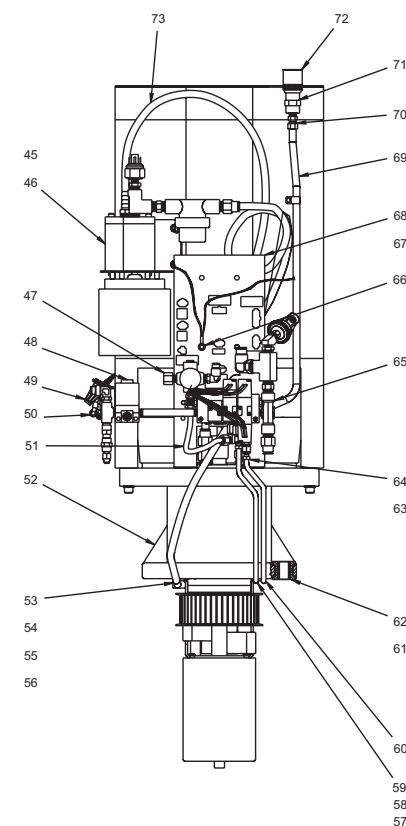
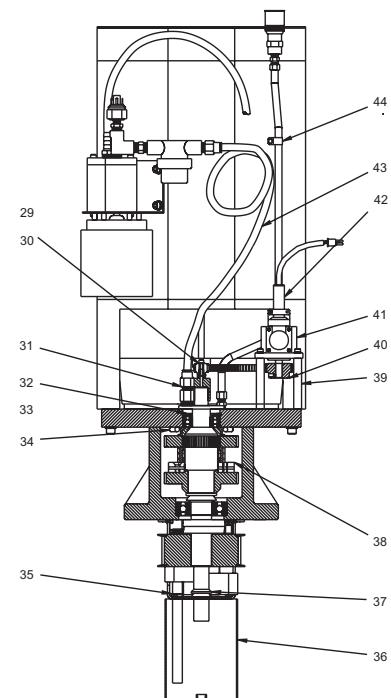
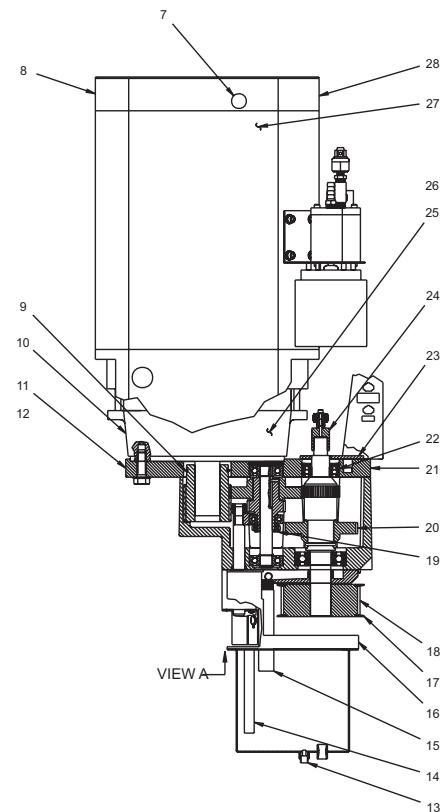
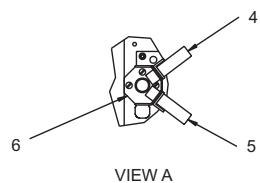
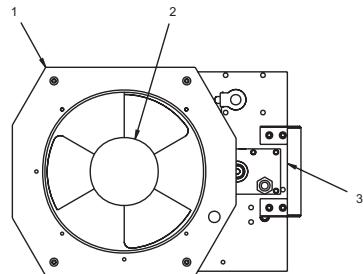


## VF 1-11 GEARBOX ASSEMBLY HT10K

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



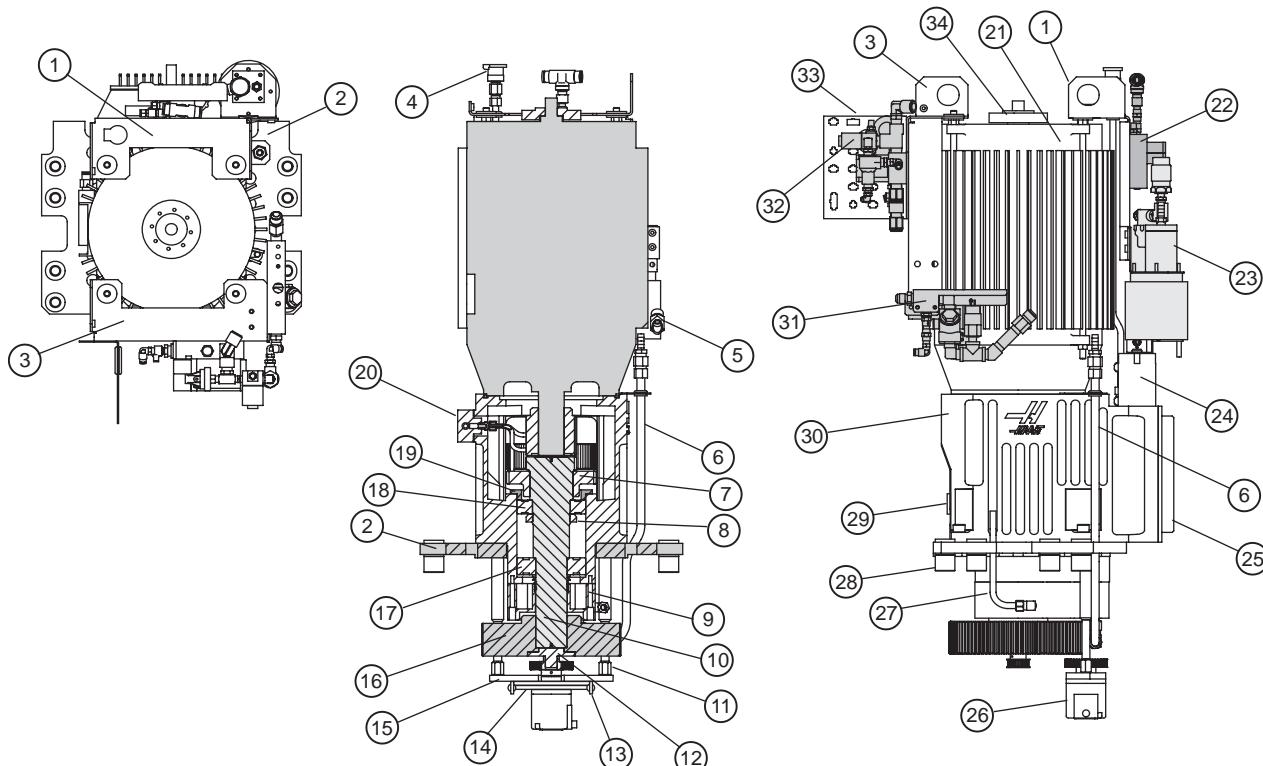


## VF 1-11 GEARBOX ASSEMBLY HT10K TSC

1. 25-0108	Fan bracket motor shroud	52. N/A	
2. 36-3035	Spindle fan assembly	53. 58-3616	3/8 90 deg. elbow 1/4NPT
3. 59-7130	Protective strip	54. 59-4006	Hose crimp, 35/64
4. 32-2011	Switch (30" cable lenght)	55. 59-2040	Cable clamp 7/16
5. 32-2010	24" limit switch	56. 63-1031	Cable clamp 1/4
6. 25-7264	Switch mounting bracket	57. 63-0001	Nylon cable clamp 1/2
7. 59-1482	Nylon finish plug 13/16	58. 58-7635	Low gear tube VF-3
8. 29-0022	Shroud caution decal	59. N/A	
9. 57-0006	O-ring 2-328 buna	60. 58-7636	High gear tube vf-3
10. 29-7399	Transmission motor label	61. 22-7521A	Spacer trans
11. 29-9128	Label, transmission	62. 22-7520A	Isolater trans
12. 48-0020	Pin, dowel 1/4 x 1	63. 58-2110	Sleeve nuts lube assembly
13. 58-2745	Magnetic oil plug	64. 58-2100	Sleeve lube assembly
14. 22-7446	Pick up tube dry sump	65. 30-3146	Air solenoid assy mac tp
15. 22-7445A	Drain tube dry sump	66. 33-5008	Ground strap spindle motor shroud
16. 25-7433	Sump bracket	67. 33-3200	Solenoid bracket cable assembly
17. 22-7376	Sprocket flange	68. 25-7336	Solenoid mounting bracket
18. 20-7374	1 1/8 Sprocket	69. 58-9114B	Trans fill tube
19. N/A		70. 58-2070	1/4NPT male to 3/8 comp
20. N/A		71. 58-2065	Coupling, 1/4NPT
21. N/A		72. 22-7487	Oil fill cap modified
22. N/A		73. 58-2020	3/8OD natural tubing
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		



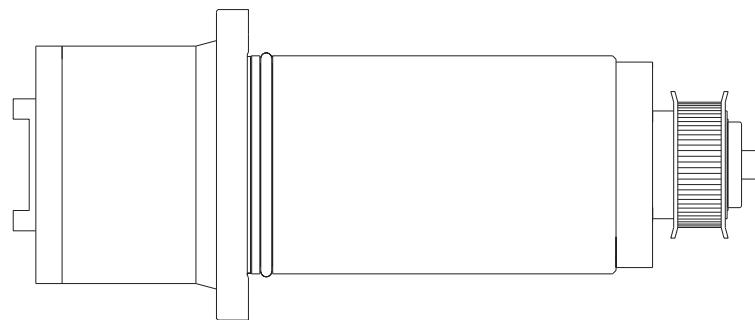
## 50 TAPER GEARBOX ASSEMBLY



- |             |                               |             |                           |
|-------------|-------------------------------|-------------|---------------------------|
| 1. 25-4420  | Oil Pump Bracket              | 26. 32-1457 | Rtap Encoder              |
| 2. 20-1452  | Transmission Plate            | 27.         | Dipstick                  |
| 3. 25-4419  | Solenoid Bracket              | 28. 20-1396 | Transmission Spacer Plug  |
| 4. 22-7487  | Oil Fill Cap                  | 29.         | Oil Sight Level           |
| 5. 30-3275  | TSC Check Valve               | 30. 20-1526 | Housing Gearbox           |
| 6. 58-0609  | Oil Pickup Tube               | 31. 30-3275 | Check Valve Assembly      |
| 7. 20-1440  | Out put Gear                  | 32. 30-3642 | TRP TSC Solenoid Assembly |
| 8. 51-0089  | Bearing Locknut               | 33. 25-4421 | Spindle Connector Bracket |
| 9. 20-1459  | Oil Pan                       | 34. 20-1147 | X-Axis Support Bumper     |
| 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           |             |                           |



## SPINDLE ASSEMBLIES



### SPINDLES

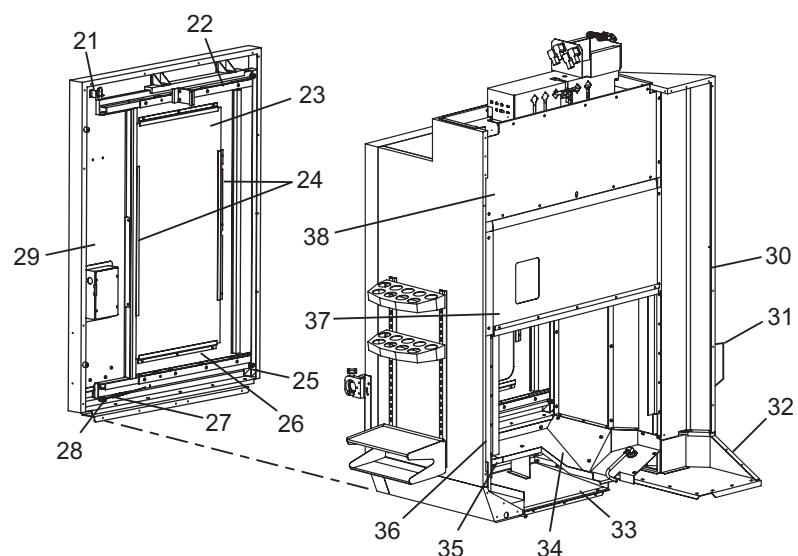
- 30-0319A 7.5 Spindle Assembly
- 30-2132 10K Spindle Assembly
- 30-1360A 15K Spindle Assembly
- 30-30723 15K spindle Assembly VF5-11
- 30-2014 50 Taper Spindle Assembly

### DRAWBAR

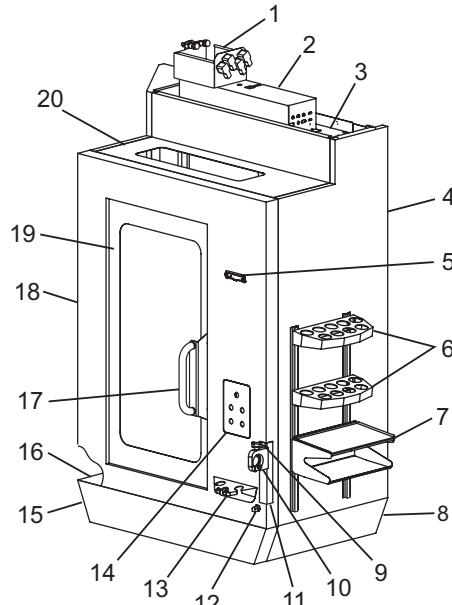
- 30-30714 7.5k spindle with or without TSC
- 30-30729 50 Taper



## MDC-500 FRONT PANELS ASSEMBLY



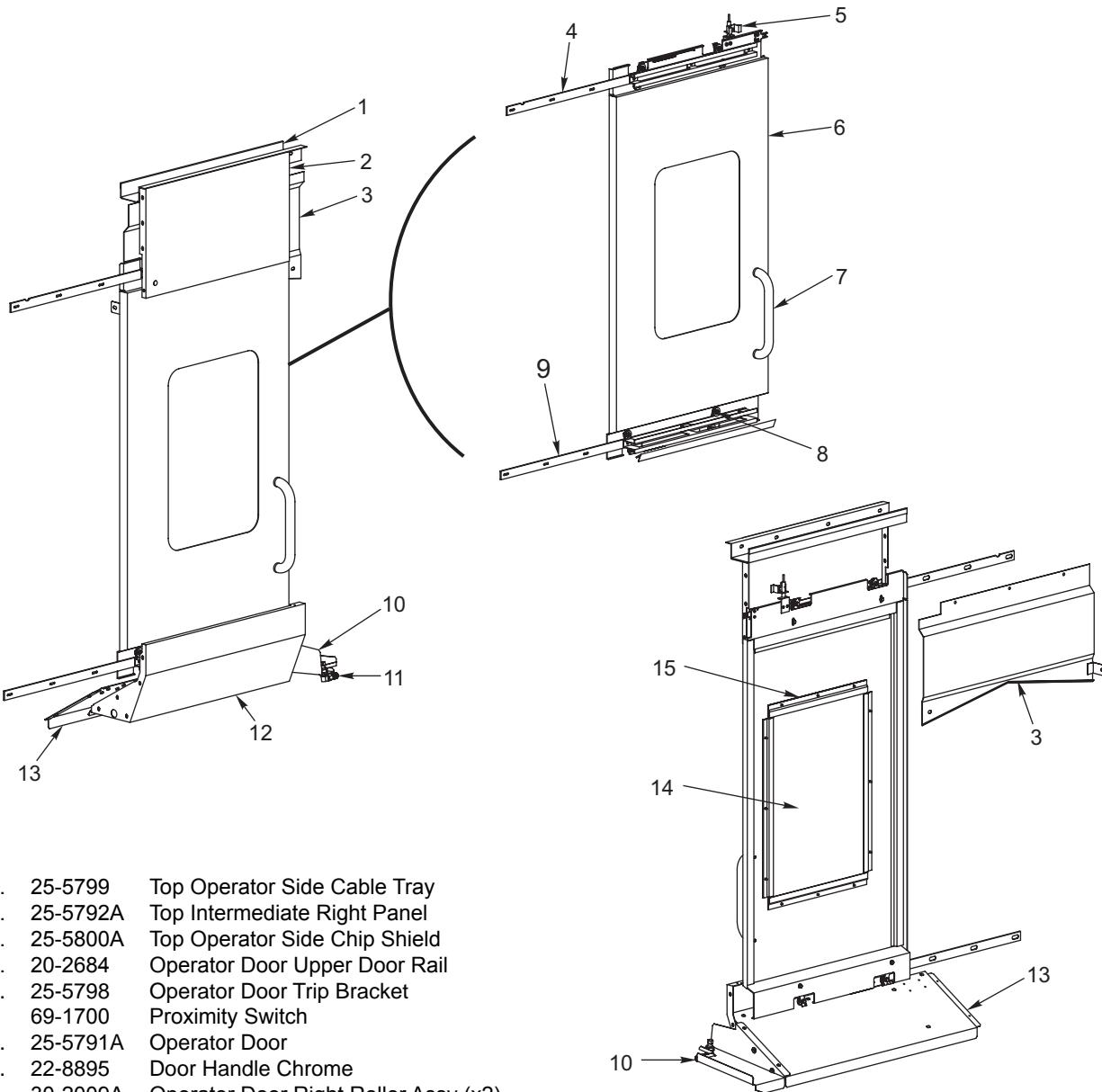
View Rotated 90° CW for Clarity



- |              |  |              |                                    |
|--------------|--|--------------|------------------------------------|
| 1. 25-6801A  | 4th Axis Box Connector / Cable Support   | 22. 20-2317  | Rail Load Station (x2)             |
| 2. 25-5683C  | Intermediate J-Box Top Cover             | 23. 28-0165  | Front Door Window                  |
| 3. 25-5681A  | Intermediate Top Cover                   | 24. 25-0668  | Side Window Retainer (x2)          |
| 4. 25-5678B  | Front Right Panel                        | 25. 59-6400A | Guide Wheel                        |
| 5. 59-0123   | Sanders K 18 Wire Clip                   | 49-2015      | PTHS 1/4-20 x 7/8                  |
| 6. 25-0440A  | Tool Tray (x2)                           | 46-1625      | Nut 1/4-20 Hex                     |
| 7. 25-6182D  | Front Table                              | 45-16390     | Washer                             |
| 8. 25-5740D  | Front Right Pan                          | 26. 25-0669  | Top-Bottom Window Retainer (x2)    |
| 9. 59-0278   | Knob Head 3/8-16 x 1-1/4 Dog Point Screw | 27. 59-9743  | Front Door Spring                  |
| 10. 20-1341  | Tool Holder Block                        | 28. 30-2009A | Lower Right Corner Roller Assembly |
| 11. 25-0798  | Tool Holder Bracket                      | 29. 25-5810A | Front Door                         |
| 12. 58-1671  | Nipple 1/8 NPT x 2                       | 30. 25-5682A | Tool Trays Panel                   |
| 58-3618      | Street Elbow 1/4, 90 Degree              | 31. 25-0563B | Tool Box Assembly                  |
| 13. 25-5412  | Nozzle Holder Bracket                    | 32. 25-5738D | Left Intermediate Pan              |
| 14. 25-1257A | Front Panel Switch Box                   | 33. 25-5742A | Center Bottom Pan                  |
| 15. 25-5741B | Front Center Pan                         | 34. 25-5784C | Front Left Chip Shield Pan         |
| 16. 25-5739  | Front Left pan                           | 35. 25-5785C | Front Right Chip Shield Pan        |
| 17. 25-7412  | Door Handle Bracket                      | 36. 25-5806A | Operator Door Tunnel               |
| 22-8895      | Door Handle Chrome                       | 37. 25-5685A | Lower Partition                    |
| 18. 25-5809B | Center Front Panel                       | 38. 25-5684C | Upper Partition                    |
| 19. 30-8652  | Front Door Assembly                      |              |                                    |
| 20. 25-5680A | Center Front Panel                       |              |                                    |
| 21. 69-1700  | Proximity Limit Switch                   |              |                                    |



## MDC-500 OPERATOR DOOR ASSEMBLY

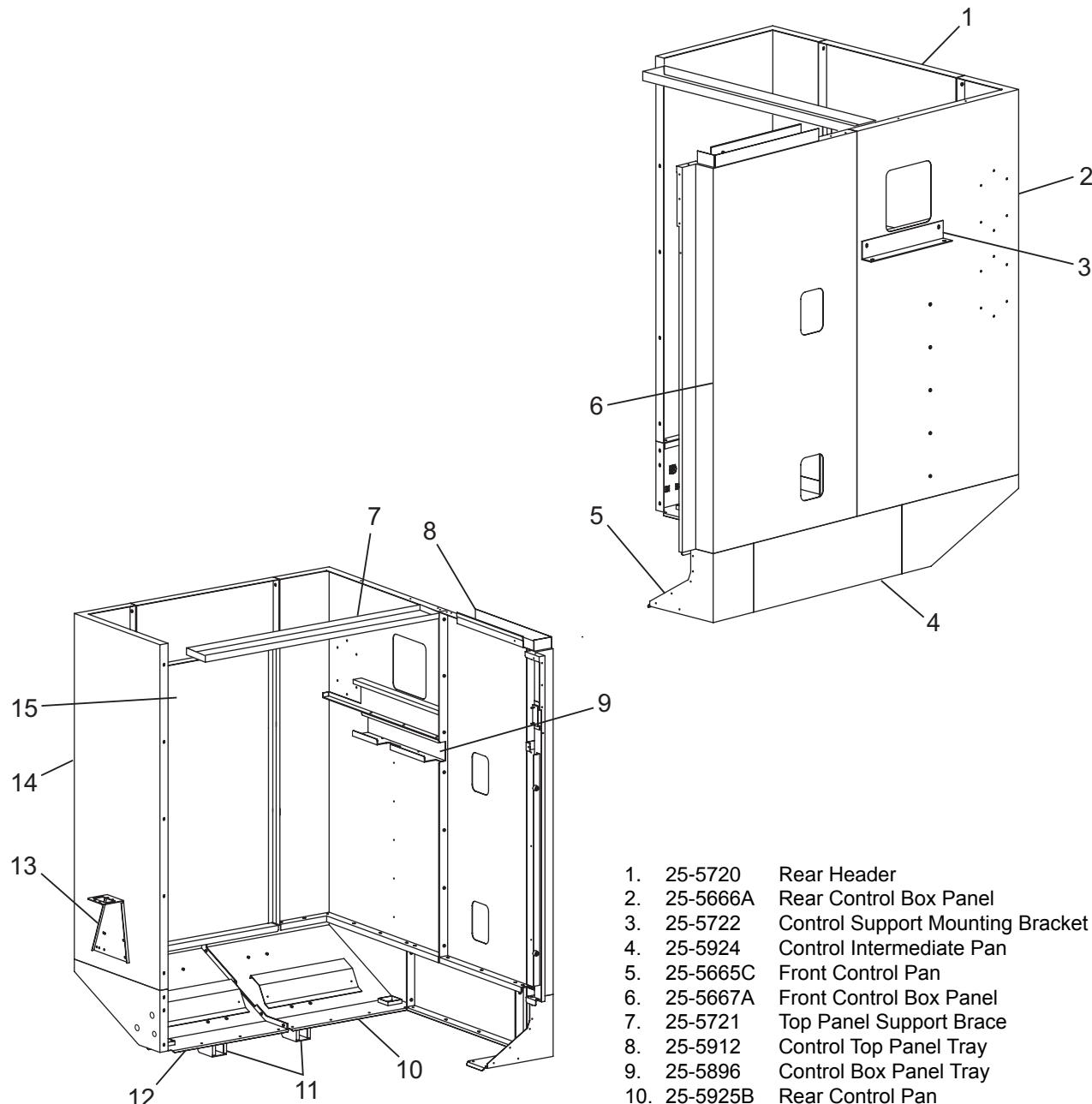


View Rotated 180° for Clarity

1. 25-5799 Top Operator Side Cable Tray
2. 25-5792A Top Intermediate Right Panel
3. 25-5800A Top Operator Side Chip Shield
4. 20-2684 Operator Door Upper Door Rail
5. 25-5798 Operator Door Trip Bracket
6. 69-1700 Proximity Switch
7. 25-5791A Operator Door
8. 22-8895 Door Handle Chrome
9. 30-2009A Operator Door Right Roller Assy (x2)
10. 59-9743 Door Spring
11. 20-2685 Operator Door Lower Door Rail
12. 25-5790B Right Bottom Rollup Chip Shield
13. 30-8526 Rear Washdown Nozzle
14. 25-5788C Right Intermediate Pan
15. 25-5789B Operator Side Lower Chip Shield
16. 28-0151 Window
17. 25-5228 Window Z Frame (x2)



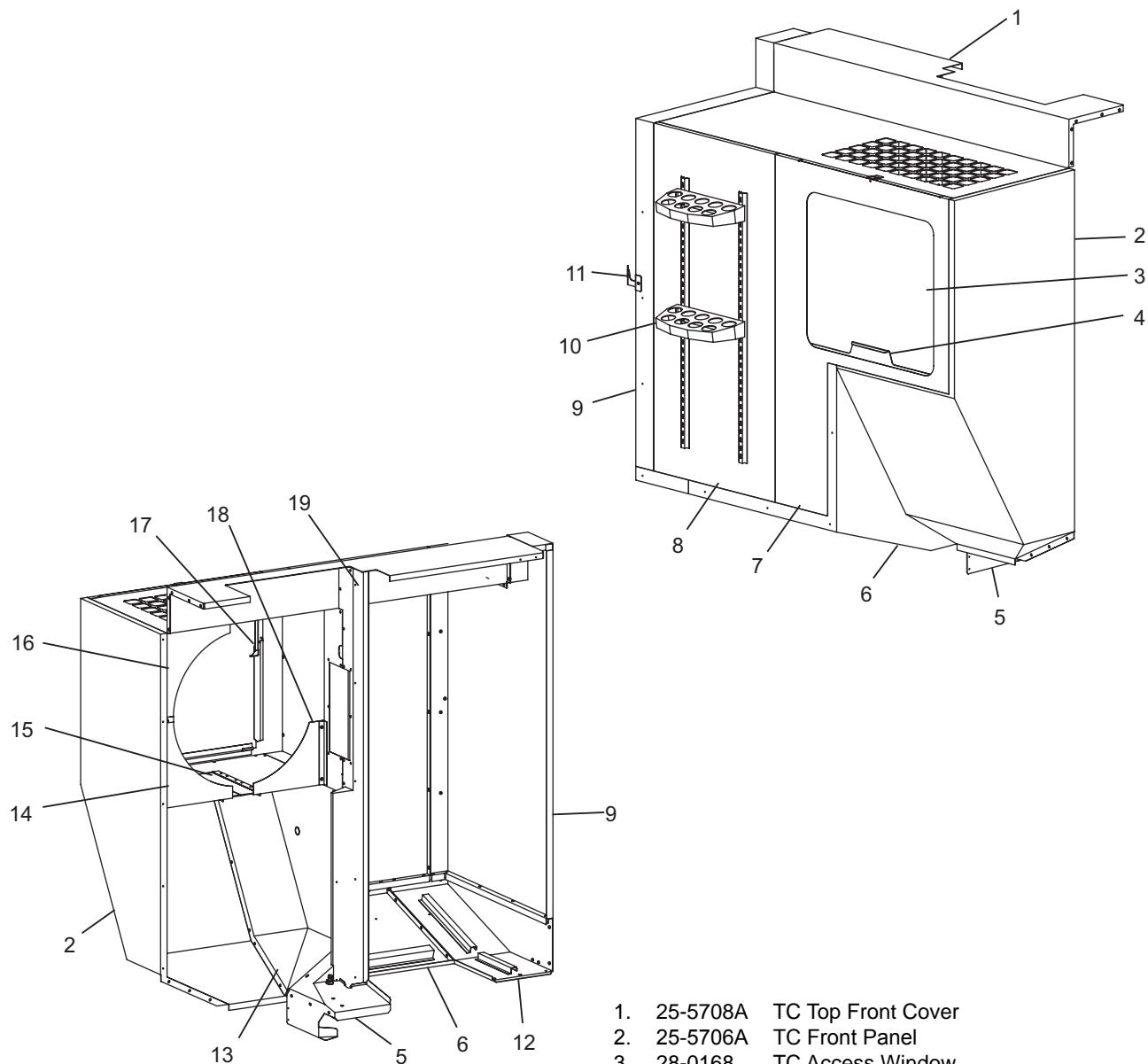
## MDC-500 REAR PANELS



- |     |          |                                  |
|-----|----------|----------------------------------|
| 1.  | 25-5720  | Rear Header                      |
| 2.  | 25-5666A | Rear Control Box Panel           |
| 3.  | 25-5722  | Control Support Mounting Bracket |
| 4.  | 25-5924  | Control Intermediate Pan         |
| 5.  | 25-5665C | Front Control Pan                |
| 6.  | 25-5667A | 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. | 25-5925B | Rear Control Pan                 |
| 11. | 25-5897  | Rear Panel Support Bracket (x2)  |
| 12. | 25-5664C | Rear Left Pan                    |
| 13. | 25-8951  | TSC Filter Bracket               |
| 14. | 25-5718  | Rear Left Panel                  |
| 15. | 25-5719  | Rear Panel Access Cover          |



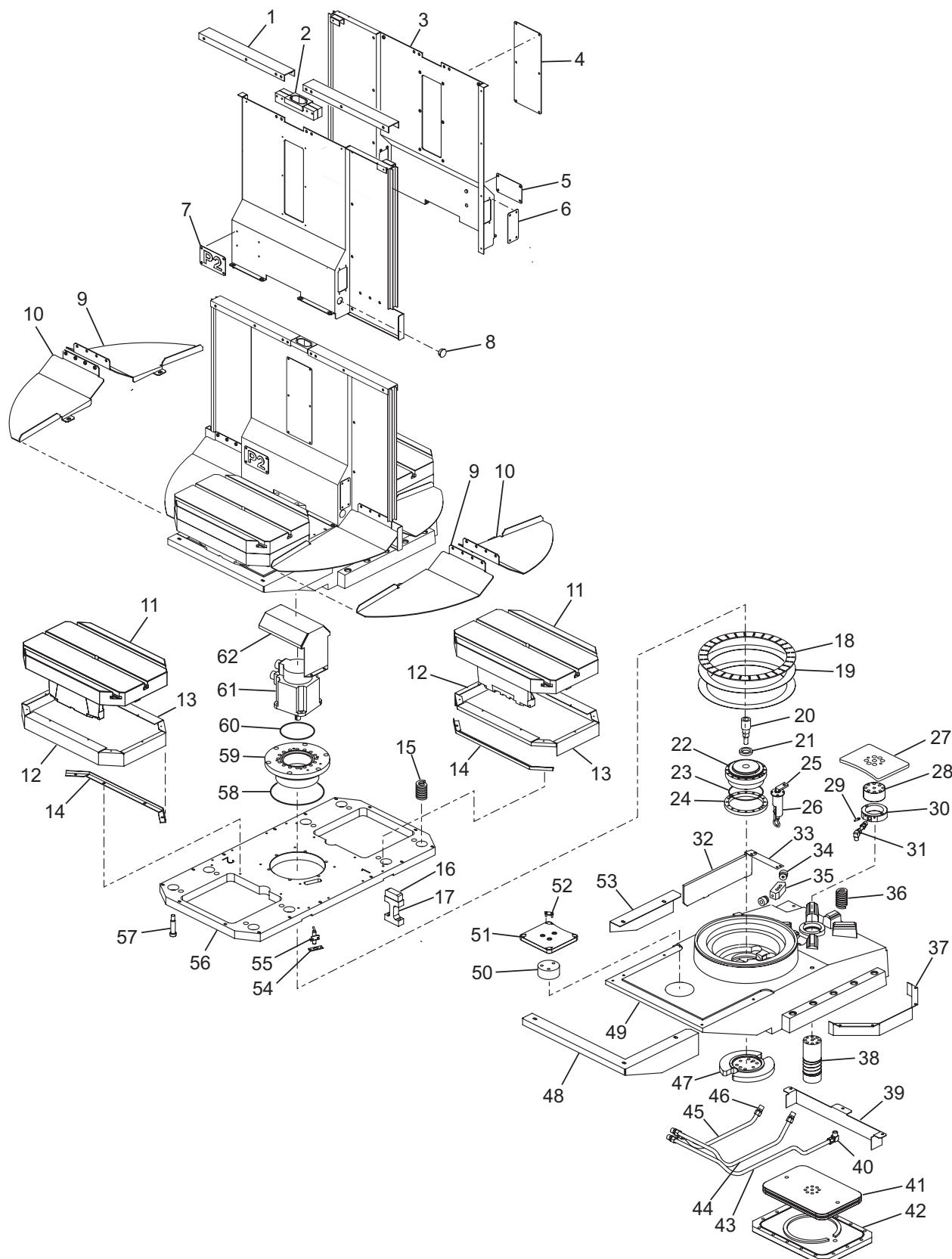
## MDC-500 TOOL CHANGER ENCLOSURE



- 1. 25-5708A TC Top Front Cover
- 2. 25-5706A TC Front Panel
- 3. 28-0168 TC Access Window
- 4. 25-9248A Window Plate Handle
- 5. 25-5717A Left Bottom Rollup Chip Shield
- 6. 25-5707D TC Front Pan
- 7. 25-5710B TC Side Panel
- 8. 25-5955A TC Side Rear Panel
- 9. 25-5709 TC Rear Panel
- 10. 25-0440A Tool Tray (x2)
- 11. 25-9262A Wash Handle and Hose Holding Bracket
- 12. 25-5705A TC Rear Pan
- 13. 25-5715C Rear TC Panel Chip Shield
- 14. 25-5713 Front TC Chip Guard
- 15. 26-0155 Left Chip Shield Small Nylon Strip Brush
- 16. 25-5714 Right TC Upper Shield
- 17. 25-4221C Window Rest Opposite Side
- 18. 25-5712A Rear Tool Splash Guard
- 19. 25-5703 TC Bracket Roll Up Mount



## MDC-500 PALLET AND CHANGER ASSEMBLY



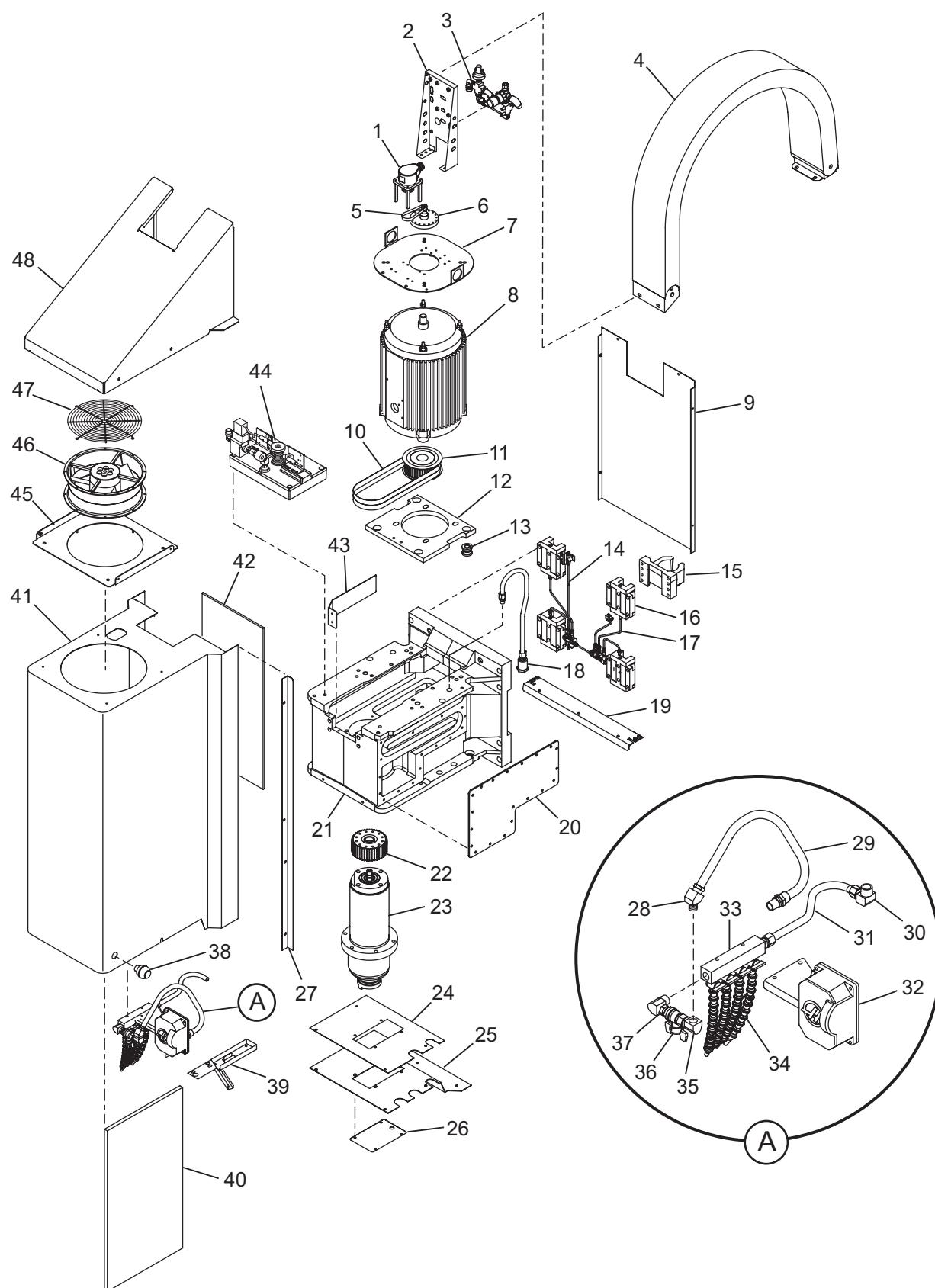


## MDC-500 PALLET AND CHANGER ASSEMBLY

1. 25-5813A	Rotating Door Cap	52. 25-5934	Button Retainer (x4)
2. 20-2695B	Rotating Door Fairlead (x2)	40-1640	SHCS 10-32 x .50 (x8)
3. 25-5812B	Rotating Door (x2)	20-2814	Stabilizer Button (x4)
4. 25-6813	Cable Access Cover (x2)	53. 25-6794	Left APC Base Chip Shield
5. 29-0579	(P1) Name Plate	54. 25-5903	Proximity Switch Pallet Home Mount
6. 25-5883	Access Cover (x4)	55. 69-1601	Proximity Switch
7. 29-0580	(P2) Name Plate	56. 20-2729C	Pallet Support Frame
8. 59-0198	Hole Plug 1 in. Dia. (x2)	57. 49-0117	Shoulder Bolt .625 x 2 in. LG (x8)
9. 25-6943A	PC Table Chip Shield	58. 57-0139	O-Ring 2-263
10. 25-6944A	PC Table Chip Shield Opposite Side (x2)	59. 20-2724	Motor Flange RV20E
11. 20-2689D	PC Table Cast Machined	60. 57-2875	O-Ring 2-157
12. 25-5906A	Rear Table Skirt (x2)	61. 62-0014	Servo Motor
13. 25-5907A	Front Table Skirt (x2)	62. 25-6845	Motor Cover
14. 25-5909A	H-Frame Seal (x2)		
15. 59-0726	Spring 9588K83 (x8)		
16. 20-2809	APC H-Frame Button		
17. 20-2785A	APC Support Frame Pad		
18. 25-5915	PC Roller Cage		
51-0018	Roller Bearing 4mm x 7.50 (x60)		
19. 25-5916	Wear Surface Rotary Frame (x2)		
20.	Shaft RV20E161		
21. 57-0367	Seal		
22.	Body RV20E161		
23. 57-2875	O-Ring 2-157		
24. 20-2725	Nut Plate RV20E		
25. 20-2698	Pallet Flag		
26. 20-2699B	Pallet Clamp Switch Plunger		
20-3073B	Clamp Switch Housing		
32-2236	Proximity NC Unclamp Switch		
27. 20-2715	Pallet Clamp		
28. 20-2716A	Pallet Clamp Shaft		
29. 20-2582B	Air Blast Nozzle (x6)		
30. 20-2727B	Air Blast Ring		
31. 58-2070	Fitting Comp		
58-0780A	Air Blast Input Tube		
58-3617	Fitting Comp		
32. 25-7041	Cable Clamp Side Cover		
33. 25-6827	Switch Cable Cover		
34. 59-0725	High Load Bumper (x2)		
35. 20-2728	Stop Block		
36. 59-0727	Die Spring		
37. 25-5900A	APC Half Skirt (x2)		
38. 20-2716A	Pallet Clamp Shaft		
39. 25-6904A	PC Base Chip Guard		
40. 58-3052	Fitting Comp		
41. 20-2700	Pallet Clamp Piston		
42. 20-2719	Clamp Cylinder Cover		
43. 58-0777A	APC Unclamp Tube		
44. 58-0779A	APC Airblast Tube		
45. 58-0778A	APC Clamp Tube		
46. 58-3087	Fitting Comp (x5)		
47. 20-2783	Drive Plate RV20E		
48. 25-6793	Right APC Chip Shield		
49. 20-2690B	PC Base Cast Machined		
50. 20-2813	Stabilizer Spacer		
51. 20-2812	Stabilizer Plate		



### MILL DRILL SPINDLE HEAD ASSEMBLY



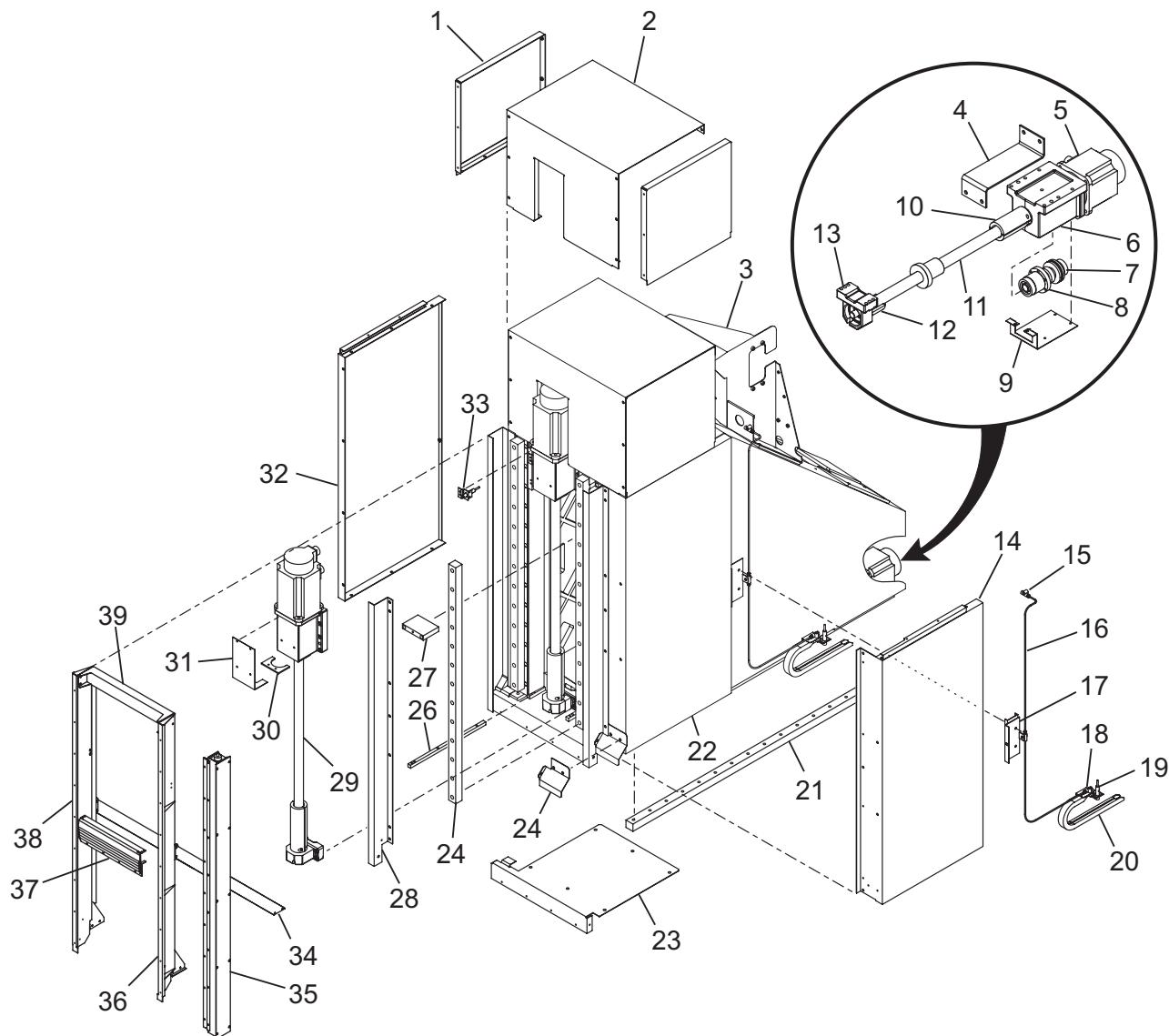


## MILL DRILL SPINDLE HEAD ASSEMBLY

1. 30-30064 Encoder
- 22-9671 Encoder Standoff (x4)
- 54-0037 Drive Sprocket
2. 25-7336E Solenoid Mounting Bracket
3. 30-3156B Air Solenoid Assy.
4. 59-0091A Cable Carrier
5. 54-0036 Drive Belt
6. 20-0531 Encoder Drive Sprocket
7. 25-9667C Encoder Mounting Plate
8. 62-3045 Spindle Motor 10HP
9. 25-9667C Encoder Mounting Plate
10. 54-2660 Spindle Drive Belt
11. 20-9672 Sprocket 1.375
- 22-7376B Sprocket Flange (x2)
12. 20-7429C Motor Isolated Sub-Plate
13. 22-7521B Trans Spacer (x4)
- 22.7520A Isolator Trans (x8)
14. 30-7494 Spindle Head Upper Oil Line Assy.
15. 20-7008F Nut Housing Machined
16. 50-3400 X-Axis Linear Guide
17. 30-7525 Column Oil Line Assy.
18. 58-0883 Cooling Jacket Tube
- 58-2071 Fitting Comp (x2)
- 58-1680 Bulkhead Fitting
19. 25-5737 Gordillo Adapter Plate
20. 25-6288 Coolant Jacket Cover
21. 20-7005E Spindle Head Machined
22. 20-7373 Pulley 1.875
23. 30-6656 Spindle 7-5K
24. 59-9134B Bottom Head Cover Sound Foam
25. 25-7096D Bottom Head Cover
26. 25-7284 Inspection Cover
27. 25-5747 Spindle Head Right Chip Seal
- 25-5748 Spindle Head Left Chip Seal
28. 58-1721 Elbow 45-Degree (x2)
29. 52-0026A P-Cool Hose Straight Swivel
30. 58-3619 Elbow NPT .50
31. 58-0205A Manifold Connector Tube
32. 30-7151 P-Cool Assy.
33. 20-7247A Coolant Block
34. 58-3694 Loc-Line Valves .25 (x4)
- 59-8500 Loc-Line .25 (x4)
- 58-5000 Loc-Line Nozzle (x4)
35. 58-1722 Street Elbow
36. 58-0326 Ball Valve
37. 58-3600 Nipple
38. 61-1040 Pushbutton Switch (Tool Release)
39. 25-8164 P-Cool Cable Cover
40. 59-9132A Spindle Head Cover Sound Foam (x2)
41. 25-7600H Spindle Head Cover
42. 59-9131A Front Head Cover Sound Foam
43. 25-0982 Thermal Liner Retaining Bracket (x2)
44. 30-3201B TRP Assy.
45. 25-6804 Spindle Fan Mounting Bracket
46. 36-3035C Spindle Fan Assy.
47. 59-0144 Fan Guard
48. 25-6805 Top Spindle Head Chip Cover



## MILL DRILL COLUMN AND FRAME ASSEMBLY



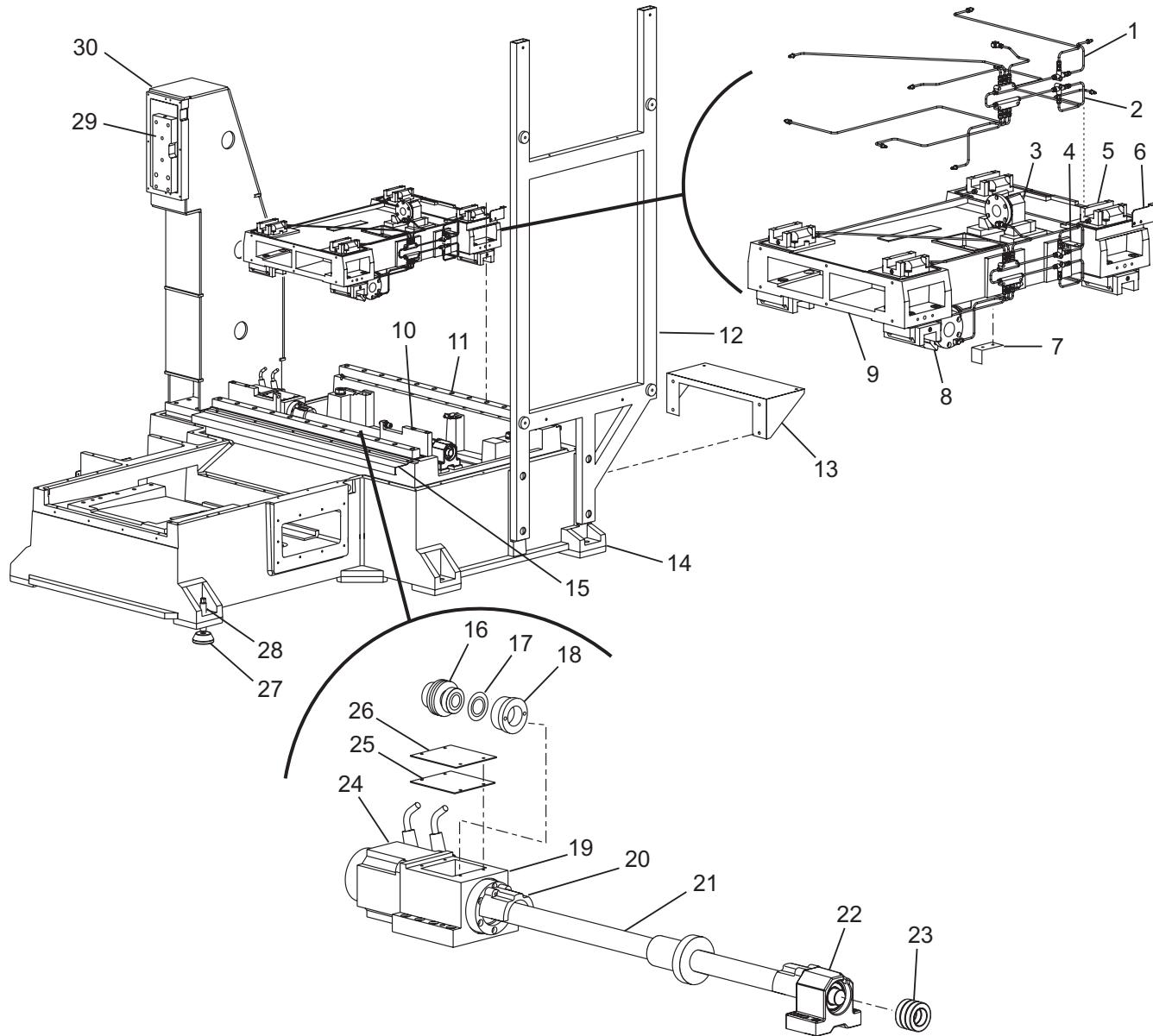


## MILL DRILL COLUMN AND FRAME ASSEMBLY

1. 25-5729 Top Column Side Cover (x2)
2. 25-5728 Top Column Top Cover
3. 25-5734C Cable Carrier Mounting Bracket
4. 25-5736 Column-Saddle Shipping Bracket
5. 62-0014 Servo Motor
6. 20-7010B Motor Mount Machined
7. 30-1220A Coupling Assy.
8. 30-0154 Motor Housing Bearing Assy.
9. 25-7042 Motor Mount Cover Plate
10. 28-0185 Bumper (Motor End)
11. 24-0023 Ballscrew 32-8-800
12. 28-0201 Bumper (Support End)
13. 30-0153 Support Bearing Assy.
14. 25-5724 Right Column Cover
15. 58-2760 Lube Fitting BIJUR No. B-3288 (x 3)
- 58-2110 Lube Fitting Compression Nut (x 4)
16. 58-0766 Copper Tube (x2)
17. 25-5733 Column Cover Nutplate (x2)
- 25-5732 Column Cover Support (x2)
18. 25-5735 Column Oil Line Bracket
19. 25-7267 Y-Axis Mounting Bracket
- 69-1700 Proximity Switch
20. 59-0305 Column Cable Carrier
21. 50-3400 X-Axis Linear Guide 35 x 1320 (x2)
22. 20-2588A Column Casting Machined
23. 25-5723 Bottom Chip Cover Plate (x2)
24. 25-5730A Y-Axis Rail Cover
25. 50-3300 Linear Guide 35 x 1000 (x2)
26. 20-2615 Bottom Plate Mounting Bar (x3)
27. 20-2616 Cover Mounting Bar (x2)
28. 25-5726 Gordillo Right Guide
- 25-5727 Gordillo Left Guide
29. 30-3103 Z-Axis Ballscrew Assy. 32-10-993.6
30. 20-3047 Bumper .15 in.
31. 25-0357 Motor Mount Cover Plate
32. 25-5725 Left Column Cover
33. 25-7266 X-Axis Mounting Bracket
- 69-1700 Proximity Switch
34. 25-5773 Frame Shade Roller Brace (x2)
35. 59-0706 Shade Roller 70.5 x 21 in. (x2)
36. 25-5770 Shade Roller Right Frame
37. 59-0705 Z-Axis Gordillo Cover
38. 25-5771 Shade Roller Left Frame
39. 25-5772 Shade Roller Top Frame



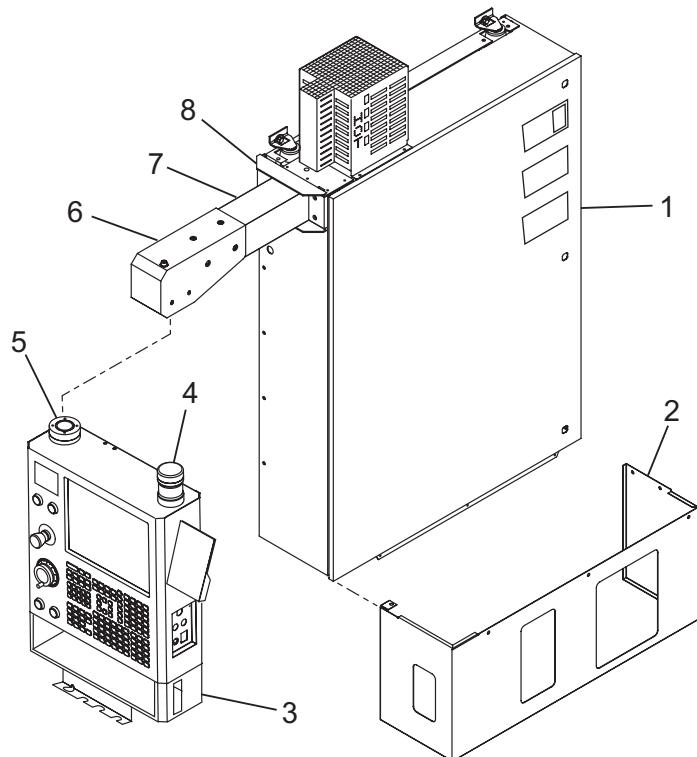
### MILL DRILL BASE AND SADDLE ASSEMBLY



- |              |                                   |              |                          |
|--------------|-----------------------------------|--------------|--------------------------|
| 1. 30-7138   | Saddle Oil Line Assy.             | 16. 30-1215  | Coupling Assy.           |
| 58-3031      | Banjo Elbow                       | 17. 20-9213  | Ballscrew Spacer Ring    |
| 2. 30-7140   | Base Oil Line Assy.               | 18. 20-9211  | Ballscrew Nut Housing    |
| 3. 20-2958A  | Nut Housing Casting Machined      | 19. 20-0151A | Z-Axis Modified Housing  |
| 4. 25-5919   | Cable Carrier Mounting Bracket    | 20. 28-0191  | Bumper 2.5 in. (x2)      |
| 5. 50-3400   | X-Axis Linear Guide 35 x 840 (x2) | 21. 24-0026A | Ballscrew 40-8-1031      |
| 6. 25-5187   | Z-Axis Trip Bracket               | 22. 20-0152  | Bearing Housing          |
| 7. 25-5677   | X-Axis Trip Bracket               | 23. 51-0007  | Deep Groove Bearing (x4) |
| 8. 20-0150   | Ballscrew Ball Nut Housing        | 24. 62-0014  | Servo Motor              |
| 9. 20-2587A  | Saddle Casting Machined           | 25. 26-7233A | Deflector Shield Gasket  |
| 10. 20-2593  | X-Axis Base Ship Block (x2)       | 26. 25-9203  | Motor Mount Cover Plate  |
| 11. 50-9011  | Linear Guide 45 x 1200 (x2)       | 27. 14-7068  | Leveling Pad Casting     |
| 12. 20-2589A | Control Box Support               | 28. 44-0018  | Leveling Screw           |
| 13. 25-5662  | Rear Pan Brace                    | 29. 20-2595  | TC Bracket Spacer Plate  |
| 14. 20-2586E | Base Casting Machined             | 30. 20-2591  | TC Bracket Machined      |
| 15. 25-5668  | X-Axis Lower Chip Shield          |              |                          |



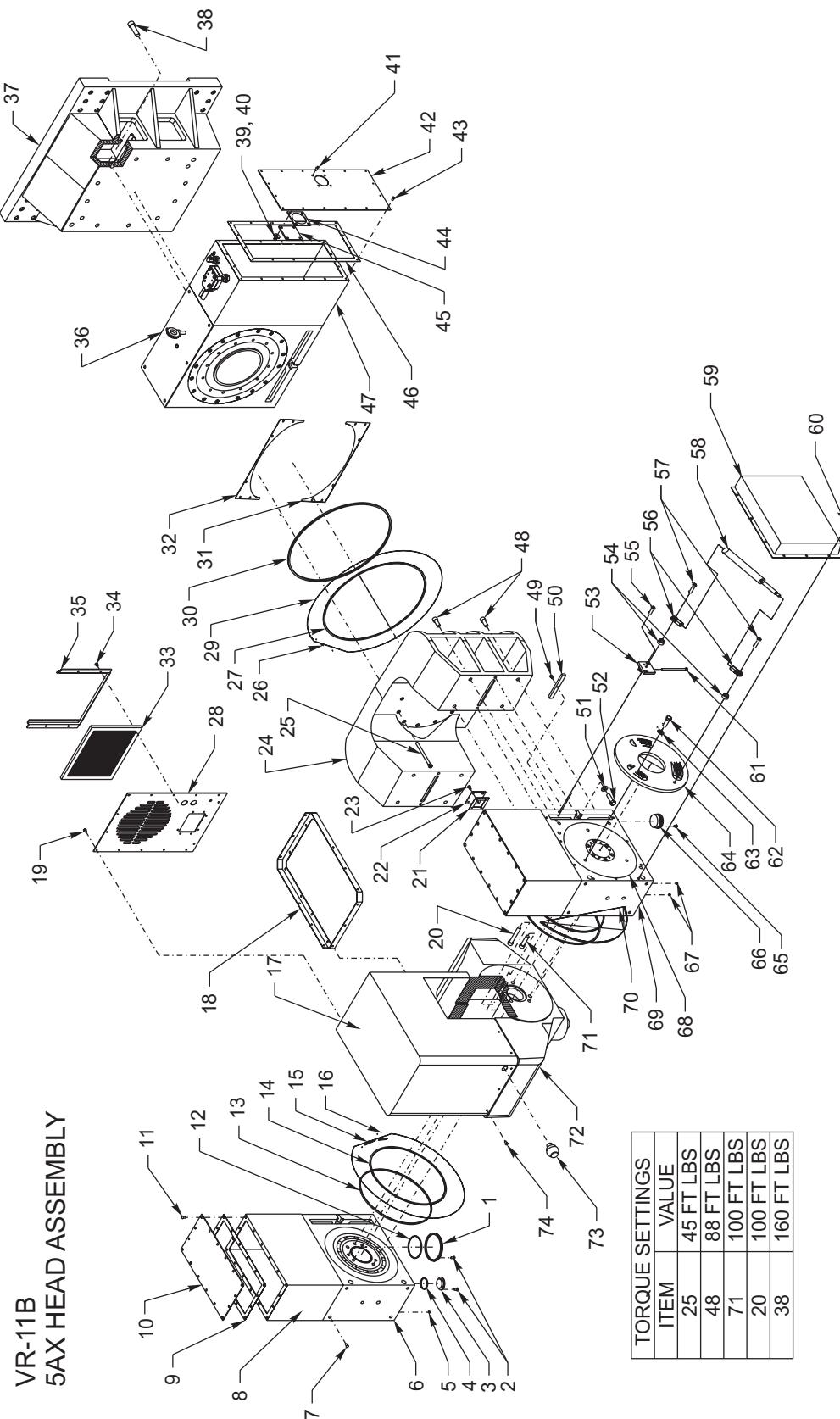
## MILL DRILL CONTROL ASSEMBLY



1. 30-30256 CNC Control
2. 25-10649 Control Box Skirt
3. 32-9651B Pendant Control Assy.  
32-6006A Front Panel Assy.
4. 28-1071 Top Beacon Light Molded  
28-1075C Beacon Plastic Base
5. 20-7109C Swivel Arm Mount  
20-7110C Swivel Control Mount
6. 25-6659A Swivel Mounting Plate  
25-6660 Arm End Cap Bottom Cover  
25-6661A Arm End Cap
7. 20-4137 Control Arm
8. 25-6375 Control Arm Stiffener



## VR-SERIES HEAD ASSEMBLY

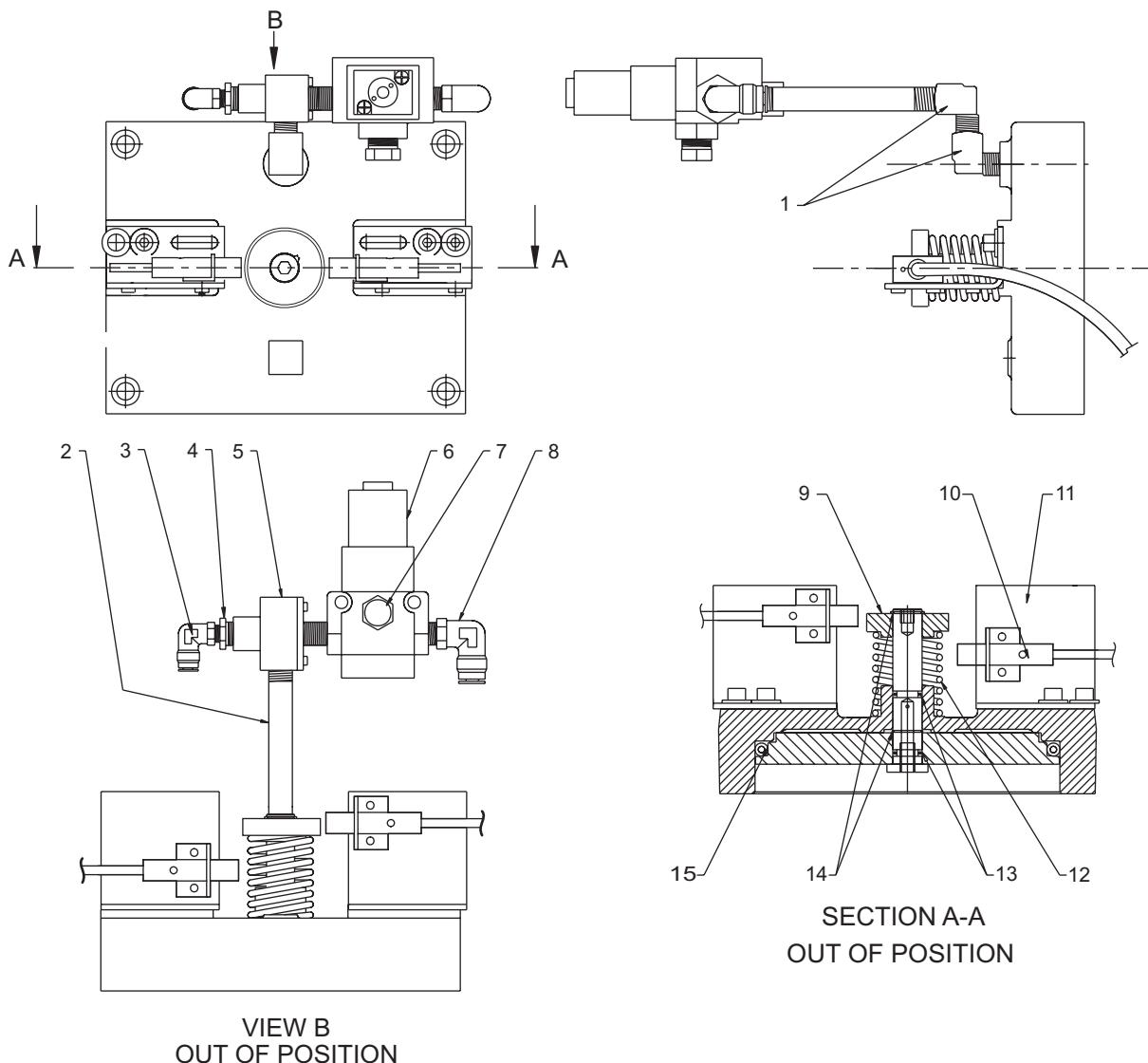


**VR-SERIES HEAD ASSEMBLY**

ID	QTY	DWG#	DESCRIPTION	ID	QTY	DWG#	DESCRIPTION
1.	1	20-4382	WORM HOUSING COVER, 5AX	62.	3	43-0052	HHB 1/2-13 X 3/4
2.	94	49-1750	BHCS 10-32 X 3/8	63.	3	45-1740	WASHER BLACK HARD 1/2
3.	1	20-4381	SIGHT GLASS PLUG	64.	1	20-4366	COUNTERBALANCE PLATE
4.	1	57-2831	O-RING 2-130 BUNA	65.	1	49-1750	BHCS 10-32 X 3/8
5.	1	58-3105	1/4 NPT PIPE PLUG	66.	1	20-4388	WORM PLUG 310 PULLEY SIDE
6.	1	30-1071	HRT310 DRIVE ASSY 5AX	67.	3	58-1627	1/8-27 PIPE PLUG
7.	19	40-1980	BHCS 1/4-20 X 1/2	68.	1	20-4365	BRAKE DISC COUNTERBALANCE
8.	2	25-4371	MOTOR ENCLOSURE 310/5AX	69.	1	30-1072	HRT310 DRIVEN ASSY 5AX
9.	4	57-4223	GASKET MOTOR ENCLOSURE	70.	2	25-4373	TOP COVER 310/5AX
10.	2	25-4375	ENCLOSURE COVER 310/5AX	71.	8	40-1661	SHCS 1/2-13 X 2
11.		49-1750	BHCS 10-32 X 3/8	72.	1	20-4360	5AX SPINDLE HEAD (MACHINED)
12.	1	57-2250	O-RING 2-156 VITON	73.	1	61-1040	SWITCH PSHBTN GRAY CABLE
13.	2	57-4384	HRT310 TEFLON SEAL	74.		49-1750	BHCS 10-32 X 3/8
14.	2	57-2980	O-RING 2-278 VITON				
15.	3	94-4409	VR11 ORING BANDCLAMP				
16.	13FT	25-9414	BANDING TR 310, VR 8-11				
17.	1	25-4363	5AX HEAD COVER				
18.	1	25-4364	HEAD COVER MOUNTING ANGLE				
19.		49-1750	BHCS 10-32 X 3/8				
20.	4	40-16626	SHCS 1/2-13 X 3 1/4				
21.	1	57-4133	J-BOX GASKET				
22.	1	25-4372	BLOCK OFF PLATE 310/5AX				
23.	4	40-1669	BHCS 8-32 X 3/8				
24.	1	20-4361	5AX YOKE (MACHINED)				
25.	12	40-164391	SHCS 3/8-16 X 5 1/4				
26.		94-4409	VR11 ORING BANDCLAMP				
27.	1	57-0093	O-RING 2-385 BUNA				
28.	1	25-4362	5AX HEAD COVER, BACK PLATE				
29.		25-9414	BANDING TR 310, VR 8-11				
30.	1	57-4385	HRT450 TEFLON SEAL				
31.	1	25-4405	TOP FRONT COVER 5AX				
32.	1	25-4406	BOTTOM FRONT COVER 5AX				
33.	1	59-9088	AIR FILTER HEAD COVER				
34.		49-1750	BHCS 10-32 X 3/8				
35.	1	25-4407	HEAD FILTER BRACKET				
36.	1	30-1070	HRT450 ASSY W/5AX MODS				
37.	1	20-4367	5AX HEAD SPACER (MACHINED)				
38.	12	40-16643	SHCS 5/8-11 X 2 1/4				
39.	4	45-1850	WASHER FENDER 1/4 ID X 1 OD				
40.	4	46-1625	NUT HEX BLK OX 1/4-20				
41.	4	40-1976	BHCS 1/4-20 X 3/4				
42.	1	25-4386	ENCLOSURE COVER 450/5AX				
43.		49-1750	BHCS 10-32 X 3/8				
44.	1	57-4278	GASKET SIGHT GLASS				
45.	1	28-4278	SIGHT GLASS PRESS GAGE				
46.	1	57-4261	ENCLOSURE COVER GASKET 450				
47.	1	25-4366	MOTOR ENCLOSURE 450				
48.	8	40-16575	SHCS 1/2-13 X 1 1/4				
49.	20	40-1630	SHCS 1/4-20 X 5/16				
50.	2	20-4230	KEY, BODY				
51.	4	45-1740	WASHER BLACK HARD 1/2				
52.	4	40-1830	HHB 1/2-13 X 1 3/4				
53.	1	20-4362	PRELOAD CAM CBALANCE				
54.	2	20-4364	STANDOFF TAPERED				
55.	2	40-1639	SHCS 3/8-16 X 1				
56.	2	51-4363	RODEND BALLJOINT F10MM				
57.	2	40-16372	SHCS 3/8-16 X 1 1/2				
58.	1	59-4367	SPRING AIR COMPRESSION				
59.	1	25-4361	COUNTERBALANCE COVER				
60.		49-1750	BHCS 10-32 X 3/8				
61.	1	40-1696	SHCS 1/4-20 X 4 1/2				



### TOOL RELEASE PISTON ASSEMBLY



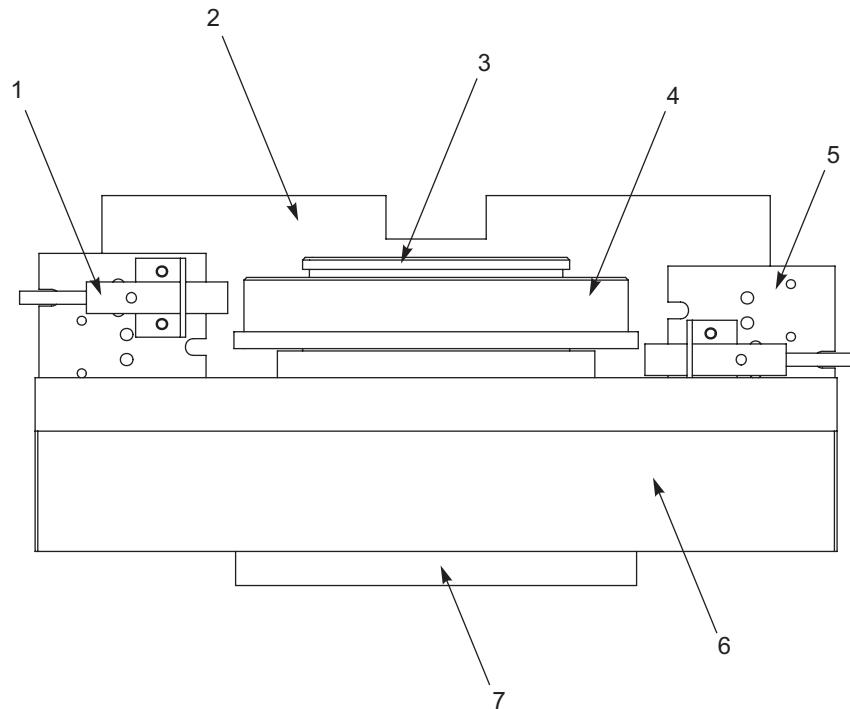
- |              |                                  |
|--------------|----------------------------------|
| 1. 58-3613   | 1/4 Street elbow                 |
| 2. 58-3050   | Elbow 1/4 bylon tubing           |
| 3. 58-3670   | 1/4NPT M 1/8F reducer            |
| 4. 58-3691   | Nipple 1/4 NPT hex X 1 3/8 brass |
| 5. 59-2832B  | Quick exhaust 1/4                |
| 6. 32-5620   | TRP solenoid valve assembly      |
| 7. 58-2265   | Air muffler 3/8 flat             |
| 8. 58-3685   | 1/4NPT M 3/8 tube swivel elbow   |
| 9. 20-1656   | Spring retainer TRP 40T          |
| 10. 32-2201  | Prox L/S Tool Clamp              |
| 11. 25-7050C | Switch mounting bracket          |
| 12. 59-2760  | Comp spring/large wire           |
| 13. 57-0040  | O-ring 2-111 Buna                |
| 14. 56-0040  | Retaining ring N5100-62          |
| 15. 57-0018  | O-ring 2-446 buna                |

