HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

Mechanical Service Manual 96-0283D RevD English June 2011

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

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

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

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

Haas Automation Inc.

Mill and Lathe Service Manual

Mechanical Components

June 2011

96-0283D

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Common Abbreviations

°/sec or deg/sec – Degrees per second
µ – Micron
AC – Alternating Current
AMP (or A) – Ampere
APC – Automatic Pallet Changer
APL – Automatic Parts Loader
arc-sec – Arc seconds
ASCII – American Standard Code for Information Interchange
ATC – Automatic Tool Changer
ATC FWD – Automatic Tool Changer Forward
ATC REV – Automatic Tool Changer Reverse
AWG – American Wire Gauge
bar – Metric air pressure
BHCS – Button Head Cap Screw
blocks/sec – Blocks per second
BT – British Tooling (Common usage)
CAD – Computer Assisted Design
CAM – Computer Assisted Manufacturing (Assisted Machining)
CAT-5 – Category 5 Cable
CB – Circuit Breaker
CC – Cubic Centimeter
CCW – Counter Clock Wise
CFM – Cubic Feet per Minute
CMM – Coordinate Measuring Machine
CNC – Computer Numerical Control
CNCR SPINDLE – Concurrent Spindle with axis motion
CRC – Cyclic Redundancy Check digit
CRT – Cathode Ray Tube
CT – Caterpillar Tooling
CTS – Clear To Send
CW – Clock Wise
DB – Drawbar
DC – Direct Current
DGNOS – Diagnostic
DHCP – Dynamic Host Configuration Protocol
DIR – Directory
DNC – Distributive Numerical Control
DOS – Disk Operating System
DTE – Data Terminal Equipment
ENA CNVR – Enable Conveyor
EDM – Electrical Discharge Machining
EOB – End Of Block
EOF – End Of File
EPROM – Erasable Programmable Read Only Memory
E-STOP – Emergency Stop
FHCS – Flat Head Cap Screw
fpm – Feet per Minute
ft – Foot
FU – Fuse
FWD – Forward
GA – Gauge
gal – Gallon
gpm – Gallons per Minute
HHB – Hex Head Bolts
hp – Horsepower
HS – Horizontal Series of Machining Centers
I/O – Input/Output
I/O PCB – Input Output Printed Circuit Board
ID – Inside Diameter
IGBT – Isolated Gate Bipolar Transistor
in – Inch
in-lb – Torque (inch-pounds)
ipm – Inches per Minute
kg – Kilogram
kVA – Kilovolt ampere
kW – Kilowatt
l – Liter
LAN – Local Area Network
lb – Pound
LCD – Liquid Crystal Display
LED – Light Emitting Diode
LO CLNT – Low Coolant
LOW AIR PR – Low Air Pressure
lpm – Liters per Minute
LVPS – Low Voltage Power Supply
m – Meter
m^2 – Square meter
M-FIN – M -code Finished
m/min – Meters per Minute
MB – Megabyte (1 million)
MCD RLY BRD – M -Code Relay Board
MDI – Manual Data Input
MEM – Memory
MHz – Megahertz
mm – MilliMeter
MOCON – Motor Control
MOTIF – Motor Interface
mph – Miles per hour
MSG – Message
MSHCP – Metric Socket Head Cap Screw
N (unit of force) – Newton/newtons
NC – Numerical Control
NC – Normally Closed
Nm – Torque/metric - Newton meters
NO – Normally Open
OD – Outside Diameter
OPER – Operator
oz – Ounce
P – Pocket
PARAM – Parameter
PCB – Printed Circuit Board
PGM – Program
POR – Power On Reset
POSIT – Positions
PROG – Program
psi – Pounds per Square Inch
PST – Pallet Schedule Table
PWM – Pulse Width Modulation
RAM – Random Access Memory
RET – Return
REV CNVR – Reverse Conveyor
RJH – Remote Jog Handle
rpm – Revolutions Per Minute
RTS – Request To Send
RXD – Receive Data

SDIST – Servo Distribution PCB
SFM – Surface Feet per Minute
SHCS – Socket Head Cap Screw
SIO – Serial Input/Output
SKBIF – Serial Key Board Inter Face PCB
SMTC – Side-Mount Tool Changer
SP – Spindle
sq ft or ft2 – Square feet
T – Tool Number
TC – Tool Changer
TIR – Total Indicated Runout
TNC – Tool Nose Compensation
ft-lb – Torque (foot-pounds)
TRP – Tool Release Piston
TS – Tail Stock
TSC – Thru the Spindle Coolant
TXD – Transmit Data
V – Volt
V AC – Volts alternating current
V DC – Volts direct current
VDI – Verein Deutscher Ingenieure
VMC – Vertical Machining Center
WAN – Wide Area Network

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
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. Do not replace the spindle drive if the belt is broken. Find the problem first; don't just replace the easiest part to get to.

There are hundreds of parameters, wires, switches, etc., that you can change in this machine. Don't start randomly changing parts and parameters. Always 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).

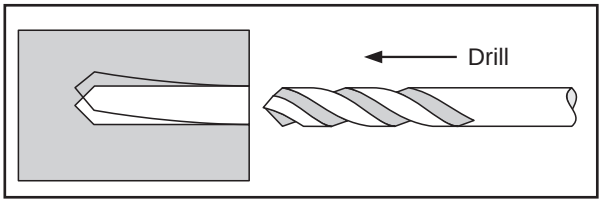
• Cutter diameter too large for depth of cut.

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.

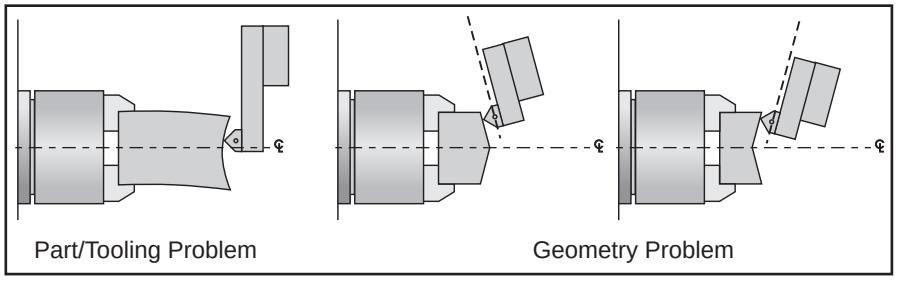
• Check spindle to turret pocket alignment. It may be out of alignment due to a crash or misadjustment.

• 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.

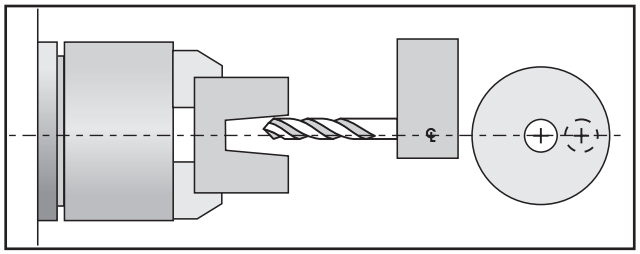
• Check for thermal growth of the ballscrews (see Thermal Growth” section).



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.



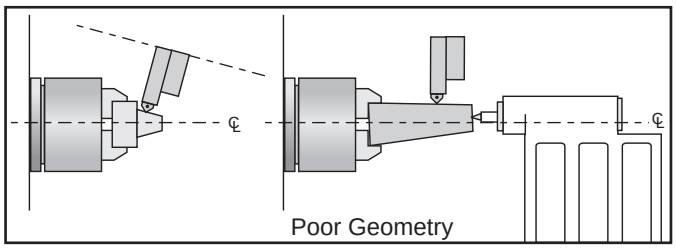
Outside diameter (O.D.) is tapered

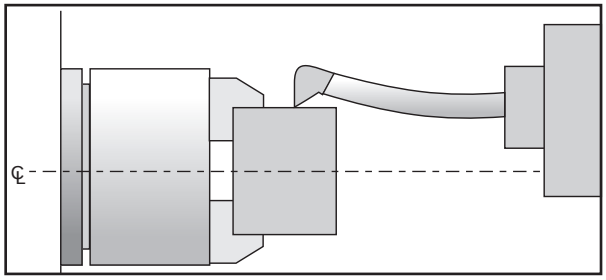
• Check tooling setup. Turning long, unsupported parts can cause a tapered O.D.

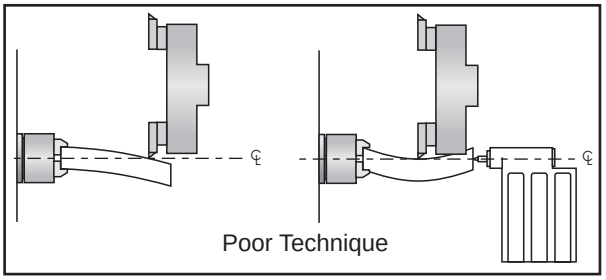
• Check tailstock setup. Excessive hold pressure on the tailstock can distort parts.

• 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.





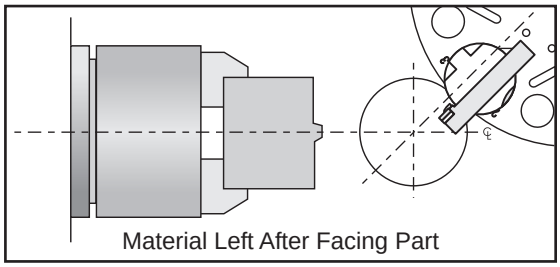


Material left after facing a part

• 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

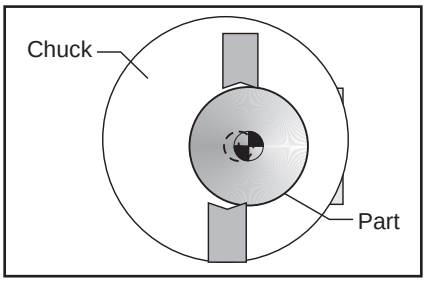
• Check turret alignment.

• 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.

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

LUBRICATION CHART

System	Lubricant	Quantity
Way Lube & Pneumatics		
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
Transmission		
Vertical Mills 40 Taper	Mobil Nuto H46	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
Rotary Table	Mobil SHC 634	Cover sight glass
SHS210 / TR110 / HRT110	Mobil SHC 626	1/4 full on sight glass
Axes		
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)	mobil Vactra #2	1 drop every 10 engages
Hydraulic Brake		
EC-1600/2000/3000 & HS-3/4/6/7 incl R	Mobil DTE 25	Between Min/Max marks on brake booster
HRT110 / HRT450 / HRT600 / TR110	Mobil DTE 25	1/4” to 1/2” below reservoir cap
Hydraulic Power Unit (HPU)	Mobil Nuto H46	8 gal (26.4L) 10 gal. (37.9L) for SL-30B and larger
High Pressure Coolant (HPC)	Mobil 5-30W Synthetic	Reservoir 25% full
Toolchangers (SMTC)		
Standard	Mobil EP 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	Mobil EP 320	

Counterbalance System

Machine Tank Size	Tank Height	Quarts of Oil	# of Pump Strokes
40 cubic feet	23”	2 Mobil DTE 25 per tank	93
80 cubic feet	36”	3 Mobil DTE 25 per tank	140
110 cubic feet	42”	3 Mobil DTE 25 per tank	140

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

Spindle Air Pressure

System	Pressure
Vertical Mills	15 psi
30K 30 Taper	25 psi
Horizontal Mills	25 psi
SR-100 Spindle Taper Constant Air	54 psi
Office Mill	4 psi
MiniMill	25 psi
Grease Pack (GR and TM Series)	3 psi
SL-Series/TL-15/25	10-12 psi
TL-15/25 Subspindle	10-12 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	35 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

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

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

Table (4X)

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

Table (5Deg)

System-EC-630/1600	**Pressure**
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

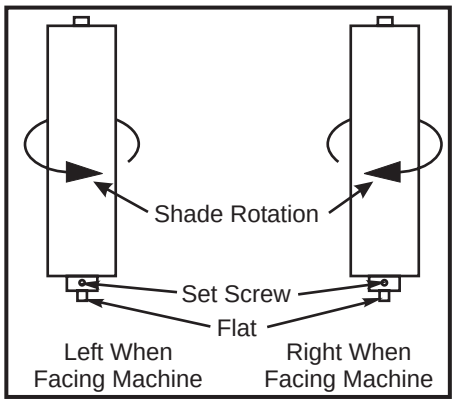
Jog the Z-axis to a position that gains the most access to the way cover to be removed. Horizontal mills with pallet changers: if the way cover closest to the load station, or farthest from the spindle needs to be replaced, rotate the H-frame 45°.

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

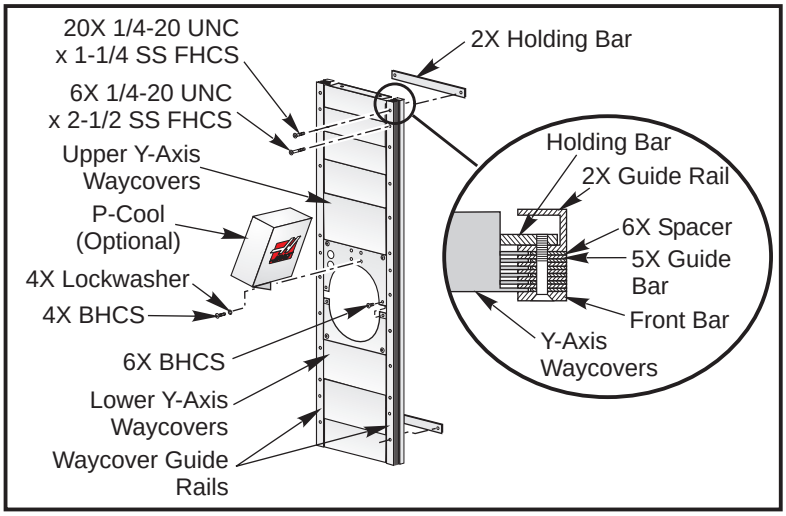
Upper Way Cover - Removal

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 the attach the upper way cover to the spindle head and the lower way cover.



Upper Way Cover - Installation

1. Install the four SHCS at the top of the way cover. Slide it up and down to ensure it moves freely.

2. Slide 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.

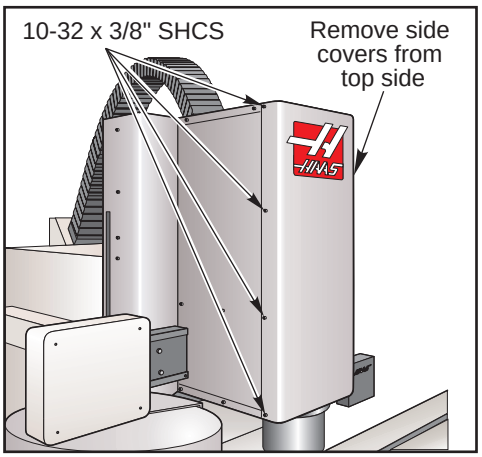
4. Replace the left and right vertical guides using BHCS.

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.

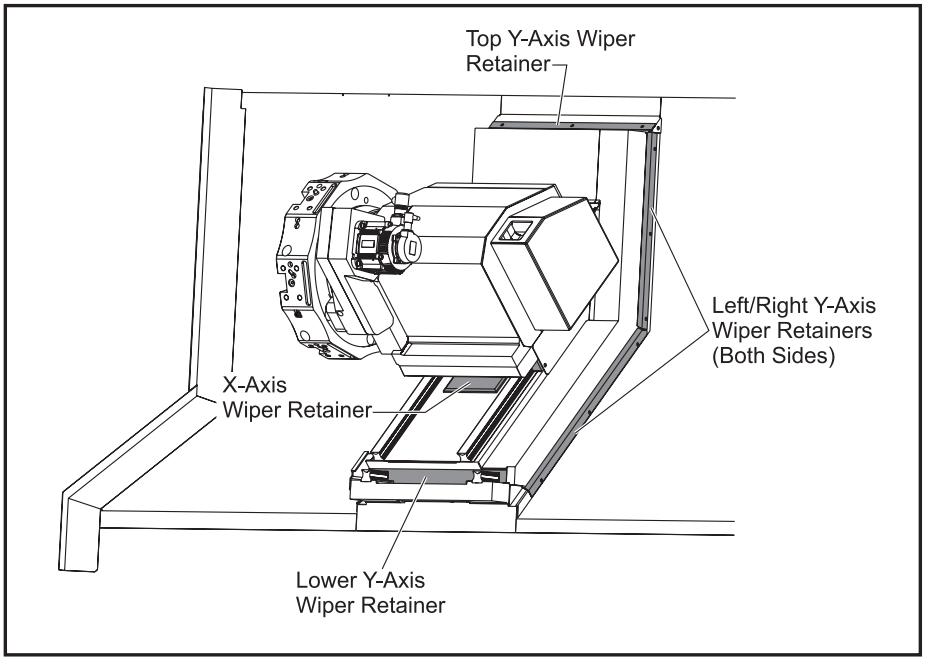
3. Pull the front cover from the bottom until you can disconnect the tool release cable (quick disconnect), then remove the cover. Remove the side covers. Jog Z-axis as necessary to make screw removal easier.

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.

ST-Y Series Lathe Y-Axis Wiper Replacement



1. Examine the Y- and X-axis wipers and determine which wipers need replacing.
2. Remove the fasteners securing the wiper retainer, then remove the retainer/wiper assembly.
3. Position the new wiper and secure with the retainer and fasteners.

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 ½ second before the tool will be released and the tool will remain released for ½ second after the button is released.

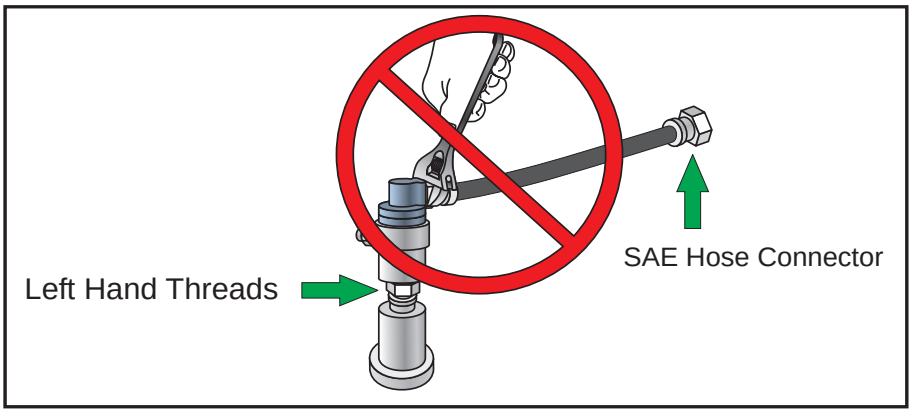
Tool Release Piston Removal

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.**

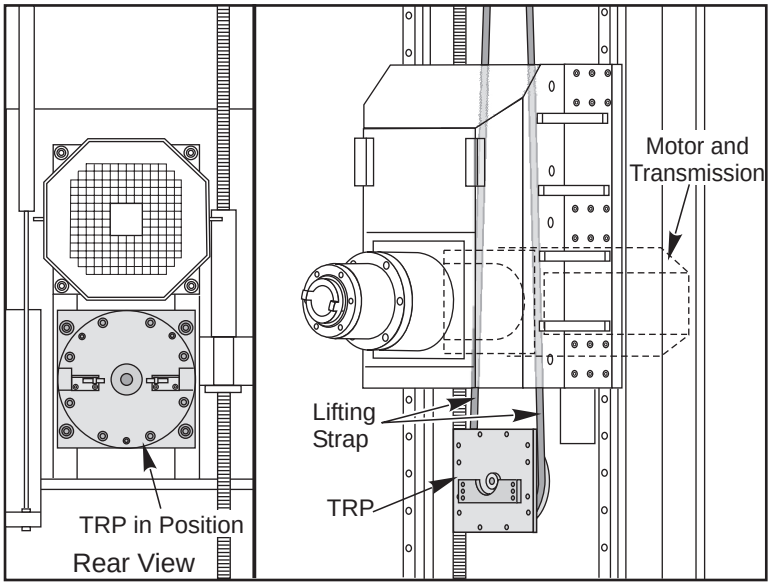
4. Disconnect the air line at the lube/air panel.

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.



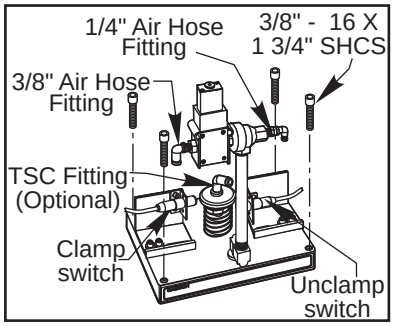
Horizontal Mill Tool Release Piston

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.

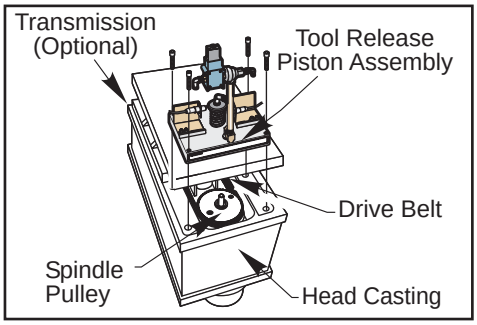
NOTE: Steps 9 and 10 apply only to machines with TSC.

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

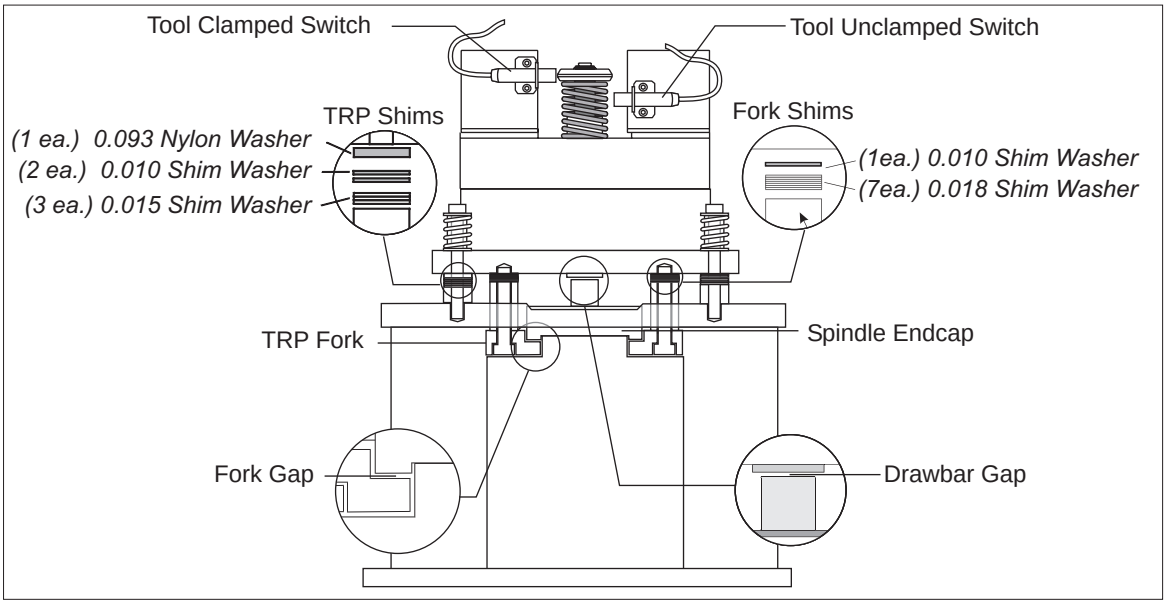
- Set pre-charge
- Adjust the tool clamp/unclamp switches
- Set the drawbar height

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.

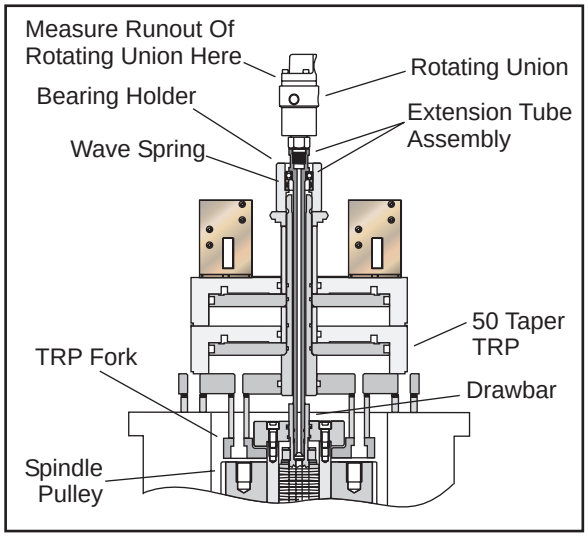
	Part No.	Description	30-0013A (New)	30-0013 (Old Style)
Fork:	(45-0014)	0.010 Shim Washer	1 ea.	None
	(45-0015)	0.018 Shim Washer	7 ea.	5 ea.
TRP:	(45-0019)	0.093 Nylon Washer	1 ea.	1 ea.
Spacers:	(45-0017)	0.010 Shim Washer	2 ea.	2 ea.
	(45-0018)	0.015 Shim Washer	3 ea.	2 ea.

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

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

6. **50 Taper -** 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.

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.

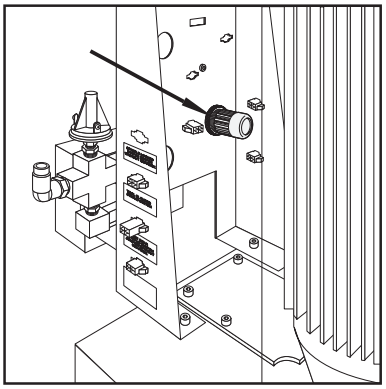
Setting Pre-Charge

Do not perform on machines equipped with Through the Spindle Coolant (TSC). It will damage the machine. Perform adjustments in “Precharge Regulator Adjustment” section.

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

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

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



Air Pressure Regulator Adjustment Knob

2. Verify Parameter 149, Precharge DELAY, is set to 300.

3. Execute a tool change. A banging noise will be heard as the tool release piston contacts the drawbar.

4. Turn air pressure regulator ½ 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. Exces-sive pressure to the precharge system will cause damage to the tool changer and tooling in the machine.

5. Replace the head covers.

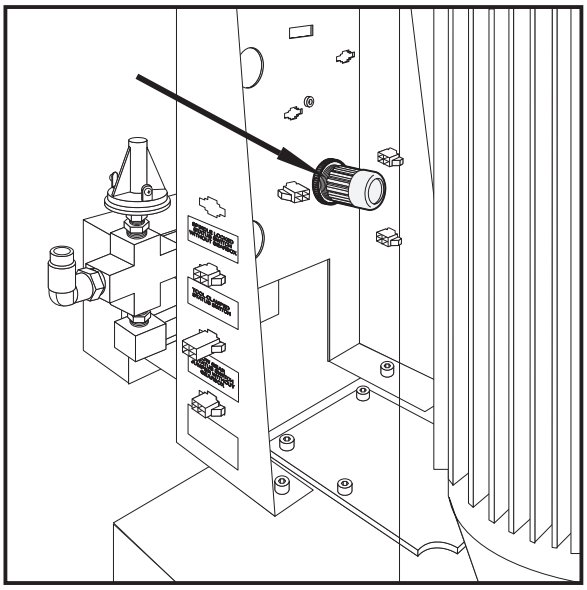
TRP Switch Adjustment

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

1. Install an inline pressure gauge between the regulator and the check valve.

2. Remove the toolholder from the spindle.

3. Rotate the regulator adjusting knob to the fully out position (turn counter-clockwise).



4. Press MDI.

5. Enter #1120=1, and press Cycle Start.

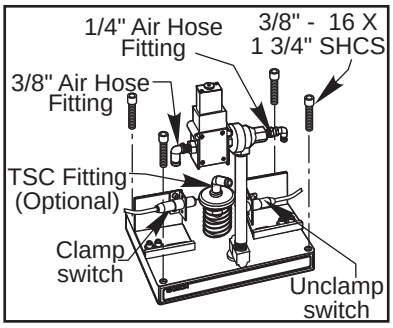
6. Adjust the pressure regulator to 30 PSI and press Reset.

7. Press Cycle Start again to verify that the regulator is set to 30 PSI, then press Reset.

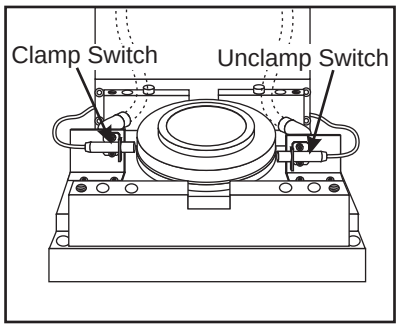
8. Lock the regulator adjusting knob, by pressing it in and remove the inline gauge.

Adjustment Procedure

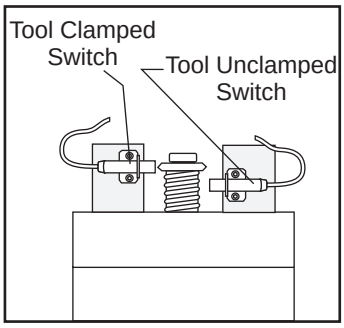
Upon completion of the Tool Release Piston switch adjustment procedure, the switches should indicate that the tool is released from the spindle taper with the tool **0.060”** out of the taper and that the tool is **not** released with the tool **0.050”** out of the taper.



Conventional Spindle Switches



Inline Spindle Drawbar Switches



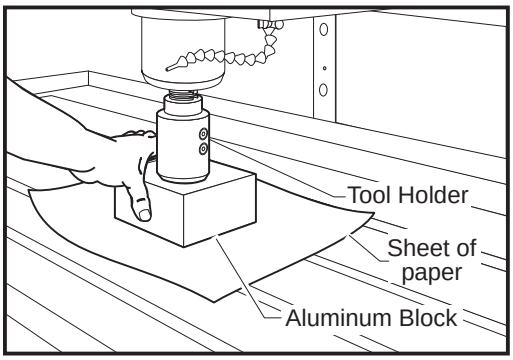
50 Taper Tool Clamp/Unclamp Switches

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.

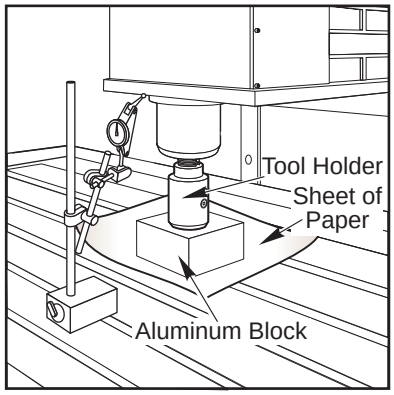


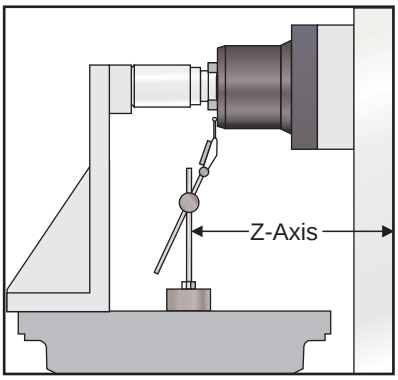
4. Jog Z-axis until the toolholder is about 0.030” above the aluminum block. Switch to .001” increments. Jog one increment at a time until the toolholder just makes contact with the block (should still be able to move the block). This is the Zero Point. **Do not press** the Tool Release button; it will 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.

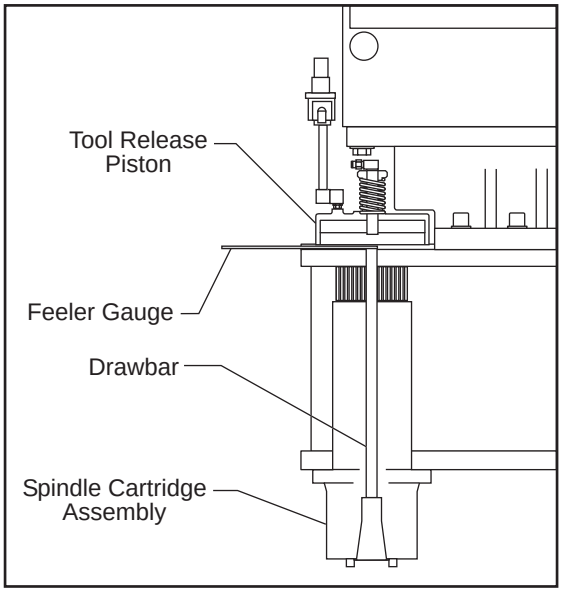
15. Set the pressure regulator back to 85 PSI and set Parameter 76 to 1500.

Upper (Clamp) Switch

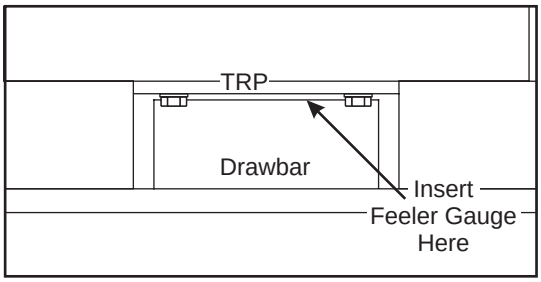
1. Remove the tool holder from the spindle.

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

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

For 30K spindles, note the special instructions in the procedure.

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.

30K Spindle: Jog the Z-axis to .060" 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”.

30K Spindle: The block should be tight at .050", and loose at .060".

If the block moves at .100" (.050" for a 30K spindle), 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" (.060" for a 30K spindle), 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” (.060" for a 30K spindle), remove shim washers. If the block was loose at .100” (.050" for a 30K spindle), add shim washers.

Shim Washer Addition/Removal

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

1. Check tool release tip and drawbar condition and replace damaged parts before setting drawbar height.

2. Remove the tool release bolt.

3. Add or remove the required number of shim washers.

4. Reinstall the tool release bolt.

5. Install the TRP assembly and recheck settings. Adjust as required.

Upper (Clamp) Switch

1. Delete everything in MDI mode and write #1120 = 1.

2. Start with the upper switch all the way in.

3. Place a 0.020” shim between the tool release piston adjustment bolt and drawbar and press Cycle Start.

4. If DB CLS = 0 (tool unclamp), the process is complete. If not, adjust the upper switch out until the switch untrips (DB CLS = 0), and test the adjustment.

5. Press Reset.

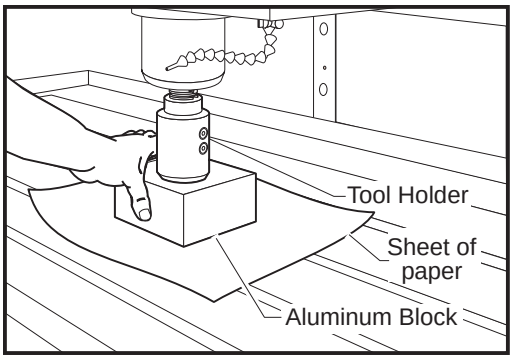
6. Replace the 0.020” shim with a 0.040” shim and press Cycle Start.

7. Verify that DB CLS = 1. Readjust if necessary.

Setting TRP Height

This procedure must be done before adjusting the Clamp-Unclamp switches.
Place a tool in the spindle and place a machined aluminum block on the table under the toolholder (Vert), or set up a fixture to support an aluminum block for horizontal mills. Be sure to place a clean piece of paper under the block to protect the table, or fixture surface.

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



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

40 Taper

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

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

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

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

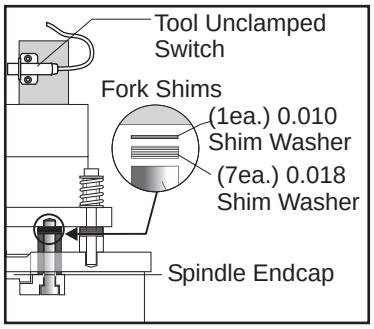
6. If the block moves at 0.100”, jog the Z-axis in the negative (-) direction one increment at a time. Check for movement of the block between increments until the block is tight. Each increment is equal to one piece of shim stock.

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

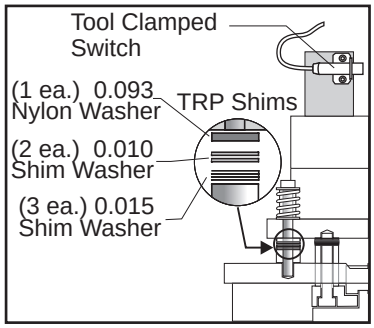
8. If the block is tight at 0.110”, move the Z-axis in the positive (+) direction one increment at a time. Press the Tool Release button and check for movement between increments until the aluminum block is loose.

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

50 Taper



Fork Shim Location



TRP Shim Location

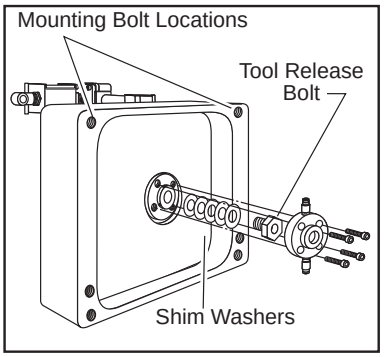
10. The tool push out adjustment is 0.060” +/-0.010”. Add or remove shims from the tool release fork to make adjustments. The shims come in 0.010” and 0.018” thicknesses. Jog away from the plate (upward for Vert) 0.060. Press and hold the Tool Release button, and feel for movement in the aluminum block.

- If the block is tight when the button is pressed, shims may have to be added to the TRP fork.
- If the block is loose when the button is pressed, shims may have to be removed from the TRP fork.
- If the aluminum block is tight at 0.060”, release the button and jog the Z-Axis away from the block 0.001” and press the Tool Release button again. Feel for movement in the aluminum block. Repeat this until movement is felt. Note the last position where the block was tight. If the position is 0.070” or more, add shims to the TRP fork.
- If the aluminum block is loose at 0.060”, jog the Z-Axis toward the block 0.001 at a time and check for movement in the aluminum block. If the position where the block becomes tight is 0.050” or less, remove shims from the TRP fork.

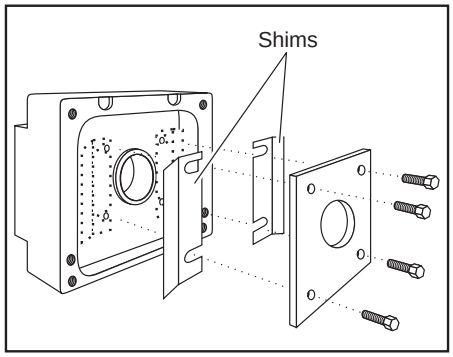
11. If shims were added to the TRP fork, add half that amount to the spacers supporting the TRP. This will keep the two clearance gaps between the TRP and the rotating spindle equal (approximately 0.095” each). If shims were removed from the TRP fork, remove half that number of shims from the spacers.

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

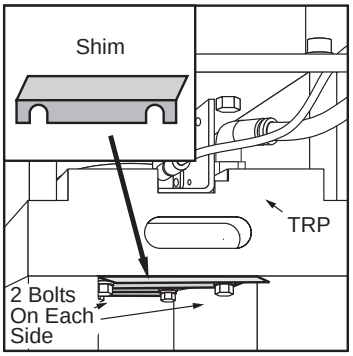
Shims



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.

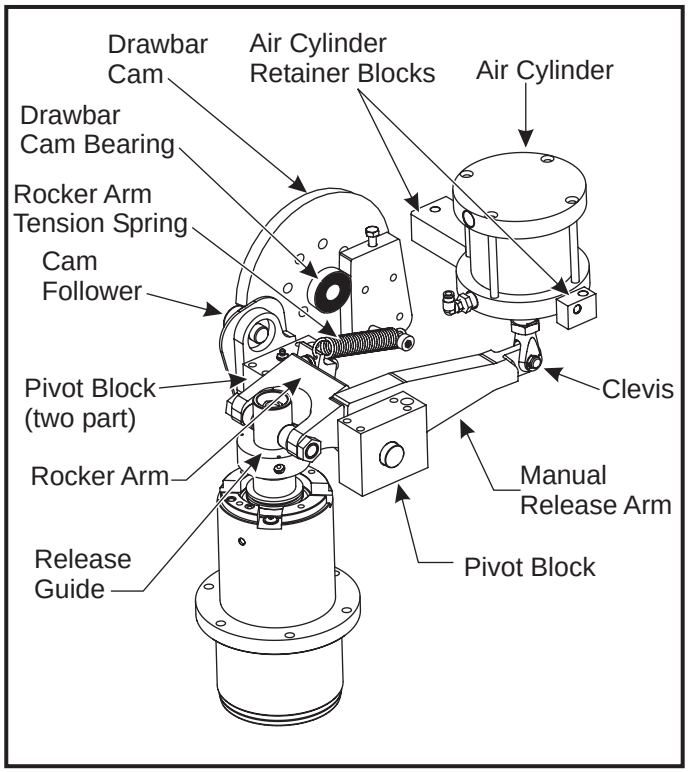
DT-1 Tool Clamp System

Introduction

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

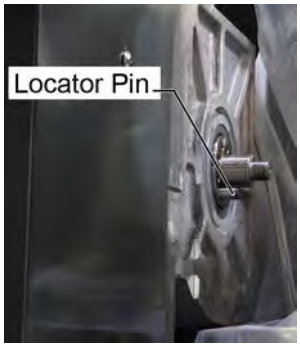
1. Remove the clevis pin from the end of the air cylinder shaft. Access the pin and its retaining C-clips through the hole in the spindle head casting (see photo in the previous section).

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

This adjusts tool pushout when the air cylinder controls tool release during tool loading.

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.

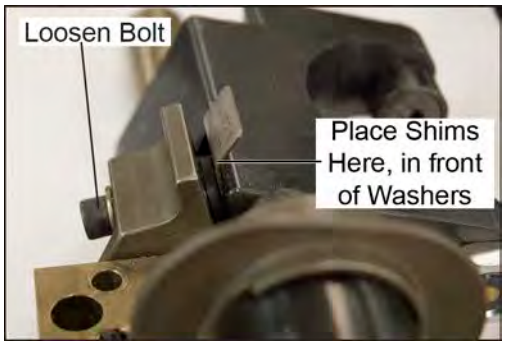
1. Place the split tool in the spindle.

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.

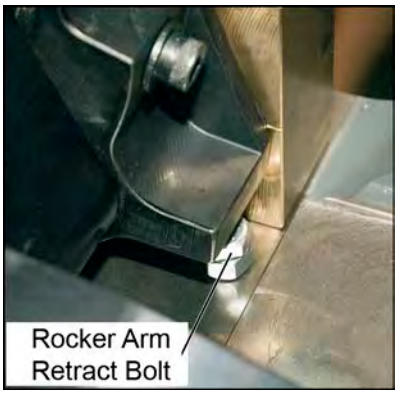
6. To add or remove shims, loosen the connecting bolt in the rocker arm assembly (see photo above). Add or remove shims as needed. Shims provide pushout adjustment at a 1:2 ratio; that is, adding a 0.010” shim will increase pushout by 0.020”.

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

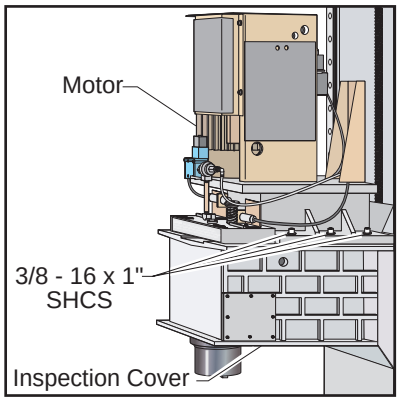
Please read this section in its entirety before attempting to replace the Spindle drive belt.

Drive Belt Replacement (Vert & EC-Series)

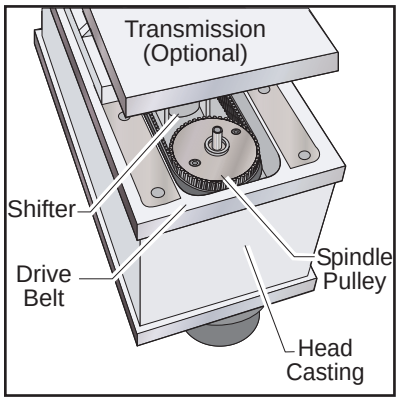
Removal

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 (½” to ¾” max.) to allow the drive belt to be pulled upward over the spindle pulley.

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

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

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

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

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

Installation

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 as sembly and replace the transmission mount plate to the spindle head.

3. a. **Vert:** Tighten the drive belt in accordance with the following section.
   b. **Horiz:** Use a belt tensioning tool to tighten the drive belts. Do not over tighten.

4. Set the spindle orientation (“Spindle Orientation” section).

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

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

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

Drive Belt Tensioning (Vert & EC-Series)

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

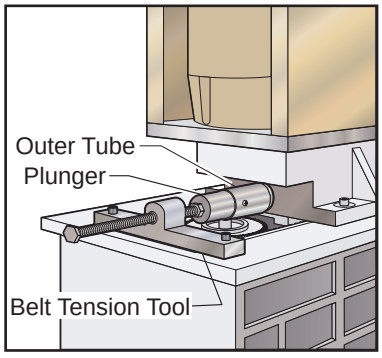
1. Turn the machine On. Jog the spindle head down to a level that will allow access to the drive belt.

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_f (pounds force)/Hz tension readings. Cogged belt tension must be measured in lb_f.

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

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 6th). Take 2 readings at each point.

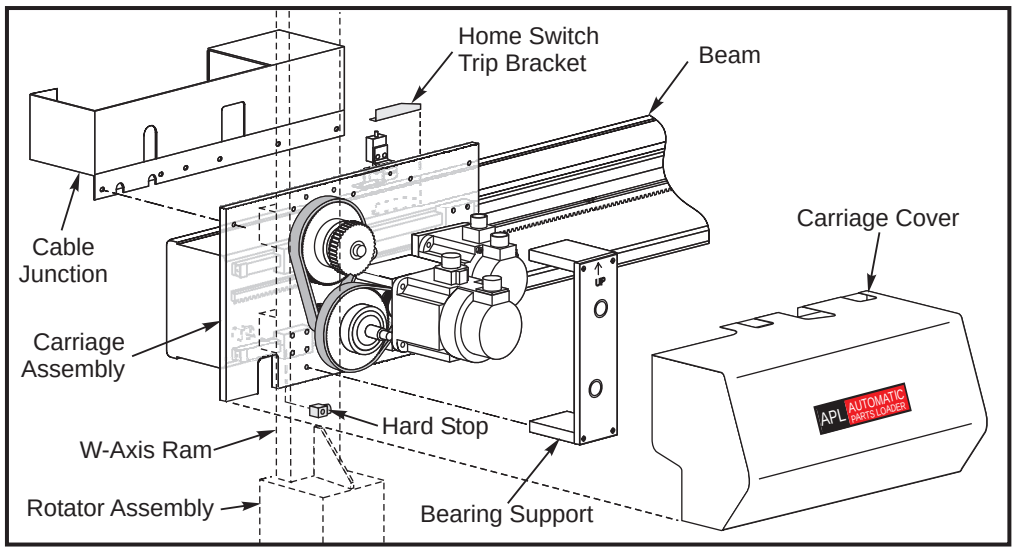
4. Adjust the assembly until the belt tension is between 160 and 180 Hz.

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)

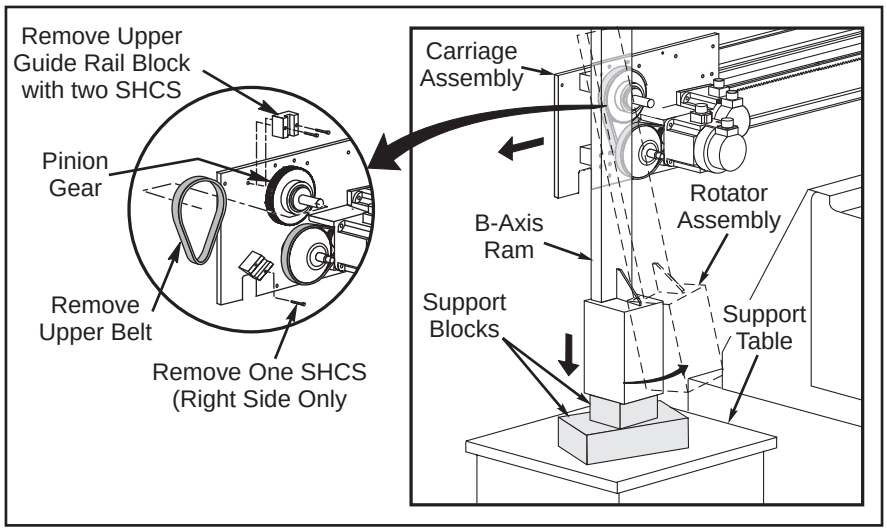
1. Jog the APL U-axis as far to the left of the machine as possible and disable the axis by selecting Parameter 354 and changing the bit value from 0 to 1.

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 pinon 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.

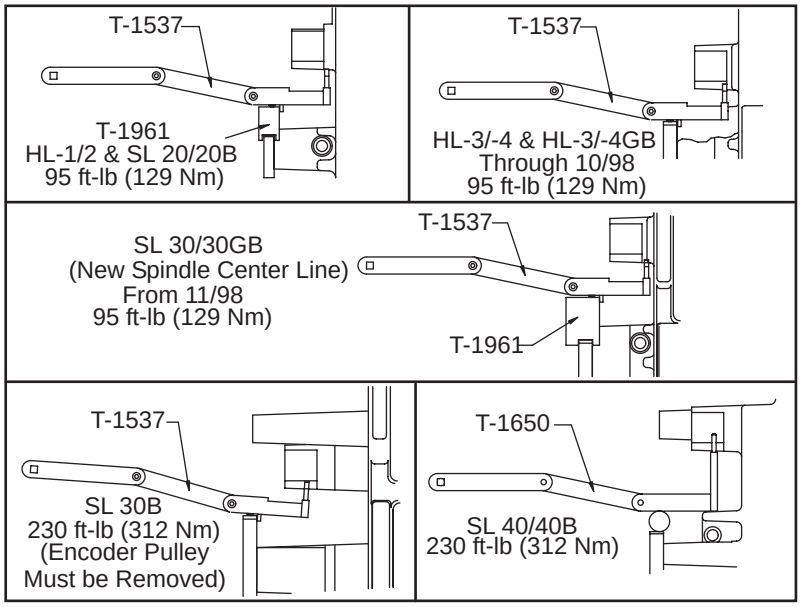
8. Manually push the APL back past the home switch plate to the center of the parts table, Zero Return the W-axis, re-fasten the rubber stop and home plate on the beam.

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.

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

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 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 toolholder inside the spindle taper). It may also occur due to heavy milling, milling with long tooling, or cuts with heavy vibration. This also is the result of thermal expansion.

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

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

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

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

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

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

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

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

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

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

Checking Spindle Oil Flow

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

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

The following gives the range for each type of spindle:

Lathes	1.0cc every two hours.
40 and 50 Taper	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.
30K 30 Taper*	*Airmatic Pumps (These pumps are identified by the addition of a solenoid on top of the pump). Set spindle air pressure regulator to 25 PSI for 30K spindles and 20 PSI for 15K.

*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 for the 30K or 6cc for the 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.

Spindle Vibration Analysis

Vibration analysis is useful for verifying vibration complaints, isolating the issue and can also help determine whether problem vibration is caused by an actual machine malfunction or another reason.

The vibration analyzer produces a plot in which you can identify vibration and noise signatures from various machine components based on their rotational speeds.

Analyzer Software Setup

You can run the analyzer software directly from the included CD-ROM, but it is recommended that you copy the files to your computer's hard drive. This way, the software will save your language and measurement unit settings so you do not need to adjust them every time you use the software.

1. To change the operating language, select File > Language and then choose a language from the pop-out list (English, German, and French are the default available languages).
2. Select Extras > Preferences. Under the Preferences tab, select "inch" under "Measurement system" and "point" under "Decimal separator".

Procedures

Setup

1. Make sure the spindle is warmed up.
2. Connect the power and signal cables to the vibration analyzer sensor unit.

   Mills: place the sensor on the left side of the machine's spindle, parallel to the X-axis.
   Lathes: Place the sensor on top of the spindle head casting, except SL-10 where the sensor is placed on the base of the spindle head casting below the coolant collector.
3. Connect the RS-232 cable from the vibration analyzer control unit to a computer, then turn the computer on and open the analyzer software.
4. In the orange menu bar on the left side, select "Monitoring" and click "yes" at the "connect" prompt.
5. Click on the "spectrum monitoring" button in the toolbar at the top of the window. Make sure that the "FFT" option is selected for "Analysis".

Vibration Analysis (Displacement)

1. To change graph settings, right-click anywhere in the graph window to call up the graph options window. Make the following adjustments:

   a. Set the Y-axis unit to “displacement”.
   b. Set the Y-axis scaling to “0.1 mil”.
   c. Set the Y-axis amplitude to “RMS”.
   d. Set the X-axis to “CPM” (Cycles Per Minute).
   e. Set “Averages” to 16.

2. Run the spindle at maximum RPM until the averages reading at the top of the graph reads 16/16.

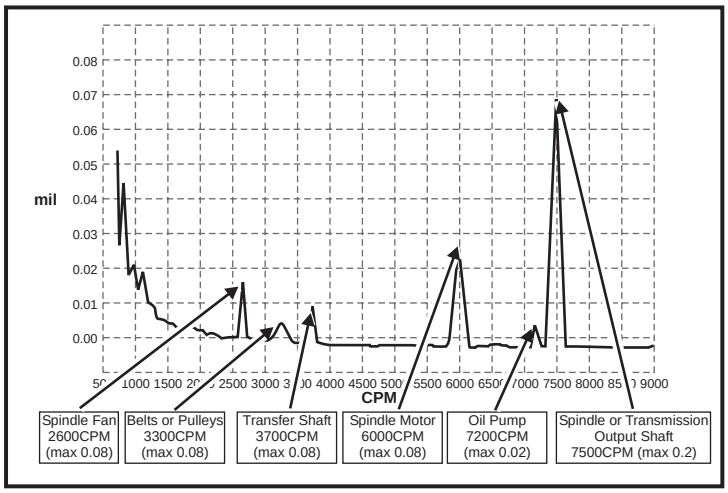
Note: Do not run high-speed spindles at maximum RPM without a balanced tool holder in the spindle.

Noise Analysis (Velocity)

1. Set the Y-Axis unit to “velocity”.

2. Run the test repeatedly, each time changing the “spectrum” setting to the next highest frequency range, from 0-33000 CPM to 390000-453000 CPM.

Results Analysis



Vibration Analysis Sample Plot (7500 RPM Spindle)

1. In the plot view, hover the mouse cursor over an X-axis value to get the Y-axis reading for that point on the graph (a crosshair cursor follows the plotted line as you move along the axis). Refer to the tables at the end of this section to determine the appropriate points to look at. Zoom in on a section of the graph by click-and-dragging the mouse over the section you want to see more closely. Right-click and select “undo zoom” to see the whole graph again.

   In the example above, the various machine components labeled appear in the plot in the X-axis position corresponding to their rates of rotation. Note that this example is a 7500 RPM spindle and so the degree of vibration (Y-Axis) shown at 7500 CPM is spindle vibration and at approximately 0.07 mil displacement is well below the limit (0.2).

2. You can click the “Copy to Clipboard” button in the toolbar to save a copy of the graph. You can then paste the graph into an e-mail, Word or Excel document, or graphics program and save it as an image.

3. If any of the tests indicate too much vibration or noise, repeat the test with belts removed. In the case of an inline spindle with no spindle drive belt, remove the spindle and mount the indicator on the lower lip of the side of the spindle head casting. Note that this sensor position does not provide valid vibration data for the machine; use it only to isolate the cause of vibration or noise for diagnostic purposes.

7500 RPM Spindle Displacement Plot		
Description	**CPM**	**Max (mil)**
Spindle Fan	2600 CPM	0.08
Belts or Pulleys	3300 CPM	0.08
Transfer Shaft	3700 CPM	0.08
Spindle Motor	6000 CPM	0.08
Oil Pump	7200 CPM	0.02
Spindle or Transmission Ouptut Shaft	7500 CPM	0.2

7.5K Noise (Velocity) Plot: Check the value for the highest peak over 20,000 CPM. The value should not exceed 0.005. View all plots up to 453K CPM.

10,000 RPM Spindle Displacement Plot		
Description	**CPM**	**Max (mil)**
Spindle Fan	2600 CPM	0.08
Belts or Pulleys	4400 CPM	0.08
Transfer Shaft	4900 CPM	0.08
Oil Pump	7200 CPM	0.02
Spindle Motor	8000 CPM	0.08
Spindle or Transmission Ouptut Shaft	10000 CPM	0.2

10K Noise (Velocity) Plot: Check the value for the highest peak over 20,000 CPM. The value should not exceed 0.005. View all plots up to 453K CPM.

12,000 RPM In-Line Spindle Displacement Plot		
Description	**CPM**	**Max (mil)**
Spindle	12000 CPM	0.2

12K Noise (Velocity) Plot: There should be no peaks over 20,000 CPM that exceed 0.01 in/sec. There should also be no more than four peaks over 0.005 in/sec. Ignore spikes at 12K and 24K CPM. View all plots up to 453K CPM.

15,000 RPM 40 Taper Spindle Displacement Plot		
Description	**CPM**	**Max (mil)**
Spindle Fan	2600 CPM	0.08
Oil Pump	7200 CPM	0.02
Spindle Motor	12000 CPM	0.08
Spindle or Transmission Output Shaft	15000 CPM	0.2

15K Noise (Velocity) Plot: 7.5K Noise (Velocity) Plot: Check the value for the highest peak over 20,000 CPM. The value should not exceed 0.005. View all plots up to 453K CPM.

30,000 RPM Spindle Displacement Plot		
Description	**CPM**	**Max (mil)**
Spindle	30000 CPM	0.04

30K Noise (Velocity) Plot: Not to exceed 0.06 in/sec at 30,000 CPM, 0.02 in/sec at 60,000 CPM, and 0.01 in/sec at multiples of 30,000 after 90,000. At CPM values between multiples of 30,000 from 30K and up, not to exceed .005 in/sec. View all plots up to 453K CPM.

DT-1 15,000 RPM 30 Taper Spindle Displacement Plot		
Description	**CPM**	**Max (mil)**
Spindle	15000 CPM	0.06

DT-1 Noise (Velocity) Plot: Take four plots: 0-32K / 30-90K / 90-150K / 150-210K CPM. Spikes between 30-60K must not exceed 0.015 in/sec. Spikes between 60-210K must not exceed 0.010 in/sec. View all plots up to 453K CPM.

Office Mill 30K, 40K 20 Taper Spindle Displacement Plot
Take plots at 10K intervals up to spindle maximum RPM. Take two displacement plots at each speed, one at at 0-32K CPM and the other at 30-90K CPM. Plot spikes must not exceed 0.02 mils.

Office Mill Noise (Velocity) Plot: Take 8 plots at all ranges from 0-32K to 390-450K CPM. Plot spikes at the CPM value equal to maximum spindle speed (30K or 40K as applicable) must not exceed 0.06 in/sec; spikes at CPM values above max spindle speed must not exceed 0.02 in/sec. View all plots up to 453K CPM.

5,000 and 10,000 RPM 50 Taper and Gearbox Spindles Displacement Plots		
Description	**CPM**	**Max (mil)**
Spindle or Output Shaft (5K)	5000 CPM	0.1
Spindle or Output Shaft (10K)	10000 CPM	0.06
Gear box spindles: Take plots in low gear, at 1 RPM below the shift point indicated in Paramter 142, as well as maximum RPM.		

50 Taper and Gearbox Spindle Noise (Velocity) Plot: Not to exceed 0.005 in/sec at the highest consecutive peak above 20,000 CPM. View all plots up to 453K CPM.

Lathe Displacement Plots		
Model	**Prior to 2002 (Max. mils)**	**2002 and Later (Max. mils)**
Mini Lathe	0.200	0.200
SL-10	0.100	0.100
SL-20	0.250	0.120
SL-20B	0.180	0.180
SL-30	0.180	0.120
SL-30B / 40 / 40B	0.350	0.350
Sub-Spindle	0.200	0.150
TL-1/2/3	N/A	0.050
TL-3W/3B/4	N/A	0.350

Lathe Noise (Velocity) Plot: All lathes except TL-3W/3B/4, not to exceed 0.005 in/sec above 50K CPM. TL-3W/3B/4, not to exceed 0.01 in/sec. View all plots up to 453K CPM.

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.

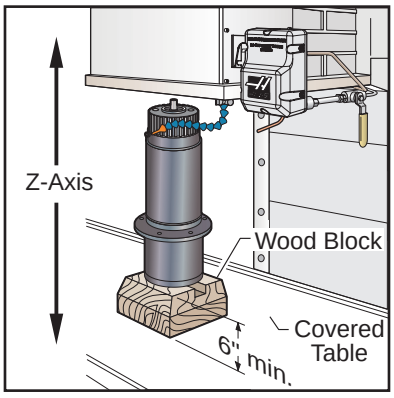
NOTE: When replacing a new design spindle in any vertical machine, it is important to note that the cavity between the housing and the spindle cartridge will be filled with either oil or grease. An oil filled spindle is identified by the oil fill hole to the left side of the spindle head near the spindle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



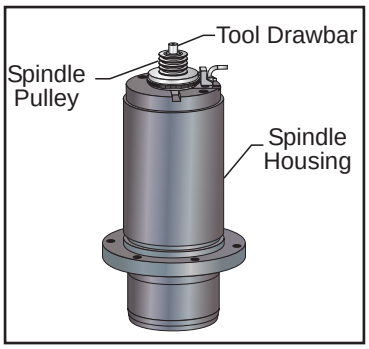
Position Wood Block Under Spindle

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.

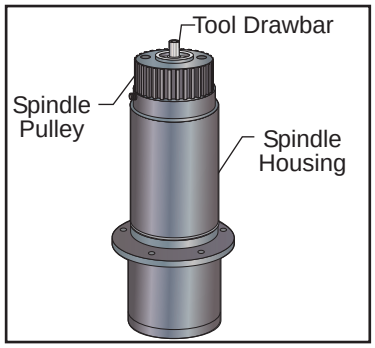
11. Remove the 6 bolts from the spindle.

12. **Vert**: Jog the Z-axis up slowlyuntil it is completely free of the casting.
Horiz: Slide the spindle out of the casting.
In-line drive: Remove spider coupling and transfer tube from the spindle or motor. Check these two components for any irregularities, and replace if needed.

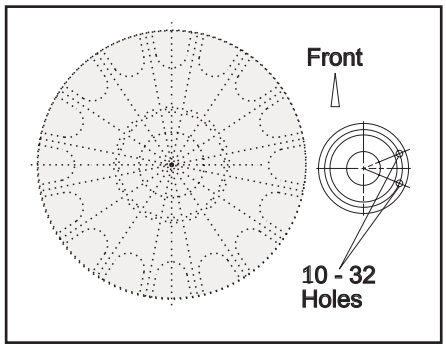
Installation



30K Spindle Cartridge



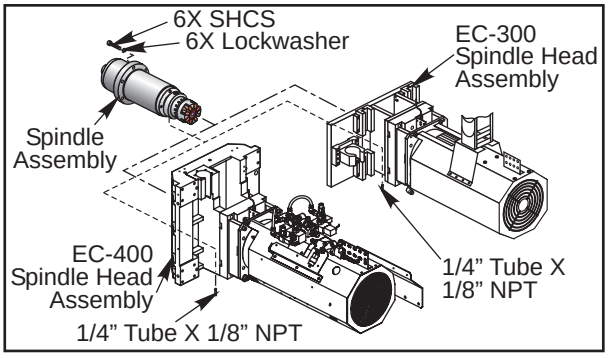
Vertical Spindle Cartridge

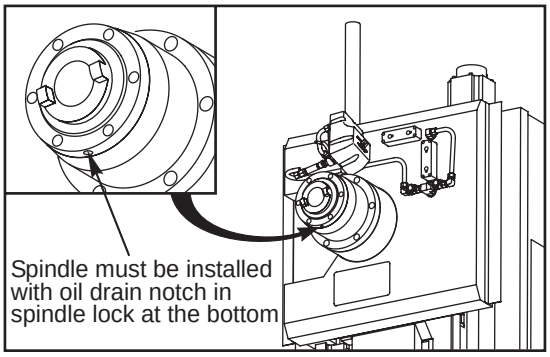


Underside View of Vertical Spindle Cartridge

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.

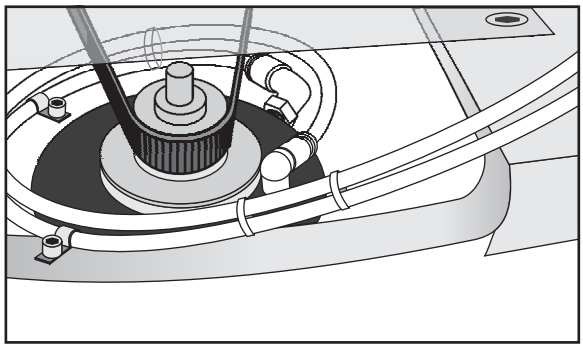
HORIZ only: Refer to “Spindle Troubleshooting - Overheating” and use the spindle run-in program. Verify that the spindle temperatures are acceptable.

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. Apply a light coat of lithium grease to the spider coupling and install 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.

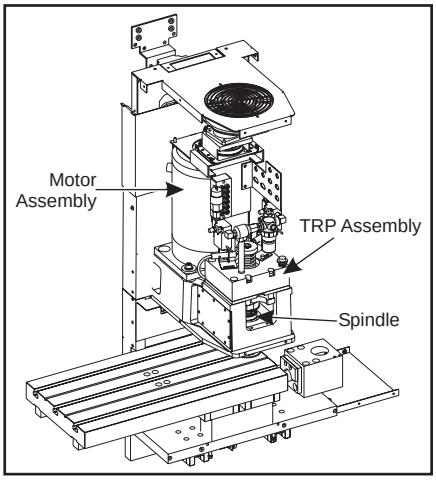
    b. **Vert:** Check for correct amount of lubrication to the spindle bearings (0.5-1.0cc every two hours) in an air mist-lubricated spindle.

- 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

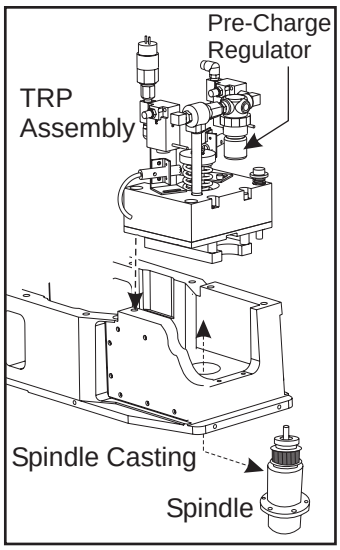


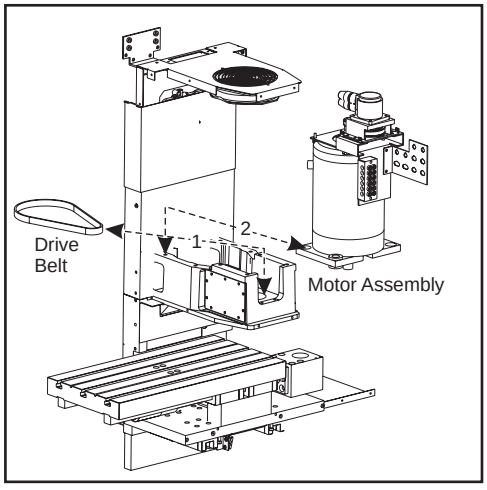
OM2A Spindle Assembly

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 6th). 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.

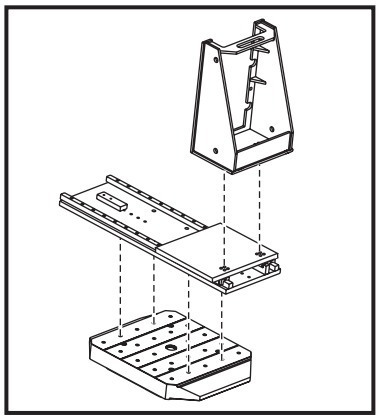
19. Run program O02025 (Spindle Run-in) to break in the spindle. This program will take approximately six hours to complete.

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

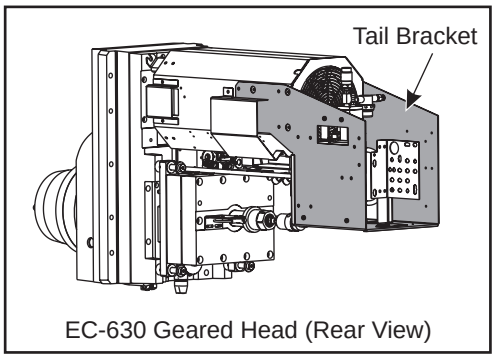
This procedure is the same for both service fixtures.

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.



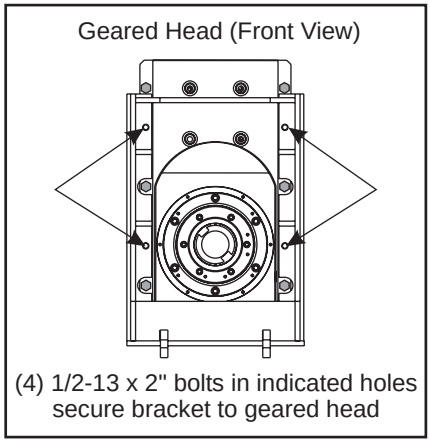
EC-630 Geared Head (Rear View)

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.

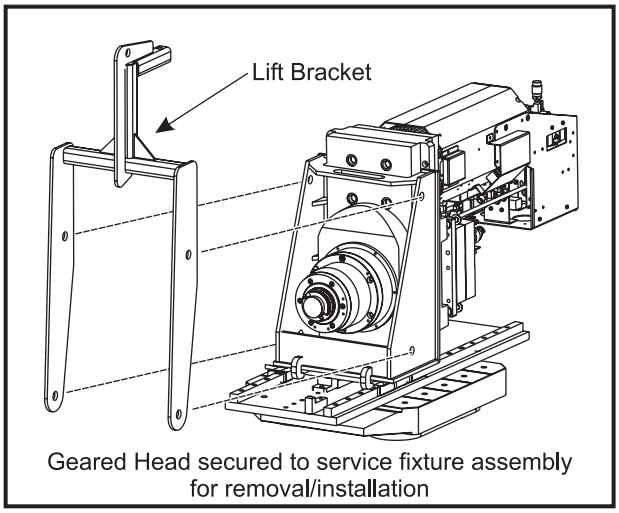
6. On the I/O board inside the control cabinet, remove the connector on P3 and replace with a tool changer jumper (33-8521). Remove the connector on P15 and replace with a spindle status jumper (33-8668A). install an encoder jumper, TRP unclamp jumper, motor overheat jumper, and disable GB in Parameter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

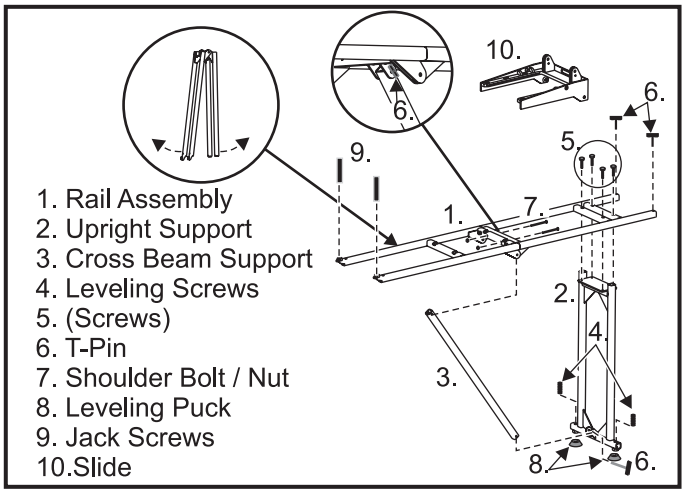
Load Station Fixture

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.

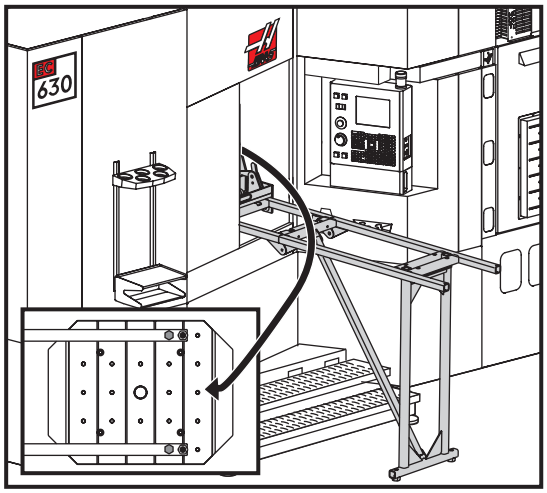
2. Remove the four screws holding the geared head bracket to the fixture slide. Using a crane or forklift, carefully lift the geared head out of the pallet load station. Set the geared head down on the pallet on which the service fixture was shipped, and secure it to the pallet using four 1/2-13 x 1”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

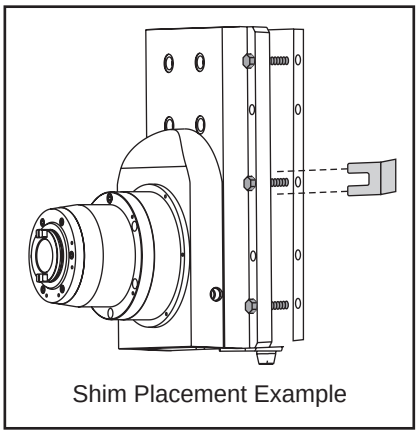
3a. **(Load Station Method)** Command a pallet change. Jog the Z-axis forward for sufficient clearance and jog the A-axis to -90 degrees. Jog the Z-axis toward the machine column. Remove the T-pin and slide the geared head into the column, jogging the axes as necessary to align the geared head bolt holes 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.



Shim Placement Example

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.

9. 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.

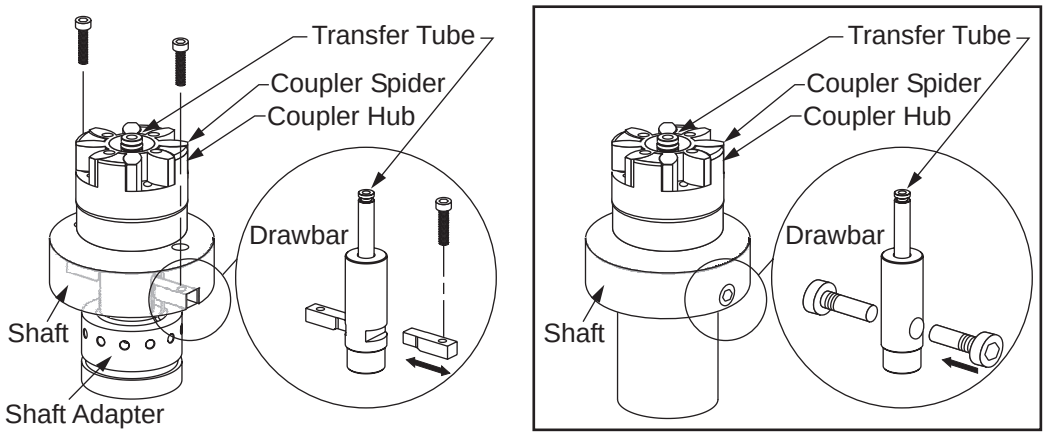
NOTE: Direct drive machines do not require movement of the drive assembly to access/remove the drawbar.

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.



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.

EC-630 Drawbar Replacement

Tools Needed

Haas Mechanical Service Manual
Drawbar Force Gauge part number D1001-H
Spindle Lock 50 Taper part number T-2080
3/8 drive socket wrench
3/8 drive torque wrench
Grease Mobil CM-P part number 99-0007
SAE combination wrench set
3/8 drive 5/16 hex bit
Flashlight
Masking tape
5/32 T-handle or hex bit
12” adjustable wrench
3/8 drive 12” extension

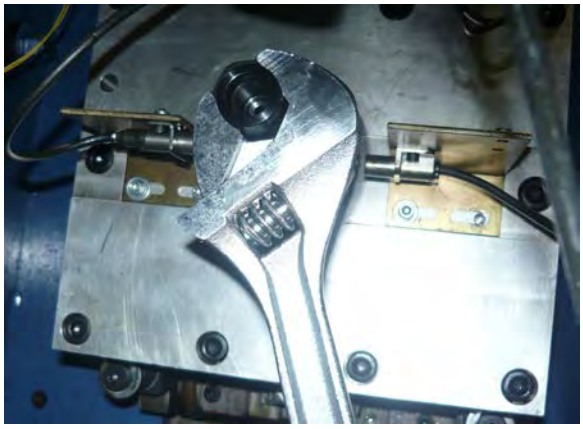
1. Remove the air supply to the machine and press in the Emergency Stop button.

2. Remove one of the bolts on the spindle bearing cap. Use a longer 3/8-16 bolt and tool T-2080 to lock the spindle. Do not tighten more than 25 ft lbs.

3. Remove the TSC (Through Spindle Coolant) coolant union and extension tube (Note: These parts have a left-hand thread).

4. Disconnect the two TRP (Tool Release Piston) switches.

5. Mark and remove the three air hoses at the top of the TRP. Ensure the main air supply to the machine is disconnected before unplugging these hoses.



6. Remove the encoder belt and entire encoder assembly. The encoder cable must stay connected so that the machine can stay powered up.

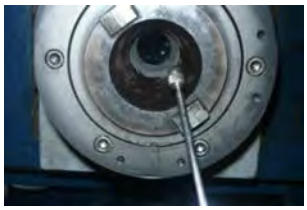
7. To prevent the TRP shims from getting lost, put masking tape around the shims and spacers before removing the bolts. This will keep the shims attached to the spacers.

8. Remove the bottom two TRP bolts only. Remove the spacers and shims. Place a piece of wood under the TRP to support it. Note: The TRP is heavy and it is not recommended to remove from the machine.

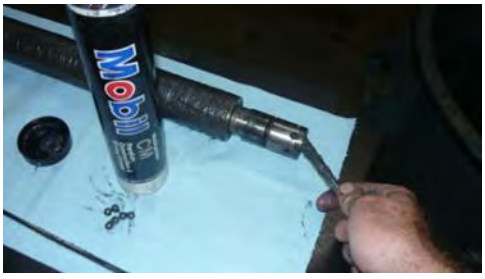
9. Once the TRP is supported, remove the top two bolts, spacers and shims. The TRP is now separated from the machine. The spindle head can be carefully jogged upward until the backside of the spindle is accessible.

10. Remove the eight spindle cap bolts.

11. Pull the drawbar out of the back of the spindle. The drawbar may stick in the bore. In this case use a 3/8 drive 12” extension to push it out. Lightly tap on the extension with a plastic or rubber mallet avoiding damage to the spindle taper and drawbar. Some of the retention balls may have fallen into the spindle bore. Make sure all retention balls and any broken springs are removed from the bore with a magnet.



12. The drawbar retention balls are held in place with moly grease until the drawbar is installed. Verify that they cannot be pushed through the ball sockets. Note that the replacement drawbar is already greased. No more grease is needed.



13. When installing the drawbar, make sure the ¼” dowel pin at the top of the drawbar lines up with groove at the top of the spindle bore. Push on the drawbar to make sure it is seated in the shaft bore.

14. Install the nylon washer.

15. The spindle cap has a hole for a small roll pin. This roll pin must line up with a small hole at the top of the spindle shaft. This ensures that the cap is oriented correctly for balancing.

16. Tighten the eight bolts on the spindle cap to 25 foot pounds in a star pattern.

17. Re-install encoder, TRP, extension tube, and coolant rotary union.

18. Remove Spindle Lock tool. The original 3/8-16 bolt is tightened to 35 ft lbs.

19. Re-install encoder assembly and encoder belt.

20. Test function of tool release.

21. Test drawbar force with the force gauge part number D1001-H. Drawbar force on a new drawbar should be between 3700 and 4200 lbs.

22. Verify drawbar height and adjust if needed.

23. Adjust spindle orientation to ATC double arm.

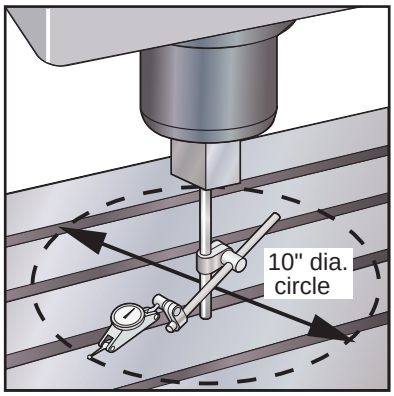
Mill Spindle Sweep Adjustment

Vertical Mills

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

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

2. Establish a reference point (indicator zero), sweep the three remaining points and record the reading.



Spindle Sweep Area

3. Shim the spindle, if necessary, to correct the spindle sweep to specifications.

4. Recheck sweep. It must be within .0005” in both X/Z and Y/Z planes, as stated in the inspection report supplied with the mill.

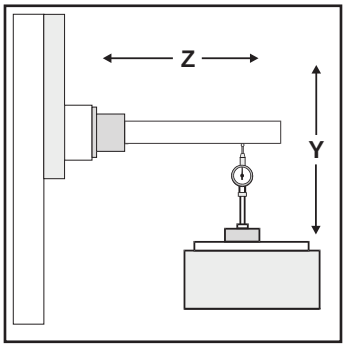
Horizontal Mills

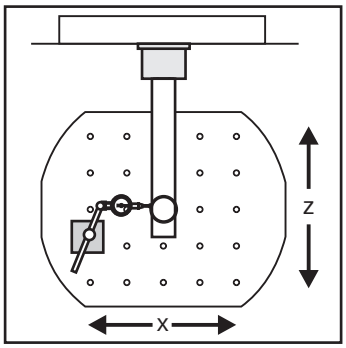
NOTE: The machine must be properly leveled for the spindle sweep adjustment to be accurate.