**40 Taper Complete Assembly Non-TSC 30-3201B  
Mini Mill TRP Assembly 30-1668B**

**TRP base XHC 30-3207**



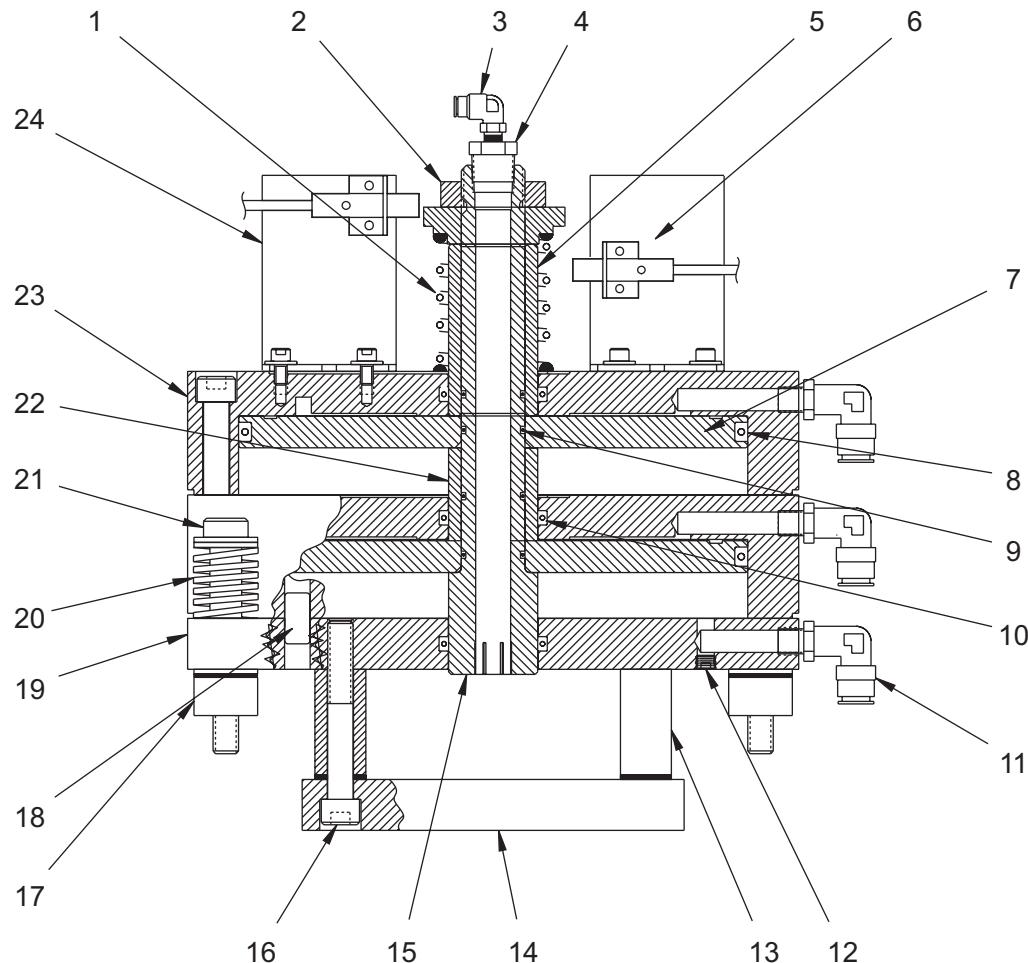
### IN-LINE SPINDLE TOOL RELEASE PISTON



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. 25-4648B Bracket Switch Mounting
6. 20-4269 TRP Cylinder In-line
7. 20-2521 Striker Plate



## 50 TAPER TOOL RELEASE PISTON

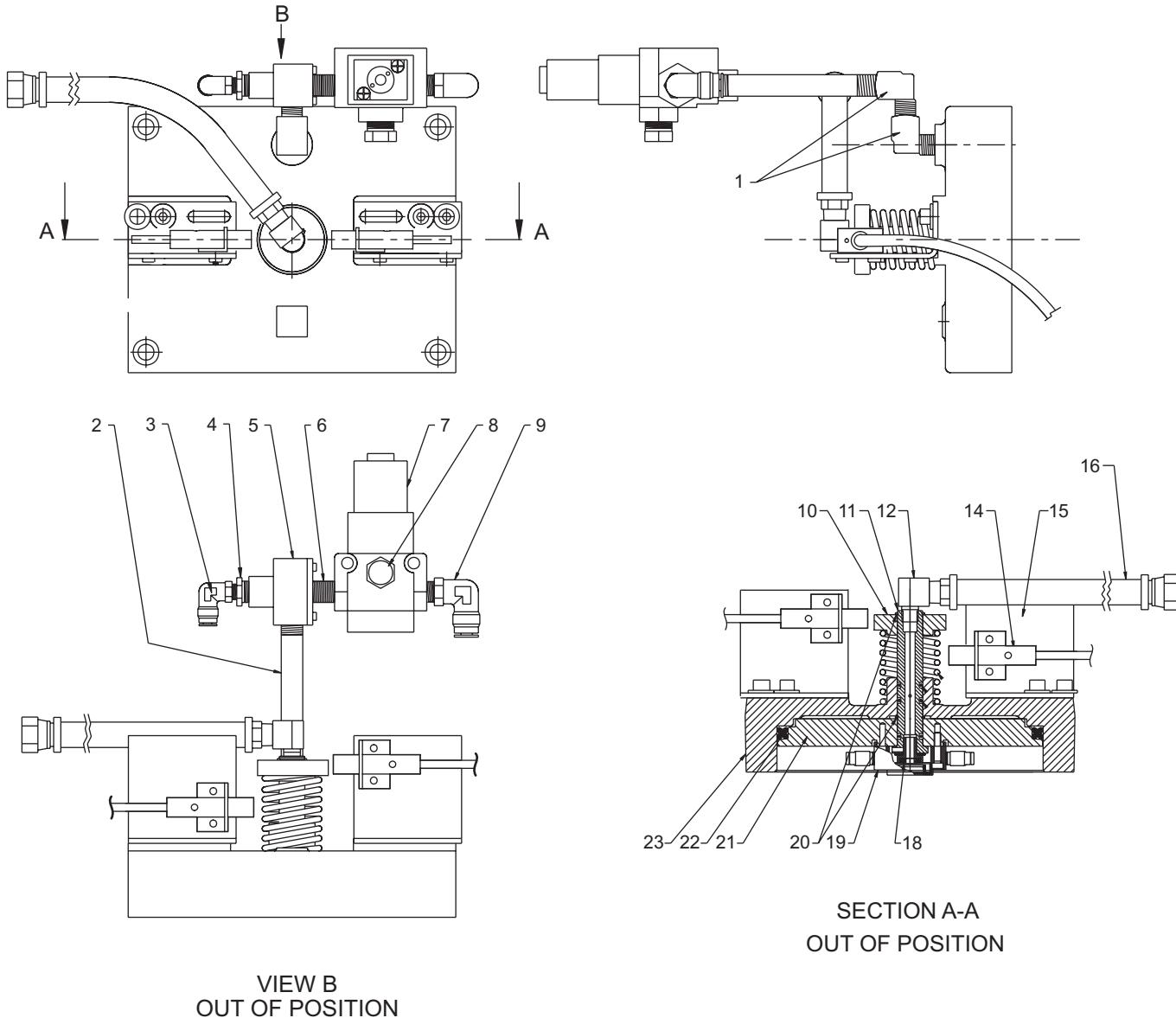


- |              |                           |              |                           |
|--------------|---------------------------|--------------|---------------------------|
| 1. 59-0049   | Spring compression        | 18. 48-1662  | Dowel pin 1/2 x 1         |
| 2. 52-0003   | Shaft clamp               | 19. 20-2988  | Sub plate TRP 50T         |
| 3. 58-3050   | Elbow 1/4 nylon tubing    | 20. 59-0016  | Spring compression        |
| 4. 58-3631   | Reducer bushing 1/2M-1.8F | 21. 49-0003  | Shoulder bolt 5/8 x 3 1/2 |
| 5. 20-0021B  | Spacer upper TRP 50T      | 22. 20-0020A | Spacer lower TRP 50T      |
| 6. 32-2203   | Limit switch unclamped    | 23. 20-0022A | Housing air cylinder      |
| 32-2204      | Limit switch clamped      | 24. 25-0009A | Switch mounting bracket   |
| 7. 20-0019A  | Piston TRP 50T            |              |                           |
| 8. 57-0082   | O-ring 2-448 Viton        |              |                           |
| 9. 57-0027   | O-ring 2-121 Buna         |              |                           |
| 10. 57-0095  | O-ring 2-327 Viton        |              |                           |
| 11. 58-1695  | Elbow 1/4MPT              |              |                           |
| 12. 58-1627  | 1/8-27 pipe plug          |              |                           |
| 13. 20-0013A | Spacer fork spindle       |              |                           |
| 14. 20-0015  | Fork lift Spindle         |              |                           |
| 15. 20-0018A | Shaft TRP 50T             |              |                           |
| 16. N/A      |                           |              |                           |
| 17. 22-0014A | Spacer .62ID x 1.25OD.857 |              |                           |

## 50 Taper complete assembly 30-0013B



### TSCHP Tool Release Piston Assembly



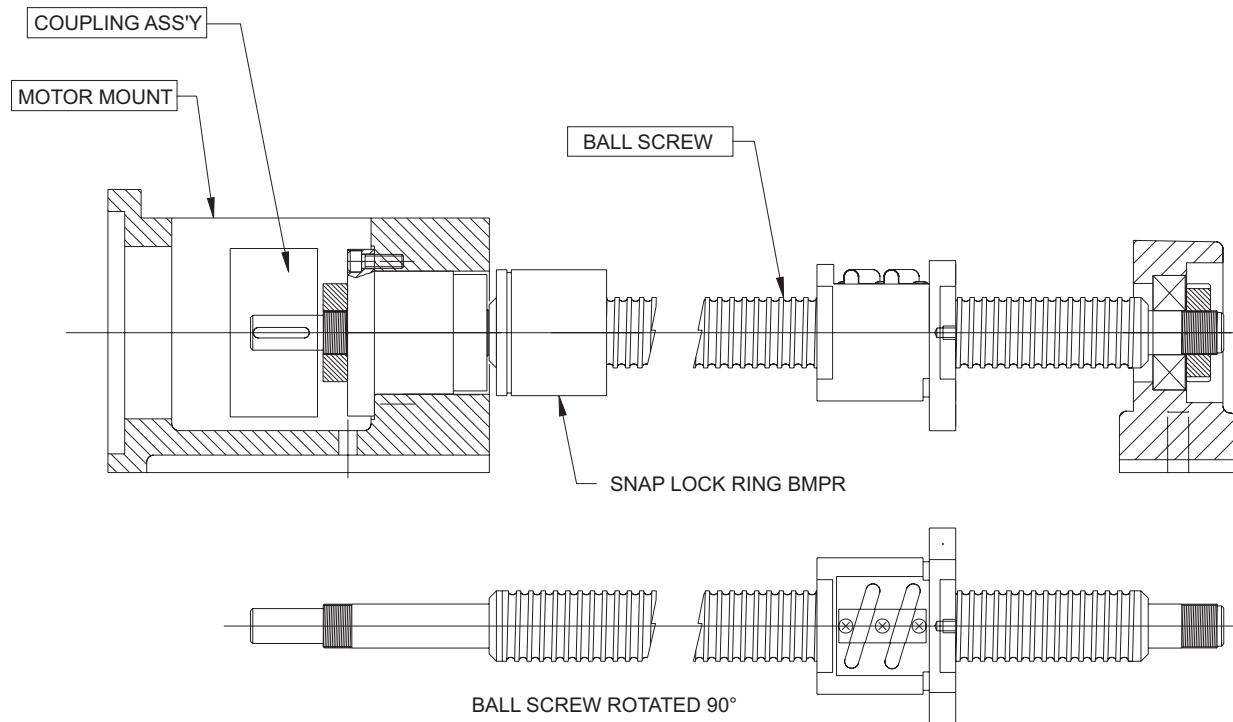
### 30-3207 Complete assembly

1. 58-3618 1/4 Street elbow 90 deg.
2. 58-3727A 1/4NPT x 4 nipple brass (VR-8/9/11)
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 (50T)
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. 20-1656 Spring retainer TRP 30 degree
11. 20-7626C Shaft TRP hex
12. 58-3614 1/4F 1/8M street elbow

14. 32-2200 Limit switch unclamp
15. 32-2201 Limit switch clamp
16. 25-7050C Switch mount tool release
17. 30-6733 Hose Assy Ck Vlv/TRP VF1-11/40T QAPC
18. 30-6734 Hose Assy Ck Vlv/TRP VF5-11/50T , VF-SS, VS-3
19. 30-7292 Hose Assy Ck Vlv/TRP VR-8, VR-9, VR-11
20. 20-7640 Tool Release Bolt, 3/8-LH
21. 20-9590 Seal Housing
22. 56-0040 Retaining ring N5100-62
23. 20-7630B Piston TRP rectangle TSC
24. 57-0105 Quad-ring Q4-114 Viton
25. 20-1514 Cylinder housing



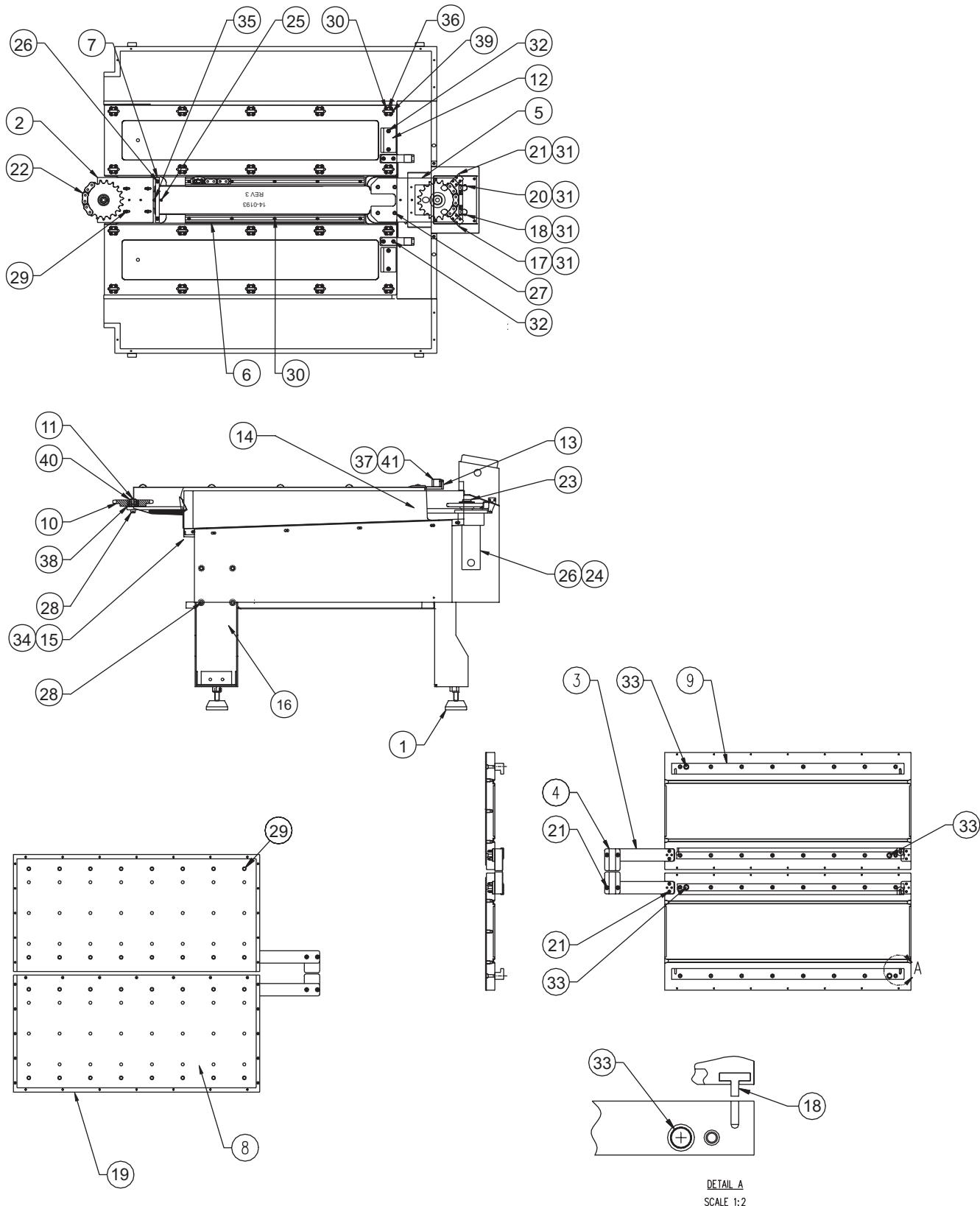
## BALL SCREW ASSEMBLY



	<b>Mini-mill</b>	<b>VF 0-1</b>	<b>VF 2</b>	<b>VF 3</b>	<b>VF 4</b>	<b>VF-5</b>
Base	24-3006	30-3103	30-3103	30-3107	30-3107	30-2273
Saddle	24-3006	30-3103	30-3104	30-3106	30-3108	30-2720
Column	24-3006	30-4053	30-4053	30-3135	30-3135	30-6524
	<b>VF-5XT</b>	<b>VF-6/8</b>	<b>VF-7/9</b>	<b>VF-10/11</b>		
Base	30-2538	30-0474	30-0474	30-0474		
Saddle	30-2536	30-0470	30-0473	30-0516		
Column	30-2536	30-7624	30-7624	30-7624		
<b>50 Taper</b>	<b>VF5</b>	<b>VF-5XT</b>	<b>VF-6/8</b>	<b>VF-7/9</b>	<b>VF-10/11</b>	
Base	30-0202	30-2540	30-0895	30-0895	30-0895	
Saddle	30-0198	30-2539	30-0896	30-0897	30-0516	
Column	30-0202	30-2539	30-0895	30-0895	30-0895	



### APC ASSEMBLY



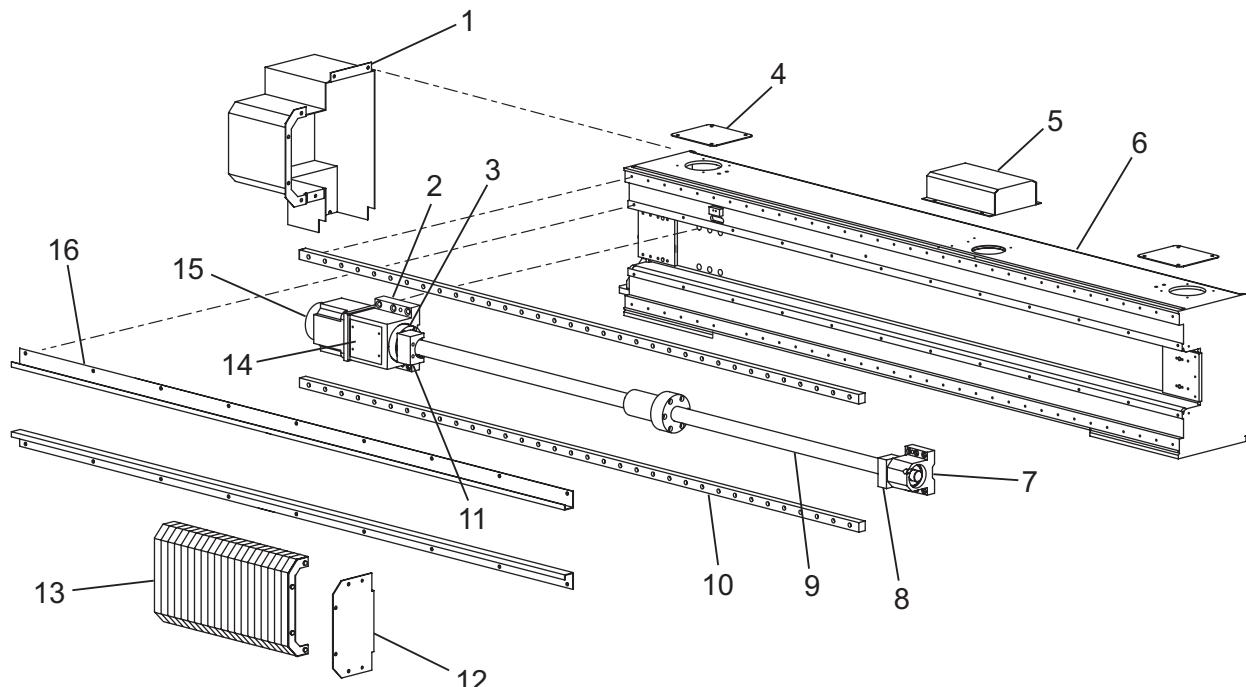


## APC ASSEMBLY

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	20-0050A	SUPPORT, MOTOR, APC
6.	2	20-0051	GUIDE, CHAIN, APC
7.	1	20-0052	TENSIONER BLOCK
8.	2	20-1671	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.	1	20-0193	BASE, MACHINED
15.	1	25-0066A	SHIELD, SPLASH, LOW PROFILE
16.	3	25-0072	LEG, APC
17.	1	25-0082	SWITCH BRACKET, CHAIN, LOW
18.	4	26-8964	WIPER APC
19.	2	25-0095A	PALLET DRIP PAN
20.	1	25-0101	SWITCH BRACKET ARM #2
21.	1	25-0102	SWITCH BRACKET, CHAIN, HIGH
22.	1	30-0054	CHAIN ASSEMBLY, APC
23.	1	30-0055	SLIP CLUTCH ASSEMBLY
24.	1	32-1875	SHUTTLE MOTOR, 507-01-110AH
25.	1	40-1614	SHCS, 1/4-20 X 1 1/4
26.	2	40-1617	FHCS, 1/4-20 X 1"
27.	4	40-1636	SHCS, 3/8-16 X 1 1/4
28.	13	40-1654	SHCS, 1/2-13 X 1"
29.	4	40-1667	SHCS, 5/16-18 X 1 1/4
30.	124	40-1703	FHCS, 10-32 X 1/2
31.	8	40-1850	SHCS, 10-32 X 3/8"
32.	8	40-1920A	FHCS, 1/4-20 X 5/8
33.	4	40-1970	FHCS, 1/4-28 X 1"
34.	3	40-1981	FBHCS, 1/4-20 X 1/2
35.	1	46-1625	NUT, HEX, BLACK OX, 1/4-20
36.	20	48-0012	DOWEL PIN, 12mm X 30 mm LG.
37.	4	51-0030	BUSHING, DRILL .6260 I.D.
38.	2	51-2836	BEARING, RADIAL, #60052RS
39.	20	51-4000A	BEARING, RADIAL 12 X 32 X 10MM
40.	1	56-0085	RETAINING RING 5100-100
41.	2	59-1057	BUMPER, PALLET



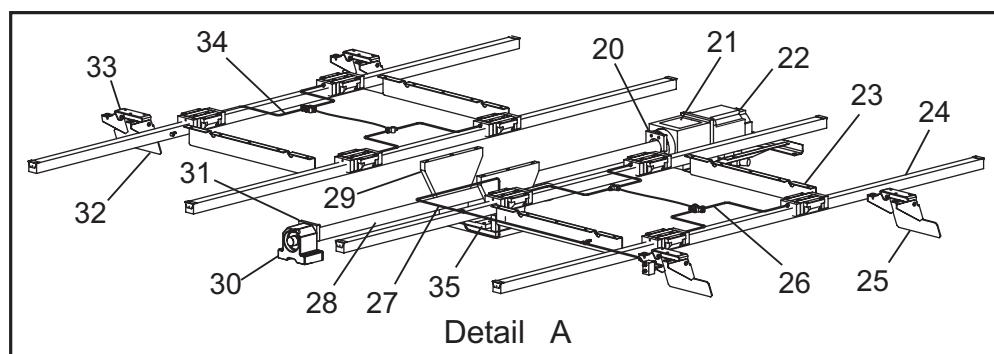
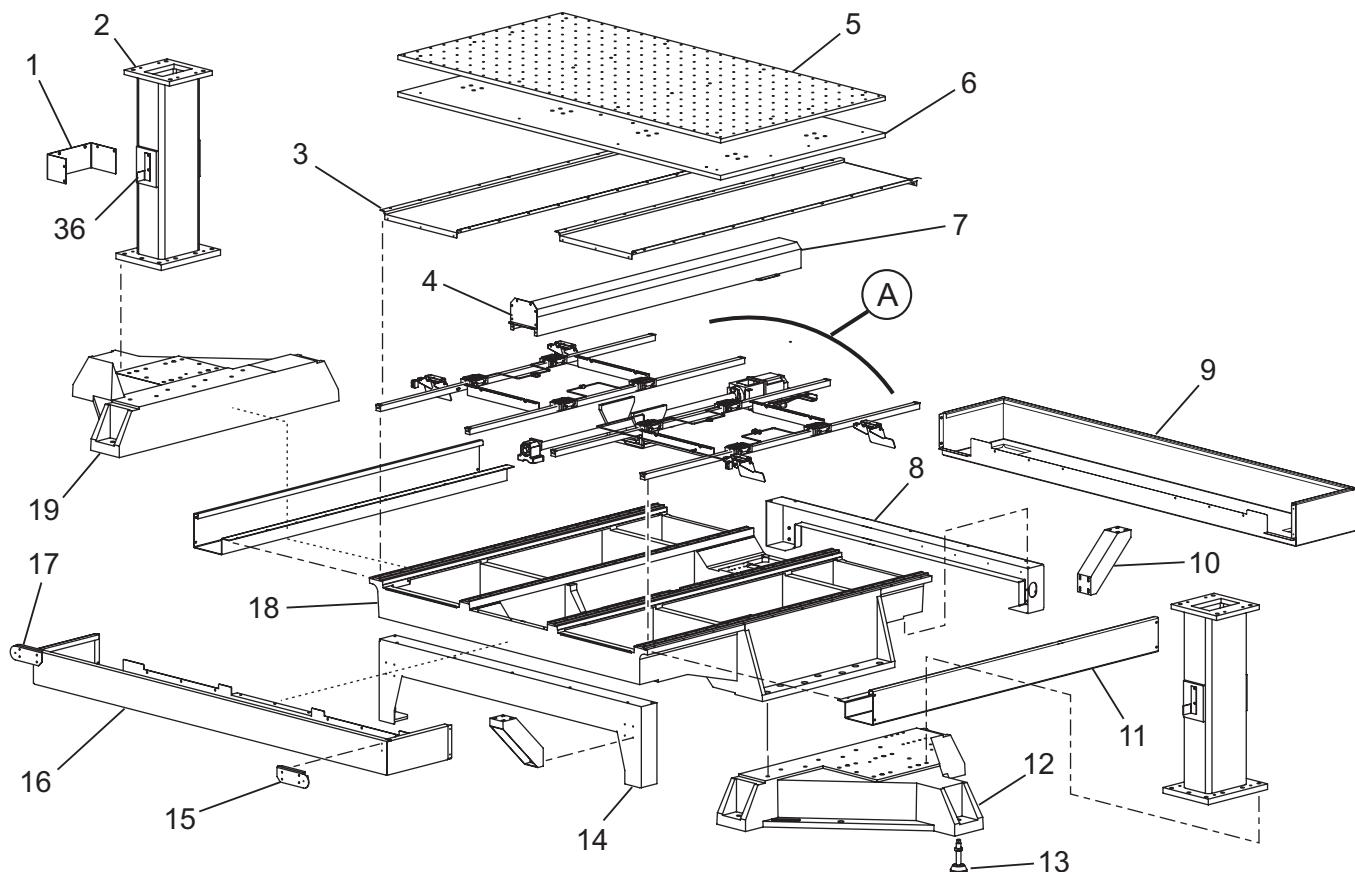
### GANTRY ROUTER BRIDGE ASSEMBLY PARTS LIST



- |             |                                     |             |  |
|-------------|-------------------------------------|-------------|--|
| 1. 25-1147  | Y-axis Servo Motor Cover            | 10. 50-0110 | Linear Guide 2x (GR 408)               |
| 2. 20-0151A | Ballscrew Motor Mount               | 50-0024A    | Linear Guide 2x (GR 510-512)           |
| 3. 30-0154  | Motor housing bearing assembly      | 50-0107A    | Linear Guide 2x (GR 710-712)           |
| 20-9211     | Ballnut Housing (40mm)              | 11. 28-0215 | Bumper .500 40-50mm                    |
| 20-9212     | Bearing Housing (40mm)              | 12. 25-1164 | Y-axis right bellow mount (GR 510-712) |
| 4. 25-1304  | Cable Hole Covers (2x) (GR 510-712) | 25-7436     | Y-axis right bellow mount (GR 408)     |
| 5. 25-1360  | Y-axis Cable Carrier Cover          | 13. 59-0817 | 2x Y-axis bellows (GR 408)             |
| 6. 20-3256A | Bridge (GR 408)                     | 59-0360     | 2x Y-axis bellows (GR 510-512)         |
| 20-3238     | Bridge (GR 510-512)                 | 59-0718     | 2x Y-axis bellows (GR 710-712)         |
| 20-2829     | Bridge (GR 710-712)                 | 14. 25-9203 | Motor mount cover plate                |
| 7. 20-0152  | Bearing Housing (40-50mm)           | 15. 62-0016 | Yaskawa (13) Servo motor               |
| 8. 28-0195  | Bumper 1.25 40-50mm                 | 16. 25-7435 | 2x Y-axis bellows guide (GR 408)       |
| 28-0215     | Bumper .500 (GR 408)                | 25-1163     | 2x Y-axis bellows guide (GR 510-512)   |
| 9. 24-0118  | Y-axis Ballscrew (GR 408)           | 25-5960     | 2x Y-axis bellows guide (GR 710-712)   |
| 24-0030B    | Y-axis Ballscrew (GR 510-512)       |             |  |
| 24-0111B    | Y axis ballscrew (GR 710-712)       |             |  |



**GR-408 BASE & TABLE ASSEMBLY PARTS LIST**



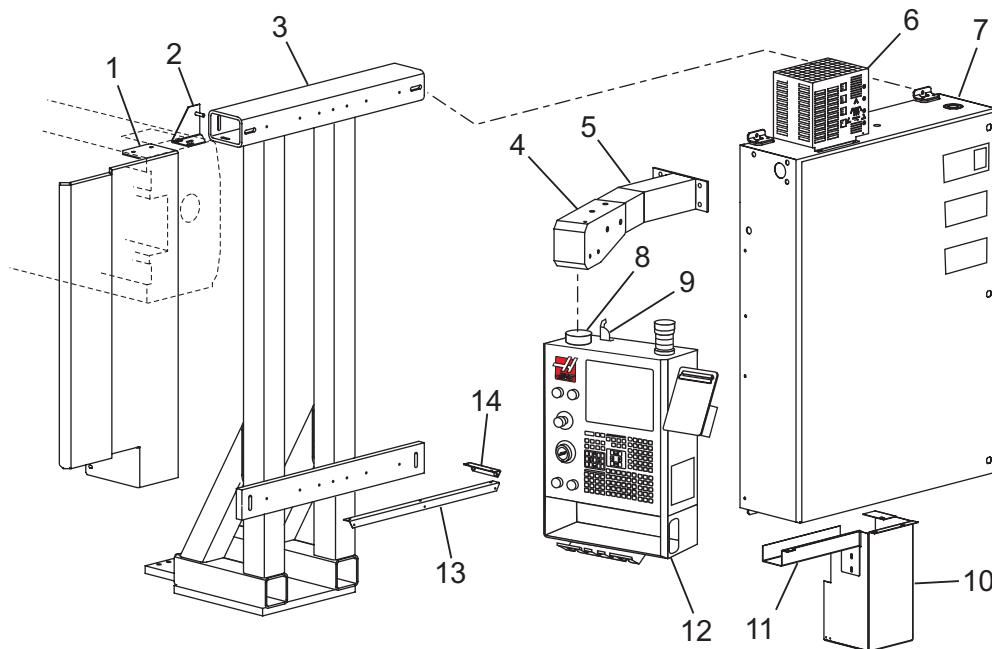


## GR-408 BASE & TABLE ASSEMBLY PARTS LIST

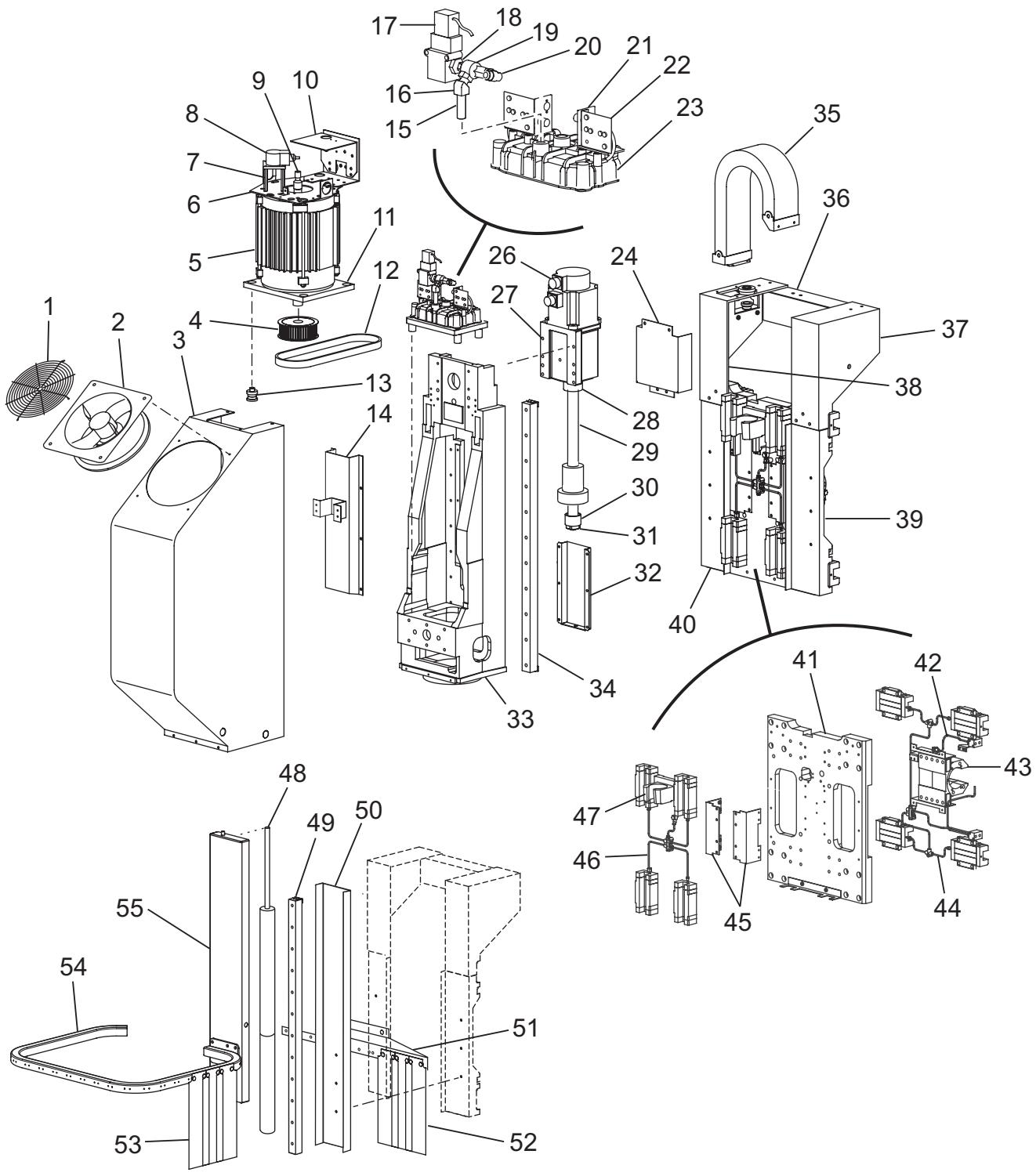
1. 25-7720A MOM-408 Bracket
2. 20-3254 2X Bridge Support
3. 25-7427A 2X Chip Tray
4. 25-7429 X-Axis Ballscrew End Cover
5. 20-3268 Table
6. 20-3267A Sub-Table  
25-7552 Proximity Switch Trip Bracket
7. 25-7428 X-Axis Ballscrew Cover  
25-7801 Cable Cover
8. 25-7417 Rear Chip Pan Support
9. 25-7416A Rear 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. 14-7068 8x Leveling Pad
14. 25-7441 Bed Support Panel
15. 25-7721 Right Side Reflector Bracket
16. 25-7418A Front Chop Pan Drain
17. 25-7722 Left Side Reflector Bracket
18. 20-3259A Base
19. 20-3262 TC Side Door
20. 30-1222 Ballscrew Support Bearing Assembly
21. 20-0151A Ballscrew Motor Mount
22. 62-0016 Servo Motor
23. 25-7571A 4x Chip scraper
24. 50-0024A 4X Linear Guide
25. 25-7567 2X Right Chip Scraper
26. 30-8356A X-Axis Right Lube Line Assembly
27. 30-8412 X-Axis Ballnut Lube Assembly
28. 24-0116 X-Axis Ballscrew
29. 20-3269 X-Axis Ballnut Support
30. 30-0472 2x Ballscrew Bearing Housing
31. 28-0215 3x Bumper (.500")
32. 25-7568 2x Left Chip Scraper
33. 25-7569 4x Chip Scraper Mount
34. 30-8357A X-Axis Left Lube Line Assembly
35. 20-0150 X-Axis Ballscrew Nut Housing
36. 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. 25-4311A Front Regen Cover  
25-0462A Back Regen Cover
7. 32-9654B Control Box Assembly
8. 93-0282 Swivel Control Assembly
9. 25-1129 Pendant Hard Stop
10. 25-7442A Control Junction Box
11. 25-7443A Wire Cover Junction Box
12. 32-6006C Control Pendant Assembly
13. 25-1136 Control Skirt Bracket
14. 25-1137 Control Skirt Bracket

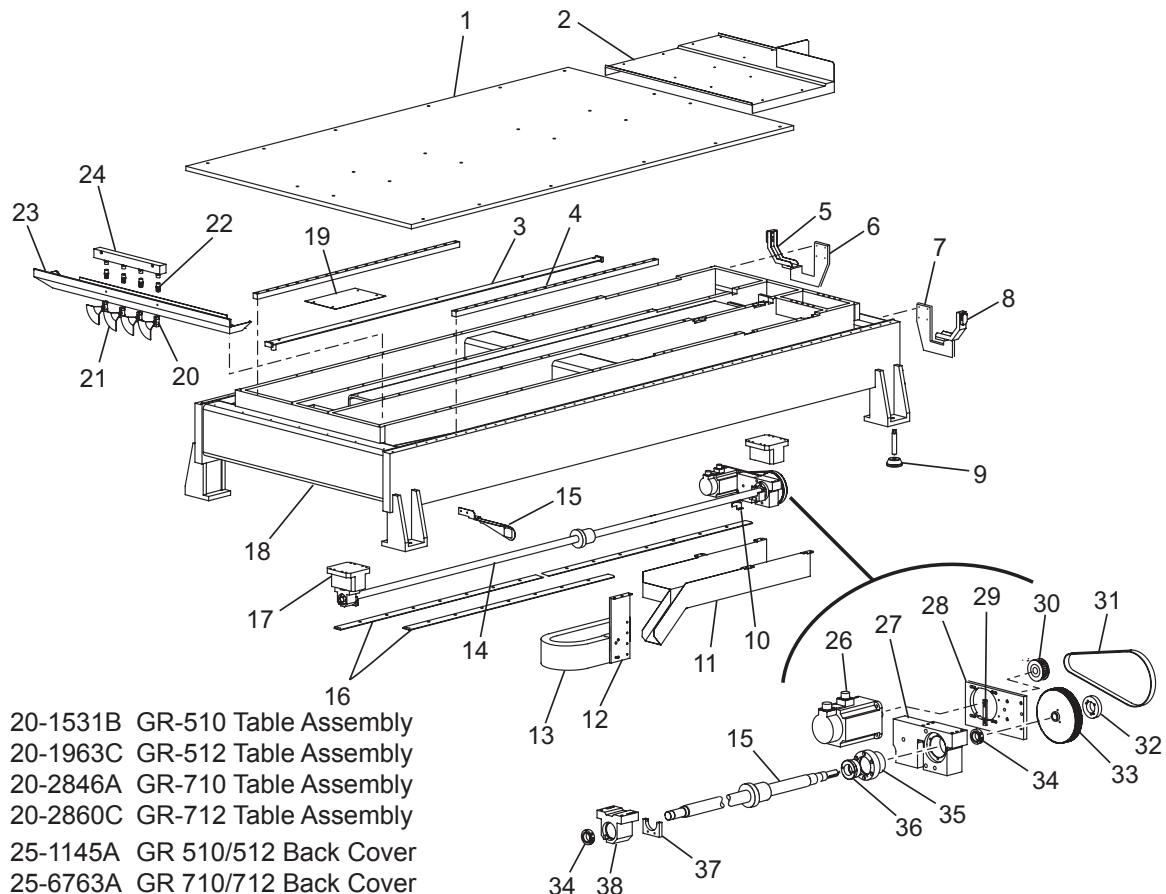
**GR-408 RAM ASSEMBLY PARTS LIST**

Runner Block Assembly (Optional)



## GR-408 RAM ASSEMBLY PARTS LIST

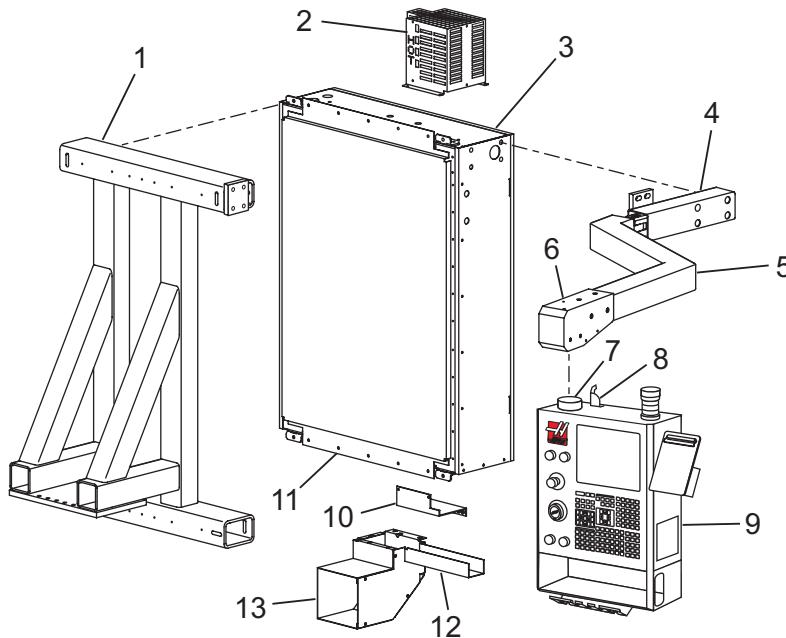
- |              |                                    |              |                             |
|--------------|------------------------------------|--------------|-----------------------------|
| 1. 59-0144   | Fan Guard                          | 42. 30-3778  | Y-Axis Lube Line Assembly   |
| 2. 25-1157   | Spindle Fan Cover                  | 43. 20-0150  | Ballnut Housing (40-50mm)   |
| 3. 25-1162   | Head Cover                         | 44. 30-3786B | Y-Axis Lube Line Assembly   |
| 4. 20-3076   | 2x Sprocket Flange                 | 45. 25-1165A | Y-Axis Bellows Moving Mount |
| 20-0997      | Pulley                             | 46. 30-3788  | Z-Axis Lube Line Assembly   |
| 5. 62-1015   | Spindle Motor                      | 47. 20-1532  | Ballnut Housing (32mm)      |
| 6. 25-6181   | Encoder Mounting Plate             | 48. 59-0058  | Air Cylinder (1.25x26)      |
| 7. N/A       |                                    | 49. 50-3007  | Linear Guide                |
| 8. 30-9569A  | Encoder Assembly                   | 50. 25-7659  | Curtain Lift Inside Mount   |
| 9. 54-7127   | Encoder Drive Sprocket             | 51. 25-7662  | Rear Curtain Lift Mount     |
| 10. 25-6180C | Solenoid Motor Plate               | 52. 59-0845  | Rear Curtains               |
| 11. 20-2415  | Spindle Motor Plate                | 53. 59-0844  | Front Curtains              |
| 12. 54-2121  | Belt                               | 54. 20-3463A | Curtain Lift Rod            |
| 13. 22-7520A | 8x Isolator                        | 55. 25-7660  | Curtain Lift Cover          |
| 14. 25-6777  | Z-Axis Ballscrew Cover             |              |                             |
| 15. 58-0004  | Nipple 1/4 NPT x2                  |              |                             |
| 16. 58-3613  | Street Elbow 1/4F x NPT 1/4M       |              |                             |
| 17. 32-5620  | TRP Solenoid Valve Assembly        |              |                             |
| 18. 58-3691  | Nipple 1/4 NPT Hex                 |              |                             |
| 19. 59-2832B | Quick Exhaust                      |              |                             |
| 20. 58-3685  | 90° Elbow 3/8 x NPT 1/4-M          |              |                             |
| 21. 25-5516  | 2x Clamp/Unclamp Bracket           |              |                             |
| 22. 25-7267  | 2x Switch Mounting Bracket         |              |                             |
| 69-1700      | 2x Proximity Switch                |              |                             |
| 23. 20-1491A | Cylinder Housing Casting Machined  |              |                             |
| 24. 25-6777  | Z-axis Ballscrew Shield            |              |                             |
| 26. 62-0036C | Servo Motor                        |              |                             |
| 27. 20-7010B | Motor Mount                        |              |                             |
| 28. 20-3531  | 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. 20-3477A | GR Tube Ram Machined               |              |                             |
| 34. 50-0025  | 2x Linear Guide                    |              |                             |
| 35. 59-0393  | Cable Carrier Assembly             |              |                             |
| 36. 25-1150A | Z-Axis Cable Carrier               |              |                             |
| 37. 25-1148A | Y-Axis Right Cable Carrier Bracket |              |                             |
| 38. 25-1149A | Y-Axis Left Cable Carrier Bracket  |              |                             |
| 39. 25-1156  | Right Sub Plate Cover              |              |                             |
| 40. 25-1155  | Left Sub Plate Cover               |              |                             |
| 41. 20-1525B | Router Sub Plate                   |              |                             |
| 25-5967      | Sub Plate Cover                    |              |                             |

**GR-510/512/710/712 BASE & TABLE ASSEMBLY PARTS LIST**

1. 20-1531B GR-510 Table Assembly  
20-1963C GR-512 Table Assembly  
20-2846A GR-710 Table Assembly  
20-2860C GR-712 Table Assembly
2. 25-1145A GR 510/512 Back Cover  
25-6763A 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. 14-7068 4x Leveling Screw
10. 25-5187 Table Trip Bracket  
25-7267 Y-Axis Mounting Bracket  
69-1700 Proximity Switch
11. 25-1348 GR 510, 512 Base Cable Trough  
25-6767 GR 710, 712 Base Cable Trough
12. 25-1159 Cable Carrier Fixed End Bracket
13. 59-0395 Cable Carrier X-Axis (GR-510/710)  
59-0603 Cable Carrier X-Axis (GR-512/712)
14. 24-0029 Ballscrew 40mm (GR510, 710)  
24-0037 Ballscrew 50mm (GR512, 712)
15. 25-4795A 2x Reflector Mount
16. 20-1556A 3x Cable Carrier Track
17. 20-1530 2x Ballscrew Mount Extension
18. 20-1552B GR510 Base  
20-1860A GR512 Base  
20-2993A GR710 Base  
20-2998A GR712 Base
19. 25-1373 Front Ballscrew Shield
20. 58-2066 4x Hose Barb Fitting
21. 58-0511 Valve
22. 58-0287 4x Hex Nipple
23. 25-7736 GR510, 512 Front Gutter  
25-5965B GR710, 712 Front Gutter
24. 20-1814 Vacuum Table Manifold
25. N/A
26. 62-0016 Servo Motor 13 NO BRK
27. 20-1540A Housing Mount X-Axis
28. 20-1558 Plate, Motor Mount
29. 20-4116 Motor Spacer
30. 20-1550 Pulley, 8mm x 25 tooth  
25-1557 Flanges 25 Tooth
31. 54-0108 Belt X-Axis
32. 20-1534 Lock Ring 75 Tooth
33. 20-1533 Pulley, 8mm x 75 Tooth
34. 51-0008 Bearing Locknut TCN-06-F
35. 20-9212 Bearing Housing 40mm BS
36. 20-9211 Nut Housing 40mm BS
37. 28-0216 Bumper .750 40mm
38. 20-0152 Bearing HSNG 40/50mm BS



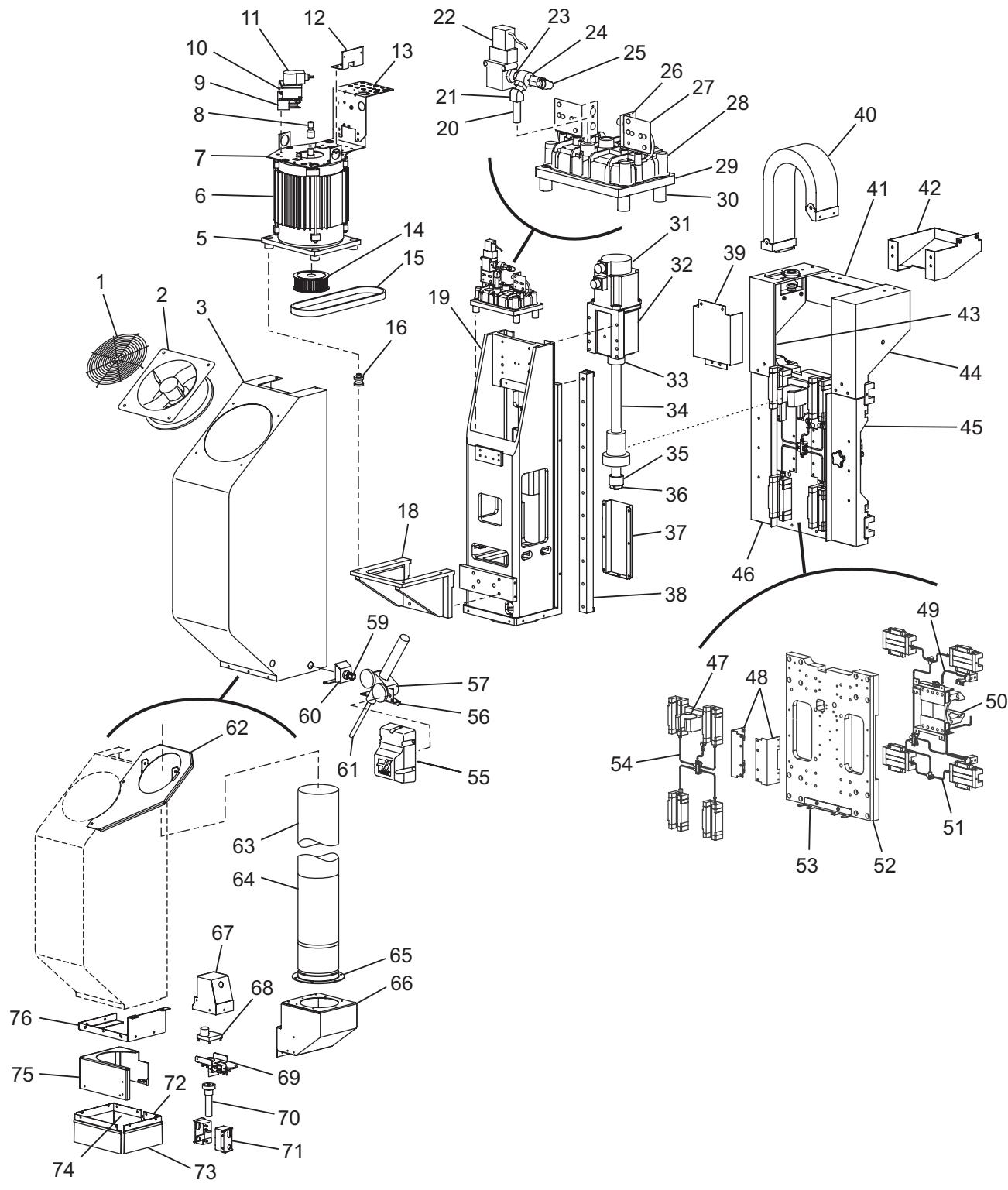
## GR-510/512/710/712 CONTROL ASSEMBLY PARTS LIST



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. 32-6006F Control Pendant Assembly
10. 25-1245A Regulator Mounting Bracket
11. 25-1246 Control Cabinet Back Cover
12. 25-1228B Control Cover Junction Box
13. 25-1227B Control Junction Box



## GR-510/512/710/712 RAM ASSEMBLY PARTS LIST



Dust Shroud Assembly (Optional)

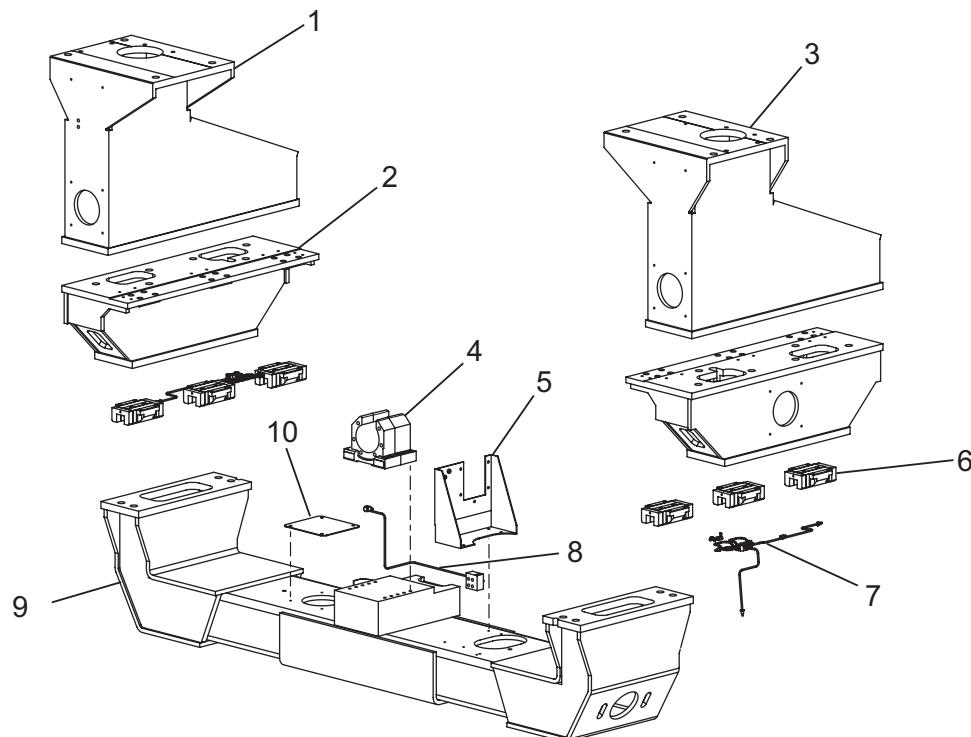


## GR-510/512/710/712 RAM ASSEMBLY PARTS LIST

1. 59-0144 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. 30-9569A 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 1/4 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 1/4 NPT HEX x 1
24. 59-2832B Tool Changer Quick Exhaust
25. 58-3685 90 Degree Elbow 3/8 x NPT 1/4M
26. 25-5516 2X Clamp Unclamp Bracket
27. 25-7267 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. 20-7010B Motor Mount
33. 20-3531 Ballscrew Cover Spacer  
51-1011U 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. 25-7849 P-Cool Motor Mounting Bracket
58. Not Used
59. 58-3697 Fitting 1/2 x NPT - 1/2M
60. 25-5654 Pipe Fitting Bracket
61. 58-0961 P-Cool Nozzle
62. 25-7707A Dust Shroud Bracket
63. 59-0929 Duct to Hose Adapter
64. 59-0930 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. 26-0196b Left Rear Brush
73. 26-0195A 3X Dust Shroud Front Brush
74. 26-0197b X-Axis Rear Chip Guard
75. 25-7640C Dust Shroud Door
76. 25-7641C Dust Shroud Hood



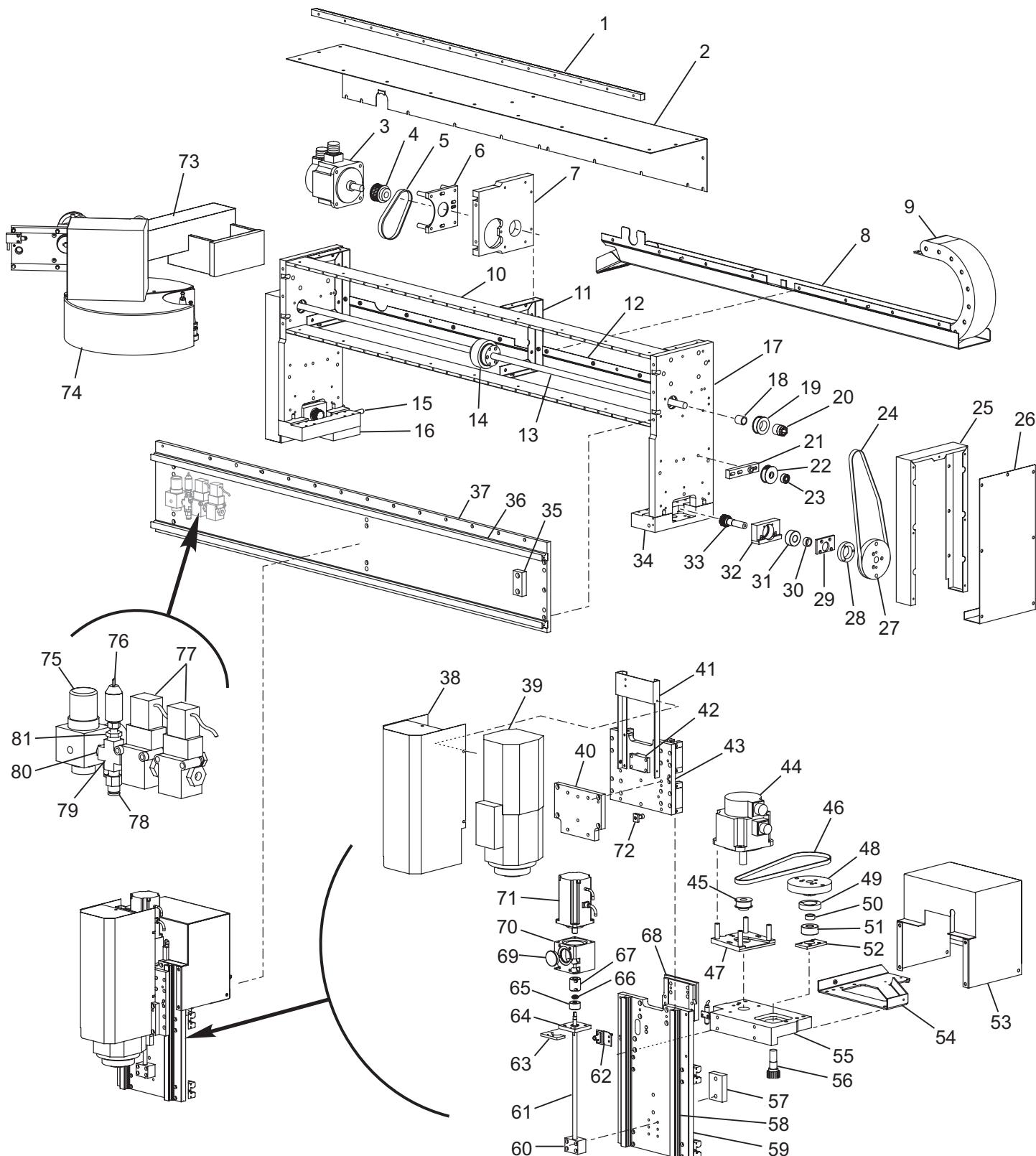
### GR-510/512/710/712 SADDLE ASSEMBLY PARTS LIST



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) (GR512, 712)
5. 25-1158 X-Axis Moving Cable Carrier Bracket
6. 50-0023C 6x Linear Guide Trucks (GR510, 710)  
50-0029C 6x Linear Guide Trucks (GR512, 712)
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



## SR-100/200 BRIDGE-SPINDLE HEAD ASSEMBLY



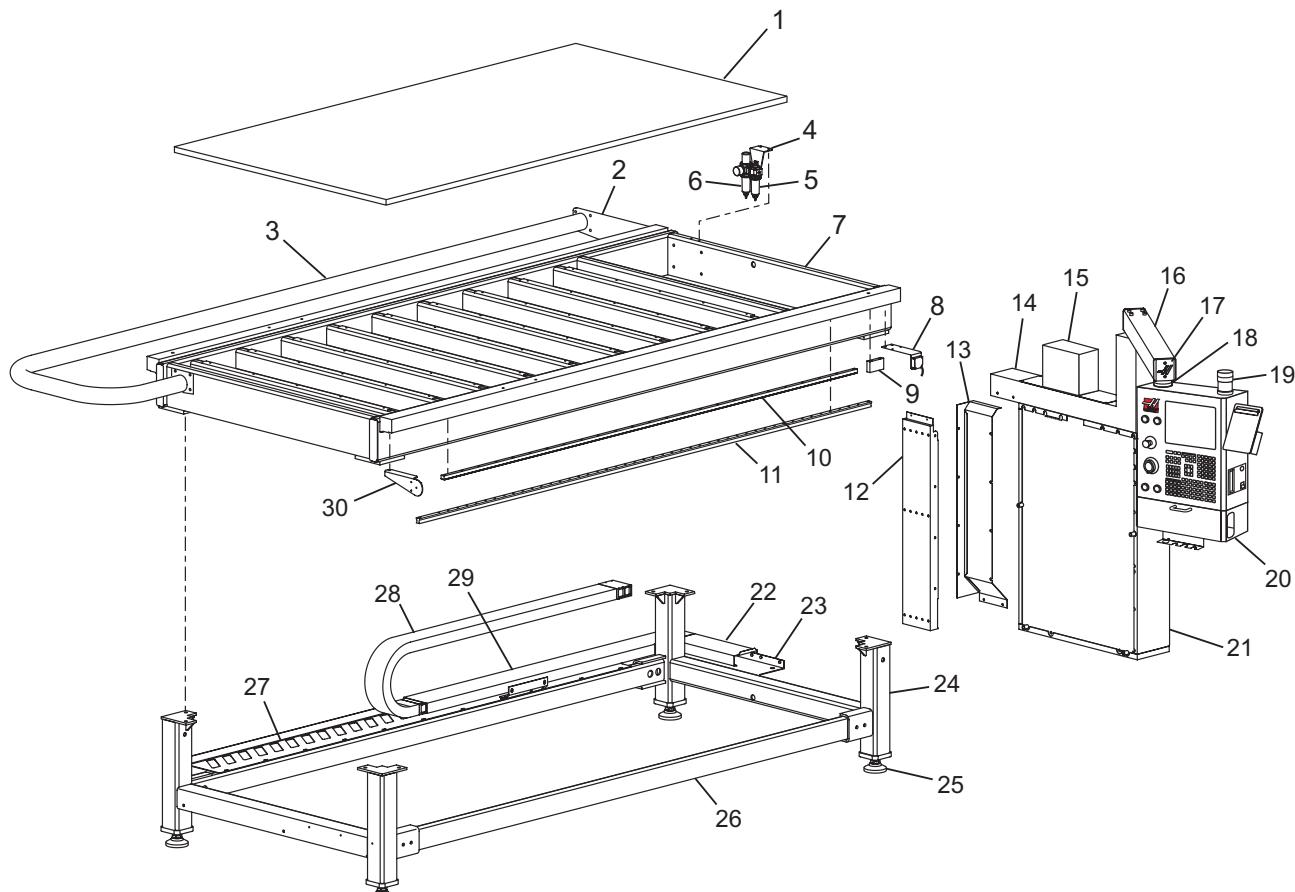


## SR-100/200 BRIDGE-SPINDLE HEAD ASSEMBLY

1. 20-2980	Y-Axis Gear Rack (SR-100)	38. 25-9082	Head Cover
20-4363	Y-Axis Gear Rack (SR-200)	39. 62-4441	Spindle HSD 24K - 5 HP
2. 25-9095	Bridge Top Cover (SR-100)	40. 20-3968	Spindle Mounting Plate
25-9505	Bridge Top Cover (SR-200)	41. 25-9078	Head Cover Bracket
3. 62-0048	Servo Motor Yaskawaw 04 w/Brake	42. 20-4055	Z-Axis Nut Housing
4. 20-4081	Pulley Modified 32T	43. 20-3967	Ram Plate
5. 54-0255	Belt PGGT 5-25-400	44. 62-0024	Servo Motor Yaskawa 05 No Brake
6. 20-3998	X-Axis Motor Mounting Plate	45. 20-4519	Drive Pulley 45600B
20-4207	Standoff (x4)	46. 54-4505	Drive Belt PGGT 5M x15
7. 20-3929	X-Axis Drive Plate	47. 20-3998	Motor Mounting Plate
8. 25-9094	Y-Axis Carrier Tray (SR-100)	20-4207	Standoff (x4)
25-9510	Y-Axis Carrier Tray (SR-200)	48. 20-3964	Pulley 78 Groove
9. 59-1049	Y-Axis Cable Carrier (SR-100)	49. 20-4124	Driven Pulley Lockring
59-1091	Y-Axis Cable Carrier (SR-200)	50. 20-4016A	Pulley Spacer .47 in.
10. 20-4115	Bridge Support (x2) (SR-100)	51. 51-7001	Bearing M20-47-20.6
20-4371	Bridge Support (x2) (SR-200)	52. 20-4040	Bearing Retainer
11. 25-9100	Bridge Cover Tack Strip (x3)	53. 25-9091	Y-Axis Motor Cover
12. 25-9096	Bridge Bottom Cover (SR-100)	54. 25-9093	Y-Axis Carrier Bracket
25-9508	Bridge Bottom Cover (SR-200)	55. 20-3963	Y-Axis Drive Plate
13. 20-4036	X-Axis Drive Shaft (SR-100)	69-1601	Proximity Switch 3WR 1.5 ft.
20-4370	X-Axis Drive Shaft (SR-200)	56. 20-4017	Pinion Gear 20T
14. 20-3997	Driven Pulley 56T	57. 20-3989	Y-Axis Hard Stop
51-0194	Bearing	58. 50-0129	Linear Guide 25 x 430 (x2)
15. 20-4134	Cable Guide	59. 20-3966	Y-Axis Sub-Plate
16. 20-4132	X-Axis Carrier Mount	60. 20-3984	Z-Axis Hard Stop
17. 20-3930	Column (x2)	61. 24-0122	Ballscrew 12-5-398
51-0195	Bearing (x2)	62. 25-7267	Y-Axis Switch Mounting Bracket
56-0114	Retaining Ring (x2)	69-1601	Proximity Switch 3WR 1.5 ft.
18. 20-4038	Pulley Spacer 1.05 in. (x2)	63. 20-2748	Bumper
19. 20-4037	Drive Shaft End Pulley 32T (x2)	64. 20-4758	Motor Mounting Cap
20. 59-1058	Shaft Trantorque 3/4 in. (x2)	20-4764	Bearing Spacer
21. 20-3996	Idler Mount (x2)	65. 51-0189	X-Axis Ballscrew Bearing (x2)
22. 20-3999	Idler Pulley 32T (x2)	66. 57-0001	V-Ring Seal .531in. ID x .881 in. OD
23. 51-4732	Bearing M10-28-12 (x2)	67. 52-0171	Coupling 8 mm x 4 mm
56-0115	Retaining Ring (x2)	68. 20-4054	Z-Axis Motor Mounting Plate
24. 54-0254	Belt PGGT 5-15-1000	69. 59-1086	Pry Out Plug 1.500 in. dia.
25. 25-9102	Column Tack Strip (x2)	70. 20-4757	Motor Mount
26. 25-9104	Column Cover (x2)	71. 62-0048	Servo Motor Yaskawa 04 w/ brake
27. 20-3964	Pulley 78T (x2)	72. 20-4295	Lube Junction
28. 20-4124	Pulley Lock Ring (x2)	73. 20-4096	Tool Changer Arm Machined
29. 20-4040	Pinion Gear Bearing Retainer (x2)	74. 30-9942	Tool Changer Assy. (optional)
30. 20-4016A	Pulley Spacer .47 in.	75. 59-0087	Air Regulator 1/4 NPT
31. 51-7001	Dbl Row Bearing M20-47-20.6 (x2)	58-27395	Gauge 0-160 PSI
32. 20-4034	X-Axis Bearing Block (x2)	76. 32-1002A	Pressure Switch 70 PSI
33. 20-4017	Pinion Gear 20T	77. 32-5620	TRP Solenoid Valve Assembly
34. 20-3962A	X-Axis Track Block (x2)	78. 58-3680	Straight Fitting 3/8 x 1/4M NPT
35. 20-3989	Y-Axis Hard Stop	79. 58-3740	Cross Fitting 1/4F NPT
36. 50-0128	Linear Guide 25 x 1706 (x2) (SR-100)	80. 58-2165	Close Nipple 1/4 NPT
50-0135	Linear Guide 25 x 2315 (x2) (SR-200)	81. 58-1735	Reducer 1/4M x 1/8F NPT
37. 20-3965	Bridge Plate (SR-100)		
20-4358	Bridge Plate (SR-200)		



## SR-100/200 BED-CONTROL ASSEMBLY

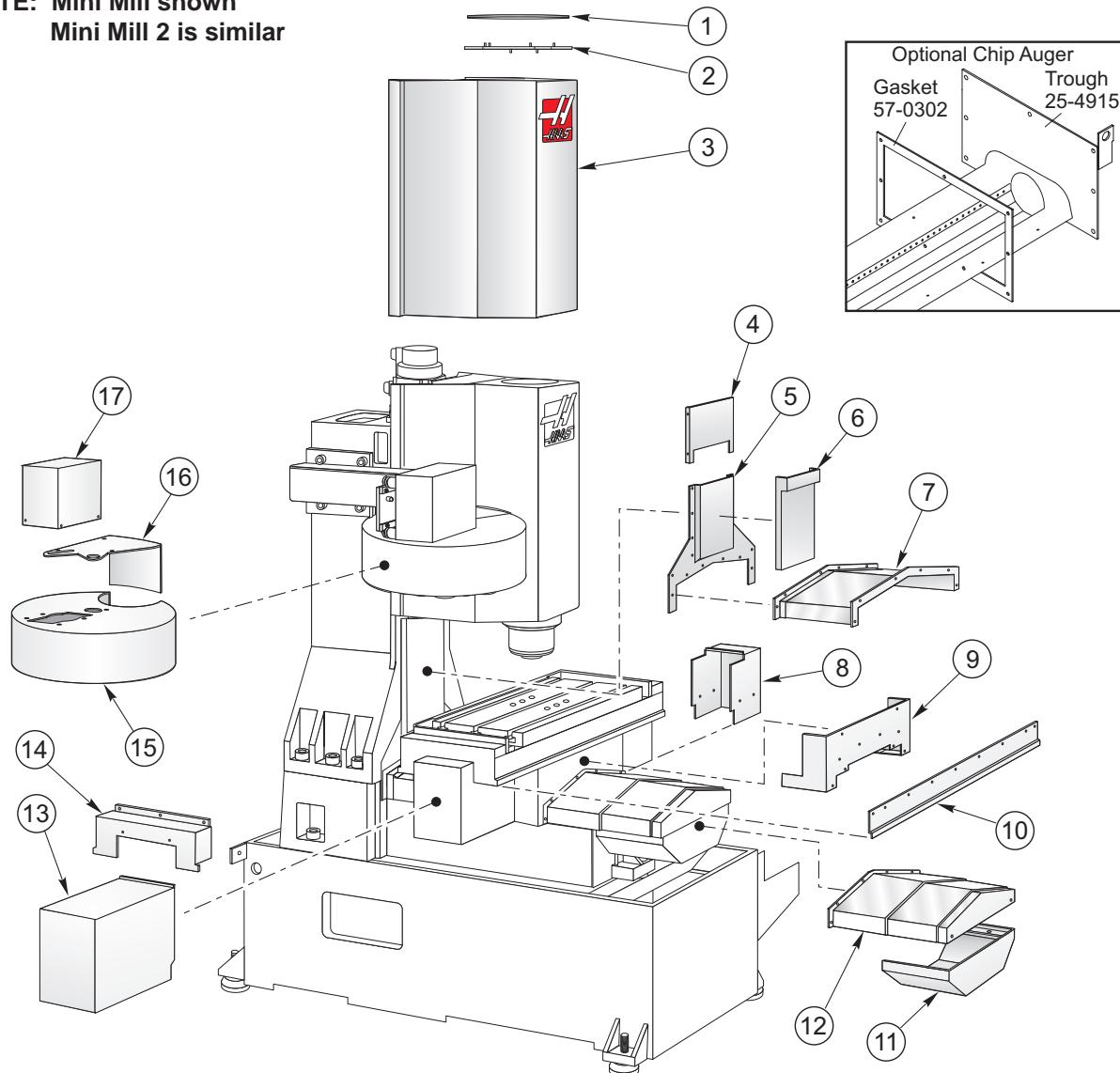


- |  |  |
|--|--|
| 1. 14-2322 Table Section 4 x 8 x 1 (SR-100)      | 16. 20-4135 Pendant Arm                        |
| 14-2349 Table Section 48 x 72 x 1 (SR-200)       | 17. 14-1962 End Cap (x2)                       |
| 2. 20-4205A Barrier Plate                        | 18. 20-7109C Swivel Arm Mount                  |
| 3. 20-4204A Barrier Tube                         | 20-7110C Swivel Control Mount                  |
| 4. 25-9146 Air Filter Regulator Bracket          | 19. 28-1075C Beacon                            |
| 5. 59-1070 Filter Coalescing 1/4 NPT             | 20. 32-9677 CNC Control Assembly (SR-100)      |
| 6. 59-1069 Air Regulator / Filter 1/4 NPT        | 32-9679 CNC Control Assembly (SR-200)          |
| 7. 20-3913A Bed Machined (SR-100)                | 21. 30-9756 Control Box Assembly               |
| 20-4352 Bed Machined (SR-200)                    | 22. 25-9122 Cable Short Cover (SR-100)         |
| 8. 25-9211 Light Beam Bracket                    | 25-9513 Cable Short Cover (SR-200)             |
| 69-1837 Photo Relay, Sensor                      | 23. 25-9103 Cable Corner Tray (SR-100)         |
| 9. 20-3995 X-Axis Hard Stop (x4)                 | 25-9512 Cable Corner Tray (SR-200)             |
| 10. 20-3914 X-Axis Gear Rack (x2) (SR-100)       | 24. 20-3927 Leg Bed (x2) (SR-100)              |
| 20-4353 X-Axis Gear Rack (x2) (SR-200)           | 20-4357 Leg Bed (x2) (SR-200)                  |
| 11. 50-0127 Linear Guide 25 x 2910 (x2) (SR-100) | 25. 59-1021 Leveling Mount (x4)                |
| 50-0134 Linear Guide 25 x 4120 (x2) (SR-200)     | 26. 20-3928 Stringer Leg (x2) (SR-100)         |
| 12. 25-9120 Vertical Cable Channel               | 20-4354 Stringer Leg (x2) (SR-200)             |
| 13. 25-9121 Vertical Cable Cover                 | 27. 25-9101 X-Axis Cable Carrier Tray (SR-100) |
| 14. 25-9119A Pendant Arm Support                 | 25-9511 X-Axis Cable Carrier Tray (SR-200)     |
| 25-6948A Control Cable Box Cover                 | 28. 59-1048 X-Axis Cable Carrier (SR-100)      |
| 15. 25-7745 Regen Top                            | 59-1090 X-Axis Cable Carrier (SR-200)          |
| 25-7746 Regen Front                              | 29. 25-9123 Cover Cable Long (SR-100)          |
| 25-7747 Regen Back                               | 25-9516 Cover Cable Long (SR-200)              |
|  | 30. 25-9205 Reflector Bracket                  |
|  | 69-1837 Photo-Relay, Sensor                    |