1. Place an indicator on the table and insert a 6” precision test bar into the spindle.

2. Jog the Z-axis while indicating the bottom, then the side, of the test bar. The readings must be within 0.0005”/10” in both the Y/Z and X/Z planes, as stated in the inspection report supplied with the machine.

3. Shim the spindle, if necessary, to correct the spindle sweep to specifications. Recheck spindle sweep.





Spindle Orientation

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

1. Place the machine in low gear.

2. Adjust Parameter 257, “Spindl Orient Ofset”, until the spindle dogs are parallel to the X-axis. Ensure that the dogs are within 0.030” using a dial indicator.

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

A, B Axis Re-Alignment (Vert)

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

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

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

Lathe Spindle Assembly

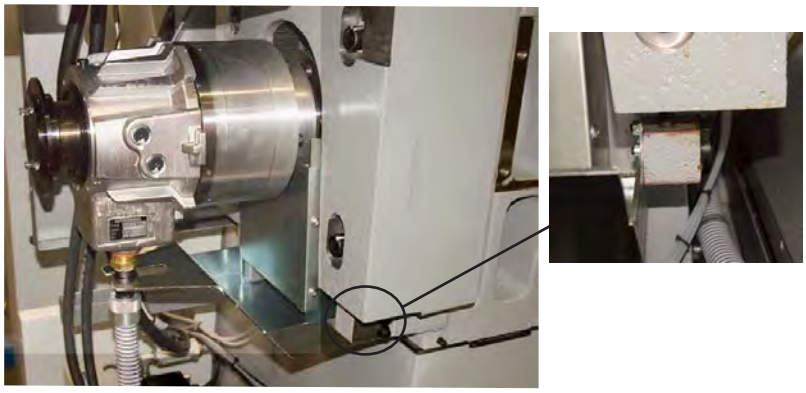
ST Lathe Main Spindle Removal

1. Remove the left side panel

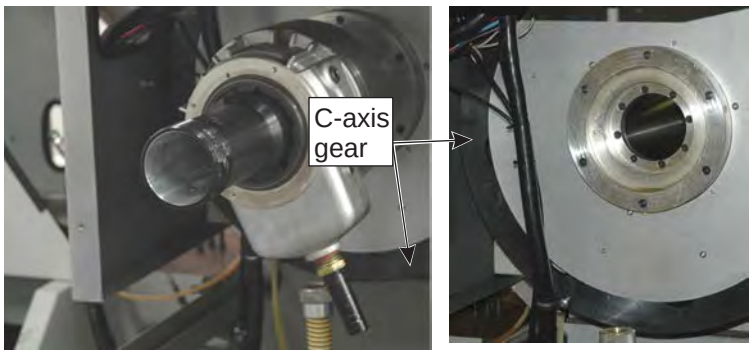
2. Remove the chuck. Tape the threads on the drawtube to protect them.

3. Disconnect the hydraulic pressure and return hoses. Mark the clamp/unclamp hydraulic hoses before removal to ensure correct reinstallation

4. Remove the anti-rotation bracket - There are two bolts on each side of the anti-rotation bracket.

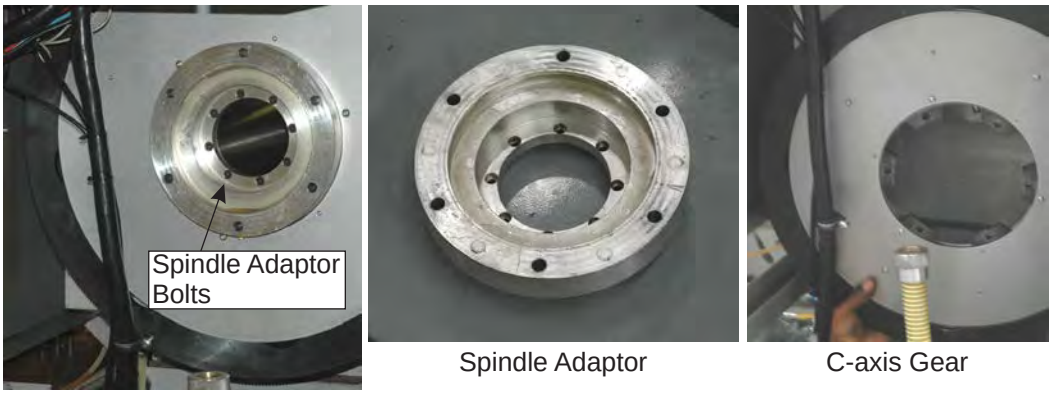


5. Remove the actuator bolts. If the lathe is equipped with a C-axis, the bolts are accessed behind the C-Axis gear.



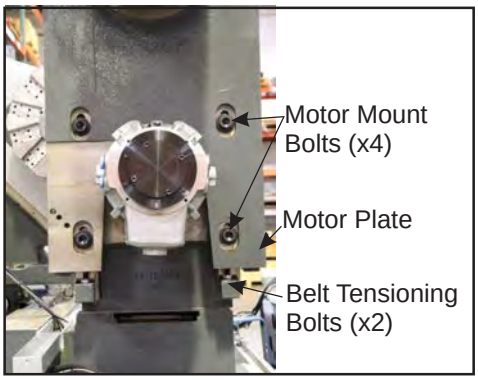
6. Remove the actuator

7. Remove the spindle adapter bolts. This will also remove the C-axis gear if equipped.



Spindle Adaptor C-axis Gear

8. Loosen the motor mounting bolts just enough for the motor plate assembly to slide. Loosen the belt tensioning bolts to remove the belt.

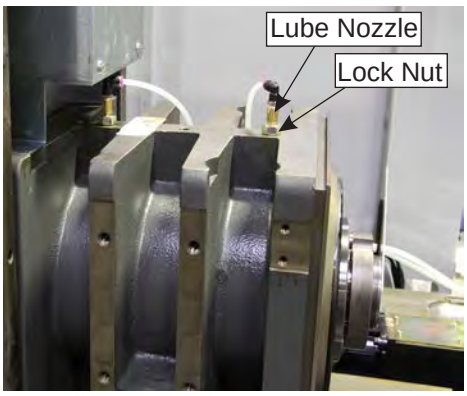


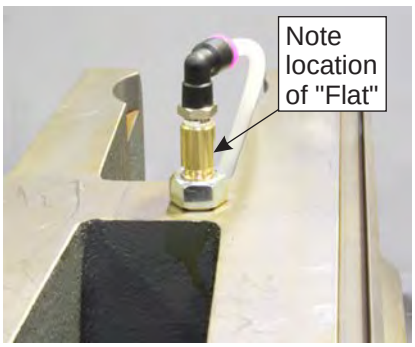
9. Remove the bolts from the spindle gear and slide the spindle gear from the spindle shaft

10. Remove the bolts from the spindle retaining ring and remove the ring

11. Remove the front left panel, to access to the spindle lube nozzles

12. Disconnect the lube lines and then loosen the locking nuts. Unscrew and remove the spindle lube nozzles.





13. Remove the spindle carefully through the spindle casting. The spindle will come out towards the inside of the machine.

Lathe Spindle Removal (Other)

This section describes removal of the HL,SL, Toolroom and Mini-Lathe spindle

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.

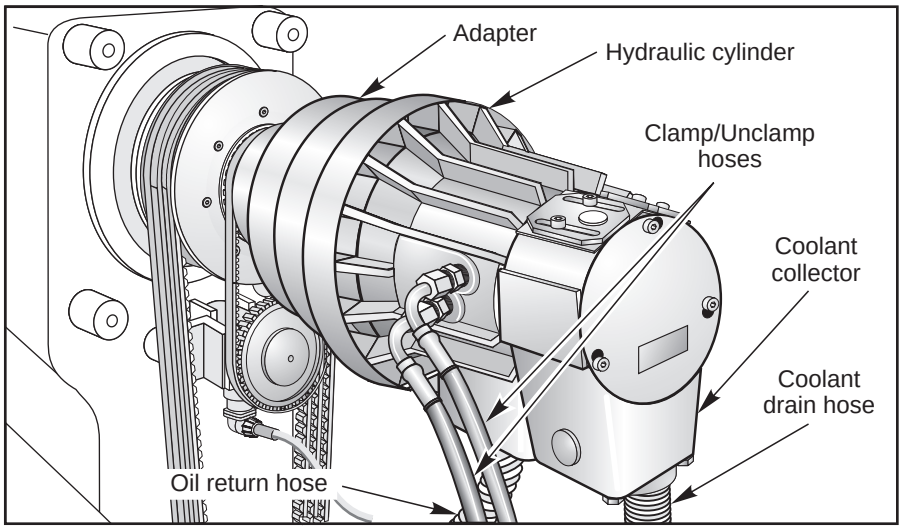
TL and ML: Remove the SHCS that secure the spindle front cap to the spindle housing and remove the spindle cartridge from the motor end of the spindle housing.

2. Disconnect oil return hose and coolant drain hose from the hydraulic cylinder, and disconnect.the anti- rotation bracket.

3. Loosen the hydraulic clamp and unclamp hoses from the hydraulic cylinder, then remove.

4. Loosen the SHCS from the adapter, and detach the hydraulic cylinder.

5. Loosen the SHCS on the inside of adapter, and detach from spindle shaft.



Hydraulic Cylinder

6. Loosen the four SHCS holding the spindle motor. Slide the motor up by squeezing the belts. Tighten the SHCS and remove the drive belts from the spindle assembly.

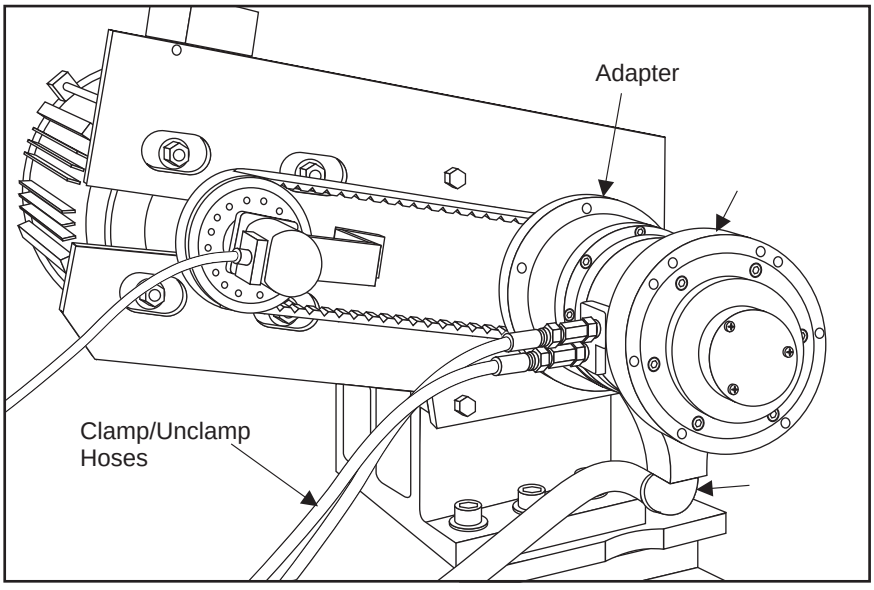
7. Unplug the encoder. Unscrew the encoder bracket, remove the encoder, then remove the belt. SL-10 - You do not have to remove the encoder.

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.

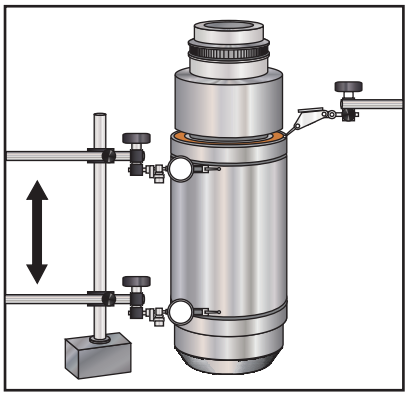


SL-10 Hydraulic Cylinder (Coolant Collector not Shown)

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”.

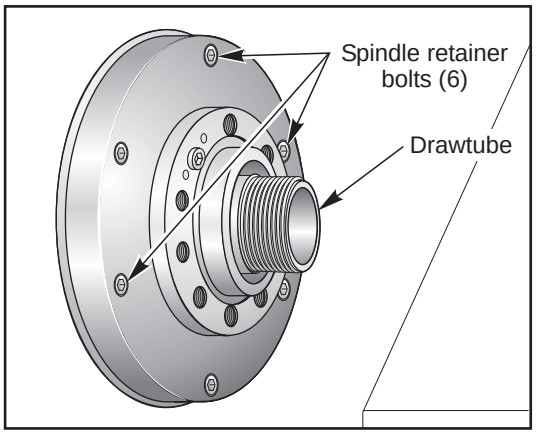


2. Install spindle into housing. Check location of oil holes for proper alignment.

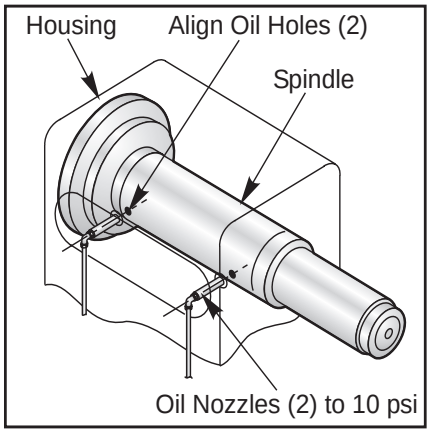
3. Place the retainer ring on the spindle with the O-ring toward the spindle. Ensure that the drain holes are at the bottom of the retainer ring and that the O-ring remains in place.

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.

10. Clean hydraulic union threads and check the threads by assembling the tube to the union and the nut to the other end.

11. Unscrew the tube half way and apply removable threadlocker to the last 4 threads of the drawtube. Tighten the tube.

12. Install the assembly to the spindle

13. Install the return hose barb to the union. Do not use a plastic hose barb.

14. Install the anti-rotation bracket. Make sure this does not push on or bind the union.

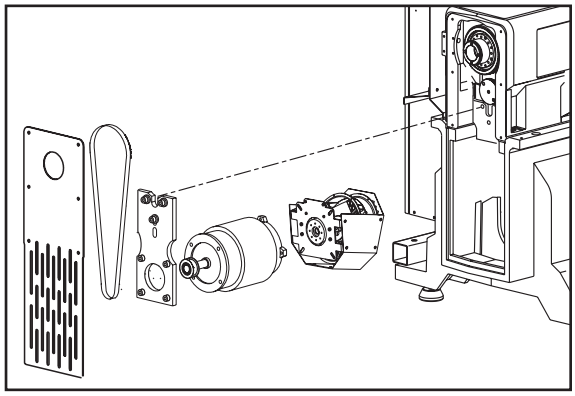
15. Install the pressure and return hoses.

16. Measure runout. Face runout and union runout should not exceed .001” (.03mm).

17. Replace the enclosure panels.

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

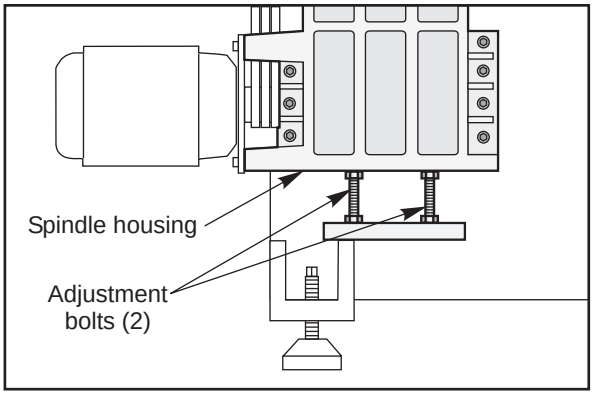
TOOLS REQUIRED: Dual Indicator Stand

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

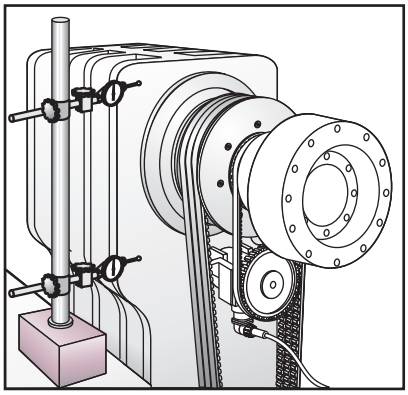
1. Loosen all spindle head mounting bolts. Loosen the locknuts on the two jack screws (adjustment bolts) underneath the spindle head casting, then screw them in to lower the spindle casting.

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 180º 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 180º 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.

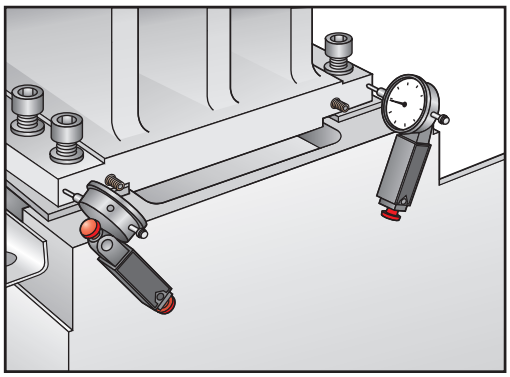
2. Loosen the eight SHCS mounting bolts for the spindle head. Back out the two set screws on the front side, lower edge of the spindle head.

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.

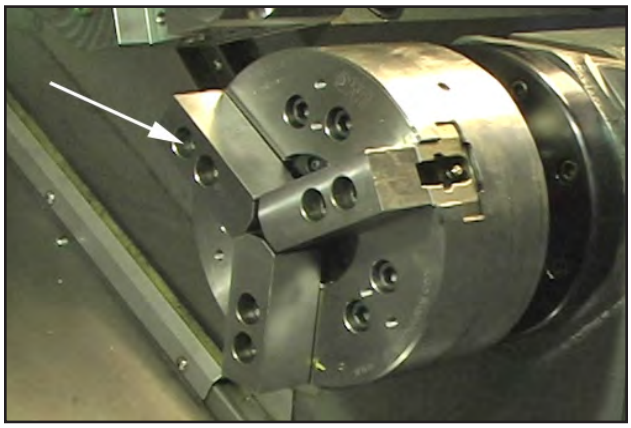
Secondary Spindle Cartridge Replacement DS

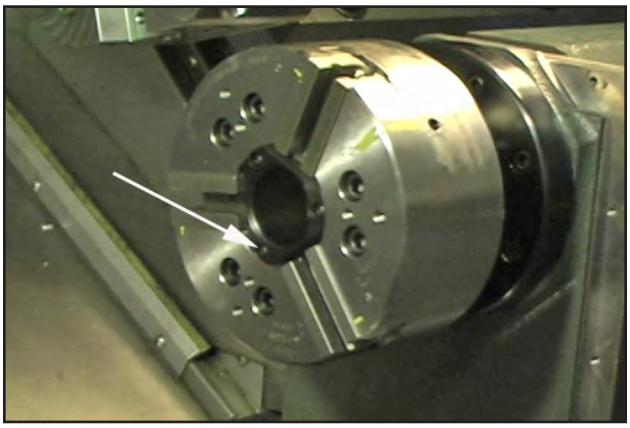
Remove Secondary Spindle Jaws and Chuck

1. Press: “**Emergency Stop**”.

2. Remove the three jaws by removing the six socket head cap screws. Use a mallet to tap the allen wrench to help break the screws free.

3. Remove the three socket had cap screws and remove the chuck center cap.



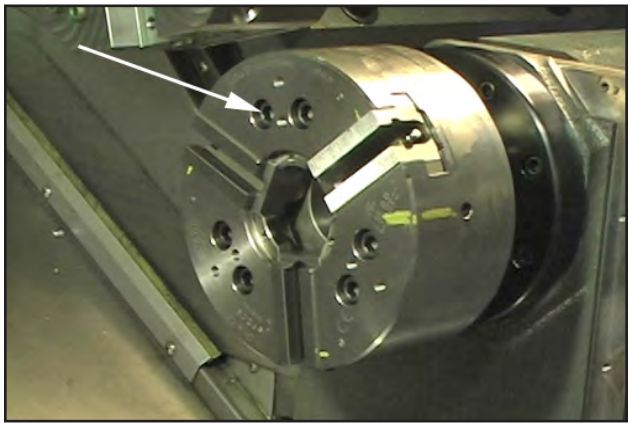


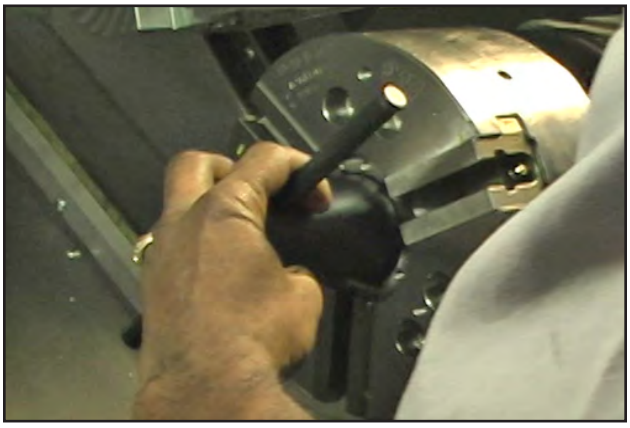
4. Release “**Emergency Stop**”. Press; “**RESE**T” two or three times.

5. Clamp or un-clamp the chuck by pressing on the foot pedal, press “**Emergency Stop**” halfway through the stroke.

6. Loosen the six chuck socket head cap screws. Use a mallet to tap the allen wrench to help break the screws free.

7. Use the chuck key and carefully remove the chuck.





Shut Down Hydraulic and Coolant Pumps

1. Press; “**Emergency Stop**”.

2. Shut off the hydraulic system by setting Parameter 209; Bit 29 to a value of ”0”.

Press: “**PARAM DGNOS**”

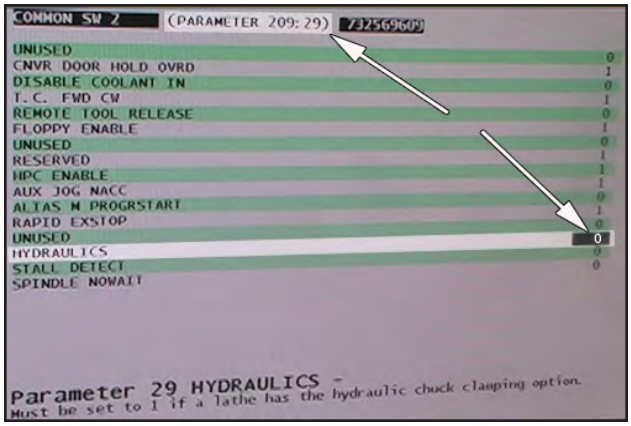
Press: “**209”**

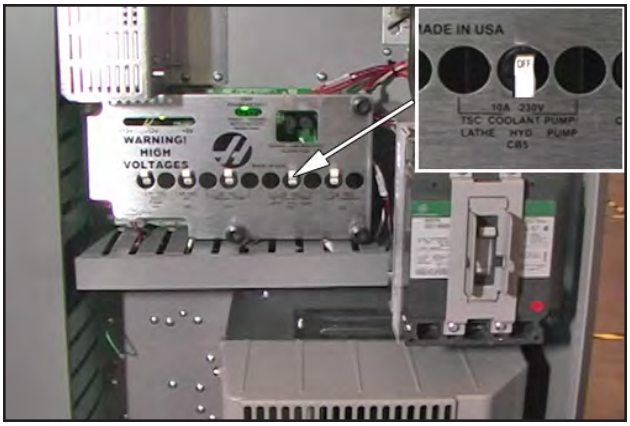
Press: **“Page down to BIT 29”**

Set Value to 0

Press: **“0”; “WRITE /ENTER”**

3. Shut off the coolant pump breaker located in the main electrical control box.



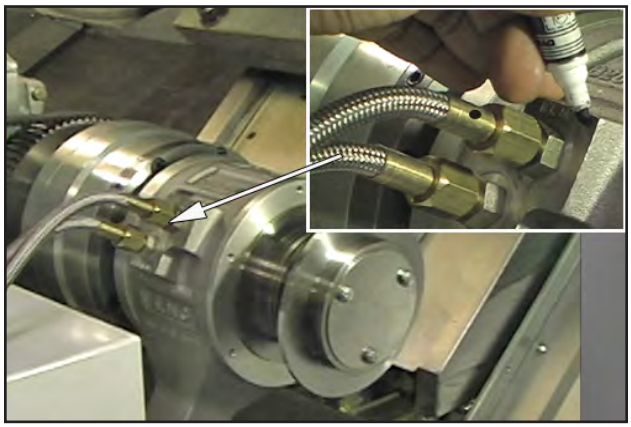


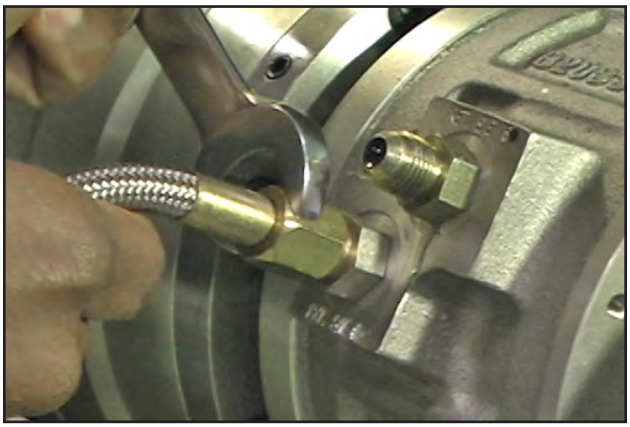
4. Remove the front right panel.

Spindle Actuator Removal

1. Mark the hydraulic hoses and fittings to aid in reassembly.

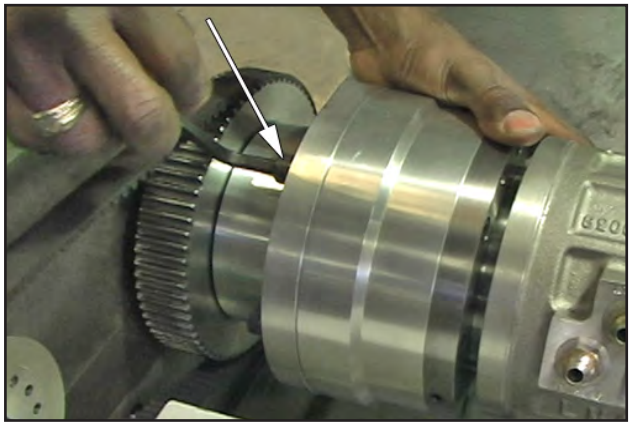
2. Disconnect the pressure and return hydraulic hoses. Secure hoses with tie wraps/wire out of the way and to prevent hydraulic fluid from dripping out of the hoses.





3. Remove the six rear actuator socket head cap screws. If necessary, use a mallet to tap the allen wrench to help break the screws free.

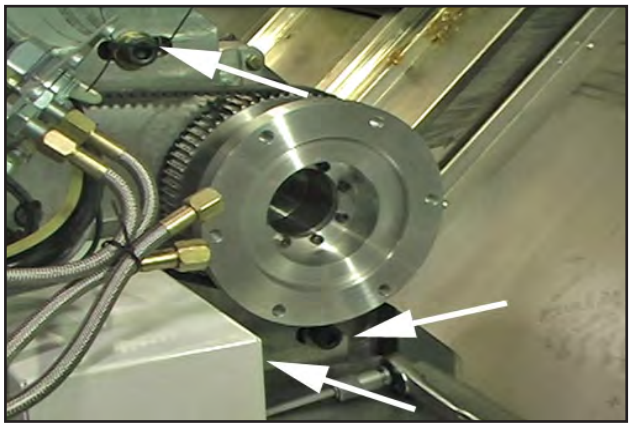
4. Carefully remove the actuator and draw tube by pulling out while supporting the draw tube. Set aside.



Spindle Drive Gear Removal

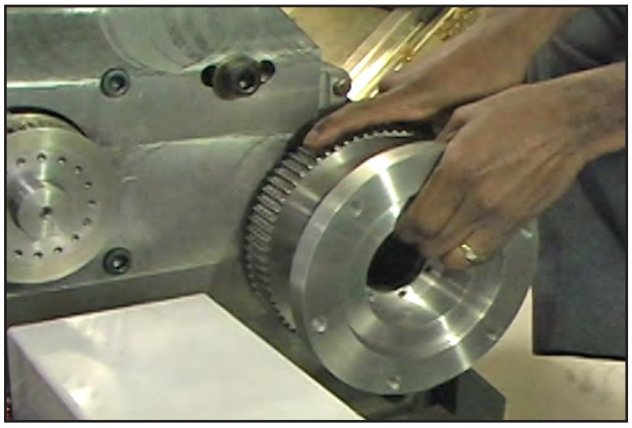
1. Loosen the three secondary spindle motor plate caps screws. Remove the drive belt.

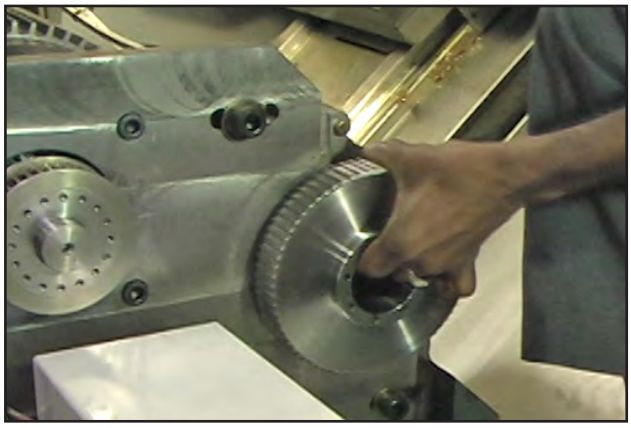
2. Remove the eight actuator adapter plate socket head cap screws while supporting the plate



3. Remove the actuator adapter plate.

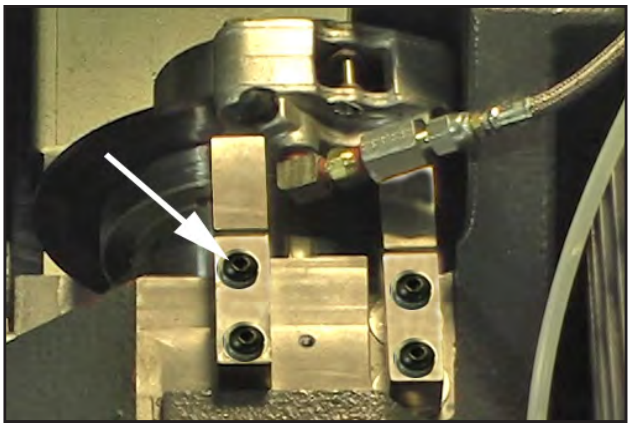
4. Remove the drive gear. If necessary gently tap the drive gear to break free.

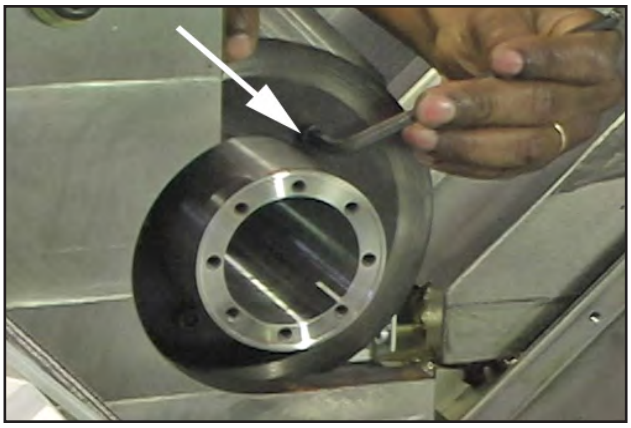




Brake Caliper and Disc Removal

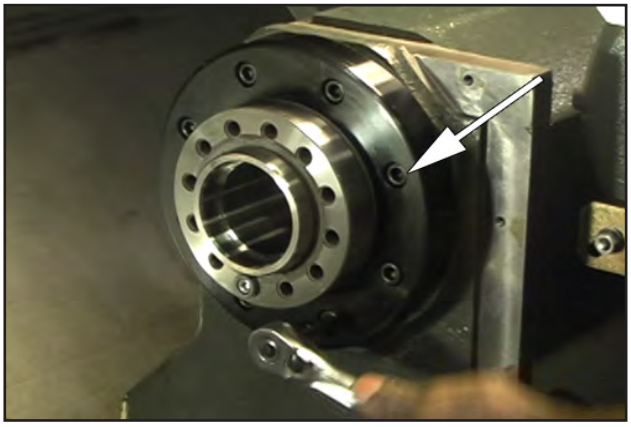
1. Remove the four socket head caps screws and remove the brake caliper.
2. Remove the six socket head cap screws on the brake disc. If necessary, use a mallet to tap the allen wrench to help break the cap screws free. Slide the brake disc part way off the spindle shaft.

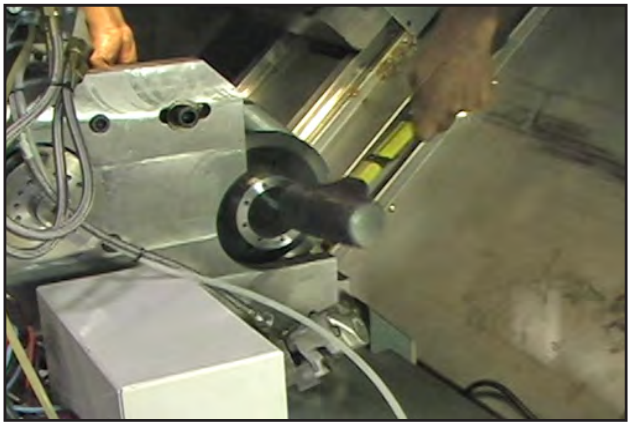




3. Remove the eight spindle cap socket head cap screws.

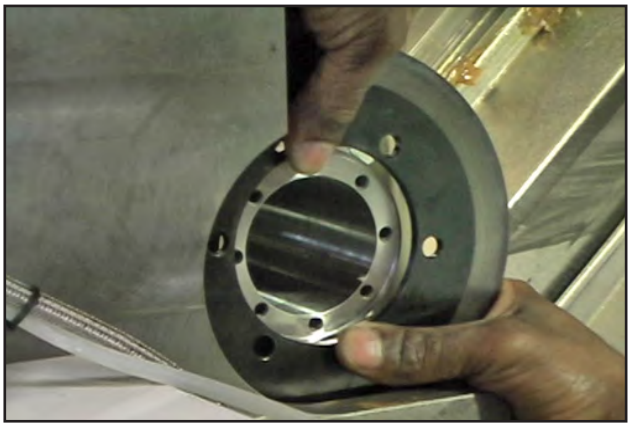
4. Tap the spindle cartridge with a mallet from the actuator side and pull from the chuck side, until there is enough clearance to completely remove the brake disc.

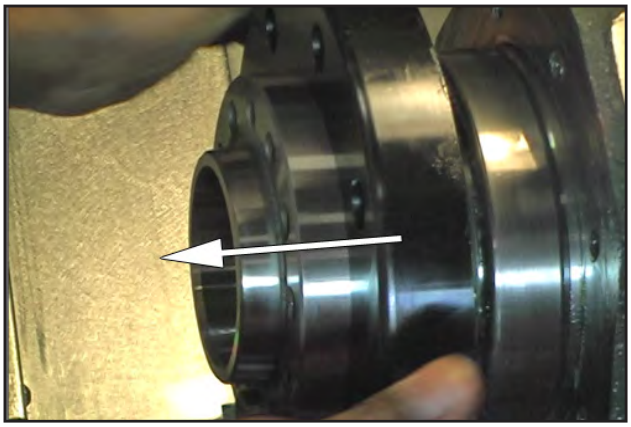




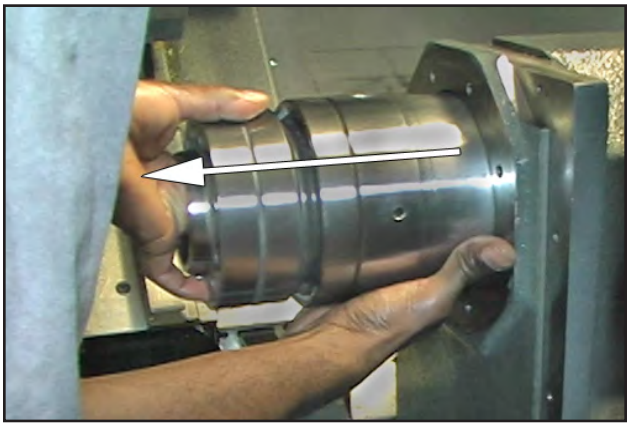
5. Remove the brake disc.

6. Remove the main spindle cap.





7. Carefully remove the spindle cartridge.

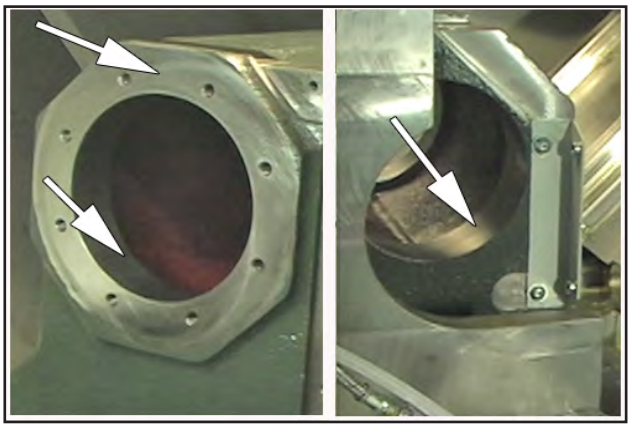


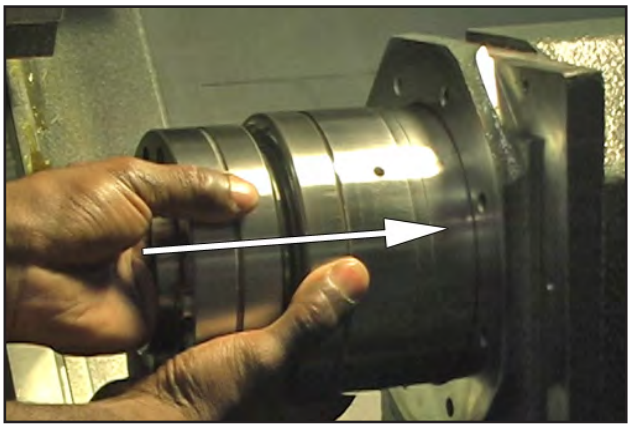
Secondary Spindle Cartridge Install - DS

Install New Spindle and Drive Gear

1. Clean the face and interior secondary spindle cartridge mounting surfaces with alcohol.

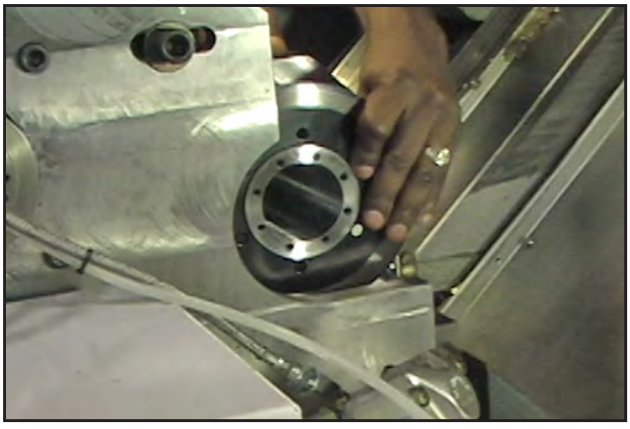
2. Partially slide the new cartridge into the secondary spindle casting.

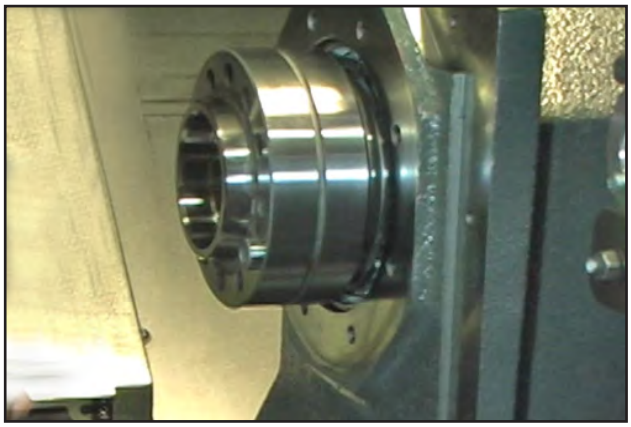




3. Slip the brake disc on the shaft but do not install socket head cap screws yet..

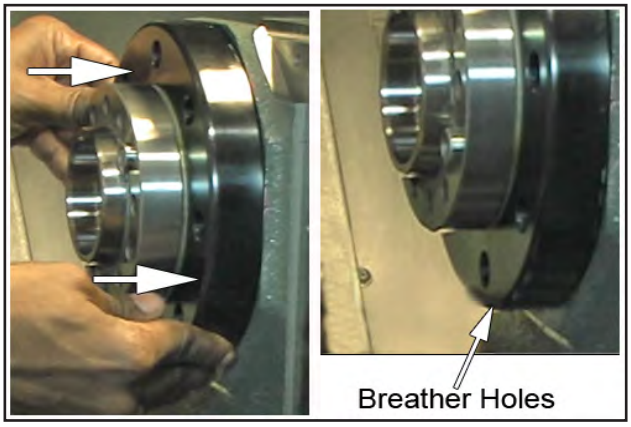
4. Push the new spindle all the way in.





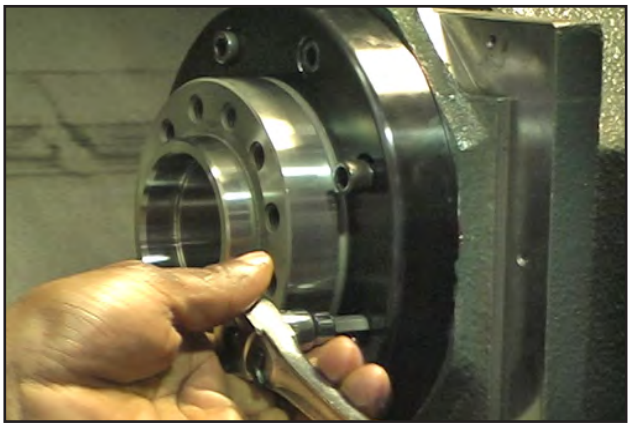
5. Push the main spindle cap onto the spindle shaft. Note the location of the breather holes.

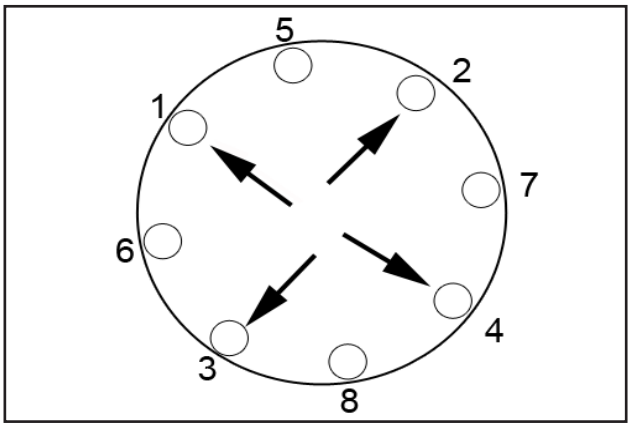
6. Rotate the cap so that breather holes are positioned at the 6 o'clock position.



7. Loosely install the eight main spindle cap socket head cap screws.

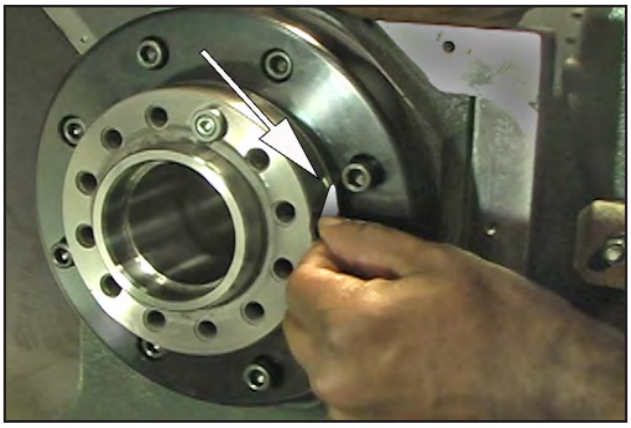
8. Tighten four of the socket head cap screws to 10 ft-lbs.

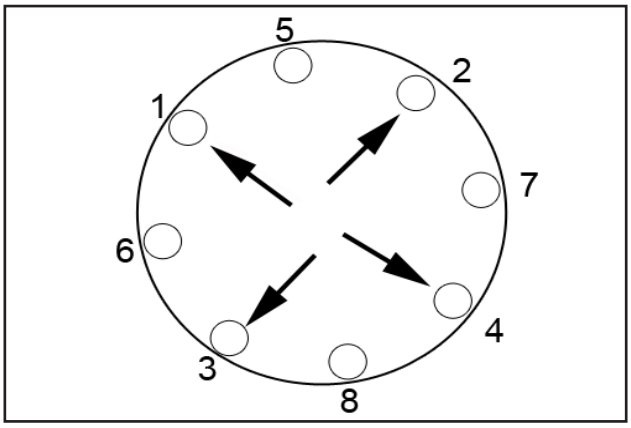




9. Using a .001” shim check for clearance all the way around between the spindle cap and spindle shaft. Adjust ring to provide minimum .001” clearance.

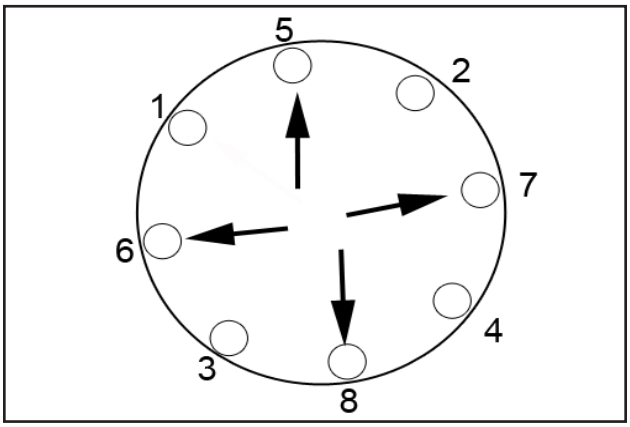
10. Torque the four cap screws to 20 ft -lbs and then recheck spindle cap / spindle shaft clearance.





11. Once the spindle cap to spindle shaft clearance is set, torque the remaining four cap screw to 10 ft-lbs.

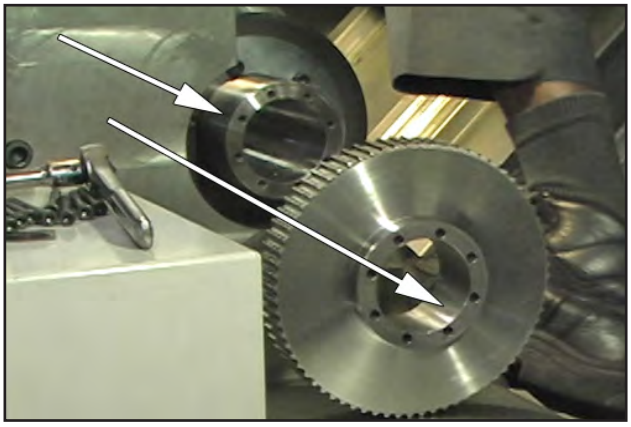
Recheck clearance, then torque to 20 ft-lbs.



12. Torque all eight of the bolts in a star pattern increments of 30,40 & 50 ft/lbs. Check alignment of the spindle and retaining ring at each torque value.

13. Install the six socket head cap screws on the brake disc. If necessary, use a mallet to tap the allen wrench to help set the cap screws.

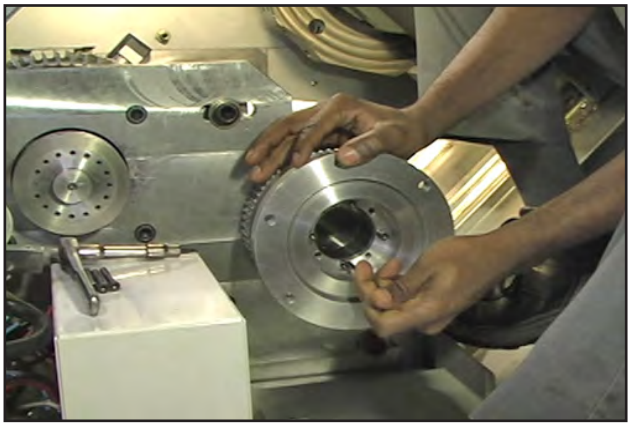
14. Clean the spindle shaft and inner circumference of the spindle drive gear with alcohol.



15. Clean the drive gear and actuator adaptor plate with alcohol.

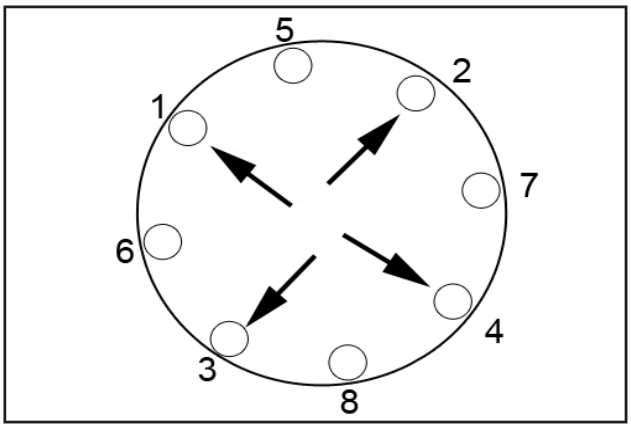
16. Slide the drive gear onto the spindle shaft and use a cap screw to align the gear with the mounting holes.

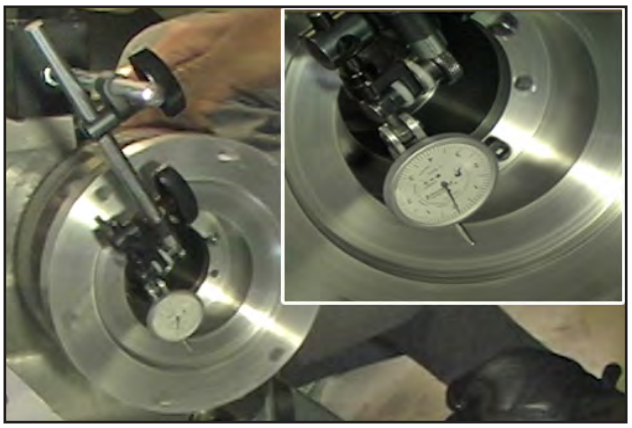
17. While holding the drive gear in alignment, slide the actuator mounting plate onto the spindle shaft and finger tighten one of the mounting cap screws.



18. Hand tighten four of the actuator mounting plates's socket head cap screws.

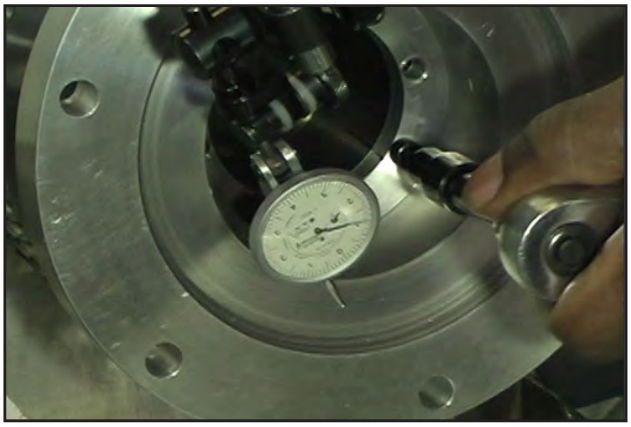
19. Mount a magnetic based dial indicator to indicate the inner front face of the actuator plate. Zero the Indicator.

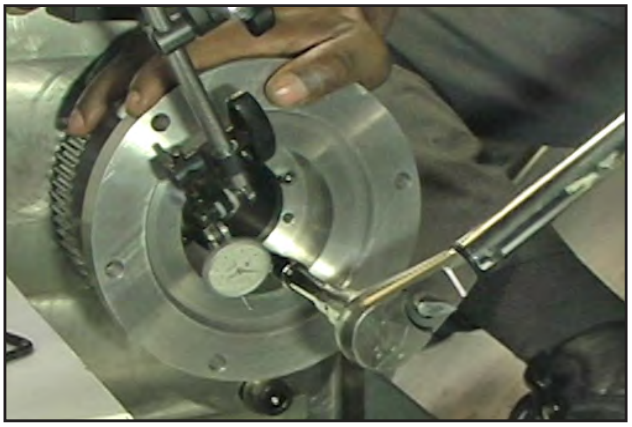




20. Tighten each of the four mounting cap screw to align the inner face to within .0004"

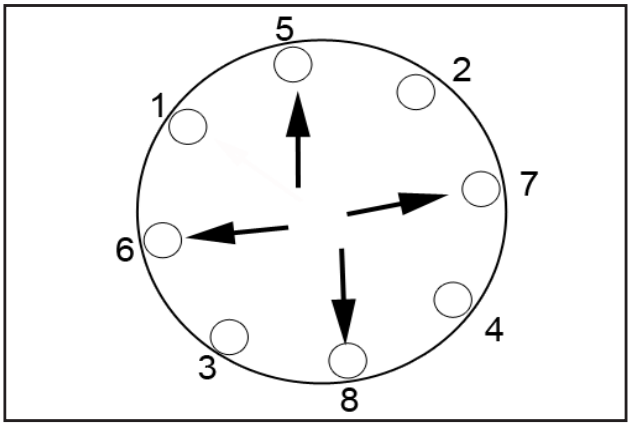
21. Once aligned, torque the four mounting cap screws to 16 ft-lbs. Recheck and adjust if needed.

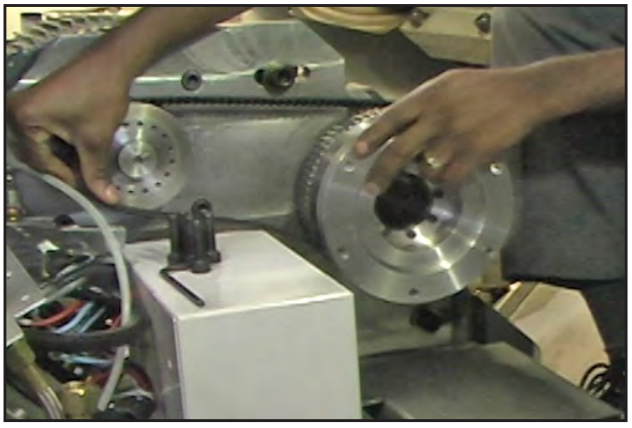




22. Install and torque the remaining four cap screws to 16 ft-lbs.

23. Inspect and replace the drive belt if necessary. Install the drive belt over the motor and spindle pulleys.

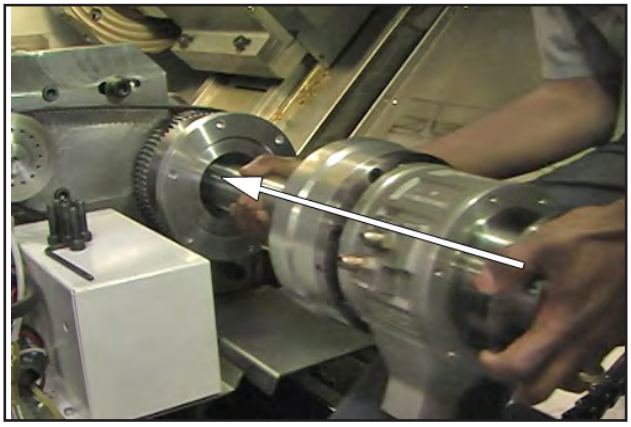


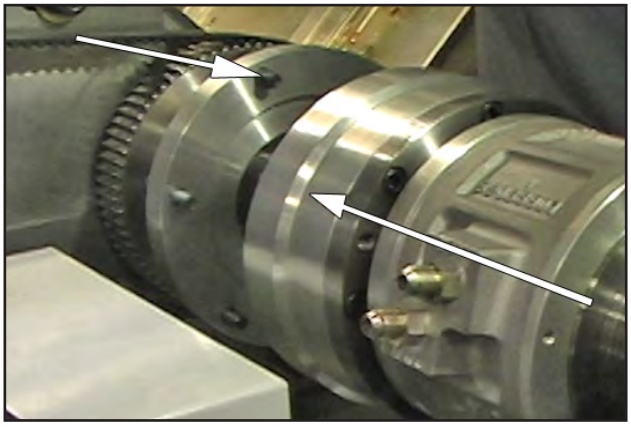


Install and Align Actuator

1. Clean the actuator plate and actuator shaft with alcohol and slide the actuator into the spindle shaft. Stop just short of pushing the plates flush.

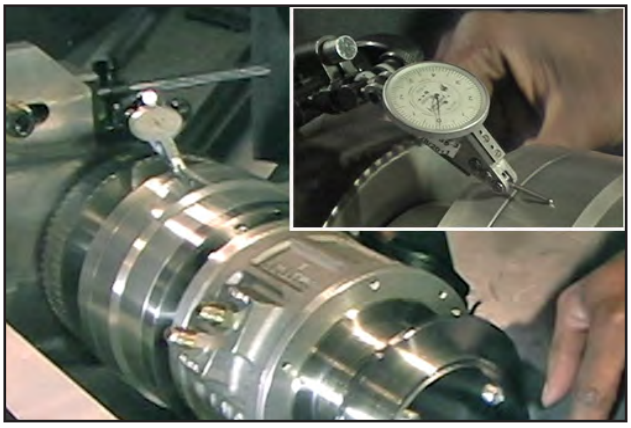
2. Install the actuator mounting cap screws and use them as guide to align the holes in the actuator. Push the actuator in until you can thread the caps crews. Finger tighten the six cap screws.

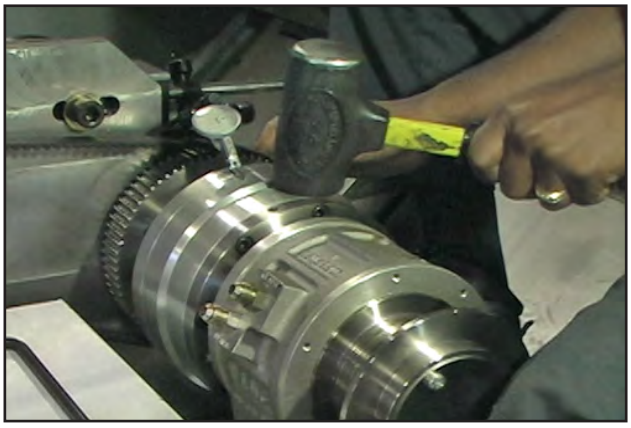




3. Mount a magnetic based dial indicator to indicate the outer diameter of the actuator.

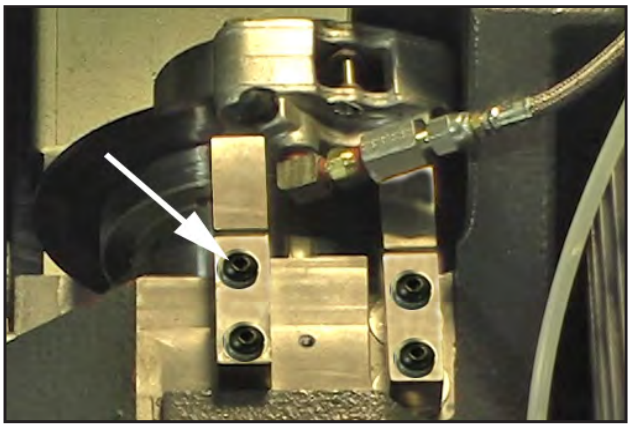
4. Rotate the actuator and adjust actuator run out by tapping on the actuator with a mallet.





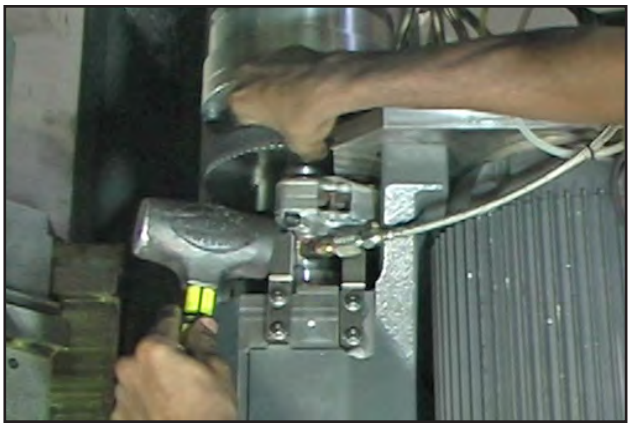
5. Once aligned, tighten the actuator mounting cap screws by tapping the allen wrench with a mallet.

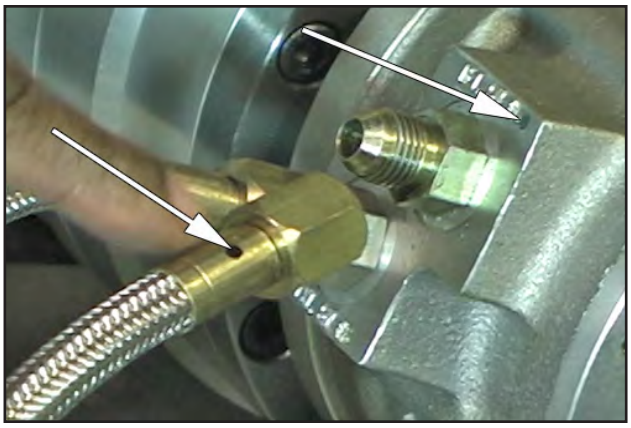
6. Mount the brake caliper and finger tighten the socket head cap screws.



7. Rotate the spindle and check for clearance between the rotor and brake show adjust the caliper mount to provide adequate clearance then tighten the four caps crews.

8. Connect the pressure and return hydraulic hoses; refer to the markings made during disassembly.

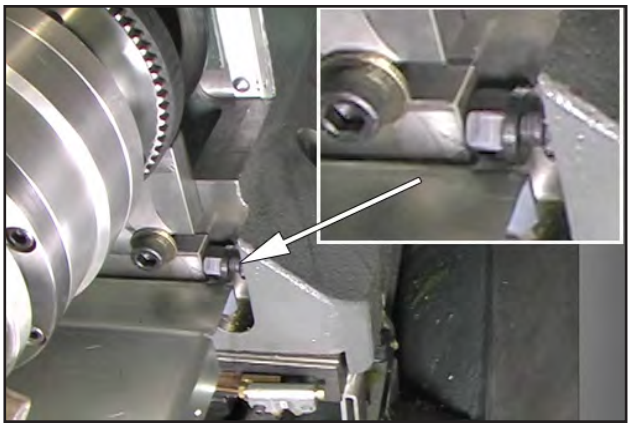


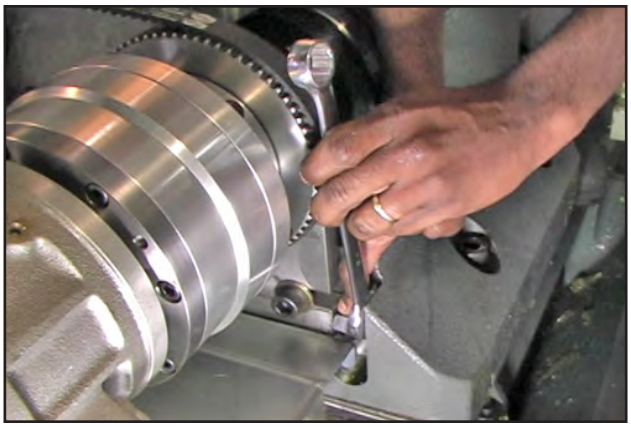


Tension Drive Belt

1. Place a large jacking screw in the space between the motor mounting plate and the base.

2. Tighten the jacking screw until the drive belt is just taut.





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

A. Set the Gates Sonic Tension Meter so that it is reading Hertz (Hz).

B. 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.

C. 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 6th). Take 2 readings at each point.

D. Adjust the assembly until the belt tension is between 160 and 180 Hz.

E. Torque spindle motor fasteners to 80 ft-lb.??

F. Remove the Jacking screw.

3. Install the chuck and jaws.

4. Turn on the coolant pump breaker located in the main electrical control box.

5. Turn on the hydraulic system by setting Parameter 209; Bit 29 to a value of "1".

Press: "**PARAM DGNOS**"

Press: “**209**”

Press: **“Page down to BIT 29”**

Set Value to 1

Press: **“1”; “WRITE /ENTER”**

6. Check for leaks and remove all tools and parts from the lathe enclosure.

7. Install the front right panel.

Sub Spindle Motor Replacement- DS

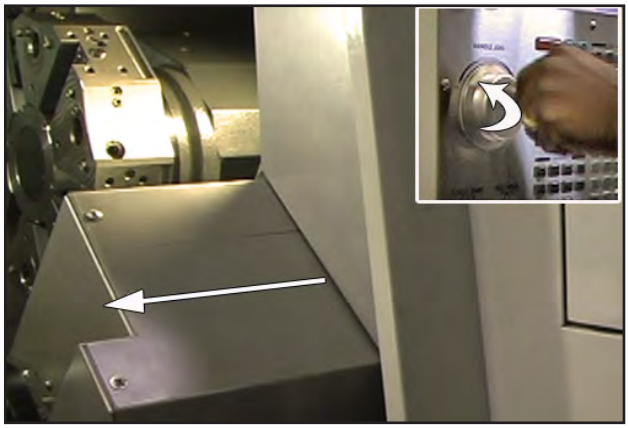
Motor Removal

Remove Front Right Panel.

Remove Motor Cover

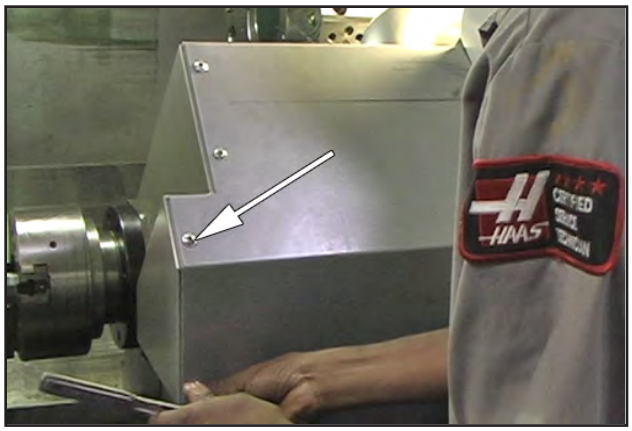
1. Jog the secondary spindle all the way to the left.

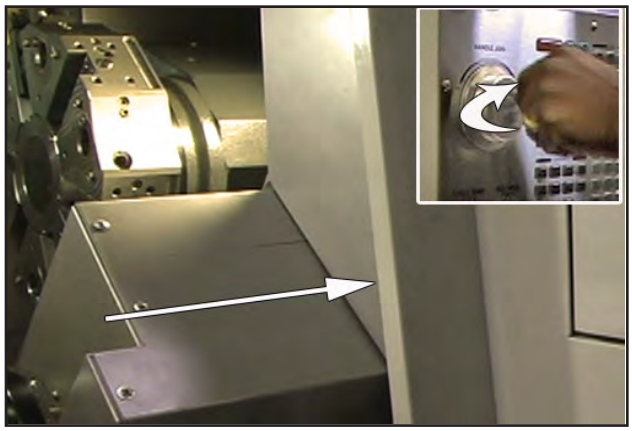
2. Loosen the hose clamp for blower duct and remove the hose. Secure the hose out of the way.



3. Remove the left side secondary spindle front cover screws.

4. Jog the secondary spindle all the way to the right.



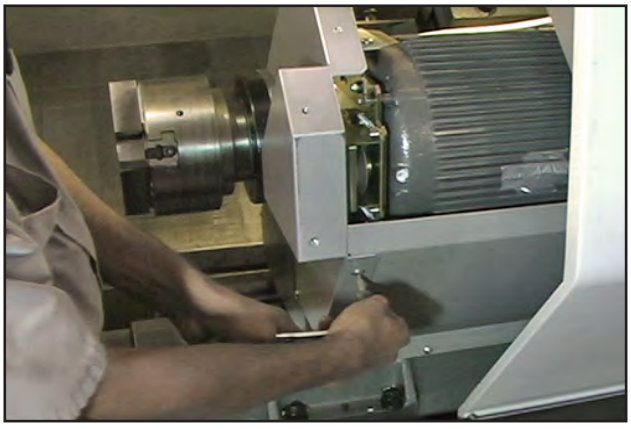


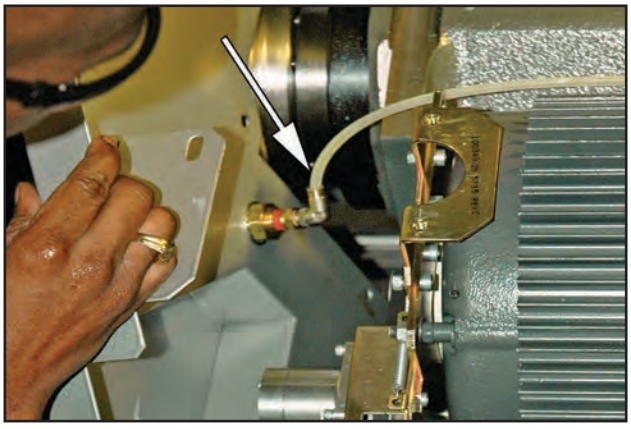
5. Remove the right side secondary spindle front cover screws.

6. Remove the front cover.

7. Remove the left side cover screws.

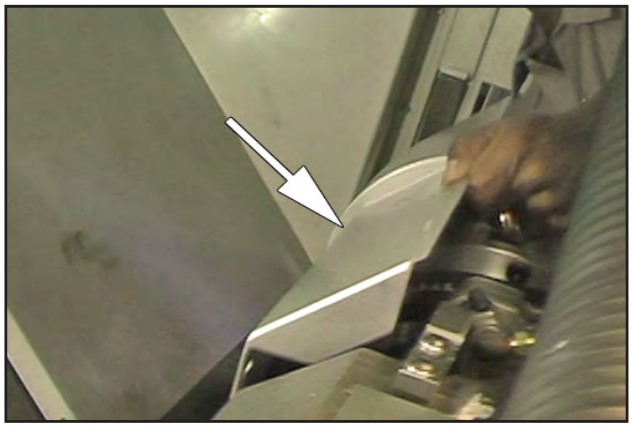
8. Carefully remove the left side panel and disconnect the jet blast air line from the bulkhead fitting.

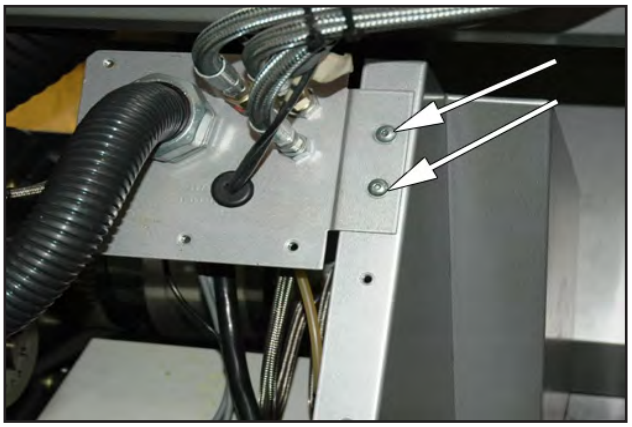




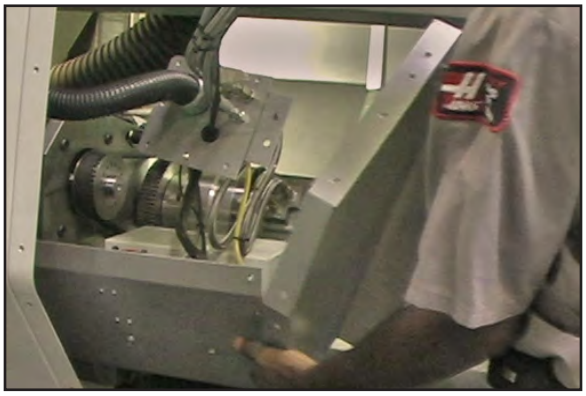
9. Remove the rear cover screws and remove the rear cover.

10. Remove hose manifold mounting screws and suspend the manifold /hoses out of the way.





11. Remove the right side cover screws and remove the right side cover.

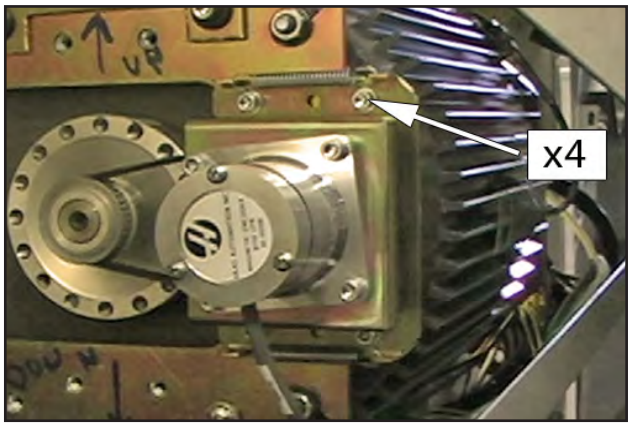


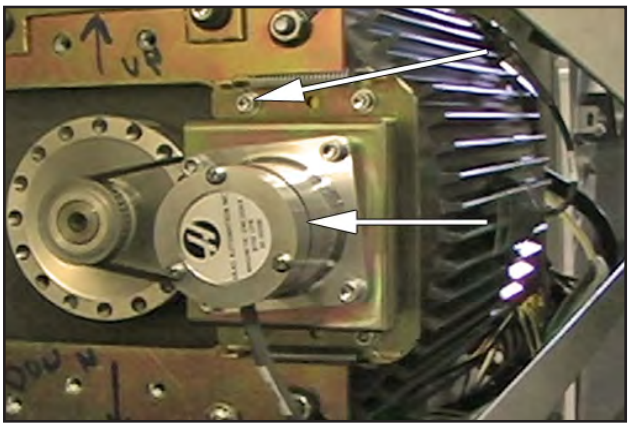
CAUTION! Turn off and lock out system power.

Remove Motor and Encoder Belts

12. Relieve the tension on the encoder belt by loosening the 4 encoder belt tensioning bolts.

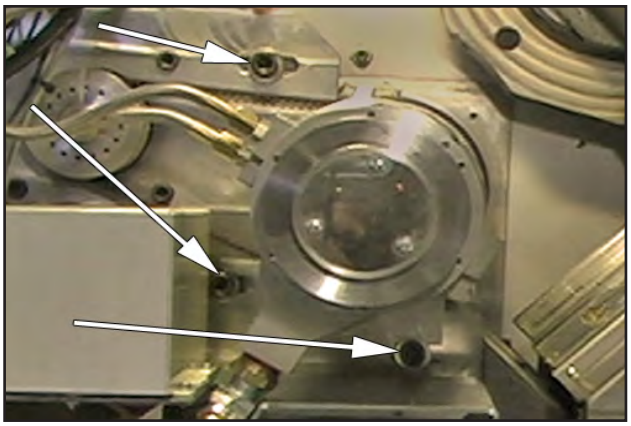
13. Slide the encoder to the left and tighten one of the tensioning bolts to hold the encoder with the belt in the slack position. Remove the encoder belt.

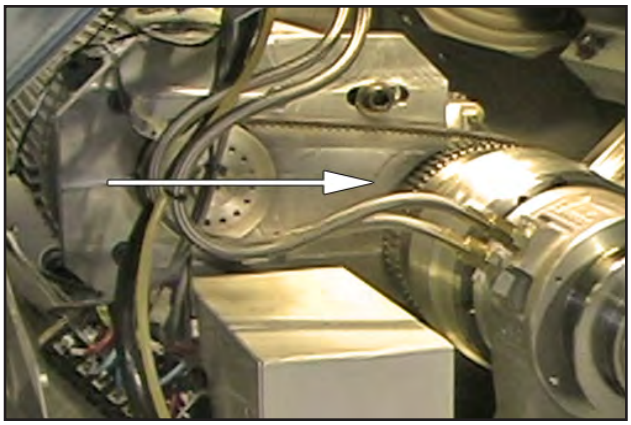




14. Loosen the motor tensioning bolts.

15. Slide the motor assembly to the right to loosen the drive belt.

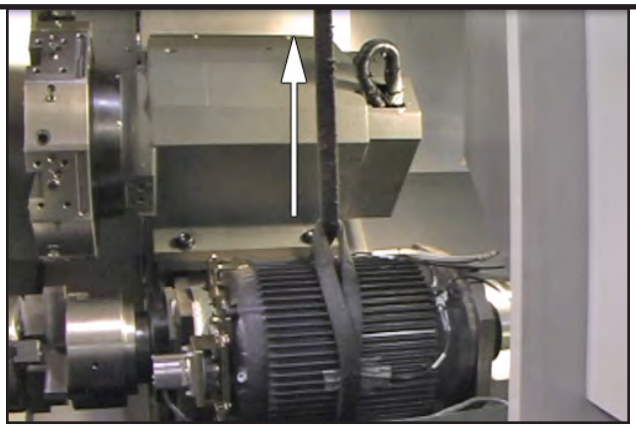




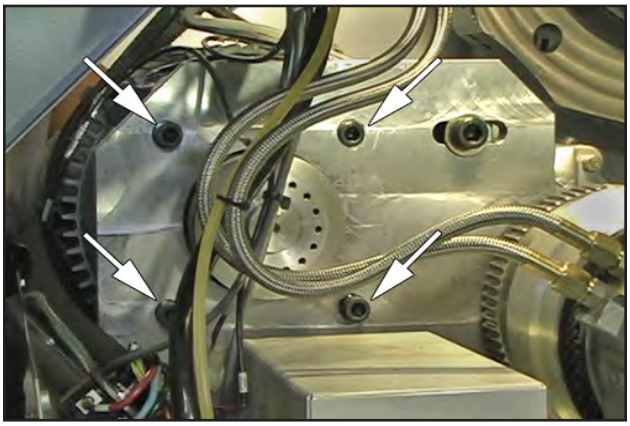
16. Remove the drive belt from the motor pulley.

17. Support the secondary spindle motor with a lifting strap rated for 500 lb and attach to an appropriately rated shop crane or hoist.

CAUTION! Do not apply upward force! Just keep the lifting strap taut.



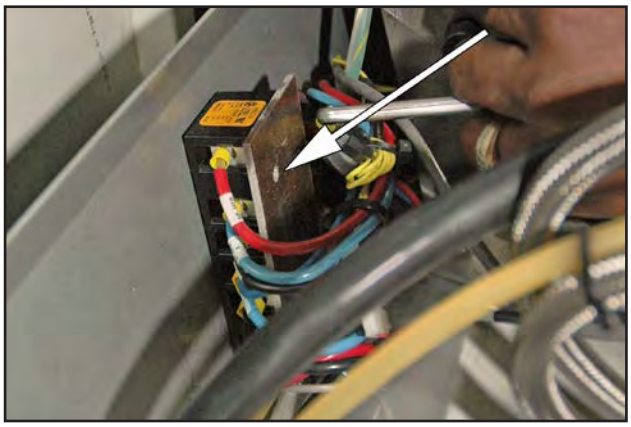
18. Remove the motor mount bolts.

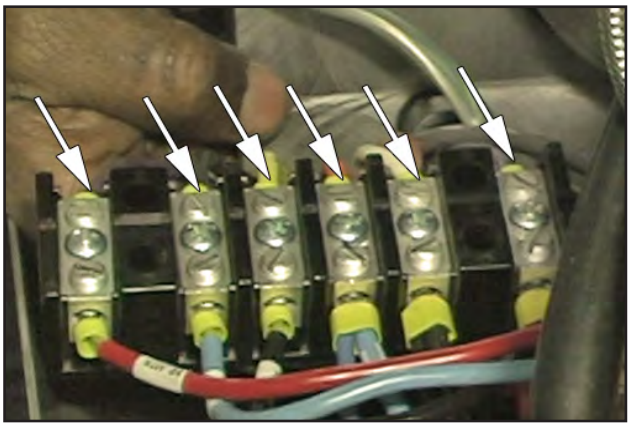


Disconnect Wiring Harness

19. Remove the cover from the motor terminal block.

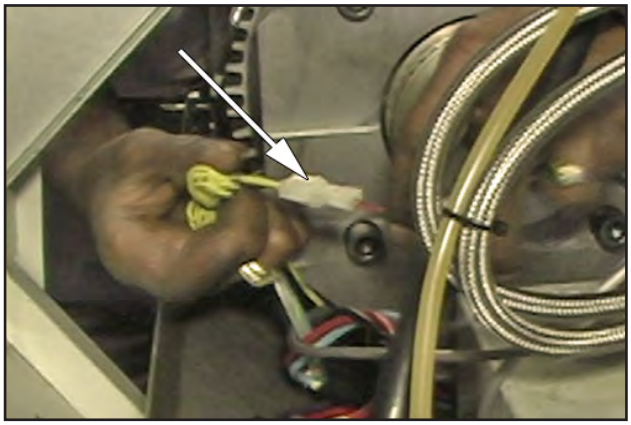
20. Carefully note wire connections, then disconnect the motor wiring harness from the terminal block.