## MINI MILL INTERIOR SHEET METAL

NOTE: Mini Mill shown  
Mini Mill 2 is similar

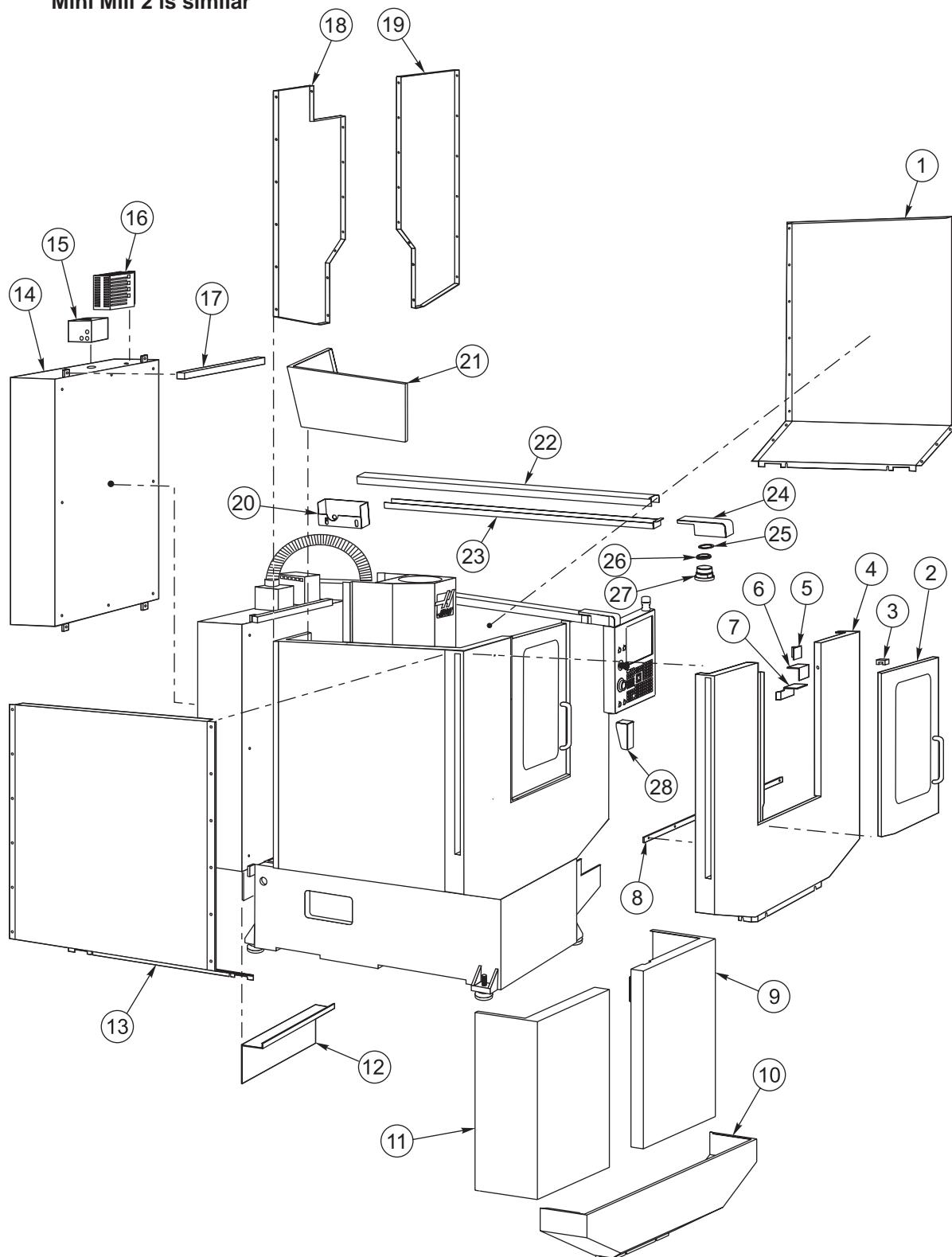


- |             |                                       |              |                                       |
|-------------|---------------------------------------|--------------|---------------------------------------|
| 1. 59-0144  | Fan Guard Spindle 8.75 in.            | 10. 25-0378A | Table Cover Front/Back (2) (MM/SMM)   |
| 2. 25-0389  | Fan Mounting Plate                    | 25-11363     | Table Cover Front/Back (2) (MM2/SMM2) |
| 3. 25-0382C | Head Cover                            | 11. 25-0374  | Cover Y-Axis Motor (MM/SMM)           |
| 4. 25-6102  | Cover Rear Head                       | 25-11335     | Cover Y-Axis Motor (MM2/SMM2)         |
| 5. 25-0381  | Cover Z-Axis Support Bearing (MM/SMM) | 12. 25-0372  | Waycover Y-Axis Front (MM/SMM)        |
| 6. 25-0380  | Waycover Z-Axis (MM/SMM)              | 25-11336     | Waycover Y-Axis Front (MM2/SMM2)      |
| 25-11356    | Waycover Z-Axis (MM2/SMM2)            | 13. 25-0376  | Cover X-Axis Motor                    |
| 7. 25-0373  | Waycover Y-Axis Rear (MM/SMM)         | 14. 25-0379A | Table Cover End (2) (MM/SMM)          |
| 25-11334    | Waycover Y-Axis Rear (MM2/SMM2)       | 25-11366     | Table Cover End (2) (MM2/SMM2)        |
| 8. 25-0377  | Cover X-Axis Support Bearing (MM/SMM) | 15. 25-0633  | T/C Shroud                            |
| 9. 25-0375  | Saddle Cover (2)                      | 16. 25-0636A | Trap Door                             |
|             |                                       | 17. 25-1025B | Cover T/C                             |



## MINI MILL EXTERIOR SHEET METAL

NOTE: Mini Mill shown  
Mini Mill 2 is similar





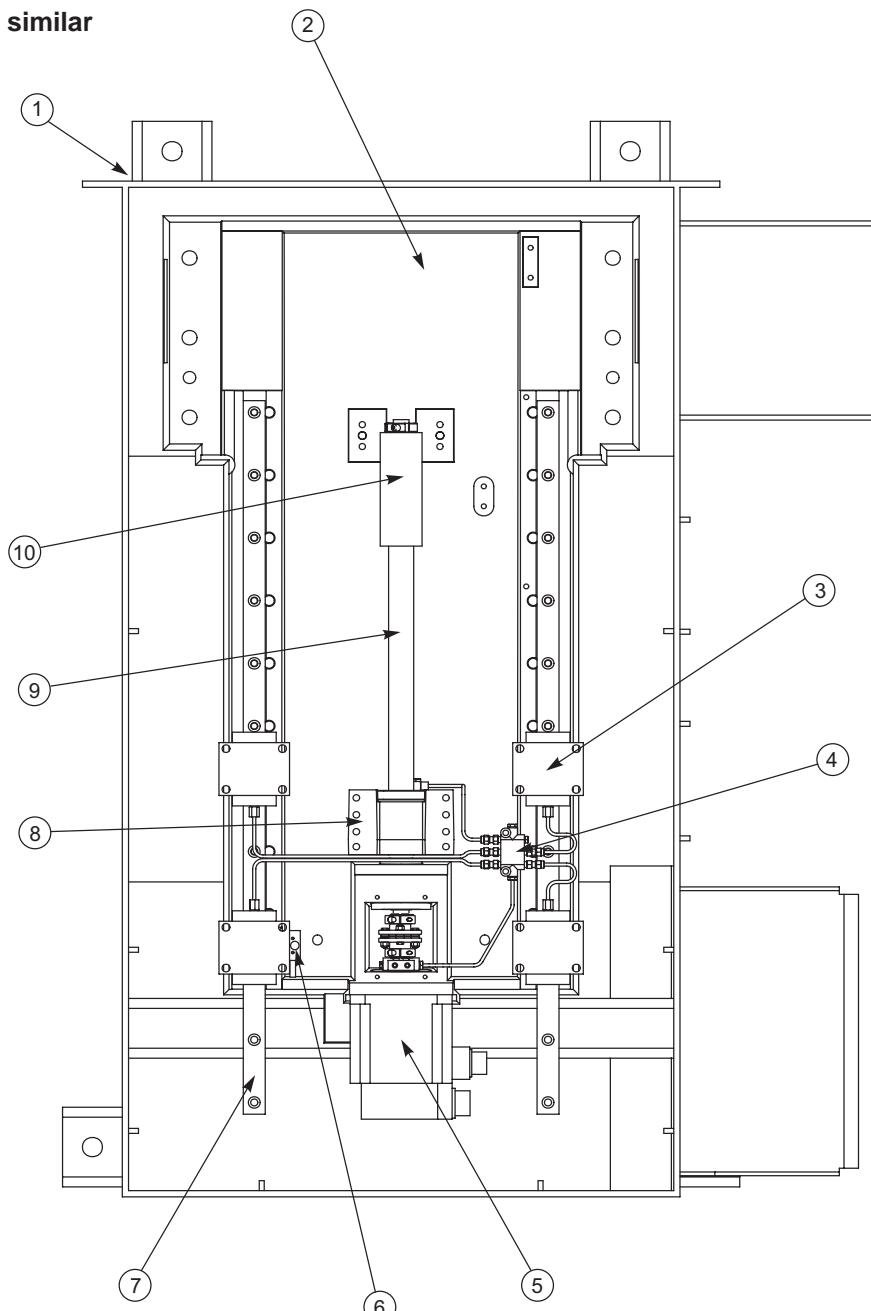
## MINI MILL EXTERIOR SHEET METAL PARTS LIST

- |               |   |              |                                  |
|---------------|---|--------------|----------------------------------|
| 1. 25-0754A   | Side Panel (MM/SMM)                     | 17. 25-8529  | Bracket, Arm Support CNC Control |
| 25-11381      | Side Panel (MM2/SMM2)                   | 18. 25-0384C | Back Panel Left (MM/SMM)         |
| 2. 30-30403   | Door Assembly                           | 25-11382A    | Back Panel Left (MM2/SMM2)       |
| 28-0011       | Window Door                             | 19. 25-0385C | Back Panel Right (MM/SMM)        |
| 3. 20-0712    | Guide Block Door                        | 25-11383     | Back Panel Right (MM2/SMM2)      |
| 4. 25-0753D   | Panel Enclosure Front (MM/SMM)          | 20. 25-11406 | Pendant Cable Cover Control      |
| 5. 25-11478   | Bracket Interlock Key                   | 21. 25-11397 | Chip Shield T/C (MM2/SMM2)       |
| 6. 25-7050C   | Switch Mounting Bracket                 | 22. 25-11412 | Cover, Pendant Cable Channel     |
| 7. 25-5463    | Door Keeper Sensor Mounting Bracket     | 23. 25-11413 | Channel Pendant Cables           |
| 8. 22-7616    | Rail Door Lower                         | 24. 25-11415 | Cover, Swivel                    |
| 9. 25-11386A  | Front Panel Enclosure Right (MM2/SMM2)  | 25. 55-0020  | Wave Washer                      |
| 10. 25-11384  | Front Panel Enclosure Center (MM2/SMM2) | 26. 51-2043  | Bearing Locknut                  |
| 11. 25-11385  | Front Panel Enclosure Left (MM2/SMM2)   | 27. 20-4296  | Swivel Thin Pendant              |
| 12. 25-7195M  | Bracket Lube Mounting                   | 28. 30-30345 | Pendant Support Bracket Assembly |
| 13. 25-0754A  | Side Panel (MM/SMM)                     |              |                                  |
| 25-11381      | Side Panel (MM2/SMM2)                   |              |                                  |
| 14. 25-11310A | Main Chassis CNC Control                |              |                                  |
| 15. 25-11390  | Junction Box CNC Control                |              |                                  |
| 16. 25-4311A  | Regen Cover, Front                      |              |                                  |
| 25-0462A      | Regen Cover, Back                       |              |                                  |



## MINI-MILL BASE

NOTE: Mini Mill shown  
Mini Mill 2 is similar

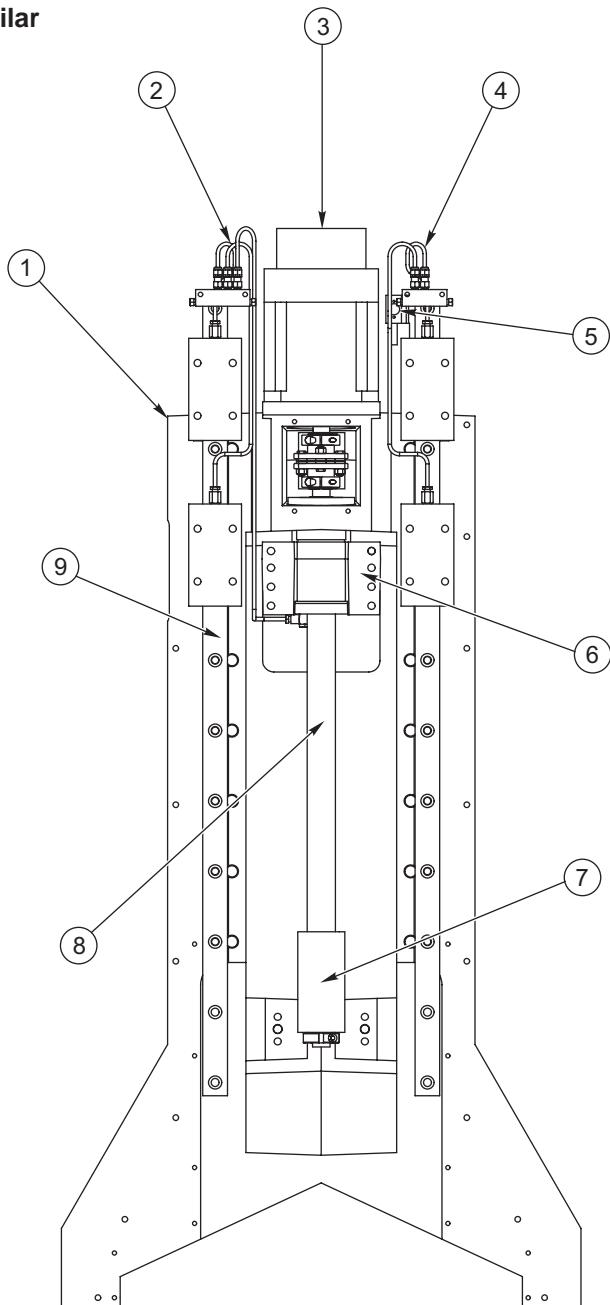


- |             |   |             |   |
|-------------|---|-------------|---|
| 1. 20-3005D | Base Weldment                             | 9. 24-3006  | Ballscrew 32-6-669.2 X/Y/Z-Axis (MM/MM2)    |
| 2. 20-3000B | Machining Bed (MM/SMM)                    | 24-0016     | Ballscrew 32-10-669.2 X/Y/Z-Axis (SMM/SMM2) |
| 20-9440     | Machining Bed (MM2/SMM2)                  | 10. 28-0212 | Bumper Y-axis (MM/SMM)                      |
| 3. 50-0011  | Runner Block Linear Guide Y-Axis          |             |   |
| 4. 30-1752  | Lube Line Assembly Y-Axis                 |             |   |
| 5. 62-0024  | Servomotor Yaskawa 05 No Brake (MM/MM2)   |             |   |
| 62-0014     | Servomotor Yaskawa 09 No Brake (SMM/SMM2) |             |   |
| 6. 32-2132  | Home Switch 3.5 ft. NC                    |             |   |
| 7. 50-3007  | Linear Guide X/Y/Z-Axis                   |             |   |
| 8. 20-7008F | Nut Housing Machined                      |             |   |



## MINI-MILL COLUMN

NOTE: Mini Mill shown  
Mini Mill 2 is similar

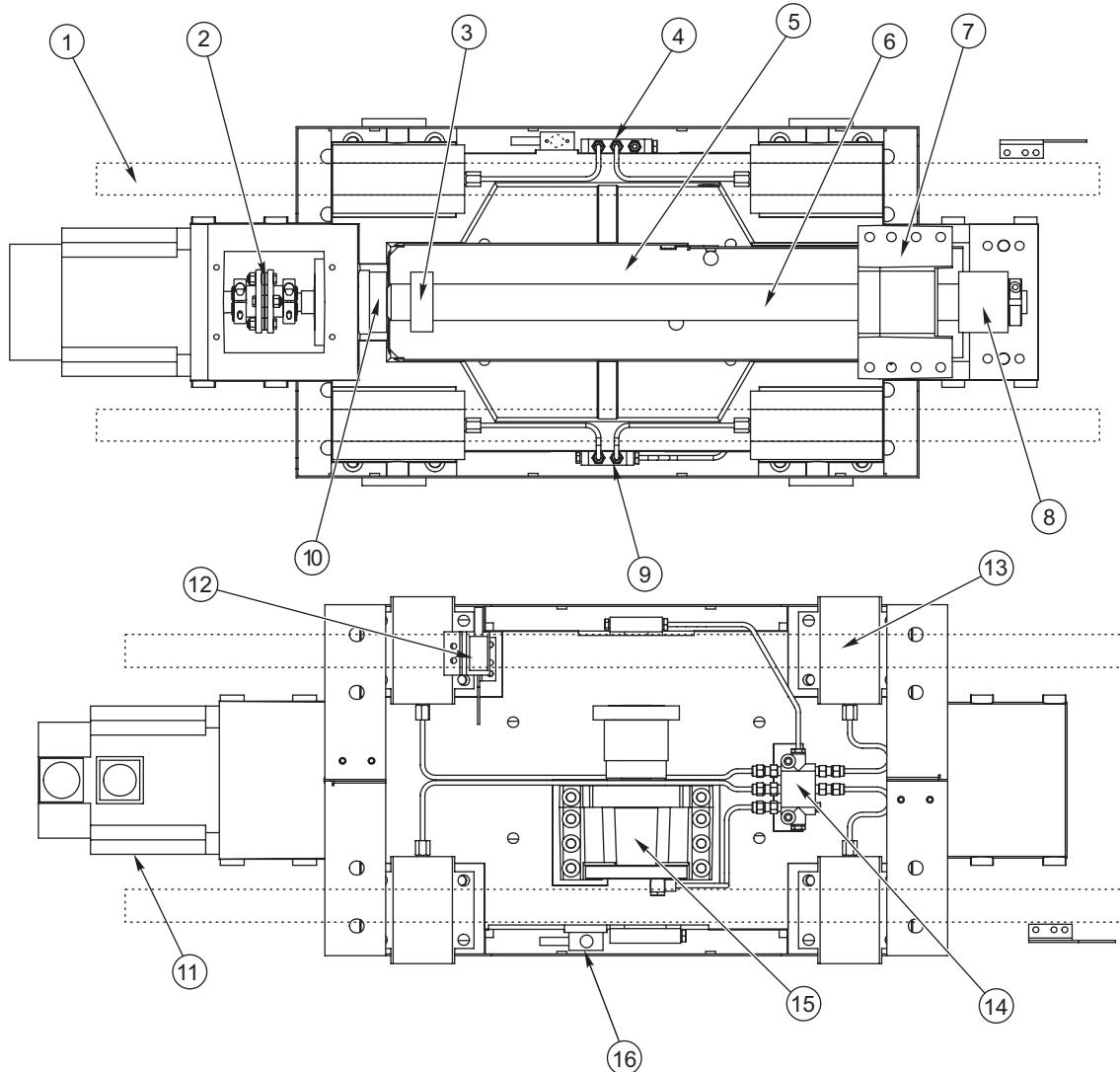


- |             |                                 |             |                             |
|-------------|---------------------------------|-------------|-----------------------------|
| 1. 20-1357A | Column Machining (MM/SMM)       | 8. 24-3006  | Ballscrew 32-6-669.2 (MM)   |
| 2. 30-3048  | Lube Line Assembly Z-Axis Left  | 24-7146     | Ballscrew 32-6-800 (MM2)    |
| 3. 62-0036C | Servomotor SEM C8 w/Brake       | 24-0016     | Ballscrew 32-10-669.2 (SMM) |
| 4. 30-3049  | Lube Line Assembly Z-Axis Right | 24-0009     | Ballscrew 32-10-800 (SMM2)  |
| 5. 32-2130  | Home Switch 1.5 ft. NC          | 9. 50-10000 | Linear Guide 30 x 930       |
| 6. 20-7008F | Nut Housing Machined            |             |                             |
| 7. 28-0222  | Bumper Z-Axis (MM)              |             |                             |
| 28-10022    | Bumper Z-Axis (MM2)             |             |                             |
| 28-0223     | Bumper Z-Axis (SMM)             |             |                             |
| 28-10024    | Bumper Z-Axis (MM2)             |             |                             |



## MINI-MILL SADDLE

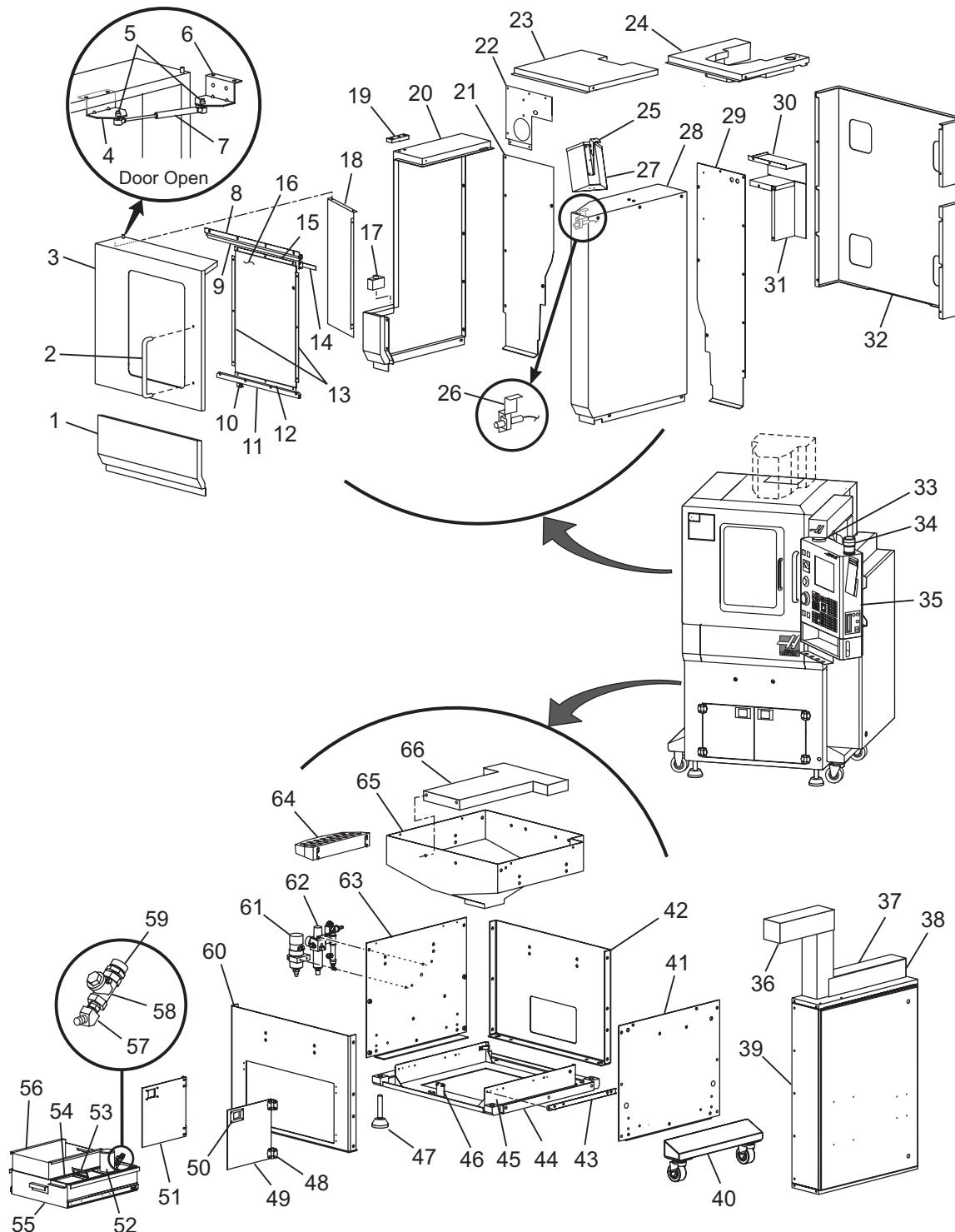
**NOTE:** Mini Mill shown  
Mini Mill 2 is similar



- |             |   |              |                                  |
|-------------|---|--------------|----------------------------------|
| 1. 50-10000 | Linear Guide 30 x 930 (MM/SMM)            | 12. 32-2132  | Home Switch 3.5 ft. NC           |
| 50-10001    | Linear Guide 30 x 1040 (MM2/SMM2)         | 13. 50-0011  | Runner Block Linear Guide Y-Axis |
| 2. 30-1220A | Coupling assembly                         | 14. 30-1752  | Lube Line Assembly Y-Axis        |
| 3. 20-0505  | Bumper Ballscrew (MM/MM2)                 | 15. 20-7008F | Nut Housing Machined             |
| 4. 30-1751  | Lube Assembly X-Axis Back                 | 16. 32-2130  | Home Switch 1.5 ft. NC           |
| 5. 25-0659  | Carrier Tray X-Axis (MM/SMM)              |              |                                  |
| 25-11364    | Carrier Tray X-Axis (MM2/SMM2)            |              |                                  |
| 6. 24-3006  | Ballscrew 32-6-669.2 (MM)                 |              |                                  |
| 24-7146     | Ballscrew 32-6-800 (MM2)                  |              |                                  |
| 24-0016     | Ballscrew 32-10-669.2 (SMM)               |              |                                  |
| 24-0009     | Ballscrew 32-10-800 (SMM2)                |              |                                  |
| 7. 20-3006  | Nut Housing X-Axis                        |              |                                  |
| 8. 28-0221  | Bumper X-Axis                             |              |                                  |
| 9. 30-1750  | Lube Assembly X-Axis Front                |              |                                  |
| 10. 30-0154 | Motor Housing Bearing Assembly            |              |                                  |
| 11. 62-0053 | Servomotor Yaskawa 05/SEM (MM/MM2)        |              |                                  |
| 62-0014     | Servomotor Yaskawa 09 No Brake (SMM/SMM2) |              |                                  |



### OM-1/OM-2 EXTERIOR SHEET METAL



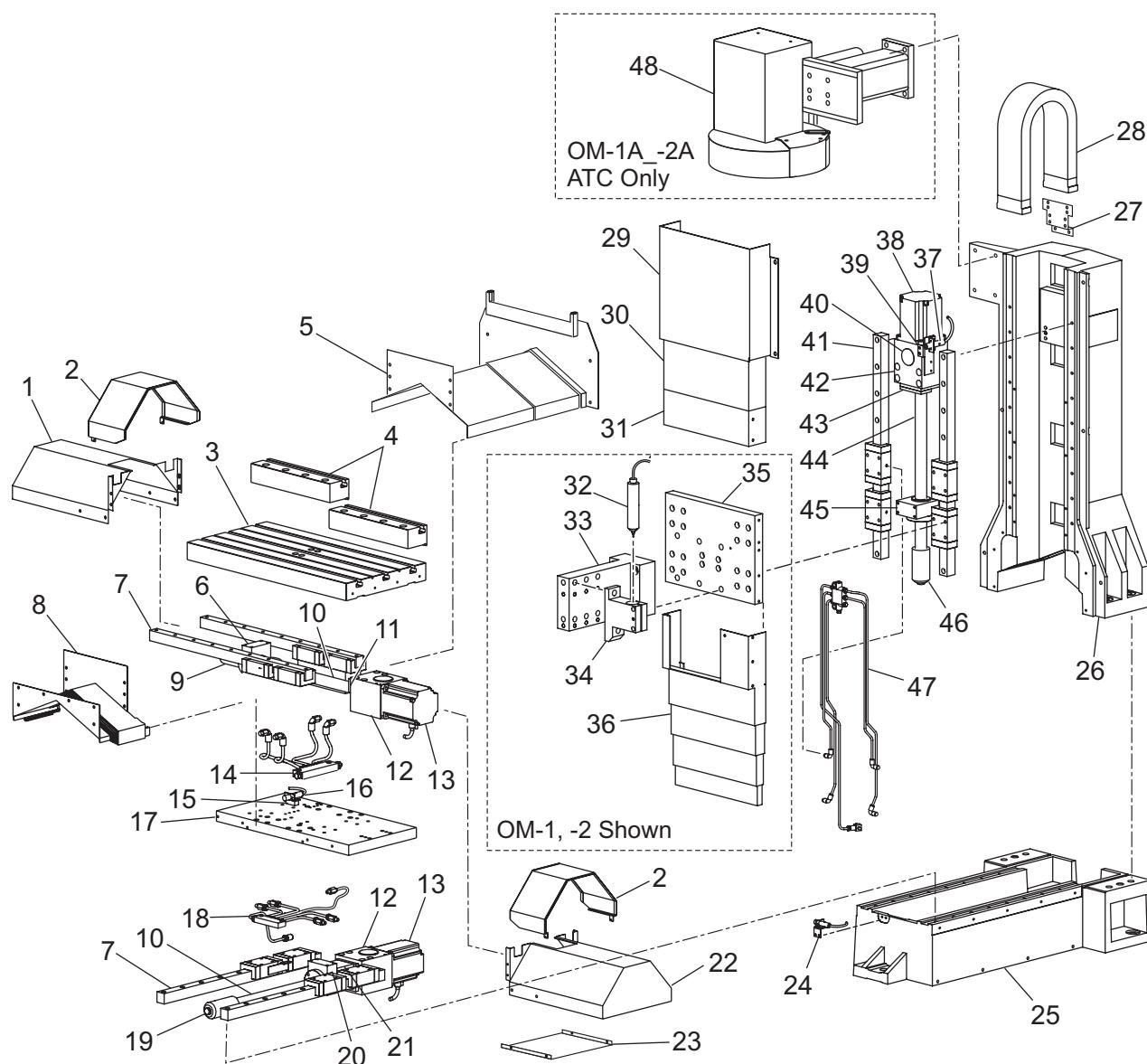


## OM-1/OM-2 EXTERIOR SHEET METAL

1. 25-7321	Bottom Front Panel	44. 25-7350	Base Bottom
2. 22-8895	Door Handle	45. 25-7072	Coolant Tank Support
3. 25-7317	Enclosure Door	46. 25-7672	Tank Shipping Bracket
4. 25-7393	Gas Spring Door Bracket	47. 14-7068	4X Casting Level Pad
5. 59-0008	2X Gas Spring Ball Stud	48. 59-0023	4X Door Hinge
6. 25-7394	Gas Spring Enclosure Bracket	49. 25-5856A	Right Front Lower Door
7. 59-0839	Gas Spring Assy	50. 58-0227	2X Door Latch Assy
8. 25-7331	Op Door Guide Bracket	51. 25-5855A	Left Front Lower Door
9. 28-0174	Window Top Guide	52. 32-0189A	Coolant Pump Assy
10. 25-7673	Shield Support Bracket	53. 25-6838	Coolant Tank Filter
11. 20-3241	Op Door Bottom Guide	54. 25-7070	Pump Assy Bracket
12. 25-7341	Bottom Window Frame	55. 25-7069	Coolant Tank
13. 25-7337	2X Window Frame Sides	56. 25-7071	Chip Tray
14. 25-7333	Door Switch Trip Flag Bracket	57. 58-1721	45 Degree Elbow 3-8npt
15. 25-7338	Top Window Frame	58. 58-3600	Nipple 3-8 Hex
16. 28-0182	Window	58. 59-2228	Swing Check Valve
17. 20-3239	Door Hinge Stud	59. 58-3662	Garden Hose Conn. .372" to .75"
20-3240	Door Hinge Bushing	60. 25-7346A	Base Front
20-3242	Hinge Bottom	61. 59-0814	Auto Lube Pump
18. 25-7392	Operator Door Shield	62. 30-8572	Air Regulator Assy
19. 20-3244	Top Hinge	63. 25-7347	Base Left
20-3243	Top Hinge Bracket	64. 25-7390	Tool Tray
20. 25-7319	Left Panel	65. 25-7490A	Base Basin
21. 25-7325A	Left Back Panel	66. 25-7354A	Short Machine Support
22. 25-7326	Left Top Back Panel		
23. 25-7322A	Top Panel (OM-2)		
24. 25-7468	Top Panel (OM-1)		
25. 25-4789A	Work Light Bracket Adjust		
26. 25-7330	Door Switch Bracket		
69-1700	Proximity Switch		
27. 25-4788	Work Light Housing		
28. 25-7320	Right Panel		
29. 25-7323A	Right Back Panel		
30. 25-7353	Horiz. Cables Back Cover		
31. 25-7352	Vert. Cables Back Cover		
32. 25-7329	Back Cover Panel		
33. 20-7109C	Swivel Arm Mount		
20-7110C	Swivel Mount		
34. 28-1071	Beacon		
35. 32-6004E	Control Pendant Assy		
36. 20-3263A	Pendant Arm		
37. 25-6946A	Pendant Arm Support		
38. 25-6948A	Control Cable Box Cover		
39. 30-7480	Control Box Assy		
40. 30-7741	Swivel Caster Assy (Left Side) (Optional)		
30-7742	Swivel Caster Assy (Right Side) (Optional)		
41. 25-7348A	Base Right		
42. 25-7351A	Base Rear		
43. 59-0837	2X Drawer Slide		



**OM-1/OM-2 INTERNAL SHEET METAL**



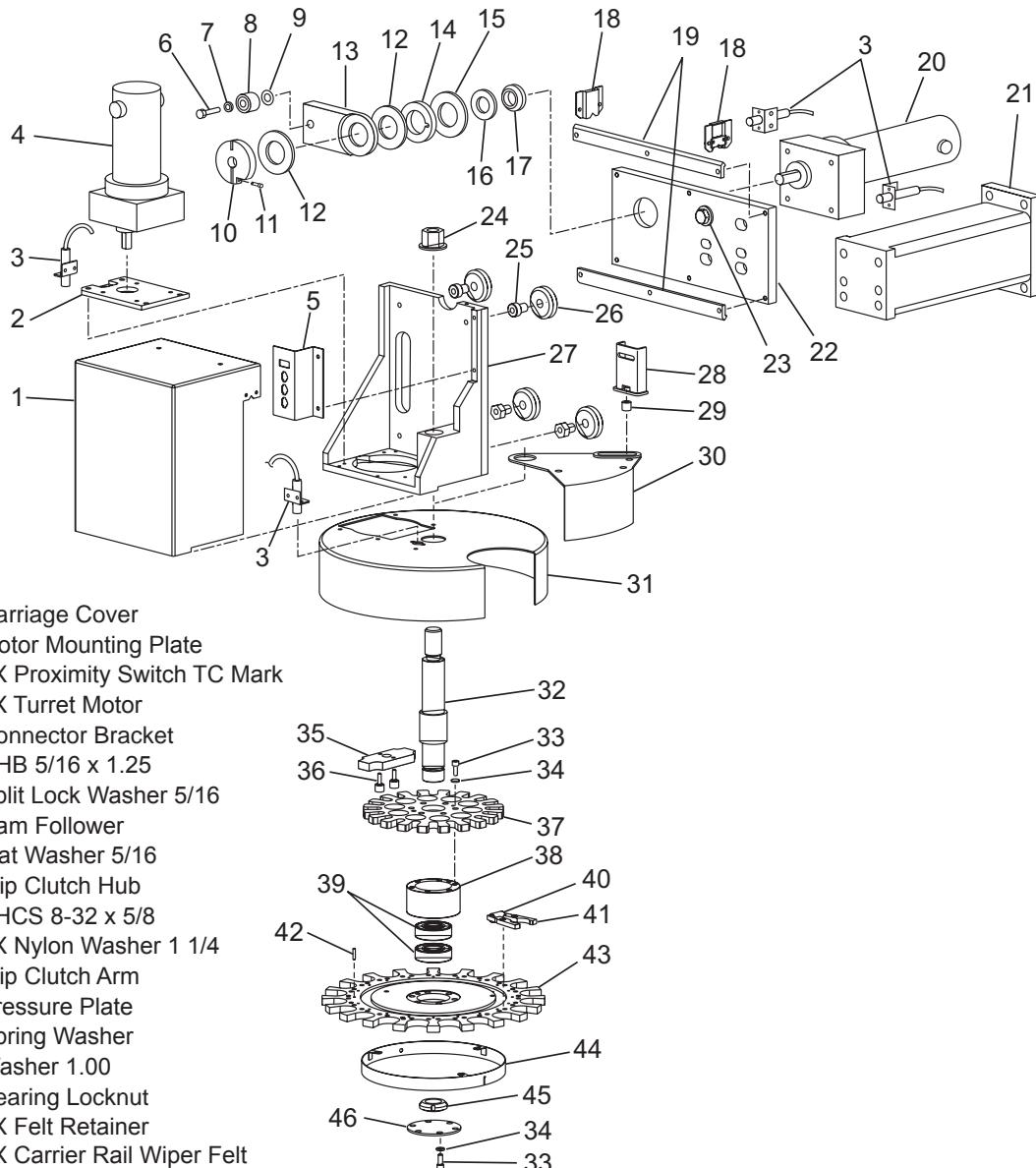


## OM-1/OM-2 INTERNAL SHEET METAL

1. 25-6831 X-Axis Short Waycover
2. 25-6848 X-Axis Floater Waycover
3. 20-2743A Table
4. 20-2775 2X Riser Rail (OL-1)
5. 25-5841A Y-Axis Rear Waycover
6. 20-3082 Nut Housing
7. 50-0106 2X Linear Guide
8. 25-5840A Y-Axis Front Waycover
9. 20-2749A Ball Screw Bumper
10. 24-0110 Ball Screw
11. 20-2748 Bumper (Motor End)
12. 20-2747 Motor Mount
13. 62-2495A Servo Motor
14. 30-7541D X-Axis Lube Line Assy
15. 20-2834 Switch Spacer
16. 69-1700 Proximity Switch
17. 20-10215 Saddle
18. 30-7542C Y-Axis Lube Line Assy
19. 20-2750 Ball Screw Bumper
20. 20-2746A Nut Housing
21. 20-2750 Pocket Stop
22. 25-5842A X-Axis Side Waycover
23. Not Used
24. 25-5846 Home Switch Bracket  
69-1700 Proximity Switch
25. 20-2739A Base (Bed)
26. 20-2740A Column
27. 25-7466A Cable Carrier Bracket
28. 59-0882 Z-Axis Cable Carrier (OM-1, -2 only)  
59-0821 Z-Axis Cable Carrier (OM-1A, -2A only)
29. 25-5989A Z-Axis Top Waycover
30. 25-5990 Z-Axis Upper Mid Waycover
31. 25-5844 Z-Axis Upper Bottom Waycover
32. 20-2744 Spindle
33. 20-2745 Spindle Head Adapter
34. 20-1580 30mm Toolholder
35. 20-2744 Spindle Head
36. 25-6874 Z-Axis Lower Waycover (40K Spindle Option)  
25-5845 Z-Axis Lower Waycover
37. 69-1700 Proximity Switch
38. 62-0048 Servo Motor
39. 25-5848A Switch Bracket
40. 59-1086 Plug
41. 50-0106 2X Linear Guide
42. 20-2747 Motor Mount
43. 20-2748 Bumper (Motor End)
44. 24-0110 Ball Screw
45. 20-2746A Nut Housing
46. 20-2749A Ball Screw Bumper
47. 30-7540C Z-Axis Lube Line Assy
48. 30-7868 ATC



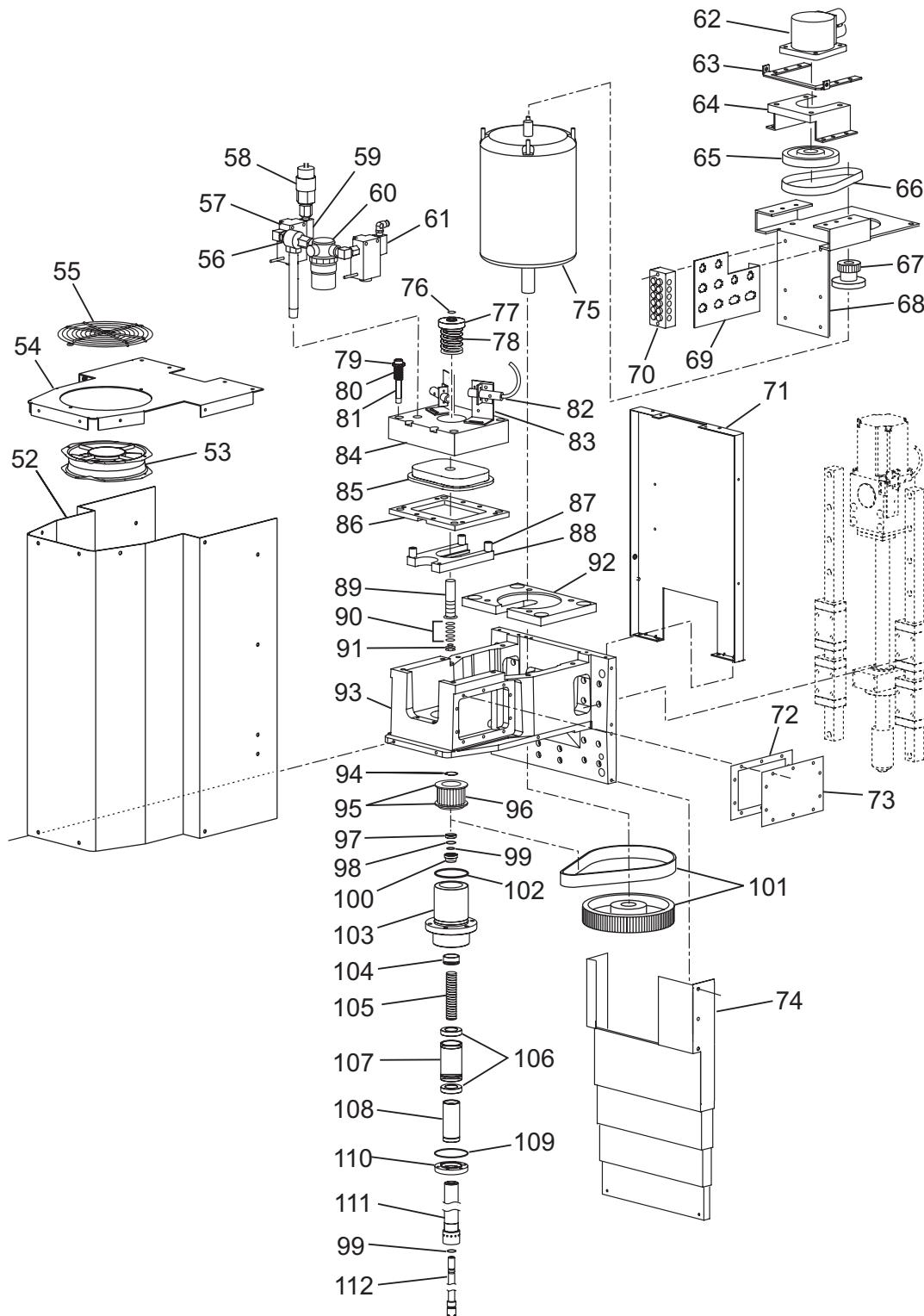
## OM-1/OM-2 Tool Changer



- |              |                             |  |
|--------------|-----------------------------|--|
| 1. 25-6953   | Carriage Cover              |  |
| 2. 20-2747   | Motor Mounting Plate        |  |
| 3. 32-2205   | 4X Proximity Switch TC Mark |  |
| 4. 32-1911A  | 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. 22-7477  | 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. 32-1911A | Turret Motor                |  |
| 21. 20-3122  | TC Mount                    |  |
| 22. 20-3119B | 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. 22-2065  | 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. 20-3118A | Geneva Driver               |  |
| 36. 54-0257  | 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. 20-3113A | 20X Extractor               |  |
| 42. 48-0025  | 19X Roll Pin 1/8 x 5/8      |  |
| 43. 20-3112A | Carousel                    |  |
| 44. 25-6949  | Number Ring                 |  |
| 45. 51-2041  | Bearing Locknut             |  |
| 46. 25-0635  | Bearing Cover               |  |



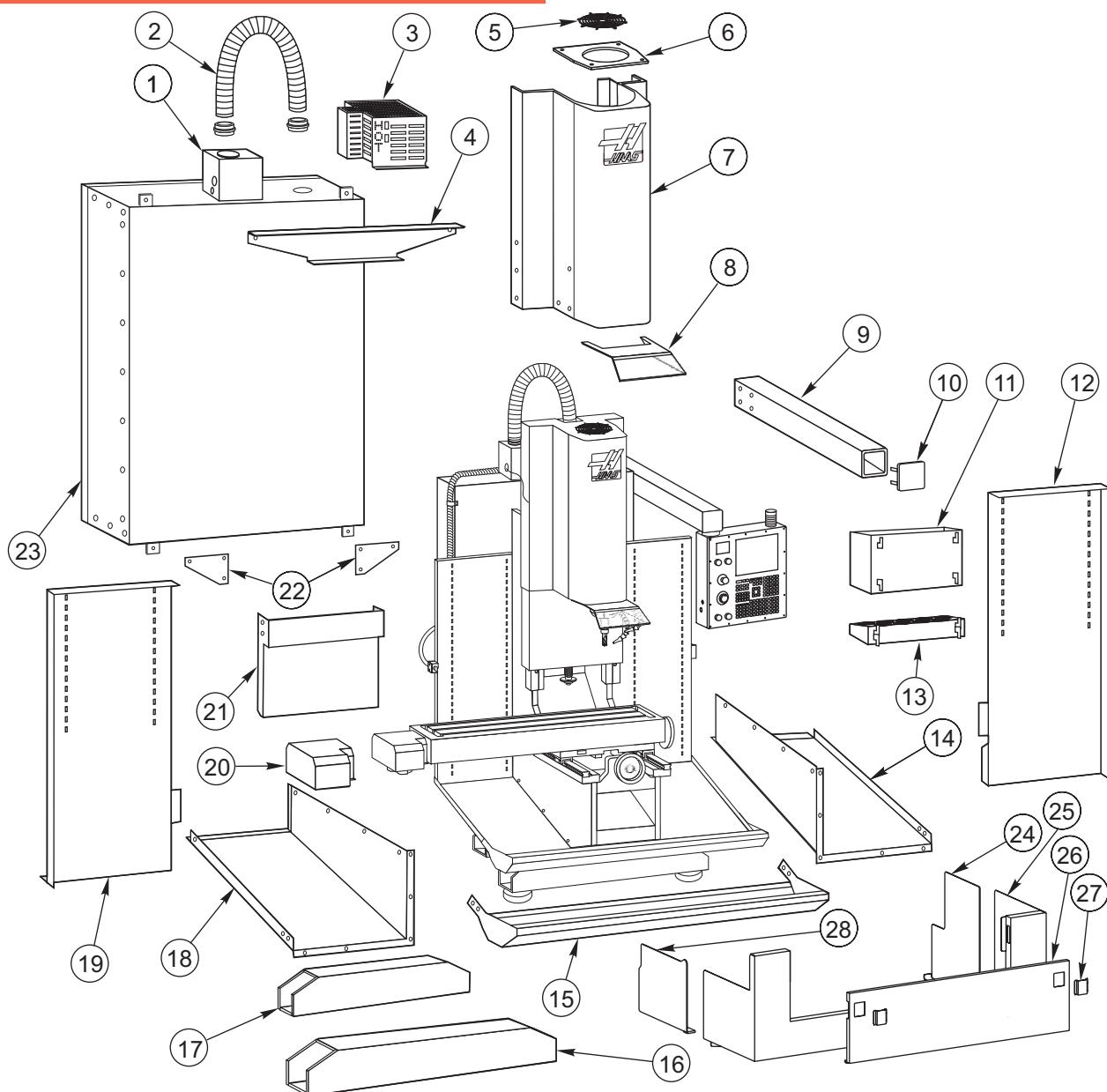
## OM-1, -2 SPINDLE HEAD ASSEMBLY





## OM-1, -2 SPINDLE HEAD ASSEMBLY

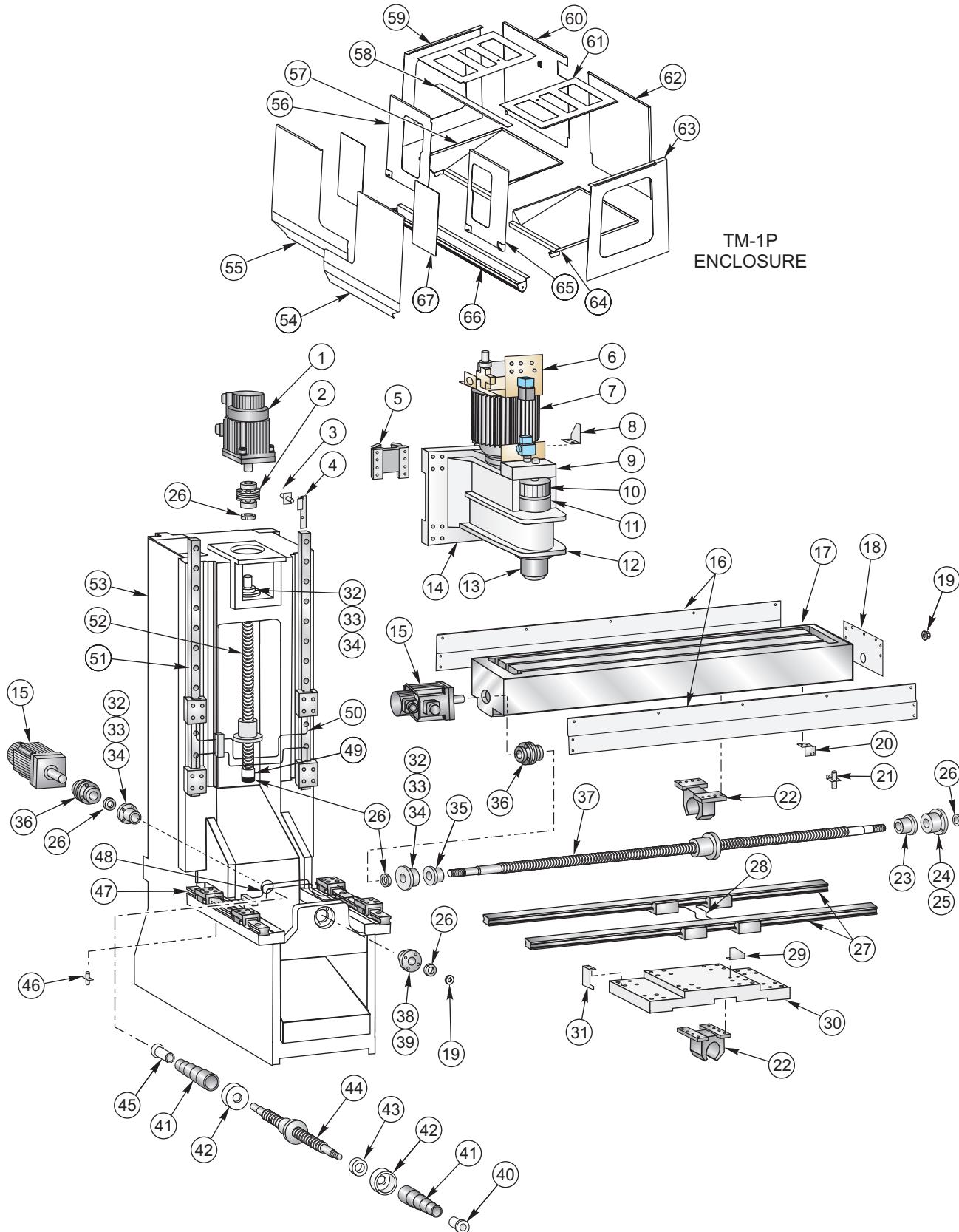
52. 25-7461A	Spindle Head Cover	98. 57-0070	O-Ring 2-114
53. 66-1480	Fan	99.	O-Ring 2-012
54. 25-7462A	Top Head Cover	100. 20-3202	Draw Bar Retainer
55. 59-0144	Fan Guard	101.	3MR-635-15 Polychain GT2 Belt
56. 59-2832B	Quick Exhaust	102. 20-3226	Pulley 90T
58-3729	Nipple	103. 57-4120	O-Ring 2-226
57. 36-30675	Solenoid	104. 20-3192A	Spindle Housing
58. 53-3012	Pressure Switch	105. 20-3197	Spindle Lock Ring
59. 58-2743	Branch Tee	106.	Spring 4.51g_Comp. 1_15
60. 58-2736	Air Regulator 0-10 B-1	107.	2X Bearing 25_42_9mm
61. 36-30670	Solenoid	108. 20-3196	Spindle Outer Spacer
62. 60-1813	Encoder	109. 20-3195	Spindle Inner Spacer
63. 25-6298	Encoder Spring Clamp	110.	O-Ring 2-033
64. 25-6293	Encoder Spring Box	111. 20-3193A	Spindle Cap
65. 20-3323	Encoder Drive Sprocket	112. 20-3194A	Spindle Shaft
66. HDT_Wb1	Encoder Drive Belt	113. 20-3201	Spindle Draw Bar
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		

**TM-1/TM-2 EXTERIOR SHEET METAL**

- |              |                            |              |                               |
|--------------|----------------------------|--------------|-------------------------------|
| 1. 25-11390  | Junction Box CNC Control   | 15. 25-4005  | Trough                        |
| 2. 59-0385A  | Corrugated Tubing Assembly | 16. 20-1859  | Leveling Foot Front           |
| 3. 32-0041B  | Regen Assembly             | 17. 20-1858  | Leveling Foot Rear (TM-1)     |
| 4. 25-4044A  | Support Upper Control Box  | 20-1859      | Leveling Foot Rear (TM-2)     |
| 5. 59-0144   | Fan Guard Spindle          | 18. 25-6654B | Pan Left                      |
| 6. 25-0389   | Fan Mounting Plate         | 19. 25-6597A | Panel Back Left               |
| 7. 25-4003F  | Cover Spindle Head         | 20. 25-4000A | Cover Table Motor             |
| 8. 25-4008   | Splash Shield Spindle      | 21. 25-4010  | Head Cover Bottom             |
| 9. 20-1097B  | Pendant Support Arm        | 22. 20-2485  | Support Lower Control Box (2) |
| 10. 14-1962  | Casting End Cap (2)        | 23. 30-30299 | Control Box                   |
| 25-5394      | Retainer End Cap           | 24. 25-1380C | Spash Guard Right             |
| 11. 25-0563B | Tool Box Assembly          | 25. 25-1378B | Spash Guard Front (TM-1)      |
| 12. 25-6598A | Back Panel Right           | 25-5577B     | Table Chip Guard (TM-2)       |
| 13. 25-0440A | Tool Tray 40T              | 26. 25-5578  | Door                          |
| 14. 25-6655A | Pan Right                  | 27. 58-0227  | Latch Push Close (2)          |
|              |                            | 28. 25-1379B | Spash Guard Left              |



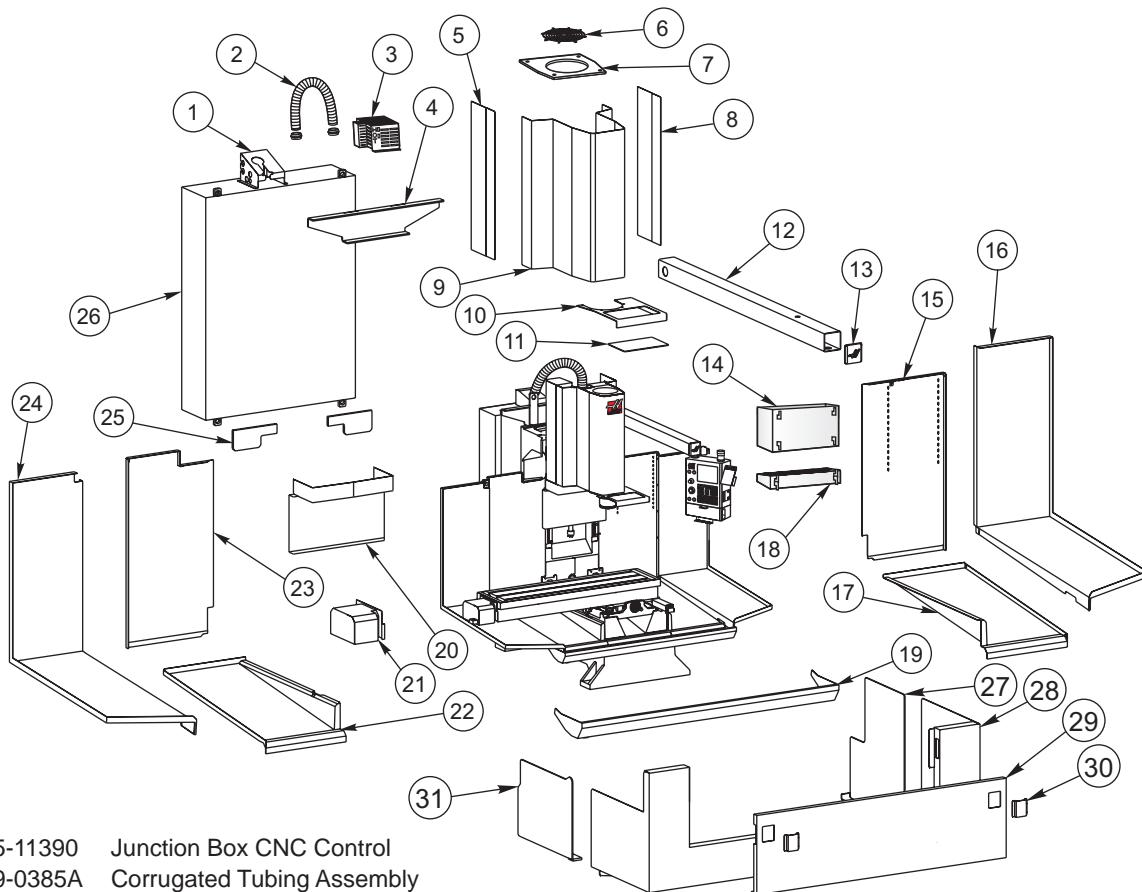
### TM-1/TM-2 ENCLOSURE & INTERIOR PARTS





## TM-1/TM-2 ENCLOSURE & INTERIOR PARTS LIST

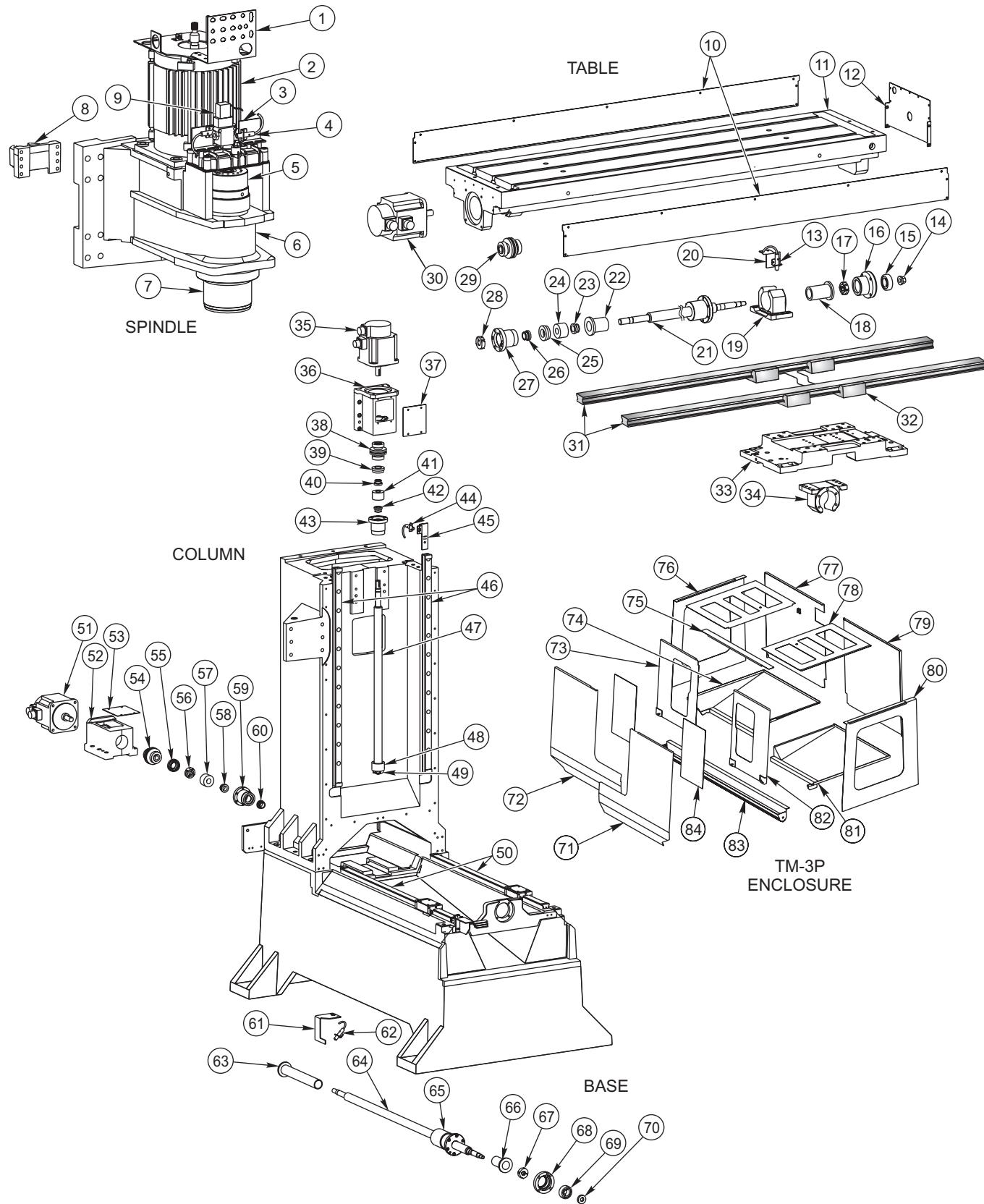
1. 62-0024	Servomotor Yaskawa 05 No Brake	47. 50-0013A	Linear Guide 30 X 710 (2) (TM-1)
2. 30-1220A	Coupling Assembly BL	50-0014A	Linear Guide 30 X 1030 (2) (TM-2)
3. 69-1601	Proximity Switch	48. 30-2794A	Lube Line Assembly Y-Axis
4. 25-4024	Switch Bracket Z-Axis	49. 28-0221	Bumper X-Axis
5. 20-7008F	Nut Housing Machined	50. 30-2042	Lube Line Assembly Z-Axis
6. 30-2465B	Air Solenoid Assembly	51. 50-0014A	Linear Guide 30 X 1030 (2)
7. 30-1674C	Spindle Motor Assembly	52. 24-0021	Ballscrew 32-6-809.37 Z-Axis
8. 25-5190B	Proximity Sensor Trip Flag Z-Axis	53. 20-1303C	Base Machining (TM-1)
9. 30-1668B	TRP Assembly	20-2490	Base Machining (TM-2)
10. 20-7373	1 7/8 Pulley	54. 25-7879A	Panel Frnt Rt
11. 20-3823	Oil Injection Cover 40T	55. 25-7878A	Panel Frnt Lt
12. 20-4196	Spindle Housing 40T	56. 30-8926	Door Assy Lt
13. 30-1337A	Spindle Assembly 40T	57. 25-7874A	Pan Encl Lt
14. 20-3007C	Plate Spindle Motor	58. 25-8707	Header Brace
15. 62-1015	Spindle Motor 5HP Lincoln	59. 25-7882	Panel Side Lt
16. 25-4001B	Cover Table Side (2) (TM-1)	60. 25-7884B	Panel Back Lt
25-5469	Cover Table Side (2) (TM-2)	61. 25-7880A	Cover Top
17. 20-1302C	Table Macining (TM-1)	62. 25-7883A	Panel Back Rt
20-2488A	Table Machined (TM-2)	63. 25-7881	panel Side Rt
18. 25-4002A	Cover Table End	64. 25-7875A	Pan Encl Rt
19. 46-0015	Nut 1/4-20 Flange (2)	65. 30-8925	Door Assy Rt
20. 25-4014	Switch Bracket X-Axis	66. 25-7905	Trough Encl
21. 69-1606	Proximity Switch	67. 28-0240	Window Door
22. 20-1093	Nut Housing X/Y-Axis (2)		
23. 28-0225	Bumper X-Axis Support End		
24. 30-2780	Bearing Housing Assembly		
25. 51-2025	Bearing Radial 304PP		
26. 51-2012	Bearing Locknut (6)		
27. 50-0012A	Linear Guide 30 X 1170 (2) (TM-1)		
50-0102	Linear Guide 30 X 1420 (2) (TM-2)		
28. 30-2767	Lube Line X-Axis		
29. 25-5192A	Proximity Sensor Trip Flag X-Axis		
30. 20-1304C	Saddle Machining		
31. 25-5191A	Proximity Sensor Trip Flag Y-Axis (TM-1)		
25-5476	Proximity Sensor Trip Flag Y-Axis (TM-2)		
32. 20-7416	Housing Bearing Cartridge (3)		
33. 51-1011U	Bearing Angular Contact (3)		
34. 20-7418	Lock Bearing Cartridge (3)		
35. 28-0224	Bumper X-Axis Motor End		
36. 30-1220A	Coupling Assembly BL (2)		
37. 24-0019	Ballscrew 32-6-1209.802 X-Axis (TM-1)		
24-0106	Ballscrew 32-6-1463.802 X-Axis (TM-2)		
38. 30-2780	Bearing Housing Assembly		
39. 51-2025	Bearing Radial 304PP		
40. 28-0226	Bumper Y-Axis Support End (TM-1)		
28-0227	Bumper Y-Axis Support End (TM-2)		
41. 59-0264A	Cover Ballscrew Y-Axis (2)		
42. 20-1113A	Retainer Y-Axis Ballscrew Cover (2)		
43. 20-1114	Spacer Ballscrew Cover		
44. 24-0020	Ballscrew 32-6-854.329 Y-Axis (TM-1)		
24-0107	Ballscrew 32-6-971.80 Y-Axis (TM-2)		
45. 28-0210	Bumper Y-Axis Motor End		
46. 69-1606	Proximity Switch		

**TM-3 EXTERIOR SHEET METAL**

- |              |                               |              |                      |
|--------------|-------------------------------|--------------|----------------------|
| 1. 25-11390  | Junction Box CNC Control      | 27. 25-8517B | Splash Guard Right   |
| 2. 59-0385A  | Corrugated Tubing Assembly    | 28. 25-5579B | Table Chip Guard     |
| 3. 32-0041B  | Regen Assembly                | 29. 25-5578  | Door                 |
| 4. 25-4044A  | Support Upper Control Box     | 30. 58-0227  | Latch Push Close (2) |
| 5. 25-8402   | Side Spindle Head Cover       | 31. 25-8516B | Splash Guard Left    |
| 6. 59-0144   | Fan Guard Spindle             |              |                      |
| 7. 25-0389   | Fan Mounting Plate            |              |                      |
| 8. 25-8402   | Side Spindle Head Cover       |              |                      |
| 9. 25-4003F  | Cover Spindle Head            |              |                      |
| 10. 25-5580  | Shield Bottom Spindle         |              |                      |
| 11. 28-0163  | Window Bottom Spindle         |              |                      |
| 12. 20-3524A | Pendant Arm                   |              |                      |
| 13. 14-1962  | Casting End Cap               |              |                      |
| 14. 25-0563B | Tool Box Assembly             |              |                      |
| 15. 25-8168  | Panel Back Right              |              |                      |
| 16. 25-8483  | Pan Extension Right           |              |                      |
| 17. 25-8170  | Pan Right                     |              |                      |
| 18. 25-0440A | Tool Tray                     |              |                      |
| 19. 25-5471  | Trough                        |              |                      |
| 20. 25-8490A | Waycover Z-Axis               |              |                      |
| 21. 25-4000A | Cover Table Motor             |              |                      |
| 22. 25-8169  | Pan Left                      |              |                      |
| 23. 25-8167  | Panel Back Left               |              |                      |
| 24. 25-8482  | Pan Extension Left            |              |                      |
| 25. 20-3712  | Support Lower Control Box (2) |              |                      |
| 26. 30-30299 | Control Box                   |              |                      |



### TM-3 ENCLOSURE & INTERIOR PARTS



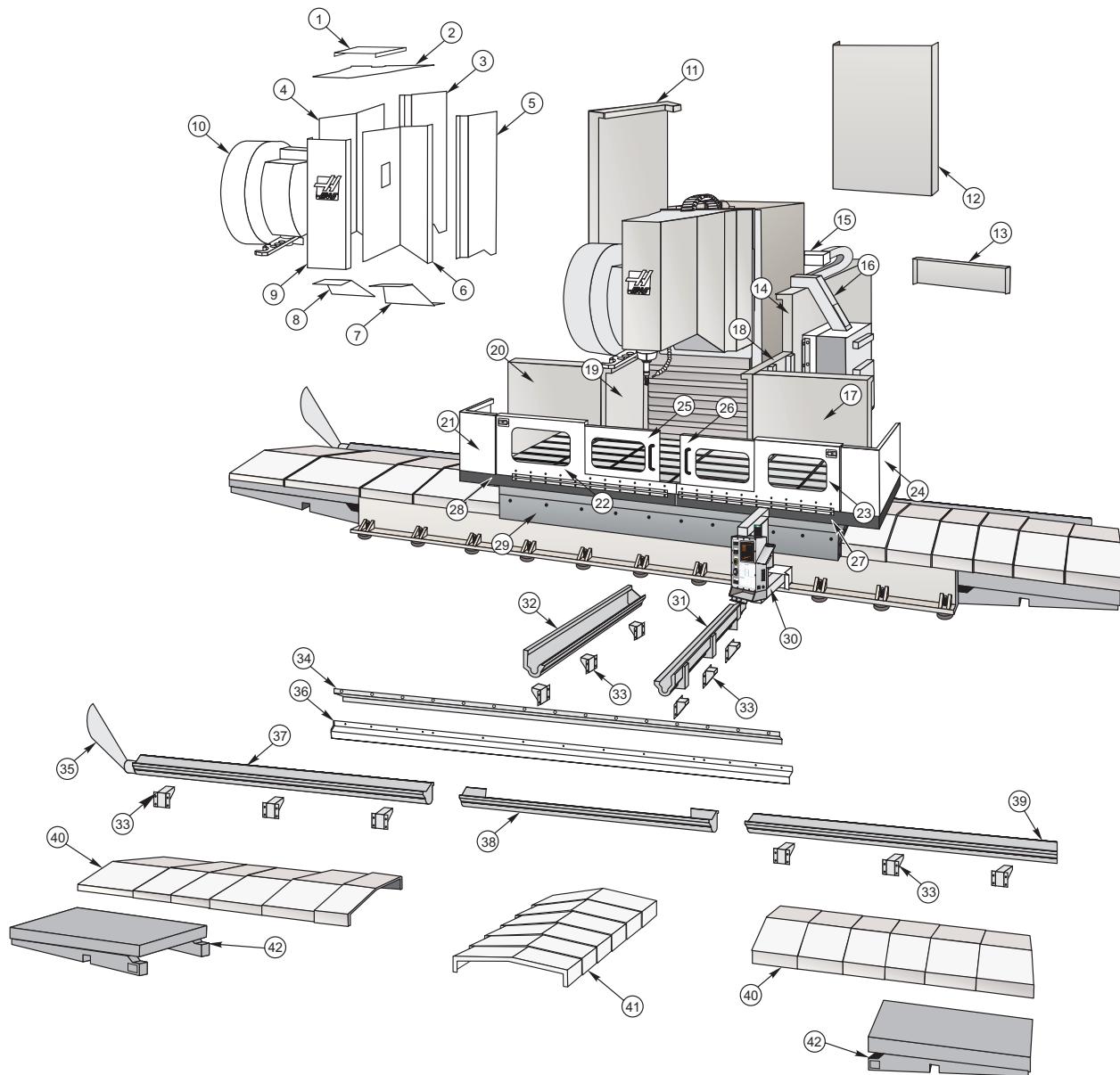


### TM-3 ENCLOSURE & INTERIOR PARTS LIST

1. 25-6180C	Solenoid Mounting Bracket	55. 20-7418	Lock Bearing Cartridge
2. 62-1015	Spindle Motor 5HP Lincoln	56. 51-2012	Bearing Locknut TCN-04-F
3. 25-7050C	Switch Mounting Bracket (x2)	57. 51-1011U	Bearing Angular Contact
4. 69-1700	Proximity Switch (x2)	58. 22-7417	Spacer Bearing Cartridge
5. 20-7373	1 7/8 Pulley	59. 20-7416	Housing Bearing Cartridge
6. 20-10217	Spindle Head Machined	60. 22-7417	Spacer Bearing Cartridge
7. 20-4196	Spindle Housing 40T	61. 25-8399	Proximity Sensor Trip Y-Axis
8. 20-7008F	Nut Housing Machined	62. 69-1606	Proximity Switch
9. 32-5620	TRP Solenoid Valve Assembly	63. 28-0265	Bumper Y-Axis Motor End
10. 25-8401	Table Cover Side (x2)	64. 24-0019	Ballscrew 32-6-1209.802 X-Axis
11. 20-3676A	Table Machined	65. 20-1113A	Retainer Y-Axis Ballscrew Cover
12. 25-4335A	Cover Table End	66. 28-0226	Bumper Y-Axis Support End
13. 69-1606	Proximity Switch	67. 51-2012	Bearing Locknut TCN-04-F
14. 46-0015	Nut 1/4-20 Flange	68. 20-1094	Bearing Housing
15. 51-2025	Bearing Radial 304PP	69. 51-2025	Bearing Radial 304PP
16. 20-1094	Bearing Housing	70. 46-0015	Nut 1/4-20 Flange
17. 51-2012	Bearing Locknut TCN-04-F	71. 25-7879A	Right Front Panel
18. 28-0225	Bumper X-Axis Support End	72. 25-7878A	Left Front Panel
19. 20-1093	Nut Housing X/Y-Axis	73. 30-8926	Door Left
20. 25-4014	Switch Bracket X-Axis	74. 25-7874A	Left Pan
21. 24-0106	Ballscrew 32-6-1463.802 X-Axis	75. 25-8707	Header Brace
22. 28-0224	Bumper X-Axis Motor End	76. 25-7882	Left Side Panel
23. 22-7417	Spacer Bearing Cartridge	77. 25-7884B	Left Back Panel
24. 51-1011U	Bearing Angular Contact	78. 25-7880A	Roof Panel
25. 20-7418	Lock Bearing Cartridge	79. 25-7883A	Right Back Panel
26. 22-7417	Spacer Bearing Cartridge	80. 25-7881	Right Side Panel
27. 20-7416	Housing Bearing Cartridge	81. 25-7875A	Right Pan
28. 51-2012	Bearing Locknut TCN-04-F	82. 30-8925	Right Door
29. 30-1220A	Coupling Assembly BL	83. 25-7905	Auger Trough
30. 62-0024	Servomotor Yaskawa 05 No Brake	84. 28-0240	Window Door
31. 50-0102	Linear Guide 30 X 1420 (x2)		
32. 50-0010	Runner Block Linear Guide X/Z-Axis (x4)		
33. 20-1304C	Saddle Machining		
34. 20-1093	Nut Housing X/Y-Axis		
35. 62-0036C	Servomotor SEM C8 W/Brake		
36. 20-7010B	Machining Motor Mount, 32 mm Ballscrew		
37. 25-9203	Cover Plate Motor Mount		
38. 30-1220A	Coupling Assembly BL		
39. 20-7418	Lock Bearing Cartridge		
40. 22-7417	Spacer Bearing Cartridge		
41. 51-1011U	Bearing Angular Contact		
42. 22-7417	Spacer Bearing Cartridge		
43. 20-7416	Housing Bearing Cartridge		
44. 69-1601	Proximity Switch		
45. 25-8393	Z Proximity Mounting		
46. 50-3007	Linear Guide X/Y/Z-Axis (x2)		
47. 24-0021	Ballscrew 32-6-809.37 Z-Axis		
48. 20-3711	Bumper Z Ballscrew		
49. 51-2012	Bearing Locknut TCN-04-F		
50. 50-3007	Linear Guide X/Y/Z-Axis (x2)		
51. 62-0053	Servomotor Yaskawa05/SEM		
52. 20-7010B	Machining Motor Mount, 32 mm Ballscrew		
53. 25-9203	Cover Plate Motor Mount		
54. 30-1220A	Coupling Assembly BL		



### VS-1/3 SHEET METAL ASSEMBLY



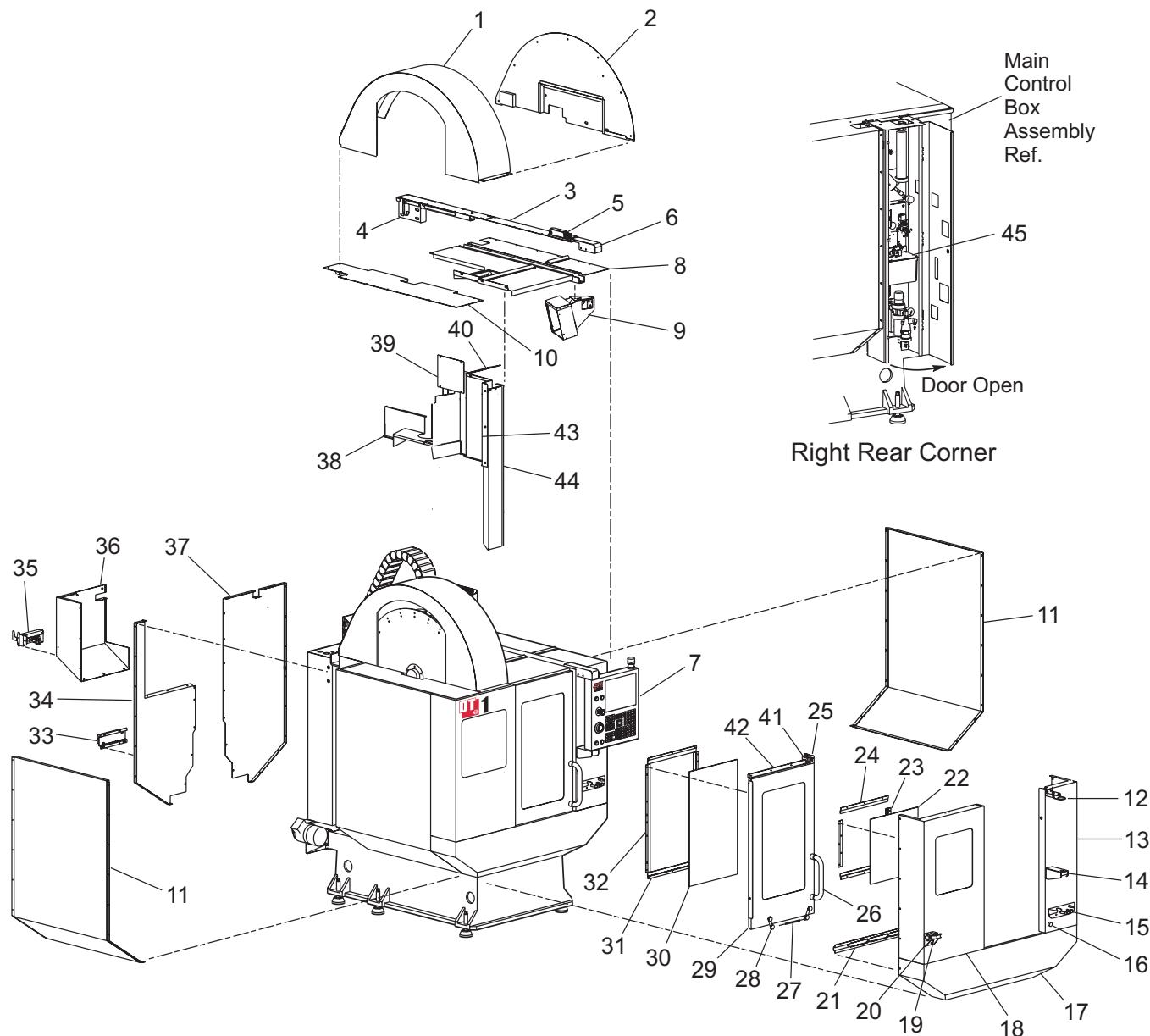


### VS-1/3 SHEET METAL ASSEMBLY PARTS LIST

1. 59-0144 Fan Guard Spindle 8.75 in.
2. 25-9278C Top Head Cover
3. 25-0523 Spacer Cover Left
4. 25-9281D Left Head Cover
5. 25-0522 Spacer Cover Right
6. 25-9282D Right Head Cover
7. 25-9280D Cover Bottom Head
8. 25-0521 Spacer Cover Bottom
9. 25-9277C Cover Front Head
10. 30-1459A T/C Enclosure Assembly
11. 25-0441 Side Panel Rear
12. 25-0528 Rear Panel
13. 25-0446A Bottom Cover Rear
14. 25-0457 Operator Side panel
15. 20-0561A Conduit Control Box
16. 25-0170 Gore Arm Cover
17. 25-0445A Panel Right Front
18. 25-0443 Side Panel Right
19. 25-0442 Side panel Left
20. 25-0444A Panel Left Front
21. 25-4388 Table Guard Left (VS-1)  
25-0453A Table Gutter Guard Left (VS-3)
22. 25-4391 Door Hinged Left (VS-1)  
25-0586A Door Left Hinged (VS-3)
23. 25-4393 Door Hinged Right (VS-1)  
25-0587A Door Right Hinged (VS-3)
24. 25-4390 Table Guard Right (VS-1)  
25-0454A Table Gutter Guard Right (VS-3)
25. 25-4398 Door Rolling Left (VS-1)  
25-0588 Door Left Rolling (VS-3)
26. 25-4399 Door Rolling Right (VS-1)  
25-0589A Door Right Rolling (VS-3)
27. 25-4258 Chip Trough Right X-Axis (VS-1)  
25-0452A Auger Trough X-Axis Right (VS-3)
28. 25-4257 Chip Trough Left X-Axis (VS-1)  
25-0450A Auger Trough X-Axis Left (VS-3)
29. 25-4262 Chip Guard X-Axis (VS-1)  
25-0630 Chip Guard X-Axis (VS-3)
30. 20-0482 Support Pendant
31. 25-0449 Auger Trough Z-Axis Right
32. 25-0448 Auger Trough Z-Axis Left
33. 25-6043 Brace Side Pan
34. 25-0630 Chip Guard X-Axis
35. 25-0548 Chute Discharge
36. 25-4263 Chip Deflector X-Axis (VS-1)
37. 25-7643 Chip Deflector Left X-Axis (VS-3)
38. 25-7644 Chip Deflector Center X-Axis (VS-3)
39. 25-7645 Chip Deflector Right X-Axis (VS-3)
40. 25-4264 Waycover X-Axis (VS-1)  
25-6007A Waycover X-Axis (VS-3)
41. 25-6008A Waycover Z-Axis
42. 25-4261A Cover Bottom X-Axis (VS-1)  
25-0645B Cover Bottom X-Axis (VS-3)



## DT-1 EXTERIOR SHEET METAL



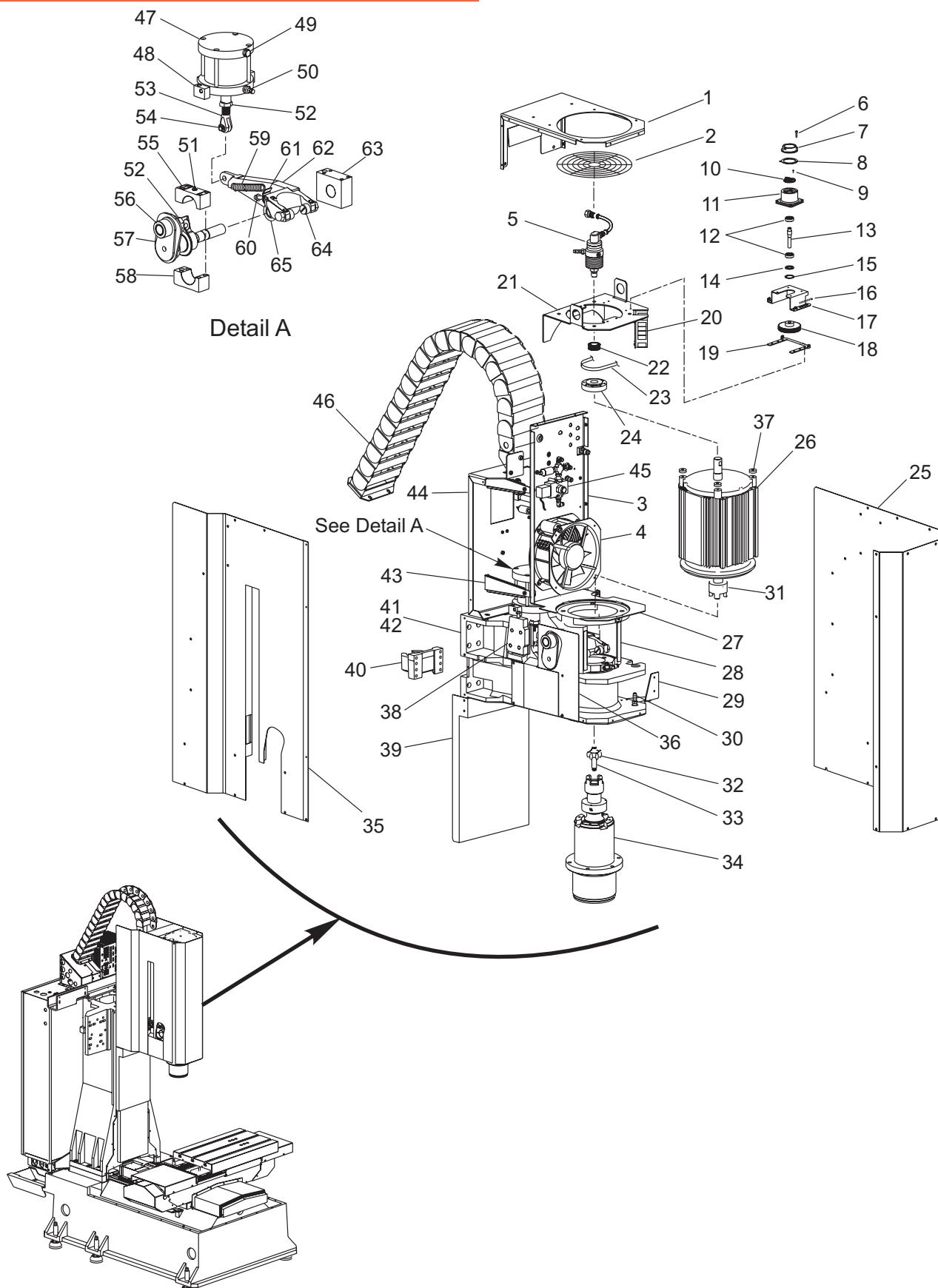


### DT-1 EXTERIOR SHEET METAL PARTS LIST

1. 25-1897B Carousel top cover
2. 25-1898A Carousel right cover
3. 25-2027A Cable channel roof cover
4. 258-1812A Pendant cable channel
5. 32-1092 Door interlock assembly
  - 61-1006 CE Interlock switch
6. 25-11415A Cover swivel
7. Thin Pendant Asembly
8. 25-1837A Right top panel enclosure
9. 25-1679 Worklight twin housing
10. 25-2011A Left top panel enclosure
11. 25-1808 2X Side panel enclosure
12. 25-11403 Pendant upper support bracket
13. 25-1807 Right front panel enclosure
14. 30-30345 Pendant support bracket assembly
15. 25-5412A Nozzle holder bracket
16. 52-1677 Bulkhead fitting NPT .25 x .750 in. dia.
17. 25-1805A Center front panel enclosure
18. 25-1806 Left front panel enclosure
19. 20-4866 Tool holder block BT-30 (optional)
  - 59-0278 Knob head .375-16 x 1.50 in. dog point screw (optional)
20. 25-2452 Tool vise mounting block (optional)
21. 22-7616 Lower door rail
22. 28-0183 Window panel 19 in. square
23. 25-6084A 2X Side window frame
24. 25-5228 2X Top-bottom window frame
25. 25-2295 Actuator key mounting bracket
26. 22-8895 Door handle chrome
  - 20-4645 2x door handle spacers
27. 59-9743 Front door spring
28. 59-6400A 4X Guide wheel door rollers
  - 45-0045 4X Washer .25in hard .25id x .625 OD x .125 in thk
  - 46-0109 2X .25-20 locknut with nylon insert
29. 25-1811A operator door
30. 28-0014 Door window
31. 25-0773 2X Top-bottom door frame
32. 25-0772 2X Door frame sides
33. 20-4310 Manifold .75 in. NPT
  - 25-7860A Manifold bracket standard (non-TSC)
34. 25-1809A Left back panel enclosure
35. 25-9262A Wash handle and hose holding bracket
36. 25-1899A Carousel back cover
37. 25-1810A Right back panel enclosure
38. 25-1901 Tool changer back clip shield
39. 25-1902 Tool changer right chip shield support
40. 25-1837A Right top panel enclosure
41. 25-0642 Union cover plate Kitagawa
  - 20-0712A Door guide block
42. 20-4642 Upper door guide
43. 25-1900A Tool changer right chip shield
44. 25-1903A Tool changer front chip shield support
45. 30-4597 Min lube panel assembly



### DT-1 SPINDLE HEAD



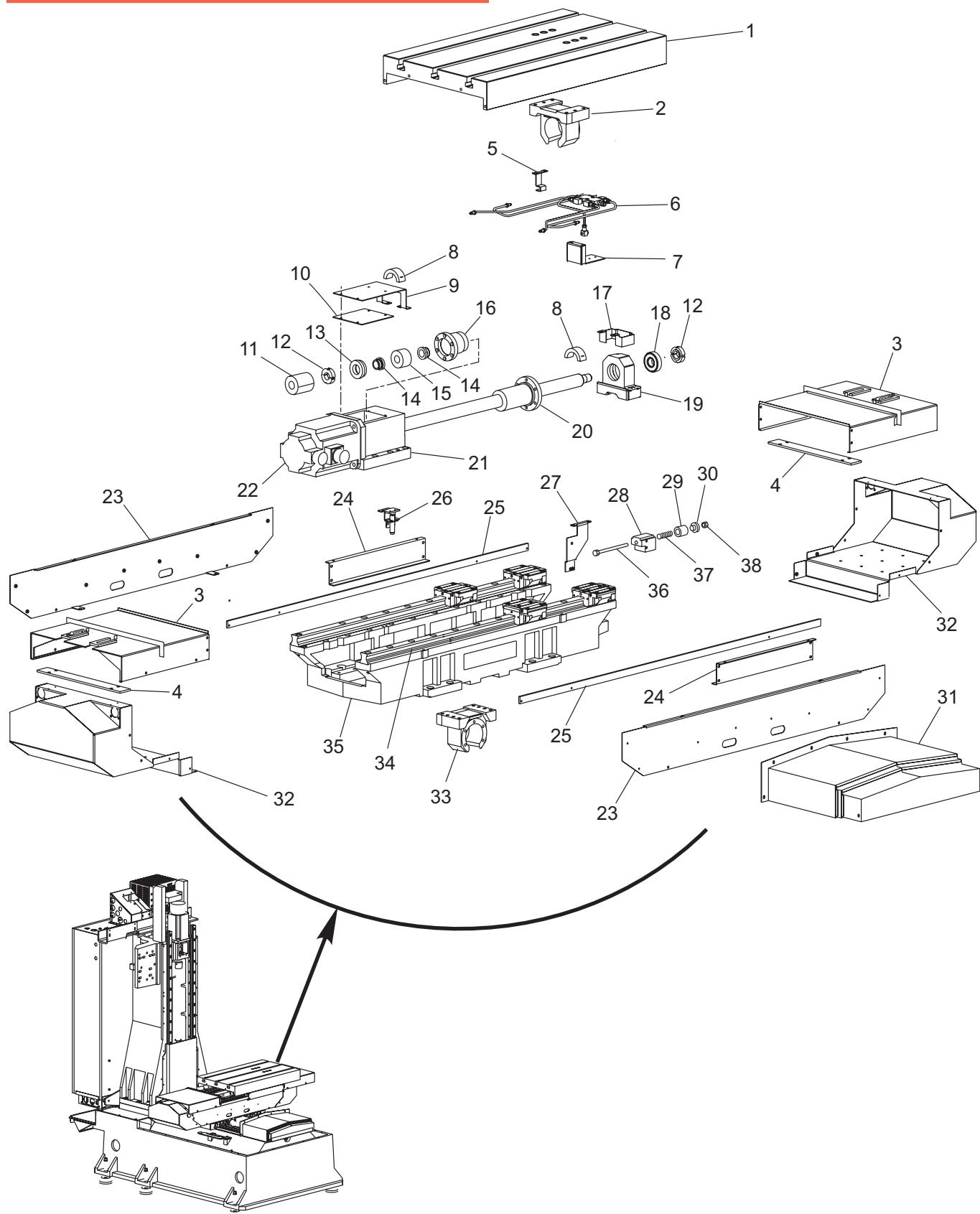


## DT-1 SPINDLE HEAD PARTS LIST

1. 25-1950A Top head cover
2. 59-0144 2X Spindle fan guard 8.75in.
3. 25-2021A fan mounting bracket
4. 66-1495 Fan 225mm 600 CFM/0 1in. H2O
5. 30-4877 Coolant union assembly TSC
6. 40-0136 3X SHCS 6-32 x .625 in.
7. 14-10211A Magnetic encoder cap (casting)
8. 57-11629 Magnetic encoder gasket
9. 41-0011 3X PGS 4-40 x .25in.
10. 30-30390 Haas magnetic encoder (Shafted)
11. 20-10250A magnetic encoder shafted body (machined)
12. 51-10060 2X Radial ball roller bearing M10-26-8
13. 20-10251 Magnetic encoder shaft
14. 59-10136 Spring wave SSB-0102
15. 56-10105 Retaining ring 1.023 in.  
HO TRU-ARC N5000-102
16. 59-0742 2X Extension spring .29OD x 1.5 in.
17. 25-6293A Encoder spring mounting box
18. 20-0179 Timing pulley .375 in . bore
19. 25-6298 Encoder spring mounting box inline
20. 20-2396 Terminal block cover  
73-3055 Terminal block cover 6 pole 115A  
No.2-No.14 barrie  
40-1798 SHCS 8-32 x 1.75 in.  
40-1800 SHCS 8-32 x .75 in.
21. 25-1952A Encoder mounting bracket
22. 20-1702 Encoder pulley
23. 54-0028 Pulley belt
24. 20-1788 Inline motor balance ub
25. 25-1955A Right front head cover
26. 62-0074 Spindle motor 5Hp
27. 25-1956A Lower baffle
28. 20-4882 Spindle motor mount
29. 25-7850 PCool bracket
30. 58-1677 Bulkhead fitting NPT-.25 x .750 in dia.  
58-2259 Hose bard fitting .375 NPT - .25 in. M
31. 52-0052 Hub motor coupling 30T
32. 52-0053 Inline coupling spider 30T
33. 20-4717 Transfer tube TSC 30T  
57-0026 O-ring
34. 30-4504 Spindle with drawbar
35. 25-1948A Left head cover
36. 25-2030A Head cover filler plate
37. 22-7034 4X Cam follower spacer
38. 20-4790A Striker block
39. 25-1895 Z-axis upper waycover
40. 20-7008F nut housing machined
41. 20-4893 Spindle head machined
42. 58-3108 2X plug .5NPT
43. 25-2494 4X Fan bracket standoff
44. 25-1954A Cable carrier mounting bracket
45. 30-4511 Solenoid valve assembly No TSC  
30-4512 Solenoid valve assembly for TSC  
30-4513 Check valve assembly for TSC
46. Cable carrier
47. 59-0574 Air cylinder 4in. dia x 1.5in. stroke
48. 20-4792 2X Air cylinder mount
49. 58-2265 Air muffler NPT-.375in.-M
50. 58-3664 reducer fitting NPT-.375-M x NPT-.125 in. F
51. 58-0562 Straight fitting LBO-.25 x NPT-.125 in.  
M grease
52. 46-1663 2X 46-1663 Jam nut .75-16
53. 49-0068 Clevis .75-16 x .500in.
54. 49-0069 Clevis pin .500 dia. X 1.00 in. long
55. 20-4869 Upper bearing block (part of 35-0063)  
59-0635 Straight grease fitting .125in. - M NPT  
(part of 35-0063)
56. 51-0119 Cam follower 1.75 in. stud .75-16
57. 20-4891 cam rocker arm machined
58. 20-4868 lower bearing block (part of 35-0063)
59. 59-0575 Extension spring .75 x .125 x 5 in.
60. 40-1716 SHCS .3125-18 x 1.75 in.  
45-1739 Flat washer set .4375 in.  
45-0089 Spherical washer set .4375 in.
61. 59-1096 Rocker arm shim .003 in.  
59-1039 Shim .010 in.  
59-0979 shim .040 in.
62. 20-4730 Manual release arm
63. 20-4740 Rocker arm bearing block
64. 51-0045 2X cam follower 1 in. dia.  
46-0001 2x nut 625
65. 20-4892 Actuator rocker arm machined



### DT-1 TABLE AND SADDLE ASSEMBLY



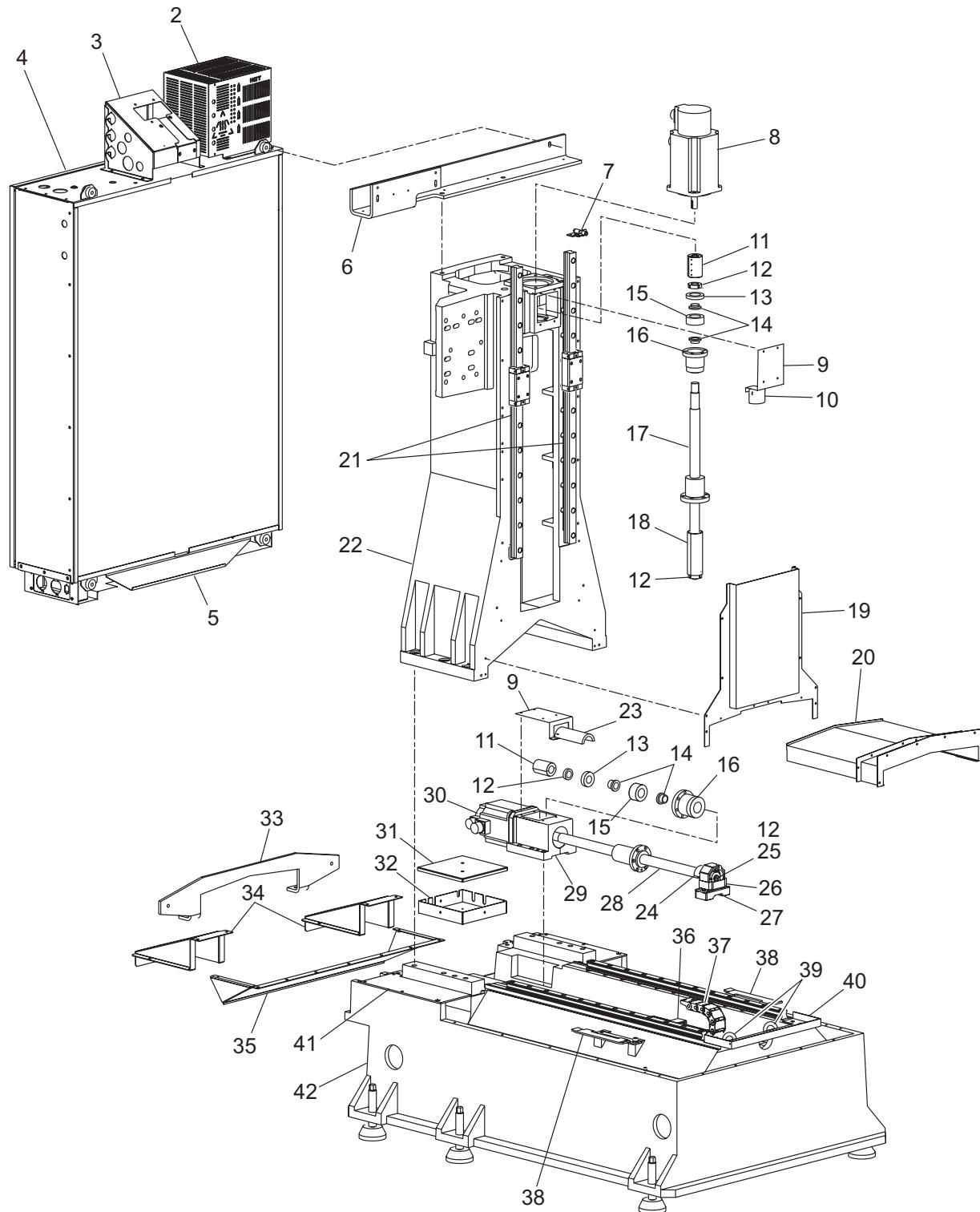


#### DT-1 TABLE AND SADDLE PARTS LIST

1. 20-4722A table machining
2. 20-3006 X-axis nut housing
3. 25-1792A 2X X-axis waycover
4. 20-4804 2X Waycover support
5. 25-1835 X-axis flag strip
6. 30-4851 Table lube line assembly
7. 25-1817A Table lube tray
8. 28-0196 2X Z-axis bumper
9. 25-7042 motor mount cover plate
10. 26-7233A Gasket
11. Coupling
12. 51-212 2X Bearing locknut TCN-04-F
13. 20-7418 lock bearing cartridge
14. 22-7417 2X bearing cartridge spacer
15. 51-1011U Bearing angle contact L2047H 25-30 percent
16. 20-7416 Bearing cartridge housing
17. 25-7080 Bumper bracket
18. 51-2025 radial bearing 304PP
19. 20-7009 Bearing housing machined
20. 24-0045 Ballscrew 32-20-840
21. 20-7010B Motor mount machined
22. 62-10013 Yaskawa servo motor sigma 5 13 w/o brake
23. 25-1825 2X X-axis saddle cover
24. 25-1793 2X X-axis truck chip guard
25. 20-4638 2X X-axis waycover transome
26. 25-5184 X-axis proximity sensor mounting bracket
  - 69-1601 Proximity switch NC 3WR 1.5ft.
27. 25-1823 Saddle cable carrier bracket
28. 20-4901 Plunger body
29. 20-4902 Plunger cap
30. 59-1127 Push-in bumper nitrile 1 in. dia.
31. 25-1794 Y-axis front waycover
32. 25-1826 2X X-axis motor cover
33. 20-7008F nut housing machined
34. 50-10003 2X linear guide 30x910
35. 20-4721 Saddle machined
36. 43-7015 HHB .3125-18 x 2.50in.
37. 59-0185 Ejector spring .50 x 2.50in.
38. 46-0031 Hex locknut – distorted thread .3125-18



## DT-1 CONTROL COLUMN AND BASE



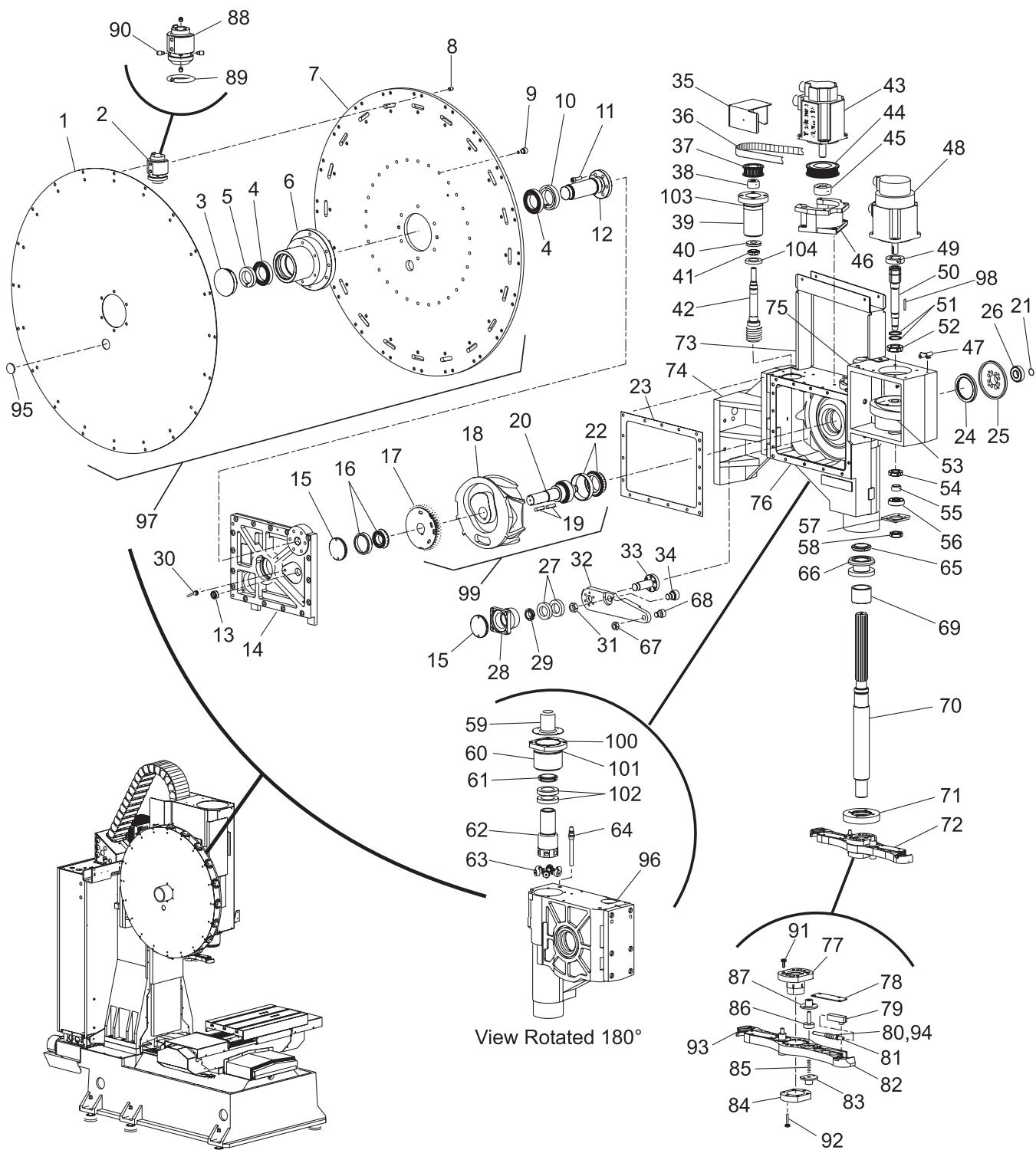


## DT-1 CONTROL COLUMN AND BASE PARTS LIST

1. not used
2. 25-0462A Regen back cover  
25-4311A Regen front cover
3. 25-11428A Cable exit cover
4. 28-0079 Main control box assembly
5. 25-1834 Wire guard
6. 25-1814A Upper control box support
7. 69-1601 Proximity switch NC 3WR 1.5ft.
8. 62-0066 Servo motor SEM C8 with brake
9. 25-7042 Motor mount cover plate
10. 28-0198 x-axis ballscrew bumper (motor end)
11. Servo coupling (2-piece) DR-8456-F
12. 51-2012 2X Bearing locknut TCN-04-F
13. 20-7418 lock bearing cartridge
14. 22-7417 2X Bearing cartridge spacer
15. 51-1011U Bearing angle contact L2047H 25-30 percent
16. 20-7416 Bearing cartridge housing
17. 24-0045 Ballscrew 32-20-840
18. 28-0079 Z-axis lower bumper
19. 25-1896 Z-axis lower waycover
20. 25-11334A Y-axis rear waycover
21. 50-10000A Linear guide 30x930in.
22. 20-9441C Column machinig
23. 28-0188 Ballscrew bumper 5.00 in.
24. 28-0203 X-axis bumper (support end)
25. 51-2025 Radial bearing 304PP
26. 25-7080 Bumper bracket
27. 20-7009 Bearing housing machined
28. 24-0045 Ballscrew 32-20-840
29. 20-7010B Ballscrew motor mount machined
30. 62-0016 Yaskawa servo motor 13 no brake
31. 25-11872A Lube tube control cover
32. 25-11354B Tube control mounting plate
33. 25-1815 Control box lower support
34. 25-2368 2X Chip chute splash shield
35. 25-1830 Chip chute
36. 25-6870 Y-axis Sensor mounting bracket  
69-1601 Promimity switch NC 3WR 1.5 ft.
37. 59-0303 Cable carrier Igus 14-3-048 18 links
38. 25-2369 Auger keeper
39. 49-1007 2X Shoulder eye bolt .625-11 x 1-1.0625in.
40. 25-1795A Y-axis front waycover mounting bracket
41. 25-1821 2X auger cover plate
42. 20-4720A Base machined



## **DT-1 TOOL CHANGER**





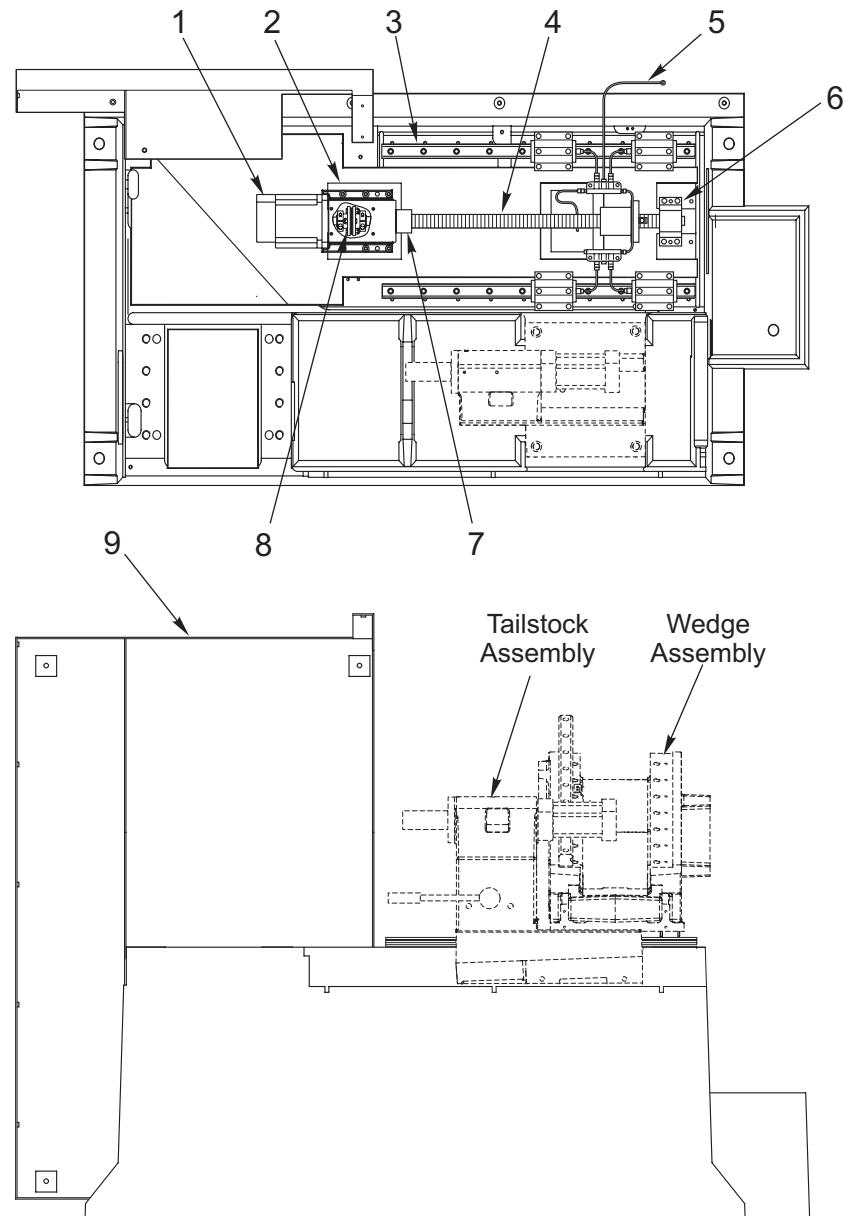
## DT-1 Tool Changer Parts List

1. 25-1868 SMTYC number plate – 20 Pocket
2. 30- 4453 20x Tool pocket assembly
3. 59-0737 Hole plug .375 in. black
4. 51-0020 2x Deep groove bearing 6010ZZW-non metallic
5. 51-0113 Bearing locknut TCN-09-F
6. 20-46992 SMTTC Carousel hub
7. 20-4690 Carousel disk 20 pocket
8. 48-0034 60x dowel ring .391 x .312 x .50 in. long
9. 51-0051 30x Cam follower .75 in. hex
10. 51-0112 Bearing locknut TCN-11-F
11. 40-0086 13x SHCS .375-16 x 1.25 in.
12. 20-4691 SMTTC Carousel shaft
13. 59-4110 Sight glass LSP501-08RG
14. 20-4681 SMTTC Cambox cover
15. 20-0236 2x SMTTC cam bearing adjuster
16. 51-0042 Roller bearing M35-72-18.25
17. 35-1001B Worm gear assembly
18. 20-4662 SMTTC cam globoidal 30T
19. 20-6406 2x Cam gear key
20. 20-4679 SMTTC Cam box main shaft
21. 56-9058 Retaining ring .781 in. SH5100-78
22. 51-0043 Roller bearing M55-90-23
23. 57-0242 SMTTC Cam box gasket
24. 57-0243 Seal 2.875 in. CR28669 3.750 O.D. x.375 in.
25. 20-4680A SMTTC cam tool release
26. 51-2025 Radial bearing 304PP
27. 51-0041 2xRoller Bearing M25-52-16.25
28. 20-0226A Cam arm bearing housing
29. 51-2041 Bearing locknut BH-05
30. 32-0274 Prox. Home switch N.C. 8mm 3 wire 5V
31. 46-1663 Jam nut .75-16
32. 20-4674A SMTTC cam arm
33. 20-0229A Cam arm shaft
34. 51-0092 Cam follower 1.25 short x .75 shank x 1 in. long
35. 25-2458 SMTTC belt cover
36. 54-0036 Drive belt Pg GT 8mm x 20 480-8m-20
37. 54-0117 HTD Sprocket P24-8M-20-1108
38. 54-0215 TL bushing 1108 x .625 in.
39. 20-0225 SMTTC worm shaft bearing housing
40. 57-0050 Seal .750 CR7693 2.047 in. O.D.
41. 51-2041 Bearing locknut BH-05
42. 20-0219 SMTTC worm shaft
43. 62-0016 Servo motor Yaskawa 13 no brake
44. 54-0016 HTD Sprocket P40-8M-20-1610
45. 54.0075 TL Bushing 1610-22M
46. 20-4741 Servo motor mount
47. 32-2130 Home switch 1.5 ft. N.C.
48. 62-0009 Servo motor Yaskawa 09 w/brake
49. 51-0107 Clamp collar 1.50 in. bore
50. 20-4686 Carousel drive gear shaft
51. 56-9057 Retaining ring 1.500 in. SH Tru-arc N5100-1
52. 51-0008 Bearing locknut TCN-06-F
53. 20-4688 Carousel drive gear
54. 51-0065 Bearing nut Ruland TCN-05-F
55. 20-4749 Carousel drive bearing spacer
56. 51-2025 Radial bearing 304PP
57. 20-0840 Bearing cap
58. 51-2012 Bearing Locknut TCN-04-0F
59. 22-0001 Output shaft cap
60. 20-0224 Stargear bearing Housing
61. 51-0038 Bearing Locknut NH-11
62. 20-0223 ATC Stargear
63. 51-0037 6x Cam follower
64. 58-1122 Coupling Fitting .375 NPT  
58-3542 Nipple .375 NPT x 8in.  
58-2269 Air Muffler NPT .375-M
65. 51-2043 Bearing locknut NH-09
66. 20-0222 Slider disc
67. 46-0007 Locking jam nut .625-18
68. 51-0045 Cam follower 1in. dia.
69. 51-0044C Bearing sleeve 2.5 x 2 x 1 7/8
70. 20-2369 Output shaft
71. 30-1025 Bearing cap assembly
72. 30-4448 SMTTC Double arm assembly BT-30.8 in.
73. 25-2472 SMTTC Cable bridge
74. 20-4881 SMTTC Mount machined
75. 20-4880 SMTTC Carousel drive support
76. 20-4646 SMTTC Cambox machined
77. 20-4659 SMTTC Double arm hub
78. 25-1838 2X Double arm cover
79. 20-4649 2X Double arm slide
80. 59-0573 2X Compression spring C0480059 2000M
81. 20-4661 2X Double arm adjuster
82. 20-4648 Double arm 8 in.
83. 20-0246 2x Double arm spring cap
84. 20-4660 Double arm clamp
85. 59-0077 2x Spring C0360-047-1750-M
86. 20-0242 2x Double arm plunger
87. 20-0245 2x Double arm plunger cap
88. 20-4693 20x Tool pocket
89. 59-0570 20x Extension spring .375 x 5.5 x .045 in.
90. 20-0270A 80x Tool pocket plunger
91. 40-2030 4xSHCS .375-16 x .75 in.
92. 40-1675 6x SHCS .312-18 x 2.50 in.
93. 20-0241 2x Arm key
94. 45-0075 Washer .312 .010 THK x .4380 in.
95. 59-0486 Large amphenol hole plug
96. 30-4454A Cambox assembly
97. 30-4455 SMTTC Carousel assembly
98. 22-2629 2x worm stub shaft key
99. 30-4472 Cam gear assembly
100. 57-2223 O-ring 2-242
101. 57-0054 O-ring 2-044
102. 51-0043 2X Radial taper roller bearing assembly M55-90-23
103. 57-0052 O-ring 2-036
104. 51-0041 Radial taper roller bearing M25-52-16-25



## LATHE ASSEMBLY DRAWINGS AND PARTS LISTS

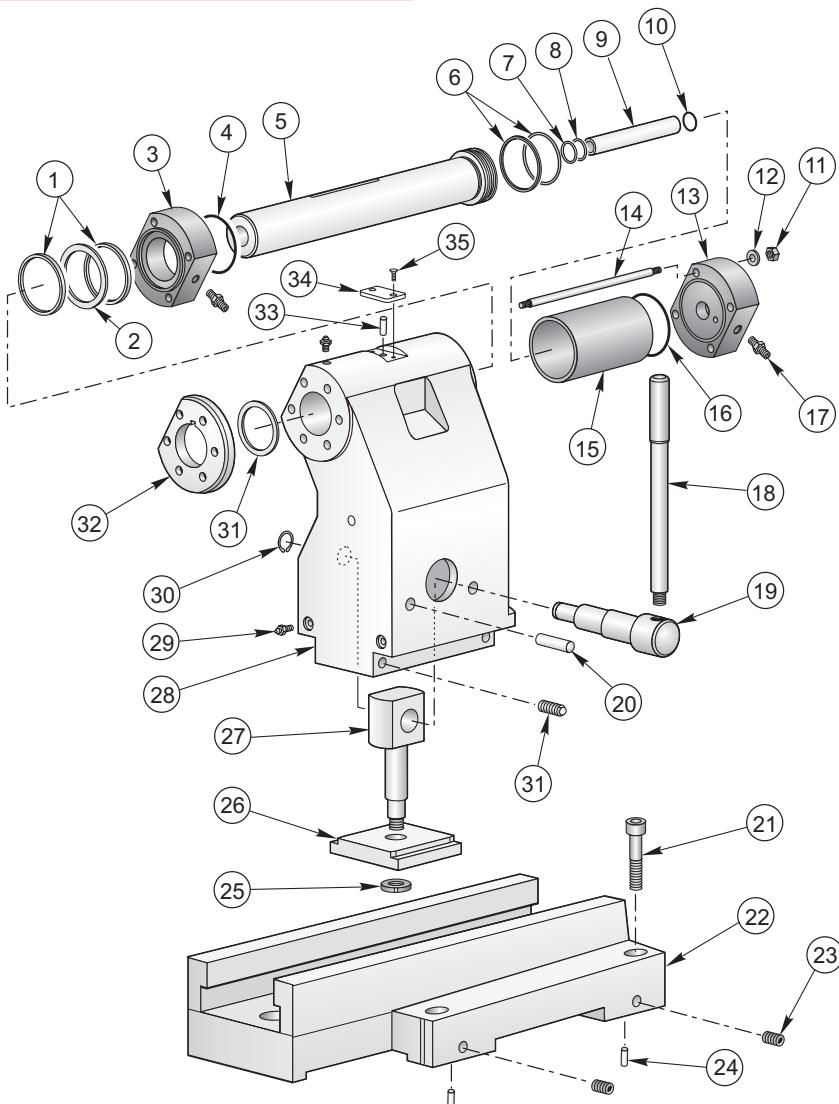
### SL-10 CASTING ASSEMBLY AND PARTS LIST



- |             |                              |             |                          |
|-------------|------------------------------|-------------|--------------------------|
| 1. 62-0014  | Motor                        | 6. 30-0153  | Support Bearing Assembly |
| 2. 20-7010B | Motor Mount Machined         | 7. 28-0231  | Bumper Z-Axis Motor End  |
| 3. 50-8766  | X-axis Linear Guide Assembly | 8. 30-1220A | Coupling Assembly        |
| 4. 30-2290A | Ball Screw Assembly          | 9. 25-0857E | Control Box Bracket      |
| 5. 30-2388A | Oil Line Assembly            |             |                          |



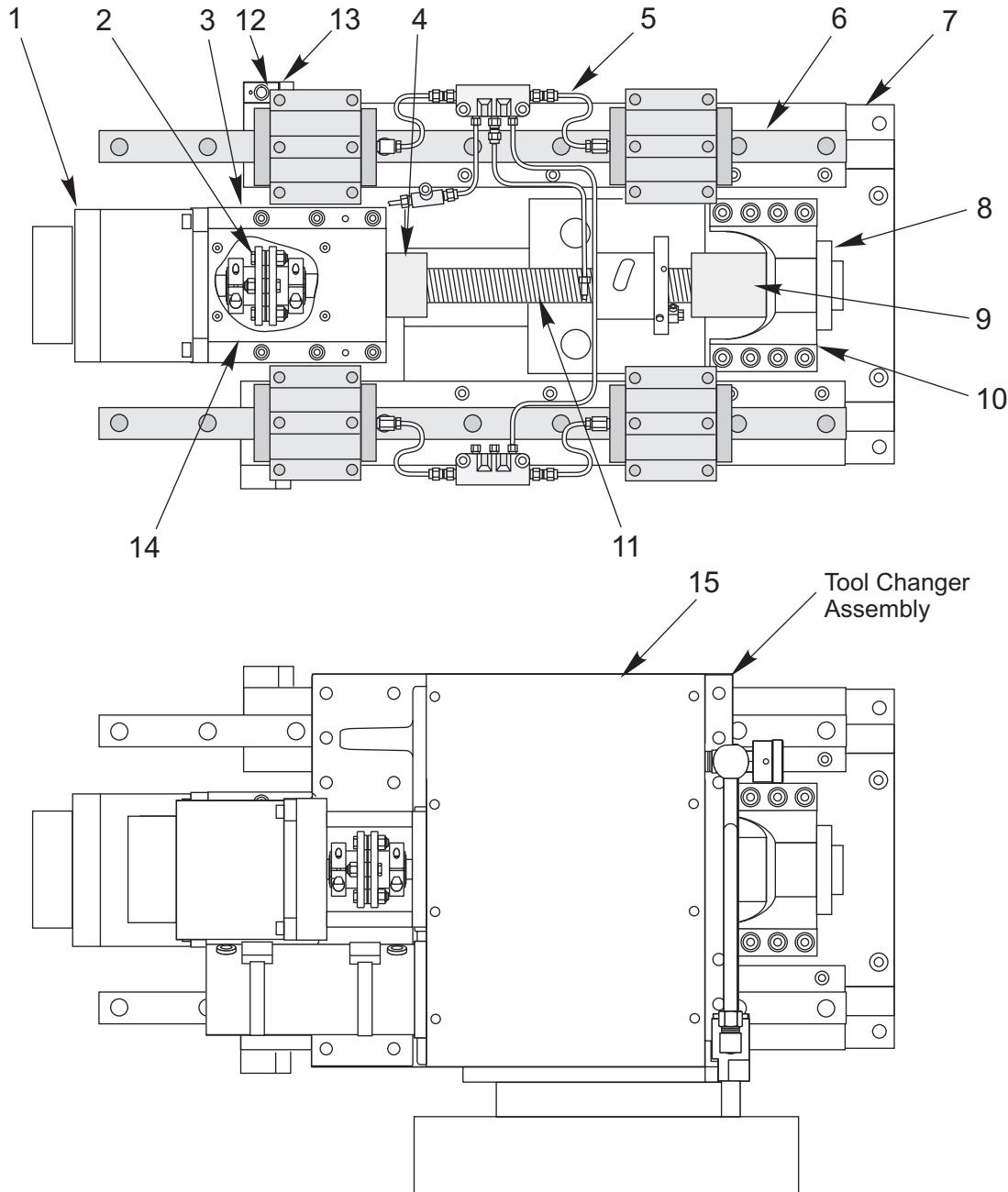
## SL-10 TAILSTOCK ASSEMBLY AND PARTS LIST



1. 57-0142	Seal Kit	19. 20-0859	Eccentric Clamp
2. 20-1070	Gland Retainer	20. 48-1755	Dowel Pin 1/2 x 2 (2)
3. 20-1017	Cylinder Head	21. 40-16643	SHCS 5/8-11 x 2-1/4 (4)
4. 57-0140	O-Ring	22. 20-1052A	TS Base Machining
5. 20-1012A	Shaft	23. 44-1699	SSS 1/2-13 Flat PT (2)
6. 57-0136	Hydraulic Piston Seal	24. 48-1755	Dowel Pin 1/2 x 2 (2)
7. 57-0141	Quad Ring	25. 51-2012	Bearing Locknut
8. 57-0143	Rod Seal	26. 20-0861	Clamp Plate
9. 20-1020	Knock-Out Tube	27. 20-0860	Clamp Rod
10. 57-0020	O-Ring	28. 20-0988A	TS Head Machining
11. 46-1653	Hex Nut 5/16-18 (4)	29. 59-2016	Grease Fitting (6)
12. 45-1600	Split Lock Washer (4)	30. 56-2086	Retaining Ring
13. 20-1014	End Cap	31. 57-0135	Wiper
14. 20-1016	Tie Rod (4)	32. 20-0857	Shaft Cap
15. 20-1013	Cylinder Tube	33. 48-0060	Anti Rotation Pin
16. 57-0140	O-Ring	34. 57-0392	Nut Retainer
17. 58-0045	Str Adapter (2)	35. 40-1703	2X FHCS
18. 20-0858	Handle		



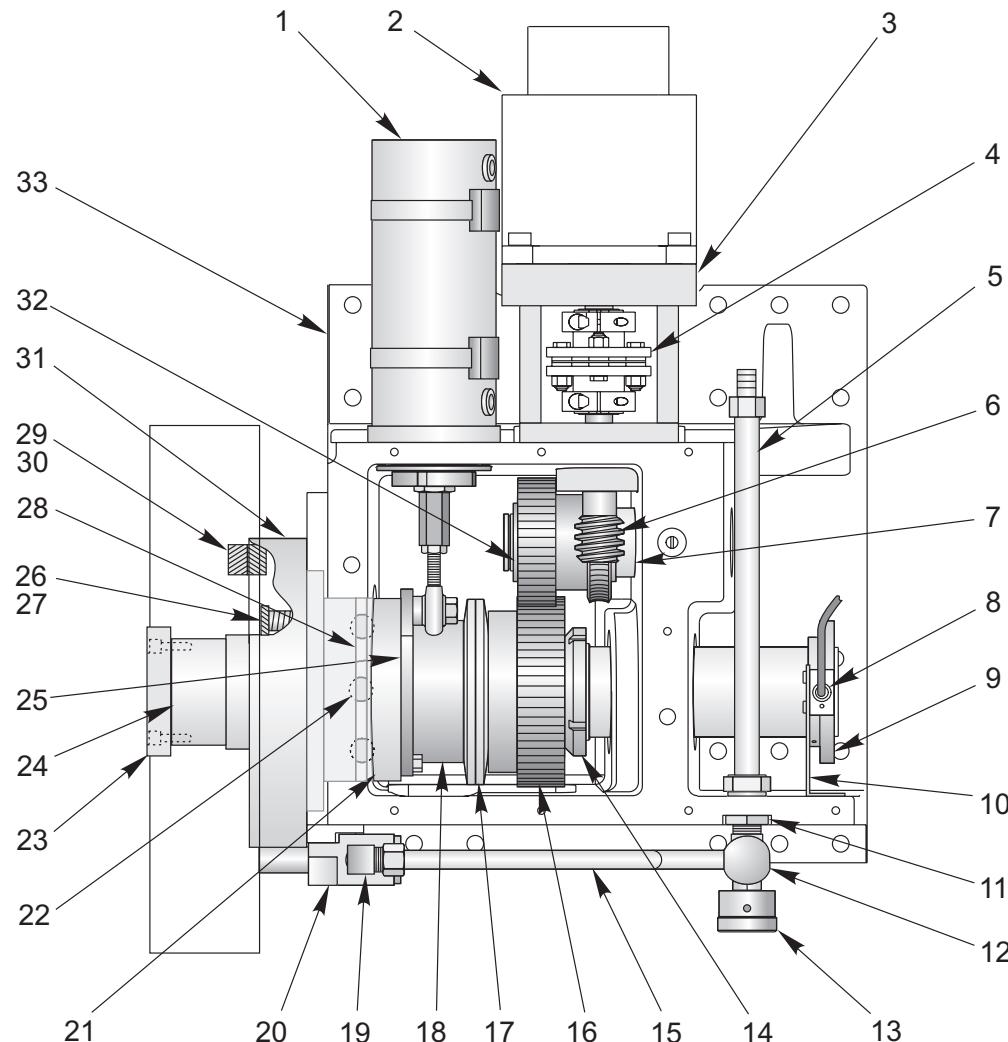
### SL-10 WEDGE ASSEMBLY AND PARTS LIST



- |             |                              |              |                                  |
|-------------|------------------------------|--------------|----------------------------------|
| 1. 62-0009  | Motor                        | 9. 20-0928   | Ring Bumper 2.56                 |
| 2. 30-1219  | Coupling Assembly            | 10. 20-0773  | Bearing Support Housing Machined |
| 3. 20-7010B | Motor Mount Machined         | 11. 30-2244A | Ball Screw Assembly              |
| 4. 28-0228  | Ring Bumper 1.68             | 12. 32-2130  | X-axis Home Limit Switch         |
| 5. 30-2387  | Lube Line Assembly           | 13. 25-5184  | Switch Mounting Bracket          |
| 6. 50-8766  | X-axis Linear Guide Assembly | 14. 25-7042A | Motor Mount Cover                |
| 7. 20-0986D | Wedge Machined               | 15. 20-0848  | TC Housing Cover                 |
| 8. 30-0154  | Bearing Motor Housing        |              |                                  |



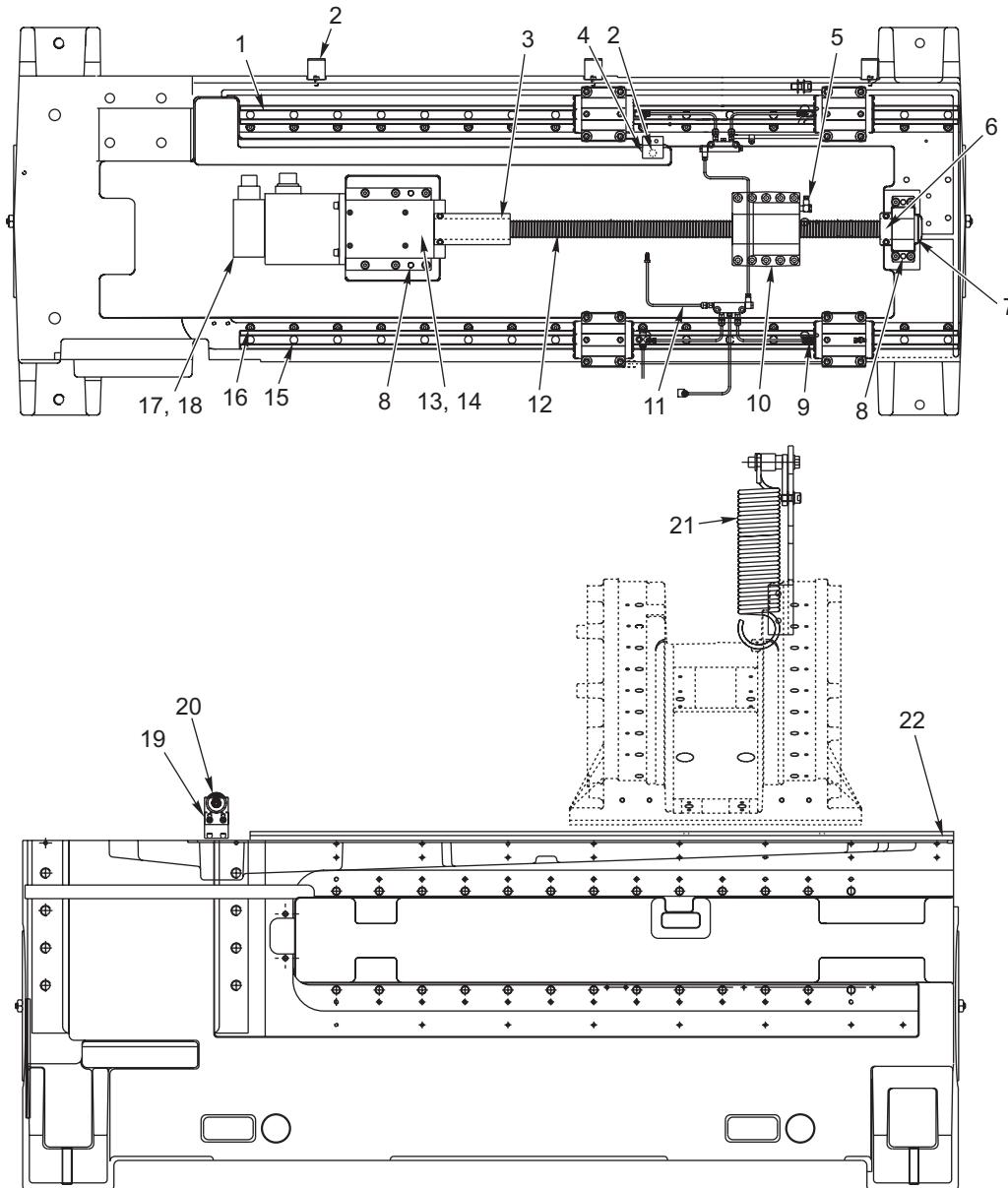
### SL-10 TOOL CHANGER ASSEMBLY AND PARTS LIST



1.	30-3076	Air Cylinder Assembly	17.	24-4010	Belleville Washers (2)
2.	62-0014	Motor	18.	22-8550A	TC Belleville Spacer
3.	20-8512A	Worm Housing	19.	58-3052	Coolant Elbow
4.	30-1220A	Coupling Assembly	20.	30-2293	Coolant Transfer Assembly
5.	30-2294	Coolant Line Assembly	21.	20-8517A	TC Turret Cams (2)
6.	20-8509	Worm Shaft	22.	59-2059	15/16 Steel Balls (3)
7.	20-8510	TC Transfer Shaft	23.	20-8532	Turret Retainer
8.	32-2132	Switch	24.	20-8530	TC Turret Sfaft
9.	20-8533	TC Switch Ring	25.	20-8516	TC Cam Lever
10.	25-0891	Turret Switch Bracket	26.	20-8518	Spring Retainer
11.	58-1680	Bulkhead Fitting	27.	59-0035	Spring
12.	58-0203	Coolant Valve	28.	20-8576	Cam Cage
13.	20-0929	Coolant Knob	29.	20-8768A	Male Turret Coupling
14.	46-7016	Bearing Nut N-13	30.	20-8769A	Female Turret Coupling
15.	58-0202	Coolant Line	31.	20-3398	Turret Mount Coupling
16.	20-8522A	TC Spur Gear	32.	20-8511A	TC Cluster Gear
22.	22-8544	Spur Gear Key	33.	20-0985D	TC Turret Housing



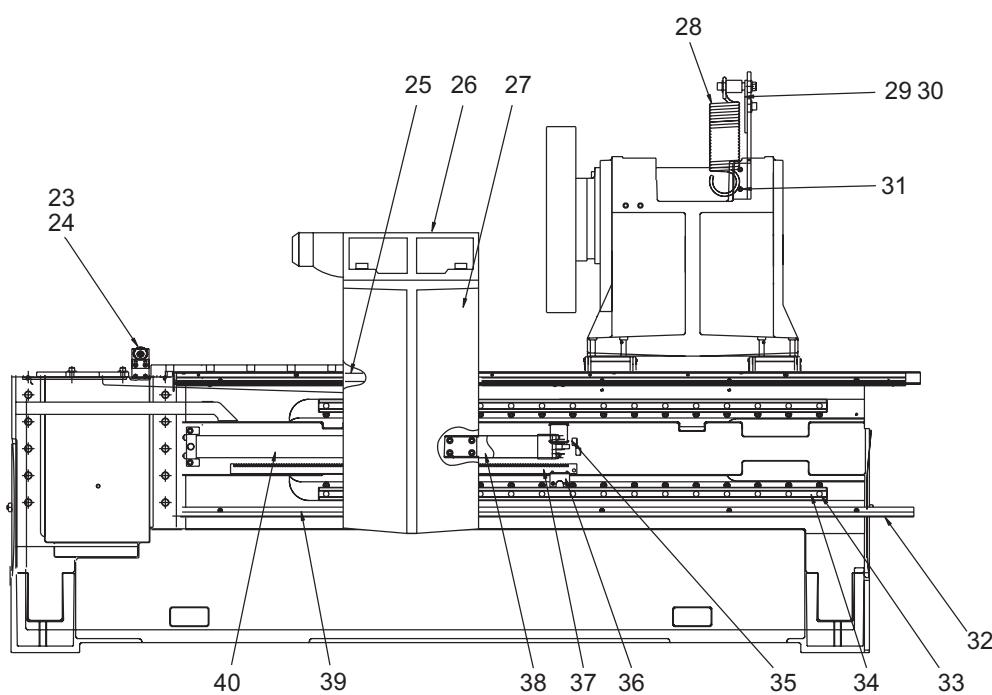
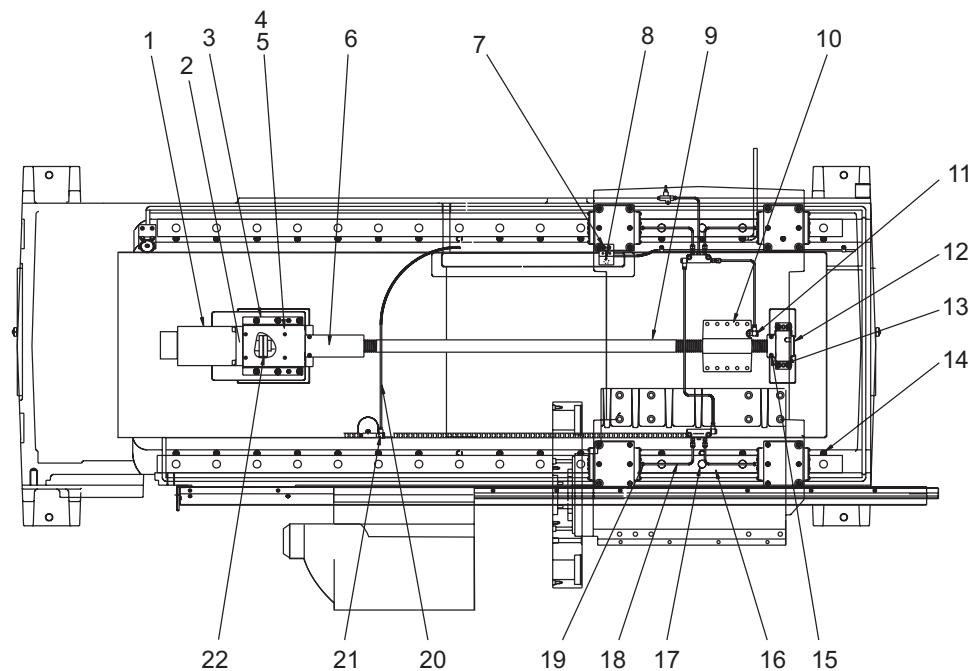
## SL-20/20L CASTING ASSEMBLY AND PARTS LIST



- |             |                                |              |                            |
|-------------|--------------------------------|--------------|----------------------------|
| 1. 50-3400  | Linear Guide X-Axis (SL-20)    | 11. 30-8717A | Oil Line Assembly          |
| 50-8549     | Linear Guide X-Axis (SL-20L)   | 12. 24-9013  | Ballscrew (SL-20)          |
| 2. 25-9746  | Cable Clamp Base (SL-20)       | 24-0103      | Ballscrew (SL-20L)         |
| 63-1030     | Cable Clamp Base (SL-20L)      | 13. 20-7010B | Motor Mount                |
| 3. 20-9058  | Ballscrew Bumper (SL-20)       | 14. 30-0154  | Motor Housing Bearing Assy |
| 28-0188     | Ballscrew Bumper (SL-20L)      | 15. 59-6600  | Guide Rail Plug            |
| 4. 25-7266  | X-Axis Mounting Bracket        | 16. 22-7458  | Linear Guide Cam           |
| 5. 58-3030  | Banjo Elbow 5/16 x M6 (SL-20)  | 17. 22-2629  | Stub Shaft/Worm Key        |
| 58-3031     | Banjo Elbow 5/16 x M6 (SL-20L) | 18. 62-0014  | Yaskawa Sigma 09 Motor     |
| 6. 25-7080  | Bumper Bracket                 | 62-0016      | Yaskawa Sigma 09 Motor     |
| 7. 30-0153  | Support Bearing Assembly       | 19. 25-8653A | Roller Bracket             |
| 8. 48-0045  | Dowel Pin                      | 20. 54-0030  | Guide Wheel                |
| 9. 24-7325  | Str Fit Metric Linear Guide    | 21. 93-0209  | Slide Spring Service Kit   |
| 10. 20-9007 | Nut Housing                    | 22. 25-8950C | Rail Interface             |



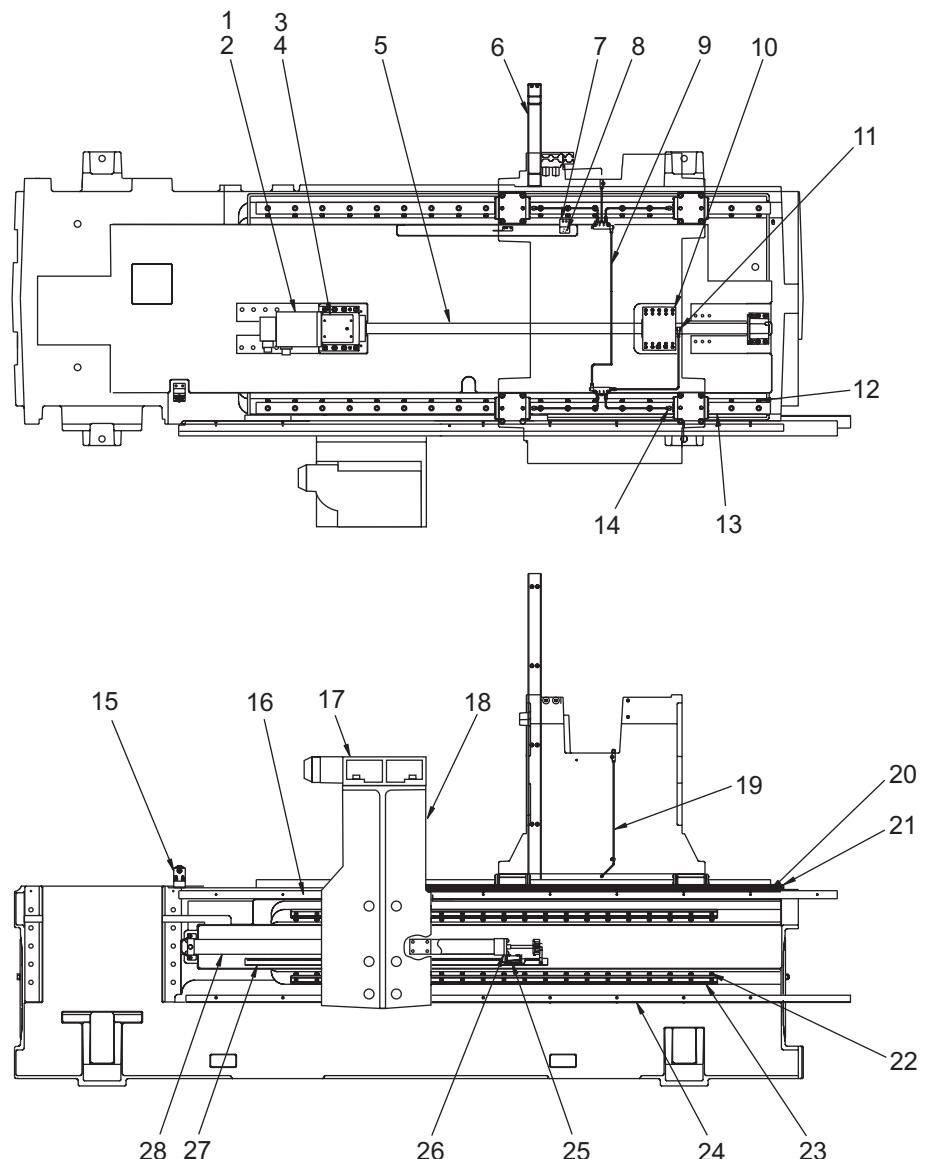
**SL-30/30L CASTING ASSEMBLY w/ TAILSTOCK**