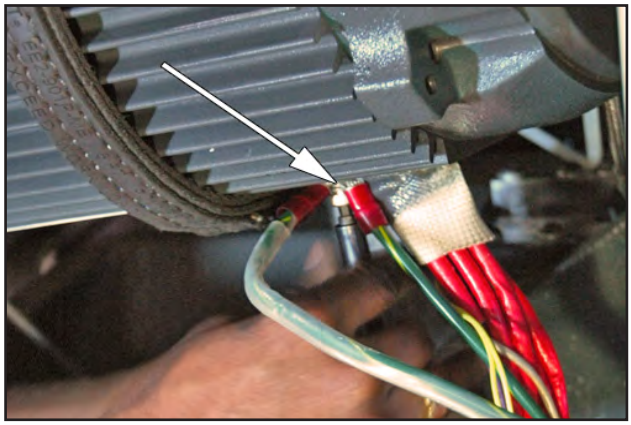




21. Disconnect the thermal sensor wire.

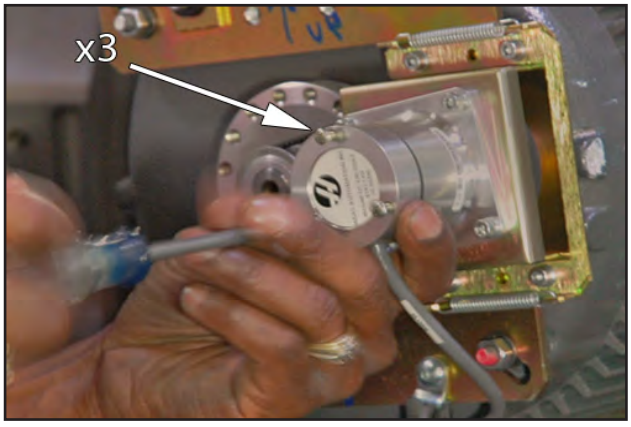
22. Raise the motor slightly to gain access to the under side of the motor. Ensure the motor pulley clears the motor mounting bracket. Disconnect the ground wires located on the under side of the motor.

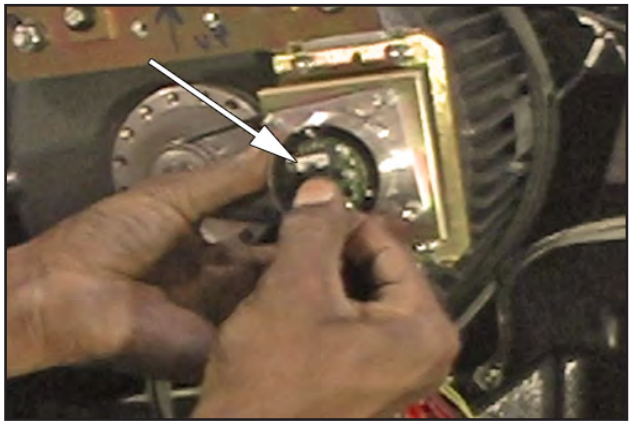




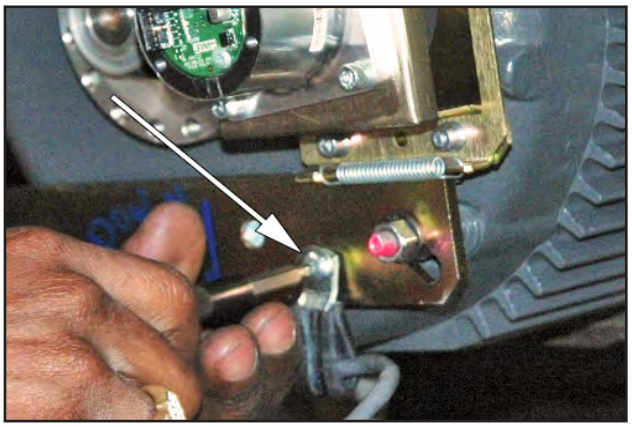
23. Remove the encoder cover screws and remove the encoder cover.

24. Unplug the encoder wire.





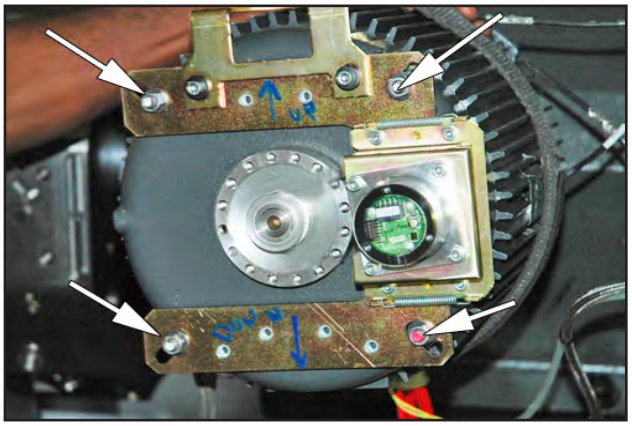
25. Unscrew the encoder wire strain relief.



26. Check for clearance and raise the motor clear of the lathe.

Remove Encoder Bracket

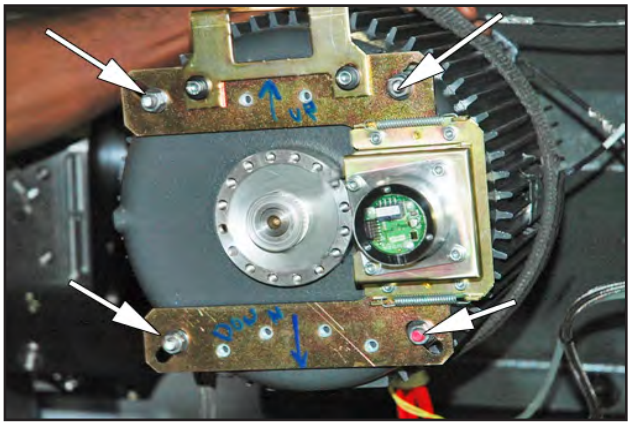
27. Support the motor and remove the encoder bracket assembly.



Install New Motor

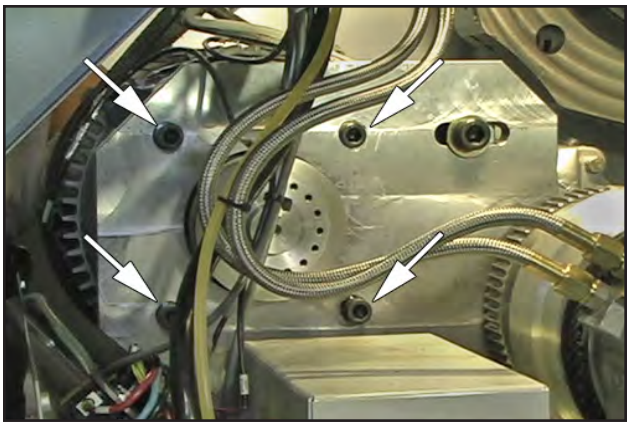
Install Encoder Bracket

1. Support the motor and install the encoder bracket assembly.



Mount Motor and Torque Bolts

2. Using the shop crane, align the motor with the motor mounts; install and torque the motor mounting bolts to 80 ft/lbs.

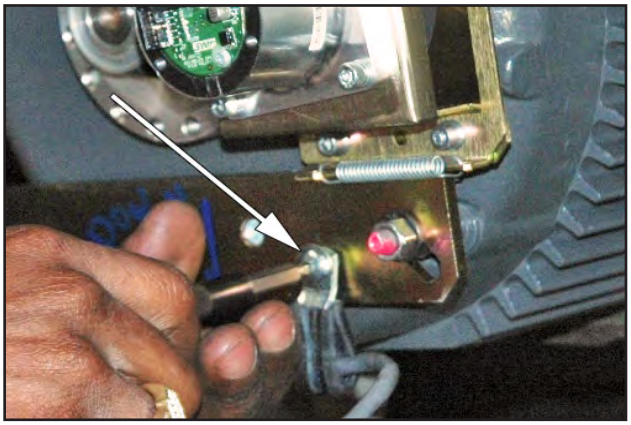


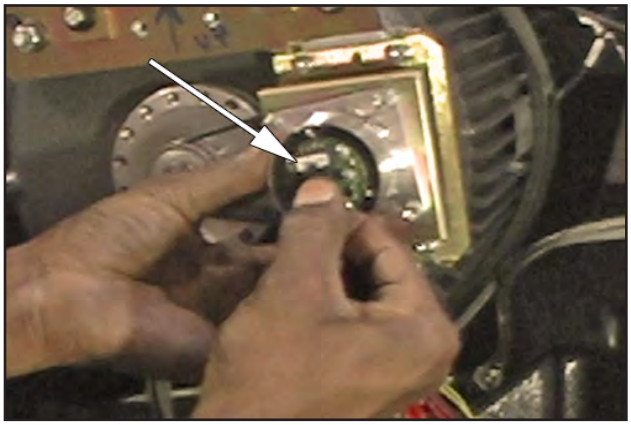
3. Remove lifting strap and clear crane from lathe enclosure.

Connect Wiring Harness

4. Attach the encoder wire strain relief.

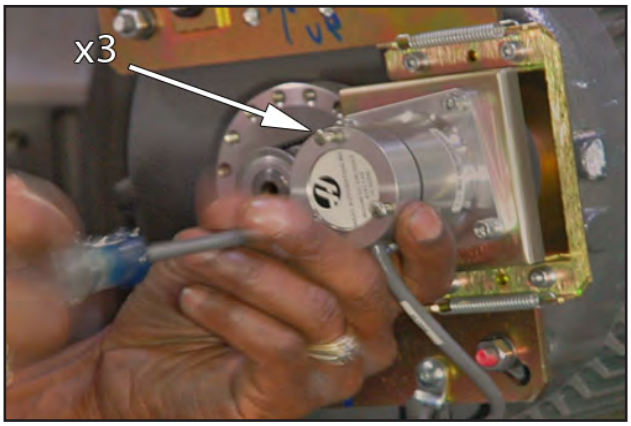
5. Plug in the encoder wire.

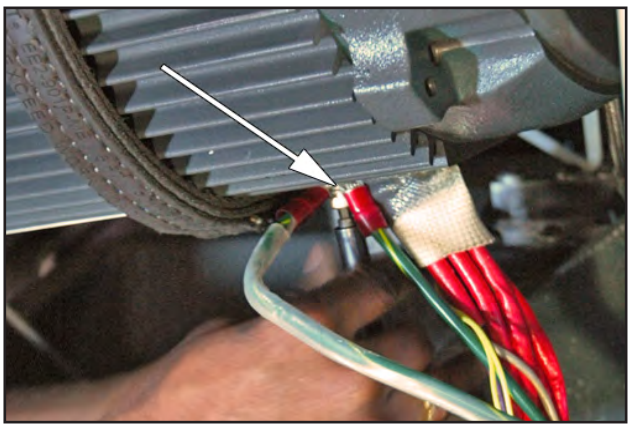




6. Install the encoder cover and tighten the encoder cover screws

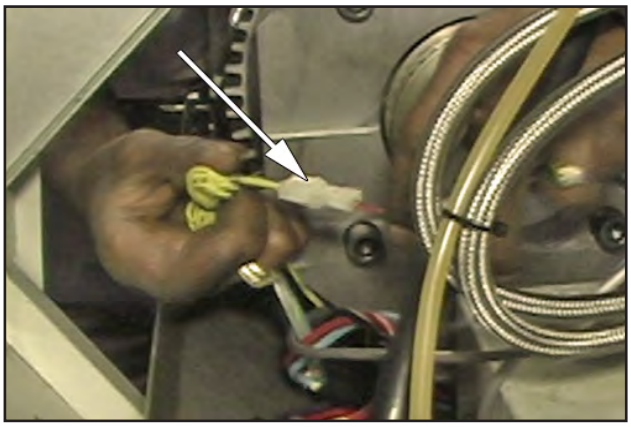
7. Connect the ground wires to the motor frame on the under side of the motor.

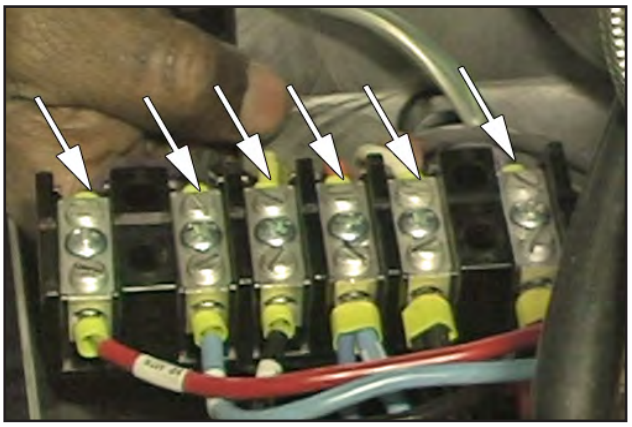




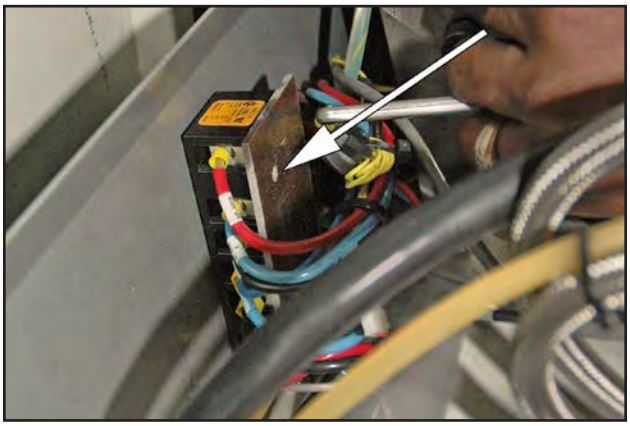
8. Connect the thermal sensor wire.

9. Refer to wire location notes and connect the motor wiring harness to the terminal block.





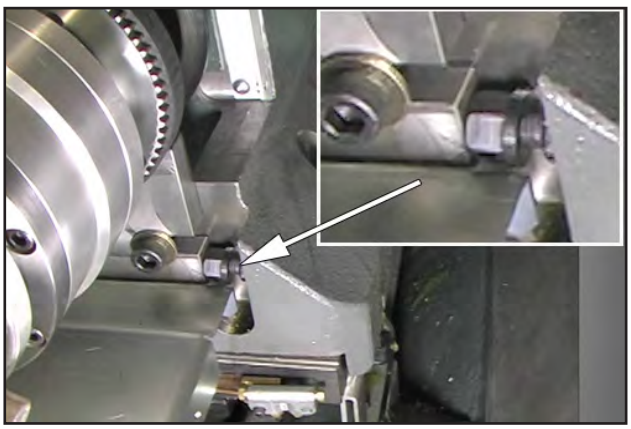
10. Install the motor terminal block cover.

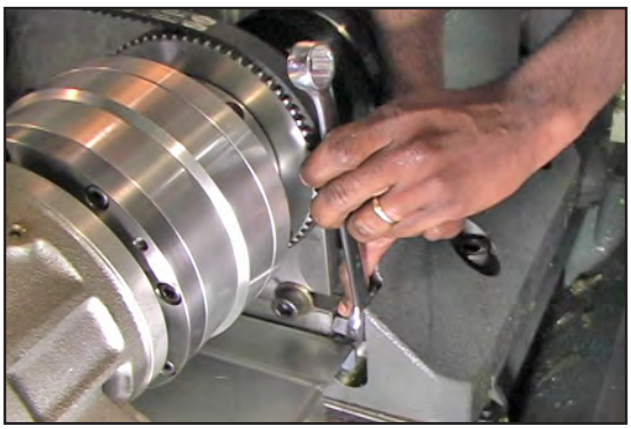


Install & Tension Motor & Encoder Belts

11. Slip the drive belt over the motor pulley and place a large jacking screw in the space between the motor mounting plate and the base.

12. Tighten the jacking screw until the drive belt is just taut.





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

A. Set the Gates Sonic Tension Meter so that it is reading Hertz (Hz).

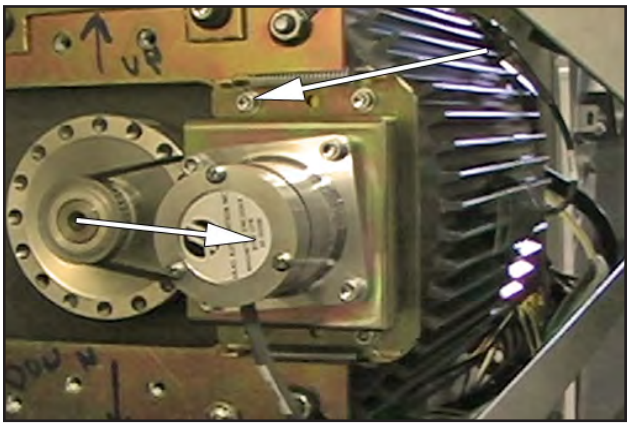
B. Place the meter's sensor within 3/8" of the belt, and pluck the belt like a guitar string, taking care that the sensor does not touch the belt.

C. 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 6th). Take 2 readings at each point.

D. Adjust the assembly until the belt tension is between 160 and 180 Hz.

E. Torque spindle motor fasteners to 80 ft-lb.

14. Slip a new encoder belt over the encoder pulleys and loosen the tensioning bolt to allow the springs to tension the pulley. Tension is automatically set by the tension springs. Tighten all of the encoder tensioning bolts.



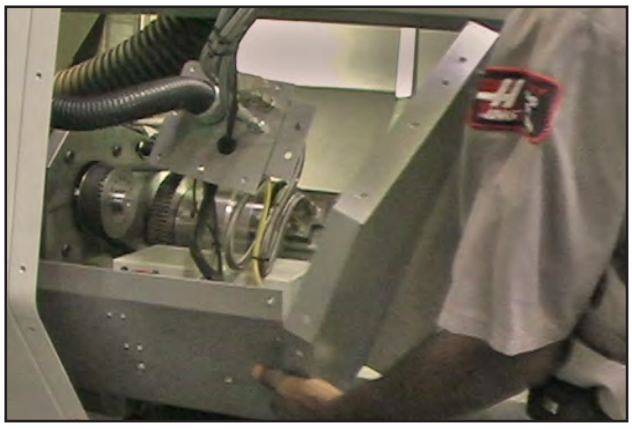
15. Double check all connections and clear all tools from inside the lathe.

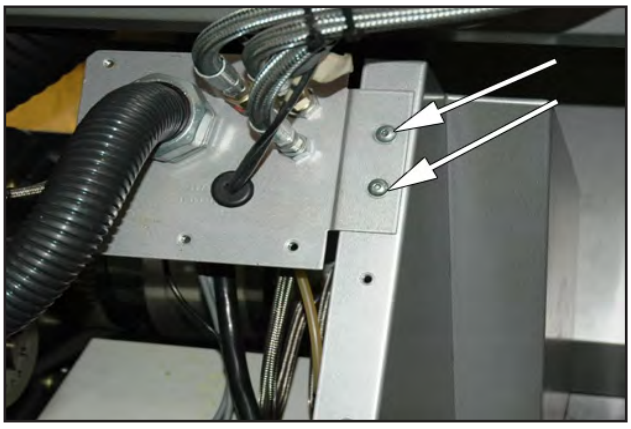
16. Run spindle motor clockwise and counter clockwise to test before cover installation.

Install Spindle Covers

1. Install the right side cover and tighten screws.

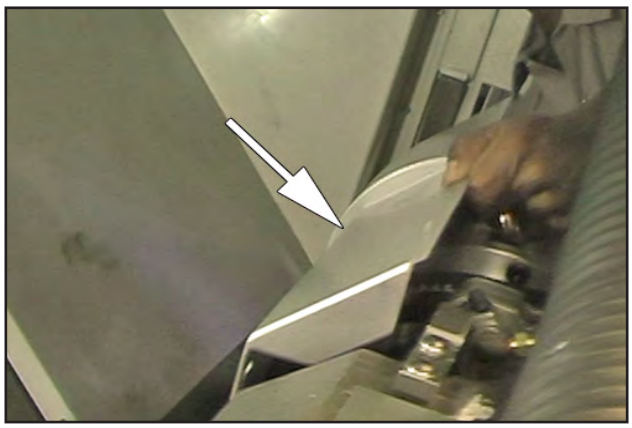
2. Install hose manifold and tighten screws.

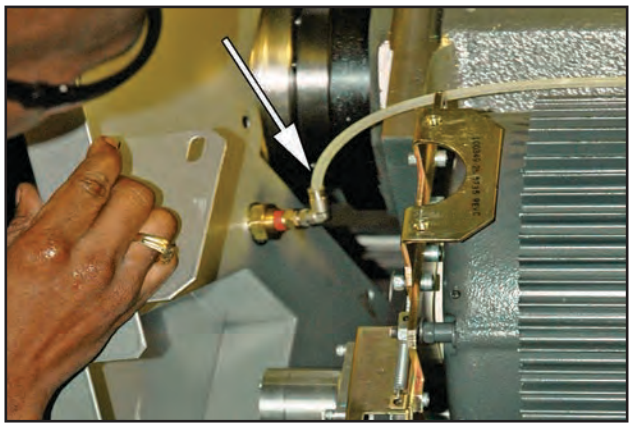




3. Install rear cover and tighten screws.

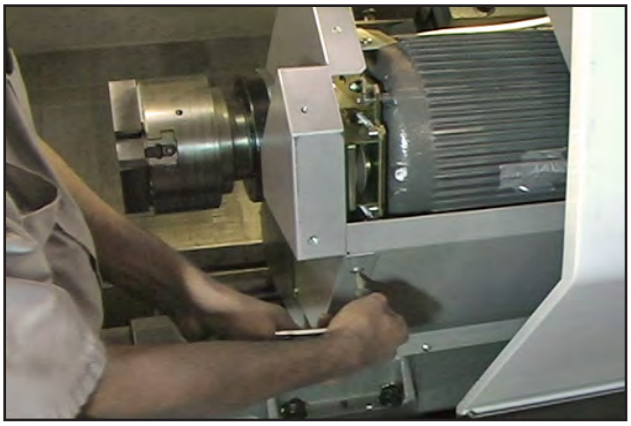
4. Carefully position the left side panel and connect the jet blast air line to the bulkhead fitting.

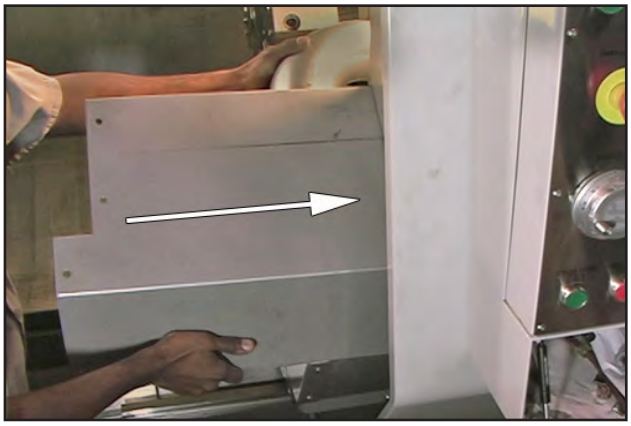




5. Install the left side cover and tighten screws.

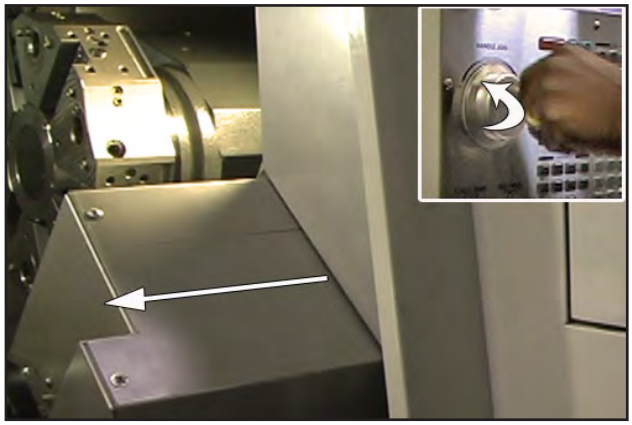
6. Slide the front cover into position and tighten screws.





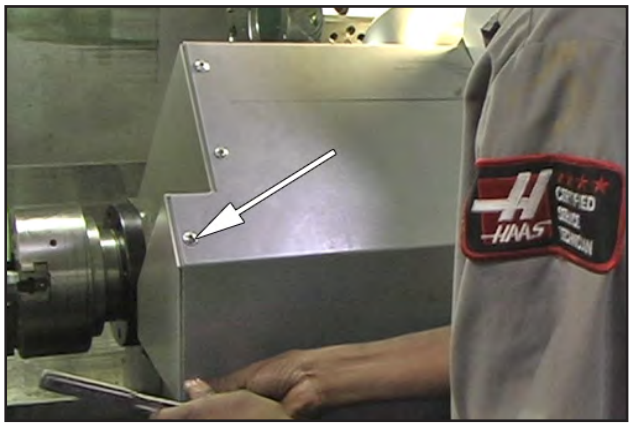
7. Install and tighten the right side front cover screws. Then turn the power on.

8. Jog the secondary spindle all the way to the left.



9. Install and tighten left side front cover screws.

10. Position the blower duct and tighten the hose clamp.



11. Double check all connections, remove all tools from inside the lathe.

12. Install the front right panel.

DS30Y Secondary Spindle Alignment

Check the following before Aligning the Secondary Spindle

I. Inspect the Linear Guides

1. Check the linear guides for visible damage. If a guide is damaged, replace it.

2. Check for a gap between the linear guides and the casting. Run a 0.001” shim along the rail, between the rail and the casting, to check for gaps that might be hidden by oil. If gaps exist, realign the linear guides.

II. Check Machine Level

1. Refer to the Electrical Service/Machine Installation Manual (96-0284B or later) for the ST lathe leveling procedure.

III. Check/Correct Backlash

If the machine was crashed, you must:

1. Test backlash in the spindle and gearbox. Refer to the Mechanical Service Manual (96-0283) for the test and correction procedure.

2. Follow the lathe squaring flow chart (Procedure)

IV. Preparation

1. Remove all tools from the tool turret.

2. If installed, remove the chuck from both the spindles.

Overview:

- Attach & Align Alignment Tool
- Adjust Secondary Spindle Head Alignment
- Adjust Secondary Spindle Head Parallelism
- Adjust Secondary Spindle Head Flatness
- Adjust Secondary Spindle Head Base Parallelism
- Adjust Secondary Spindle Head Base Flatness
- Adjust Main Spindle to Secondary Spindle Alignment

Tools Required:

- Torque Wrench (250 ft-lbs capacity)
- (2) 0.0001” Dial Indicator
- Sockets and Allen Wrenches
- Lathe Spindle Alignment Tool (T-2113)
- Inspection Mirror

Parts Required:

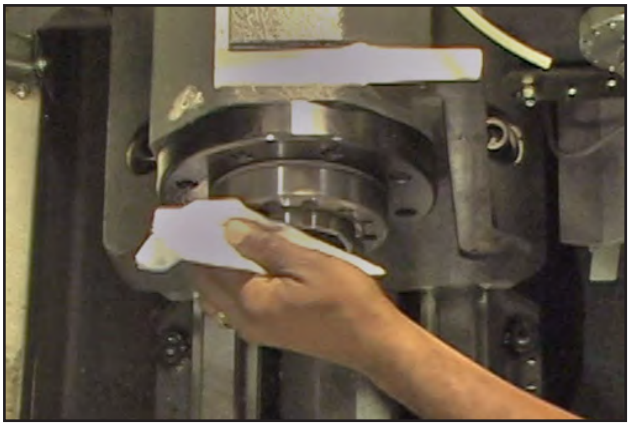
- DSY Alignment Report (EA-?????)
- Shim Stock Kit Part # 93-0378

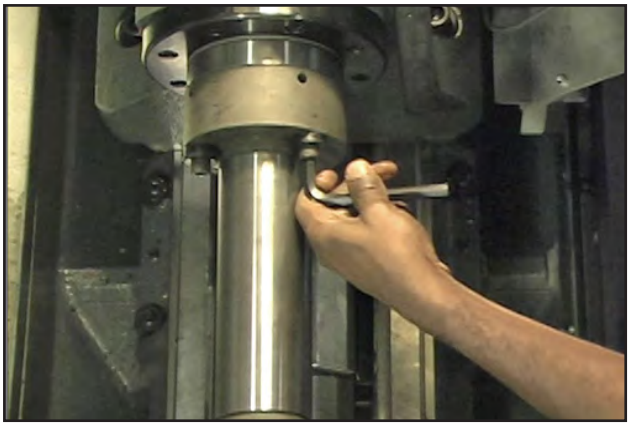
Attach & Align the Spindle Alignment Tool

1. Remove the front right panel.

2. Clean the spindle face and the spindle alignment tool (T-2113) mounting face with alcohol.

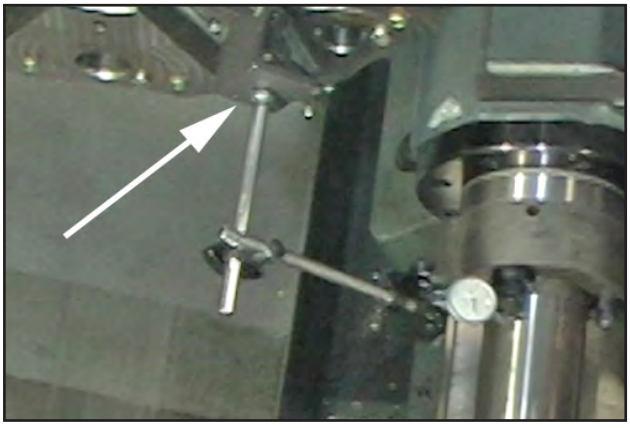
3. Secure the spindle alignment tool to the spindle face with the three included bolts.

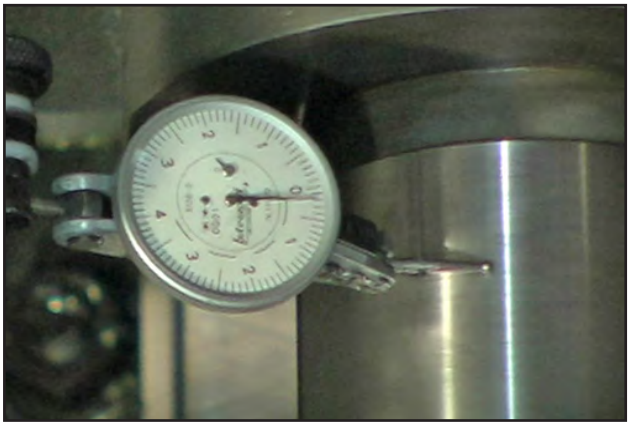




4. Mount a magnetic base and a .0001” dial indicator to the tool turret face.

5. Indicate the top dead center of the alignment tool cylindrical surface near the tool’s base. Zero the indicator.



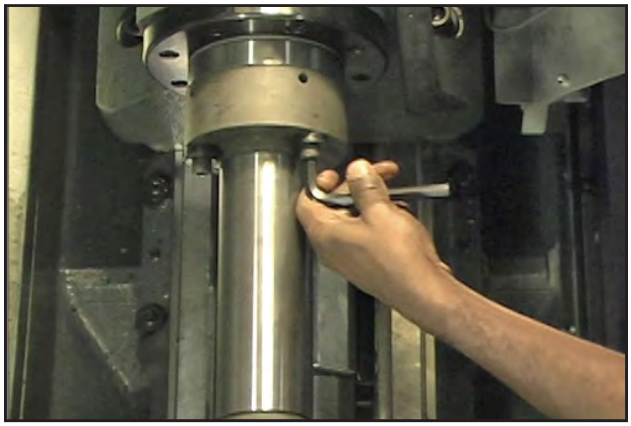


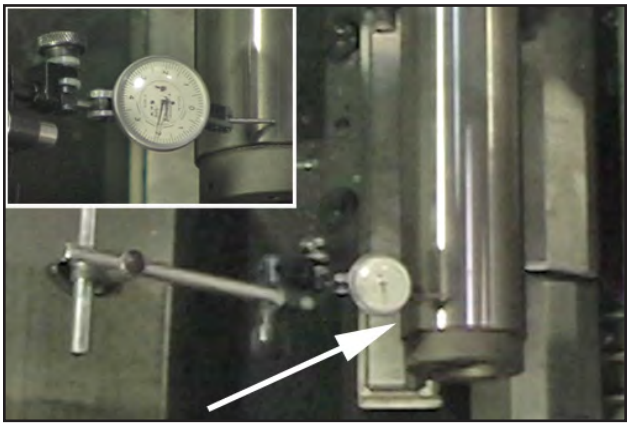
6. Rotate the spindle by hand and measure run out. Maximum TIR = .0001”.

7. Tap on the alignment tool flange tool to make adjustments.

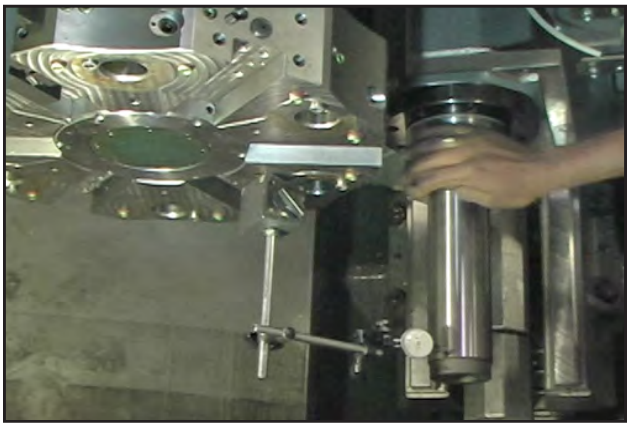
8. Snug the alignment tool mounting bolts.

9. Jog the turret in the Z- axis direction so the dial indicator indicates the top dead center of the alignment tool cylindrical surface near the alignment tool's end.





10. Rotate the spindle by hand and measure run out. Maximum TIR = .0001".

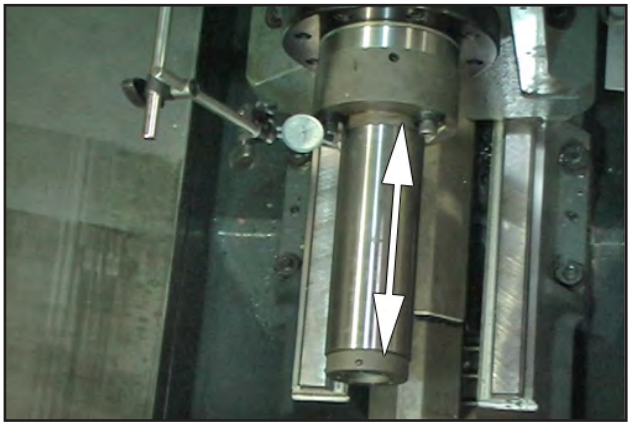


11. Make any necessary adjustments to the alignment tool flange, to eliminate run out by tightening the bolts. Recheck run out again at the base and end of the alignment tool.

Check Secondary Spindle Head Parallelism

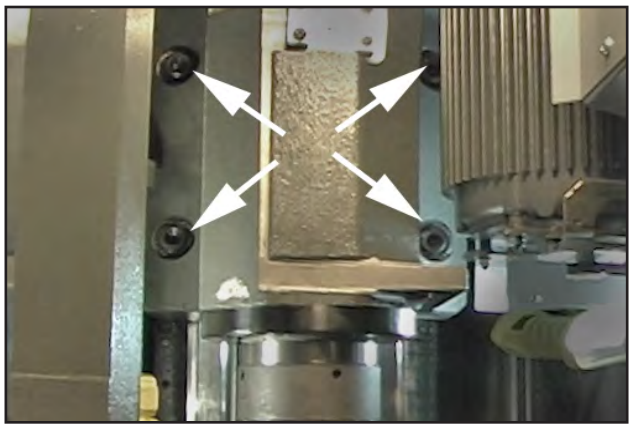
1. Move the turret as required to rest the dial indicator on the side of the alignment tool's surface

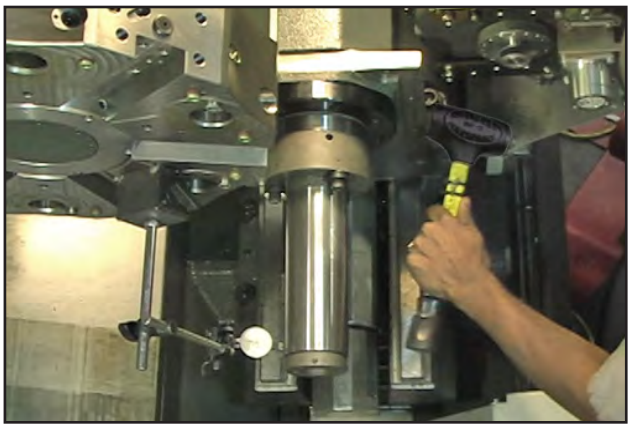
2. Use the B-axis to jog the secondary spindle so the indicator tip travels over eight inches of the alignment tool to check the parallelism. Max tolerance is. 0003"/8"



3. If adjustment is necessary, loosen the spindle head mounting bolts, leave one tight to act as a pivot point.

4. Gently tap the spindle head to make the adjustments - then tighten the spindle head mounting bolts.

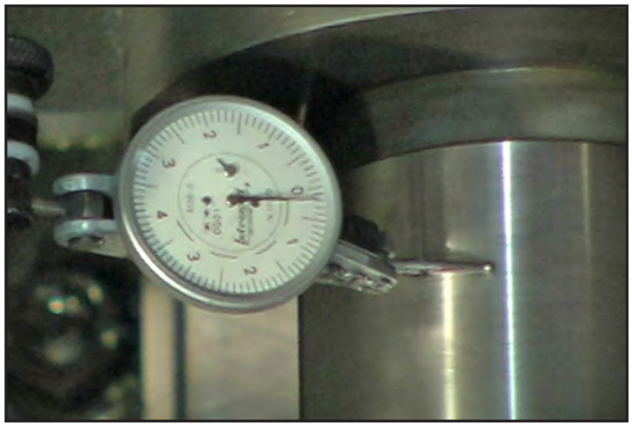


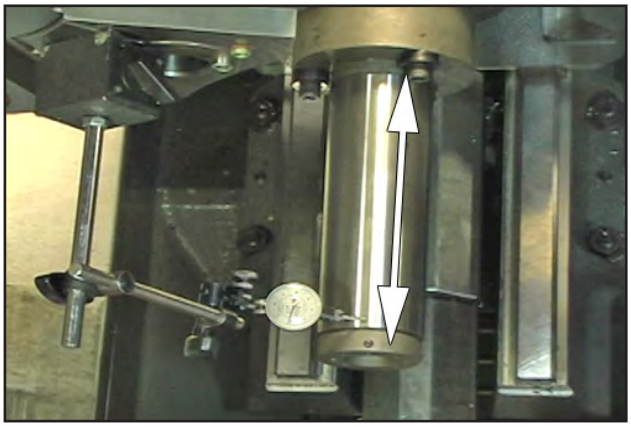


Check Secondary Spindle Head Flatness

1. Move the turret as required to rest the dial indicate the top dead center of the alignment tool's surface

2. Use the B-axis to jog the secondary spindle so the indicator tip travels over eight inches of the alignment tool to check the flatness. Max tolerance is. 0003"/8"

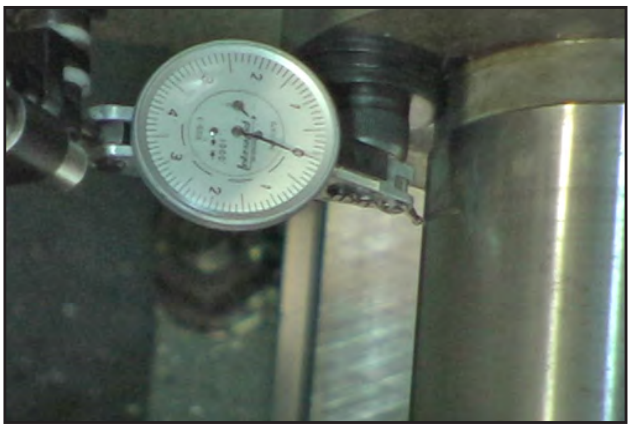


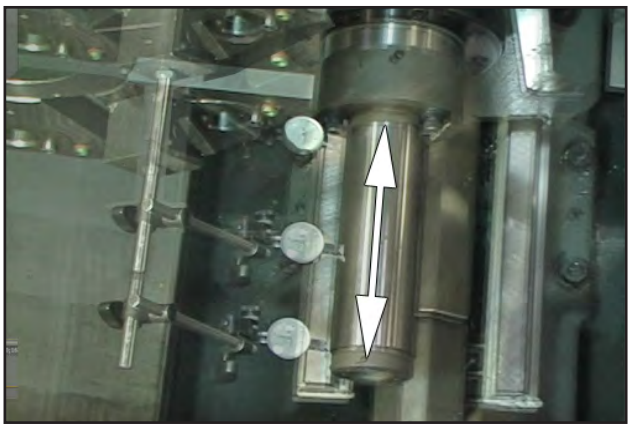


Adjust Secondary Spindle Head Base Parallelism

1. Move the turret as required to rest the dial indicator on the side of the alignment tool's surface

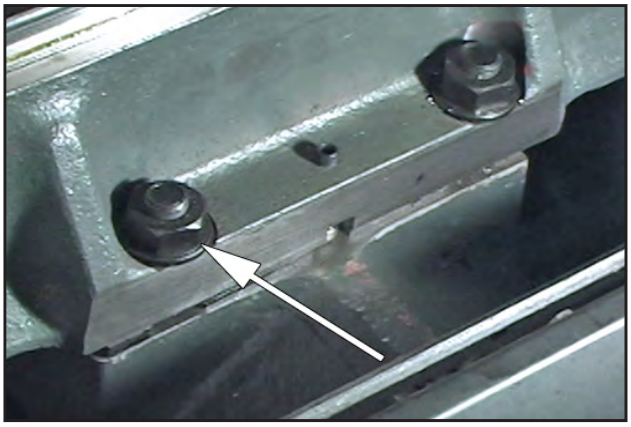
2. Use the Z-axis to jog the turret and indicator tip over eight inches of the alignment tool to check the parallelism. Max tolerance is. .0003"/8"

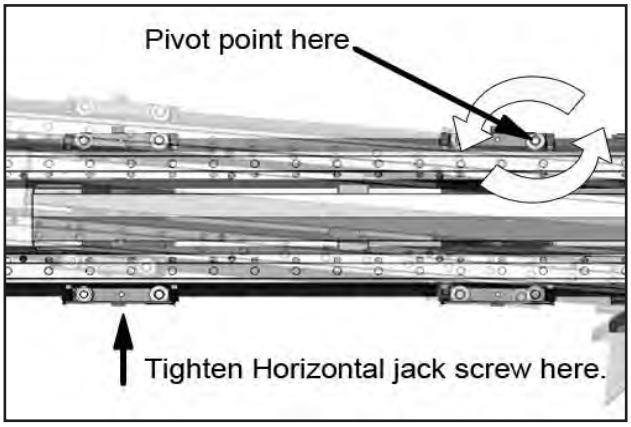




3. Determine which direction the base needs to move and leave one of the secondary spindle mounting nuts tight to act as a pivot point for the base.