## SL-30/30L CASTING ASSEMBLY W/TAILSTOCK PARTS LIST

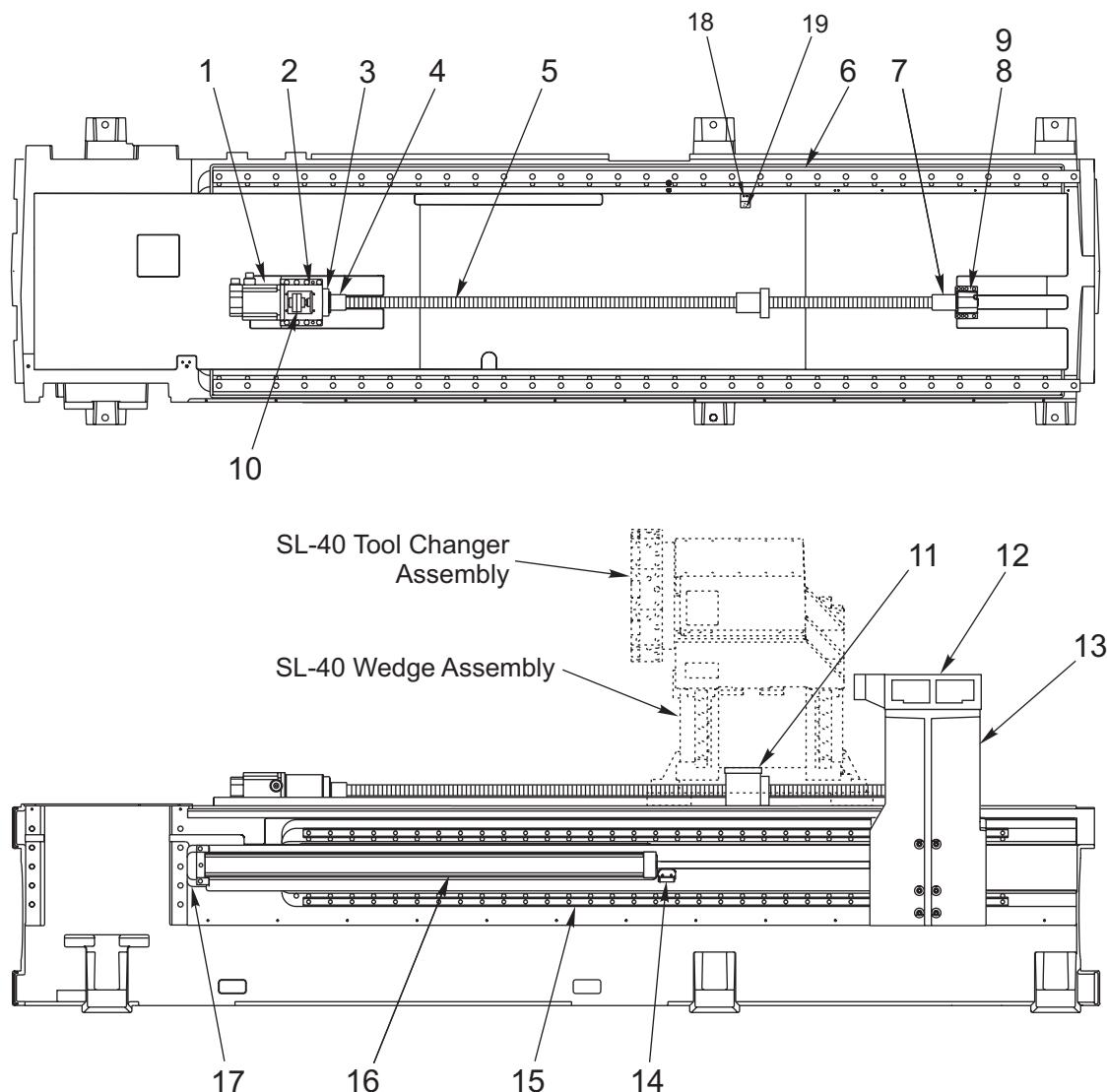
1. 22-2629 Key Stub Shaft/Worm Shaft
2. 62-0016 Servomotor Yaskawa 13 No Brake
3. 20-0151A Machining Motor Mount 40 & 50mm Ballscrew
4. 25-9203 Cover Plate Motor Mount
5. 26-7233A Gasket, Deflector Shield
6. 28-0235 Snap Lock Ring Bumper (SL-30)
7. 25-5184 Proximity Sensor Mounting Bracket
8. 32-2134 Home Switch 5.5 Ft NC
9. 30-1962 Ballscrew Assembly Z-Axis (SL-30)  
30-9477A Ballscrew Assembly Z-Axis (SL-30L)
10. 20-9211 Nut Housing 40mm Ballscrew
11. 58-3031 Banjo Elbow 5/16F X M6 M
12. 25-7080 Bumper Bracket (TL-25)
13. 48-0045 Dowel Pin 3/8 x 1 1/2
14. 22-7458 Cam Linear Guide
15. 20-3403 Bumper X-Axis (SL-30)  
28-0241 Bumper X-Axis (SL-30)
16. 50-0114 Linear Guide X-Axis (SL-30)  
50-9806 Linear Guide X-Axis (SL-30L)
17. 59-6655 Plug Guide Rail
18. 30-8863A Oil Line Assembly
19. 58-1560 Adaptor 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. 30-1225A Coupling Assembly
23. 54-0030 Guide Wheel
24. 25-8653A Roller Bracket (SL-30)
25. 25-8841B Seal Strip (SL-30)
26. 20-8807A Tailstock Head
27. 20-8808B 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 Ballscrew Strip
33. 59-6655 Plug Guide Rail
34. 50-3400 Linear Guide (SL-30)  
50-0124 Linear Guide (SL-30L)
35. 20-3846 Tailstock Cylinder Attach (SL-30L)
36. 32-0400C Encoder Read Head Assembly (SL-30)
37. 25-8024A Encoder Strip (SL-30)
38. 20-6210B Tailstock Arm (SL-30)
39. 20-1521 Guide, Waycover Tailstock Bottom (SL-30)
40. 59-0013 Hydraulic Cylinder

**SL-40 CASTING ASSEMBLY w/TAILSTOCK AND PARTS LIST**

- |             |                             |              |                               |
|-------------|-----------------------------|--------------|-------------------------------|
| 1. 22-2629  | Stub Shaft Key              | 15. 54-0030  | Support Wheel                 |
| 2. 62-0016  | Motor                       | 16. 25-8297  | Tailstock Waycover Rail/Guide |
| 3. 25-9203  | Motor Mount Cover Plate     | 17. 20-8807A | Tailstock Head Machined       |
| 4. 26-7233A | Deflector Shield Gasket     | 18. 20-8203A | Tailstock Body Machined       |
| 5. 30-0450  | Ball Screw Assembly         | 19. 30-8335  | Oil Line Assembly             |
| 6. 20-1768  | Rear Support                | 20. 25-8296  | Z-Axis Waycover Bottom Guide  |
| 7. 25-7267  | Y-Axis Mounting Bracket     | 21. 26-8320  | Tailstock Guide Strip         |
| 8. 32-2040  | Z-Axis Limit Switch         | 22. 59-6655  | Guide Rail Rubber Plug        |
| 9. 30-8325A | Oil Line Assembly           | 23. 50-8205  | Tailstock Linear Guide        |
| 10. 20-0150 | Nut Housing Machined        | 24. 25-6651  | Drip Rail                     |
| 11. 58-3031 | Banjo Elbow 5/16 F x M6 M   | 25. 32-0017  | Read Head                     |
| 12. 22-7458 | Linear Guide Cam            | 26. 20-8228  | Hydraulic Cylinder Mount      |
| 13. 50-9305 | Linear Guide                | 27. 25-8300  | Encoder Strip                 |
| 14. 24-7325 | Str Fit Metric Linear Guide | 28. 59-0034  | Hydraulic Cylinder            |



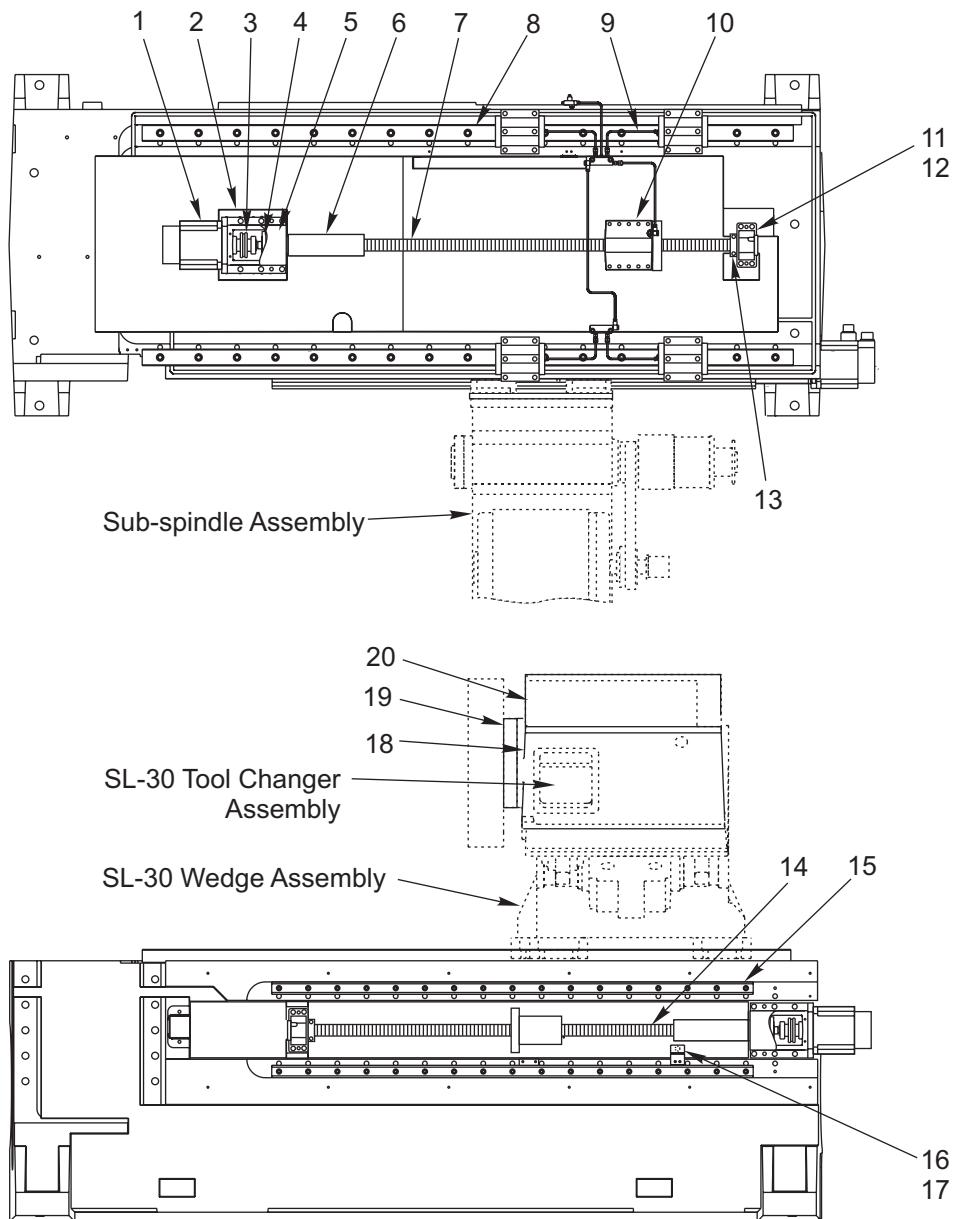
## SL-40L CASTING ASSEMBLY AND PARTS LIST



- |   |   |
|---|---|
| 1. 62-0016 Motor                          | 10. 30-1225A Coupling Assembly              |
| 2. 20-0151A Motor Mount                   | 11. 20-0150 Ball Screw Nut Housing Machined |
| 3. 20-9212 Bearing Cartridge Housing      | 12. 20-8807A Tailstock Head Machined        |
| 4. 28-0229 Snap Lock Ring Bumper          | 13. 20-1764 Tailstock Base Machined         |
| 5. 24-9970D Z-Axis Ball Screw             | 14. 25-8001A Read Head                      |
| 6. 50-0132 Z-Axis Linear Guides (2)       | 15. 50-0028 B-Axis Linear Guides (2)        |
| 7. 28-0214 Z-Axis Bumper (Support End)    | 16. 52-0042A Hydraulic Cylinder             |
| 8. 20-0152 Z-Axis Support Bearing Housing | 17. 20-1767 Cylinder Attach Bracket         |
| 9. 30-0472 Support Bearing Assembly       |   |



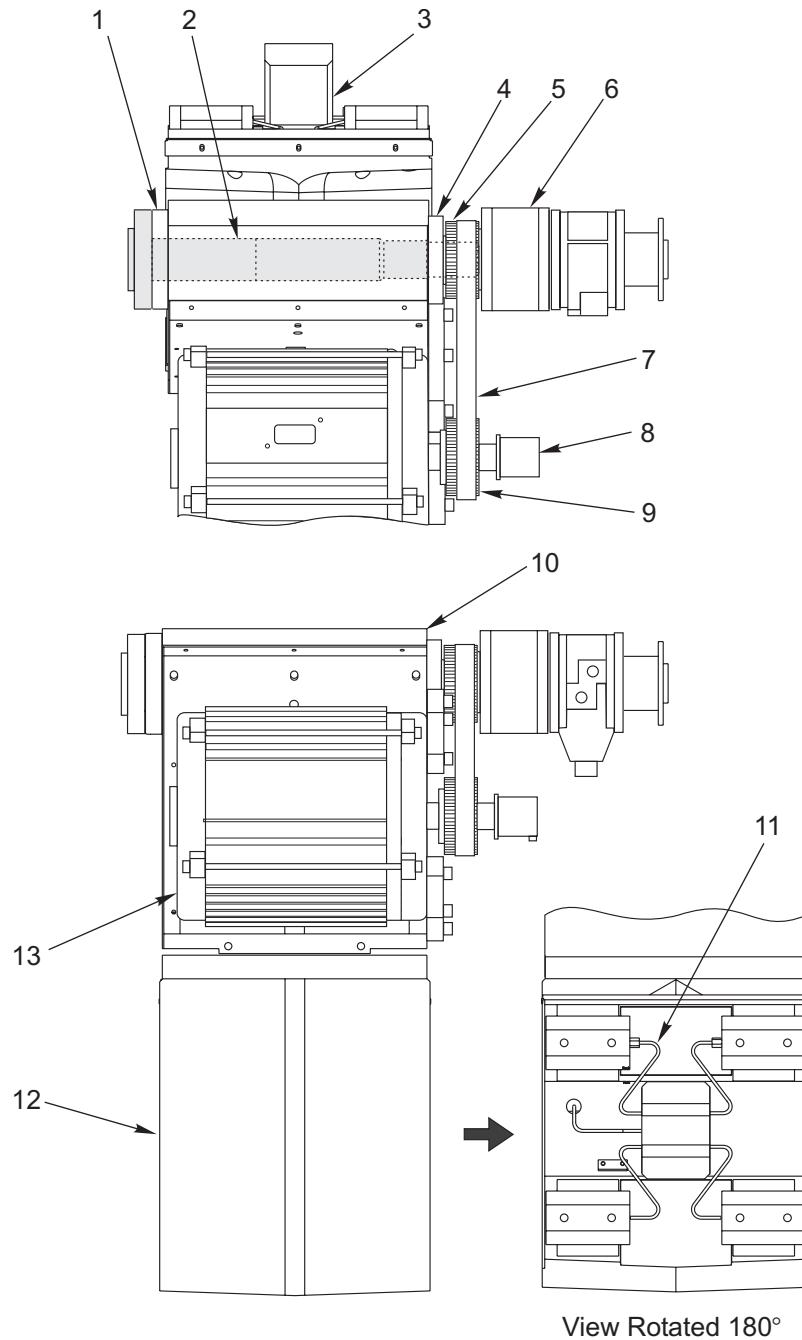
### TL-25 CASTING ASSEMBLY AND PARTS LIST



- |             |                            |              |                                   |
|-------------|----------------------------|--------------|-----------------------------------|
| 1. 62-0014  | Motor (2)                  | 11. 20-0152  | Bearing Housing Machined (2)      |
| 2. 20-7010B | Motor Mount (2)            | 12. 51-2025  | Bearing (2)                       |
| 3. 30-1220A | Coupling Assembly (2)      | 13. 28-0196  | Ball Screw Support Bumper (2)     |
| 4. 30-0154  | Motor Housing Bearing (2)  | 14. 30-3556  | B-Axis Ball Screw Assembly        |
| 5. 25-7042  | Motor Mount Cover (2)      | 15. 50-3400  | Sub-spindle Linear Guide Rail (2) |
| 6. 28-0229  | Snap Lock Ring Bumper      | 16. 32-2132  | Limit Switch                      |
| 7. 30-1962  | Z-Axis Ball Screw Assembly | 17. 25-7267  | Switch Mounting Bracket           |
| 8. 50-0114  | Linear Guide Rail (2)      | 18. 20-8771B | Tool Changer Housing              |
| 9. 30-8863A | Oil Line Assembly          | 19. 20-3398  | Turret Coupling Mount             |
| 10. 20-9211 | Nut Housing Machined       | 20. 20-0169A | Tool Changer Housing Cover        |



### TL-25 SUB-SPINDLE ASSEMBLY AND PARTS LIST

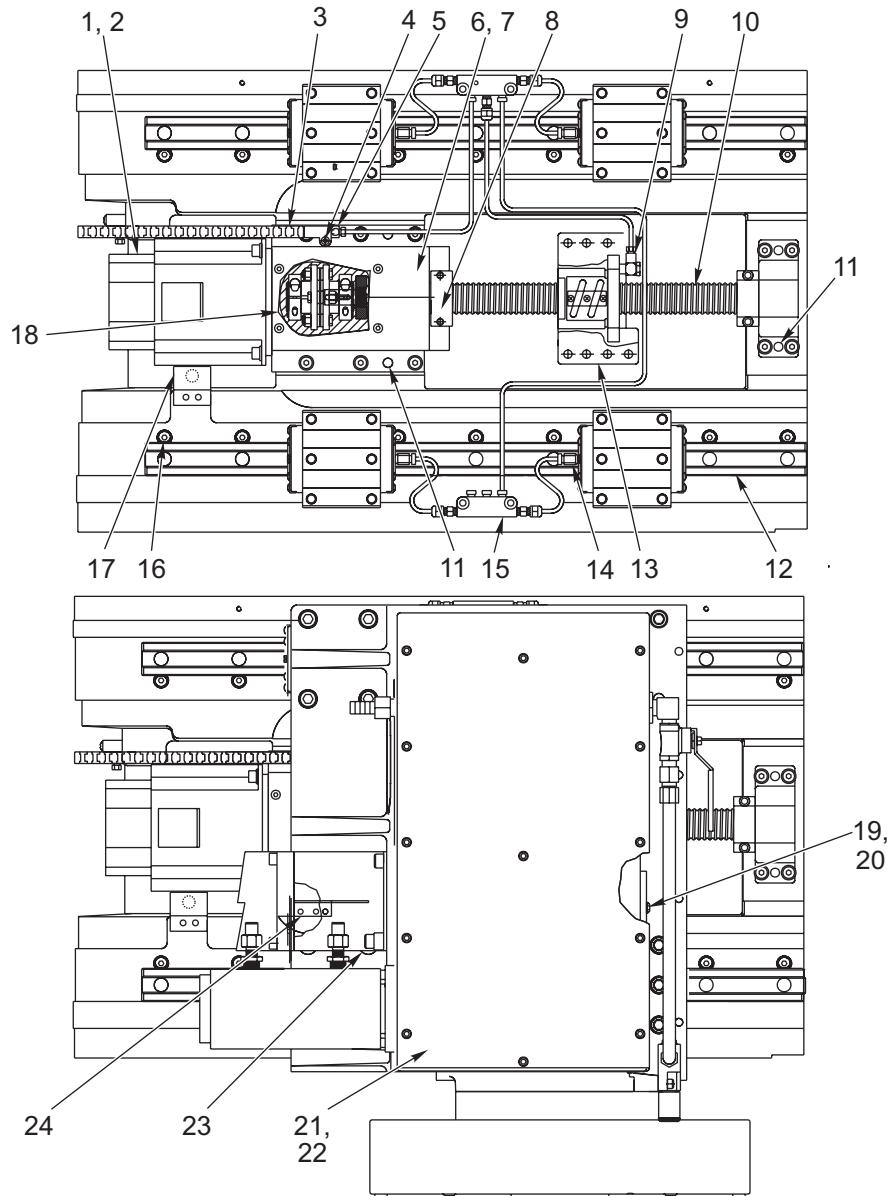


View Rotated 180°

- |             |                       |              |                           |
|-------------|-----------------------|--------------|---------------------------|
| 1. 20-0609  | Front Cap             | 8. 30-30390  | Encoder                   |
| 2. 20-0608A | Spindle Shaft         | 9. 20-0611   | Sub-spindle Motor Pulley  |
| 3. 20-0627  | Nut Housing Machined  | 10. 20-1852  | Spindle Head Machined     |
| 4. 20-3823  | Oil Injector Cover    | 11. 30-1616A | Oil Line Assembly         |
| 5. 20-0610  | Spindle Pulley        | 12. 20-1414  | Sub-spindle Base Machined |
| 6. 90-0008A | ZKP100 Rotating Union | 13. 62-1010E | Motor 5HP                 |
| 7. 54-0019  | Belt                  |              |                           |



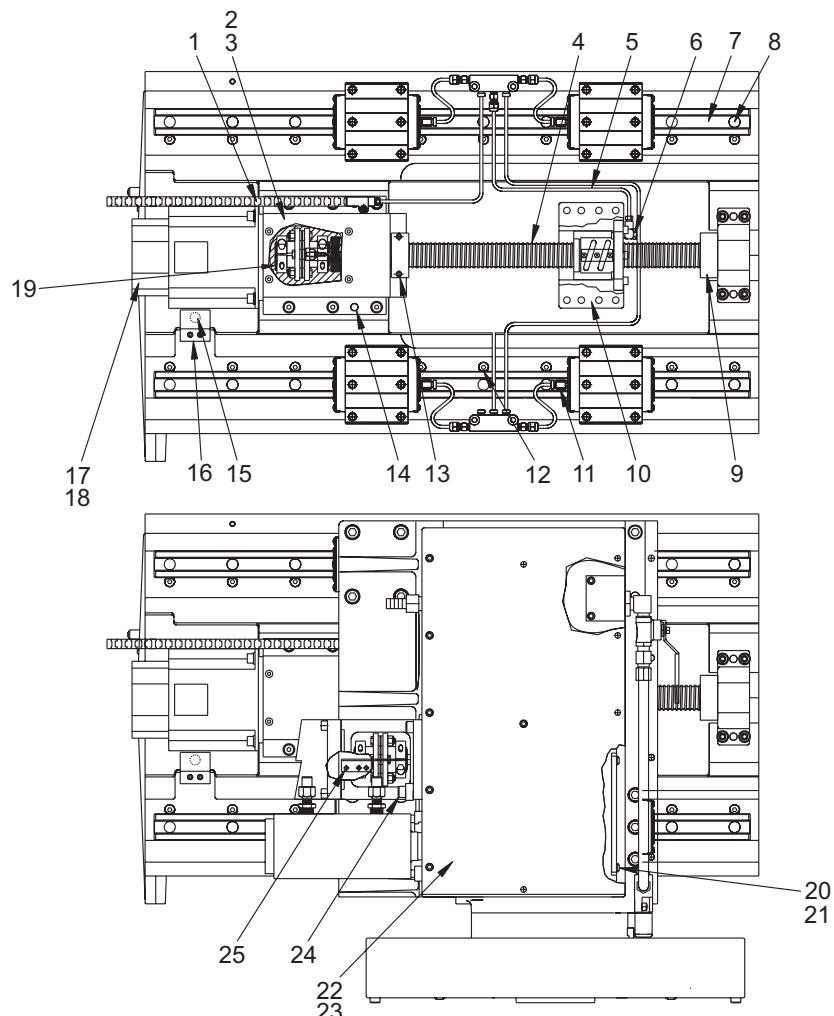
### SL-20/20L WEDGE ASSEMBLY AND PARTS LIST



- |              |                                   |              |                             |
|--------------|-----------------------------------|--------------|-----------------------------|
| 1. 62-0009   | Motor w/Brake                     | 14. 24-7325  | Str Fit Metric Linear Guide |
| 2. 22-2629   | Stub Shaft Key                    | 15. 30-8716  | Lube Line Assembly          |
| 3. 30-0592   | Oil Line Carrier                  | 16. 22-7458  | Linear Guide Cam            |
| 4. 41-1717   | Long Stud/Set Screw               | 17. 25-7266  | X-Axis Mounting Bracket     |
| 5. 58-2110   | Sleeve Nuts Lube Assembly         | 18. 30-1220A | Coupling Assembly           |
| 6. 25-7042   | Snap Lock Motor Mount Cover Plate | 19. 20-8535  | Tool Changer Access Plate   |
| 7. 26-7233A  | Deflector Shield Gasket           | 20. 57-8546  | TC Access Plate Gasket      |
| 8. 28-0196   | Z-Axis Motor End Bumper           | 21. 57-8576A | TC Cover Gasket             |
| 9. 58-3031   | Banjo Elbow 5/16 F x M6 M         | 22. 20-8545  | TC Housing Cover            |
| 10. 30-0616C | X-Axis Ball Screw Assembly        | 23. 20-8364  | Spacer                      |
| 11. 48-0045  | Dowel Pin                         | 24. 25-7459  | Trip Table Bracket          |
| 12. 50-8549  | Linear Guide                      |              |                             |
| 13. 20-7008F | Nut Housing Machined              |              |                             |



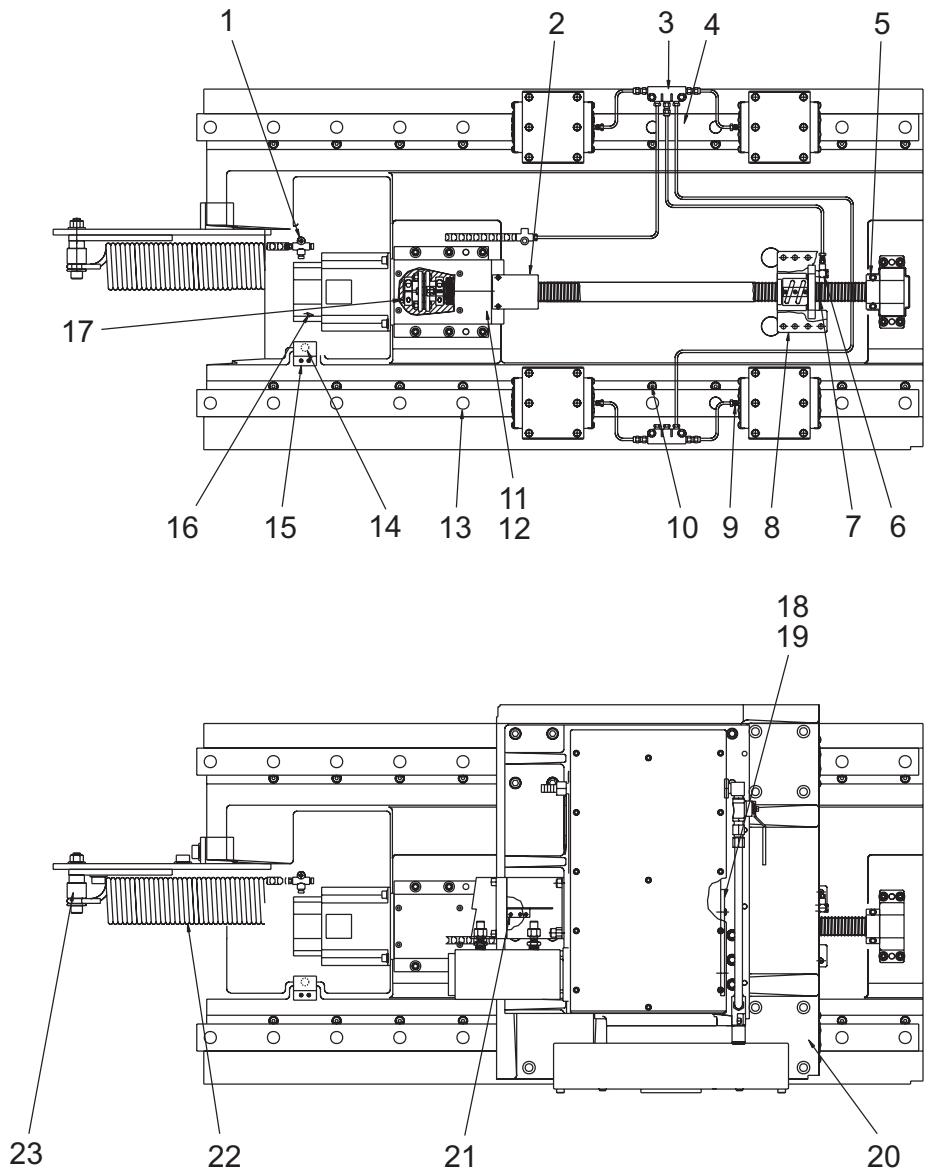
## SL-30/30L WEDGE ASSEMBLY AND PARTS LIST



- |              |                              |              |                            |
|--------------|------------------------------|--------------|----------------------------|
| 1. 30-3966   | Oil Line Assembly X-Axis     | 14. 48-0045  | Dowel Pin 3/8 x 1-1/2      |
| 2. 25-7042   | Cover Plate Motor Mount      | 15. 32-2130  | Home Switch 1.5 Ft NC      |
| 3. 26-7233A  | Gasket Deflector Shield      | 16. 25-7266  | Bracket X-Axis Mounting    |
| 4. 30-0618B  | Ballscrew Assembly           | 17. 22-2629  | Key Stub Shaft/Worm Shaft  |
| 5. 30-0593   | Wedge Oil Line Kit           | 18. 62-0036C | Servomotor SEM C8 w/Brake  |
| 6. 58-3031   | Banjo Elbow 5/16 F x M6 M    | 19. 30-1220A | Coupling Assembly          |
| 7. 50-8766   | Linear Guide 35 x 760 X-Axis | 20. 20-8535  | Plate Access T/C           |
| 8. 59-6600   | Plug Guide Rail              | 21. 57-8546  | Gasket Plate Access T/C    |
| 9. 20-3403   | Bumper Support End X-Axis    | 22. 57-8576A | Gasket Cover T/C           |
| 10. 20-7008F | Nut Housing Machined         | 23. 20-8545  | Cover Housing T/C          |
| 11. 24-7325  | Str Fit Metric Linear Guide  | 24. 20-8364  | Spacer Anti-Rotate T/C     |
| 12. 22-7458  | Cam Linear Guide             | 25. 25-5187  | Proximity Sensor Trip Flag |
| 13. 28-0197  | Bumper X-Axis                |              |                            |



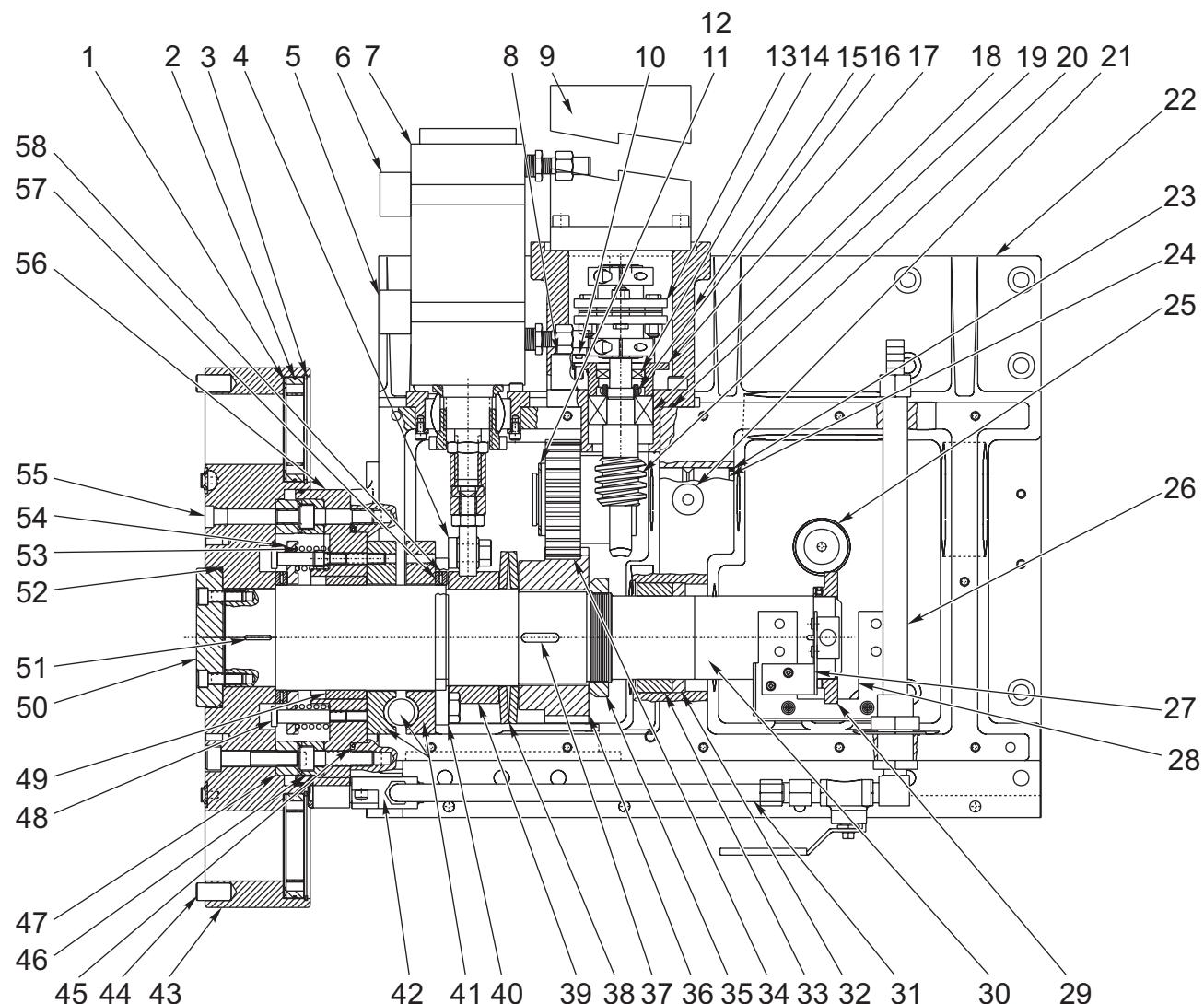
### SL-40 WEDGE ASSEMBLY AND PARTS LIST



- |              |                                   |              |                               |
|--------------|-----------------------------------|--------------|-------------------------------|
| 1. 58-2760   | 2-Way Manifold                    | 13. 59-6600  | Guide Rail Plug               |
| 2. 28-0197   | Motor End Bumper                  | 14. 32-2130  | X-Axis Home Limit Switch      |
| 3. 30-1530   | Oil Line Assembly                 | 15. 25-8534  | Limit Switch Mounting Bracket |
| 4. 50-9011   | Linear Guide                      | 16. 62-0036C | Yaskawa Sigma Motor w/Brake   |
| 5. 20-3403   | Support End Bumper                | 17. 30-1219  | Coupling Assembly             |
| 6. 58-3031   | Banjo Elbow 5/16 F M6 M           | 18. 20-5452A | TC Access Plate               |
| 7. 30-1397A  | X-Axis Ball Screw Assembly        | 19. 57-0346A | TC Access Plate Gasket        |
| 8. 20-9007   | Nut Housing Machined              | 20. 20-2423A | X-Riser                       |
| 9. 24-7325   | Str Fit Metric Linear Guide       | 21. 25-7267  | Trip Table Bracket            |
| 10. 22-7458  | Linear Guide Cam                  | 22. 59-8220A | Cross Slide Spring            |
| 11. 25-7042  | Snap Lock Motor Mount Cover Plate | 23. 20-8721A | Swing Arm Bushing             |
| 12. 26-7233A | Deflector Shield Gasket           |              |                               |



## SL-20/20L TOOL CHANGER ASSEMBLY



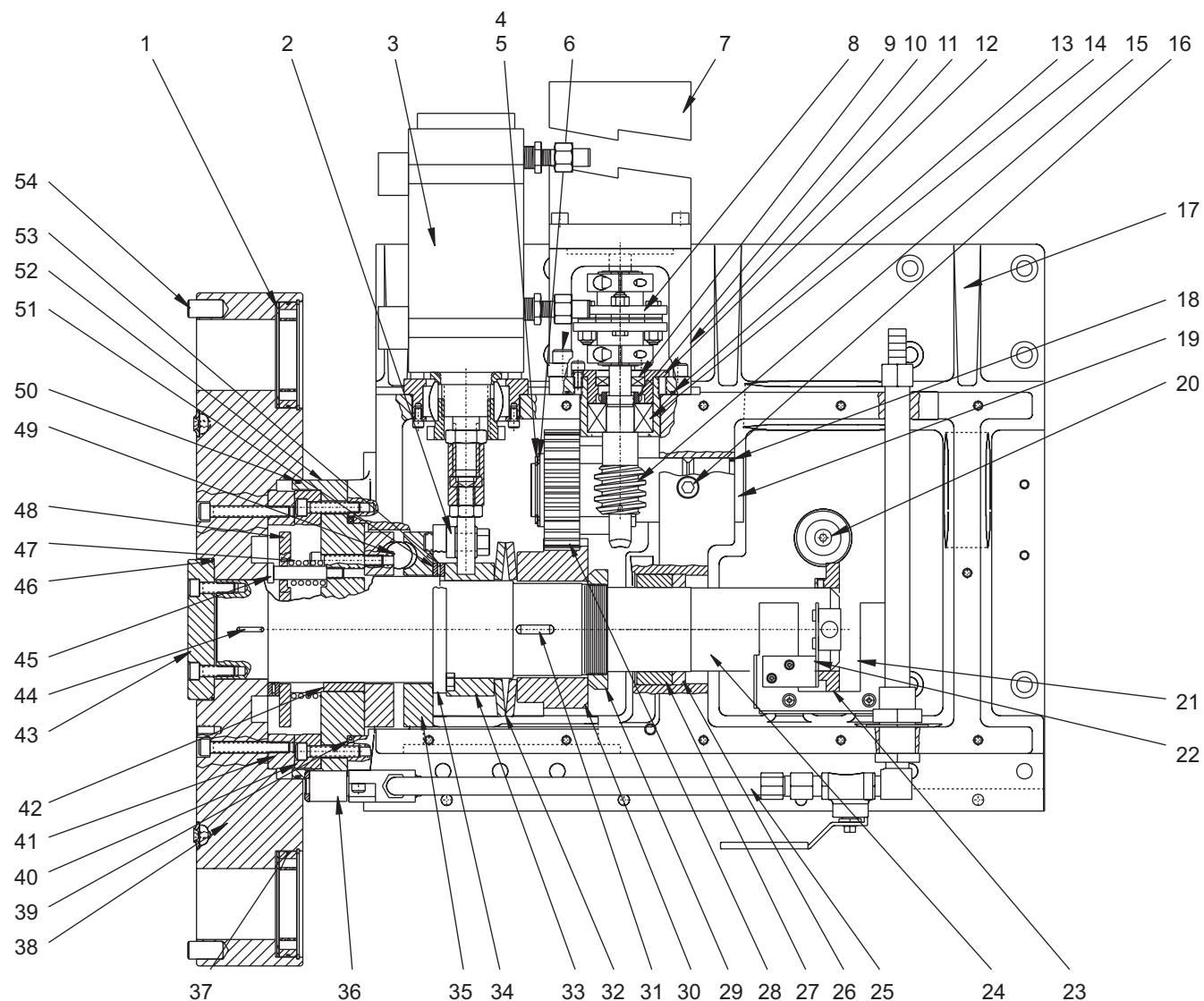


## SL-20/20L Tool Changer Assembly Parts List

1. 51-2983	Thrust washer TRB-3446	50. 20-8532	Retainer turret T/C
2. 57-2994	O-ring	51. 22-8543	Key
3. 56-2090	Retaining Ring RR-300 (SL-20)	52. 57-2154	O-ring
56-9057	Retaining Ring (SL-20L)	53. 59-0035	Spring, Turret Coupling
4. 22-8538	Rod end spacer	54. 20-8518	Retainer springs T/C
5. 32-2153	Unclamp switch (SL-20)	55. 58-3105	Pipe plug 1/4 NPT
25-8536	Clamp/Unclamp Switch (SL-20L)	56. 20-0675A	Turret mounting coupling
6. 32-2154	Clamp switch (SL-20)	57. 51-3001	Bearing thrust needle
7. 30-3650	Air Cylinder assembly	58. 51-2983	Thrust washer TRD-4860
8. 20-8364	Spacer anti-rotate T/C		
9. 69-0014	Motor		
10. 40-1632	1/4-20 x 1/2		
11. 49-4115	Washer		
12. 56-9057	Retaining Ring		
13. 30-1220A	Coupling assembly		
14. 57-2129	Seal		
15. 20-8512A	Housing worm		
16. 51-2042	Bearing locknut BH-04		
17. 20-8515	Clamp bearing worm		
18. 51-7001	Bearing		
19. 57-2022	O-ring		
20. 20-8509	Shaft worm		
21. 59-2057	5/16 steel ball		
22. 20-8503B	Turret housing		
23. 57-2831	O-ring		
24. 20-8510	Shaft transfer T/C		
25. 20-8537	Retainer spring		
26. 30-3655	Coolant line assembly		
27. 25-8534	Home bracket		
28. 25-8536	Switch bracket		
29. 20-8533	Ring switch T/C		
30. 20-8530	Shaft Turret T/C		
31. 58-8657	Copper line		
32. 57-1045	Seal		
33. 20-8539	Bearing rear		
34. 20-8511A	Gear cluster T/C		
35. 46-7016	Locknut		
36. 20-8522A	Gear spur T/C		
37. 22-8544	Key gear spur T/C		
38. 24-4010	Bellville washer		
39. 22-8550A	Spacer Bellville T/C		
40. 20-8516	Lever cam T/C		
41. 93-8138	Cam Turret T/C		
42. 30-3660A	Transfer housing		
43. 30-2851A	Turret T/C		
44. 48-1665	Dowel pin 1/2 x 1		
45. 57-0029	Seal CR29841		
46. 20-8506A	Coupling, turret female		
47. 20-8505A	Coupling, turret male		
48. 49-1010	Shoulder bolt 3/8 x 1 1/2		
49. 20-8557	Bushing and 57-0029 Seal		



## SL-30/30L TOOL CHANGER ASSEMBLY



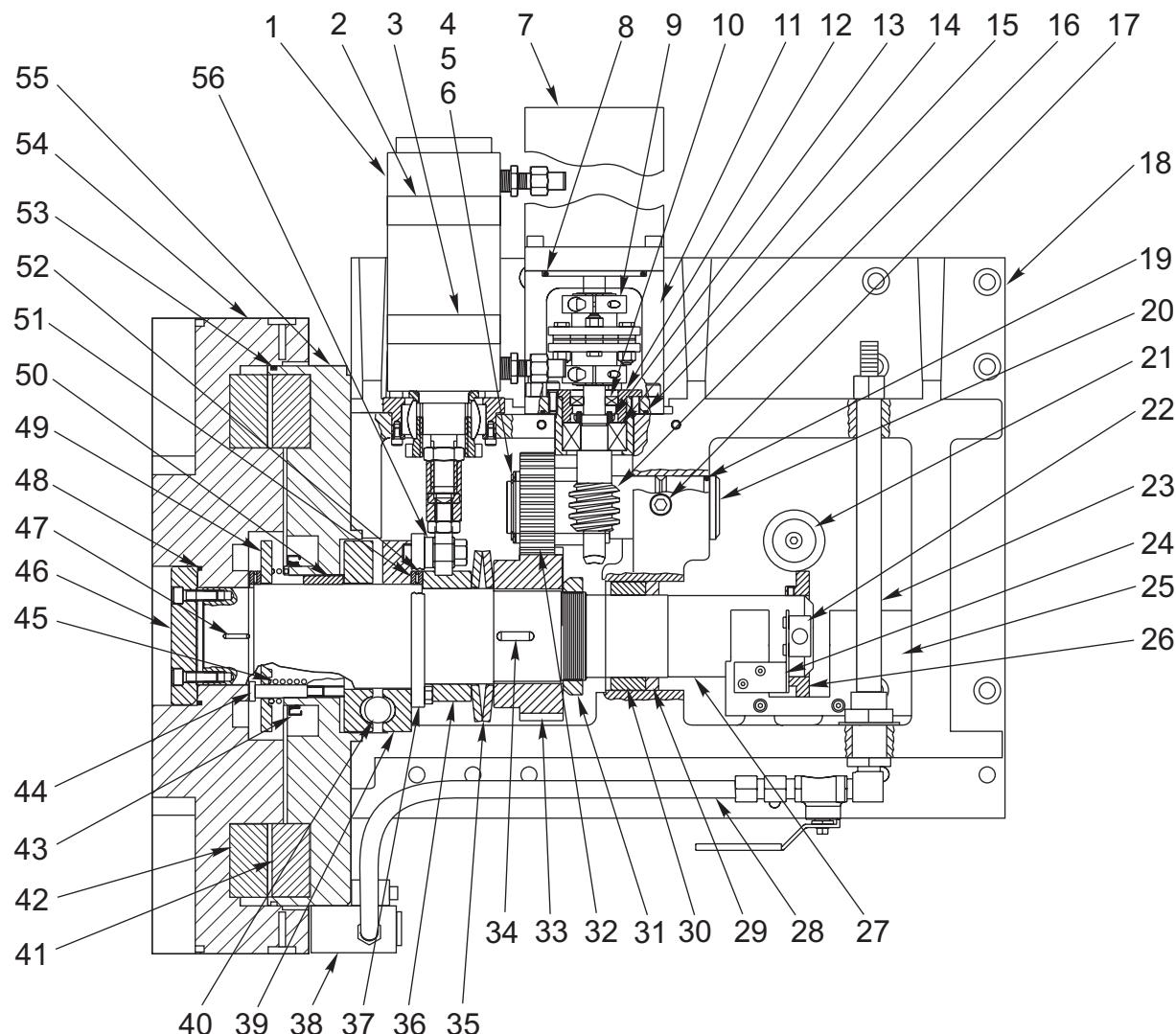


### SL-30/30L TOOL CHANGER ASSEMBLY PARTS LIST

1. 51-2984	Thrust washer TRB-3446	28. 20-8511A	Gear Cluster T/C
2. 22-8538	Spacer Rod End T/C	29. 46-7016	Lock Nut N-13
3. 30-3650	Air Cylinder Assembly	30. 20-8522A	Gear Spur T/C
4. 56-9057	Retaining Ring 1.500 SH	31. 22-8544	Key Gear Spur T/C
5. 49-4115	Washer 1 1/2 Steel .075 thick	32. 24-4010	Bellville Washer
6. 45-2001	Washer 1 1/2 Steel .002 thick	33. 22-8550A	Spacer Belleville T/C
7. 62-0035B	Servomotor C8 w/o Brake	34. 20-8516	Lever Cam T/C
8. 30-1220A	Coupling Assembly	35. 93-8138	Lathe Turret Cam Upgrade Kit
9. 57-2129	Seal .625 CR6372	36. 30-1957	Coolant Transfer Tip Assembly
10. 51-2042	Bearing Locknut BH-04	37. 57-2994	O-Ring 2-039 Buna
11. 20-8512A	Housing Worm	38. 20-0671	Turret T/C
12. 20-8515	Clamp Bearing Worm T/C	39. 57-0030	O-Ring 2-258 Buna
13. 57-2022	O-Ring 2-150 V-1164-75	40. 20-8768A	Coupling Turret Male
14. 51-7001	R Bearing Angular M20-47-20.6	41. 20-8769A	Coupling Turret Female
15. 20-8509	Worm Shaft	42. 20-8557	Bushing Front Turret
16. 59-2057	Ball 5/16 Steel	43. 20-8532	Retainer Turret T/C
17. 20-0674A	Tool Changer Machined	44. 22-8543	Key Turret T/C
18. 57-2831	O-Ring 2-130 Buna	45. 49-1010	Shoulder Bolt 3/8 x 1 1/2
19. 20-8510	Shaft Transfer T/C	46. 57-2154	O-Ring 2-240 Buna
20. 20-8537	Retainer Spring T/C	47. 59-0035	Die Spring
21. 25-8536	Bracket Limit Switch T/C Clamp/Unclamp	48. 20-8518	Retainer Spring T/C
22. 25-8534	Bracket Home Switch	49. 59-2059	Ball 15/16 Steel
23. 20-8533	Ring Switch T/C	50. 57-2975	O-Ring 2-274 Buna
24. 20-8530	Shaft Turret T/C	51. 51-2983	Thrust Washer TRD-4860
25. 30-3655	Transfer Coolant Line Assembly	52. 20-0676A	Mount Coupling Turret
26. 57-1045	Seal 2.375 CR23646	53. 51-3001	Bearing Thrust Needle
27. 20-8539	Bearing Rear T/C	54. 48-0049	Dowel Pin 1/2 x 1 Pull



## SL-40 TOOL CHANGER ASSEMBLY



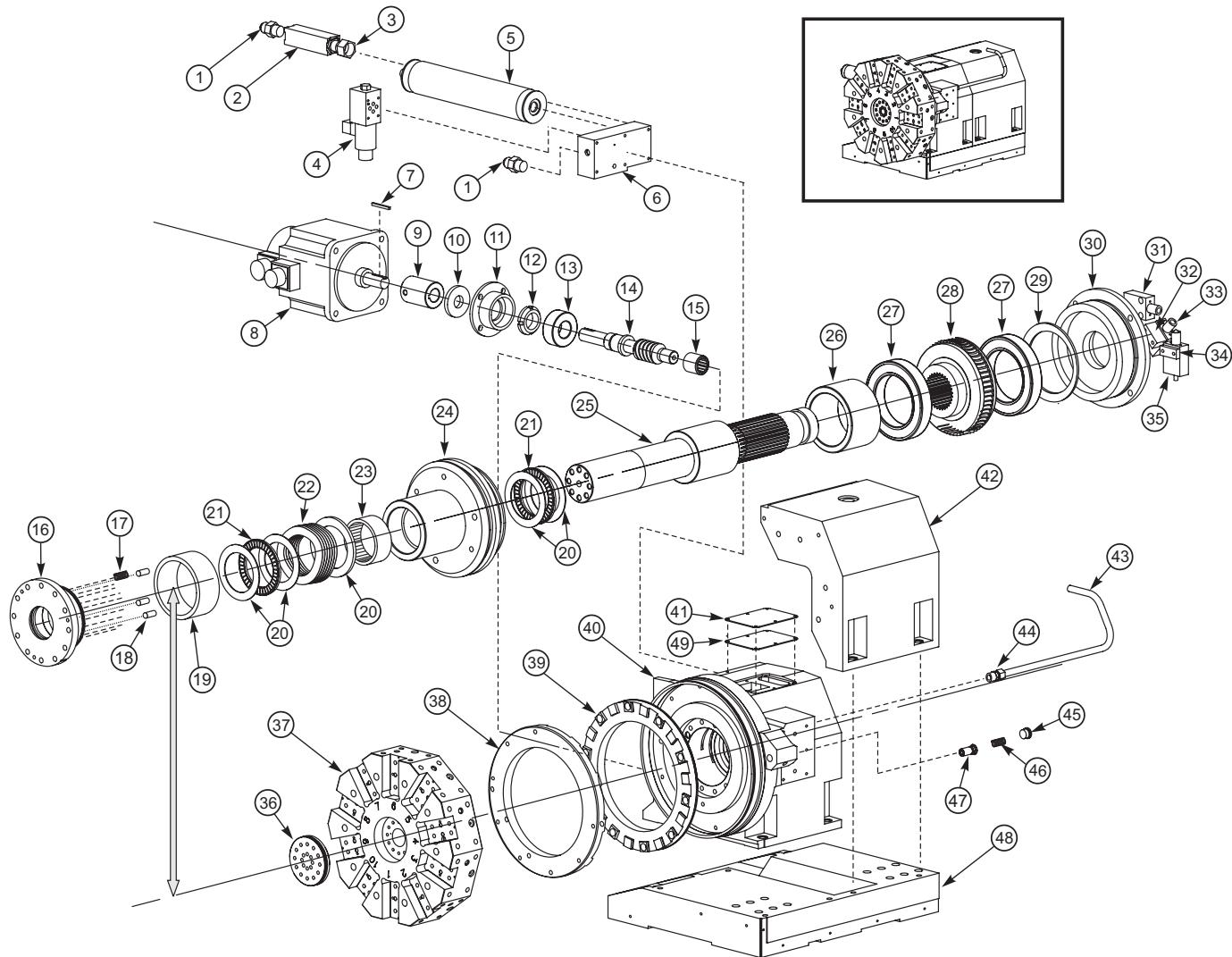


## SL-40 TOOL CHANGER ASSEMBLY PARTS LIST

- |              |  |             |                          |
|--------------|--|-------------|--------------------------|
| 1. 30-3650   | Air Cylinder Assembly  | 50. 20-8557 | Bushing and 57-0029 Seal |
| 2. 32-2162   | Clamp Switch   | 51. 51-3001 | Needle Thrust Bearing    |
| 3. 32-2161   | Unclamp Switch   | 52. 51-2983 | Thrust Washer TRD-4860   |
| 4. 49-4115   | 1-1/2 Steel Washer   | 53. 57-0047 | O-Ring                   |
| 5. 56-9057   | Retaining Ring 5100-150  | 54. 20-0397 | Turret Block             |
| 6. 45-2001   | Shim .002 Thick  | 55. 20-0250 | Coupling Mount           |
| 7. 62-0014   | Motor  | 56. 22-8538 | TC End Rod Spacer        |
| 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,<br>(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  |             |                          |



## SL-40 HYDRAULIC TOOL CHANGER



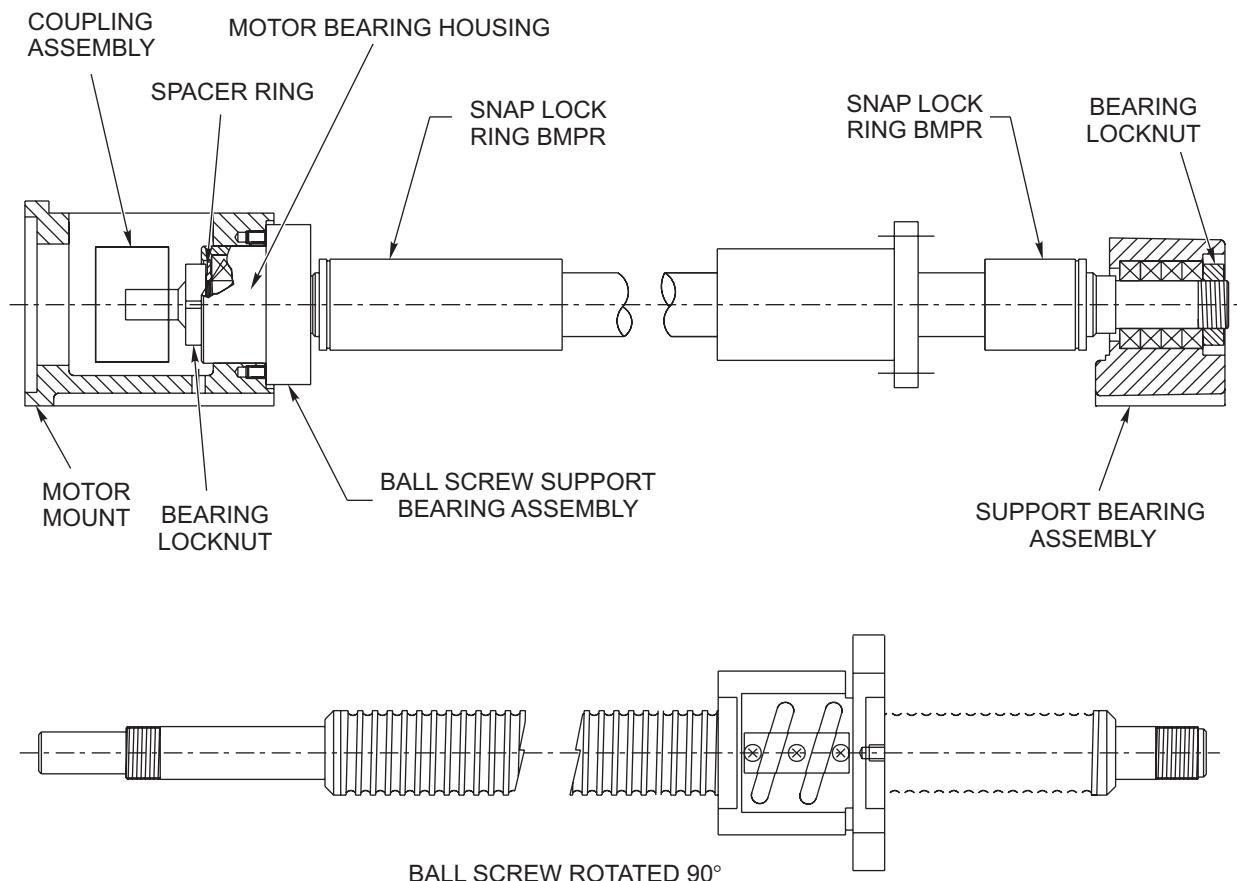


## SL-40 HYDRAULIC TOOL CHANGER PARTS LIST

1. 58-0038 Fitting ORB
2. 58-0723 Check Valve
3. 58-0726 Fitting ORB-6-M x ORB-6-F 90
4. 90-0104B Hydraulic Valve DIR Control Single Solenoid
5. 52-0156 Hydraulic Accumulator
6. 20-2437 Valve Block
7. 20-2443 Key 5mm x 1.0
8. 62-0014 Servomotor C8 without Brake
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. 20-2430A 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. 20-2474 Shim Home Switch
33. 32-2130 Home Switch
34. 20-2438 Support Block
35. 32-2235 Proximity Switch
36. 20-2426 Turret Worm Clamp
37. 21-0442A Machined Turret
38. 20-0247 Female Turret Coupling
39. 20-0248 Male Turret Coupling
40. 20-2422A T/C SL-40 Housing
41. 25-5452A T/C Access Plate
42. 20-2424A T/C Housing
43. 58-0728A Coolant Tube
44. 58-3087 Compression Fitting
45. 58-0080 Plug
46. 59-0103 Spring
47. 20-0401 Coolant Shaft
48. 20-2423A X Riser X
49. 57-0346A Gasket



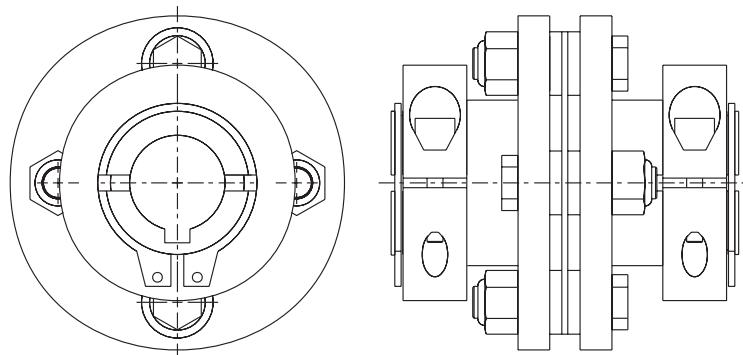
### BALL SCREW ASSEMBLY



BALL SCREW ASSY "A"	BALL SCREW	SNAP LOCK RING BMPR	MOTOR MOUNT	COUPLING ASSY	APPLICATION
30-2977 BS ASSY 32mm	24-8765 BALLSCR 32mm	NONE	20-7010A	30-1220A	MINI LATHE (Z)
30-2972 BS ASSY 32mm	24-8765 BALLSCR 32mm	NONE	20-7010A	30-1220A	MINI LATHE (X)
30-2290 BS ASSY 32mm	24-7146 BALLSCR 32mm	20-0735 SNAP LOCK RING BMPR 1.75	20-7010A	30-1220A	SL-10 (Z)
30-2244 BS ASSY 32mm	24-8548B BALLSCR 32mm	20-1126 SNAP LOCK RING BMPR 1.68	20-7010A	30-1220A	SL-10 (X)
30-1603 BS ASSY 32mm (1.26) X 33.268	24-9013 BALLSCR 32mm (1.26) X 33.268	28-0232 SNAP LOCK RING BMPR 5.79	20-7010B	30-1220A	SL-20 (Z)
30-0617 BS ASSY 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	SL-30 (Z)
30-1397A BS ASSY 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	SL-40 (X)
30-0618B BS ASSY 32mm (1.26) X 16.475	24-8765 BALLSCR 32mm (1.26) X 16.475	NONE	20-7010A	30-1220A	SL-30 (X)
30-0616C BS ASSY 10mm	24-0040 BALLSCR 32-10-524	NONE	20-7010B	30-1220A	SL-20/20L (X)
30-0450 BS ASSY 40mm (1.57) X 57.897	24-0003A BALLSCR 40mm (1.57) X 57.897			30-1215	SL-40 (Z)



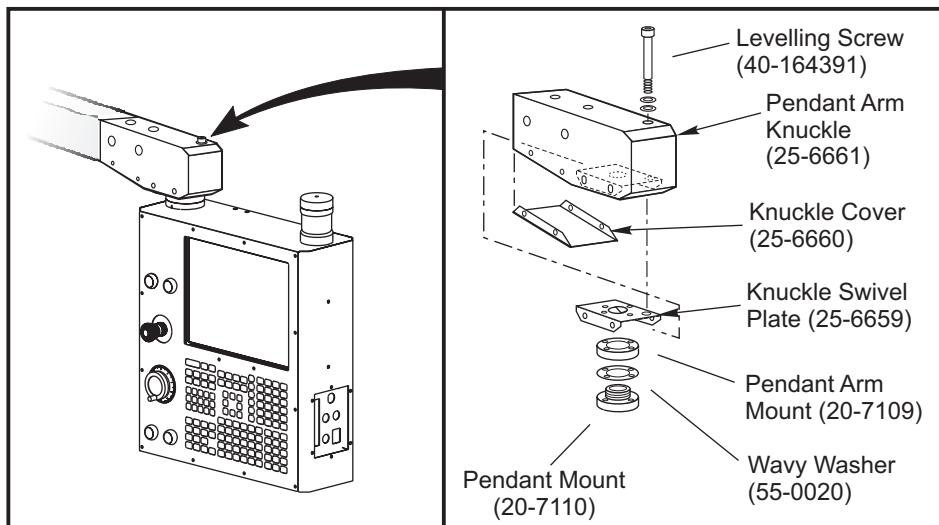
## COUPLING ASSEMBLY



WHERE USED	APPLICATION
30-2290A BSCREW ASSY 32mm	SL-10 (Z)
30-2244A BSCREW ASSY 32mm	SL-10 (X)
30-0615A BSCREW ASSY 32mm (1.26) X 33.27	SL-20 (Z)
30-1962 BSCREW ASSY 32mm (1.26) X 48.23	SL-30 (Z)
30-1397A BSCREW ASSY 32mm (1.26) X 25.65	SL-40 (X)
30-0616C BSCREW ASSY 32mm (1.26) X 13.53	SL-20 (X)
30-0618B BSCREW ASSY 32mm (1.26) X 16.78	SL-30 (X)
30-1397A BSCREW ASSY 32mm (1.26) X 25.65	SL-40 (Z)
30-0450 BSCREW ASSY 32mm (1.57) X 57.90	SL-40 (Z)

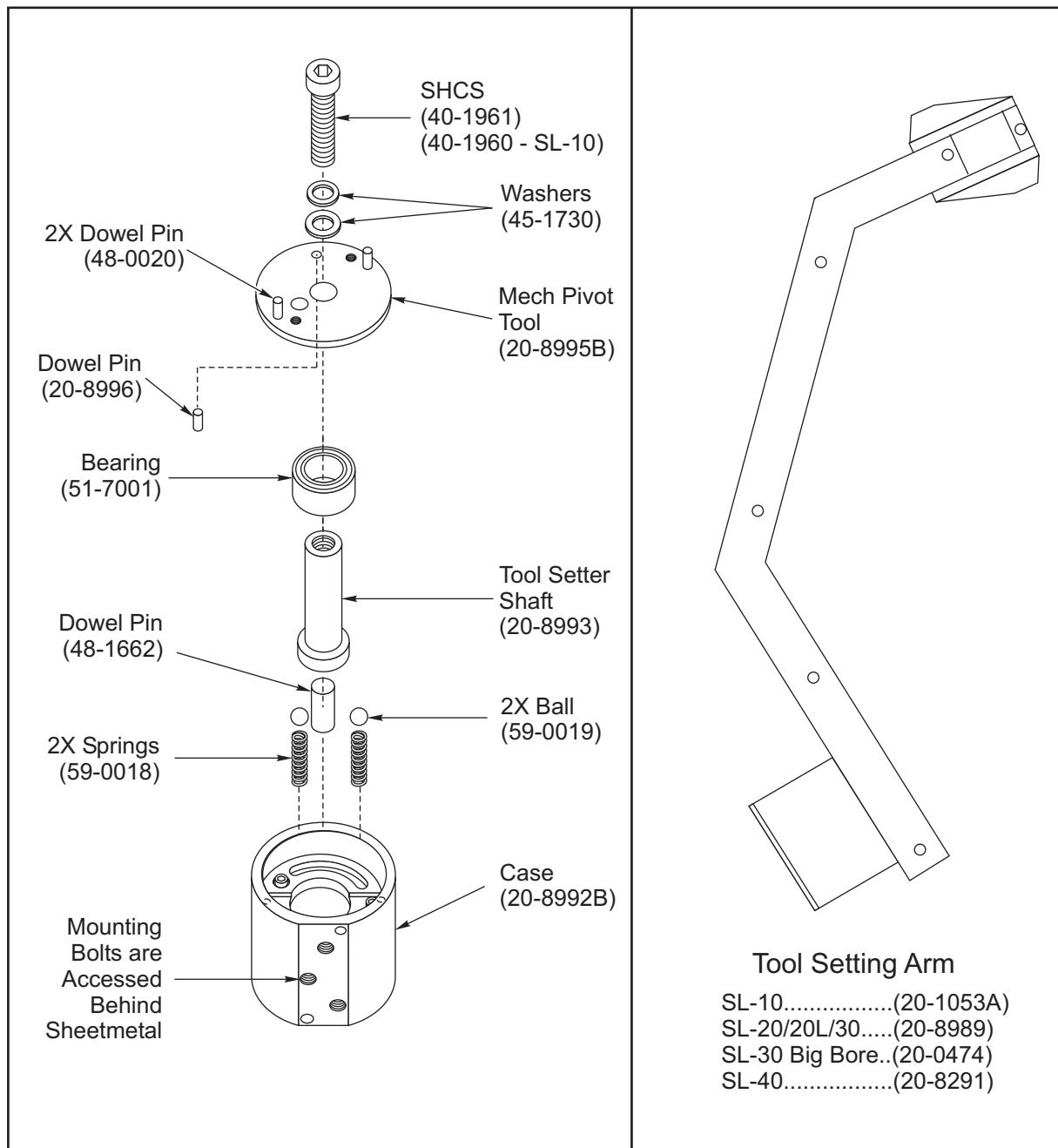


## PENDANT LEVELING ASSEMBLY



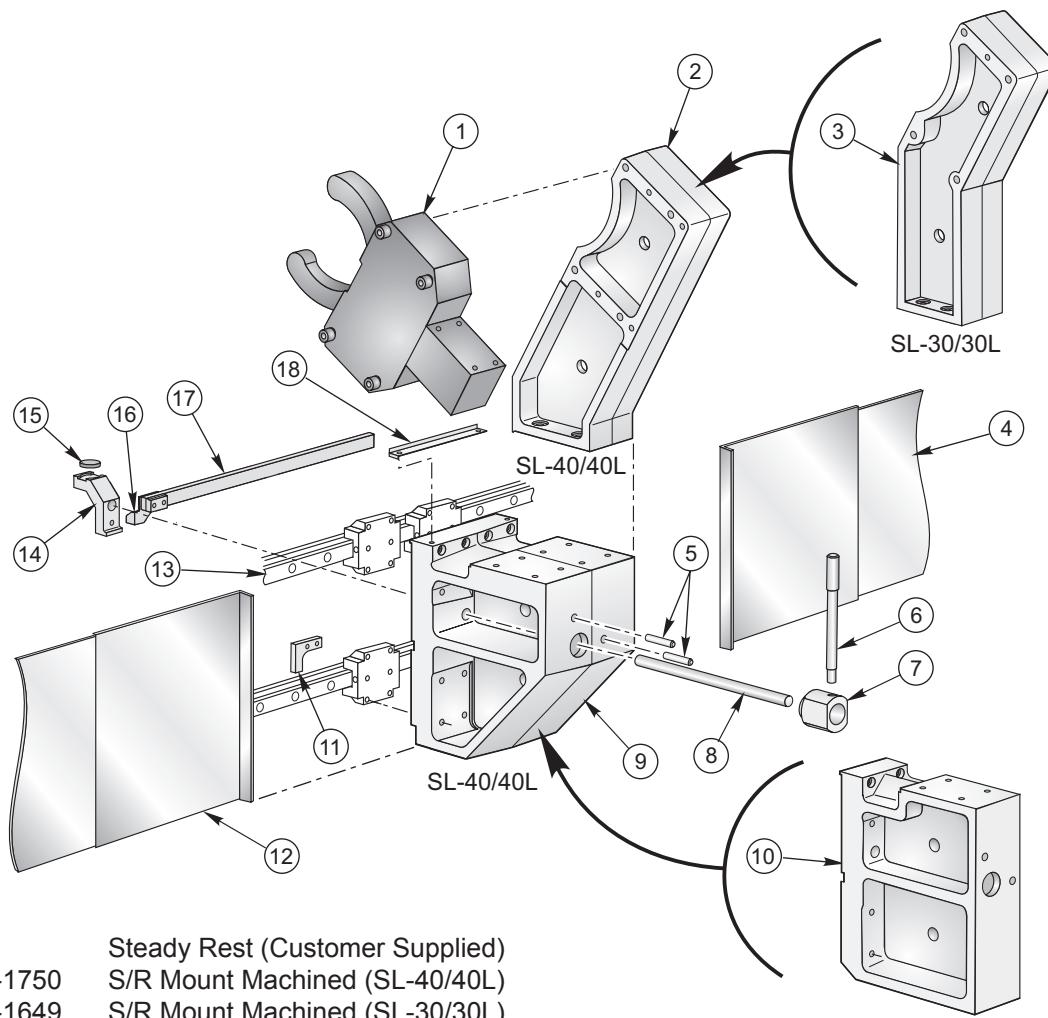


## LATHE TOOL SETTING ARM





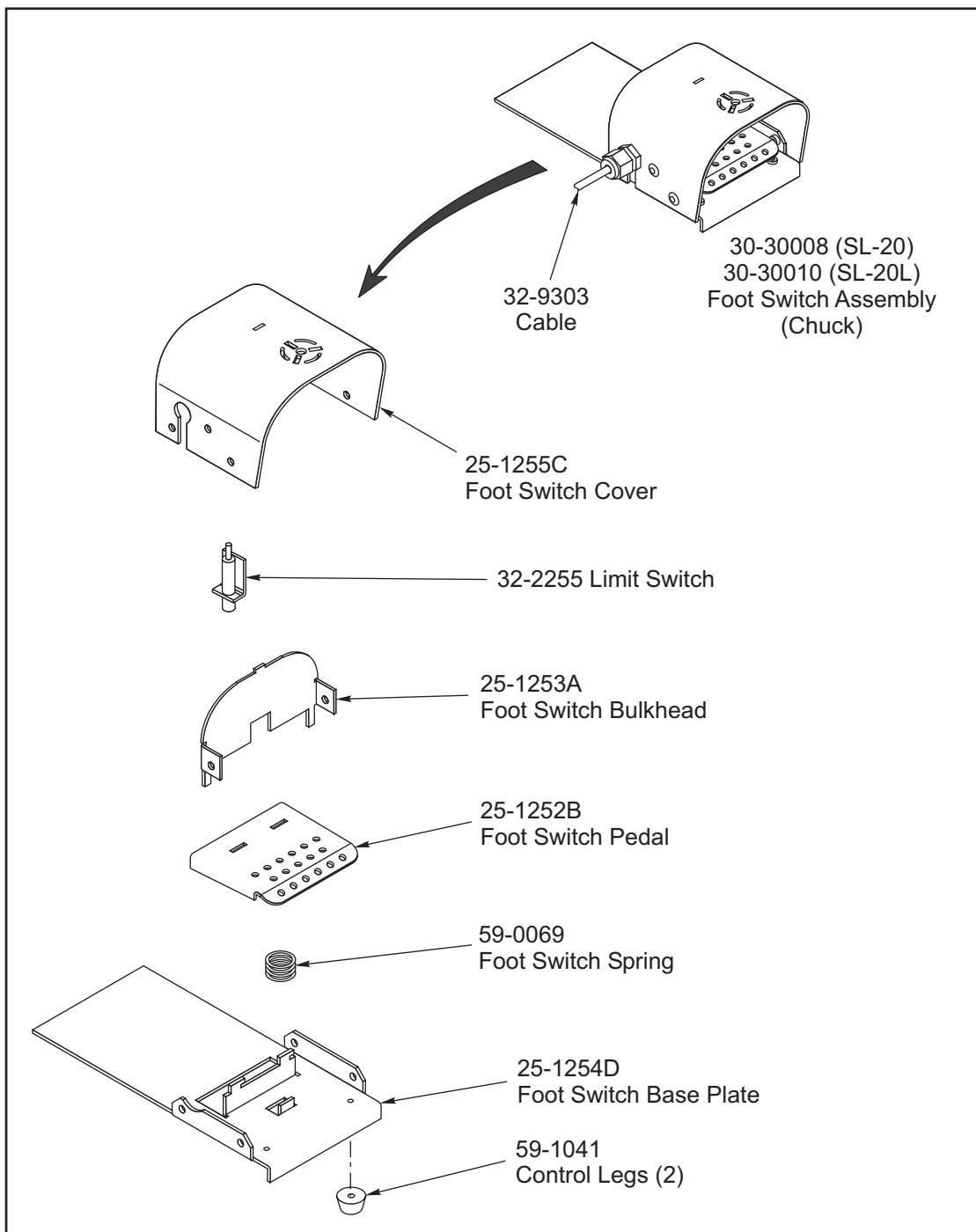
## SL-30/30L AND SL-40/40L STEADY REST



- |   |                                       |
|---|---------------------------------------|
| 1. Steady Rest (Customer Supplied)              | 14. 20-1625B S/R Brake (SL-30/40)     |
| 2. 20-1750 S/R Mount Machined (SL-40/40L)       | 20-3720 S/R Brake (SL-30L)            |
| 3. 20-1649 S/R Mount Machined (SL-30/30L)       | 20-2406 S/R Brake (SL-40L)            |
| 4. 25-8248 Waycover Left T/S (SL-40)            | 15. 57-0045 Brake Pad                 |
| 25-4737 Waycover Left T/S (SL-40L)              | 16. 20-1620 Right Travel Stop (SL-30) |
| 25-8756C Waycover Left T/S (SL-30)              | 17. 20-1628A S/R Push Bar (SL-40/40L) |
| 25-8564A T/S Left Base Cover (SL-30L)           | 20-1622 S/R Push Bar (SL-30)          |
| 5. 48-0009 Dowel Pin 1/2 x 3 1/4 (SL-30/40/40L) | 18. 25-1320A Strip Shield (SL-40/40L) |
| 6. 20-0858 Handle T/S (SL-40/40L)               | 25-1314 Strip Shield (SL-30)          |
| 7. 20-1626A Handle Collar T/S (SL-40/40L)       |                                       |
| 8. 20-1627B Locking Pin (SL-40/40L)             |                                       |
| 20-1621B Locking Pin (SL-30 only)               |                                       |
| 9. 20-1751A S/R Base Machined (SL-40/40L)       |                                       |
| 10. 20-1648A S/R Base Machined (SL-30/30L)      |                                       |
| 11. 20-1620 S/R Limit Stop (SL-40/40L)          |                                       |
| 12. 25-1318B Waycover S/R (SL-40)               |                                       |
| 25-4600A Waycover S/R (SL-40L)                  |                                       |
| 25-1316 Waycover S/R (SL-30)                    |                                       |
| 25-8646 Right Front Base Cover (SL-30L)         |                                       |
| 13. 50-8205 Linear Guide (SL-40)                |                                       |
| 50-0027 Linear Guide (SL-40L)                   |                                       |
| 50-0021 Linear Guide (SL-30)                    |                                       |
| 50-0124 Linear Guide (SL-30L)                   |                                       |

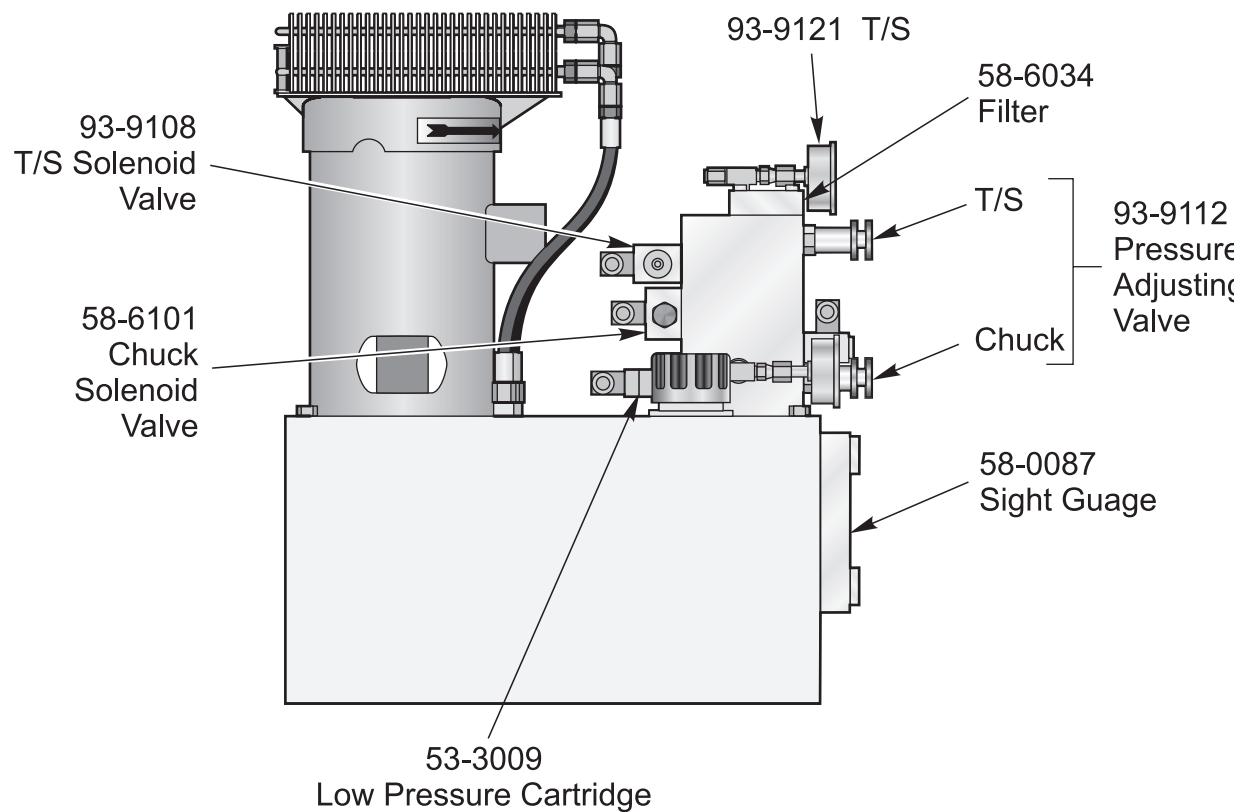
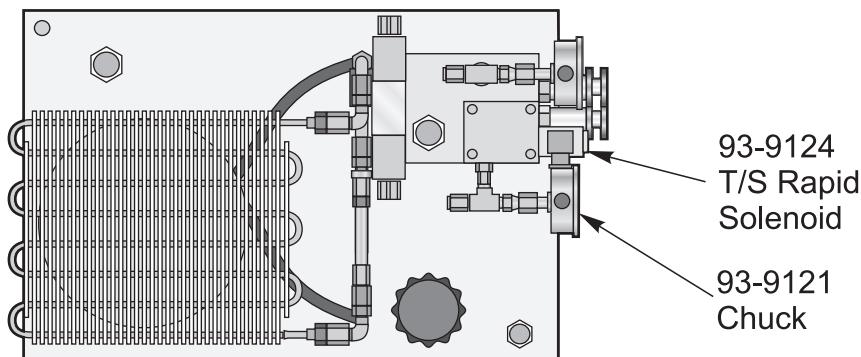


## FOOT SWITCH ASSEMBLY



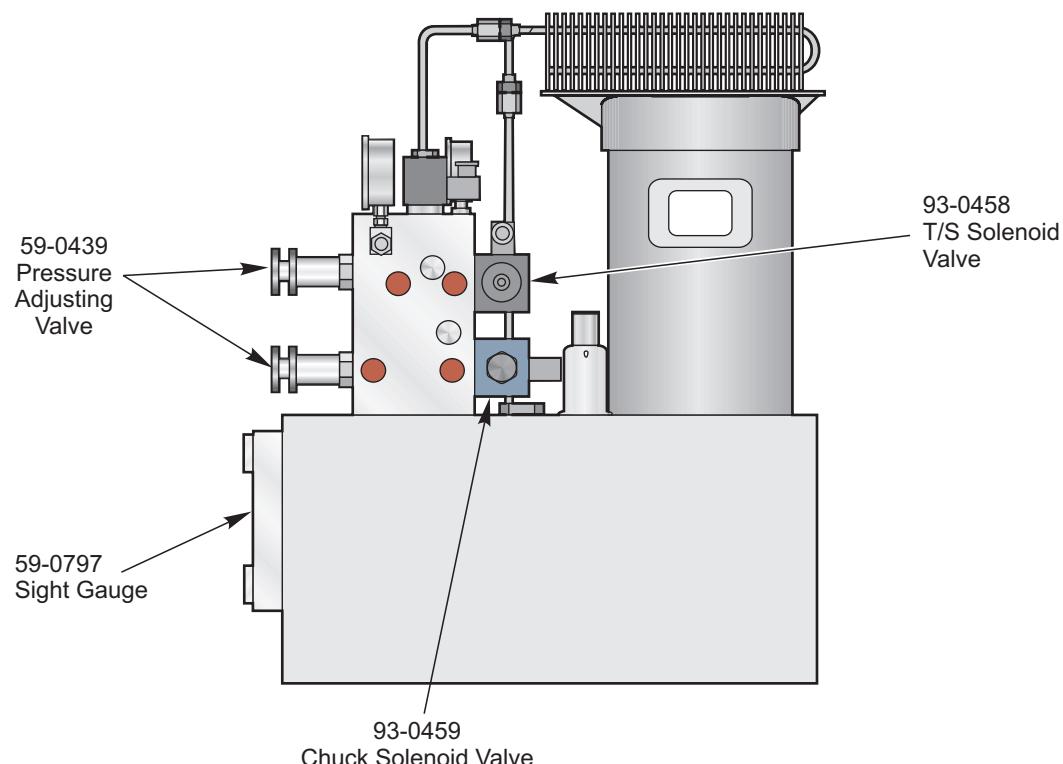
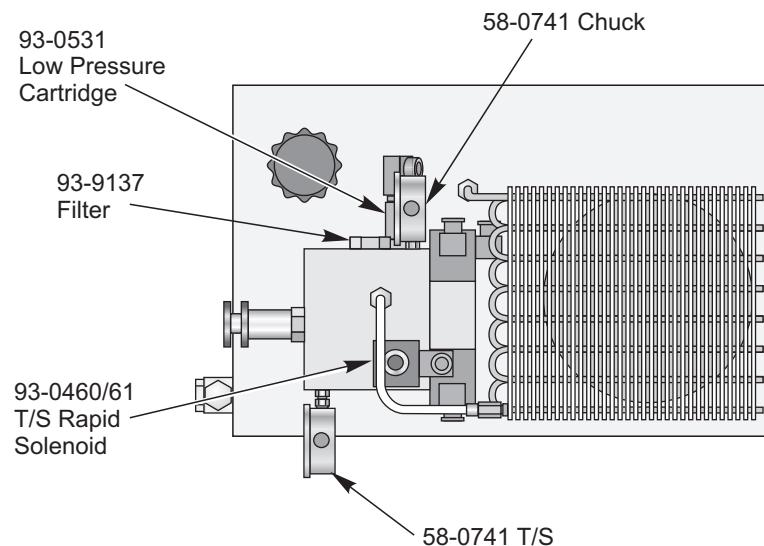


PARKER HYDRAULIC POWER UNIT



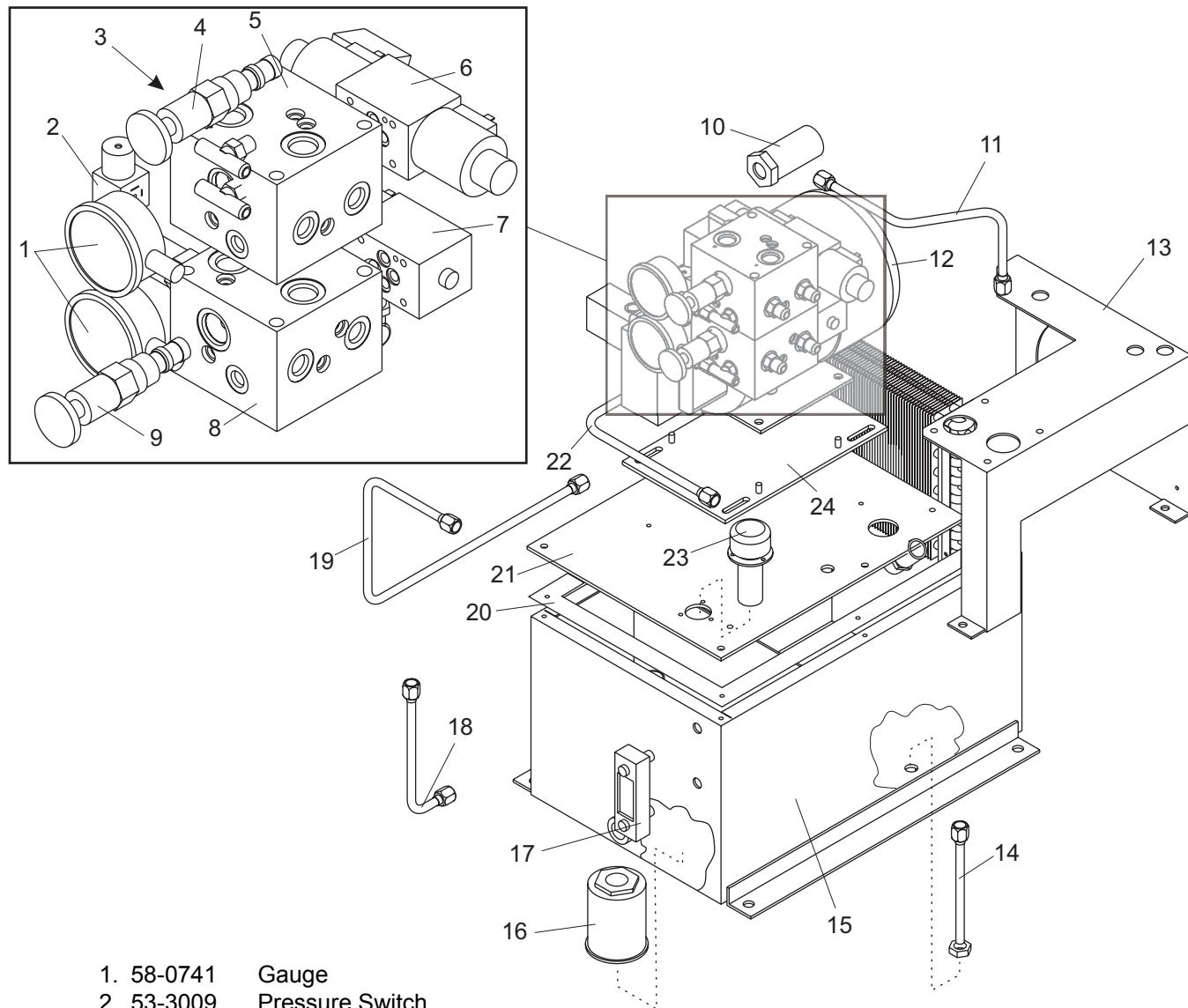


## REXROTH HYDRAULIC POWER UNIT





## HAAS HYDRAULIC POWER UNIT



- |              |                             |             |                         |
|--------------|-----------------------------|-------------|-------------------------|
| 1. 58-0741   | Gauge                       | 14. 58-0855 | Hydraulic Tube          |
| 2. 53-3009   | Pressure Switch             | 15. 25-6936 | Reservoir               |
| 3. 90-0114   | Hydraulic Valve             | 16. 59-0798 | Suction Strainer        |
| 4. 59-0439   | Pressure Adjusting Valve    | 17. 59-0797 | Level Sight Gauge       |
| 5. 20-3109   | Valve Block (Tailstock)     | 18. 58-0858 | Hydraulic Tube Return   |
| 6. 90-0105   | Hydraulic Valve (Tailstock) | 19. 58-0856 | Hydraulic Tube Pressure |
| 7. 90-0104   | Hydrulic Valve (Chuck)      | 20. 57-0389 | Reservoir Gasket        |
| 8. 20-3108   | Valve Block (Chuck)         | 21. 25-6935 | Reservoir Cover Plate   |
| 9. 59-0439   | Pressure Adjusting Valve    | 22. 58-0857 | Hydraulic Tube Pressure |
| 10. 58-0875  | In-Line Filter              | 23. 59-0799 | Filter Breather         |
| 11. 58-0879  | Hydraulic Tube              | 24. 25-6937 | Subplate Motor Mount    |
| 12. 62-0999A | Pump Motor                  |             |                         |
| 13. 25-6938  | Valve Block Bracket         |             |                         |

### Filter Replacement

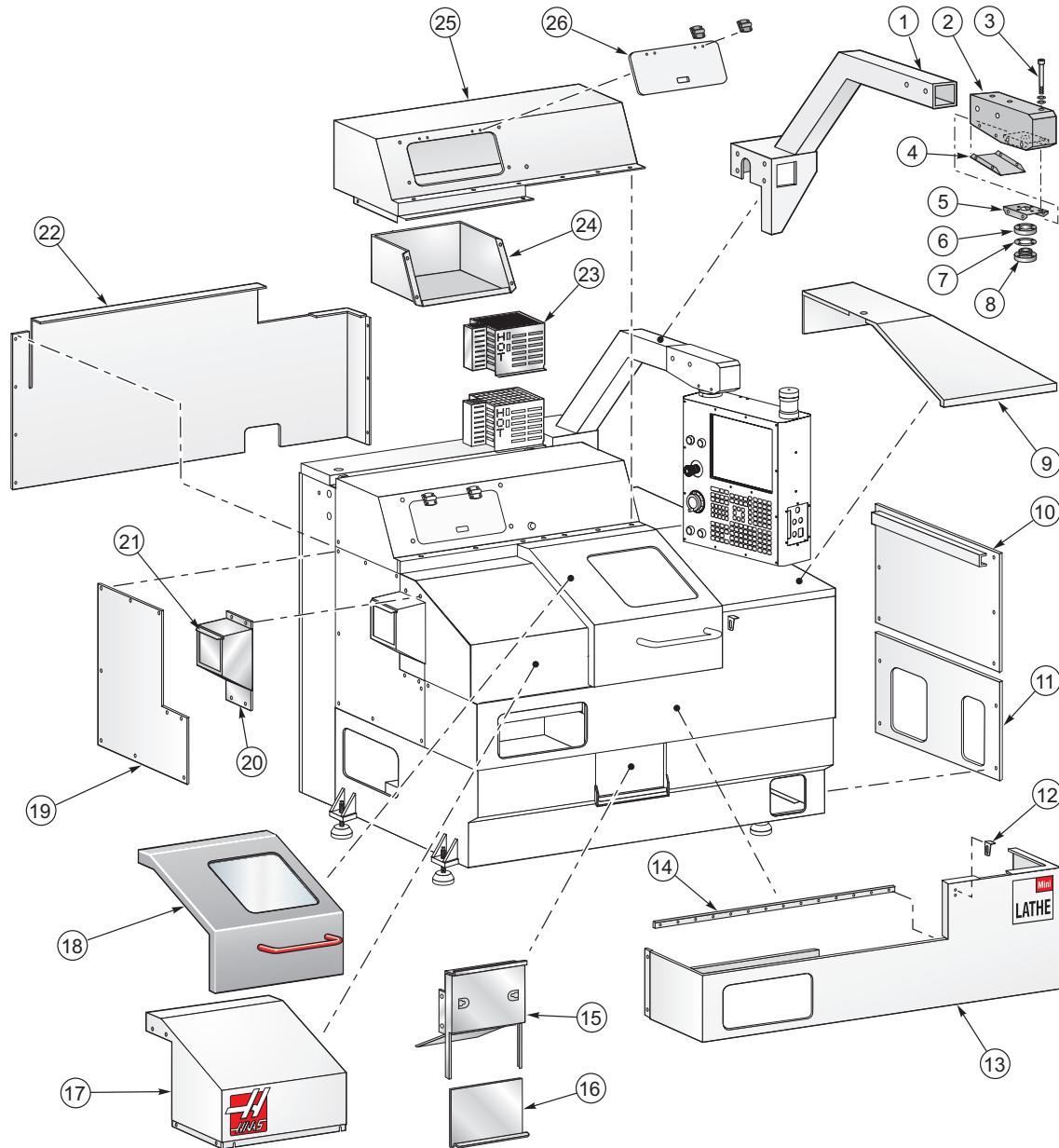
Filter Manufacturer	Oil Filter Part Number
Pall	58-1064
Hydac	58-1064
Flow Ezy	58-1064

### Replacement Element Part Number

58-1065
58-1066
58-1067



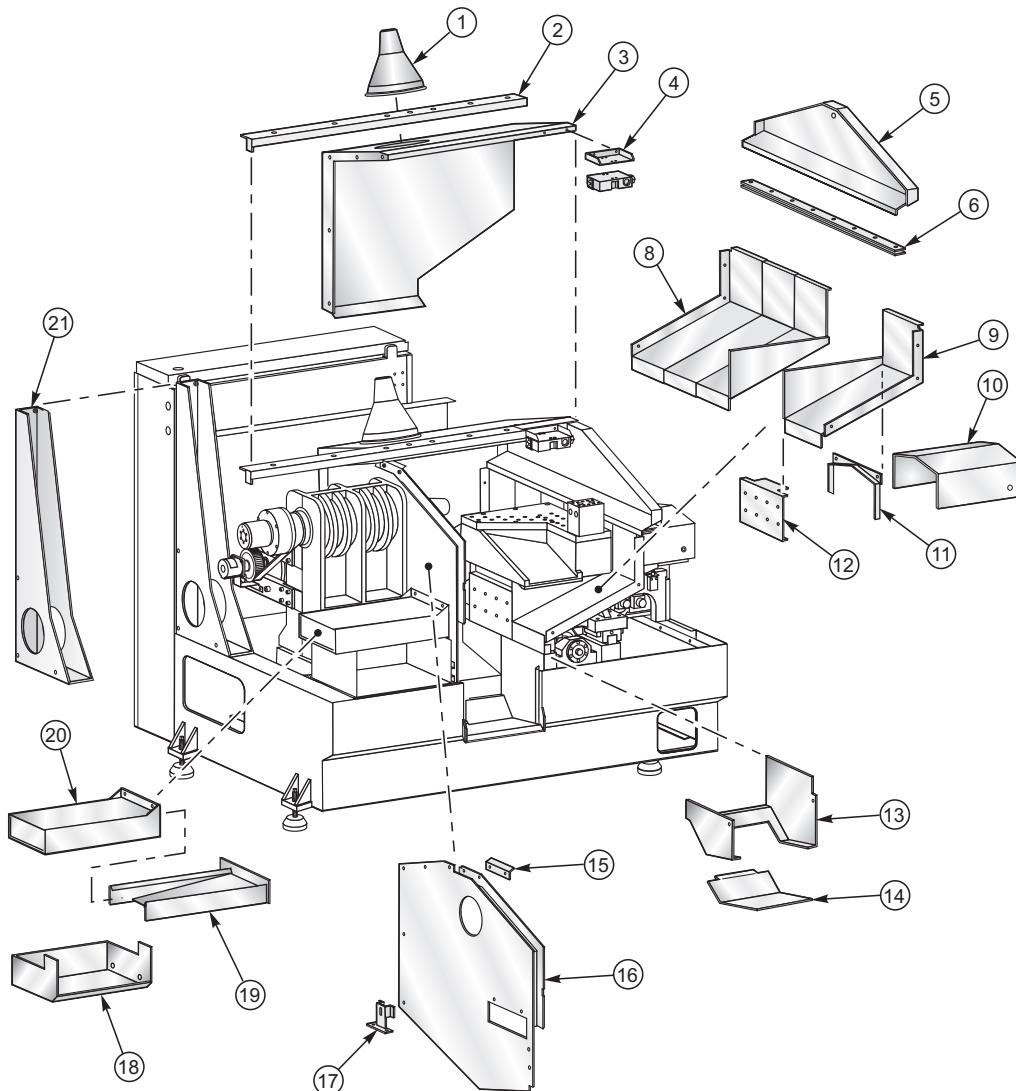
### MINI LATHE EXTERNAL SHEETMETAL AND PARTS LIST



- |              |                      |             |                        |
|--------------|----------------------|-------------|------------------------|
| 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           |



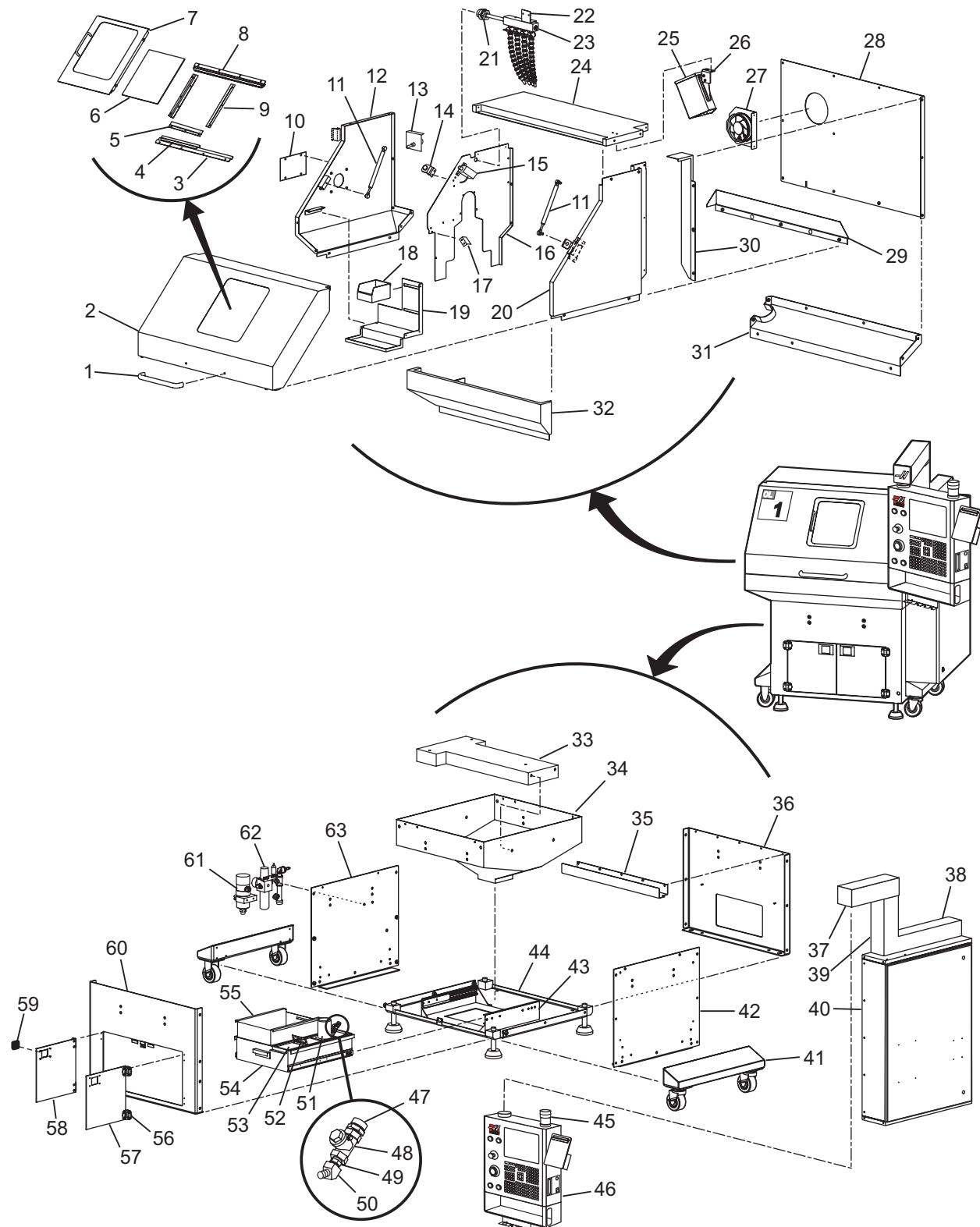
## MINI LATHE INTERNAL SHEETMETAL AND PARTS LIST



- |              |                        |              |                           |
|--------------|------------------------|--------------|---------------------------|
| 1. 32-0106   | Work Light Assembly    | 12. 25-4132C | Saddle Bra                |
| 2. 25-4092   | Upper Roller Track     | 13. 25-4143  | Chip Tray Body            |
| 3. 25-4105A  | Splash Liner           | 14. 25-4130  | Chip Tray                 |
| 4. 25-4100   | CE Hanger              | 15. 26-0054  | Door Brass Wiper          |
| 5. 25-4136   | Header                 | 16. 25-4104A | Fixed Bulkhead            |
| 6. 20-1240A  | Guide Bar Assembly     | 17. 25-4107  | Bulkhead Bracket          |
| 7. Not Used  |                        | 18. 25-4089  | Part Tray                 |
| 8. 25-4134A  | Rear Way Cover         | 19. 25-4138  | Part Catcher Drawer       |
| 9. 25-4135A  | Front Way Cover        | 20. 25-4147  | Part Catcher Drawer Frame |
| 10. 25-4133  | Z-Axis Sliding Cover   | 21. 25-4102A | Stand                     |
| 11. 25-4139A | Z-Axis Way Cover Wiper |              |                           |



### OFFICE LATHE EXTERNAL SHEETMETAL AND PARTS LIST



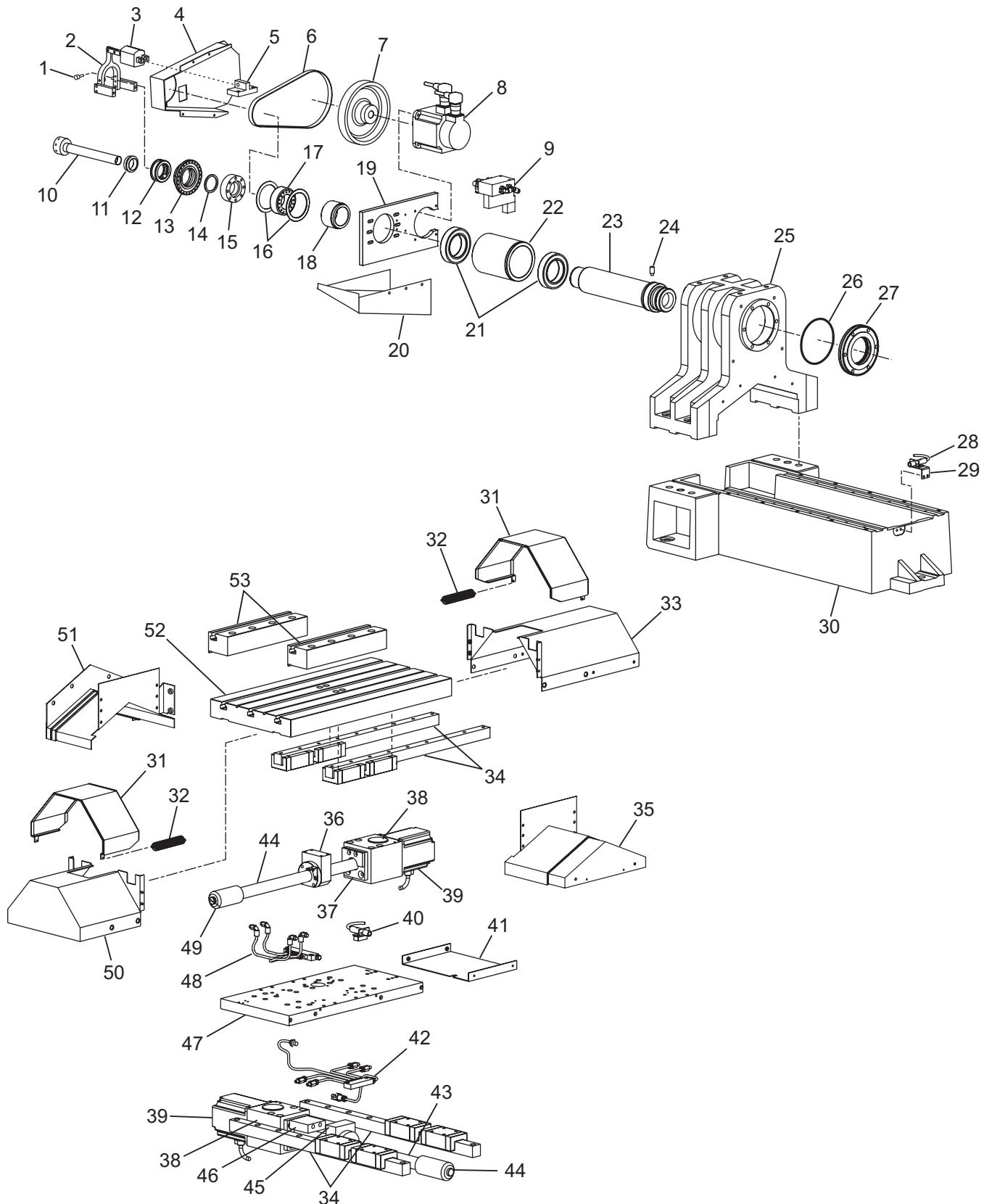


## OFFICE LATHE EXTERNAL SHEETMETAL AND PARTS LIST

- |              |                                       |              |                             |
|--------------|---------------------------------------|--------------|-----------------------------|
| 1. 22-8895   | Chrome Handle                         | 39. 25-6946A | Pendant Arm Support         |
| 2. 25-6905   | Set-Up Door Panel                     | 40. 32-9841A | Electrical Control Box Assy |
| 3. 25-6070A  | Window Rail                           | 41. 30-7741  | Right Swiveling Caster      |
| 4. 28-0175   | Bottom Window Guide                   | 30-7742      | Left Swiveling Caster       |
| 5. 25-6247A  | Bottom Window Frame                   | 42. 25-7348A | Base Right Panel            |
| 6. 28-0173A  | Window                                | 43. 25-7072  | Coolant Tank Support        |
| 7. 25-7549   | Operator Door Panel                   | 44. 25-7350  | Base Bottom                 |
| 59-0901      | Small Handle                          | 45. 28-1071  | Top Beacon Light Assy       |
| 8. 25-6081   | Window Guide Bracket                  | 46. 25-8354C | Front Pendant Enclosure     |
| 28-0174      | Top Window Guide                      | 47. 58-3662  | .375 Garden Hose Fitting    |
| 9. 25-6084A  | Left Window Side Frame                | 48. 59-2228  | .375 Swing Valve Brass      |
| 25-6108      | Right Window Side Frame               | 49. 58-3600  | .375 Hex Nipple             |
| 10. 25-7198B | Junction Box Cover                    | 50. 58-1721  | 45 Degree Elbow             |
| 11. 59-0101  | 2X Gas Spring                         | 51. 32-5005  | Coolant Pump Kit            |
| 12. 25-6907  | Left Panel                            | 52. 25-6838  | Coolant Tank Filter         |
| 13. 59-2746  | Reverse Acting TV-4DMP Model CS-1781  | 53. 25-7070  | Pump Assy Bracket           |
| 25-7579      | Drawbar Relief Bracket                | 54. 25-7069  | Coolant Tank                |
| 14. 32-1210C | Chuck Release Button                  | 55. 25-7071  | Chip Tray                   |
| 25-6924      | Chuck Release Bracket                 | 56. 59-0023  | 4X Door Hinge               |
| 15. 25-7553  | Door Switch Bracket                   | 57. 25-5856A | Right Base Door             |
| 32-2305      | Proximity Switch                      | 58. 25-5855A | Left Base Door              |
| 16. 25-6912  | Spindle Partition                     | 59. 58-0227  | 2X Push Close Latch         |
| 17. 25-7573  | Coolant Splash Shield                 | 60. 25-7346A | Base Front Panel            |
| 18. 59-0712  | 3X AKROBIN AKRO-Mils 30-210 Red       | 61. 59-0814  | Auto Lube Pump              |
| 19. 25-6933  | Tool Tray                             | 62. 30-8257  | Air Regulator Assy          |
| 20. 25-6908  | Right Panel                           | 63. 25-7347A | Base Left 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. 25-7355A | Long Machine Support                  |              |                             |
| 34. 25-7491A | Base Basin                            |              |                             |
| 35. 25-7499  | Back Cables Trough                    |              |                             |
| 36. 25-7351A | Base Rear Panel                       |              |                             |
| 37. 20-3263A | Pendant Arm                           |              |                             |
| 38. 25-6948A | Pendant Arm Cover                     |              |                             |



### OFFICE LATHE INTERNAL SHEETMETAL AND PARTS LIST



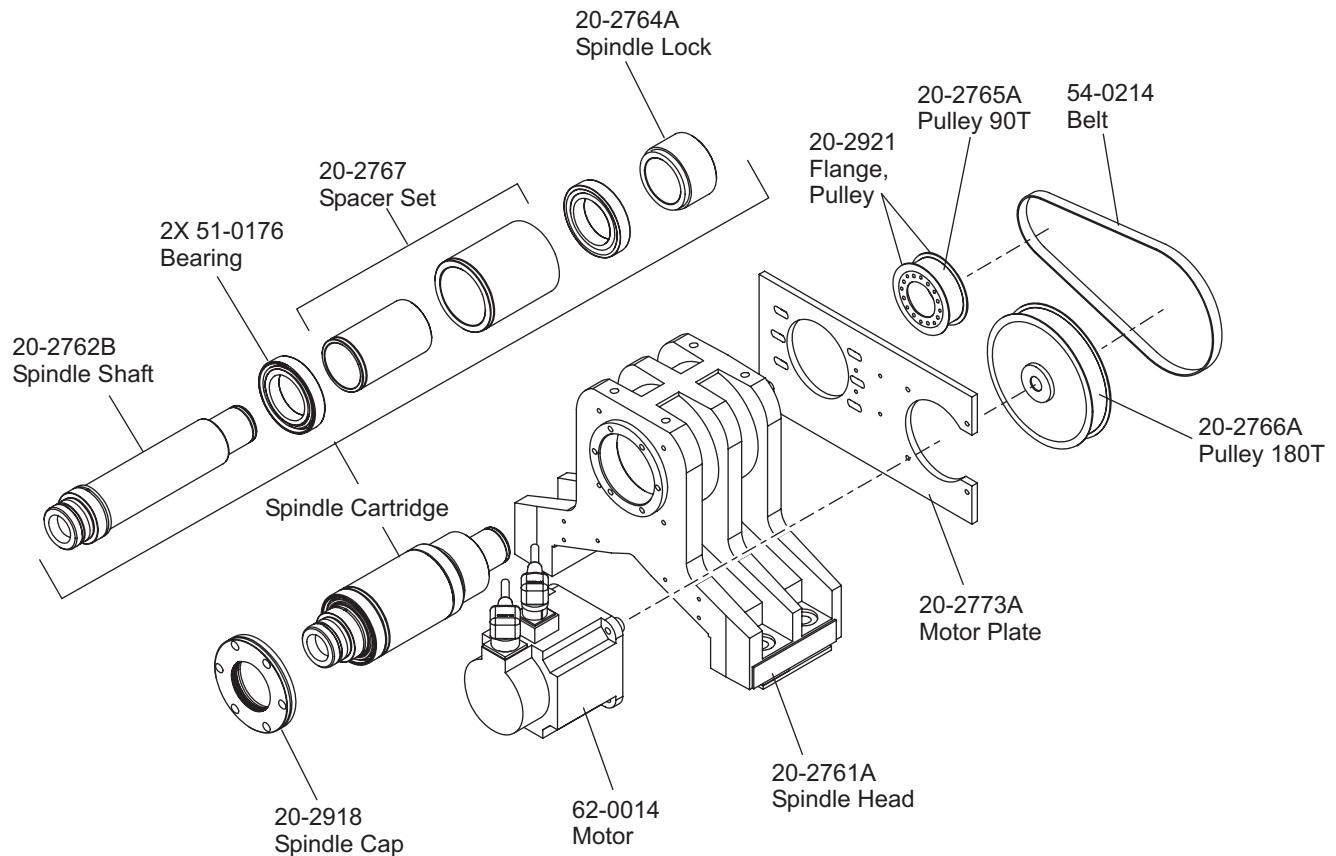


## OFFICE LATHE INTERNAL SHEETMETAL AND PARTS LIST

1. 49-0146 2X Track Roller
2. 20-3088A Lever AAC
3. 59-0789A Air Cylinder AAC
4. 25-6828A Spindle Belt Cover
5. 20-3090A Cylinder Mount AAC
6. 54-0214 Belt
7. 20-2766A Pulley 180T 3mm
8. 62-0014 Servo Motor
9. 30-30486 Solenoid Assy
10. 20-3087 Drawbar AAC
11. 20-3107 Locking Collar AAC
12. 20-10255 Collet Closer Cone
13. 20-2055 Detent Ring
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. 51-0176 2X Bearing
22. 20-2767 Spacer Set 60mm
23. 20-2762B 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. 32-2195 Proximity Switch
29. 25-5846 Switch Bracket
30. 20-2739A Bed Machined
31. 25-6848 2X X-Axis Floater Waycover
32. 59-0883 4X Spring - Ext - 3/8 x 2.50 lg x .035
33. 25-5842A X-Axis Waycover
34. 50-0106 4X Linear Guide
35. 25-6068B Z-Axis Right Waycover
36. 20-3082 X-Axis Nut Housing
37. 20-2748 X-Axis Bumper  
20-2754 Ball Screw Bearing Cap
38. 20-2747 2X Motor Mount  
59-1086 Plug
39. 62-2495A 2X Servo Motor
40. 32-2193 Proximity Switch  
20-2834 Switch Spacer
41. 25-6847 X-Axis Bottom Waycover
42. 30-7542B Y-Axis Lube Line Assy
43. 24-0110 2X Ball Screw
44. 20-2751 Y-Axis Ball Screw Bumper
45. 20-2746A Y-Axis Nut Housing
46. 20-2750 Y-Axis Bumper
47. 20-10215 Saddle Machined
48. 30-7541D X-Axis Lube Line Assy
49. 20-2749A Ball Screw Bumper
50. 25-6831 X-Axis Short Waycover
51. 25-6067A Z-Axis Left Waycover
52. 20-2743A Table Machined
53. 20-2775 2X Riser Rail

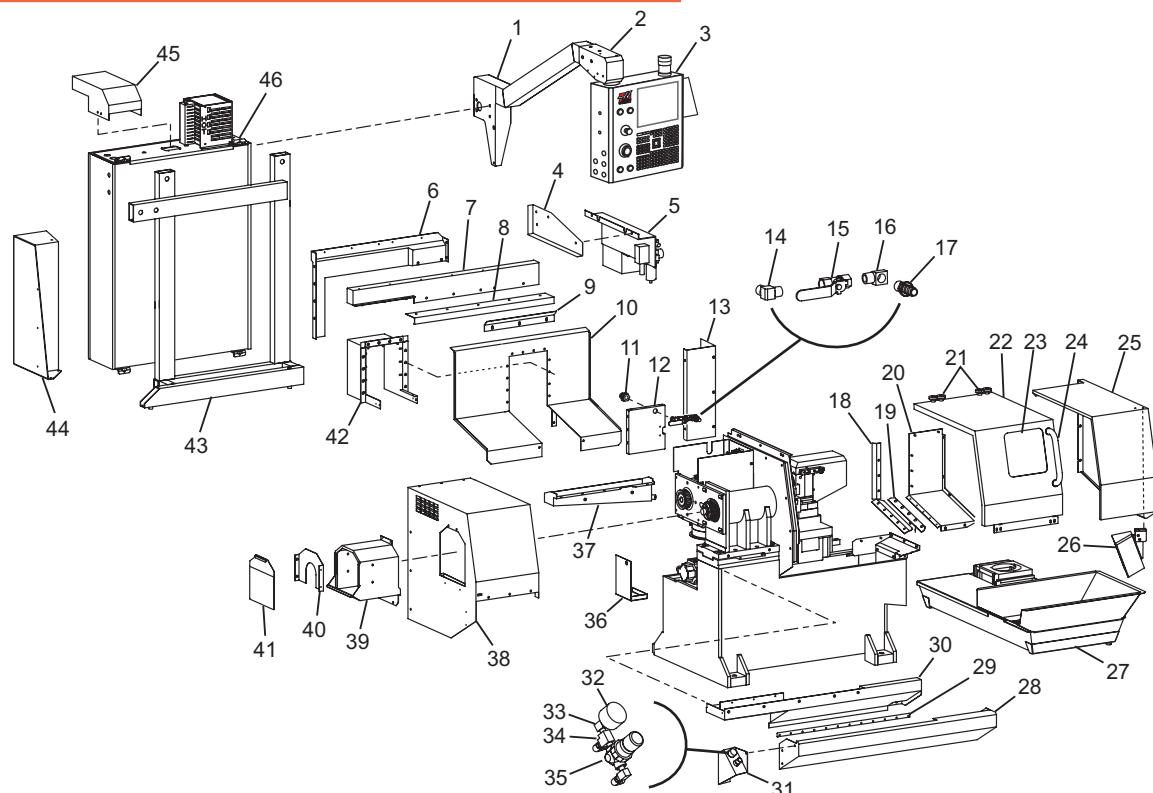


### OFFICE LATHE EXPLODED SPINDLE HEAD

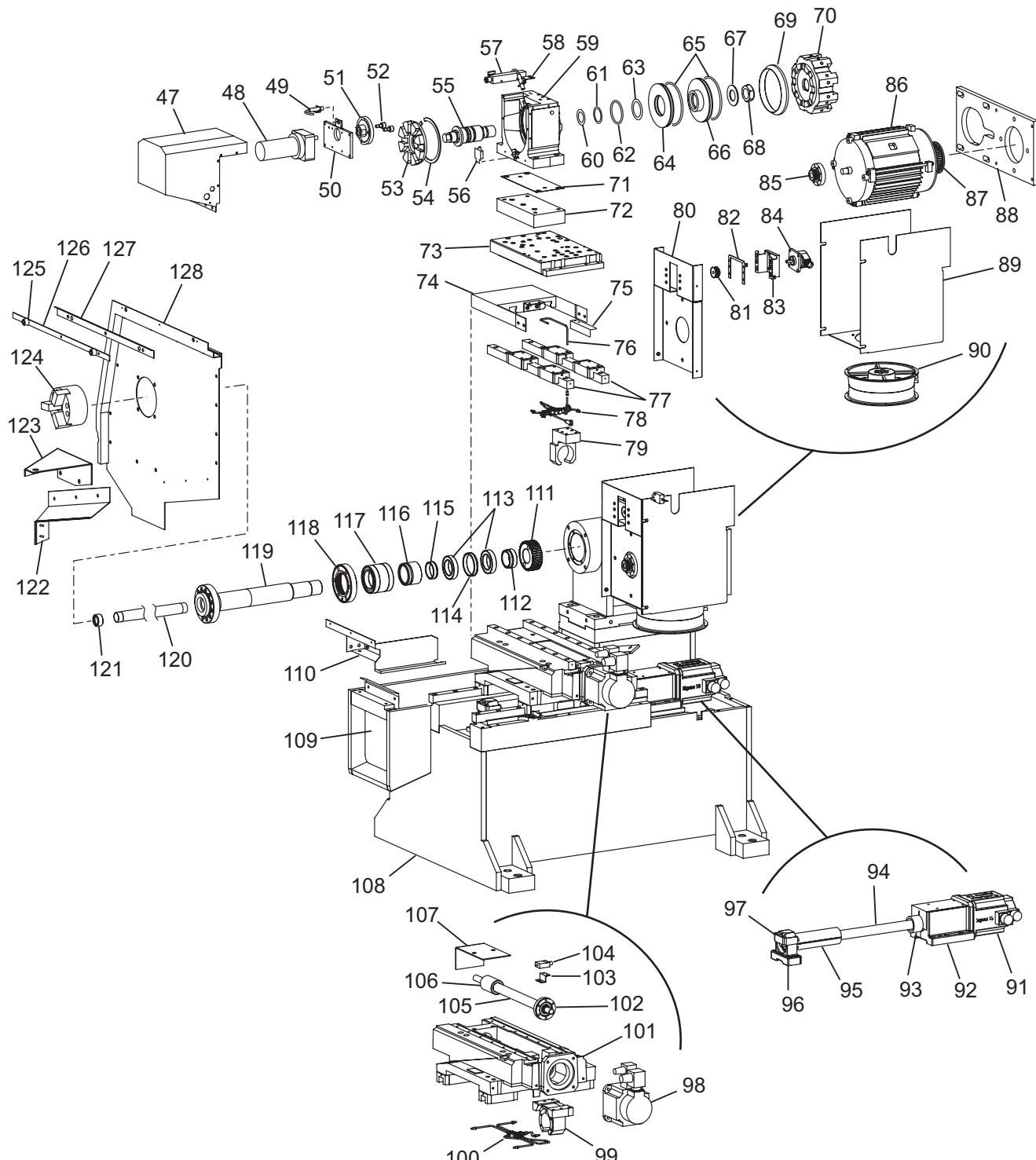




### GT-10 EXTERNAL SHEETMETAL AND PARTS LIST



- |              |                                      |              |   |
|--------------|--------------------------------------|--------------|---|
| 1. 20-3574   | Pendant Arm                          | 26. 25-4788  | Worklight Housing                                   |
| 2. 25-6661A  | Arm End Cap                          | 25-4789A     | Worklight Adjustable Bracket                        |
| 3. 32-6012C  | Control Pendant Assy                 | 27. 30-30354 | Coolant Tank Assy                                   |
| 4. 25-8703   | Lube Rack Support                    | 28. 25-7968B | Front Skirt   |
| 5. 30-4900B  | Lube Rack Assy                       | 29. 20-3568  | V-Track   |
| 6. 25-7952   | Rear Splash Shield                   | 20-6016A     | 2X Rail Spacer                                      |
| 7. 25-7954   | Enclosure Support                    | 30. 25-7949A | BTM Door Track                                      |
| 8. 25-7967   | Door Retainer                        | 31. 25-8428  | AC5C Air Regulator Housing Box                      |
| 9. 25-7966A  | Top Door Splash Shield               | 32. 58-27395 | Gauge 0-160 PSI x NPT.125 in. M Back                |
| 10. 25-7955  | Z-Axis Sliding Cover                 | 33. 58-16700 | 2X Street Elbow NPT .125-F x .125 in.-M             |
| 11. 58-1679  | Bulkhd Ftng NPT .375 x 1.000 in dia. | 34. 58-3002  | Tee NPT .125-F x .125-M x .125 in.-F                |
| 12. 25-7961  | X-Axis Front Panel                   | 35. 58-2736  | Air Regulator 0-10 PSI Output<br>NPT .125 in. Ports |
| 13. 25-7965A | Rear Right Panel                     | 58-3050      | Elbow .250 x NPT .125 in.-M                         |
| 14. 58-1694  | Male Elbow NPT .375 x .375 in.       | 36. 25-7741A | Tramp Oil Bottle Bracket                            |
| 15. 58-5105  | Ball Valve NPT .375-F x .375 in.-F   | 37. 25-7334  | Back Drain Trough                                   |
| 16. 58-1722  | Street Elbow NPT .375-F x .375 in.-M | 38. 25-7953B | Front Left Panel                                    |
| 17. 58-0029  | Hose Barb Ftng NPT .50 x .375 in.-M  | 39. 25-7963C | Chip Collector Housing                              |
| 18. 25-7361  | Z-Axis Right Chip Shield             | 40. 25-7962  | Chip Collector Housing Support                      |
| 25-7959      | Z-Axis Right Waycover Scraper        | 41. 25-0639  | Chip Collector Door                                 |
| 19. 26-0189A | RW CVR Scraper                       | 42. 25-7259A | X-Axis Rear Waycover                                |
| 20. 25-7958  | Z-Axis Right Waycover                | 25-7344      | 3X X-Axis Wiper Retainer                            |
| 21. 51-2020  | 4X Radial Bearing Fafnir 303         | 26-0191      | X-Axis Wiper Felt                                   |
| 22-7034      | 4X Cam Follower Spacer               | 43. 20-3565A | Control Mount                                       |
| 22. 25-7946  | Door                                 | 44. 25-7951A | Left Control Support Bracket                        |
| 23. 28-0170  | Front Window                         | 45. 25-7973  | Cable Exit Cover                                    |
| 25-6250B     | 2X Window Retainer                   | 46. 30-30304 | Control Box Assy                                    |
| 24. 22-8895  | Door Handle - Chrome                 |              |   |
| 25. 20-7956  | Right Front Panel                    |              |   |

**GT-10 INTERNAL SHEETMETAL**

(View Rotated 180°)

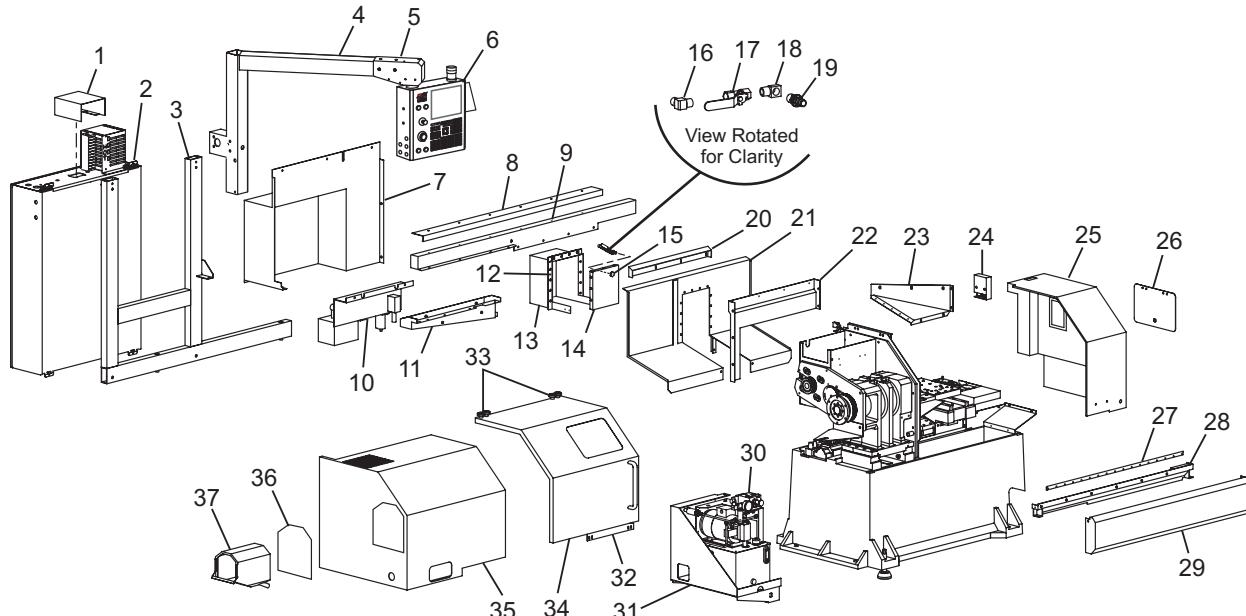


## GT-10 INTERNAL SHEETMETAL PARTS LIST

47. 25-7907	TT-20-3 TC Housing Cover	91. 62-0016	Servo Motor - Yaskawa 13 No Brake
48. 62-0025	Geneva Drive Motor	25-7042A	Motor Mount Cover
49. 32-2267	Tool Position Sensor Switch	92. 20-7010A	Motor Mount Machined
50. 20-3412	Motor Bracket	93. 28-0228	Ring Bumper 1.68 in.
51. 20-9332	Geneva Driver 2 Pin	94. 24-0016	Ballscrew 32-10-669.2
52. 51-0051	2X Cam Follower .75 in. Hex,	95. 28-0196	Ballscrew Bumper 7.25 in.
53. 20-3411A	Geneva Flower	96. 20-7009	Bearing Housing Machined
54. 56-0030	Retaining Ring 6.000 in. HO	51-2025	Radial Bearing 304PP
55. 20-3406A	Piston Shaft	97. 25-7080	Bumper Bracket
56. 25-7710	Proximity Switch Bracket	98. 62-0024	Servo Motor - Yaskawa 05 No Brake
32-2206	Tool 1 Switch	99. 20-3006	X-Axis Nut Housing
57. 20-7247A	Coolant Block	100. 30-8337A	Z-Axis Lube Line Assy
58-3665	Reducer NPT .375-M x .250 in.-F	101. 20-3213B	Saddle Machined
58-0336	Pipe Plug .375 in. Hex Socket	20-1232A	Z-Axis Support Bumper
58-3694	4X Loc-Line Valves .25 in.	102. 20-0448A	Bearing Race Adaptor 52mm
58. 25-7717	Proximity Switch Bracket - Unclamp	51-2022	Radial Bearing 205PP
32-2268	Tool Unclamp Switch	103. 25-6833	X-Axis Proximity Switch Mount
59. 20-3404B	TC Housing Machined	104. 69-1700	Proximity Switch
60. 57-0095	O-Ring 2-327	105. 24-0040	X-Axis Ballscrew 32-10-524
61. 56-0055	Retaining Ring	106. 20-3225	X-Axis Support Bumper
62. 57-2983	O-Ring 2-336	107. 25-7254	X-Axis Lower Front Waycover
63. 51-2984	Thrust Washer TRB-3446	108. 20-3557A	Base Machined
64. 20-3409	TC Lower Piston	109. 25-7964	Chute Flap Retainer
65. 57-2146	2X O-Ring 2-358	26-0221	Chute Flap
66. 20-3405	TC Upper Piston	110. 25-7957	Right Trough Spindle Shield
67. 45-0124	Washer 3.000 OD x 1.625 ID x .153 in. Thick	111. 20-0610	Sub-Spindle Pulley
68. 44-0113	Jam Nut 1.50-6 x .812 Max Height	112. 20-7532	Lock 50mm Angle Contact
69. 20-3408	TC Turret Seal	113. 51-0021	2X Bearing 6010 Open
70. 20-3410B	TC Turret	114. 20-0326	Outer Spacer Finished .575 in. x 50mm
71. 26-7233A	Gasket	115. 20-0327	Inner Spacer Finished .630 in. x 50mm
72. 20-3575A	TT-20 Riser Block	116. 20-7530	Lock 60mm Bearing
73. 20-3223A	Cross Slide	117. 51-0164	Bearing 7012
74. 25-7255A	X-Axis Upper Front Waycover	118. 20-0609	Sub-Spindle Front Cap
75. 25-7301	X-Axis Switch Flag	119. 20-0608A	Sub-Spindle Shaft
76. 58-0900	X-Axis Nut Feed Line	120. 20-0617A	Sub-Spindle Drawtube
77. 50-0031	2X X-Axis Linear Guide 30 x 550 in.	121. 20-0616A	Sub-Spindle Drawtube Adaptor
78. 30-8338	X-Axis Lube Line Assy	122. 25-7291	Z-Axis Wiper Mount
79. 20-3221	X-Axis Nut Mount	26-0190	Z-Axis Wiper
80. 25-7947	Motor - Encoder Mount	123. 25-7974	Shipping Bracket
81. 54-7127	Drive Sprocket	124. PC5	LMC Chuck Pc5 ZA5-5-34
82. 25-6298	Encoder Spring Clamp	125. 59-1041	2X Control Legs
83. 25-6293A	Encoder Spring Mounting Box	126. 25-7969	Top Door Wiper Bracket
84. 60-1813	Encoder	127. 26-0223	Top Door Wiper
85. 20-0147	Motor Balancing Hub Drive	128. 25-7948A	Fixed Bulkhead
20-0180	Timing Pulley .750 in. Bore	129. 20-3564	Spindle Head Machined
86. 62-1010D	Spindle Motor 5HP		
87. 20-0612	2X Sub-Spindle Pulley Flange		
20-3566	Drive Pulley 40T		
88. 20-3567A	Motor Mounting Plate		
89. 25-7971A	Fan Shroud		
90. 36-3035	Fan 10 in.		



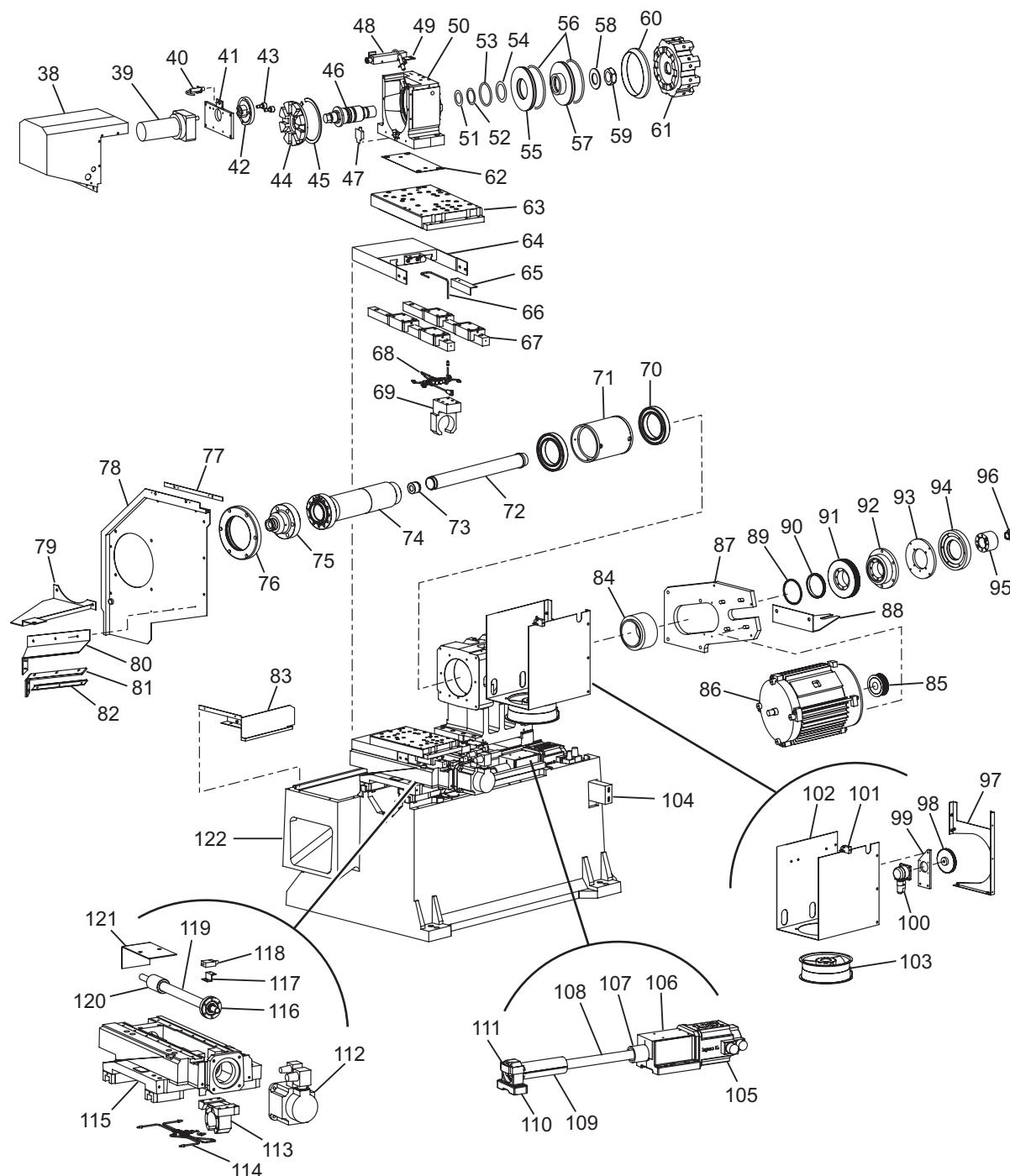
## GT-20 EXTERNAL SHEETMETAL AND PARTS LIST



- |              |                                      |              |                              |
|--------------|--------------------------------------|--------------|------------------------------|
| 1. 25-7633   | Cable Exit Cover                     | 26. 25-1350A | Tool Box Door                |
| 2. 30-30294  | Control Box Assy                     | 27. 22-6506  | V-Track                      |
| 3. 20-3224B  | Control Mount                        | 28. 25-7277  | Bottom Door Track            |
| 4. 20-3222   | Pendant Arm SB20                     | 29. 25-7251  | Front Skirt                  |
| 5. 25-6661A  | Arm End Cap                          | 30. 30-8070  | HPU Assy                     |
| 6. 32-6012C  | Control Pendant Assy                 | 31. 25-7252A | HPU Mount                    |
| 7. 25-7274A  | Rear Right Panel                     | 32. 25-5944B | Lower Wheel Mount            |
| 8. 25-7276   | Top Door Retainer                    | 54-0030      | 2X Guide Wheel               |
| 9. 25-7272   | Top Enclosure Support                | 33. 51-2020  | 4X Radial Bearing Fafnir 303 |
| 10. 30-4900B | Lube Rack Assy                       | 22-7034      | 4X Cam Follower Spacer       |
| 11. 25-7334  | Back Drain Trough                    | 34. 25-7275C | Door                         |
| 12. 25-7344  | 3X X-Axis Wiper Retainer             | 93-1338      | Door Handle                  |
| 13. 25-7259A | X-Axis Rear Waycover                 | 28-0238      | Door Window                  |
| 26-0191      | X-Axis Wiper Felt                    | 26-0177      | Window Gasket                |
| 14. 25-7345  | X-Axis Rear Cover Front Plate        | 25-6250B     | 2X Window Retainer           |
| 15. 58-1679  | Bulkhd Ftng NPT .375 x 1.000 in dia. | 35. 25-7271A | Front Left Panel             |
| 16. 58-1694  | Male Elbow NPT .375 x .375 in.       | 36. 25-7598  | Coolant Collector Open Cover |
| 17. 58-5105  | Ball Valve NPT .375-F x .375 in.-F   | 37. 25-6185A | Chip Collector Housing       |
| 18. 58-1722  | Street Elbow NPT .375-F x .375 in.-M |              |                              |
| 19. 58-0029  | Hose Barb Ftng NPT .50 x .375 in.-M  |              |                              |
| 20. 25-7260  | Top Door Splash Shield               |              |                              |
| 21. 25-7269  | Z-Axis Sliding Cover                 |              |                              |
| 22. 25-7263  | Rear Splash Shield                   |              |                              |
| 23. 25-7270A | Z-Axis Right Waycover                |              |                              |
| 24. 25-7594  | CE Lock Mount                        |              |                              |
| 61-0006B     | CE Door Interlock                    |              |                              |
| 25. 25-7273B | Front Right Panel                    |              |                              |



## GT-20 INTERNAL SHEETMETAL

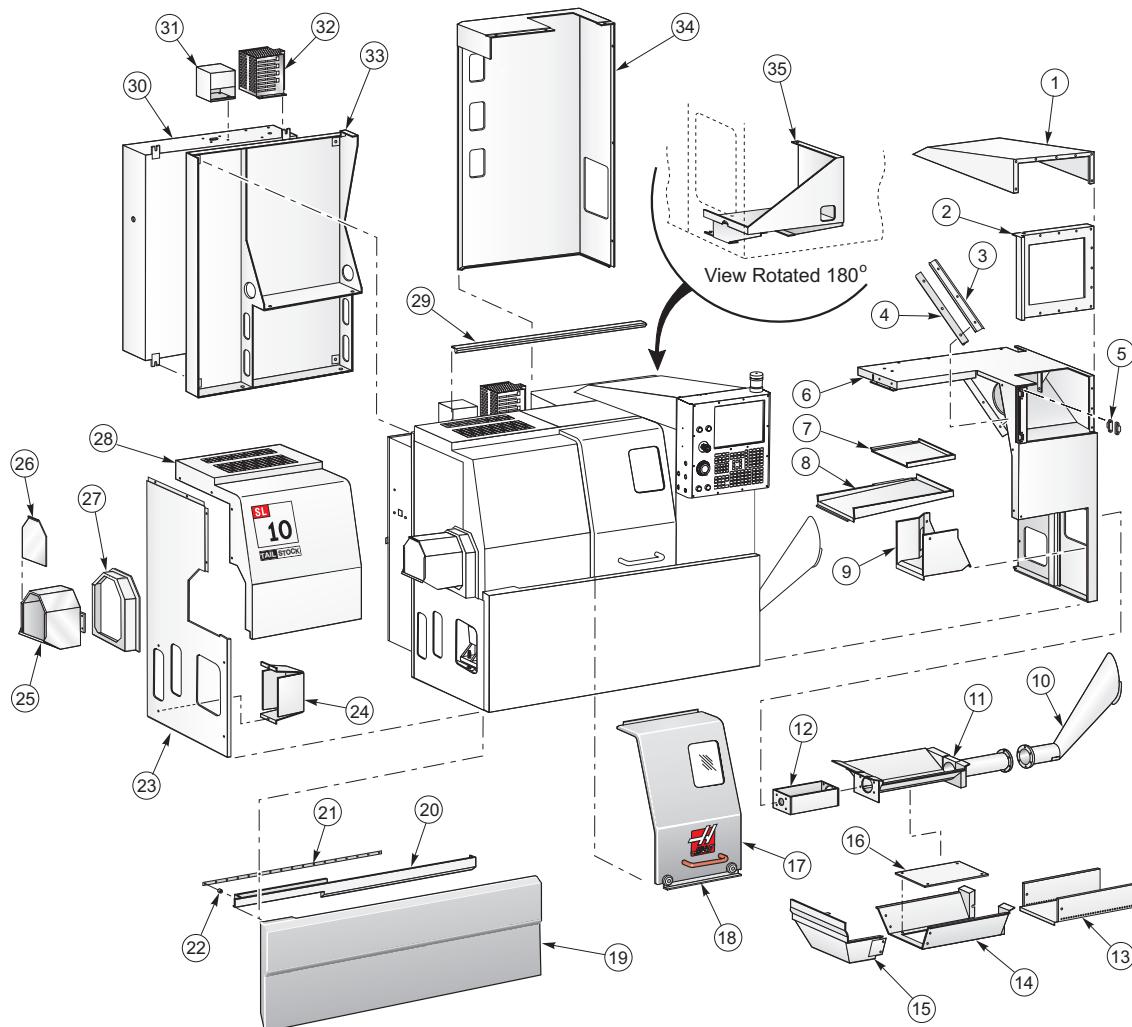


**GT-20 INTERNAL SHEETMETAL PARTS LIST**

38. 25-7907	TT-20-3 TC Housing Cover	83. 25-7289A	Right Trough Splash Tray
39. 62-0025	Geneva Drive Motor	84. 20-8564A	Spindle Ring Clamp
40. 69-1700	Proximity Switch	85. 20-2497	Sprocket GT 8M-36-20
41. 20-3412	Motor Bracket	20-2498	2X GT Sprocket Flange 8M-36-20
42. 20-9332	Geneva Driver 2 Pin	86. 62-3033	Spindle Motor
43. 51-0051	2X Cam Follower .75 in. Hex,	87. 20-2500A	Motor Mounting Plate
44. 20-3411A	Geneva Flower	88. 25-7253	Anti Rotation Bracket
45. 56-0030	Retaining Ring 6.000 in. HO	89. 22-8562B	Flange Timing Pulley
46. 20-3406A	Piston Shaft	90. 20-8567A	Spindle Timing Pulley
47. 25-7710	Proximity Switch Bracket	91. 20-2496	Sprocket GT 8M-72-20
69-1700	Proximity Switch	92. 20-2499B	Chuck CLS Cylinder Adaptor
48. 20-7247A	Coolant Block	93. 20-0575	Chip Collector Adaptor Kit
58-3665	Reducer NPT .375-M x .250 in.-F	94. 20-0576	Chip Collector Adaptor LMC
58-0336	Pipe Plug .375 in. Hex Socket	95. 20-6742	Liner 2 in. Guide
58-3694	4X Loc-Line Valves .25 in.	96. 30-0845	Spindle Liner .25 - 1.00 in. dia.
49. 25-7717	Proximity Switch Bracket - Unclamp	97. 25-7358	Outer Fan Shroud
69-1700	Proximity Switch	98. 20-3090	Cylinder Mount AAC
50. 20-3404B	TC Housing Machined	99. 20-2501	Encoder Mounting Plate
51. 57-0095	O-Ring 2-327	100. 60-1813	Encoder 2K M23 Short
52. 56-0055	Retaining Ring	101. 25-4043	Latch Spring
53. 57-2983	O-Ring 2-336	69-1700	Proximity Switch
54. 51-2984	Thrust Washer TRB-3446	102. 25-7359A	Inner Fan Shroud
55. 20-3409	TC Lower Piston	103. 36-3035	Spindle Fan Assy
56. 57-2146	2X O-Ring 2-358	104. 25-7695A	Control Mount Brace
57. 20-3405	TC Upper Piston	105. 62-0016	Servo Motor - Yaskawa 13 No Brake
58. 45-0124	Washer 3.000 OD x 1.625 ID x .153 in. Thick	25-7042A	Motor Mount Cover
59. 44-0113	Jam Nut 1.50-6 x .812 Max Height	106. 20-7010A	Motor Mount Machined
60. 20-3408	TC Turret Seal	107. 28-0214	Z-Axis Bumper
61. 20-3410B	TC Turret	108. 24-0009	Ballscrew 32-10-800
62. 26-7233A	Gasket	109. 28-0196	Ballscrew Bumper 7.25 in.
63. 20-3223A	Cross Slide	110. 20-7009	Bearing Housing Machined
64. 25-7255A	X-Axis Upper Front Waycover	51-2025	Radial Bearing 304PP
65. 25-7301	X-Axis Switch Flag	111. 25-7080	Bumper Bracket
66. 58-0900	X-Axis Nut Feed Line	112. 62-0024	Servo Motor - Yaskawa 05 No Brake
67. 50-0031	2X X-Axis Linear Guide 30 x 550 in.	113. 20-3006	X-Axis Nut Housing
68. 30-8338	X-Axis Lube Line Assy	114. 30-8337A	Z-Axis Lube Line Assy
69. 20-3221	X-Axis Nut Mount	115. 20-3213B	Saddle Machined
70. 51-7100	2X R Bearing Ang Dup M120-180-28	20-1232A	Z-Axis Support Bumper
71. 20-8565A	Spindle Bearing Spacer	116. 20-0448A	Bearing Race Adaptor 52mm
72. 20-8706	Drawtube Hyd8	51-2022	Radial Bearing 205PP
73. 20-6740A	Liner Retainer Ring	117. 25-6833	X-Axis Proximity Switch Mount
74. 20-8563B	Spindle Shaft	118. 69-1700	Proximity Switch
75. 20-4141	5C Collet Nose	119. 24-0040	X-Axis Ballscrew 32-10-524
76. 20-8568	Spindle Retainer Ring	120. 20-3225	X-Axis Support Bumper
77. 25-7294	Top Door Wiper Retainer	121. 25-7254	X-Axis Lower Front Waycover
78. 25-7265A	Fixed Bulkhead	122. 20-3191	Base Machined
79. 25-7464A	Shipping Bracket		
80. 25-7291	Z-Axis Wiper Mount		
81. 26-0190	Z-Axis Wiper		
82. 25-7292	Z-Axis Upper Retainer		
25-7293	Z-Axis Lower Retainer		