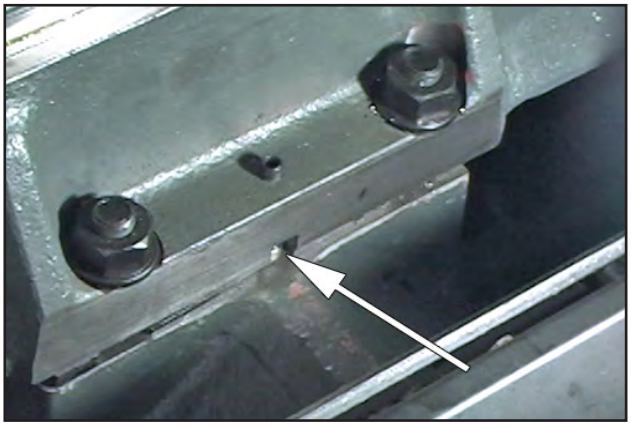
4. Tighten the diagonally opposite horizontal jacking screw to move the base into alignment.

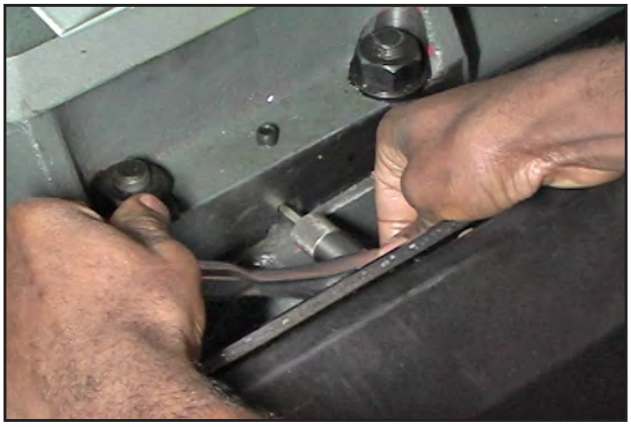




5. The secondary spindle base is adjusted for horizontal by using one of the four horizontal jacking screw located between the spindle base mounting bolts.

6. Adjust one of the appropriate side horizontal jacking screws. Max tolerance .0003”. Tighten the base mounting bolts snug and recheck.

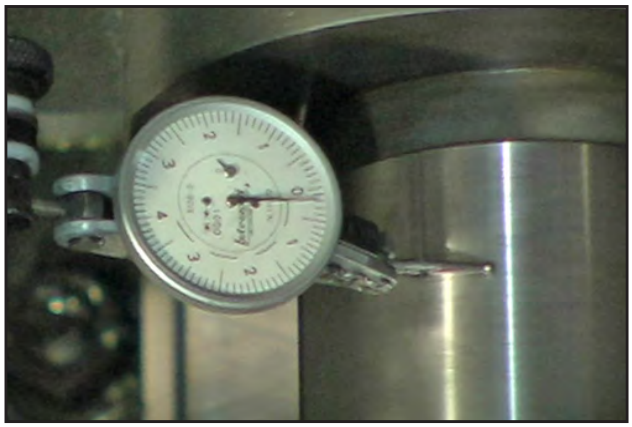


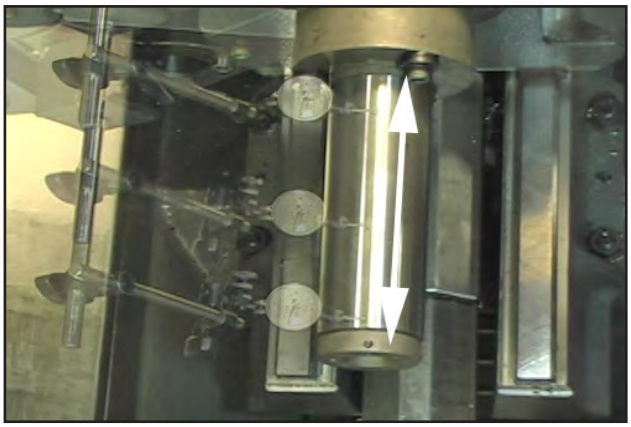


Adjust Secondary Spindle Head Base Flatness

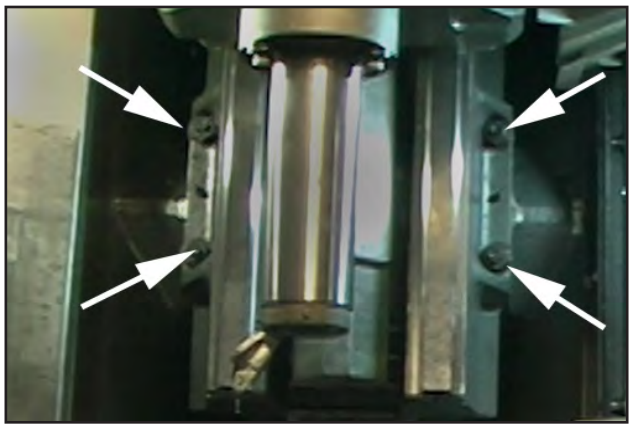
1. Move the turret as required to rest the dial indicate the top dead center of the alignment tool’s surface

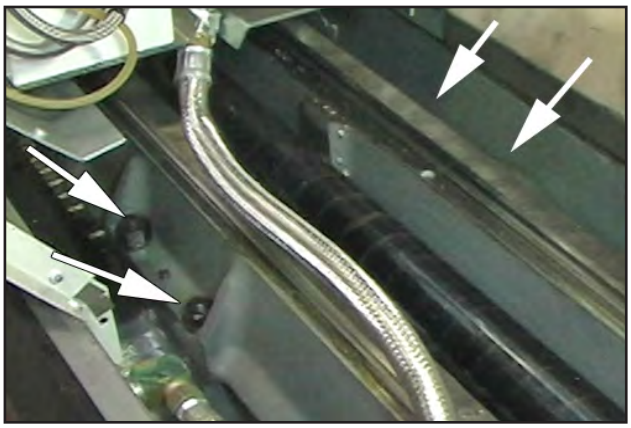
2. Use the Z-axis to jog the indicator tip over eight inches of the alignment tool to check the flatness. Max tolerance is .0003”/8”.





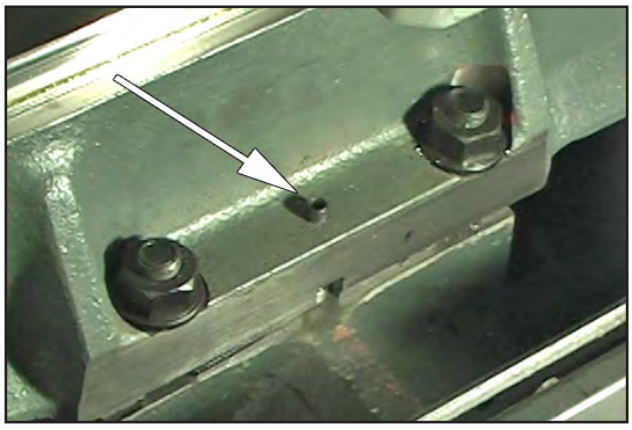
3. Loosen the eight base mounting nuts.

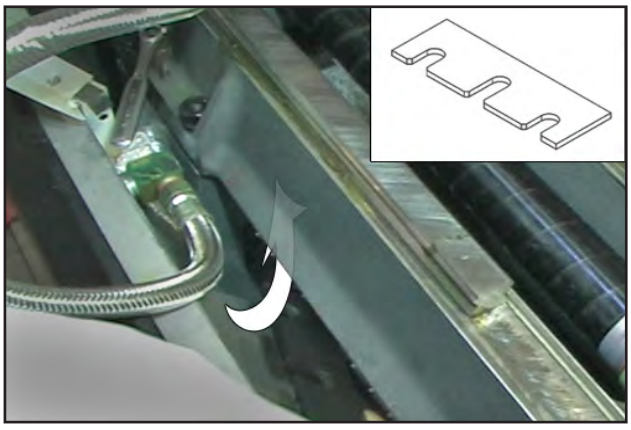




4. Tighten the vertical jacking screws located between the base mounting bolts to raise the base up off the shims

5. Add or remove shims from the underside of the front or rear as required. Loosen the jacking screws to lower base on to shims.





6. Tighten the base mounting nuts snug and recheck flatness.

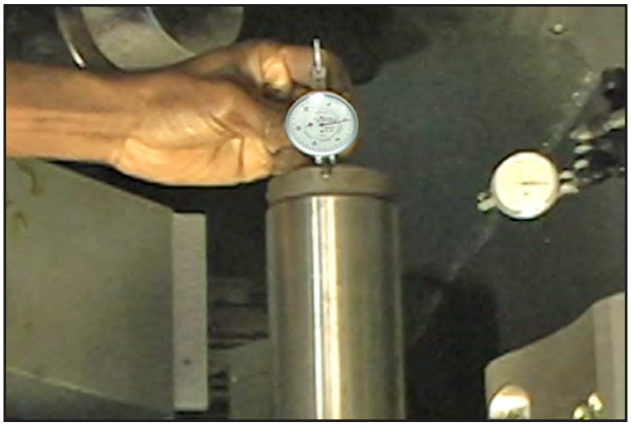
7. Use the Z-axis to jog the turret so the indicator tip travels over eight inches of the alignment tool to check the flatness.

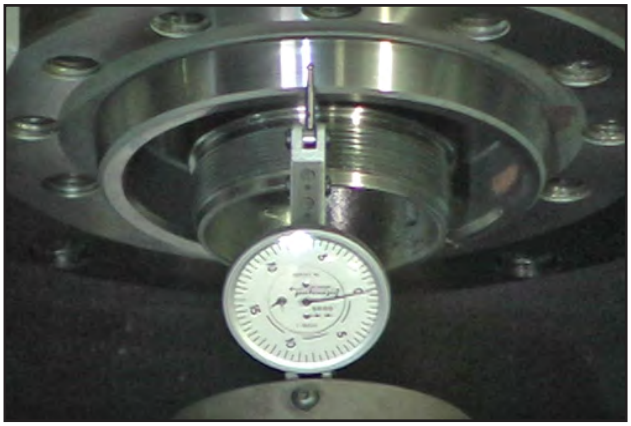
Max tolerance is .0003”/8”. If necessary repeat steps 3-7 to complete flatness alignment.

Check Spindle to Spindle Alignment

1. Mount a dial indicator on the alignment tool face.

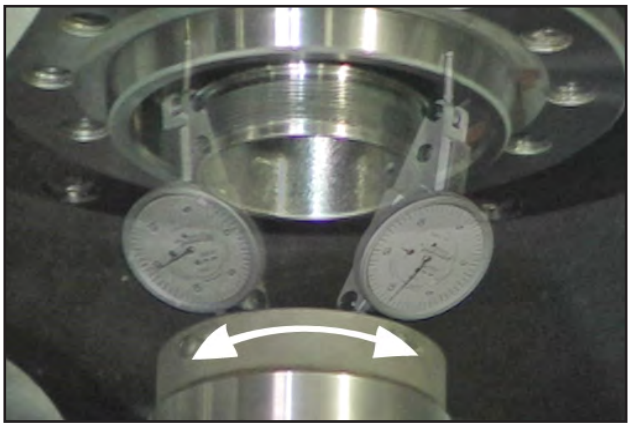
2. Jog the secondary spindle to indicate the center of the taper on the main spindle outer ring. Zero the indicator.

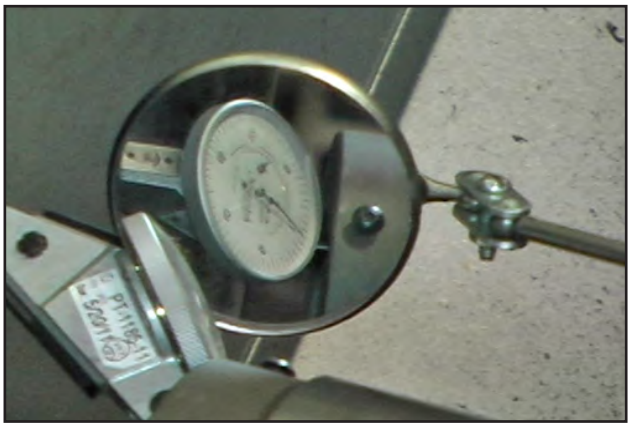




3. Turn the secondary spindle by hand to +90° and -90°. Note direction of any out of tolerance.

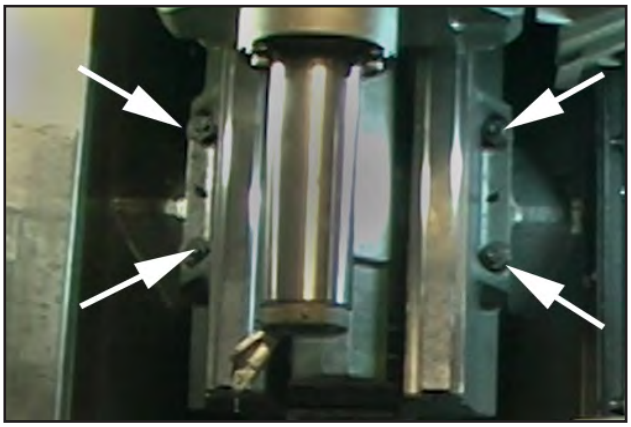
4. Use an inspection mirror to aid in the reading of the dial indicator at 90°.

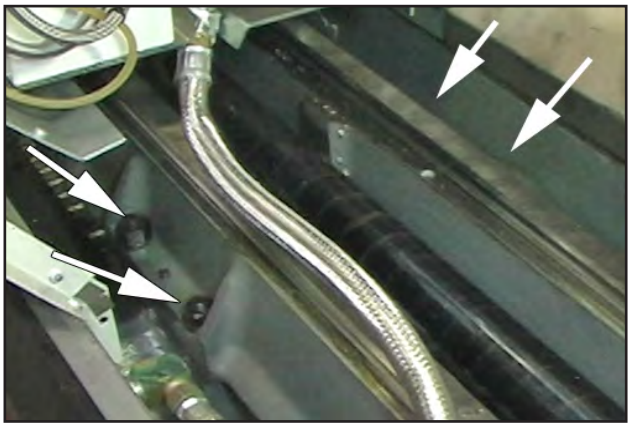




5. The secondary spindle base is adjusted for horizontal by using the four horizontal jacking screws located between the spindle base mounting bolts.

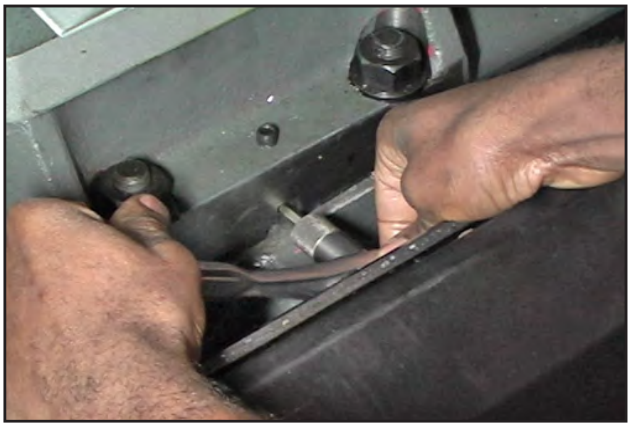
6. Loosen all eight base mounting nuts and then snug then just enough to allow movement with the jacking screws.

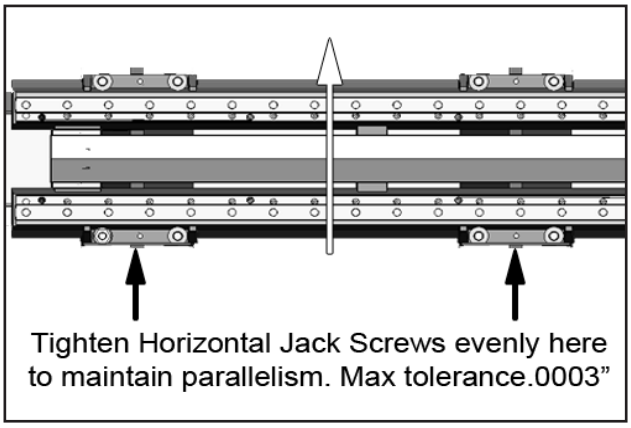




7. Adjust two of the appropriate same side horizontal jacking screws.

8. Adjust the jacking screw until +90° and -90° reads 0 on the indicator.





9. Tighten the base mounting bolts snug and recheck.

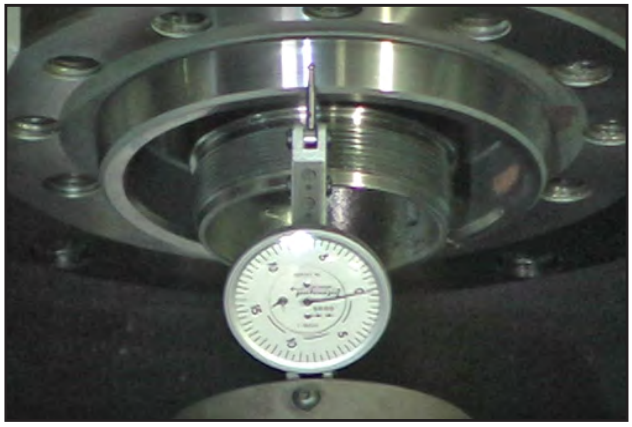
10. Repeat steps 3-8 until aligned.

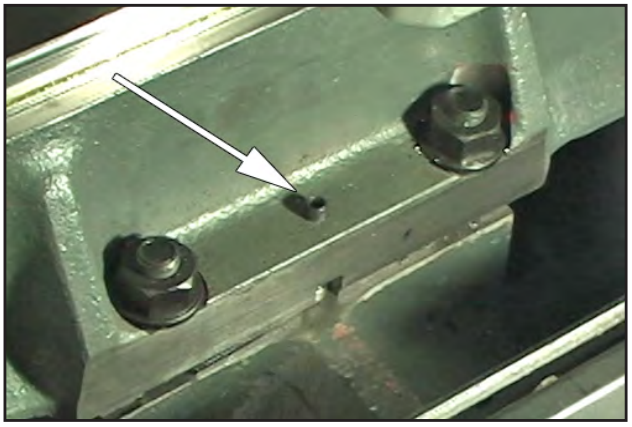
NOTE: DO NOT zero the indicator at this time.

Spindle to Spindle Vertical Adjustment

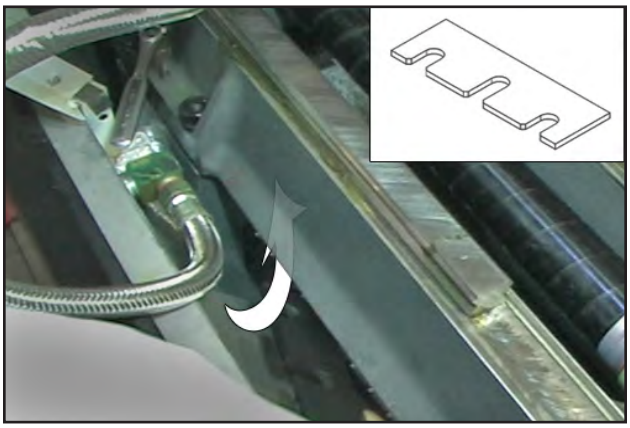
1. Rotate the spindle by hand until the indicator is back at top dead center of the main spindle. Adjust secondary spindle base as required. Max tolerance of TIR is .002”.

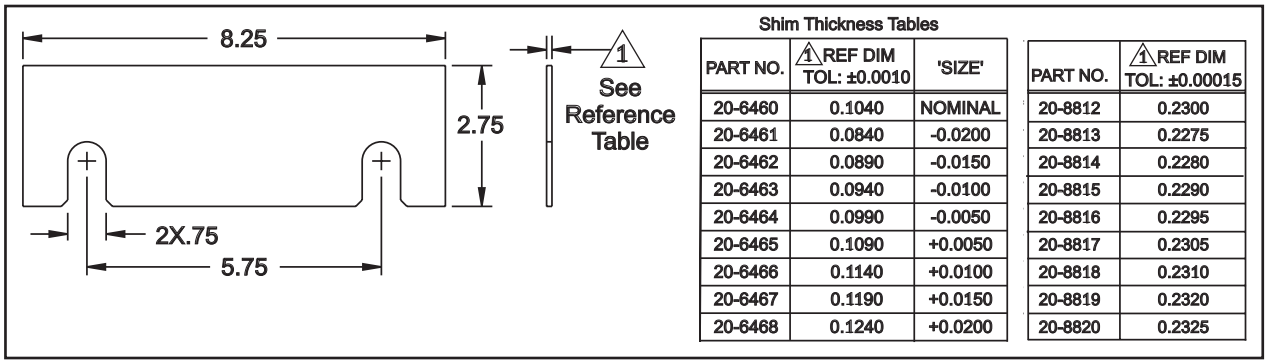
2. Tighten the vertical jacking screws located between the base mounting bolts to raise the base up off the shims.





3. Add or remove shims from the underside off all 4 each locations equally as needed. Max tolerance of TIR is .002" Loosen the jacking screws to lower base on to shims. Snug the base mounting bolts and recheck.





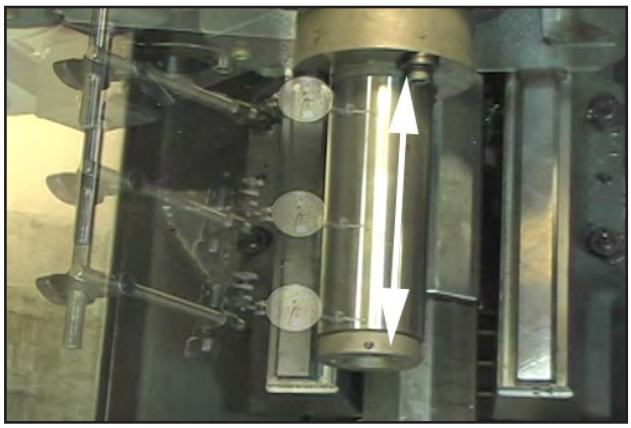
Shim Thickness Tables

PART NO.	1 REF DIM TOL: ±0.0010	'SIZE'
20-6460	0.1040	NOMINAL
20-6461	0.0840	-0.0200
20-6462	0.0890	-0.0150
20-6463	0.0940	-0.0100
20-6464	0.0990	-0.0050
20-6465	0.1090	+0.0050
20-6466	0.1140	+0.0100
20-6467	0.1190	+0.0150
20-6468	0.1240	+0.0200

PART NO.	1 REF DIM TOL: ±0.00015
20-8812	0.2300
20-8813	0.2275
20-8814	0.2280
20-8815	0.2290
20-8816	0.2295
20-8817	0.2305
20-8818	0.2310
20-8819	0.2320
20-8820	0.2325

4. Move the turret as required to rest the dial indicator on the top of the alignment tool's surface.

5. Use the Z-axis to jog the indicator tip over eight inches of the alignment tool to check the flatness. Max tolerance is .0003”/8”.



6. Move the turret as required to rest the dial indicator on the side of the alignment tool’s surface

7. Use the Z-axis to jog the secondary spindle so the indicator tip travels over eight inches of the alignment tool to check parallelism. Max tolerance is. 0003”/8”

8. When all adjustments are finished tighten secondary spindle base bolts to 250 ft-lbs torque.

NOTE: When tightening the Secondary Spindle casting bolts, remember to compensate for the length of the tool, and subtract it from the 250 ft-lbs of torque required for the Secondary Spindle head casting bolts. (Set torque wrench to about 120 ft-lbs.)

9. Recheck flatness and parallelism.

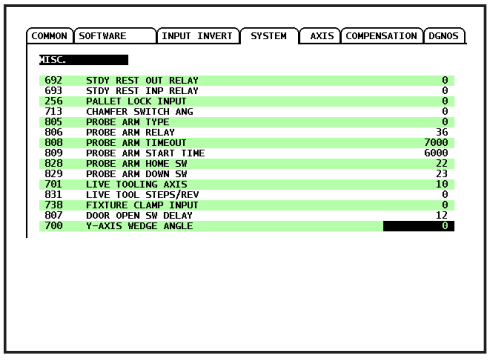
10. Install the Front Right Panel.

Adjusting X-Y Centerline

Before beginning this step. Verify the spindle and Z-axis are square (Leave the alignment bar on spindle). Verify that grid offsets for X and Y done.

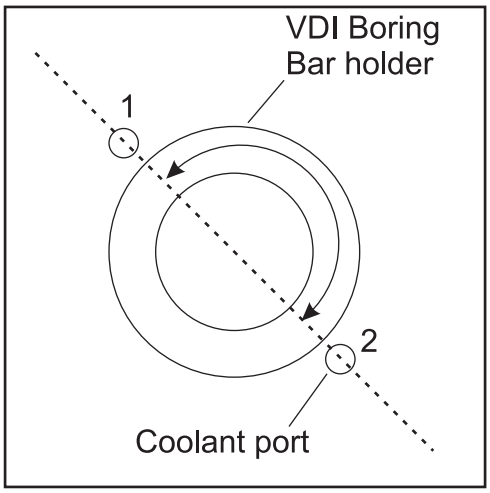
1. Set parameter 211 to 0.

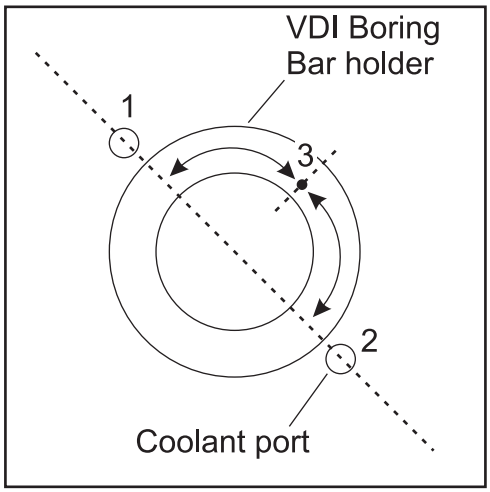
2. Write down the value of parameter 700, and then set to 0.



3. Use a .0005” indicator on the end of the alignment bar. Sweep a VDI boring bar tool holder. Jog the X axis only until the indicator reads 0 at each reference mark (points 1 and 2).

4. Rotate indicator to location 3. This is equal distance between the coolant ports.



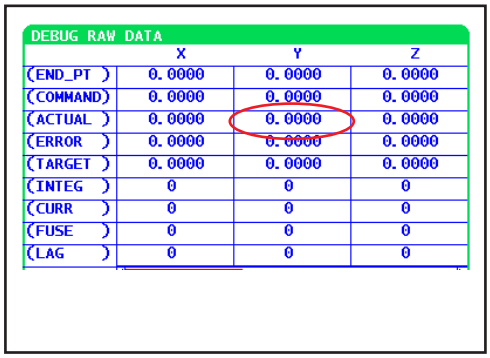


5. Write down the distance. Multiply the distance by 1.414. For example:
   +.017 * 1.414 = +.024

6. Handle jog the Y axis to +.024 and repeat step 5.

7. Repeat this process until the indicator reads 0. This is spindle centerline.

8. Go into Debug mode. Scroll to the Raw Data page and write down the number in “Y-Actual”. Enter the number (from Y-actual) for the value in Parameter 211. Enter a negative value if the number from step 5 was negative. Enter a positive value if the number from step 5 was positive.


DEBUG RAW DATA

	X	Y	Z
(END_PT)	0.0000	0.0000	0.0000
(COMMAND)	0.0000	0.0000	0.0000
(ACTUAL)	0.0000	0.0000	0.0000
(ERROR)	0.0000	0.0000	0.0000
(TARGET)	0.0000	0.0000	0.0000
(INTEG)	0	0	0
(CURR)	0	0	0
(FUSE)	0	0	0
(LAG)	0	0	0

9. Go to the Commanded position page and write down the X-axis position. Enter this number into Parameter 254.

10. Enter the original value for parameter 700 (step 4).

11. Zero Return Y axis. Note: The software will automatically zero return the X-axis.

12. Move X to spindle centerline and verify the alignment.

Spindle Motor Replacement - TL

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.

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

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

Sub Spindle Head Alignment

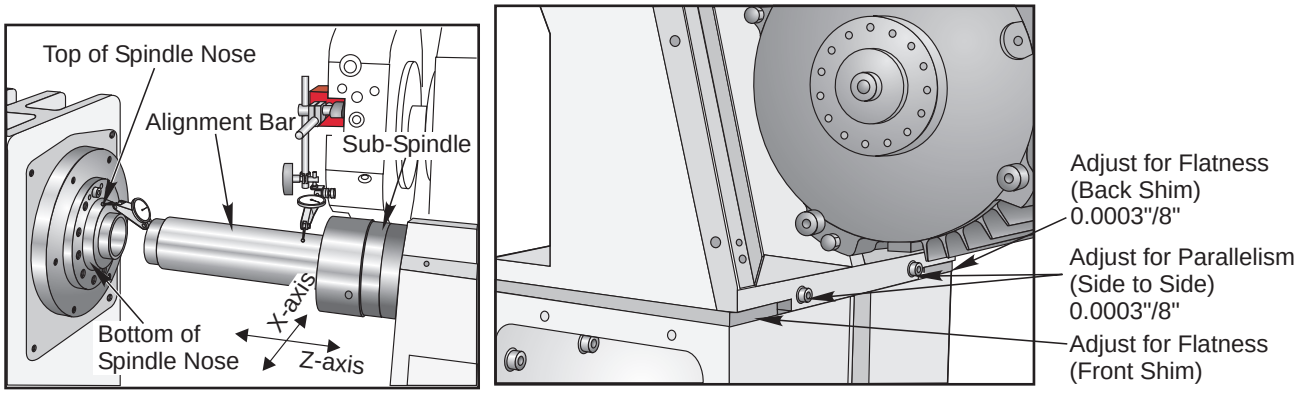
1. Insure that the main spindle is aligned. Follow alignment procedures for Lathe Spindle Assembly.

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.

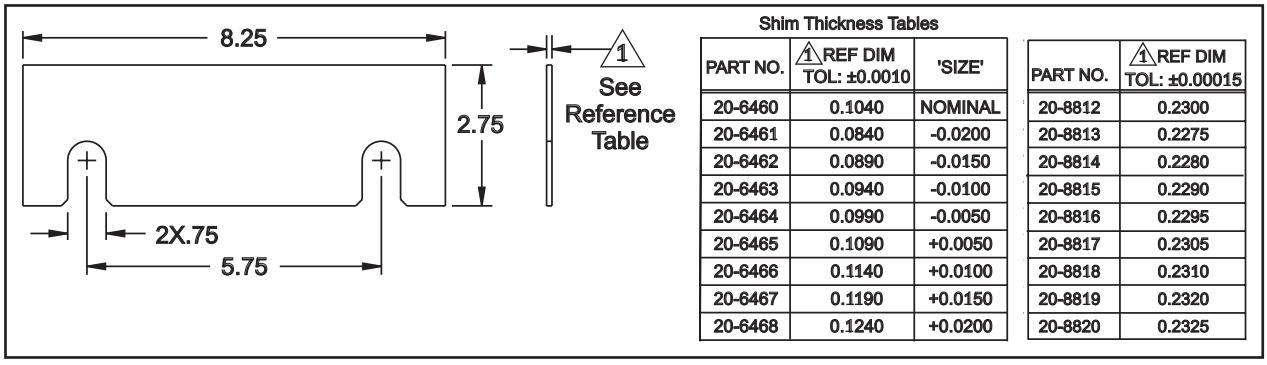
NOTE: Test bar should be indicated to .0 runout before checking alignment of sub-spindle

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 Thickness Tables

PART NO.	1 REF DIM TOL: ±0.0010	'SIZE'
20-6460	0.1040	NOMINAL
20-6461	0.0840	-0.0200
20-6462	0.0890	-0.0150
20-6463	0.0940	-0.0100
20-6464	0.0990	-0.0050
20-6465	0.1090	+0.0050
20-6466	0.1140	+0.0100
20-6467	0.1190	+0.0150
20-6468	0.1240	+0.0200

PART NO.	1 REF DIM TOL: ±0.00015
20-8812	0.2300
20-8813	0.2275
20-8814	0.2280
20-8815	0.2290
20-8816	0.2295
20-8817	0.2305
20-8818	0.2310
20-8819	0.2320
20-8820	0.2325

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”.

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.

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.

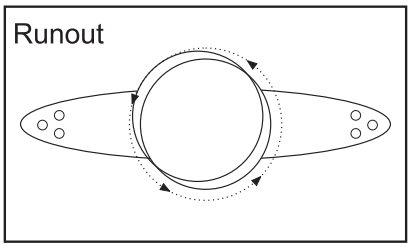
• Check for proper drive belt tensioning. Adjust drive belt tension as noted in "Belt Replacement and Tensioning" section of the Mill/Lathe Mechanical Components Service Manual.

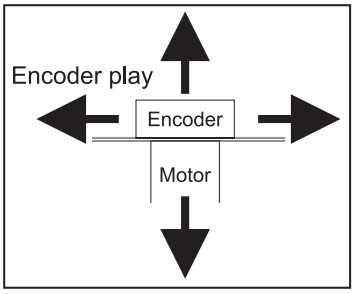
• Lathe belts may need replacing. Lathe belts are a matched set and should be replaced as a set, not individually. The belts (V-belts and toothed belts) must face the same direction; use the belt label as a reference. Toothed belts must have all the labels in a line.

• 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). 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.

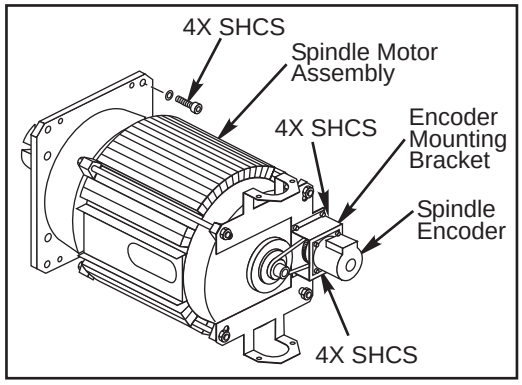
3. a. **Vert:** Remove the tool release piston assembly ("Tool Release Piston Assembly" section).

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

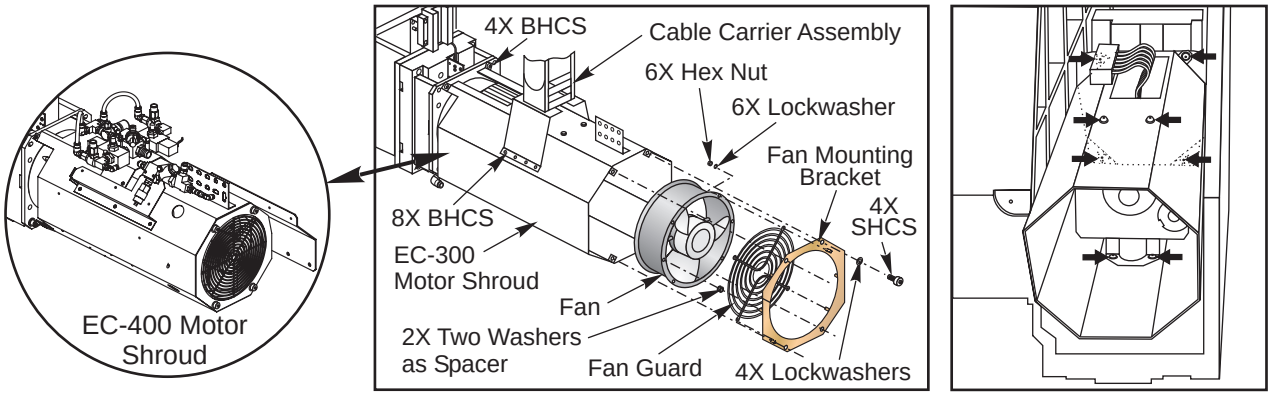
4. Press the Power Off button on the control panel and turn the main breaker off. If there is an external breaker box, turn it off and lock it out.

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.



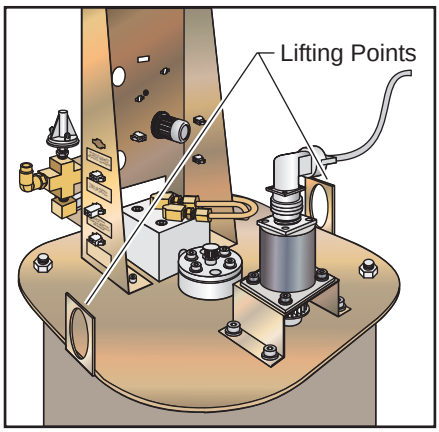
EC-400: Remove the motor shroud, which is held on with four (4) BHCS. Disconnect the encoder cable, spindle air blast, and TSC coolant union, if equipped.



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.

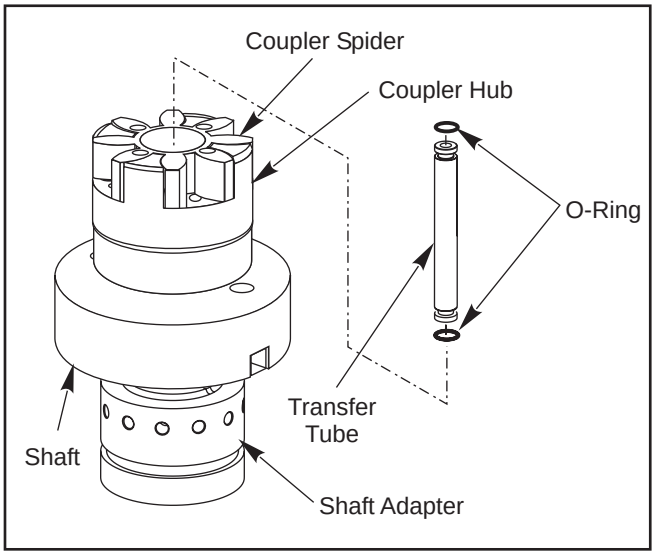
2. Check the condition of the coupler hub on top of the spindle, and the condition of the coupler spider. Lift the motor up and position it just above the TRP using a forklift or hoist. Check the condition of the coupler hub on the motor, and align it with the coupler on the spindle. Inspect the transfer 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.

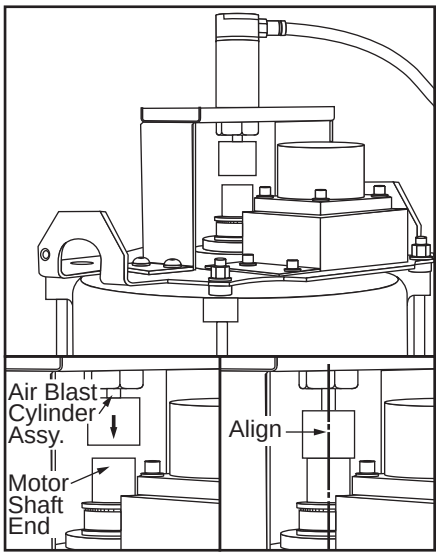
3. Lower/bring the motor toward the TRP. The couplers should engage with very little interference. It may be necessary to rotate/move the spindle back and forth slightly to line up the coupler hubs or rock the motor housing to square the assemblies. Do this by hand on the spindle dogs, at the spindle 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.