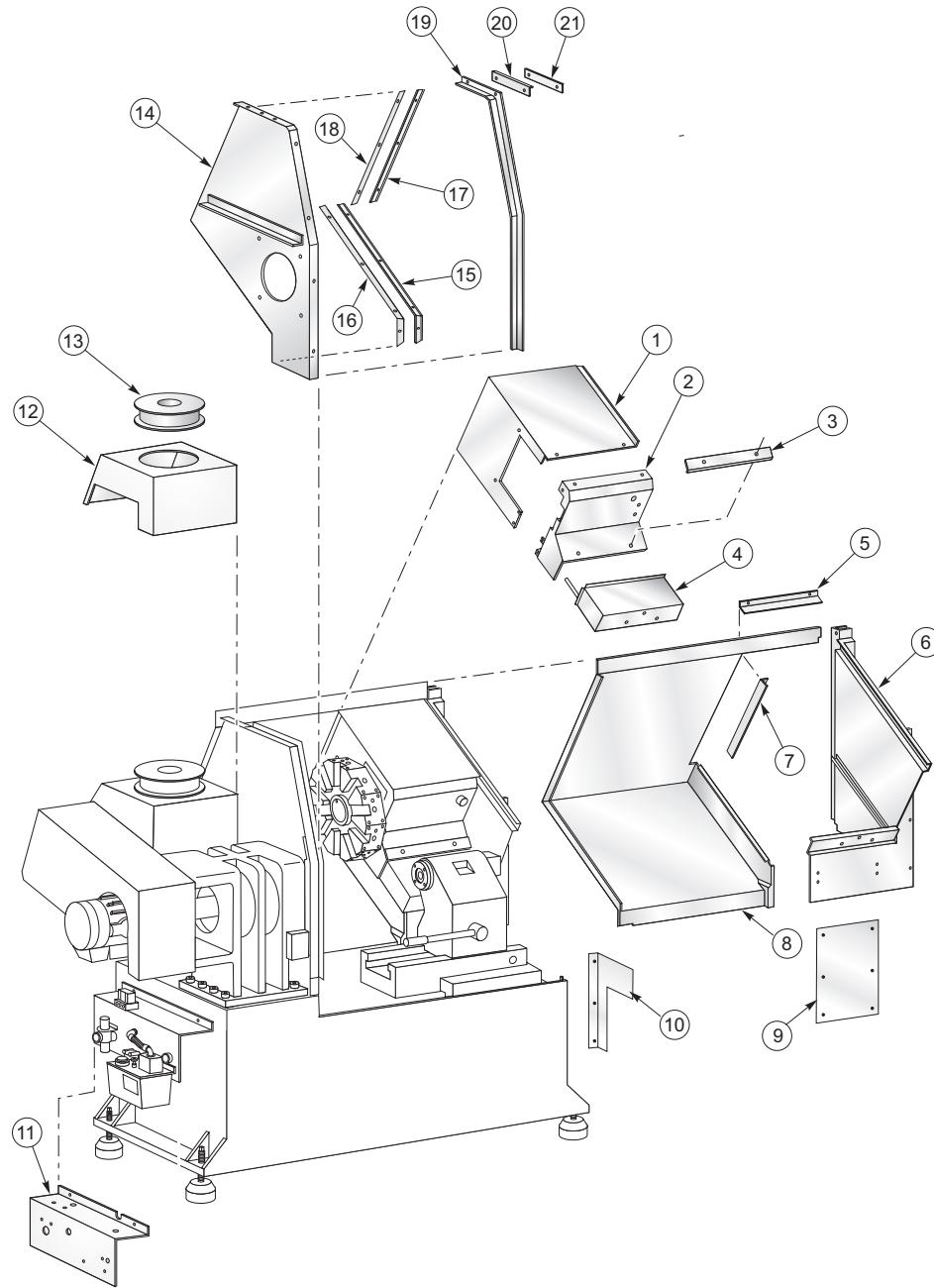
## SL-10 EXTERNAL SHEETMETAL AND PARTS LIST



- |              |                                    |               |                               |
|--------------|------------------------------------|---------------|-------------------------------|
| 1. 25-0875D  | Monitor Cover                      | 18. 25-0860D  | Door Inner Liner              |
| 2. 25-0876B  | Pendant Back Cover                 | 19. 25-0862C  | Front Skirt                   |
| 3. 25-0879A  | Z-Axis Right Bottom Wiper Retainer | 20. 25-0865D  | Lower Door Rail               |
| 4. 26-0030   | Z-Axis Right Bottom Wiper Felt     | 21. 22-6506   | Door V-Track                  |
| 5. 59-0252B  | R-Type Hinge Half                  | 22. 20-6016A  | Door V-Track Spacer           |
| 6. 25-4074B  | Right Panel                        | 23. 25-6190A  | Bottom Left Side Panel        |
| 7. 25-1002A  | Tailstock Pan                      | 24. 25-0398A  | Tramp Lube Oil Bottle Panel   |
| 8. 25-0890A  | NOTS Tray                          | 25. 25-6185A  | Coolant Collector             |
| 9. 25-1023A  | Motor Pump Coolant Tray            | 26. 25-0606   | Coolant Collector Door        |
| 10. 25-0548  | Discharge Chute                    | 27. 25-6150A  | Coolant Collector Enclosure   |
| 11. 25-0887D | Auger Pan Weldment                 | 28. 25-6189A  | Top Left End Panel            |
| 12. 25-8515  | Auger Mount                        | 29. 25-0869A  | Upper Door Rail               |
| 13. 25-0888A | Chip Tray Extension                | 30. 25-11310A | Main Electrical Control Box   |
| 14. 25-0878C | Chip Tray Right                    | 31. 25-5517A  | Cable Exit Cover              |
| 15. 25-0877C | Chip Tray Left                     | 32. 32-0042A  | Regen Assembly                |
| 16. 25-6574A | Chip Tray Bottom                   | 33. 25-0857E  | Control Box Bracket           |
| 17. 25-0858E | Door (25-0016 Window)              | 34. 25-0867C  | Rear Panel                    |
|              |                                    | 35. 25-0863C  | Hydraulic Pump Mount Weldment |



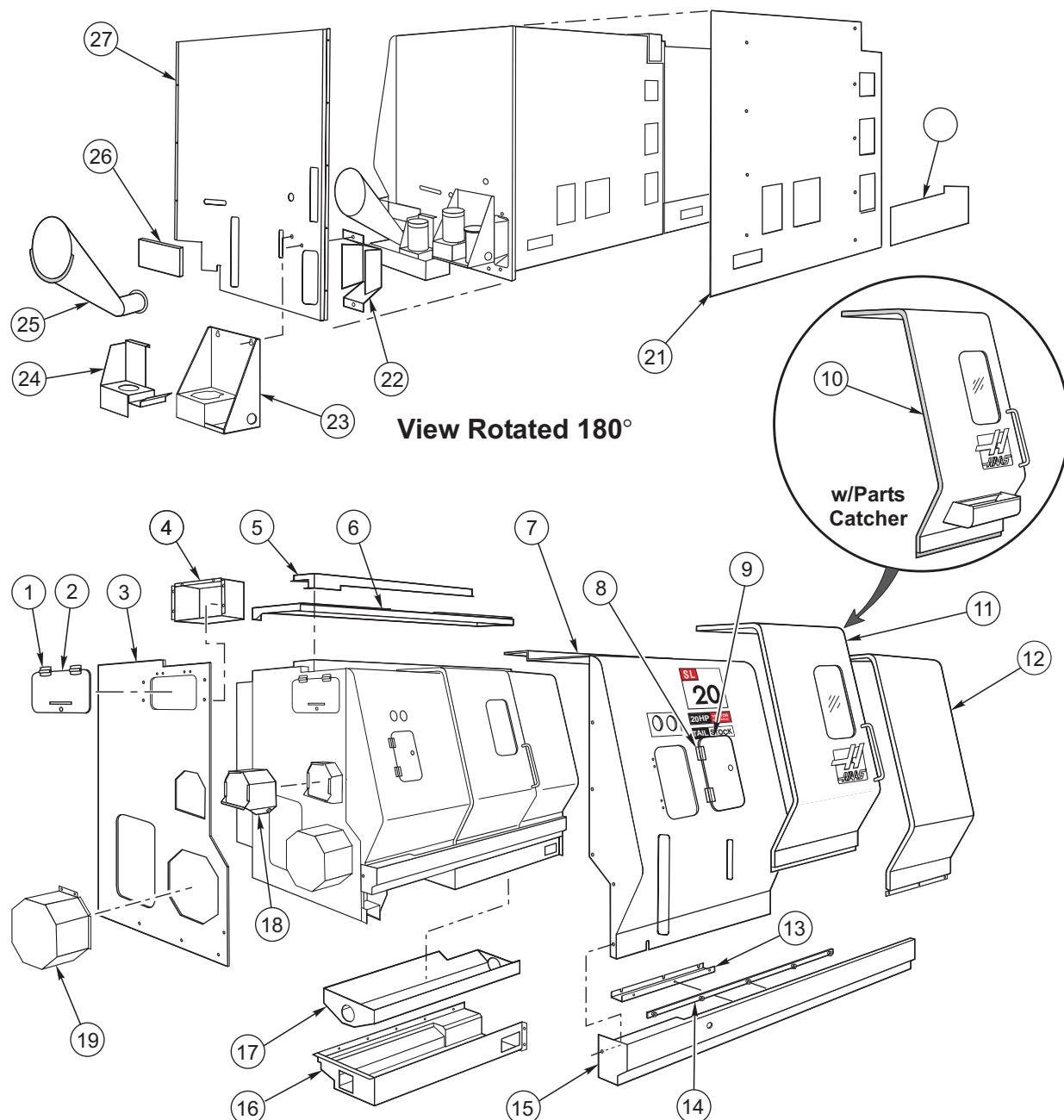
## SL-10 INTERNAL SHEETMETAL AND PARTS LIST



1. 25-0870B X-Axis Top Cover
2. 25-0871B X-Axis Front Cover
3. 25-0884 X-Axis Wiper Retainer
4. 25-0872B X-Axis Way Cover
5. 26-0034 X-Axis Top Wiper Felt
6. 25-0866C Moving Bulkhead
7. 26-0035 X-Axis Side Wiper Felt
8. 25-0873D Z-Axis Sliding Cover
9. 26-0036 Cover, Z-axis Right
10. 25-6138A Chip Shield Wedge SL-10
11. 25-7195M Lube Rack Bracket
12. 25-0886B Fan Mount
13. 36-3035C Spindle Motor Fan
14. 25-0861E Fixed Bulkhead
15. 25-0880A Z-Axis Left Bottom Wiper Retainer
16. 26-0032 Z-Axis Left Bottom Wiper Felt
17. 25-0881A Z-Axis Left Top Wiper Retainer
18. 26-0033 Z-Axis Left Top Wiper Felt
19. 25-0859B Door Drain
20. 26-0039 Door Wiper
21. 25-0947 Top Wiper Retainer



## SL-20/20L EXTERNAL SHEETMETAL AND PARTS LIST



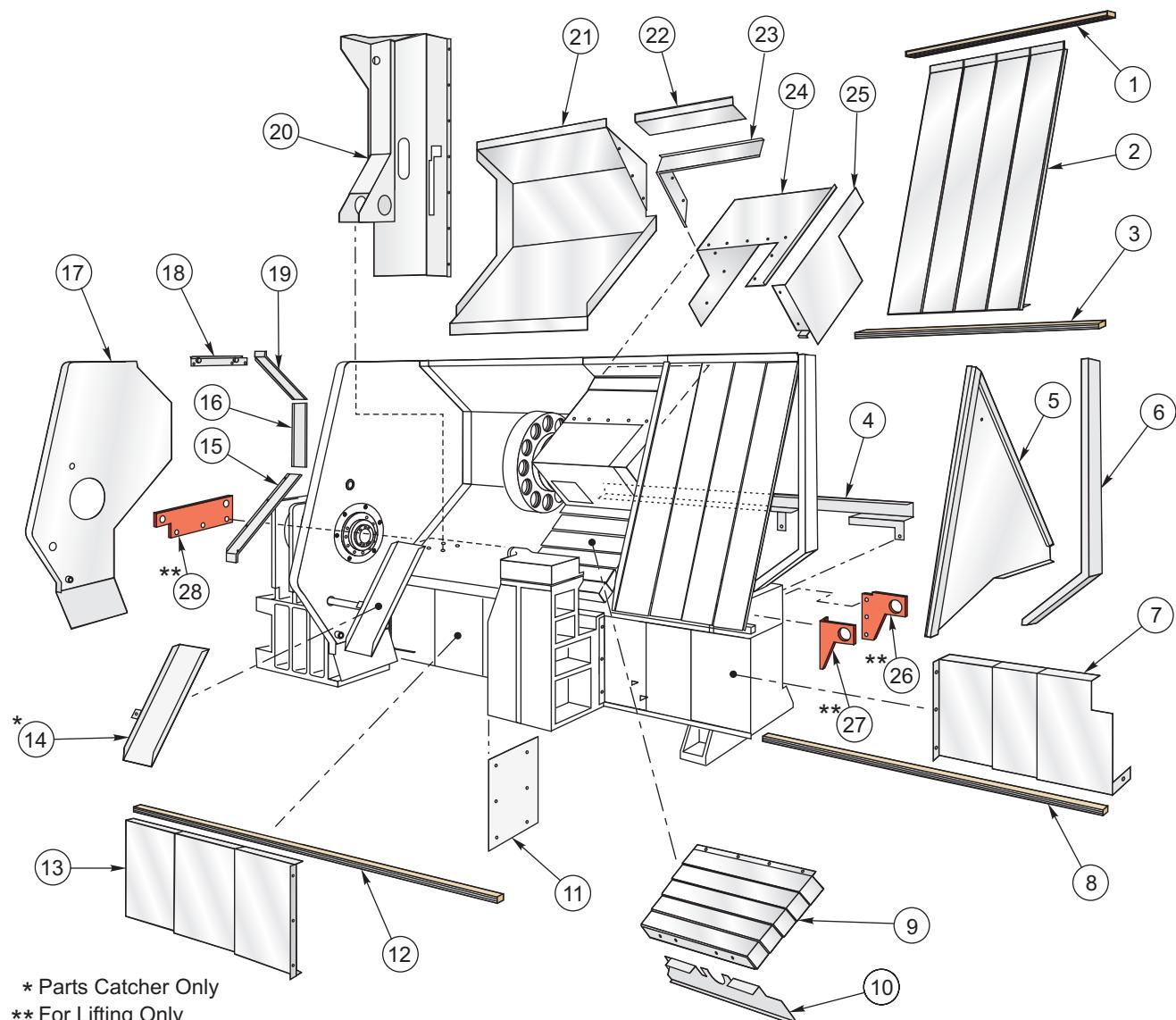


## SL-20/20L EXTERNAL SHEETMETAL AND PARTS LIST

1. 59-0023 Door Hinges
2. 25-1350A Toolbox Door
3. 25-8909H Left Side Panel
4. 25-1349 Toolbox
5. 25-8935D Top Door Roller Mount (SL-20)  
25-8036B Top Door Roller Mount (SL-20L)
6. 25-8916D Top Panel (SL-20)  
25-8096 Top Panel (SL-20L)  
25-8104 Roof Extension (SL-20L)  
25-8037A Left Roof Panel (SL-20L)
7. 25-8924G Left Front Panel (SL-20)  
25-8029 Left Front Panel (SL-20L)
8. 59-0023 Door Hinges
9. 25-8021 Access Door
10. 30-1489 Door Assembly w/Parts Catcher
11. 30-1486A Door Assembly  
30-9121 Right Door Assembly (SL-20L)
12. 25-8919C Right Front Panel (SL-20)  
25-8095A Right Front Panel (SL-20L)
13. 25-8784C Door Drip Panel (SL-20)  
25-8098 Door Drip Panel (SL-20L)
14. 22-6506 Door V-Track
15. 25-5370A Front Rail (SL-20)  
25-8035 Front Rail (SL-20L)
16. 25-6550C Chip Auger Tray (SL-20)  
25-7985 Chip Auger Tray (SL-20L)
17. 25-8971E Chip Auger Pan (SL-20)  
25-8108 Chip Auger Pan (SL-20L)
18. 25-8468 Coolant Collector  
25-0606 Door
19. 25-6115A Motor Enclosure
20. 25-0428A Left Bottom Rear Cover
21. 25-1459C Rear Cover (SL-20)  
25-8097A Rear Cover (SL-20L)  
25-8105 Right Rear Panel (SL-20L)
22. 25-0398A Tramp Lube Oil Pan
23. 25-0243B HP Pump Bracket
24. 25-8067B Coolant Pump Mount
25. 25-0548 Discharge Chute
26. 25-6628 Discharge Chute Filler (SL-20)  
25-8109 Discharge Chute Filler (SL-20L)
27. 25-5374C Right End Panel (SL-20)  
25-8026B Right End Panel (SL-20L)



## SL-20/20L INTERNAL SHEETMETAL AND PARTS LIST



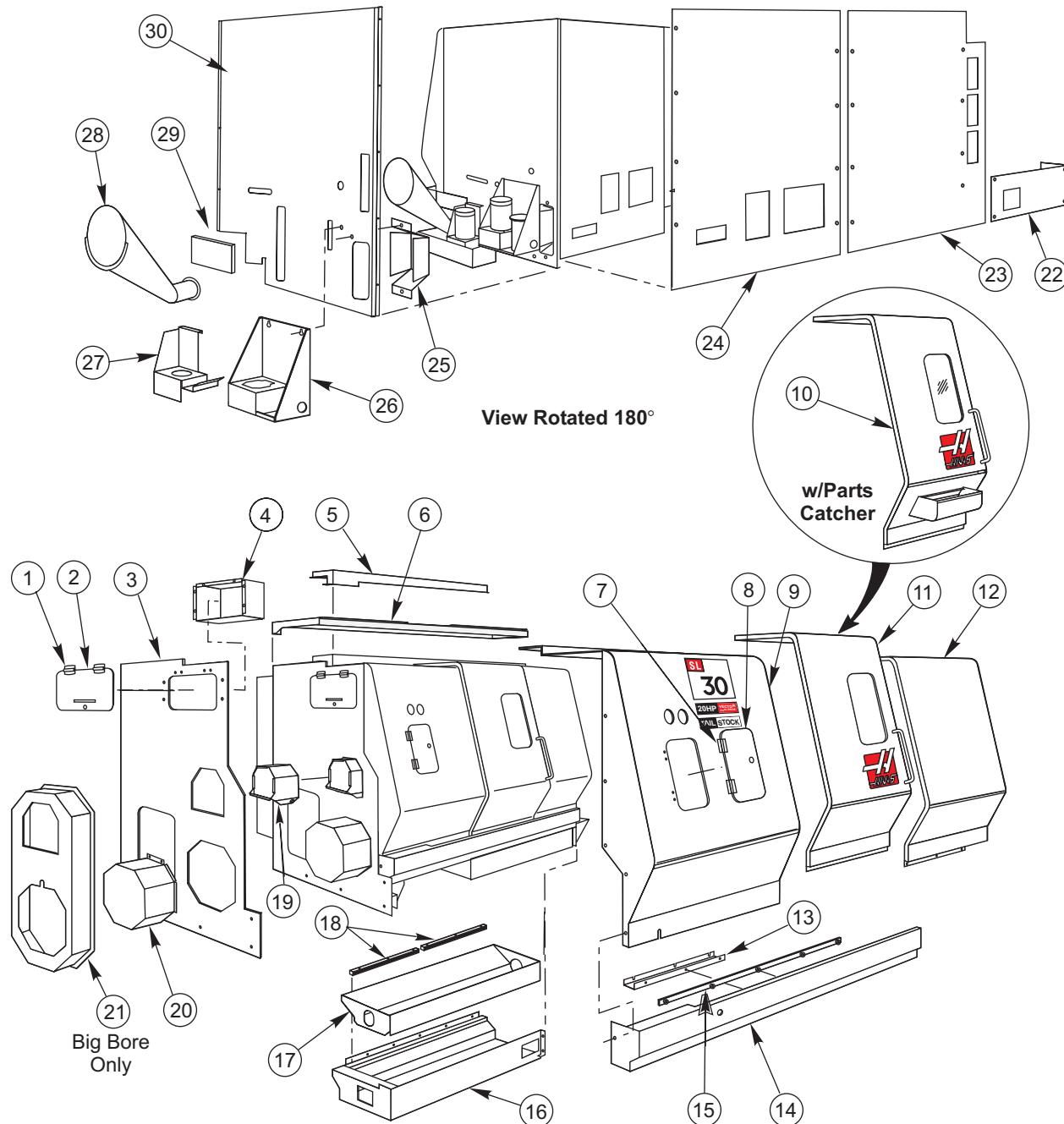


## SL-20/20L INTERNAL SHEETMETAL AND PARTS LIST

1. 22-8053      Upper Waycover Guide (SL-20)  
25-7994      Upper Waycover Guide (SL-20L)
2. 25-8051      Z-Axis Waycovers (SL-20)  
25-7990      Z-Axis Waycovers (SL-20L)
3. 20-1466      Lower Waycover Guide (SL-20)  
25-7984      Lower Waycover Guide (SL-20L)
4. 25-4423A      Cable Rail
5. 25-8933E      Moving Bulkhead (SL-20)  
25-7989      Moving Bulkhead (SL-20L)
6. 25-8908A      Right Support
7. 25-4329      Tailstock Right Waycovers (SL-20)  
25-8410      Tailstock Right Base Cover (SL-20L)
8. 20-1467      Lower Tailstock Waycover Guide (SL-20 only)
9. 25-8665A      Tool Changer Waycover
10. 25-8926D      Front Wedge Cover (SL-20)  
25-7987      Front Wedge Cover (SL-20L)
11. 25-0250A      Tailstock Cover
12. 25-4317      Upper Tailstock Waycover Guide (SL-20 only)
13. 25-4316A      Left Tailstock Waycovers (SL-20)  
25-8409B      Tailstock Left Base Cover (SL-20L)
14. 25-8980C      Parts Catcher Tray (Optional)
15. 25-4320A      Z-Axis Bottom Wiper (SL-20)  
30-9275      Z-Axis Bottom Wiper (SL-20L)
16. 25-4321A      Z-Axis Back Wiper (SL-20)  
30-9274      Z-Axis Back Wiper (SL-20L)
17. 25-8938J      Fixed Bulkhead (SL-20)  
25-8451      Fixed Bulkhead (SL-20L)
18. 30-3191B      Upper Door Wiper Assembly
19. 25-4322A      Z-Axis Top Wiper (SL-20)  
30-9273      Z-Axis Top Wiper (SL-20L)
20. 25-8925D      Control Box Mounting Bracket
21. 25-8921E      Rear Sliding Cover (SL-20)  
25-7988      Rear Sliding Cover (SL-20L)
22. 25-8928B      Tool Changer Tunnel Panel
23. 25-4324A      X-Axis Wiper
24. 25-8605C      Tool Changer Sliding Cover
25. 25-8694B      Tool Changer Splash Shield
26. 20-1633      Right Rear Lifting Bracket
27. 20-1632      Right Front Lifting Bracket
28. 20-1631      Left End Lifting Bracket



### SL-30/30L EXTERNAL SHEETMETAL AND PARTS LIST



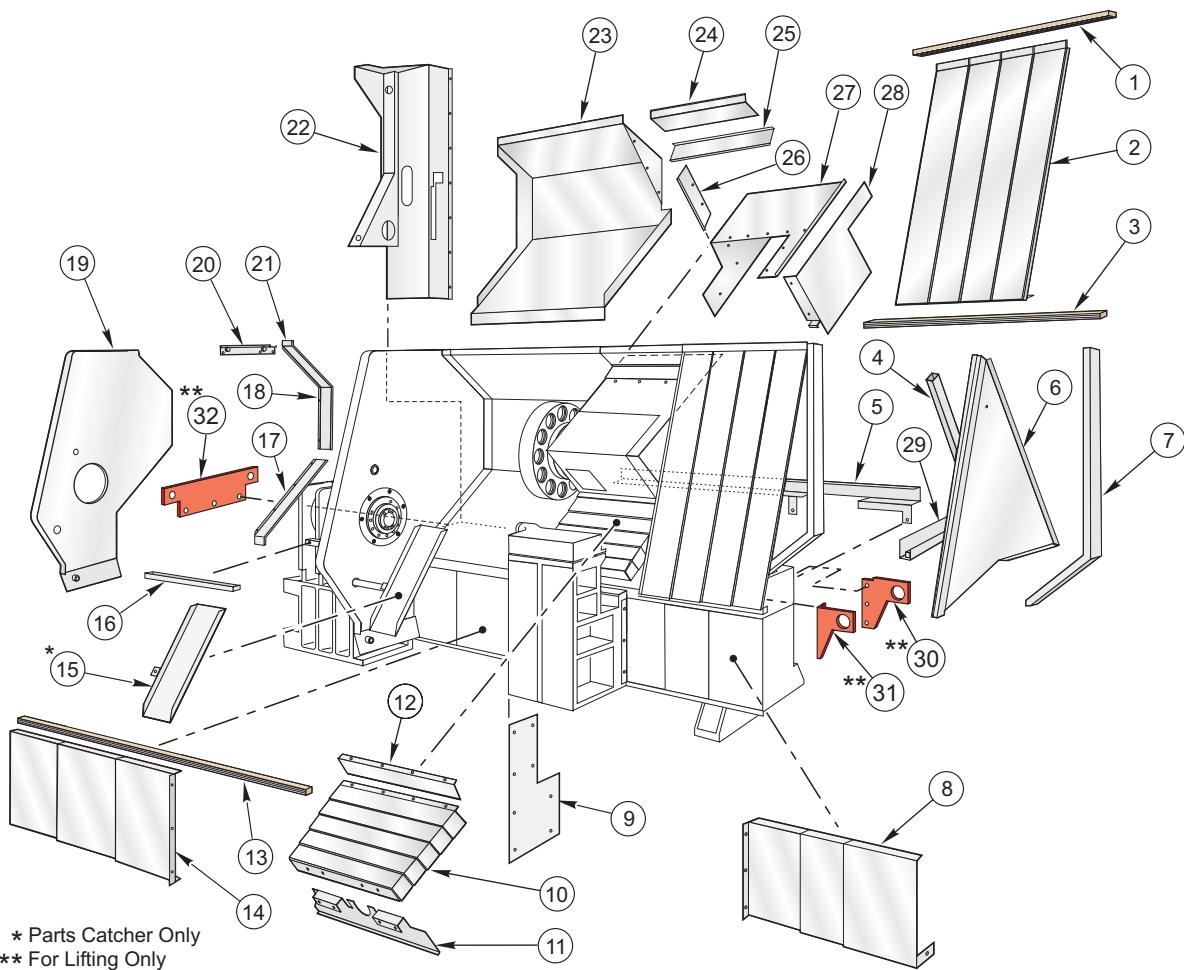


## SL-30/30L EXTERNAL SHEETMETAL AND PARTS LIST

1. 59-0023 Door Hinges (2)
2. 25-1350A Toolbox Door
3. 25-6345D Left Side Panel (SL-30)  
25-8567 Left Side Panel (SL-30L)
4. 25-1349 Toolbox
5. 25-8819D Top Door Roller Mount (SL-30)  
25-8634B Right Roof Beam (SL-30L)  
25-8636A Left Roof Beam (SL-30L)
6. 25-8818F Top Right Panel (SL-30)  
25-8618A Top Right Panel (SL-30L)  
25-8610 Top Left Panel (SL-30L)
7. 59-0023 Door Hinges (2)
8. 25-8021A Access Door (SL-30)  
25-8021 Access Door (SL-30L)
9. 25-6341 Left Front Panel
10. 30-1490A Door w/Parts Catcher Assembly (SL-30)  
30-9945 Door w/Parts Catcher Assembly (SL-30L)
11. 30-1487A Door Assembly (SL-30)  
30-9450 Right Door Assembly (SL-30L)  
30-9449 Left Door Assembly (SL-30L)
12. 25-8786G Right Front Panel (SL-30)  
25-8617 Right Front Panel (SL-30L)
13. 25-8830A Door Drip Tray
14. 25-6333A Front Rail (SL-30)  
25-8624A Front Rail (SL-30L)
15. 22-6023 Door V-Track (SL-30)  
20-2574 Door V-Track (SL-30L)
16. 25-6323A Chip Tray (SL-30)  
25-8613 Chip Tray (SL-30L)
17. 25-8880D Chip Auger Pan (SL-30)  
25-8561 Chip Auger Pan (SL-30L)
18. 20-1521 Lower Tailstock Waycover Guide (SL-30)  
25-8564A Tailstock Left Base Cover (SL-30L)
19. 25-0640B Coolant Collector (25-0639A Door)
20. 25-6115A Motor Enclosure
21. 25-6510D Motor Enclosure (Big Bore)
22. 25-0517C Left Bottom Rear Panel
23. 25-0526C Center Rear Panel (SL-30)  
25-8632 Rear Panel (SL-30L)  
25-8633 Left Rear Panel (SL-30L)
24. 25-0518 Right Rear Panel (SL-30)  
25-8629A Right Rear Panel (SL-30L)
25. 25-0398A Tramp Lube Oil Pan
26. 25-0243C HP Pump Bracket
27. 25-8067B Coolant Pump Mount
28. 25-0548 Auger Discharge Chute
29. 25-6650 Chip Tray Filler
30. 25-6336C Right Side Panel (SL-30)  
25-8623B Right Side Panel (SL-30L)



## SL-30/30L INTERNAL SHEETMETAL AND PARTS LIST



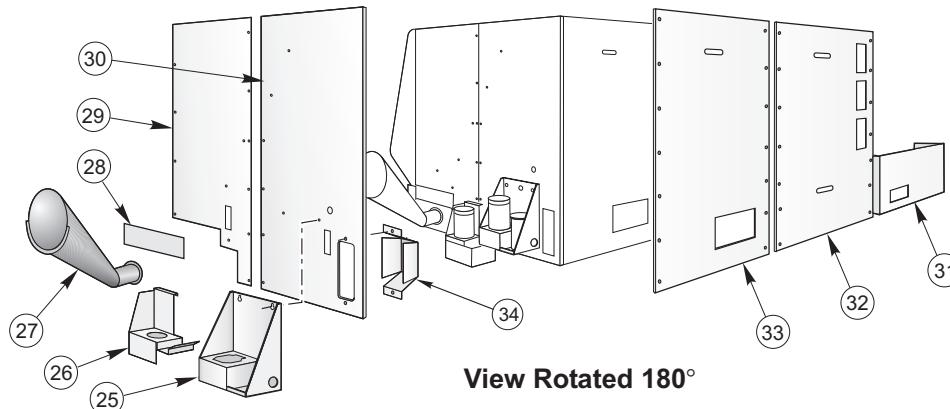


## SL-30/30L INTERNAL SHEETMETAL AND PARTS LIST

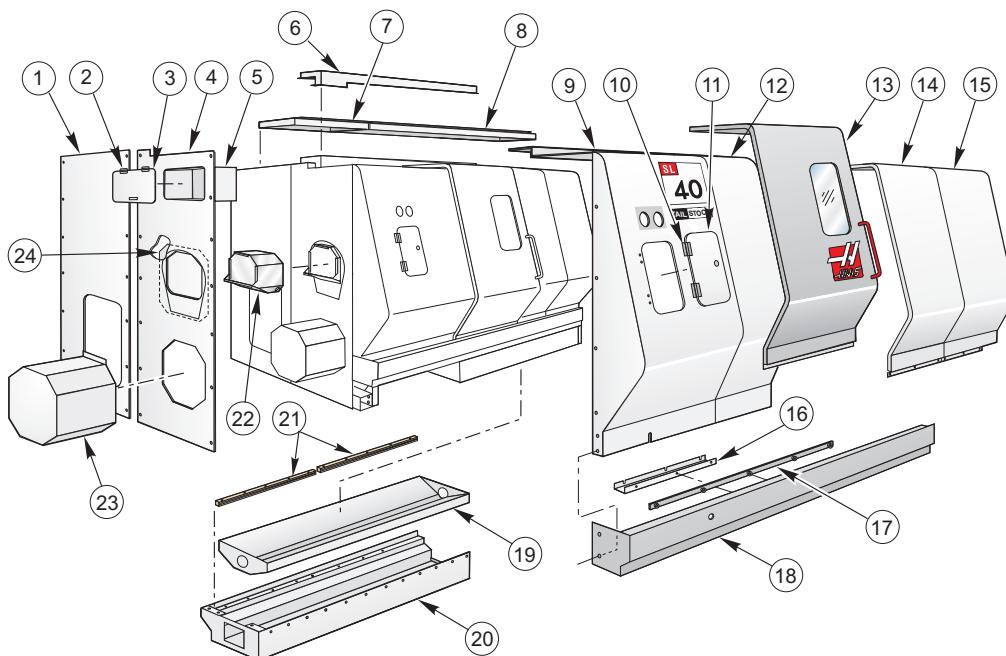
1. 22-8049 Z-Axis Top Waycover Guide
2. 25-8047 Z-Axis Waycover (SL-30)
- 25-8575 Z-Axis Waycover (SL-30L)
3. 22-8048 Z-Axis Bottom Waycover Guide (SL-30)
- 25-8683 Z-Axis Bottom Waycover Guide (SL-30L)
4. 22-8783 Moving Bulkhead Support
5. 25-0830A Cable Channel Cover
6. 25-8843B Moving Bulkhead (SL-30)
- 25-8614A Moving Bulkhead (SL-30L)
7. 25-6319 Right End Support Bracket (SL-30)
- 25-8628 Right End Support Bracket (SL-30L)
8. 25-8025B Right Tailstock Waycover (SL-30)
- 25-8646 Tailstock Right Base Cover (SL-30L)
9. 25-0251A Tailstock Cover
10. 25-8757 Tool Changer Waycover
11. 25-8755D Front Wedge Cover
12. 25-6458A Tool Changer Waycover Mount
13. 25-8829B Upper Tailstock Waycover Guide (SL-30 only)
14. 25-8756C Left Tailstock Waycover (SL-30)
- 25-8564A Tailstock Left Base Cover (SL-30L)
15. 25-6512B Parts Catcher Tray (Optional)
16. 25-8849A Z-Axis Drip Tray (SL-30 only)
17. 30-3647 Z-Axis Lower Wiper Assembly (SL-30)
- 30-9472 Z-Axis Lower Wiper Assembly (SL-30L)
18. 30-3646 Z-Axis Middle Wiper Assembly (SL-30)
- 30-9471 Z-Axis Middle Wiper Assembly (SL-30L)
19. 25-6346B Fixed Bulkhead (SL-30)
- 25-8563 Fixed Bulkhead (SL-30L)
20. 30-3192B Door Wiper Assembly (SL-30)
- 30-9469 Door Wiper Assembly (SL-30L)
21. 30-3645 Z-Axis Upper Wiper Assembly (SL-30)
- 30-9470 Z-Axis Upper Wiper Assembly (SL-30L)
22. 25-8681A Left Roof Support
23. 25-8754D Rear Sliding Cover (SL-30)
- 25-8638 Rear Sliding Cover (SL-30L)
24. 25-8782C Tool Changer Tunnel Panel (SL-30)
- 25-8620C Tool Changer Tunnel Panel (SL-30L)
25. 30-3648 X-Axis Top Wiper Assembly
26. 30-3649 X-Axis Side Wiper Assembly
27. 25-8823D X-Axis Tool Changer Sliding Cover
28. 25-8772B 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



### SL-40 EXTERNAL SHEETMETAL AND PARTS LIST



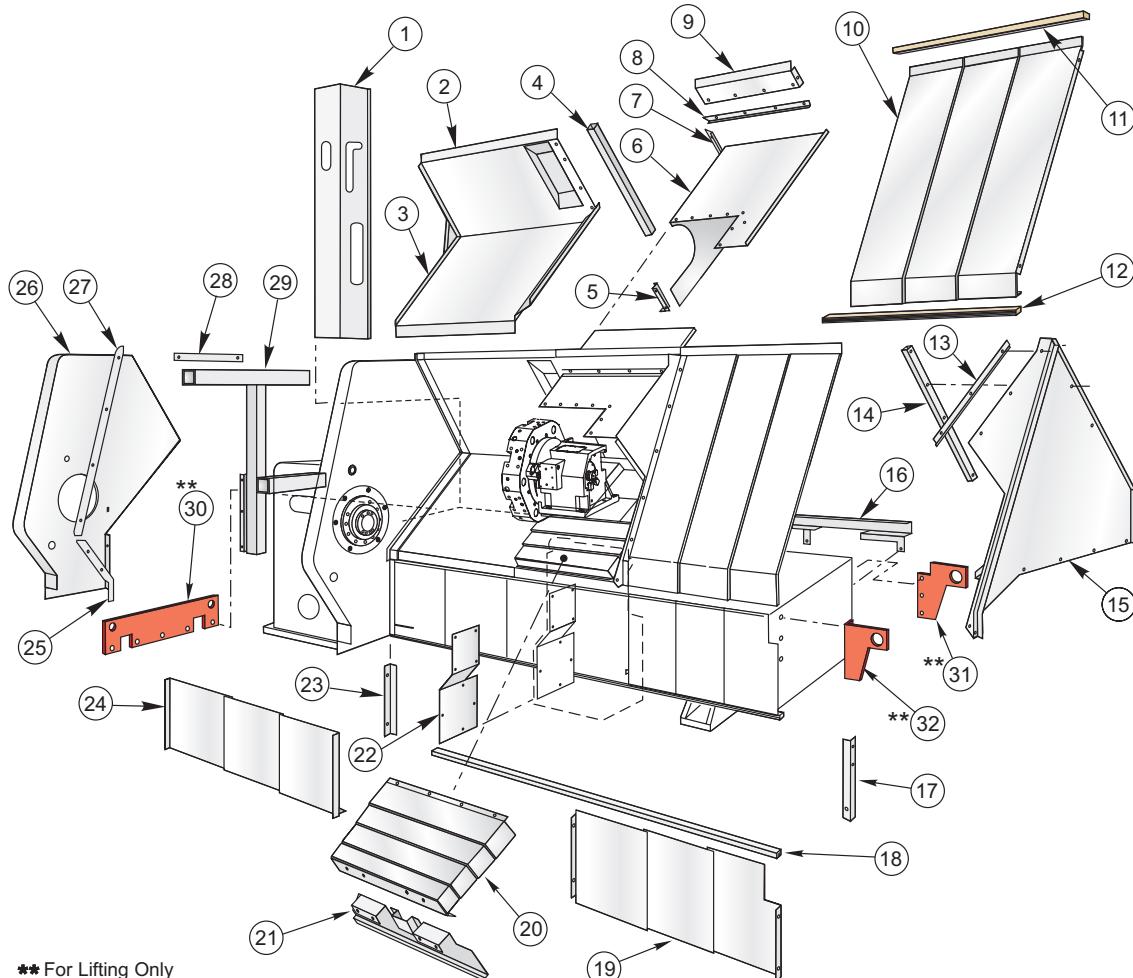
View Rotated 180°



- |              |                          |              |                                    |
|--------------|--------------------------|--------------|------------------------------------|
| 1. 25-0780D  | Left End Rear Panel      | 18. 25-8235C | Front Rail                         |
| 2. 59-0023   | Toolbox Door Hinge       | 19. 25-8269C | Chip Auger Pan                     |
| 3. 25-1350A  | Toolbox Door             | 20. 25-6601A | Chip Tray                          |
| 4. 25-8211F  | Left End Front Panel     | 21. 22-8301  | Lower Tailstock Waycover Guide (2) |
| 5. 25-4729A  | Toolbox                  | 22. 25-0640B | Coolant Collector                  |
| 6. 25-8285D  | Door Rail Mount          | 23. 25-4740  | Motor Enclosure                    |
| 7. 25-8218B  | Left Top Panel           | 24. 25-0641B | Left End Front Panel Filler        |
| 8. 25-8219C  | Right Top Panel          | 25. 25-0243C | HP Pump Bracket                    |
| 9. 25-8206A  | Front Left Panel         | 26. 25-8067B | Coolant Pump Mount                 |
| 10. 59-0023  | Access Door Hinge        | 27. 25-0548  | Auger Discharge Chute              |
| 11. 25-8021  | Access Door              | 28. 25-0164  | Discharge Chute Filler             |
| 12. 25-8207A | Front Left Middle Panel  | 29. 25-8213C | Right End Front Panel              |
| 13. 30-1488  | Door Assembly            | 30. 25-8214F | Right End Rear Panel               |
| 14. 25-8208D | Front Right Middle Panel | 31. 25-0783A | Rear Lower Left Cover              |
| 15. 25-8209A | Front Right Panel        | 32. 25-0784A | Rear Middle Panel                  |
| 16. 25-6311  | X-Axis Drip Tray         | 33. 25-0781  | Rear Right Panel                   |
| 17. 22-6023  | Door V-Track             | 34. 25-0398A | Tramp Lube Oil Pan Bracket         |



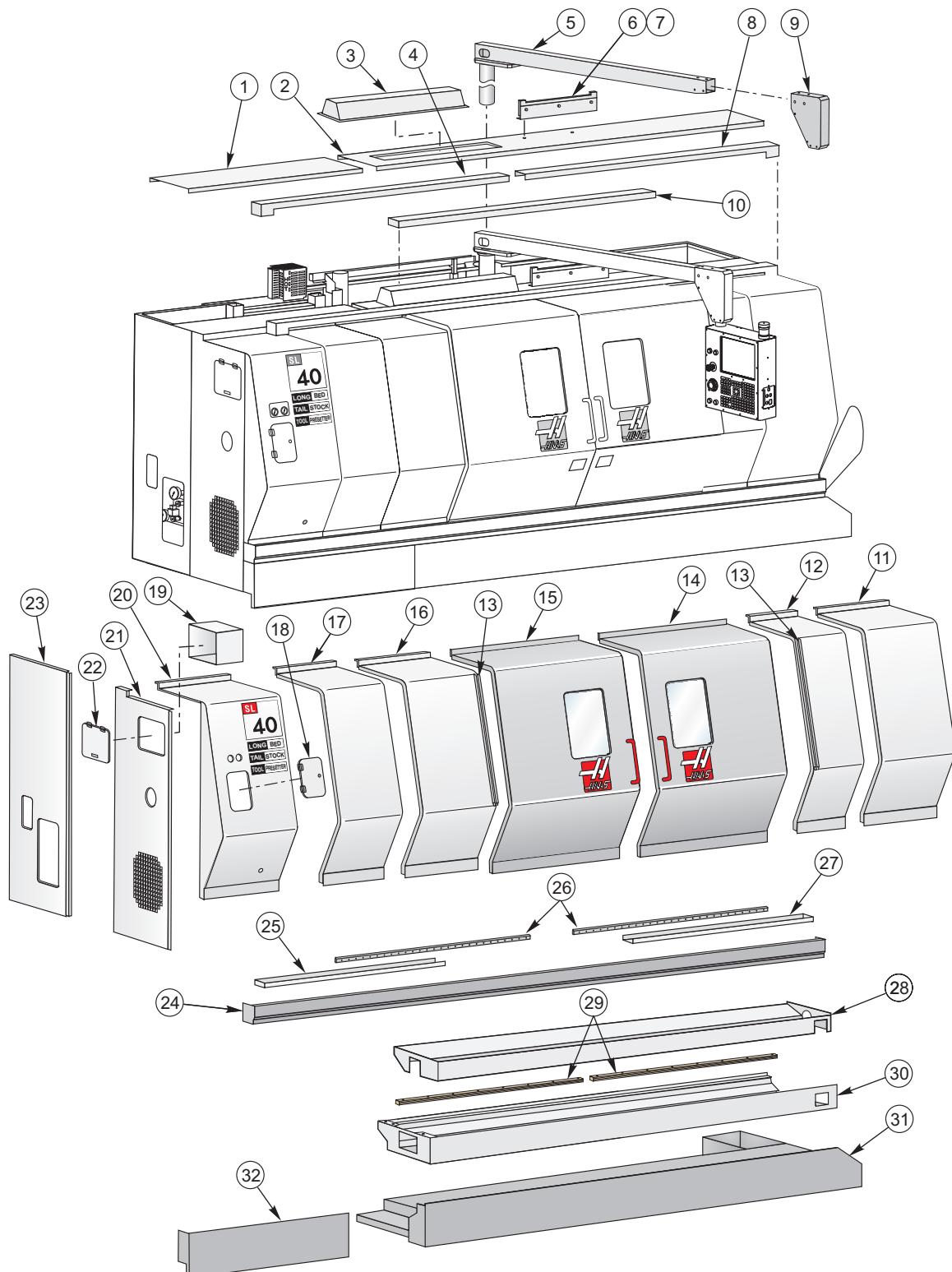
## SL-40 INTERNAL SHEETMETAL AND PARTS LIST



- |  |  |
|--|--|
| 1. 22-8233A Control Box Mounting Bracket     | 18. 25-8297 Tailstock Waycover Guide           |
| 2. 25-0145C Z-Axis Top Rear Sliding Cover    | 19. 25-8249 Z-Axis Bottom Right Waycover       |
| 3. 25-8246C Z-Axis Bottom Rear Sliding Cover | 20. 25-8250 X-Axis Waycover                    |
| 4. 25-8653A Z-Axis Waycover Support Bracket  | 21. 25-8245B Front Wedge Cover                 |
| 5. 25-5443 Tool Changer Cover Spacer         | 22. 25-0252 Tailstock Cover                    |
| 6. 25-5442A Tool Changer Cover               | 23. 25-8298 Spindle Housing Vertical Rail Drip |
| 7. 25-8253A X-Axis Vertical Wiper            | 24. 25-8248 Z-Axis Bottom Left Waycover        |
| 8. 25-8254A X-Axis Horizontal Wiper          | 25. 25-8267B Lower Door Chip Seal              |
| 9. 25-8265A X-Axis Tunnel Panel              | 26. 25-8243J Fixed Bulkhead                    |
| 10. 25-8247 Z-Axis Top Right Waycover        | 27. 25-6312A Vertical Door Seal                |
| 11. 25-8295 Z-Axis Top Waycover Guide        | 28. 30-3193 Door Wiper Assembly                |
| 12. 25-8296 Z-Axis Bottom Waycover Guide     | 29. 22-8237A Spindle Housing Support           |
| 13. 25-8264A Z-Axis Strip                    | 30. 20-1634 Left End Lifting Bracket           |
| 14. 22-8275 Moving Bulkhead Support          | 31. 20-1636 Right Rear Lifting Bracket         |
| 15. 25-8244A Moving Bulkhead                 | 32. 20-1635 Right Front Lifting Bracket        |
| 16. 25-0830A Cable Channel Cover             |  |
| 17. 25-8241A Right Enclosure Support         |  |

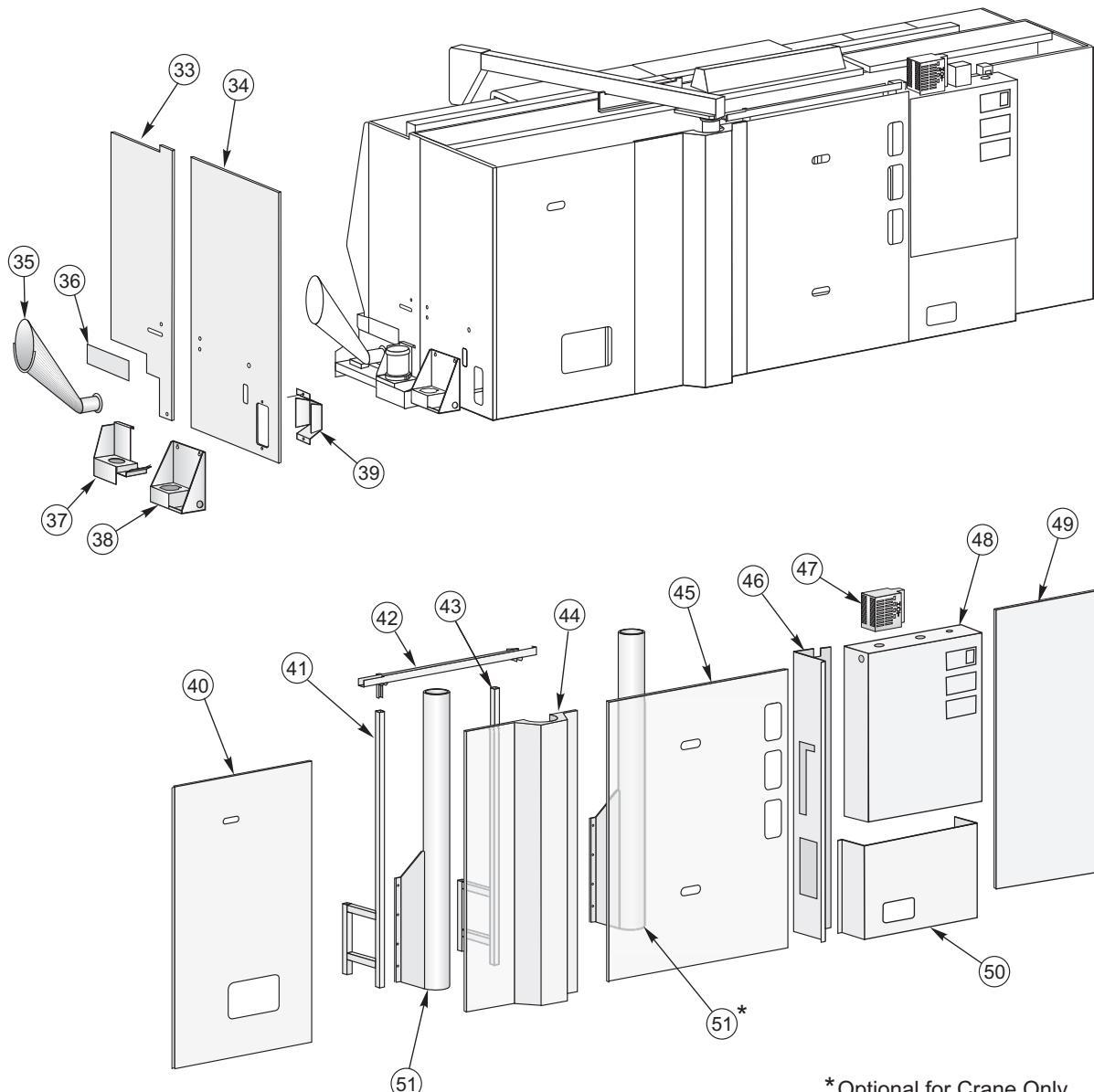


## SL-40L EXTERNAL SHEETMETAL (SHEET 1 OF 2)





**SL-40L EXTERNAL SHEETMETAL (SHEET 2 OF 2)**



\*Optional for Crane Only.

**BACK VIEW**

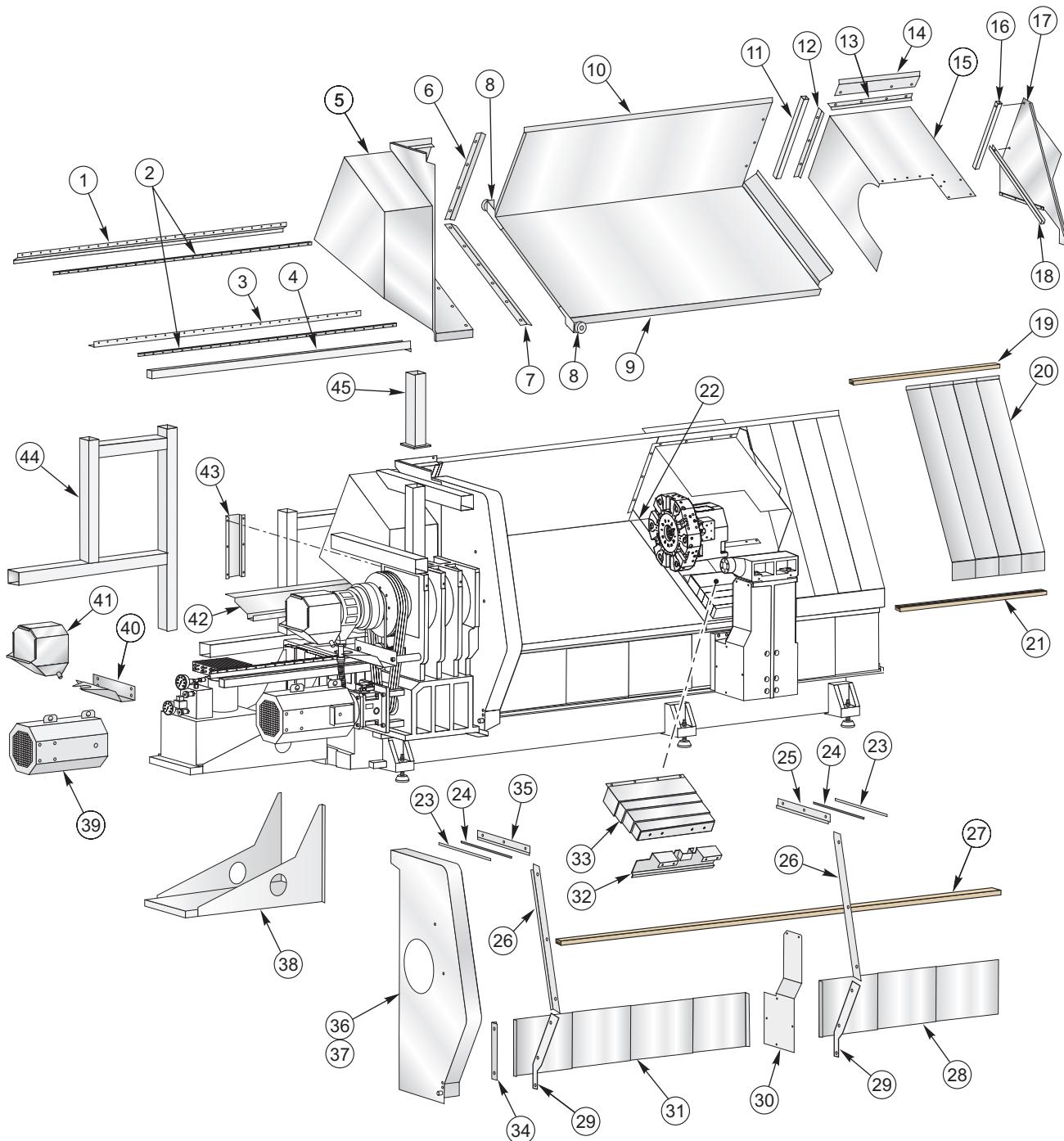


## SL-40L EXTERNAL SHEETMETAL PARTS LIST

- |              |                                     |               |                                      |
|--------------|-------------------------------------|---------------|--------------------------------------|
| 1. 25-4541A  | Left Top Front Panel                | 47. 32-0042A  | Regen Assembly                       |
| 2. 25-4542B  | Right Top Front Panel               | 48. 25-11310A | Main Electrical Control Box Assembly |
| 3. 25-4723   | Light Fixture Body                  | 49. 25-4553   | Left Back Panel                      |
| 4. 25-4563A  | Left Top Door Mount                 | 50. 25-0783A  | Left Back Lower Panel                |
| 5. 20-1775   | Pendant Boom Arm                    | 51. 20-1254   | Boom Support (2)                     |
| 6. 20-1773   | Boom Arm Detent                     |               |                                      |
| 7. 25-4578   | Boom Arm Detent Support             |               |                                      |
| 8. 25-4562   | Right Top Door Mount                |               |                                      |
| 9. 25-4633A  | 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. 25-4560C | 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<br>59-0023 Hinges (2)   |               |                                      |
| 19. 25-1349  | Toolbox                             |               |                                      |
| 20. 25-8206A | Front Left Panel                    |               |                                      |
| 21. 25-4544A | Left End Front Panel                |               |                                      |
| 22. 25-1350A | Toolbox Door<br>59-0023 Hinges (2)  |               |                                      |
| 23. 25-4546A | Left End Rear Panel                 |               |                                      |
| 24. 25-4533A | 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. 25-4571B | Chip Auger Pan                      |               |                                      |
| 29. 25-4603  | Lower Tailstock Waycover Guides (2) |               |                                      |
| 30. 25-4570A | Chip Tray                           |               |                                      |
| 31. 25-0794C | Coolant Tank                        |               |                                      |
| 32. 25-4555  | Lower Left Front Apron              |               |                                      |
| 33. 25-4540A | Right Front Panel                   |               |                                      |
| 34. 25-0781  | Right Rear Panel                    |               |                                      |
| 35. 25-0548  | Auger Discharge Chute               |               |                                      |
| 36. 25-0164  | Discharge Chute Filler              |               |                                      |
| 37. 25-8067B | Coolant Pump Mount                  |               |                                      |
| 38. 25-0243C | HP Pump Mounting Bracket            |               |                                      |
| 39. 25-0398A | Tramp Lube Oil Pan Bracket          |               |                                      |
| 40. 25-0781  | Right Rear Panel                    |               |                                      |
| 41. 20-1768  | Right Back Panel Support            |               |                                      |
| 42. 25-4577  | Monitor Cable Tray                  |               |                                      |
| 43. 20-1768  | Left Back Panel Support             |               |                                      |
| 44. 25-4554  | Center Back Panel                   |               |                                      |
| 45. 25-0784A | Back Left Center Panel              |               |                                      |
| 46. 25-4532  | Control Box Support                 |               |                                      |



## SL-40L INTERNAL SHEETMETAL



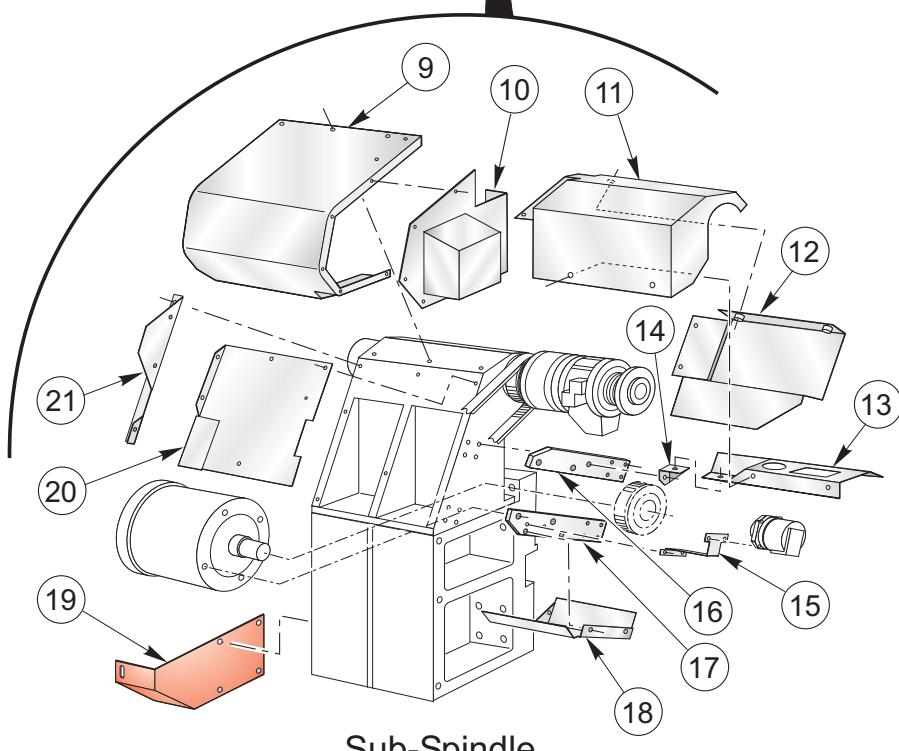
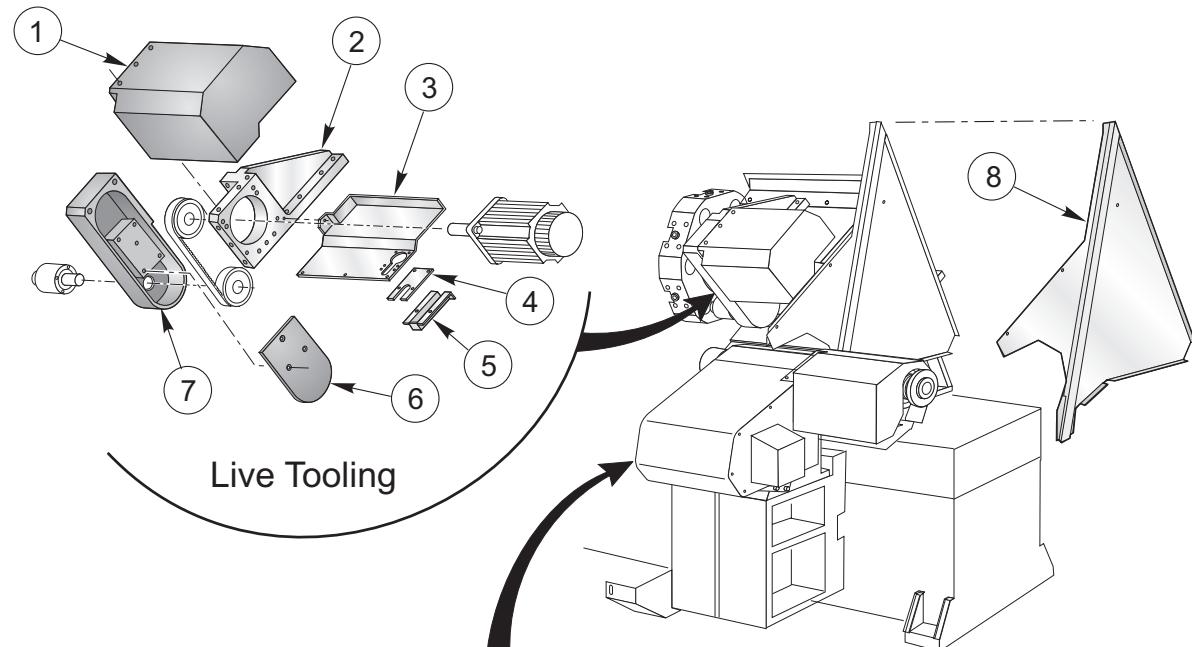


## SL-40L INTERNAL SHEETMETAL PARTS LIST

1. 25-4572 Rear V-Track Mount
2. 20-1772 Z-Axis V-Track (2)
3. 25-4573A Front V-Track Mount
4. 25-4556 Z-Axis Drip Channel
5. 25-4934A Tool Pocket Bottom  
25-4935A Tool Pocket Top
6. 25-4588A Z-Axis Top Wiper  
25-4590 Felt Clamp
7. 25-4589A Z-Axis Bottom Wiper  
25-4591 Felt Clamp
8. 25-4574 V-Track Rollers (2)
9. 25-4596A Z-Axis Bottom Left Waycover
10. 25-4595A Z-Axis Top Left Waycover
11. 22-8293A Z-Axis Waycover Support Bracket
12. 25-8253A X-Axis Vertical Wiper
13. 25-8254A X-Axis Horizontal Wiper
14. 25-4587A X-Axis Tunnel Panel
15. 25-5442A Tool Changer Cover
16. 22-8275 Bulkhead Support
17. 25-4580A Moving Bulkhead
18. 25-8258 Drip Channel
19. 25-4592 Z-Axis Top Front Waycover Guide
20. 25-4597 Z-Axis Right Waycovers
21. 25-4593 Z-Axis Bottom Front Waycover Guide
22. 26-8323 X-Axis Seal (Plastic)
23. 25-4566 Upper Door Wiper Back Plate (2)
24. 26-0086 Upper Door Wiper Felt (2)
25. 25-4568A Right Door Splash Shield
26. 25-6312A Vertical Door Seal (2)  
26-0087 Felt
27. 25-4585 Top Tailstock Waycover Guide
28. 25-4599 Tailstock Right Waycover
29. 25-8267B Lower Door Chip Seal
30. 25-0252 Tailstock Cover
31. 25-4737 Tailstock Left Waycover
32. 25-4586A Front Wedge Cover
33. 26-8250 X-Axis Waycover
34. 25-8298 Spindle Housing Vertical Rail Drip
35. 25-4567A Left Door Splash Shield
36. 25-4579C Fixed Bulkhead
37. 25-6922 Fixed Bulkhead Support
38. 25-4531B Left End HPU Support
39. 25-4739E Fan Shroud
40. 25-4071A Shield
41. 25-0640B Coolant Collector
42. 25-4569 Bottom Cable Wedge Tray
43. 25-4583 Skate Board
44. 20-1776 Control Cabinet Truss
45. 20-1777 Roof Support



## TL-15 LIVE TOOLING AND SUB-SPINDLE SHEETMETAL



1981\_F40  
BHCS



45-0022  
Washer



20-0170A  
Drive Castle



45-0025  
Washer



59-0069  
Spring



51-2042  
Locknut



20-0168B  
Shaft



Bearing  
SL-20/30



Live Tooling  
Nose



20-0277  
Pulley



## TL-15 SHEETMETAL PARTS LIST

### Live Tooling

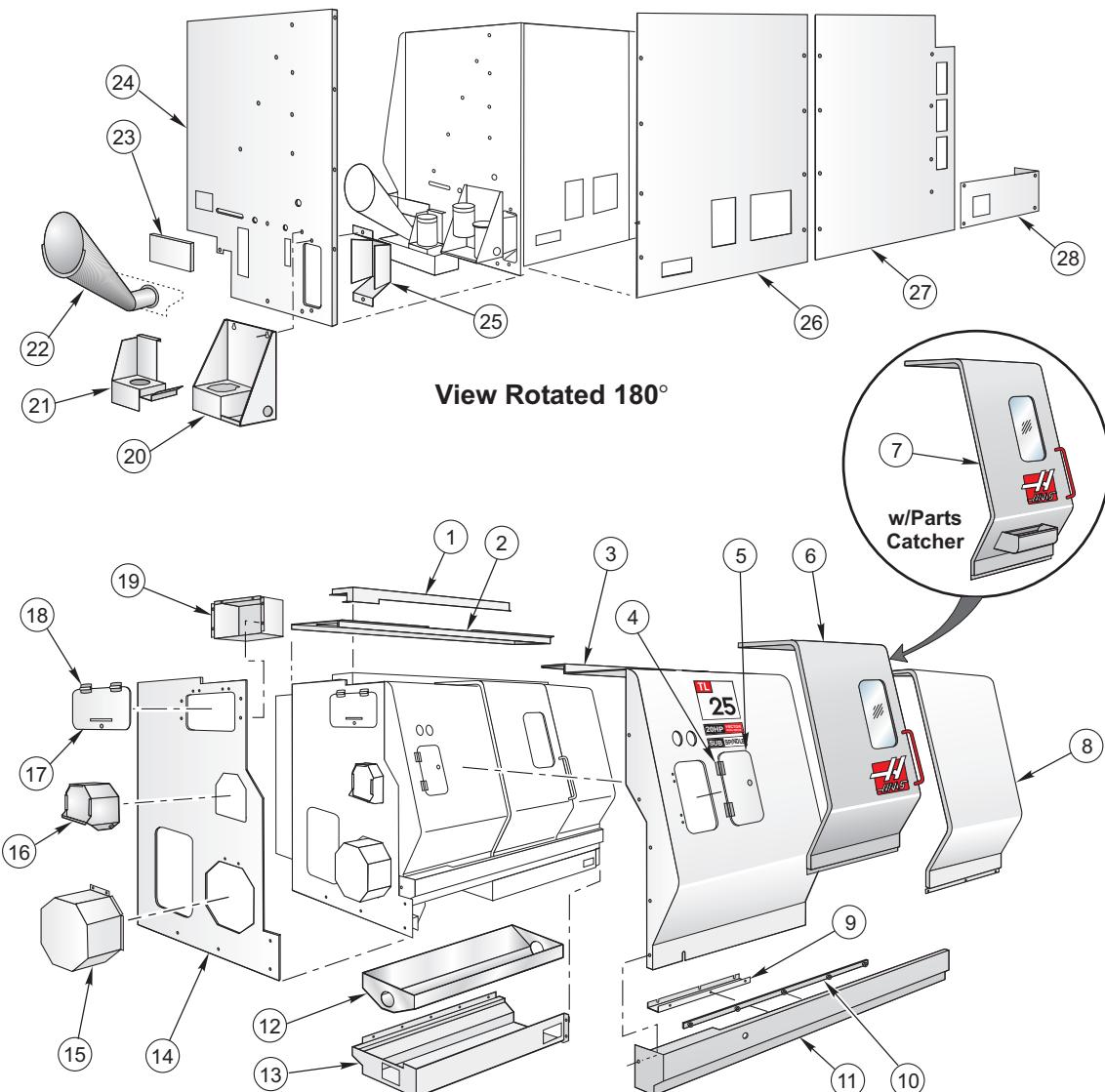
1. 25-0138C Hood
2. 20-0163A Brace
3. 25-0137C Tray
4. 25-0135A Channel Cover
- 4a. 25-6552 Channel Cover (Larger Turret)
5. 25-0136A Channel
- 5a. 25-6553 Channel (Larger Turret)
6. 20-0161 Belt Arm Cover
7. 20-0162A Belt Arm

### Sub-Spindle

8. 25-8843B Moving Bulkhead
9. 25-0610A Motor Cover
10. 25-0611A Encoder Cover
11. 25-9189 Front Union Shroud
12. 25-9188 Rear Union Shroud
13. 25-9195 Subspindle Hose Bracket
14. 25-0621 Little Bracket
15. 25-0615A Encoder Bracket
16. 20-0631A Upper Motor Arm
17. 20-0632A Lower Motor Arm
18. 25-0613B Duct Shield
19. 25-0665A Shipping Bracket
20. 25-0612A Heat Shield
21. 25-0614A Fan Shield



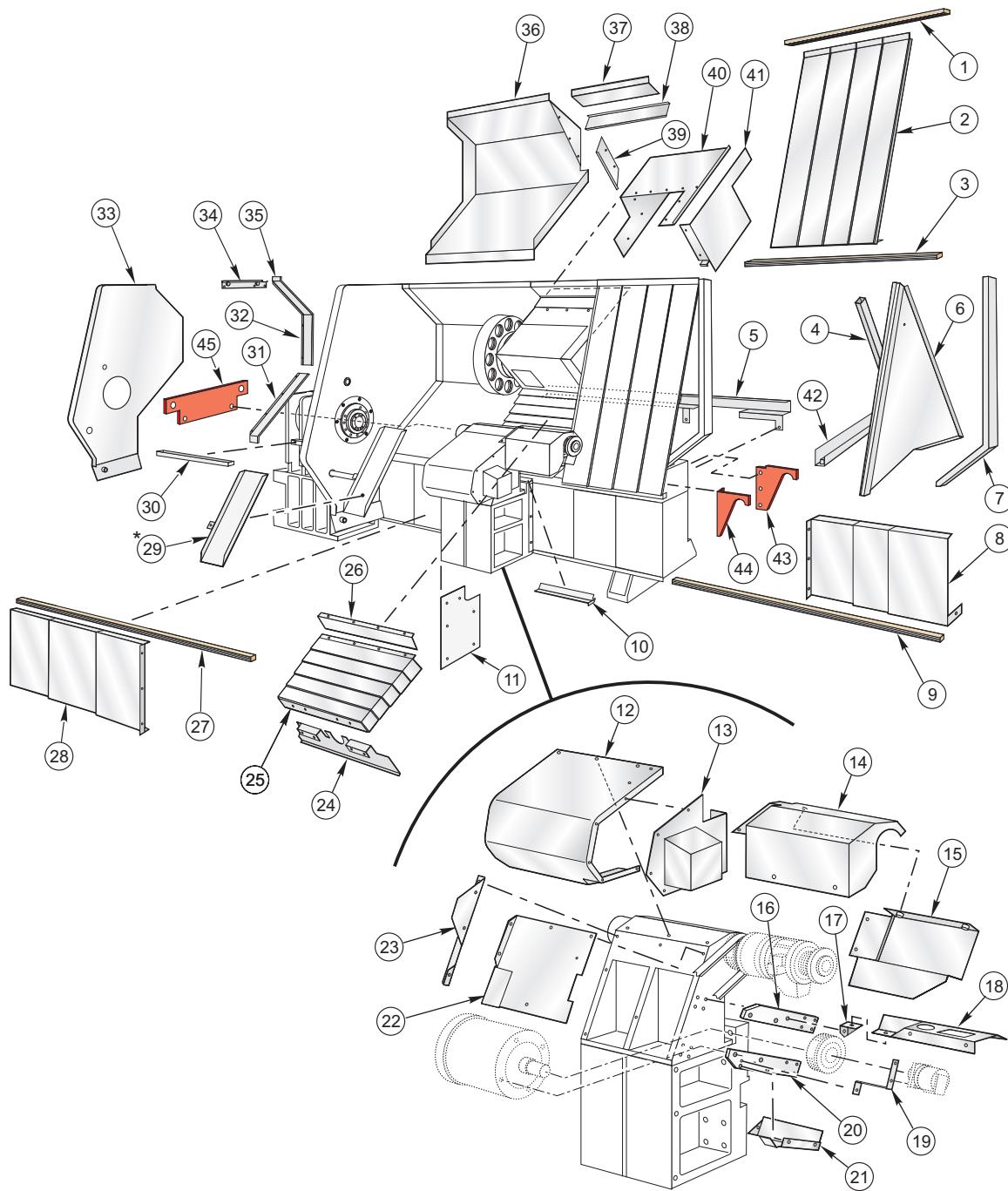
### TL-25 EXTERNAL SHEETMETAL AND PARTS LIST



- |   |   |
|---|---|
| 1. 25-8819E Top Door Roller Mount         | 15. 25-6115A Motor Enclosure            |
| 2. 25-8818F Top Right Panel               | 16. 25-0640B Coolant Collector          |
| 3. 25-6341 Left Front Panel               | 17. 25-1350A Toolbox Door               |
| 4. 59-0023 Door Hinge (2)                 | 18. 59-0023 Door Hinge (2)              |
| 5. 25-8021A Access Door                   | 19. 25-1349 Toolbox                     |
| 6. 30-1487A Door Assembly                 | 20. 25-0243C High Pressure Pump Bracket |
| 7. 30-1490A Door w/Parts Catcher Assembly | 21. 25-8067B Coolant Pump Mount         |
| 8. 25-8786G Right Front Panel             | 22. 25-0548 Auger Discharge Chute       |
| 9. 25-8830A X-Axis Drip Tray              | 23. 25-0283 Chip Tray Filler            |
| 10. 22-6023 Door V-Track                  | 24. 25-6336C Right End Panel            |
| 11. 25-6333A Front Rail                   | 25. 25-0398A Tramp Lub Oil Pan Bracket  |
| 12. 25-8880D Chip Auger Pan               | 26. 25-0518 Right Rear Panel            |
| 13. 25-6323A Chip Tray                    | 27. 25-0526C Center Rear Panel          |
| 14. 25-6345D Left Side Panel              | 28. 25-0517C Left Bottom Rear Cover     |