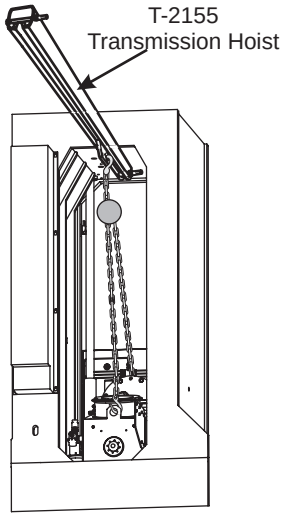
6. Remove the Low Air/Low Oil, Fan, Spindle Head Solenoid, Spindle Status, and P-Cool cables from the manifold attached to the transmission.

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.

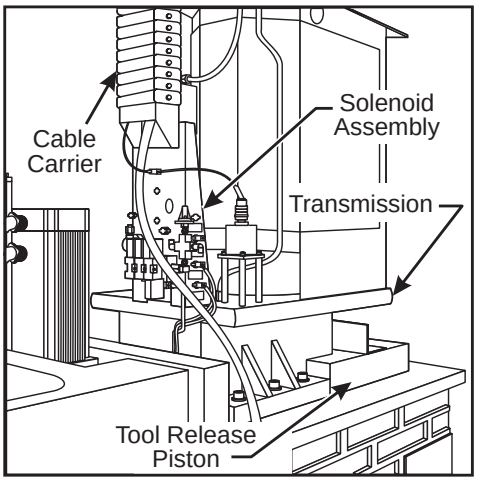
7. Remove the tool release piston assembly ("Tool Release Piston Assembly" section).

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.

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

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

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

16. Lift off the transmission/motor assembly.

Installation

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

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

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

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

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

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

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

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

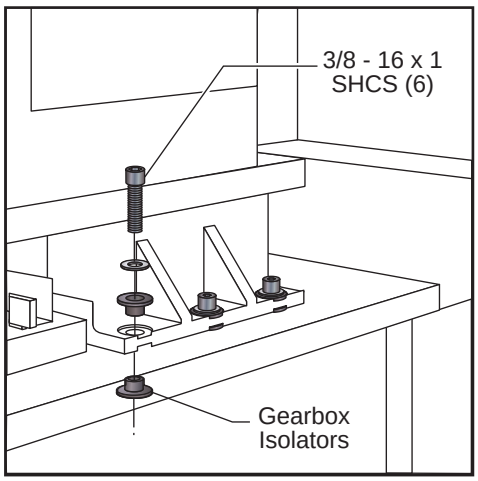
50 taper: Connect the power wires and attach the electrical plug panel to the rear of the motor. Reattach any Molex plugs to the panel, if removed during the previous procedure.

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

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

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

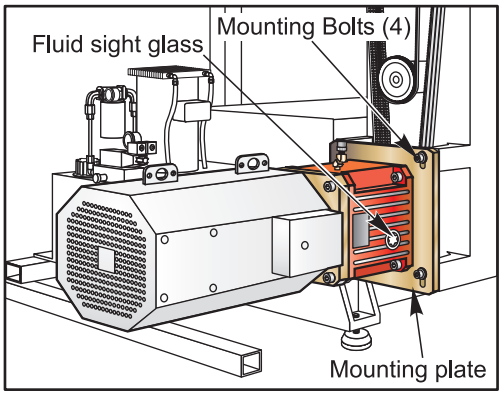
NOTE: If you are using a floor jack, the bottom left front panel needs to be removed.

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.

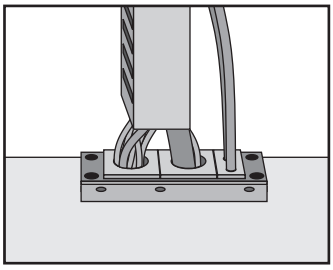
2. Ensure the new transmission is seated securely on the straps and lift up slowly. Lift only high enough to install the drive belts, then gently swing the assembly into place.

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

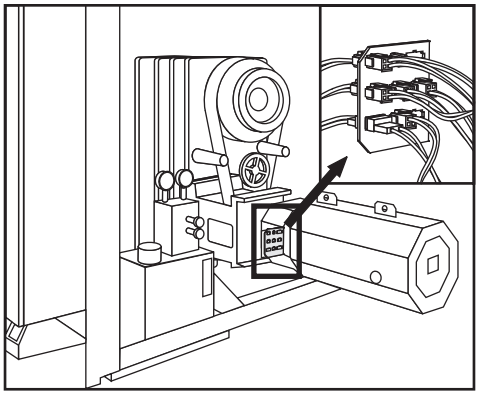
Remove cable guide covers necessary to route CBL890 to I/O PCB P15 and place CBL890 in cable guide.

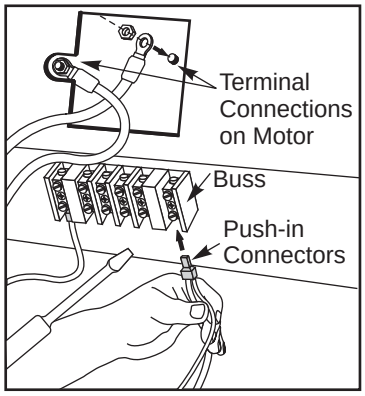
Route the other end of cable 890 in the most direct, safe path to the bracket on the side of the gearbox. Plug the connectors into their appropriate slots in the bracket, and plug the matching Hi Gear, Lo Gear, and Trans Lo Oil (from the pressure switch) connectors together. If there are no available 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 been seen moving through the clear line. The oil pump will run whenever the spindle is turning.

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

8. Replace the left side panel.

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

55 HP Lathe Transmission and Motor Replacement

Removal

1. Remove the sheet metal on the left side of the lathe in order to gain access to the motor and transmission

2. Remove the motor cables from the buss, under the motor.

3. Disconnect all the motor feedback cables at the subplate on the motor/transmission.

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

4. Use lifting eyes to support the motor/transmission assembly. There is a provision for a lifting eye close to the center of the motor cover and another at the pulley end. Use a lifting strap between the two lifting eyes and secure the strap to the lifting equipment.

5. Support the motor/transmission assembly.

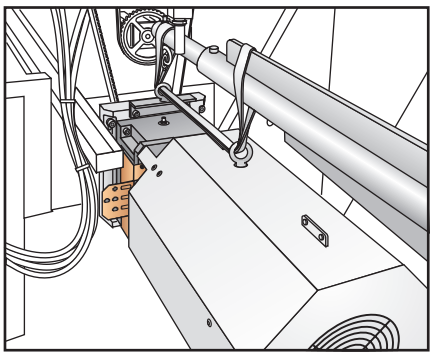
6. Remove the bolts that secure the transmission to the spindle casting.

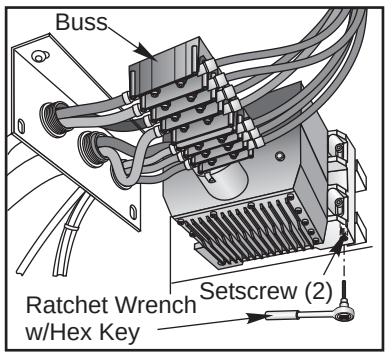
7. Lift the motor/assembly up to clear the belts and then pull the assembly away from the spindle casting.

Installation

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

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





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

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

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

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

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

7. Ensure all cables are away from moving parts.

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

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

10. Verify that the transmission oil is at the proper level. The machine is full (2 1/4 liters) when oil is visible 3/4 of the way up on the sight glass. Add 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

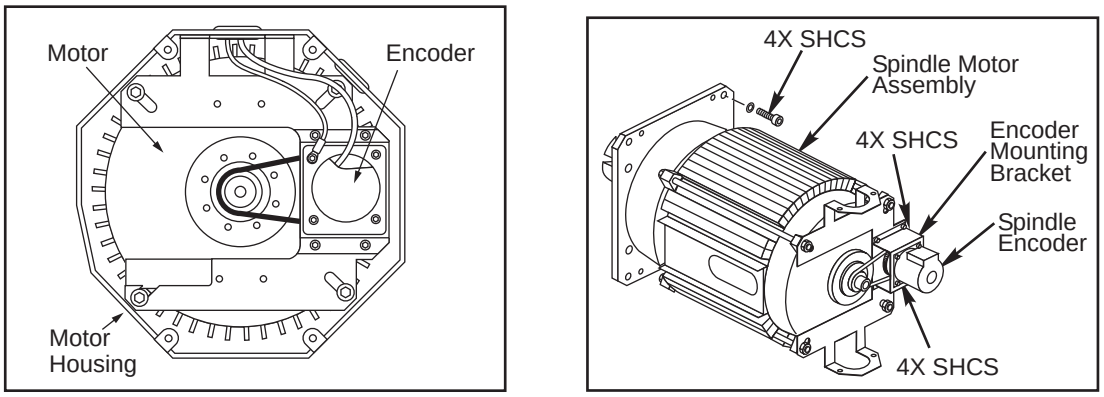
Please read this section in its entirety before attempting to remove or replace the optical encoder.

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.

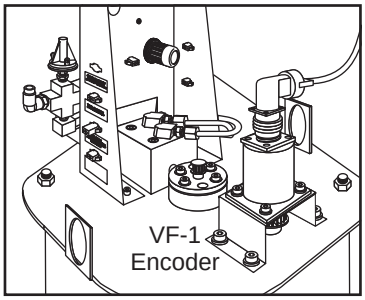
   b. **Horiz:** Remove the fan and fan shroud, then the tool release piston to access the encoder.



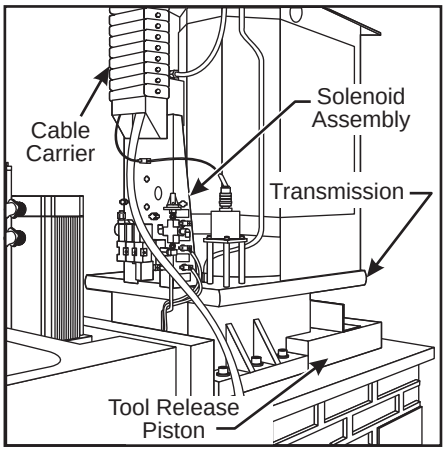
EC-300 Spindle Encoder Installation (Fan and Fan Shroud Removed)

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)



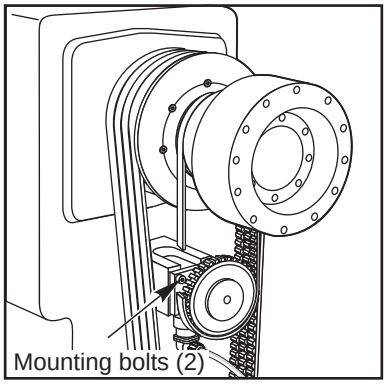
Encoder Installation for Direct Drive Machines

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.

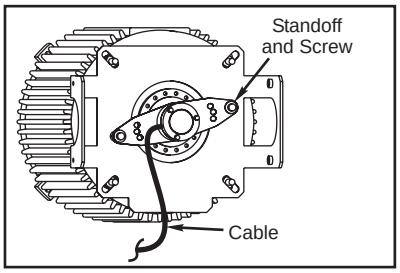
Magnetic Encoder

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:

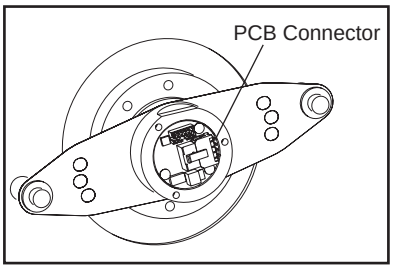
Spindle Orientation	Motor Z Faults	Z Channel Missing	Spindle not Turning
Cable Faults	Phasing Errors	Transition Faults	

Replacement Kit

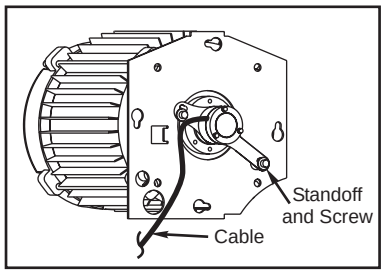
Note: There is a small amount of Three Set Screw Encoders in the field. If one of these needs replacing, do so using kit number 30-30330.



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.

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.

Most Haas machines have a coolant system for the tool and workpiece. There is a tank at the back or side of the machine that contains the coolant and a pump that moves the coolant to the spindle head (mills), or tool turret (lathes).

The makeup of the coolant has a wide variety of possibilities. Haas Automation recommends water-based coolants only. Typical coolant is water with some additives to improve lubrication and reduce rust and bacteria.

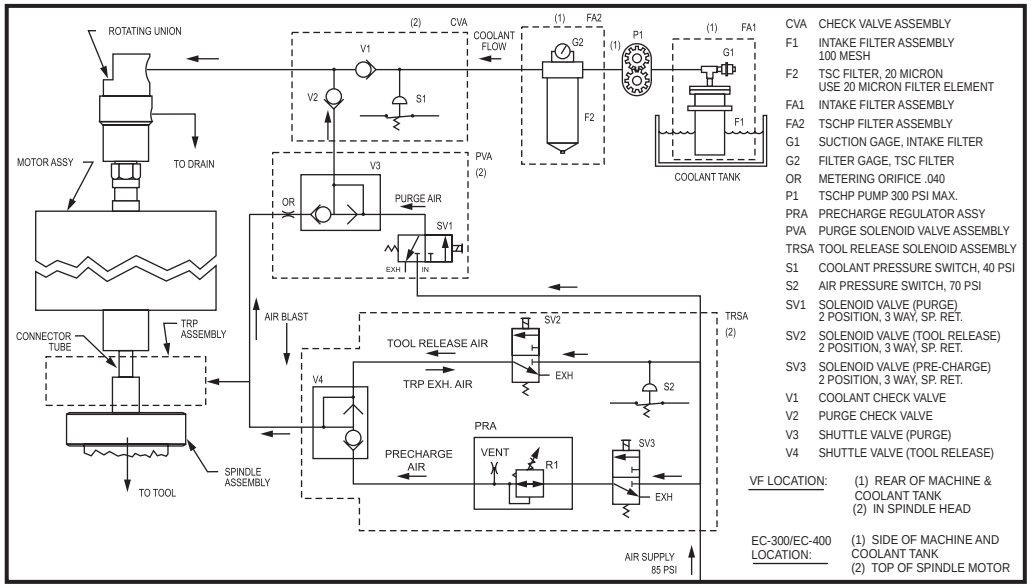
The coolant pump is electric and can be turned on and off both by the operator using the pendant buttons or M-codes within program. The machine can be operated normally without this coolant.

Mills: The coolant is first circulated through a jacket around the spindle beofre it exits into the enclosure. This helps 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.

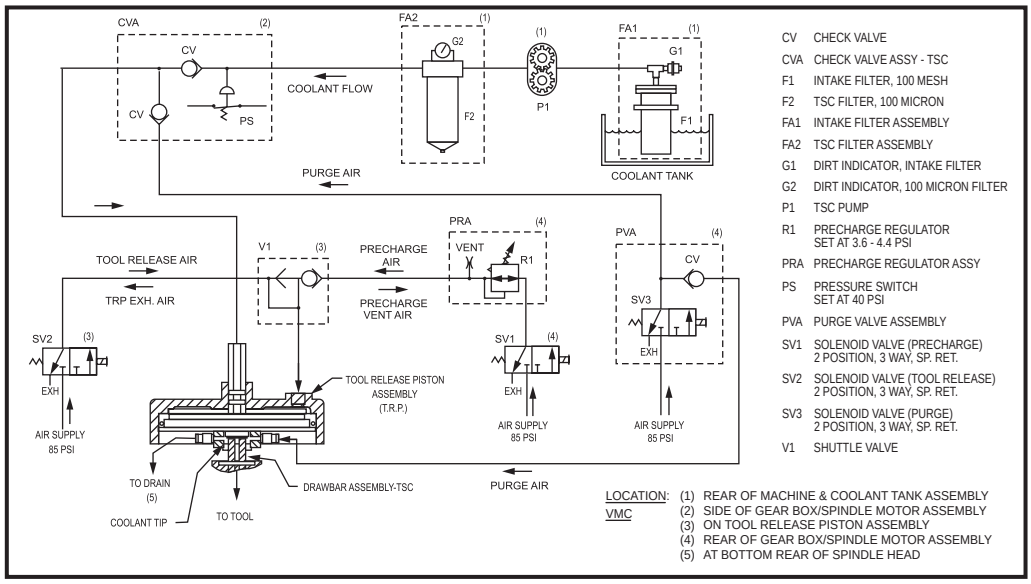
After the spindle jacket, the coolant comes out through the ports. These ports can be aimed manually or automatically (optional P-Cool) by the machine. Typically these ports are aimed directly at the tip of the working tool.

There is an optional through-the-spindle-coolant (TSC) system, which consists of a second pump. This system pumps coolant through the center of the spindle and through the tool. It provides no cooling functions to the spindle.

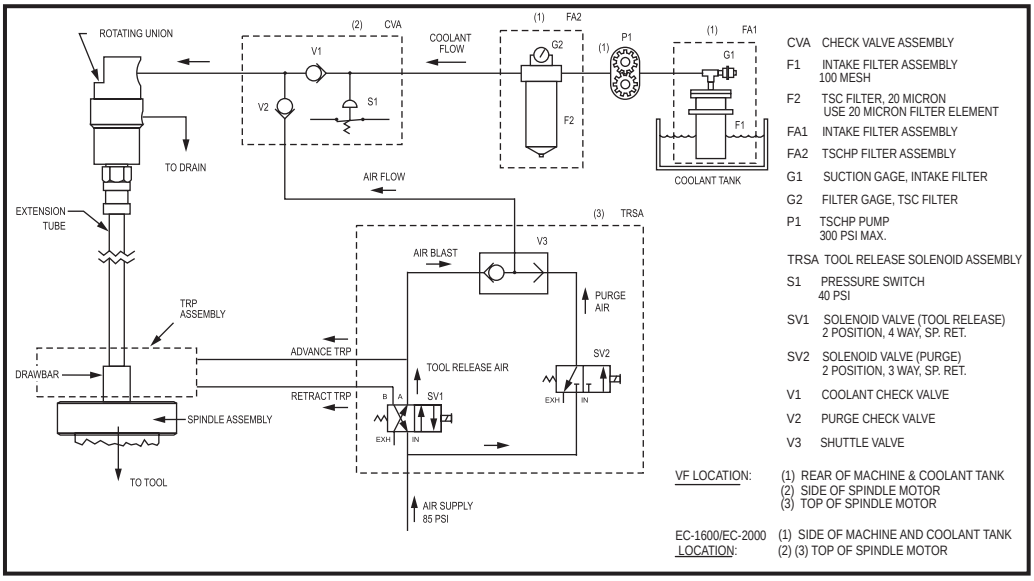
In-Line Drive (TSC)



40 Taper (TSC)



50 Taper (TSC)



Programmable Coolant (P-Cool) Troubleshooting

General Information:

Use this test to help troubleshoot a 196 alarm or a reported positioning problem of the P-Cool. Before starting this procedure, verify that you have +12VDC at the spindle head on the end of the 200 cable when the P-Cool is commanded to move. If there is no voltage, you have a problem with the cable or I/O board.

Requirements to run test:

1. Machine must have 16.05B or later software to run this test.

2. Check machine parameters.

   Par. 206 = 34

Par. 207 = 2000

Par. 253 = 0

Par. 304 = 0

Par. 612 = 0

Par. 613 = 0

Par. 614 = 0

Test Procedure:

1. Enter “DEBUG” mode

2. Change Parameter 612 (Spigot Type) to “1” (from “0”)

3. Change Parameter 57 bit 11 (Coolant Spigot) from “1” to “0” then back to “1” again. (This will clear the current P-Cool position from the display)

4. Go to the VAR / SPIGOT-INFO tab.

5. Push “CLNT DOWN”

6. Spigot data is generated

7. To retest, change Parameter 612 (Spigot Type) from “1” to “0” then back to “1”. Repeat steps 4-6.

The P-Cool will “HOME” then go to position 10 and back to 1. The result of the test is shown as the duration of the position counting switch, (in milliseconds (ms)). This page also shows the pertinent parameter settings, the number of errors that occurred (ERR CNT), and the number of alarms that occurred (ALM CNT) (See fig.1).

I/O 1 | I/O 2 | VAR | DATASTORE | Q/LOOKAHEAD | MAINT | MACROS | KEY HISTORY | FONTS

Cycle Pos	Forward High	Low	Period	DtyCyc	Reverse High	Low	Period	DtyCyc
1)	118	23	0	0%	2000	23	0	0%
2)	207	20	0	0%	113	20	0	0%
3)	104	22	0	0%	113	21	0	0%
4)	117	20	0	0%	113	21	0	0%
5)	114	21	0	0%	113	21	0	0%
6)	115	20	0	0%	113	20	0	0%
7)	114	21	0	0%	113	20	0	0%
8)	115	20	0	0%	112	21	0	0%
9)	116	22	0	0%	116	23	0	0%
10)	114	21	0	0%	112	21	0	0%
AVG	143	26	172	84%	112	20	132	84%

PAR 206:	34	PAR 207:	2000	PAR 612:	1	PAR 253:	0	PAR 304:	0
PAR 613:	0	PAR 614:	0	SCN TIM:	1721	DLY TIM:	16	SPG MOD:	0
CLNT PS:	0	SPG POS:	1	NEW POS:	3				
PRO CNT:	0	ERR CNT:	0	ALM CNT:	0				

RAW DATA | FLAGS | ADDRESSES | BDM | AXES | IRQ-INFO | TASK-INFO | SPIGOT-INFO

Figure 1 P-Cool Working Properly

Note: P-Cools with pulse durations of 15ms or lower or above 45ms are out of specification.

Common types of failures:

1. Build up of hardening material between the nozzle and P-Cool body causes binding. Clean area and maintain a minimum .005” clearance.

2. Viewing the duration numbers can determine if the position count occurs properly and if it is consistent. Duration numbers should have at least 15ms duration, in the “LOW” column (as specified for new build P-Cools). Pulse durations that are inconsistent and are very low (<5ms) would point to an internal problem with the P-Cool (See fig. 2 on next page). Replace the P-Cool assembly.

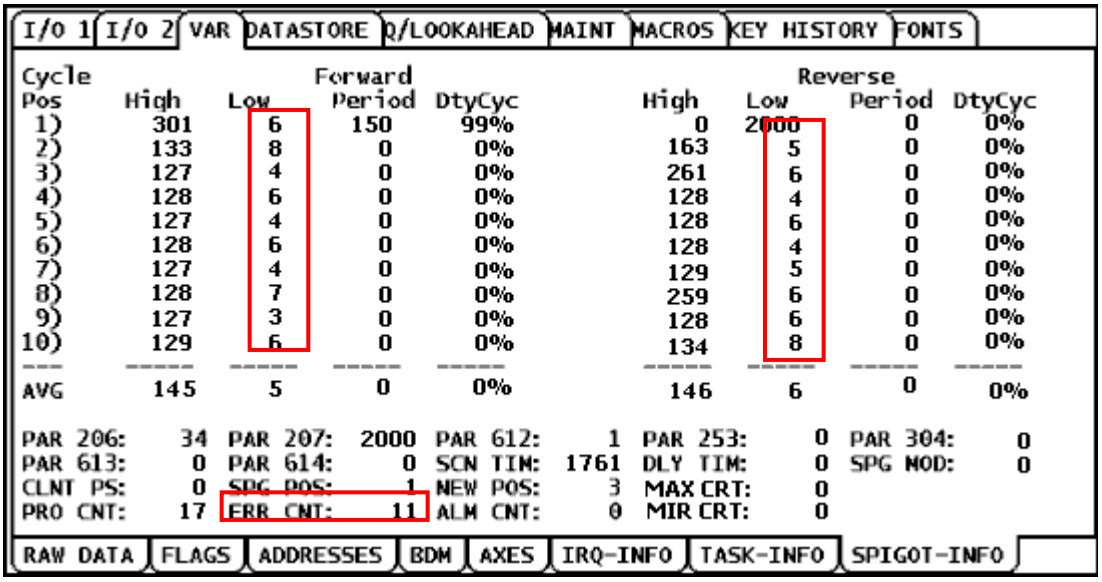


Figure 2 P-Cool out of Specification

Large pulse durations (maximum 45ms) in the “LOW” column indicate excessive drag on the nozzle shaft. This drag causes excessive current draw, resulting in a possible alarm. If the P-Cool fails to obtain the first 10 positions the durations will be “0”. This is often due to:

a. Internal motor failure.

b. Excessive internal friction within the P-Cool mechanism.

c. Excessive external friction due to binding of hose or contamination build-up.

Exiting P-Cool debug:

1. Reset parameter 612 to “0”

2. Verify that Parameter 57 bit 11 is “1”

3. Exit “DEBUG” mode

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 the in-line snubber. A jammed snubber can cause a low pressure alarm.

• 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 (±0.4 PSI). Release the solenoid and hold it down again for 20 seconds and re-check the precharge pressure. Repeat this a few times to ensure the pressure setting remains stable. Be sure the regulator adjustment knob is securely locked in place.

4. Remove the pressure gauge and short 1/4" hose. Reattach the precharge tube to the regulator.

Checking Pump Pressure

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

1. Insert the 0-600 PSI coolant pressure gauge into the coolant line between the machine enclosure and the TSC pump hose. Use wrenches to tighten the fittings snug. Do not overtighten!

2. Use a standard toolholder (no coolant through hole) and turn on TSC.

3. Check for leaks while the system is running.

4. Turn off TSC, remove pressure gauge, and reconnect the pump to the machine.

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

1. Remove the sealing cap from the pump relief valve. Loosen the lock nut.

2. Start with the pressure below 300 PSI. Adjust the pressure relief valve until the pressure on the gauge rises to 300 PSI. Tighten the lock nut, and replace the sealing cap. Setting range is 280-300 PSI.

3. Mark across the pump and sealing cap with a paint marker. This will indicate any future tampering.

Testing the Coolant Pressure Switch

1. Insert the ball valve and pressure gauge into the coolant line between the machine enclosure and the TSC pump hose. The ball valve must be *between* the pump and pressure gauge. Connect the other end to the machine. Tighten the fittings snugly with wrenches. Do not overtighten!

2. Run the system for one minute to purge air.

3. Install a through-hole toolholder (with a small drill or restrictor) and set Parameter 236 to 100.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

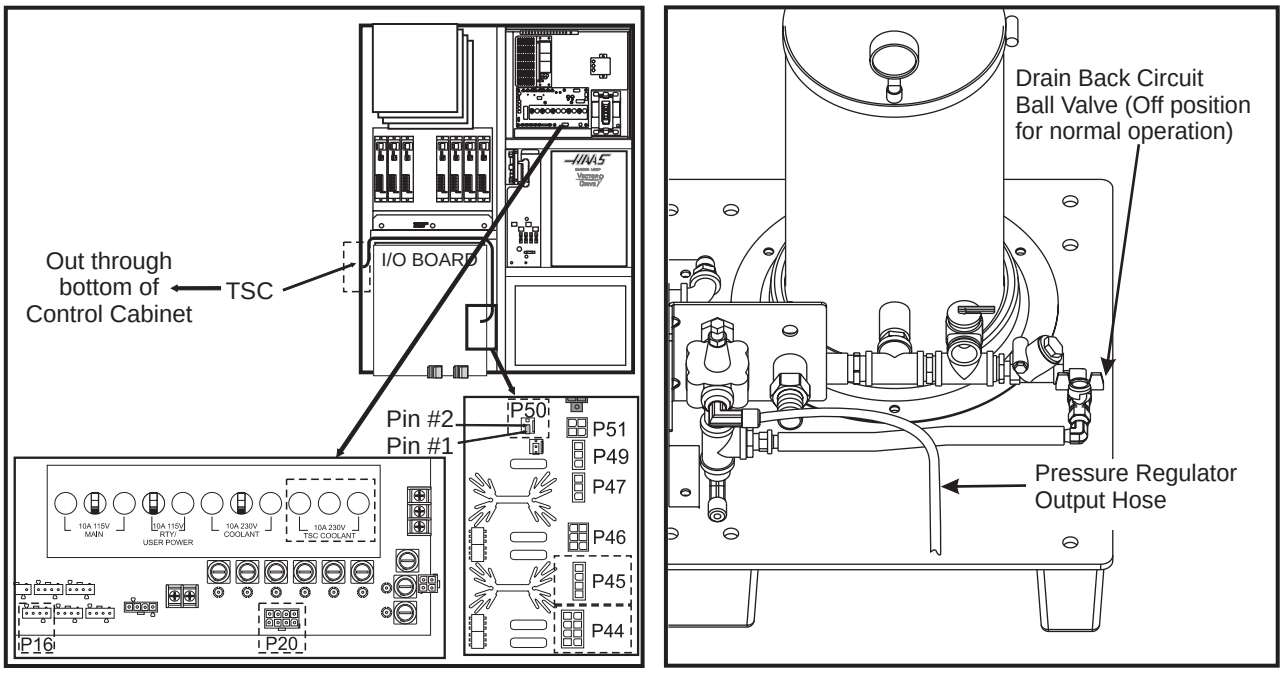
1. Check the AF tank filter bag for clogging or excess debris.

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

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

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

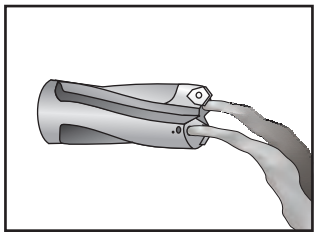
5. Verify that the standard coolant pump has not been branched off before the check valve.



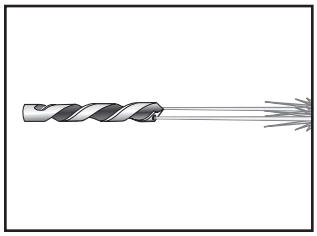
TSC 1000 Control / Electrical Connections

TSC Pressure Effects

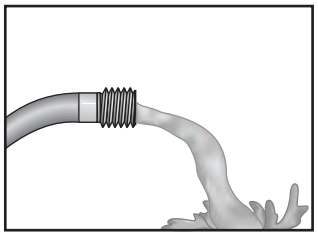
On machines using TSC during cutting operations, tooling size will have to be taken into consideration. As shown below, proper TSC system operation will deliver different pressures at the orifice of the tool; this depends on the diameter and number of coolant passages in the tool.



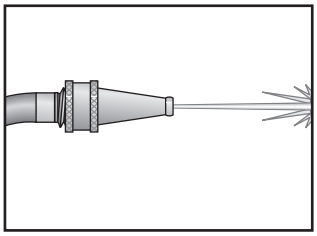
Larger tooling has larger diameter coolant passages.



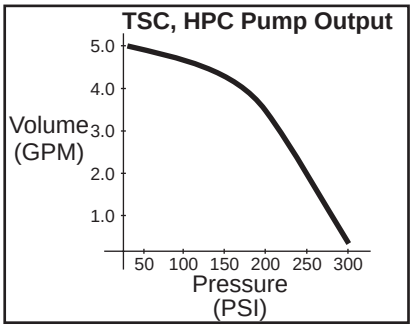
Smaller tooling has smaller diameter coolant passages.

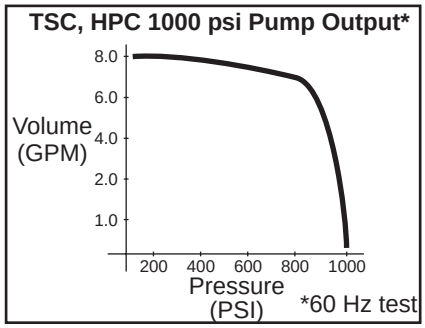


Coolant flow is higher at lower pressures

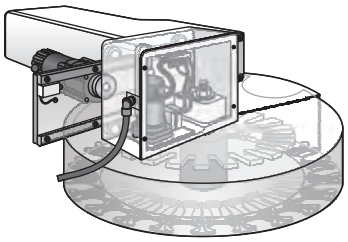


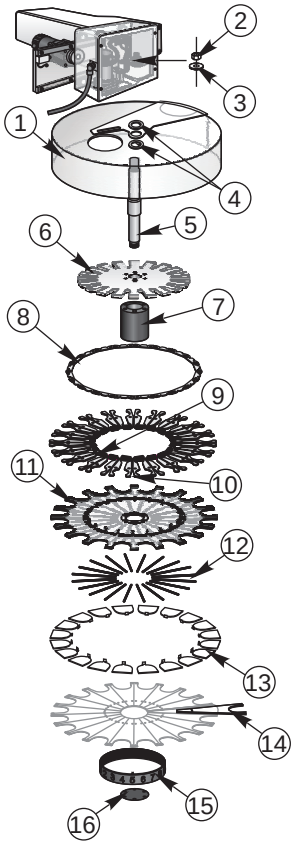
This produces higher pressures at lower flow.





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





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

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

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

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

Troubleshooting

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

Deflection

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

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

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

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

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

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

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

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

• Check drawbar height adjustment.

• If TSC, check for excessive coolant tip wear.

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

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

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

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

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

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

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

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

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

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

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

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

Toolholders twist against extractor fork during a tool change.

• Check the alignment of the ATC in the X and Y axes ("Automatic Tool Changer Alignment" section).

Toolholders spin at all pockets of the ATC when the ATC shuttle retracts.

• ATC is misaligned in the “Y” axis; realign ATC. Observe the direction the toolholder rotates, as this will be the direction in which the “Y” axis of the ATC needs to be moved.

Toolholders spin only at certain pockets of the ATC when the ATC shuttle retracts.

• Check all the extractor forks to ensure they are centered in the pocket of the ATC. If the ATC shows this problem, each extractor fork must be checked and centered to eliminate the possibility of the ATC being aligned against an incorrectly-centered fork.

Noisy Operation

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

ATC makes noise as the shuttle moves.

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

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

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

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

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

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

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

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

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

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

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

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

Orientation

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

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

• Check the orientation of the spindle.

ATC will not run.

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

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

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

• Command a tool change with the shuttle disconnected.

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

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

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

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

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

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

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

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

• Check ATC shuttle relay

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

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

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

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

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

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

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

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

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

  • Check ATC turret relay.

Tool Changer Position Switches

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

Breakage

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

ATC shuttle is broken off of the holding plate.

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

ATC extractor forks are damaged after breakage.

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

Crashing

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

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

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

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

The most common ATC crashes are outlined as follows:

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

• Rotate the carousel to an empty pocket.

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

• Check all of the extractor forks on the ATC.

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

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

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

ATC puts toolholder in spindle, but tools are dropped onto machine table when shuttle retracts.

• Inspect the balls and the Belleville springs in the drawbar. Replace drawbar.

The part or fixture on the mill table crashes into long tooling or into the ATC itself when machining.

• Reposition the tools to remove interference, or program carousel to rotate long tooling out of the way.

Carriage Casting Replacement

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

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

1. Turn the machine power off. Remove the left side enclosure panel of the machine.

2. Disconnect all cables from the carriage casting and remove any bolts holding the ATC to the holding plate.

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

3. Place a piece of cardboard over the machine's table, and carefully lower the carriage casting (with carousel) onto the machine table.

4. If the carriage casting has crashed and/or has been broken off of the holding plate, it should be inspected for damage before going any further.

5. Remove any damaged roller bolts from the carriage casting. Replace with new bolts.

6. With a lifting device, carefully lift the ATC assembly up and onto the holding plate.

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

7. With the ATC assembly securely supported, install the lower roller bolts and adjust in accordance with "Roller Bolt Replacement".

8. Repair or replace any cables damaged and adjust the ATC. Align the ATC assembly in accordance with the following sections, and set Parameter 64 in accordance with "Spindle Motor and Transmission" section.

Roller Bolt Replacement

1. Remove the shuttle motor cover from the back of the machine (VF-1, VF-2).

2. Place a support under the center of the carousel.

3. Loosen the eccentric locks on the bottom roller bolts.

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

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

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

5. Tighten the eccentric locks on the bottom rollers until there is no play between the rollers and the V-guide on the ATC holding plate.

6. Set the tool change offset (Parameter 64) in accordance with "Setting Parameter 64" section.

7. Verify the ATC alignment in accordance with the following section.

8. Reinstall the shuttle motor cover (VF-1, VF-2).

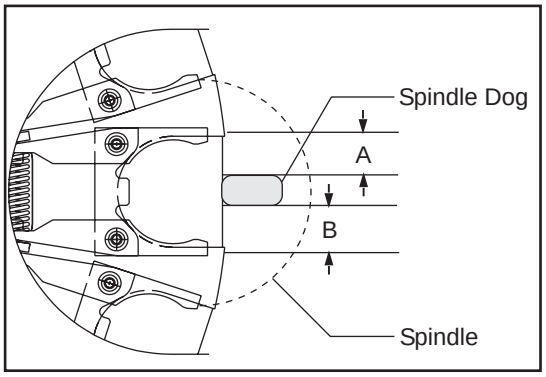
ATC Alignment

1. Verify that the spindle orientation is correct (refer to appropriate section).

2. Command an automatic tool change, and press Emergency Stop when the shuttle is fully in.

3. Verify that the spindle dog lines up to the alignment key in the ATC, in the Y plane.

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



Underside Showing Centering Measurements

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

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

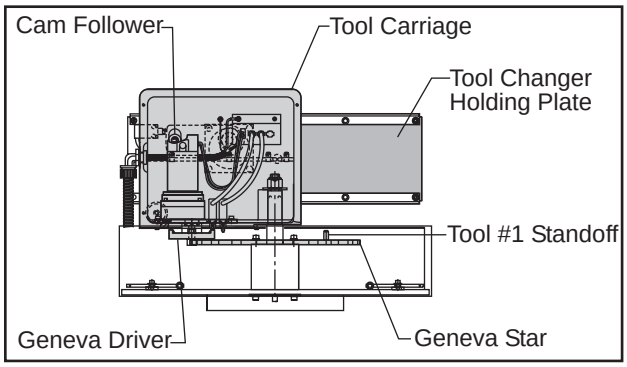
5. Make at least 50 tool changes after alignment is complete. Verify tools are being picked up squarely.

Shuttle Stroke Adjustment

1. Move the ATC away from the spindle and loosen the four HHBs in the ATC holding arm in the X-axis plane.

2. Push the cam follower to its full upward stroke, then push the entire ATC assembly in by pushing on the tool changer holding plate until ATC is fully engaged on the toolholder.

3. Ensure the extractor is making full contact on the tool flange.



Automatic Tool Changer - Mechanical Assembly (Side View)

Extractor Fork Replacement

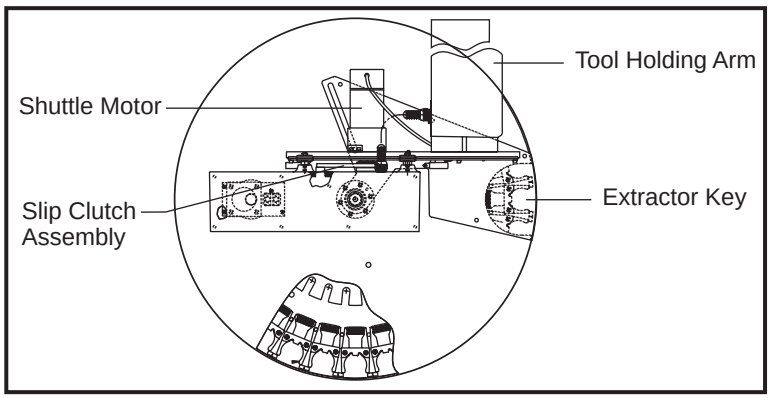
NOTE: Extractor forks that do not hold the toolholders firmly, or forks that are bent, must be replaced. Damage to the ATC will result if not replaced.

1. With no toolholders in the spindle or in the ATC, command "ATC Fwd" until the extractor fork needing replacement is facing the spindle.

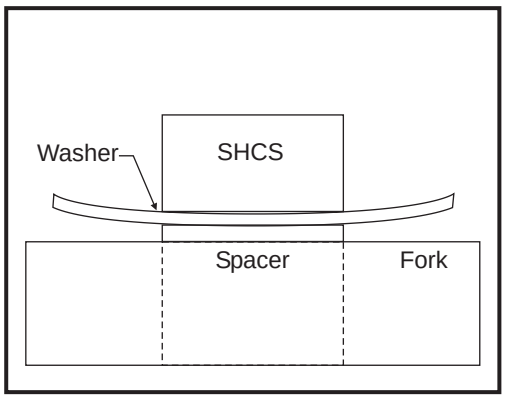
2. Command "ATC Fwd", but press Emergency Stop after the spindle head lifts up off the carousel.

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

3. Loosen the SHCS that attach the damaged extractor fork to the ATC carousel.



Automatic Tool Changer - Mechanical Assembly (Top View)



Washer Orientation Cross Section 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. Make sure that the beveled side of the washer is oriented correctly as shown in the illustration. **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.