## TL-25 INTERNAL SHEETMETAL



\* Parts Catcher Only

SUB-SPINDLE ASSEMBLY

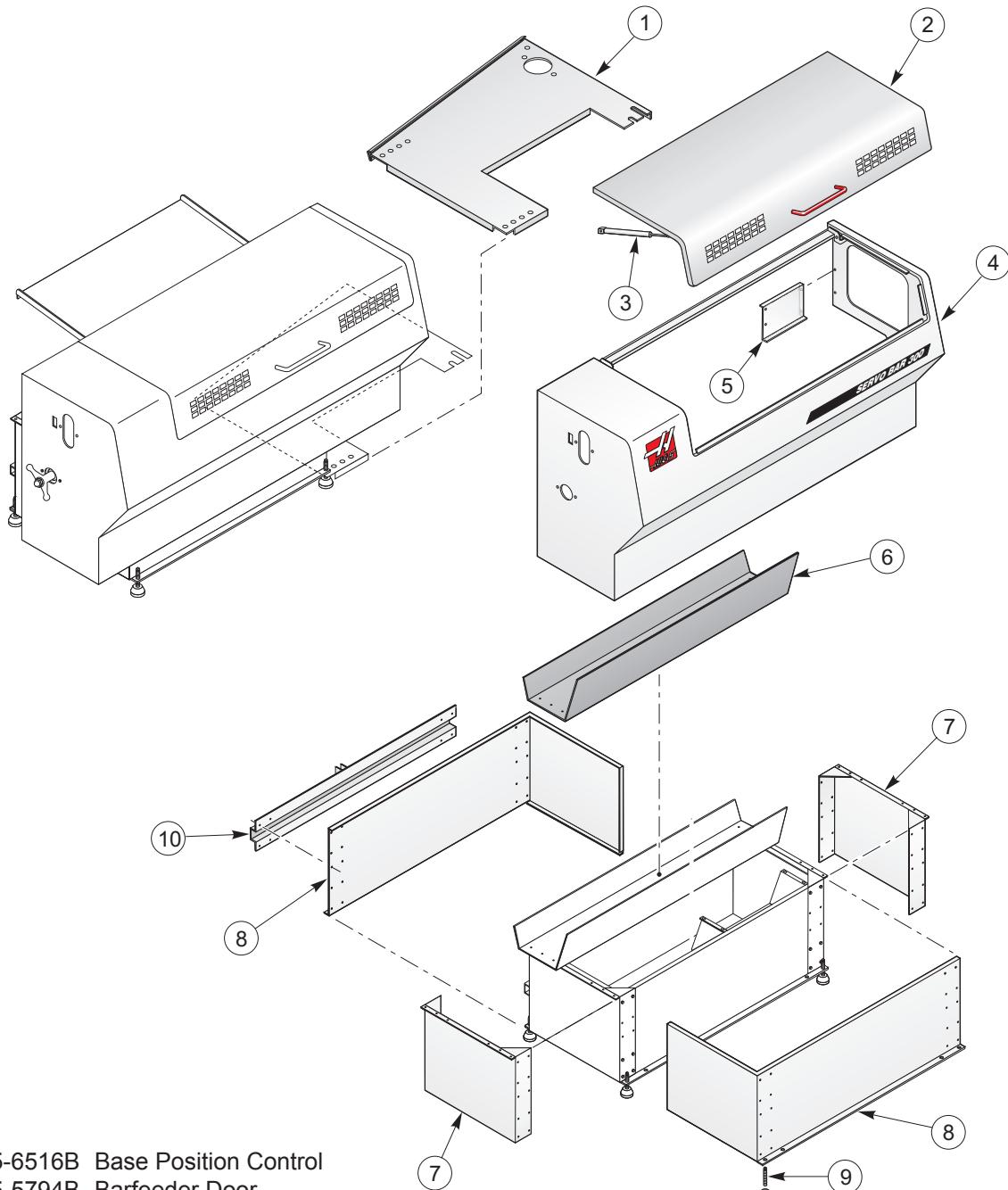


## TL-25 INTERNAL SHEETMETAL PARTS LIST

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. 22-0830A Cable Channel Cover
6. 25-8843B 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. 25-8841B Sub-spindle Base Plate
11. 25-4344 Sub-spindle Base cover
12. 25-0610A Motor Cover
13. 25-0611A Sub-spindle Encoder Cover
14. 25-9189 Front Union Shroud
15. 25-9188 Rear Union Shroud
16. 20-0631A Upper Motor Arm
17. 25-0621 Little Bracket
18. 25-9195 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. 25-8755D Front Wedge Cover
25. 25-8757 Tool Changer Waycover
26. 25-6458A Tool Changer Waycover Mount
27. 25-6333A Upper Tailstock Waycover Guide
28. 25-4349A Left Sub-spindle Waycover (4)
29. 25-6512B 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. 25-6347B Fixed Bulkhead
34. 30-3192B Door Wiper Assembly
35. 30-3645 Z-Axis Upper Wiper Assembly
36. 25-8754D Rear Sliding Cover
37. 25-8782C Tool Changer Tunnel Panel
38. 30-3648 X-Axis Top Wiper Assembly
39. 30-3649 X-Axis Side Wiper Assembly
40. 25-4354A X-Axis Tool Changer Sliding Cover
41. 25-8772B Tool Changer Splash Shield
42. 25-8830A X-Axis Drip Channel
43. 20-1591 Right Rear Lifting Bracket
44. 20-1590 Right Front Lifting Bracket
45. 20-1589 Left End Lifting Bracket



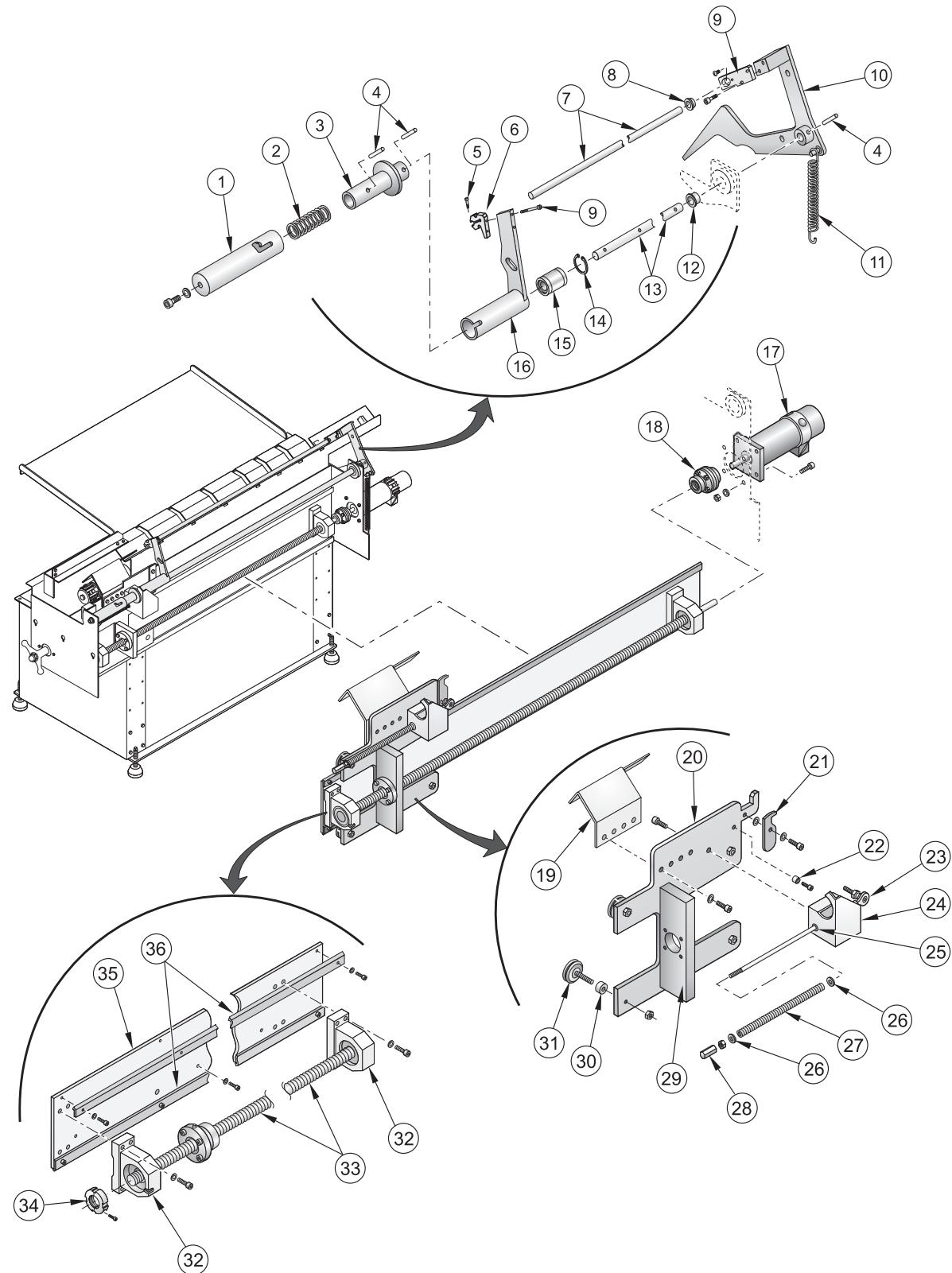
## BARFEEDER SHEETMETAL AND PARTS LIST



1. 25-6516B Base Position Control
2. 25-5794B Barfeeder Door
3. 59-0707 Gas Spring
4. 25-5795A Barfeeder Main Enclosure
5. 25-6538B Right Rear Support
6. 25-6542C Storage Pan
7. 25-6538 Adjusting End Supports
8. 25-6539A Bottom Bar Base
9. 44-0018 Leveling Screw
10. 25-6540 Charging Table Beam



## BARFEEDER EXTERNAL PARTS



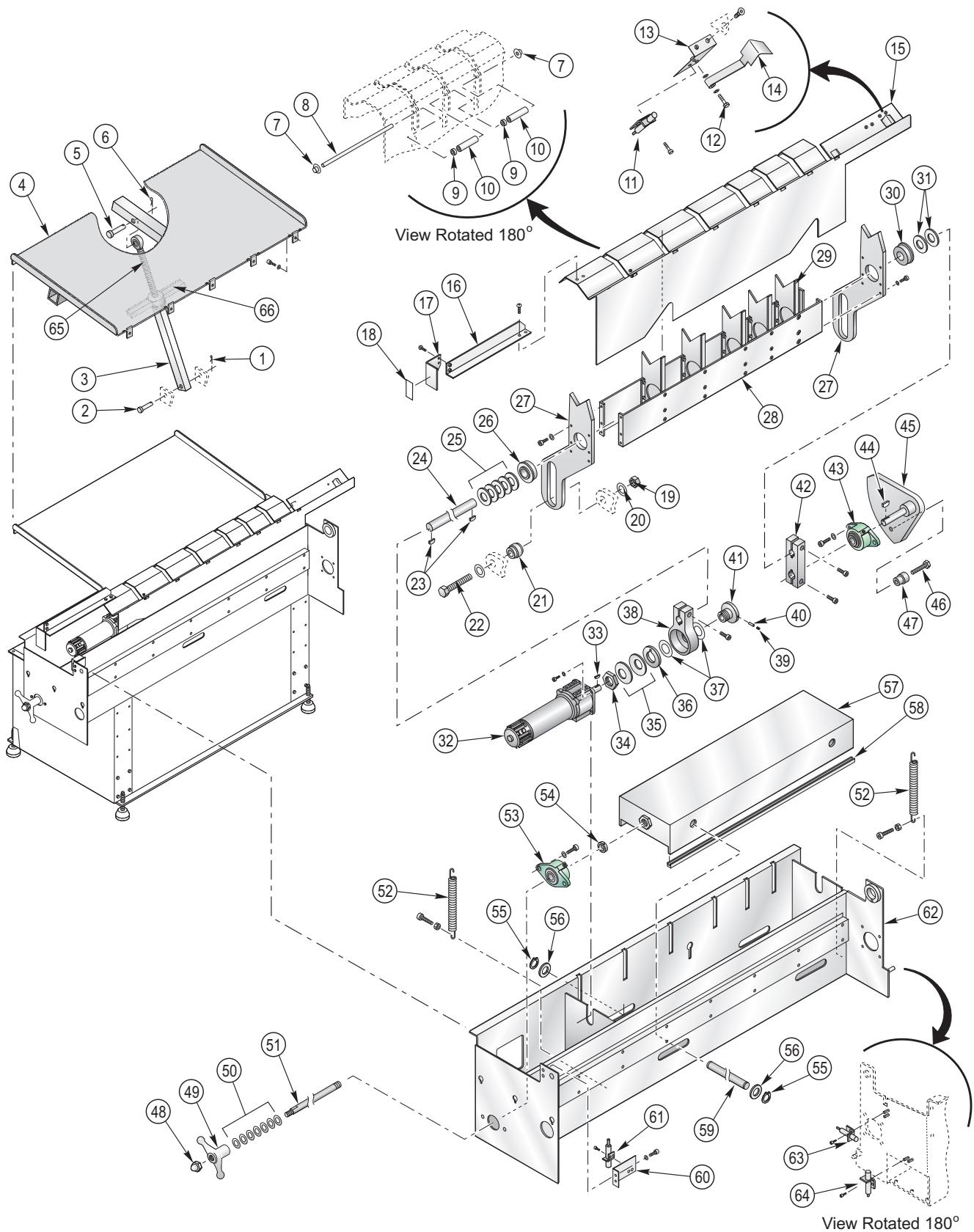


## BARFEEDER EXTERNAL PARTS LIST

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. 20-1033 Clamp Push Rod End
7. 20-6484 Push Rod
8. 20-0356 Flange Bushing 1 in.
9. 20-1921 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. 20-6023B 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. 62-2508 Servo Motor
18. 30-6767 Coupling Assembly
19. 25-6520A Bar Pusher Nose
20. 22-6501 Base Bar Carriage
21. 25-6521 Latch Pusher Bar
22. 22-9256 Bushing Extractor
23. 59-6701 5/16 Ball Joint w/Stud
24. 25-6522 Fork Activator Bar
25. 22-6502 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. 20-6478A Ballscrew Bearing
30. 22-9256 Bushing Extractor
31. 54-0030 Guide Wheel
32. 30-0153 Support Bearing Assembly (2)
33. 24-0007A Ballscrew Assembly
34. 51-2012 Bearing Locknut TCN-04-F
35. 25-6525 Rail Mounting Plate
36. 22-6505 Barfeeder V-Rail



## BARFEEDER INTERNAL PARTS





## BARFEEDER INTERNAL PARTS LIST

1. 49-1203	1/8 x 1 Cotter pin	48. 46-0010	3/4-10 Cap nut
2. 49-1201	3/4 x 3 Clevis pin	49. 59-0102	Clamp handle 3/4-10
3. 20-3886	Support stand	50. 45-0004	3/4 Flat washer
4. 25-6541	Charging table	51. 20-6026C	Height adjusting
5. 49-1202	1 x 6 Clevis pin	52. 59-0110	Spring 6 x 27/32 x .106
6. 49-1203	1/8 x 1 Cotter pin	53. 51-1015	Flange bearing 3/4
7. 46-0011	1/4 Push cap nut	54. 54-0057	Shaft collar 3/4
8. 20-0341	Transfer table	55. 56-0085	Snap ring
9. 22-9256	Bushing extractor	56. 45-0013	Washer
10. 58-1982	Hose urethane 3/8 OD x 1/4 ID (APL)	57. 25-6549A	Height adjusting box
11. 32-2213	Limit switch (end of bar)	58. 59-7200	Grommet material .125
12. 49-1019	Shoulder bolt 1/4 x 1	59. 20-6490A	Box cross rollers
13. 25-6528B	Bar end mounting	60. 25-0338	Home switch bracket
14. 25-6529C	Bar end switch paddle	61. 32-2142	Home Switch
15. 25-6527E	Bar transfer table	62. 30-0802A	Main frame
16. 25-6546A	Height indicator support bracket	63. 32-2212	Load Q limit switch
17. 25-6547	Height indicator flag	64. 32-2211	Load bar limit switch
18. 29-0051	Height gauge decal	65. 22-6025	1" Acme adjusting screw
19. 46-1702	Nut	66. 49-1020	Acme wing nut 1-5
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. 25-6530A	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. 20-0215A	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		

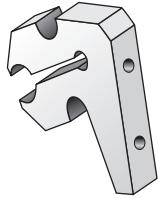


### DETAILED BAR 300 PARTS

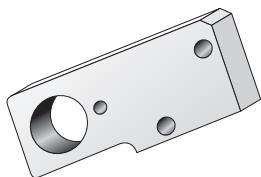
30-1389 – 3/8" Pushrod

30-0804 – 3/4" Pushrod

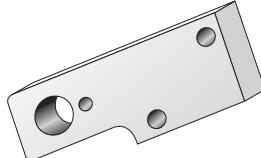
#### CURRENT



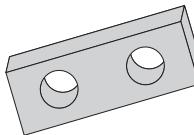
20-1033 Push Rod End Clamp



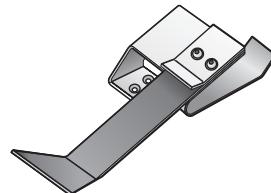
20-1034 Push Rod Control Bushing Holder 3/4"



20-1035 Push Rod Control Bushing Holder 3/8"

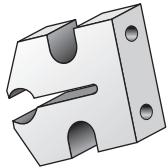


20-1923 Spacer

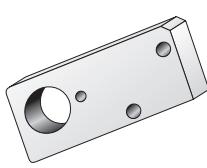


30-1336 Switch Hold Down Assembly

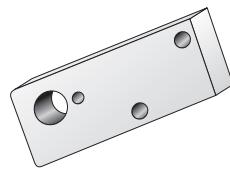
#### PREVIOUS



20-6483 Push Rod Connector Adapter



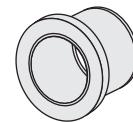
20-6032 Push Rod Control Bushing Holder 3/4"



20-6044 Push Rod Control Bushing Holder 3/8"



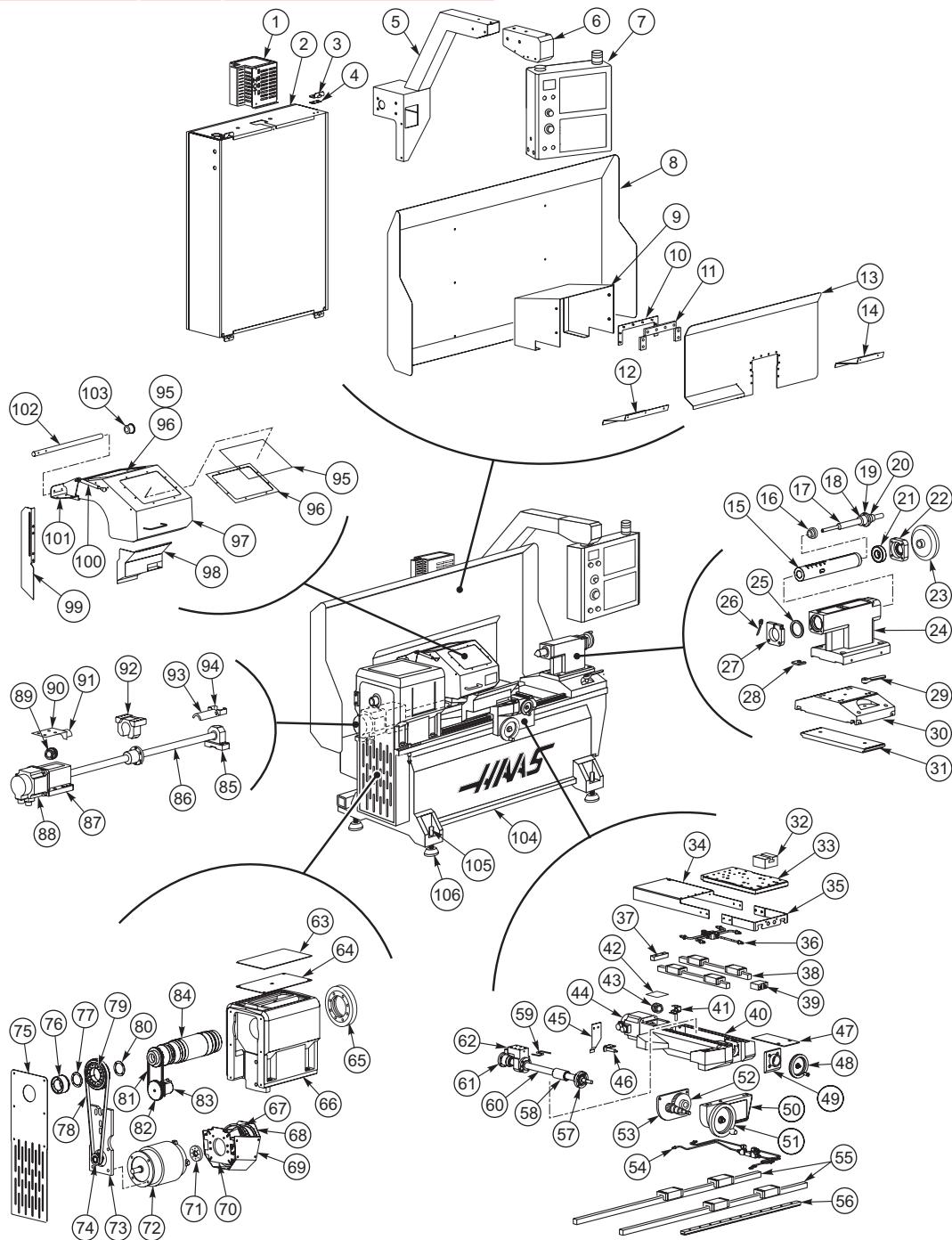
51-0055  
Nylon Flange  
Bearing 3/8"



20-1046  
Push Shaft  
Bushing 3/4"



## TOOLROOM LATHE (TL-1/2)



- |              |                          |              |                            |
|--------------|--------------------------|--------------|----------------------------|
| 1. 32-0041B  | Regen Assy               | 8. 25-5449   | TL-2 Control Support       |
| 2. 25-11310A | Control Cabinet          | 25-6354A     | TL-1 Control Support Cover |
| 3. 59-0982A  | Control Box Isolator (4) | 9. 25-4932B  | X Axis Motor Cover         |
| 4. 57-10625  | Control Box Gasket (2)   | 10. 25-6351A | Wiper Retainer             |
| 57-10624     | Control Box Gasket (2)   | 11. 26-0372A | Wiper Felt                 |
| 5. 20-2672   | Pendent Arm              | 12. 25-4931  | Rear Ballscrew Left Cover  |
| 6. 25-6661A  | Arm End Cap (leveling)   | 13. 25-6352D | Saddle Chip Guard          |
| 7. 25-8354C  | Control Pendant Shell    | 14. 25-4930B | Rear Ballscrew Right Cover |

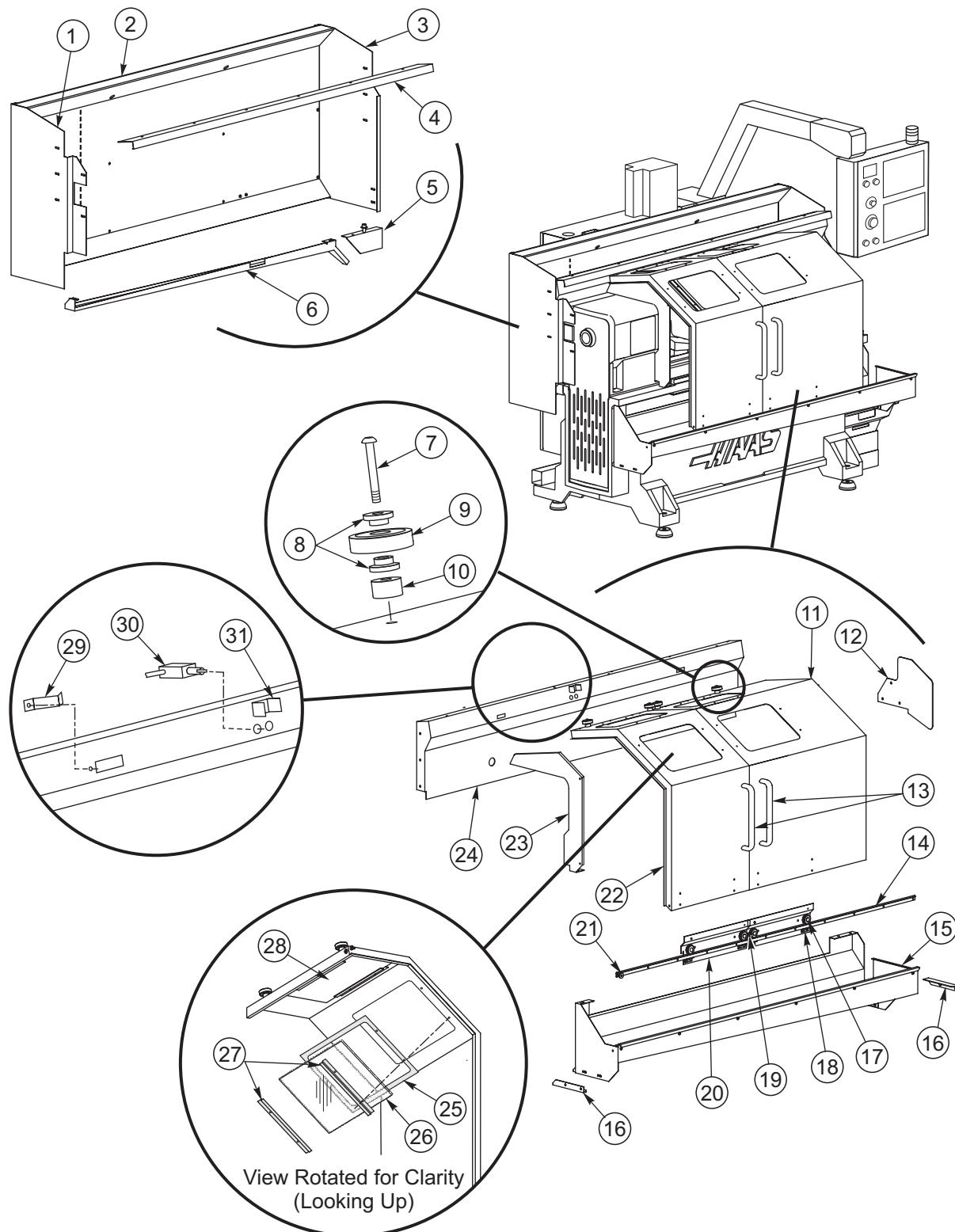


## TOOLROOM LATHE (TL-1/2) PARTS LIST

- |              |                                 |               |                               |
|--------------|---------------------------------|---------------|-------------------------------|
| 15. 20-1938A | TS Quill                        | 62. 20-1919   | X-Axis Ballscrew Nut Housing  |
| 16. 20-1957A | Quill Drive Nut                 | 63. 26-0373   | Tool Mat                      |
| 17. 20-1939A | Drive Screw                     | 64. 20-1942   | Spindle Housing Cover         |
| 18. 20-2453  | TS Bearing Spacer               | 65. 20-0862   | Clamp Ring A2-5               |
| 19. 51-2033  | Radial Bearing                  | 66. 20-1869G  | TL-1 Spindle Housing Machined |
| 20. 20-1958A | Quill Driver SCR Collar         | 20-2459C      | TL-2 Spindle Housing Machined |
| 21. 51-2033  | Radial Bearing                  | 67. 36-3035C  | Fan Assembly                  |
| 22. 20-1940C | Nut Retainer                    | 68. 25-0127   | Fan Motor End Plate           |
| 23. 20-4426  | Tailstock Handwheel             | 69. 25-5036B  | Fan Enclosure                 |
| 24. 20-1873B | TS Head Housing Machined        | 70. 25-0143A  | Spindle Enclosure Bracket     |
| 25. 26-0374  | Quill Wiper                     | 71. 20-0147   | Balancing Hub Drive Motor     |
| 26. 49-0064  | TS Handle Clamp                 | 72. 62-1015   | 5 H.P. Spindle Motor          |
| 27. 20-1960  | PLT Quill Lock                  | 73. 20-1951C  | Motor Mounting Plate          |
| 28. 20-1966  | Shim (4)                        | 74. 20-1934   | Motor Sprocket                |
| 29. 49-0064  | Handle Clamp                    | 75. 25-6353C  | TL-1 Spindle Belt Guard       |
| 30. 20-3559  | TL-1 Tailstock Base             | 25-5448A      | TL-2 Spindle Belt Guard       |
| 20-3558      | TL-2 Tailstock Base             | 76. 20-2470   | TL-1 Spindle Extension        |
| 31. 20-3560  | Clamp Plate Front               | 20-2471       | TL-2 Spindle Extension        |
| 20-3561      | Clamp Plate Back                | 77. 20-2082   | Lock Ring, Back               |
| 32. 20-2440  | TL-1 T-Slot Block               | 78. 54-0126   | Spindle Drive Belt            |
| 20-2463A     | TL-2 T-Slot Block               | 79. 20-1933   | TL-1 Spindle Pully            |
| 33. 20-2102B | X-Axis Cross Slide              | 20-2461       | TL-2 Spindle Pully            |
| 34. 25-5037C | Cross Slide Cover               | 80. 20-2081   | Lock Ring, Front              |
| 35. 25-5038D | Cross Slide Front               | 81. 54-0084   | Encoder Drive Belt            |
| 36. 30-6406  | X-Axis Lube Line                | 82. 20-0975   | Encoder Sprocket              |
| 37. 20-1232A | Z-Axis Support Bumper           | 83. 30-30390  | Haas Magnetic Encoder         |
| 38. 50-0031  | Guide Rail (2)                  | 84. 30-6275A  | Spindle Assembly              |
| 39. 20-2105  | X-Axis Manifold                 | 85. 20-7009   | Bearing Housing Machined      |
| 40. 20-1870D | Saddle Machined                 | 86. 24-0039   | Z-Axis Lead Ballscrew         |
| 41. 25-6832  | Trip Flag Prox. Switch X-Axis   | 87. 20-7010B  | Motor Mount                   |
| 42. 25-9203  | Cover                           | 88. 62-0024   | Yaskawa Servo Motor           |
| 43. 30-1220A | Coupling Assembly               | 89. 30-1220A  | Coupling                      |
| 44. 62-0024  | Yaskawa Servo Motor             | 90. 25-7042A  | Snap Lock Motor Mount Cover   |
| 45. 25-5390A | Z-Axis Switch Trip Bracket      | 91. 28-0187   | Motor Bumper                  |
| 46. 32-2132  | Prox. Switch                    | 92. 20-7008F  | Ballscrew Nut Housing         |
| 47. 25-5391  | Prox. Switch Mounting Bracket   | 93. 20-1232A  | Support Bumper                |
| 48. 20-1931A | X-Axis Handwheel 4.5"           | 94. 25-7080   | Bumper Bracket                |
| 20-1955B     | X-Axis Handwheel Handle         | 95. 28-0049B  | Window (2)                    |
| 49. 20-1949  | Saddle SCR Cover                | 96. 25-6250B  | Window Retainer (2)           |
| 50. 20-1871  | Z-Axis Saddle Skirt Machined    | 97. 25-6355   | Chuck Guard                   |
| 51. 20-4426  | Z-Axis Handwheel                | 98. 25-5465B  | TL-1 Front Chuck Guard        |
| 52. 20-2378  | Gear                            | 25-5514       | TL-2 Front Chuck Guard        |
| 53. 20-1943  | Z-Axis Gear Mounting Plate      | 99. 25-5464B  | Rear Chuck Guard              |
| 20-1945      | Shaft                           | 100. 59-0007A | Gas Spring                    |
| 54. 30-6370  | Z-Axis Lube Line Assembly       | 101. 25-5846D | Chuck Guard Hinge Bracket     |
| 55. 50-0030  | Z-Axis Guide Rail (2)           | 102. 20-2480A | Chuck Guard Hinge Pin         |
| 56. 20-1947  | TL-1 Z-Axis Rack Gear           | 103. 51-0171  | Bearing 1IN Nylon Flanged     |
| 20-2464      | TL-2 Z-Axis Rack Gear           | 104. 20-1868F | TL-1 Base Machined            |
| 57. 51-2025  | Bearing                         | 20-2451C      | TL-2 Base Machined            |
| 58. 20-1952  | X-Axis Bumper                   | 105. 44-0018  | Leveling Screw                |
| 59. 58-0608  | X-Axis Lube Line, Ballscrew Nut | 106. 14-7068  | Foot Pad                      |
| 60. 24-0038  | X-Axis Ballscrew                |               |                               |
| 61. 20-7416  | Bearing Cartridge               |               |                               |



## TL 1-2CE



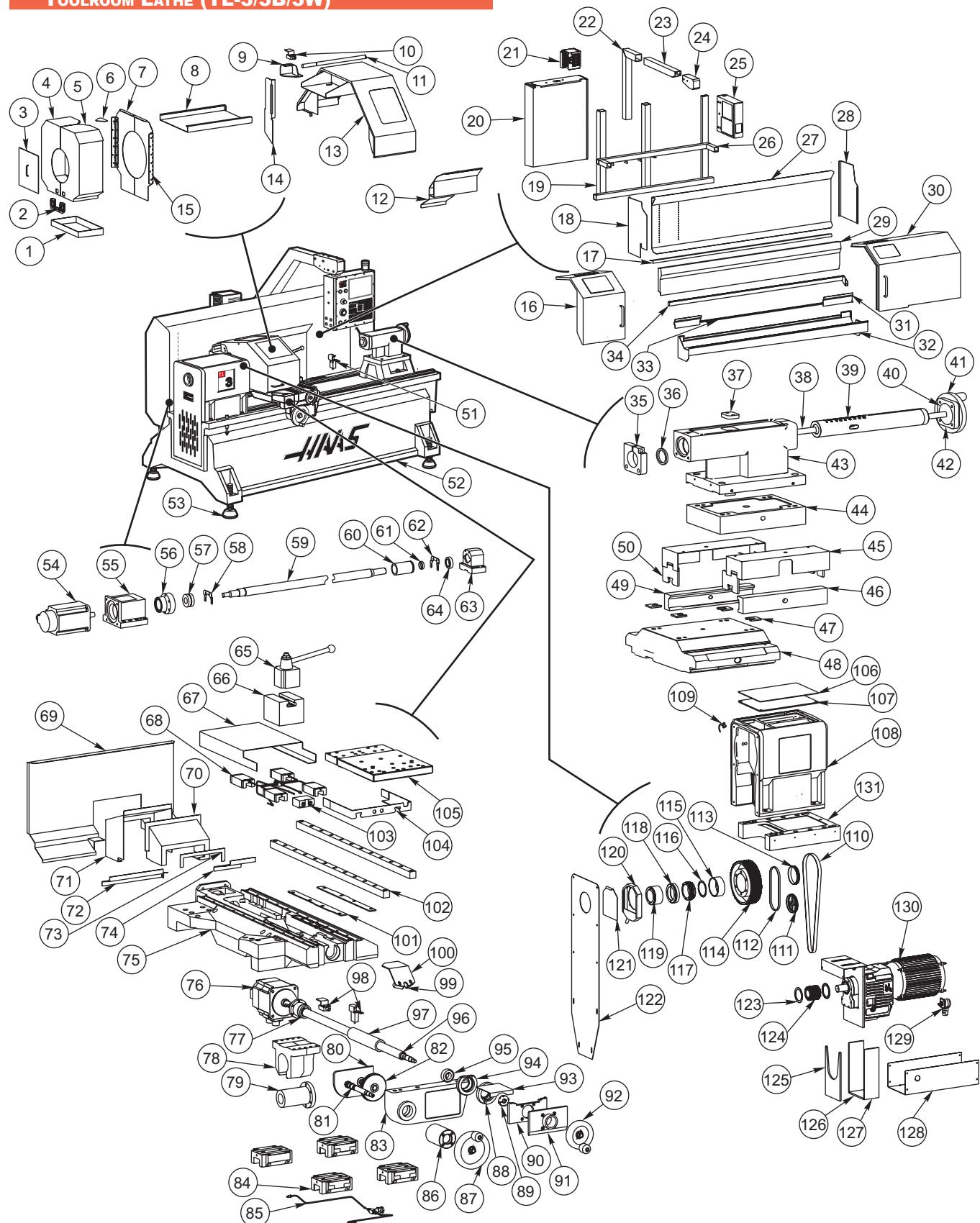


## TL 1-2CE PARTS LIST

1. 25-5932A Left Wing Guard
2. 25-5930A (TL-1-CE) Control Support Cover  
25-6783A (TL-2-CE) Control Suport Cover
3. 25-5931A 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. 25-5948B (TL-1-CE) Back Gutter  
25-6789A (TL-2-CE) Back Gutter
7. 40-1979 BHCS 1/4-20 x 1-3/4
8. 20-0260 Top Door Spacer (2x)
9. 51-2020 Bearing Radial FAFNIR 303
10. 22-7034 Spacer Cam Follower
11. 25-6408F (TL-1-CE) Long Door  
25-6791E (TL-2-CE) Right Door
12. 25-6428B Tail Stock Fin
13. 28-0178 Door Handle (2x)
14. 22-6505 (TL-1-CE) V- Rail Bar Feeder  
20-0963 (TL-2-CE) V- Track Slide Door
15. 25-5939A (TL-1-CE) Front Gutter  
25-6788 (Ti-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. 25-5944B Lower Rear Mount (2x)
21. 20-6016A Rail Spacer  
40-0126 BHCS 1/4-20 x 1 1/4
22. 25-6406B Short Door
23. 25-6418A (TL-1-CE) Bulkhead  
25-6790A (TL-2-CE) Bulkhead
24. 25-5941F (TL-1-CE) Read Guard  
25-6784D (TL-2-CE) Rear Guard
25. 26-0177 Front Window Gasket (2x)
26. 28-0170 Front Window (2x)
27. 25-6250B Window Retainer (8x)
28. 28-0171 Top Window (2x)
29. 25-4043 Latch Spring
30. 32-5075A (TL-1-CE) L/S Carriage (2x)
31. 25-6429B Door Stop



## TOOLROOM LATHE (TL-3/3B/3W)





### TL 3/3B/3W PARTS LIST

1. 25-8487C TL-3B Rear Chuck Guard Bottom
2. 58-0227 TL-3B Latch Push Close
3. 25-9340 TL-3B Rear Chuck Guard Thru Cover
4. 25-8155C TL-3B Rear Chuck Guard Left
5. 25-8486C TL-3B Rear Chuck Guard Right
6. 25-9336 TL-3B Rear Chuck Guard Top Cover
7. 25-8152C TL-3B Rear Chuck Guard Back
8. 25-8440 TL-3B Chuck Guard Rail  
    25-7314A TL-3W Chuck Guard Rail
9. 25-5781B TL-3 Chuck Guard Hinge Bracket
10. 69-1700 Proximity Switch
11. 20-2480A TL-3 Chuck Guard Hinge Pin
12. 25-5759A TL-3 Chuck Guard Front
13. 25-5762D TL-3 Chuck Guard  
    25-8150 TL-3B Chuck Guard  
    25-7313A TL-3W Chuck Guard
14. 25-5928A TL-3 Chuck Guard Rear
15. 20-10253 TL-3B Hinge Rear Chuck Guard
16. 25-7375A TL-3 Short Door
17. 25-7374 TL-3/3B Top Roller Guide
18. 25-7370A TL-3 Left Wing Guard  
    25-8434 TL-3B Left Wing Guard  
    25-5752 TL-3W Control Support Cover Wing Left
19. 20-3462 Control Support Frame Lower
20. 30-30309A Control Box
21. 32-0194 Regen Assembly
22. 20-3044B Pendant Mount Swivel
23. 20-3043 TL-3/3W Pendant Arm Swivel  
    20-3754 TL-3B Pendant Arm Swivel
24. 25-6661A Arm End Cap
25. 25-5524C Enclosure Front Pendant
26. 20-3461A Control Support Frame Upper
27. 25-7368A TL-3 Control Support Cover  
    25-8432 TL-3B Control Support Cover  
    25-5750 TL-3W Control Support Cover
28. 25-7369A TL-3 Right Wing Guard  
    25-8433 TL-3B Right Wing Guard  
    25-5751 TL-3W Control Support Cover Wing Rght
29. 25-7373C TL-3 Rear Guard  
    25-8435 TL-3B Rear Guard
30. 25-7376D TL-3 Long Door  
    25-8453 TL-3B Door, Traveling
31. 25-7603A TL-3/3B Lower Wheel Mount
32. 25-7371B TL-3 Front Gutter  
    25-8438 TL-3B Front Gutter
33. 20-3250 TL-3/3B V-Rail, Door, Lower Track
34. 25-7372B TL-3/3B Rear Gutter
35. 20-2669 T/S Quill Lock
36. 26-0374 T/S Quill Wiper
37. 20-2670 T/S Quill Key Retainer
38. 20-2658 T/S Drive Screw
39. 20-2671 Tailstock Quill
40. 20-2673 T/S Bearing Retainer
41. 20-1930A Hand Wheel
42. 20-2663 T/S Nut Retainer
43. 20-2640B T/S Head Casting Machined
44. 20-3229B TL-3B/3W T/S Riser
45. 25-7933 T/S Wiper Retainer
46. 20-3468A Clamp Plate, Back
47. 20-1966 Shim
48. 20-3466B T/S Base Machined
49. 20-3467A Clamp Plate, Front
50. 26-0212 T/S Guide Felt Wiper
51. 69-1700 Proximity Switch
52. 20-2625B TL-3 Machining Base  
    20-3203A TL-3B/3W Base Machined
53. 14-7068 Casting Level Pad
54. 62-0016 Servomotor Yaskawa 13 No Brake
55. 20-0151A Machining Motor, 40 & 50mm Ball Screw
56. 20-9212 Bearing Housing 40mm BS
57. 51-0151 Ball Bearing 240mm ID PR
58. 25-0134 Snap Lock Bumper Clamp
59. 24-0015A B Screw
60. 28-0214 Z Bumper
61. 20-0309 Spacer Torque Limit Ballscrew
62. 25-0134 Snap Lock Bumper Clamp
63. 20-0152 Bearing Housing 40/50mm BS
64. 51-0007 Bearing Deep Groove
65. TP1 Tool Post Kit 1
66. 20-2630B TL-3 T-Slot Block  
    20-3739A TL-3B/3W Tool Post
67. 25-5756A TL-3 Cross Slide Cover  
    25-7305 TL-3B/3W Cross Slide Cover
68. 30-7194 Lube Line Assembly
69. 25-5761C TL-3 Saddle Chip Guard  
    25-8437A TL-3B Billboard  
    25-7302A TL-3W Billboard
70. 25-7303 TL-3B/3W X-Tunnel
71. 25-5755 TL-3 Cover X Motor  
    25-7304 TL-3B/3W X-Motor-Cover
72. 25-5754 Cover Front Ball Screw
73. 25-5760 X Wiper Retainer
74. 25-5753 Cover Rear Ball Screw
75. 20-2634C TL-3 Machined Saddle  
    20-3211E TL-3B/3W Machined Saddle
76. 62-0016 Servomotor Yaskawa 13 No Brake
77. 20-7416 Housing Bearing Cartridge
78. 20-0150 Nut Housing Machined 40/50mm BS
79. 20-9211 Nut Housing 40mm BS
80. 20-1943 Saddle Skirt Back PL
81. 20-2377 TL-3 Z Gear Shaft  
    20-3246 TL-3B/3W Z Handle Shaft, Extended
82. 20-2378 Z Spur Gear
83. 20-1871 Saddle Skirt Machined

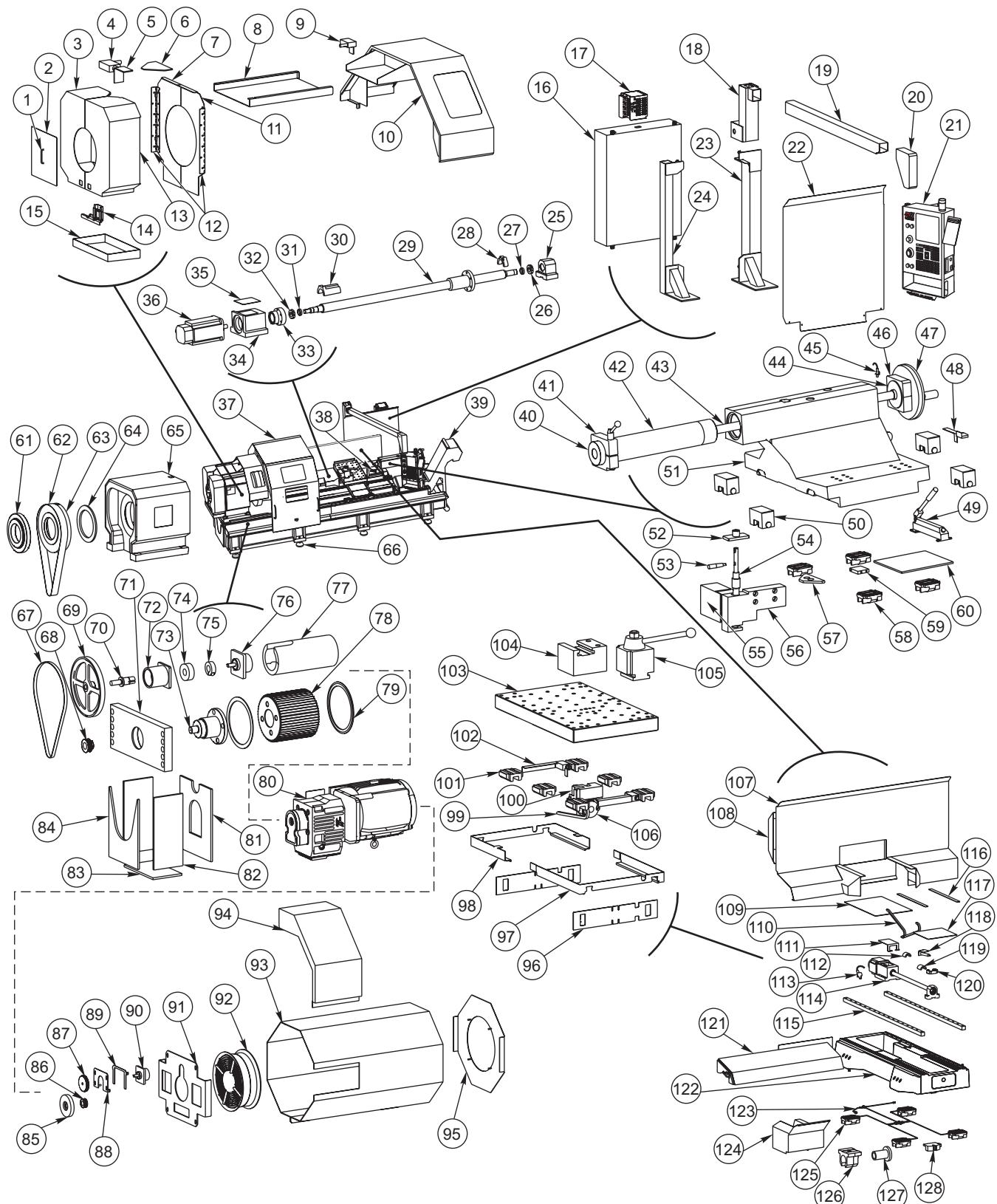


### TL 3/3B/3W PARTS LIST (CONT)

- |               |  |               |                                      |
|---------------|--|---------------|--------------------------------------|
| 84. 50-0105   | Linear Guide                             | 125. 59-0870A | TL-3B/3W Sound Foam Mtr Mount Front  |
| 85. 30-4910A  | Air/Reg Lube Assy                        | 126. 59-0869A | TL-3B/3W Sound Foam Mtr Mount Bottom |
| 86. 20-3247   | TL-3B/3W Z Handle Retainer, Extended     | 127. 59-0868A | TL-3B/3W Sound Foam Mtr Mount L/R    |
| 87. 20-1930A  | TL-3 Hand Wheel                          | 128. 25-7310C | TL-3B/3W Motor Shroud                |
|               | 20-1932A TL-3B/3W Hand Wheel             | 129. 60-1813  | TL-3B/3W Encoder 2K M23 Short        |
| 88. 20-4442   | TL-3/3B Bearing Housing                  | 130. 30-9211A | TL-3B Gear Box Assembly              |
| 89. 51-2012   | TL-3/3B Bearing Locknut                  | 30-8334A      | TL-3W Gear Box Assembly              |
| 90. 20-3257A  | TL-3B/3W Cover X Ball Screw Front        | 131. 20-3391A | TL-3W Sub Plate Spindle Machining    |
| 91. 20-2650   | TL-3/3B Saddle Screw Cover               |               |                                      |
| 92. 20-1931A  | TL-3/3B Hand Wheel                       |               |                                      |
|               | 20-2648 TL-3W Saddle Screw Cover Nose    |               |                                      |
| 93. 25-7308A  | TL-3B X Ball Screw Cover                 |               |                                      |
| 94. 20-4442   | TL-3B/3W Bearing Housing                 |               |                                      |
| 95. 51-2025   | TL-3B Bearing Radial                     |               |                                      |
| 96. 24-0108   | TL-3/3B Ball Screw                       |               |                                      |
|               | 24-0115 TL-3W Ball Screw                 |               |                                      |
| 97. 20-2638   | X Support Bumper                         |               |                                      |
| 98. 69-1700   | Proximity Switch                         |               |                                      |
| 99. 20-3755A  | TL-3B Travel Detent Bracket              |               |                                      |
| 100. 25-8459A | TL-3B Travel Detent Bracket              |               |                                      |
| 101. 25-9590  | TL-3B/3W X Waycover Retainer             |               |                                      |
| 102. 50-3007  | TL-3 Linear Guide                        |               |                                      |
|               | 50-0104 TL-3W Linear Guide               |               |                                      |
| 103. 20-2105  | X Lube Manifold                          |               |                                      |
| 104. 25-7908  | TL-3 Cross Slide Front Plate             |               |                                      |
|               | 25-5757 TL-3B/3W Cross Slide Front Plate |               |                                      |
| 105. 20-2651  | TL-3 Cross Slide                         |               |                                      |
|               | 20-3231 TL-3B/3W Cross Slide             |               |                                      |
| 106. 26-0164  | Tool Mat                                 |               |                                      |
| 107. 20-2653  | Spindle Top Cover                        |               |                                      |
| 108. 20-2639C | Spindle Head Casting Machined            |               |                                      |
| 109. 69-1700  | Proximity Switch                         |               |                                      |
| 110. 54-0211  | TL-3 Drive Belt PGGT                     |               |                                      |
|               | 54-0227 TL-3W Drive Belt PCGT            |               |                                      |
| 111. 20-1295  | TL-3/3W Sprocket Timing                  |               |                                      |
| 112. 54-0217  | TL-3/3W Timing Belt                      |               |                                      |
| 113. 20-1294  | TL-3/3W Pulley Timing Spindle            |               |                                      |
| 114. 20-2644A | TL-3/3W Sprocket GT                      |               |                                      |
| 115. 20-2680A | TL-3/3W Spindle Encoder Sprocket Spacer  |               |                                      |
| 116. 20-0167  | TL-3/3W Spindle Adaptor Gasket           |               |                                      |
| 117. 20-2682A | TL-3/3W Spindle Encoder Sprocket         |               |                                      |
| 118. 20-2681A | TL-3/3W Spindle Extension                |               |                                      |
| 119. 20-2654  | TL-3 Spindle Extension                   |               |                                      |
| 120. 25-9549  | TL-3 Housing Chip Collector              |               |                                      |
| 121. 25-9574  | TL-3 Door R/U Chip Collector             |               |                                      |
| 122. 25-5758  | TL-3 Spindle Belt Guard                  |               |                                      |
|               | 25-7307A TL-3W Belt Cover                |               |                                      |
| 123. 20-2645  | TL-3 GT Sprocket Flange                  |               |                                      |
|               | 20-3228 TL-3B/3W Pulley Flange           |               |                                      |
| 124. 20-2643  | TL-3 Sprocket GT                         |               |                                      |
|               | 20-3227 TL-3/3W Sprocket GT              |               |                                      |
| 125. 59-0870A | TL-3B/3W Sound Foam Motor Mount Front    |               |                                      |



## TOOLROOM LATHE (TL-4)





## TOOLROOM LATHE (TL-4) PARTS LIST

1. 59-0901 Handle Chuck Guard
2. 25-9340 Rear Chk Guard Thru Cvr
3. 25-8811A Rear Chuck Guard Left
4. 32-2086 L/S Left Dr
5. 25-5356 Y Axis Trip Flag
6. 25-9336 Rear Chk Guard Top Cvr
7. 25-8739A Rear Chk Grd Lft Back
8. 25-8888 Chuck Guard Rail, TL-4
9. 32-2086 L/S Left Dr
10. 25-8887 Chuck Guard, TL-4
11. 25-8810A Rear Chk Grd Rght Back
12. 20-10254 Hinge Rear Chuck Guard TL-4
13. 25-8845A Rear Chk Guard Right
14. 58-0227 Latch Push Close
15. 25-8848 Rear Chk Guard Bottom
16. 30-30309A Cntrl Box, TL-3/4
17. 32-0194 Regen Assy 5.6 Ohm 55HP
18. 20-3940 Pendant Arm Support TL-4
19. 20-3931 Pendant Arm, TL-4
20. 25-4633A Arm End Cap Monitor Support
21. 25-5524C Enclosure Front Pendant
22. 25-8767 Control Assy Back Cvr TL-4
23. 20-3911 Control Supt Post Right TL-4
24. 20-3912 Control Supt Post Left TL-4
25. 20-0152 Brng Hsng 40/50mm BS
26. 51-0008 Bearing Lock Nut
27. 20-0309 Spacer Torque Limit Ballscrew
28. 28-0194 Bumper 1 40/50mm Leadscrew
29. 24-0014 BScrew 50-10-2508 X-Axis
30. 28-0207 Bumper Z-Axis Sppt End
31. 20-0309 Spacer Torque Limit Ballscrew
32. 51-0008 Bearing Lock Nut
33. 20-9212 Bearing Housing 40mm BS
34. 20-0151A Mchng Mtr Mount, 40/50mm BS
35. 25-9203 Cover Plate Motor Mount
36. 62-0038 Srvomtr SEM G8 w/o Brk
37. 30-9616 Traveling Door Assy TL-4
38. 32-2130 Home Sw 1.5 FT NC
39. LCCTL4 Chip Conveyor for TL-4
40. 20-3871 T/S Quill TL-4
41. 20-3875 Tlstk Quill Lock
42. 20-3871 T/S Quill TL-4
43. 20-3872 T/S Drive Screw TL-4
44. 20-3878 Tlstk Brg Retainer
45. 32-2240A Sw. Prox. N. C. Mold 19 FT.
46. 20-3874 T/S Nut Retainer TL-4
47. 20-3933 Tlstk Handwheel 14 Red TL-4
48. 25-9084 Cable Carrier Bracket T/S TL-4
49. 59-1029 Hyd Hand Pump 10000 PSI TL-4
50. 20-3893 Brake Caliper
51. 20-3861 T/S Body Mach TL-4
52. 20-10247 Travel Pin, Cap TL-4
53. 59-10134 Handle, Brake Car-Lane #CL-200SH-S
54. 20-10248 Travel Pin, Brake TL-4
55. 25-11443 Cover Box, Brake TL-4
56. 20-10246 Travel Pin Housing, Brake TL-4
57. 20-3923 Bumper Tlstck/Saddle TL-4
58. 50-0001B Linear Guide 45 x 448
59. 20-3897 Brake Manifold
60. 20-3873 Hyd Pump Mount TL-4
61. 20-3924A Spindle Cap A1-20 TL-4
62. 54-0248 Drv Belt PCGT 8MGT-3200-36A MS
63. 20-3916B Sprocket 8MX-270S-130
64. 51-0193 YRTS395F(tbd) R Suprt Brg
65. 20-3881B Spindle Head Machined TL-4
66. 14-2010 Casting Leveling Pad Lrg
67. 54-0247 Belt HTD 696-3M-09
68. 20-4518 Pulley Drive HTD 3MX09 P36-3M-09 0.75
69. 20-3920 Encoder Sprocket TL-4
70. 20-2622A Encoder Jack Shaft
71. 20-10207 Bearing Support Plate TL-4
72. 20-2621 Encoder Bearing Support
73. 20-10208 Bearing Support Shaft TL-4
74. 51-7001 R Brg Ang M20-47-20.6 5204 Dbl Row
75. 51-0169 Clamp Collar 3/4 Bore
76. 60-1813 Encoder 2K M23 Short
77. 20-10206 Encoder Mount TL-4
78. 20-10209 Sprkdvr 8MX-54S-120 TL-4
79. 20-3926 Sprocket Flange
80. 30-9613A Gearbox 55HP TL-4
81. 59-1019 Sound Foam Mtrmnt Bck TL4
82. 59-1018 Sound Foam Mtrmnt L/R TL4
83. 59-1020 Sound Foam Mtrmnt Btm TL4
84. 59-1017 Sound Foam Mtrmnt Frnt TL-4
85. 20-0147 Balancing Hub Drive Motor
86. 20-0180 Pulley Timing .750 Bore
87. 20-0179 Timing Pulley .375 Bore
88. 25-6299A Encoder Spring Mount 50T Gearbox
89. 25-6298 Clamp Encoder Spring Mnt
90. 60-1813 Encoder 2K M23 Short
91. 25-5212A Encoder Mounting Plate 30HP 50T
92. 36-3036 Fan Assy SP Hi-Air-Flow
93. 25-5209 Motor Shroud 30HP Lathe Gear
94. 25-5210 J-Box Motor Shroud 30HP Lathe Gear
95. 25-5211 Fan Mounting Plate 30HP Lathe Gear
96. 26-0248A Felt, X-Ax Wiper Frnt/Bck TL-4
97. 25-8722A X Felt Retnr, Front TL4
98. 25-8725A X Felt Retnr, Back TL-4
99. 59-0757 Cbl Carrier KSchlepp Microtrac KSA#0
100. 20-3866A Riser Block Cros Slde TL4
101. 50-0021 Linear Guide 35 x 1320
102. 25-8721A Felt Rtnr Angle Brckt TL4
103. 25-3865A Cross Slide, TL-4
104. 20-3430A T-Slot Block
105. 20-3870A Tool Post TL-4
106. 51-2012 Bearing Locknut TCN-04-F

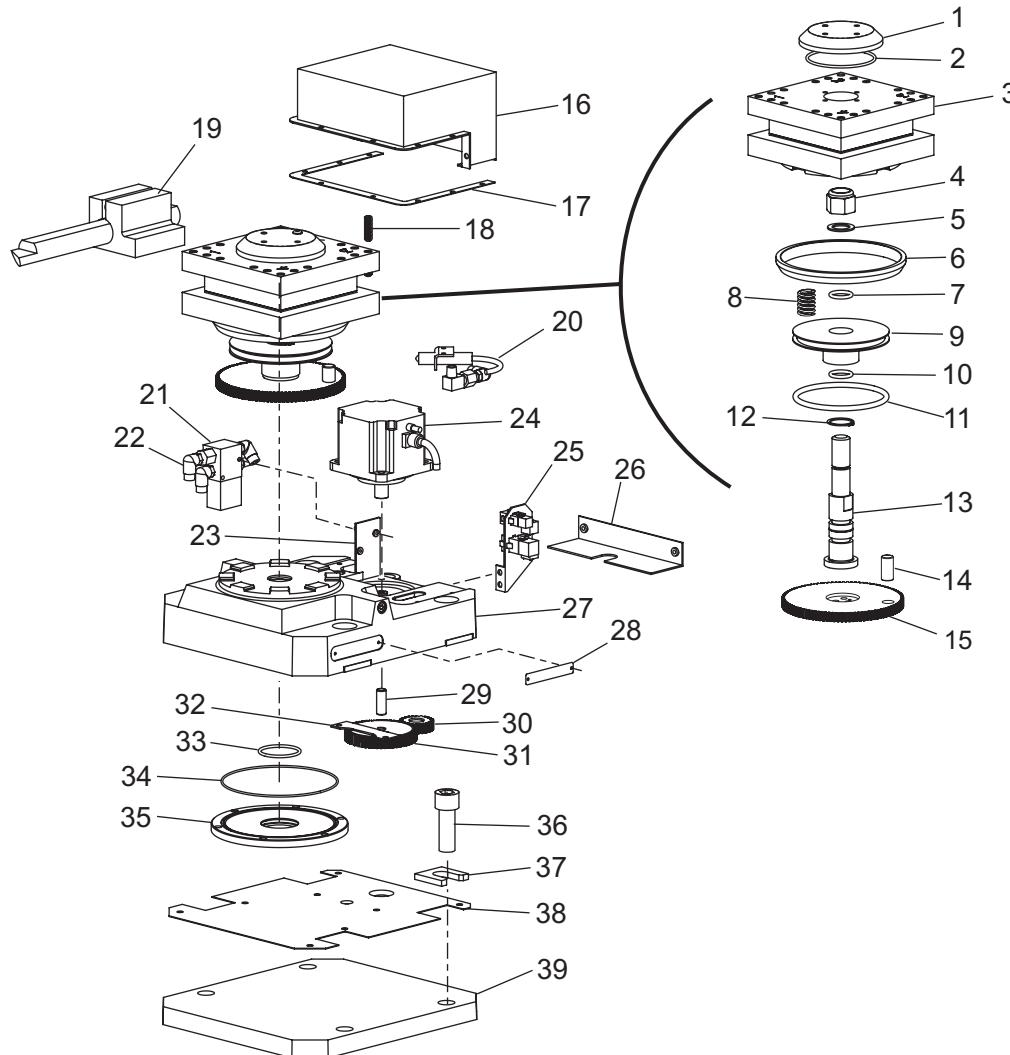


#### TOOLROOM LATHE (TL-4) PARTS LIST (CONT.)

107. 25-8737B Saddle Chip Guard TL-4
108. 25-8738 Cover, X Motor TL-4
109. 25-8716 X BScrew Back Cover TL-4
110. 59-0757 Cbl Carrier KSchlepp Microtrac KSA#0
111. 25-7042 Cover Plate Motor Mnt
112. 28-0198 Bumper Blscrw X-Axis Motor End
113. 32-2240A Sw. Prox. N. C. Mold 19 FT.
114. 30-9698 BScrew Assy X-Axis TL-4
115. 50-0021 Linear Guide 35 x 1320
116. 25-9022 X Waycvr Retnr TL-4
117. 25-8717 X BScrew Front Cover TL4
118. 32-2089 L/S NO 24in 1x2 Plug
119. 28-0204 Bumper X-Axis Mtr/Sppt
120. 25-7080 Bracket Bumper
121. 25-10601 Waycover Z-Axis Ballscrew TL-4
122. 20-3863 Machined Saddle, TL-4
123. 30-9552 Lube Line Assy, Z-Ax TL-4
124. 25-8736A Chip Guard, Front TL-4
125. 50-0001B Linear Guide 45 x 448
126. 20-0150 Nut Housing Machined 40/50mm BS
127. 20-9211 Nut Housing 40mm BScrew
128. 20-3899A Travel Detent TL-4



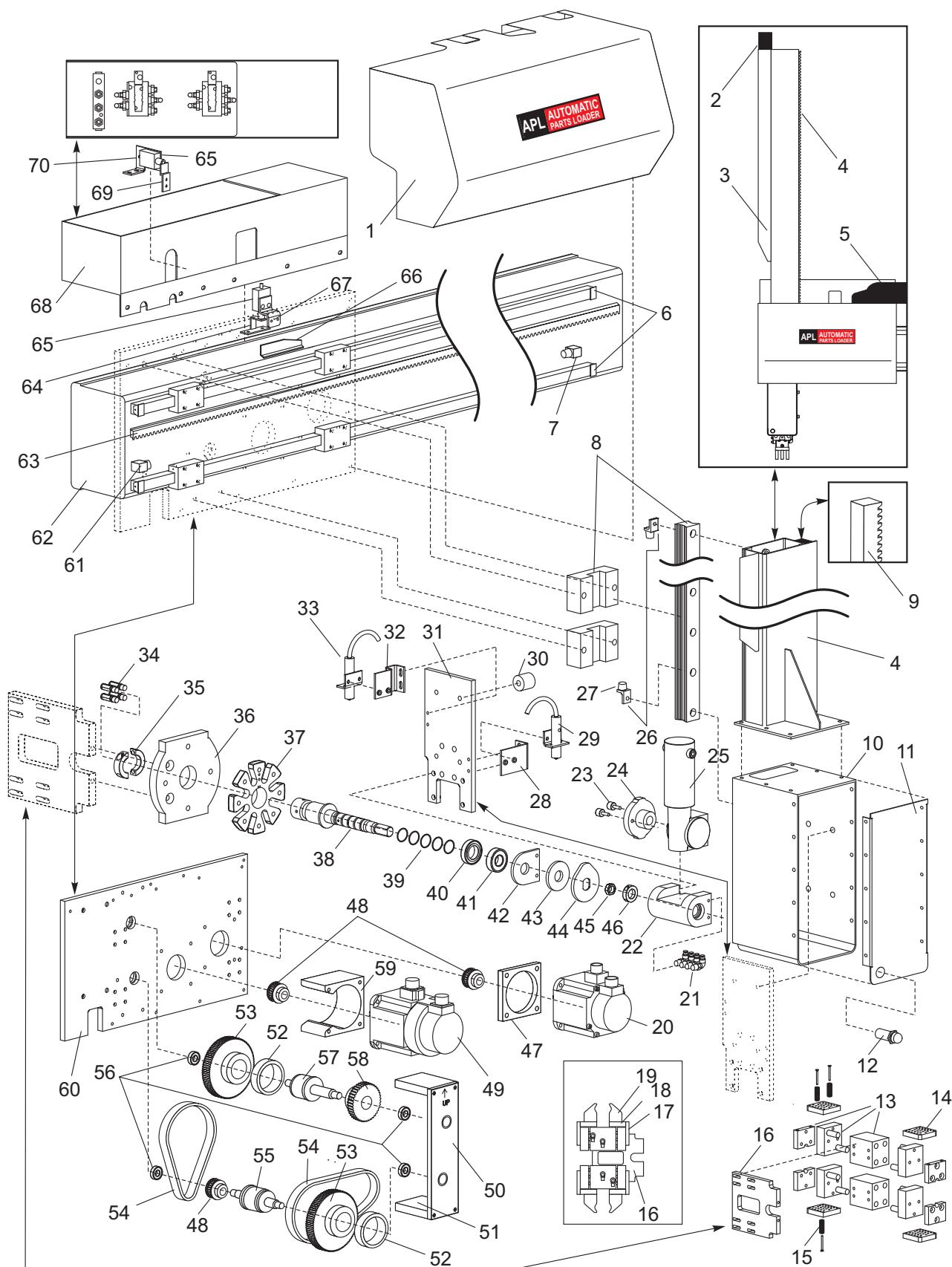
## TT-4 TOOL TURRET



- |  |  |
|--|--|
| 1. 20-2566 Tool Changer Top Cover                  | 21. 32-5671 Turret Up Solenoid Assy                  |
| 2. 57-2747 O-Ring 2-148 Buna                       | 58-4080 Orifice 1/8 NPT x .040 in.                   |
| 3. 20-4527 Tool Post (TL-1)                        | 22. 58-3050 (3) Elbow Fitting 1/4 x NPT 1/8 in. M 90 |
| 20-10028 Tool Metric (TL-2)                        | 23. 25-9762 Solenoid Bracket                         |
| 4. 46-1705 Nut 3/4-10 Nylon Lock                   | 24. 62-2492 Motor Yaskawa 02 w/o Brake               |
| 5. 45-0031 Washer 3/4 in.                          | 25. 25-10004 Connectors Bracket                      |
| 6. 20-4528 Cover Ring                              | 26. 25-9763 Box Cover                                |
| 7. 57-0020 O-Ring 2-210 Viton                      | 27. 20-4493 Tool Turret Housing Machined             |
| 8. 59-3014 Spring Century D1122                    | 28. 29-0606 Name Plate                               |
| 9. 20-4495 Piston Machined                         | 29. 48-0040 Dowel Pin 3/8 x 1 in.                    |
| 10. 57-0020 O-Ring 2-210 Viton                     | 30. 20-4498 Motor Gear 25T                           |
| 11. 57-0478 O-Ring 2-342 Buna N                    | 31. 20-4526 Idler Gear 55T                           |
| 12. 56-0085 Retaining Ring                         | 32. 25-9758 Air Hose Shield                          |
| 13. 20-4496 Piston Shaft Machined                  | 33. 57-0119 O-Ring 2-128 Buna                        |
| 14. 48-1662 Dowel Pin 1/2 x 1 in.                  | 34. 57-0479 O-Ring 2-047 Buna N                      |
| 15. 20-4525 Piston Gear 100T                       | 35. 20-4497 Piston Seal Cover                        |
| 16. 25-9761 Motor Cover                            | 36. 40-0277 (4) SHCS 5/8-11 x 1-3/4 in. (TL-1)       |
| 17. 57-0477 Motor Cover Gasket                     | 40-16644 (4) SHCS 5/8-11 x 2-1/2 in. (TL-2)          |
| 18. 44-0117 (20) SSS 5/16-18 x 1 in. Flat Pt.      | 37. 20-10002 (4) Shim .230 x 5/8 I.D. x 1.50 in.     |
| 19. 20-3032 Tool Changer Holder 1 in. Dia. Bore    | 38. 25-9757 Bottom Cover                             |
| 20. 69-1600 Proximity Switch NC 3WR 9.5 ft. w/Brkt | 39. 20-10001 Riser Plate (TL-2 Only)                 |



LATHE APL





## LATHE APL PARTS LIST

1. 25-0704	Carriage Cover	46. 51-0081	Collar Clamp
2. 59-0197	Cable Carrier	47. 20-0743	A-Axis Motor Spacer
3. 25-0705	Cable Carrier Mount	48. 20-4519	Drive Pulley
4. 25-0703	B-Axis Ram	49. 62-0009	Servo Motor
5. 59-0245	Cable Carrier	50. 20-0744	Bearing Support
6. 50-0008	Linear Guide	51. 20-0745	Bearing Spacer
7. 20-0739	Hard Stop	52. 20-4264	Lock Ring
8. 50-0009	Linear Guide	53. 20-4509	Driven Pullet
9. 20-0749	B-Axis Rack	54. 54-0218	Belt
10. 25-0768A	Rotator Housing	55. 20-0758	Idler Shaft
11. 25-0769A	Rotator Cover	56. 51-4000	Radial Bearing
12. 87-6535	Light Bulb	57. 20-0741	Drive Shaft
87-6700	Panel Light Fixture	58. 20-5164	Pinion
87-6710	Amber Lens	59. 20-0742	W-Axis Spacer
13. 30-6466	Gripper Assy	60. 20-0740	Carriage Plate
14. 20-2299A	Jaw	61. 20-0739	Hard Stop
15. 20-2297	Gripper Finger	62. 25-0693	Beam
16. 20-0747A	Gripper Plate	63. 20-0738	Horizontal Rack
17. 20-1176	Gripper Flange	64. 25-0082	Switch Bracket
18. 20-0747A	Gripper Plate	65. 32-2130	Home Switch 1.5FT NC
19. 20-1177	Gripper Jaw	66. 25-7459	Trip Bracket
20. 62-0014	Servo Motor	67. 25-6826	Home Bracket
21. 58-16700	Fittings	68. 25-0696	Cable Junction
22. 20-0790	Spindle Bearing Housing	69. 20-0467	Trip Block
23. 51-0000	Cam Follower	70. 25-0714	Limit Switch Bracket
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. 58-3681	Tube Fittings		
35. 20-1008	Taper Clamp		
36. 20-0746A	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. 57-0149	Seal		
44. 20-0794	Rotator Trip Block		
45. 46-0007	Jam Nut		



## COMMON ABBREVIATIONS

AC – Alternating Current	MCD RLY BRD – M -Code Relay Board
AMP – Ampere	MDI – Manual Data Input
APC – Automatic Pallet Changer	MEM – Memory
APL – Automatic Parts Loader	M-FIN – M -code Finished
ASCII – American Standard Code for Information Interchange	MM – MilliMeter
ATC – Automatic Tool Changer	MOCON – Motor Control
ATC FWD – Automatic Tool Changer Forward	MOTIF – Motor Interface
ATC REV – Automatic Tool Changer Reverse	MSG – Message
AWG – American Wire Gauge	MSHCP – Metric Socket Head Cap Screw
BHCS – Button Head Cap Screw	NC – Numerical Control
BT – British Tooling (Common usage)	NC – Normally Closed
CAD – Computer Assisted Design	NO – Normally Open
CAM – Computer Assisted Manufacturing (Assisted Machining)	OD – Outside Diameter
CAT-5 – Category 5 Cable	OPER – Operator
CB – Circuit Breaker	P – Pocket
CC – Cubic Centimeter	PARAM – Parameter
CCW – Counter Clock Wise	PCB – Printed Circuit Board
CFM – Cubic Feet per Minute	PGM – Program
CNC – Computerized Numeric Control	POR – Power On Reset
CNCR SPINDLE Concurrent Spindle with axis motion	POSIT – Positions
CRC – Cyclic Redundancy Check digit	PROG – Program
CRT – Cathode Ray Tube	PSI – Pounds per Square Inch
CT – Caterpillar Tooling	PST – Pallet Schedule Table
CTS – Clear To Send	PWM – Pulse Width Modulation
CW – Clock Wise	RAM – Random Access Memory
DB – Draw Bar	RET – Return
DC – Direct Current	REV CNVR – Reverse Conveyor
DGNOS – Diagnostic	RJH – Remote Jog Handle
DHCP – Dynamic Host Configuration Protocol	RPM – Revolutions Per Minute
DIR – Directory	RTS – Request To Send
DNC – Direct Numerical Control	RXD – Receive Data
DOS – Disk Operating System	SDIST – Servo Distribution PCB
DTE – Data Terminal Equipment	SFM – Surface Feet per Minute
ENA CNVR – Enable Conveyor	SHCS – Socket Head Cap Screw
EOB – End Of Block	SIO – Serial Input/Output
EOF – End Of File	SKBIF – Serial Key Board Inter Face PCB
EPROM – Erasable Programmable Read Only Memory	SMTC – Side Mount Tool Changer
E-STOP – Emergency Stop	SP – Spindle
FHCS – Flat Head Cap Screw	T – Tool Number
FT – Foot	TC – Tool Changer
FU – Fuse	TIR – Total Indicated Runout
FWD – Forward	TNC – Tool Nose Compensation
GA – Gauge	TRP – Tool Release Piston
HHB – Hex Head Bolts	TS – Tail Stock
HP – Horse Power	TSC – Thru the Spindle Coolant
HS – Horizontal Series of Machining Centers	TXD – Transmit Data
ID – Inside Diameter	VDI – Verein Deutscher Ingenieure
IGBT – Isolated Gate Bipolar Transistor	VMC – Vertical Machining Center
IN – Inch	WAN – Wide Area Network
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)	