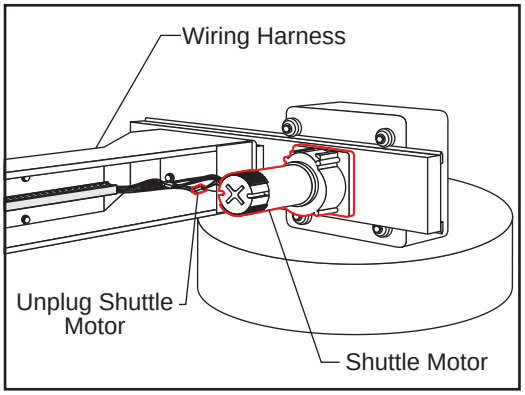
3. Push the tool changer in as far as it will go.

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

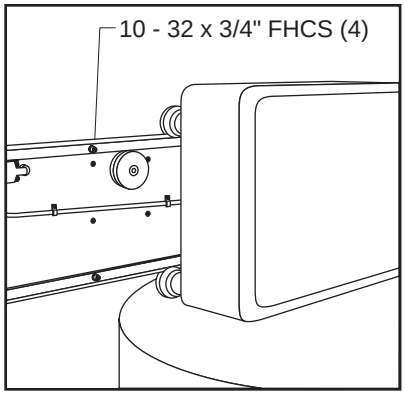
8. Remove the four FHCS attaching the shuttle motor to the holding plate on the tool changer. The FHCS are visible from the front of the VMC. Do not remove the HHBs holding the shuttle motor gearbox together.

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).

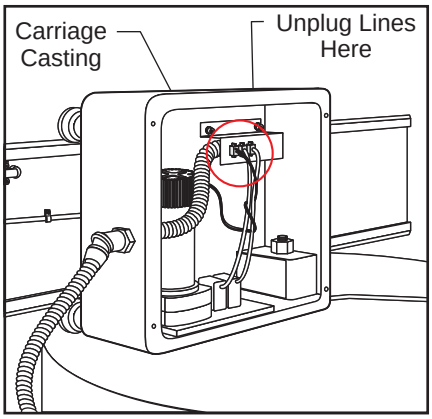
3. Press ATC Fwd, then Emergency Stop after the spindle head has moved during the tool change cycle. The tool changer should be at the full In position and the spindle head should be above the tool changer.

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.

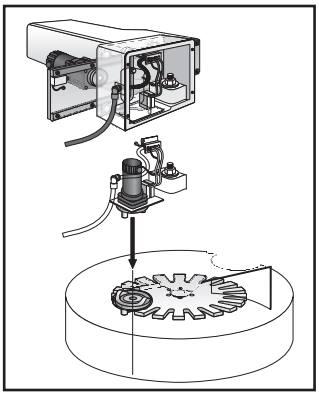


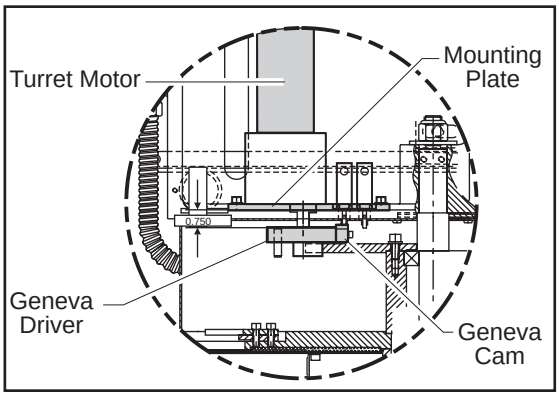
Carriage Casting with Cover Removed

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".

NOTE: The machine may alarm at this time (Alarm 115 or 127). If this occurs, Zero Return the Z-axis (Zero Ret - Singl Axis) and repeat step 7. This step may need to be repeated two times to clear all possible alarms.

8. Press "T - 9 - ATC Fwd". The tool changer should go to tool nine. If the tool changer travels to tool seven, the turret motor is wired backward. Reverse motor leads and repeat steps 7-10. The turret should run quietly with no strain in the motor, banging, or vibration.

9. Reinstall the tool carriage casting cover.

10. Test the tool changer for proper operation.

Geneva Star Replacement

NOTE: If ATC Geneva star is damaged or worn in its driven slots, it must be replaced.

1. Turn the machine power off.

2. Remove the cover from the front of the ATC shuttle.

3. Remove the turret motor assembly (refer to previous section).

4. Place a support for the ATC under the center of the carousel.

5. Loosen the nut inside the carriage casting that attaches the ATC carousel assembly to the casting. There is a socket head in the top of the shaft to hold it stationary while loosening the nut.

6. Place the cardboard over the mill table and carefully lower the carousel until it rests on the table.

7. Remove the six SHCS that attach the Geneva star to the bearing housing on the ATC carousel.

8. Install the Tool #1 standoff on the replacement Geneva star.

9. Install the replacement Geneva star. Check the concentricity of the star to the shaft on the carousel assembly; it must be within 0.005". If the star is not within tolerance, loosen the SHCS and adjust the alignment until it is acceptable.

10. Installation is reverse of removal. Grease the perimeter of the star before installation and readjust the ATC in accordance with "ATC Alignment" and "Shuttle Stroke Adjustment", if necessary.

ATC Trap Door Replacement

NOTE: If the ATC trap door is damaged in a crash, it must be replaced.

1. Turn the machine power off.

2. Remove the turret motor assembly in accordance with the previous section.

3. Place a support for the ATC under the center of the carousel.

4. Loosen the nut inside the carriage casting that attaches the ATC carousel assembly to the casting. There is a socket head in the top of the shaft to hold it stationary while loosening the nut.

5. Place the cardboard over the mill table and carefully lower the carousel until it rests on the table.

6. Remove the two SHCS that attach the guide pin for the ATC trap door to the ATC holding plate and remove the guide pin.

7. Slide the trap door from between the carousel cover and the shuttle casting. Be careful to not lose the two nylon washers that sandwich the trap door between the carousel cover and the shuttle casting.

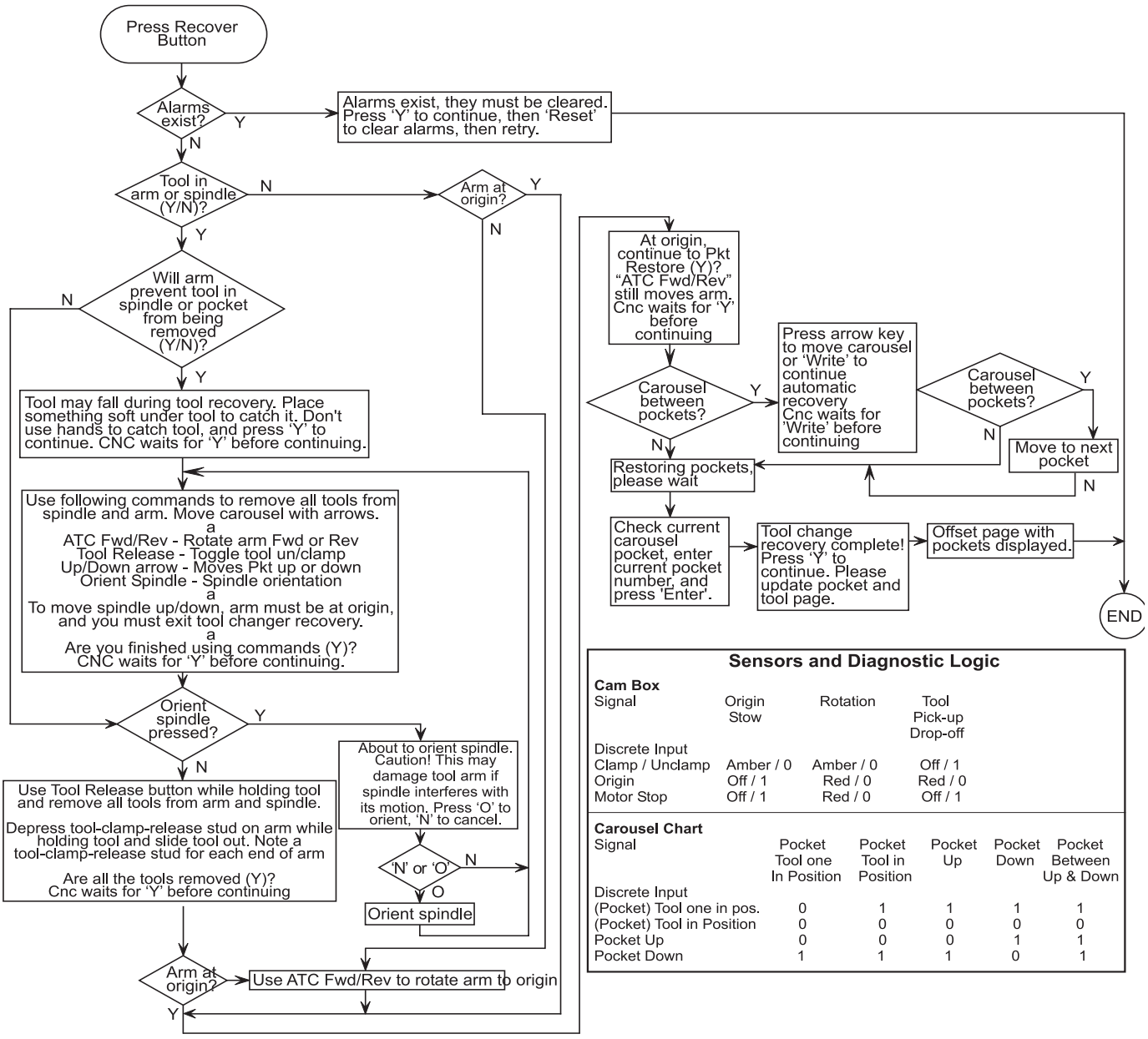
8. Installation is reverse of removal. When installing the guide pin, ensure the mounting slot is approximately central to the mounting screws and that the pin does not interfere with the top of the ATC carousel cover. Grease the carousel cover where the plastic standoffs ride, the slot in the ATC shutter, the guide pin, and the nylon washers where the shutter pivots. ATC positioning may need to be readjusted after installation.

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



Sensors and Diagnostic Logic

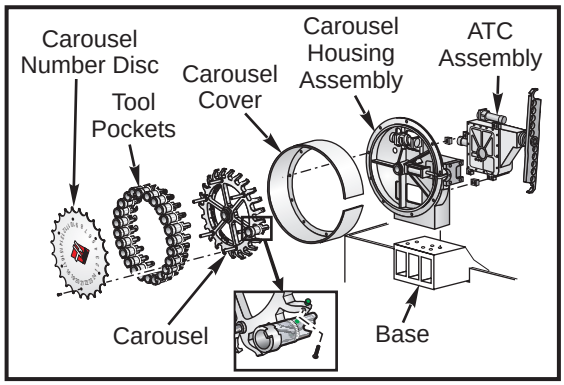
Cam Box

Signal	Origin Stow	Rotation	Tool Pick-up Drop-off
Discrete Input			
Clamp / Unclamp	Amber / 0	Amber / 0	Off / 1
Origin	Off / 1	Red / 0	Red / 0
Motor Stop	Off / 1	Red / 0	Off / 1

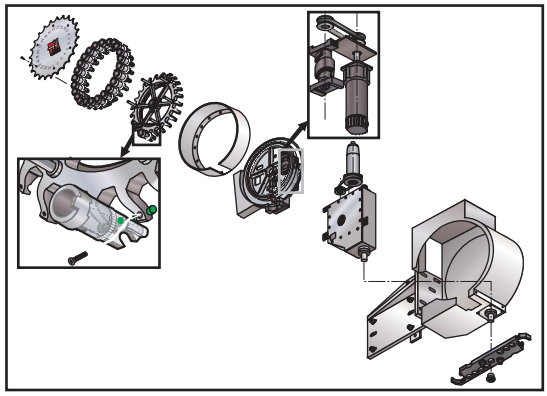
Carousel Chart

Signal	Pocket Tool one In Position	Pocket Tool in Position	Pocket Up	Pocket Down	Pocket Between Up & Down
Discrete Input					
(Pocket) Tool one in pos.	0	1	1	1	1
(Pocket) Tool in Position	0	0	0	0	0
Pocket Up	0	0	0	1	1
Pocket Down	1	1	1	0	1

40 Taper Carousel Removal and Installation



SMTC (Horiz)



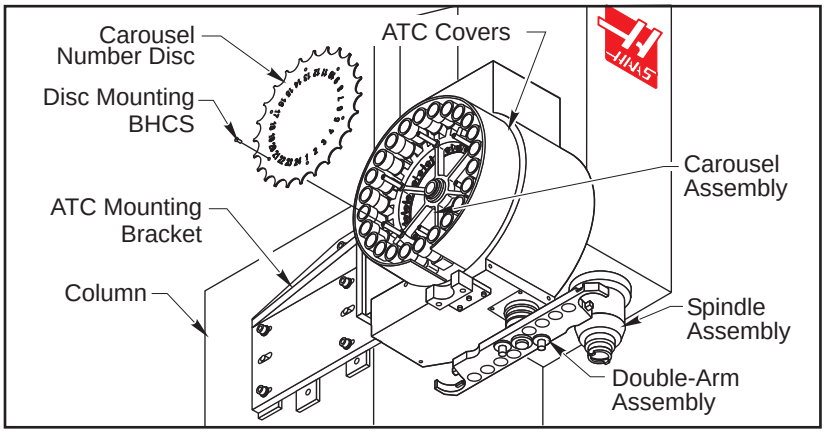
SMTC (Vert)

Special Tools Required: Lifting Device (1000lb capacity for 40-pocket ATC removal, 3000lb capacity for 60- and 70-pocket ATC removal), Spanner Wrench, Split Tools

Removal

1. Power Off machine.

2. Unscrew the BHCS from the carousel number disc and remove.



3. Using a spanner wrench, remove nut on the center shaft of the carousel.

4. Carefully pull the carousel assembly from the ATC center shaft. Lift carousel away from the machine and carefully avoid hitting the sheet metal covers. Place assembly in service area.

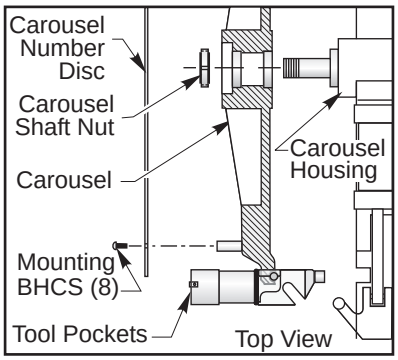
CAUTION! Be careful not to bend the tool pocket orientation tabs when storing the carousel assembly.

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

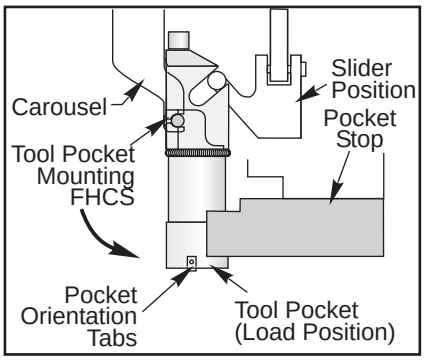
Installation

1. Carefully lift and place carousel onto the center shaft.

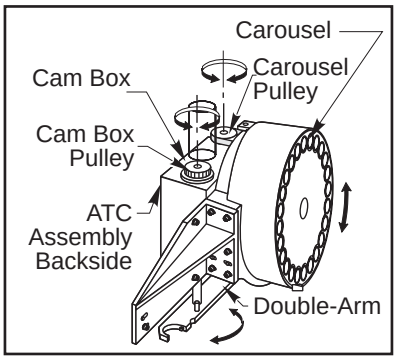
2. Install new carousel retaining nut onto the ATC center shaft and torque to 85 ft-lbs (place the locking portion of the nut toward the end of the shaft). Remove the pocket stop and slider.



Carousel Assembly



Carousel and Tool Pocket Installation



Pulley Locations and ATC Movement

3. Install each toolholder through the spindle. Attach the tool pocket to the carousel. Apply 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

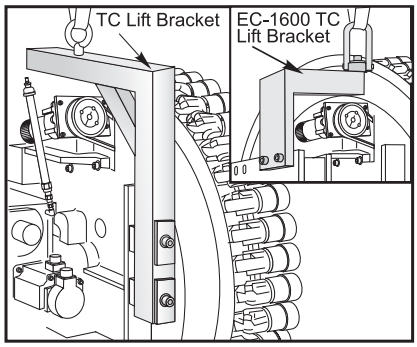
Removal

1. Power off machine.

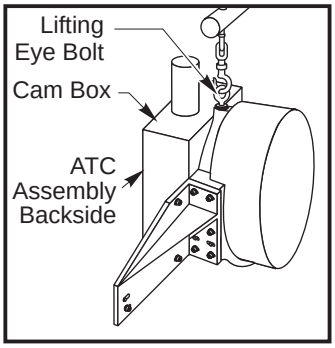
2. Remove all ATC assembly sheet metal covers and fasteners.

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.

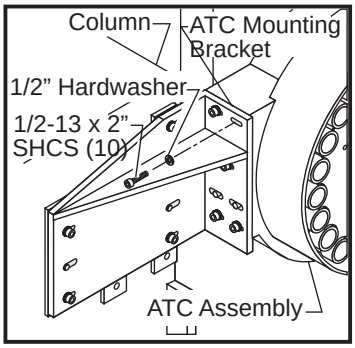
4. Insert an eyebolt into the threaded 1/2-13 hole at the top of the carousel housing. Note that 60-, 70-pocket and 50-taper/50-tool tool changers require that a lifting bar be attached to the back of the carousel housing assembly (see illustration). Attach the lifting device to the eyebolt and support 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.



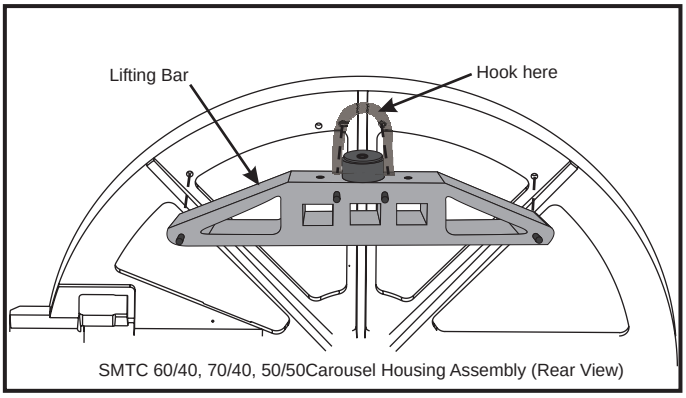
Horizontal ATC Assembly Lifting Position



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.

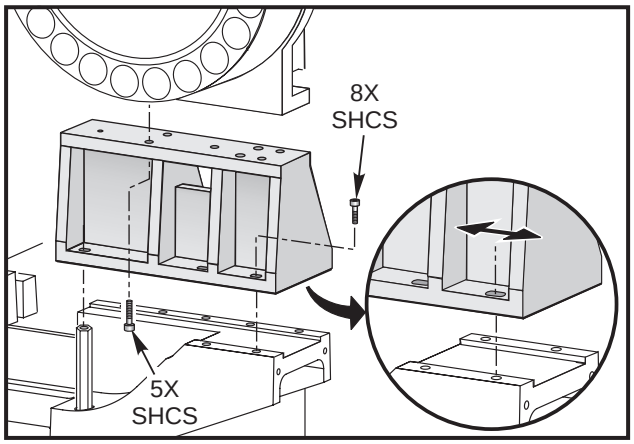
6. Lower the ATC assembly with the back side of the cam box towards the ground.

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 SMTC.

EC-1600 - EC-3000: The Y- and Z-axis, and the spindle orientation, are set by parameters. The X-axis is adjusted by physically moving the SMTC.

Horizontal Machine Double Arm to Tool Pocket Alignment

1. **EC-300, and EC-1600-EC-3000:** Go to Parameter 64, write down its value, and set it to zero. This will allow maximum clearance to spindle. **EC-400:** As the alignment is checked or adjusted, ensure the tool changer arm does not hit the spindle. Note that spindle cannot be moved in Z-axis by parameters, as other mills.

2. Without a tool in the spindle, command a tool change. Press E-Stop before the double arm reaches the pocket. This causes the mill to move the axes to the ATC position. Do not run the double arm into the spindle.

3. Clear the E-Stop alarm.

4. Using T/C Recovery, rotate the double arm in the forward direction. Continue rotating the double arm until it reaches the pocket, then extends approximately 4" (100mm) for the 40-taper spindle, or 6" (150 mm) for a 50-taper spindle in front of the pocket.

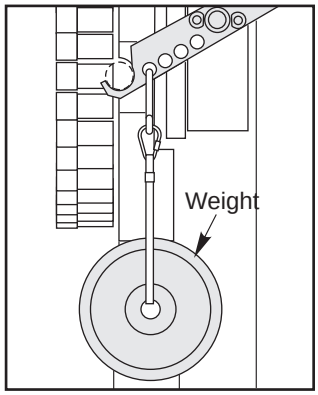
5. Using the dowel pin as a handle, install the tapered half of the split tool into the pocket. Be careful to not place your hands in the pinch point between the tool and the pocket.

6. Install second half of the split tool into end of the double arm in front of pocket. It is necessary to manually press the tool lock plunger (near center of shaft as shown in following section) for spilt tool to be inserted.

7. Using T/C Recovery in the reverse direction, move the double arm back until the halves of the split tool are approximately 1" (25 mm) apart.

8. **EC-300/EC-400/EC-500:** Slightly push the double arm in the counterclockwise direction to remove backlash in the drive assembly.

EC-1600: Hang a 40 lb (18.2 kg) weight from the pocket side of the arm. Hang the weight from the hole closest to the pocket This will preload the arm.



9. Continue to move the arm toward the pocket. Watch the double arm as it approaches the pocket. Continue moving closer until there is a maximum of 1/8" (3 mm) gap between the split tool halves, ensuring that the halves do not touch each other.

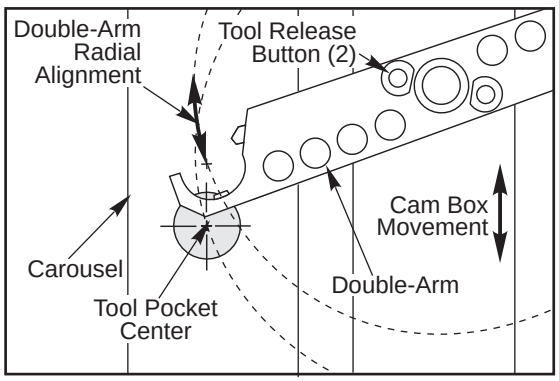
10. Check the X and Y alignment of the double arm to the pocket by inserting the alignment dowel through both halves of the split tool. The dowel should slide freely. If the pin does not slide freely, the direction of the misalignment may be determined by feeling the “step” between the split tool halves, by using a steel rule, straight edge, or similar tool.

11. If the dowel pin does not slide in freely, adjust the leveling screw under the tool changer mount. Verify machine level. If the tool changer remains out of alignment, adjust the radial alignment of the split tool to the double arm, by loosening the lock ring SHCS and adjust the double arm as described in “Double Arm Removal and Installation”.

12. If the double arm is not aligned in the Y-axis with the centerline of the split tool, loosen the four cam box SHCS and insert a pry-bar between the slots. Adjust the cam box until the centerline of the split tool is aligned with the centerline of the tool pocket.

13. Torque the cam box SHCS to 80 ft-lbs.

14. Recheck alignment.



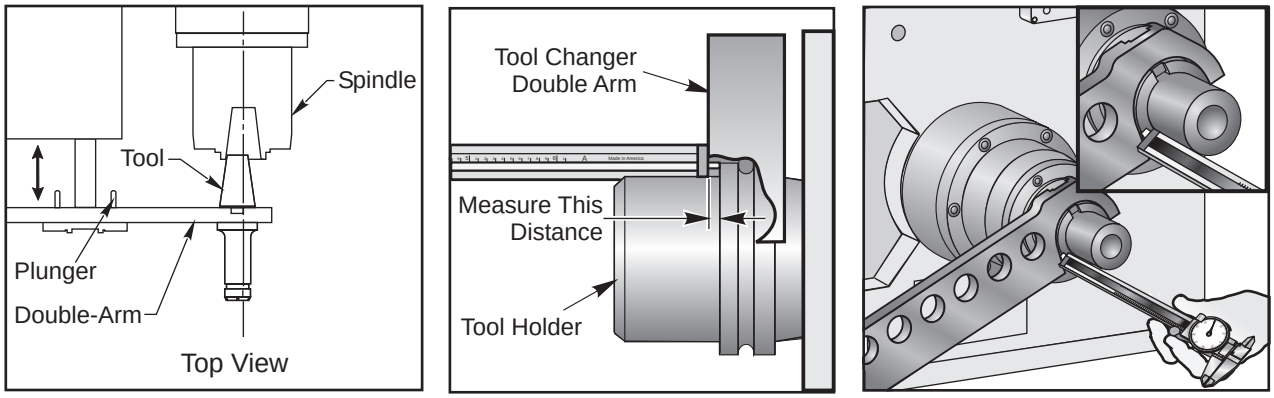
Cam Box/Double Arm Alignment, Front View

15. **EC-300 and EC-1600-3000:** Fully retract the Z-axis (Z+ direction).

16. Using Tool Change Recovery, press the down arrow to rotate the tool pocket to the tool change position.

17. Move the double arm in the forward direction until the arm rotates to the tool pocket, then move away from the pocket in the Z direction. Do not crash the arm into the spindle. This distance is approximately 4" (100 mm) for a 40 taper spindle or 6" (150 mm) for a 50 taper spindle.

18. Install a toolholder into the double arm. It will be necessary to manually depress the plunger to do this.



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

19. Measure the distance from the front of the double arm to the front face of the toolholder and record it.

20. Press the plunger to unlock the tool and remove the tool from the double arm.

21. Using Tool Change Recovery, return the double arm to the origin (Home) position.

22. Install the same toolholder, as used in the previous step, into the tool pocket.

23. Using Tool Change Recovery, rotate the double arm in the forward direction until the arm is very close to the toolholder, but not touching it. (The spring-loaded slide will be touching the toolholder.)

24. Using a caliper, measure the same two surface positions described in Step 5. The measurement should be the same, +/- .01" (.254 mm), as step 5.

25. If adjustment is required, move the double arm on the output shaft as described in “Double Arm Removal and Installation”.

26. Recheck both radial and axial positions until correct alignment is achieved.

27. Using T/C Recovery, move double arm forward, away from pocket and remove both halves of the split tool.

28. Verify the spindle is clear of the double arm. Reverse the double arm away from the spindle if necessary.

29. Return the double arm to the “Home” position and exit Tool Change Recovery.

30. Reset Parameter 64 to its original value if changed.

Double-Arm to Spindle Alignment

1. Double arm to carousel pocket alignment must be correct before setting double arm to spindle alignment.

2. With no tools in the machine, command a tool change. Press E-Stop before the double arm reaches the spindle. This causes the machine to move the axes into tool change position. Reset the E-Stop alarm.

3. Orient the spindle; use the command in Tool Changer Recovery.

4. Advance the double arm to the spindle, watching carefully for any interference. Be sure to check orientation of the spindle drive dogs to the double arm key.

5. If orientation is incorrect, press Reset to allow the spindle to be manually rotated to the correct position. Correct Parameter 257 (Spindle Orientation) as described in the “Setting Spindle Orientation”.

6. Continue moving the double arm in the forward direction until the arm extends approximately 4" (100mm) for the 40-taper spindle, or 6" (150mm) for the 50-taper spindle, in front of the spindle.

7. Using the dowel pin as a handle, install the tapered half of the split tool into the spindle. Be careful to not place your hands in the pinch point between the tool and the spindle. The Tool Release button operates in a Toggle On/Off mode during Tool Recovery. Press once to activate the Tool Release; press again to clamp.

8. Install the second half of the split tool into the end of the double arm in front of the spindle. It will be necessary to manually press the tool lock plunger (near the center of the shaft, see the previous figure) to allow the split tool to be inserted.

9. Using T/C Recovery in the reverse direction, move the double arm back toward the spindle until the halves of the split tool are approximately 1" (25.4 mm) apart.

10. **EC-300, EC 400 and EC-500:** Push the double arm in a counterclockwise direction to remove backlash.
EC-1600-3000: Hang a 40 lb (18.2 kg) weight on the pocket side of the double arm as shown in “Cam Box to Tool Pocket Alignment”.

11. Continue to move the arm toward the spindle. Watch the double arm as it approaches the spindle. The spindle dogs and the slots in the double arm should line up. Continue moving closer until there is a maximum 1/8" (3.2 mm) gap between the split tool halves, ensuring that the halves do not touch each other.

12. Check the X and Y alignment of the double arm to the spindle by inserting the alignment dowel through both halves of the split tool. The dowel should slide freely. If the pin does not slide freely, the direction of the misalignment may be determined by feeling the “step” between the split tool halves. Do this by using a steel rule, straight edge, or similar tool.

13. If misalignment is present, the method of alignment varies, depending upon the machine.

a. **EC-300/EC-400/EC-500**

1) Adjust Parameters 210 (X) and 211 (Y) to correctly center the spindle to the double arm.

2) Using T/C Recovery, move the double arm forward to clear the spindle dogs.

3) Put the mill in Debug mode.

4) Handle jog the X- and Y-axis to center the two halves of the split tool.

5) Record the actual values for the X- and Y-axis on the “Pos-Raw Dat” screen. Omit the decimals, but include the “-” sign.

6) Enter the X value into Parameter 210, and the Y value into Parameter 211.

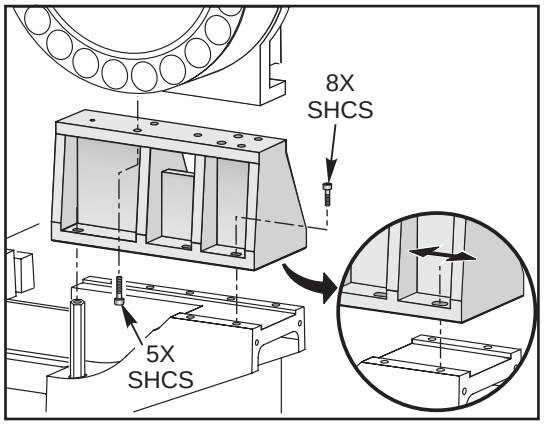
7) Remove the split tool.

8) Using T/C Recovery, return the double arm to the origin (Home) position.

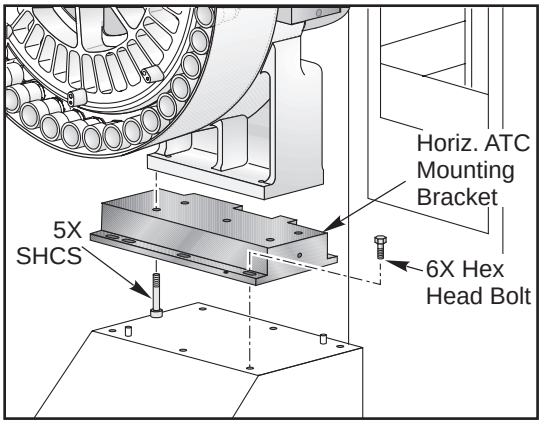
9) Return the tool pocket to the tool stored position (arrow up).

10) Cycle power to the machine and recheck alignment.

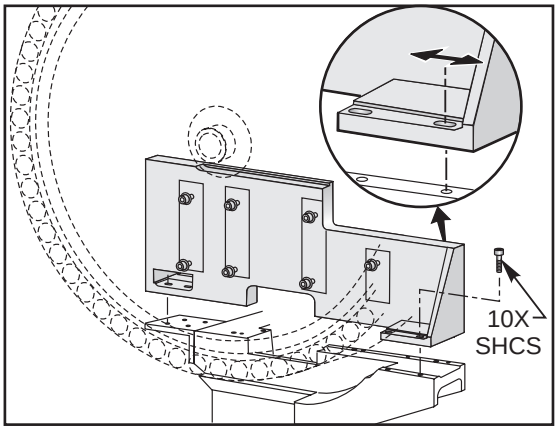
11) **EC-300:** Parameter 64 is used to adjust the Z direction (see Setting Parameter 64).
EC-400 and EC-500: If Z-axis adjustment is necessary, loosen the ATC mounting SHCS, slide the ATC as required, retorque the SHCS to 80 ft-lbs, and recheck alignment. The screws to loosen hold the tool changer spacer to the main base casting.



EC-400 24-Pocket Mount



EC-400 40-Pocket Mount



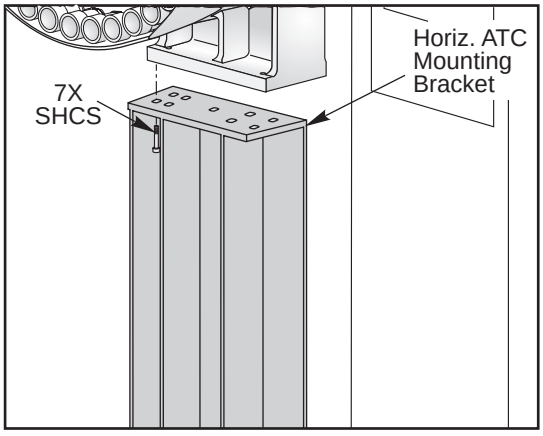
EC-400 60 and 70-Pocket Mount

b. **EC-1600-3000**

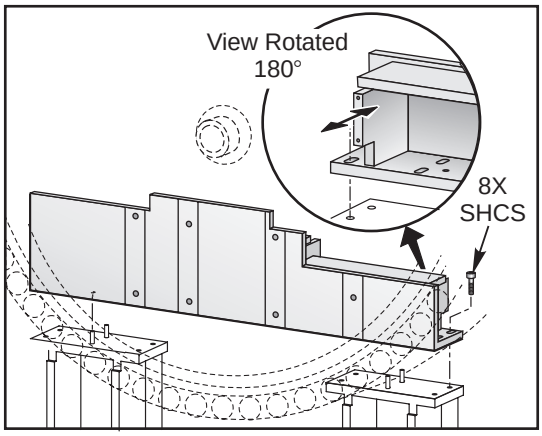
1) Adjust the Y direction and spindle orientation in the same manner as for the EC-400.

2) Adjust Parameter 64 to move the spindle in the Z-axis direction.

3) If X-axis adjustment is necessary, loosen the SHCS, slide the SMTC as required, retorque the SHCS to 80 ft-lb, and recheck alignment.



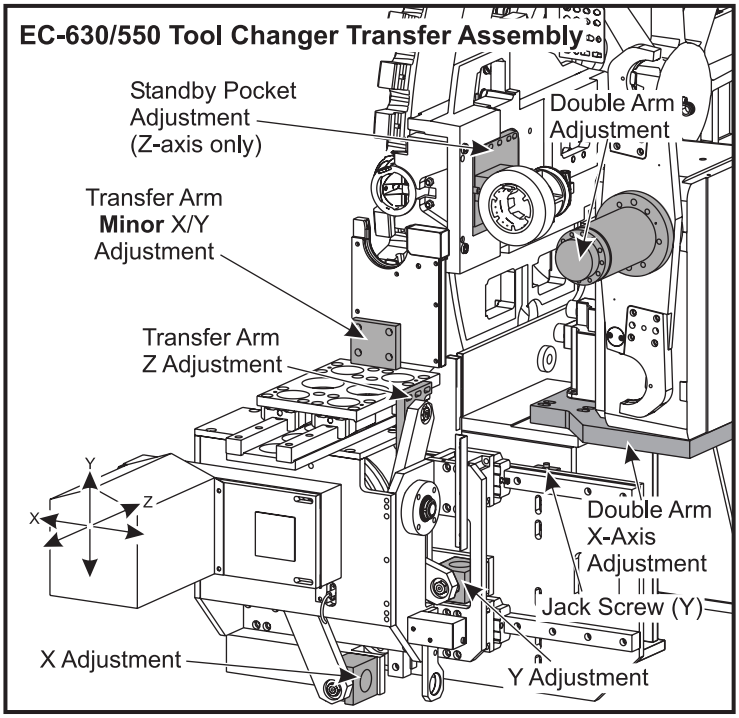
EC-1600 Standard Mount



EC-1600 50-Pocket Mount

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

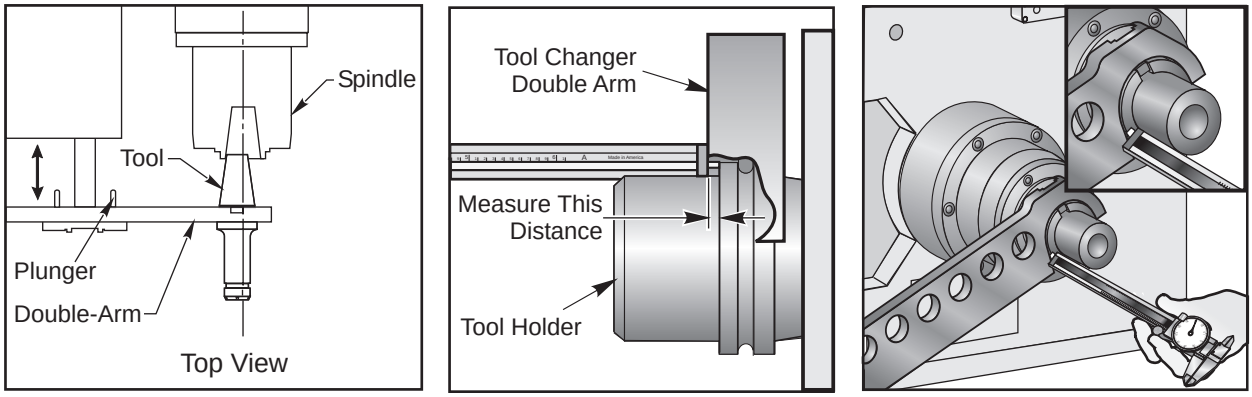
NOTE: This procedure is to ensure that the transfer arm is square to the standby pocket. The distance between the carousel and standby pockets is set by the mechanism and is **not** adjustable.

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 spilt 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 Axis	151 bit 18	170	213
U Axis	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)

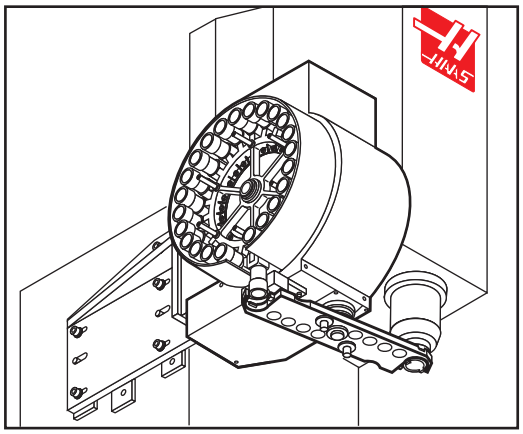
For Vertical machines, the servo tool changer, like those used on super speed machines, must have the grid offset and tool change offset set before starting the alignment procedure.

Cam Box to Tool Pocket Alignment

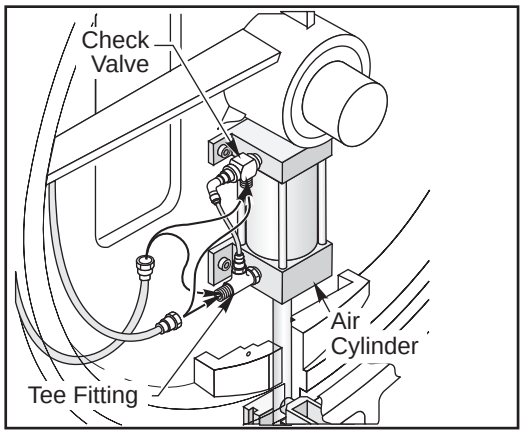
1. Remove all cam box sheet metal fasteners and covers. Place protective covers on the machine table.

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

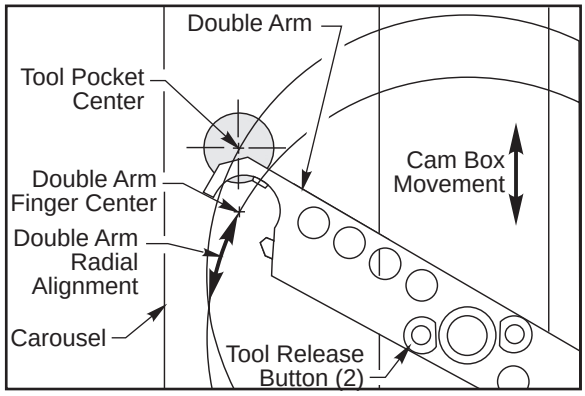
4. Power off machine. Disconnect air supply at rear of machine. Tool pocket raises once air is disconnected.

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 180^0.

7. Align the double arm underneath the tool pocket and spindle with unlocking finger buttons facing upward. Place the double arm onto the shaft and snug the lock ring on the double arm bottom with the SHCS.

8. Place the split tool (P/N's previously shown) into the double arm end beneath the tool pocket. Depress the Tool Release button on top of the double arm and insert the split tool. Slightly push the double arm in the clockwise direction to remove backlash in the drive assembly, as shown in the following figure.



Cam Box to Tool Pocket Alignment (Top View)

Radial Alignment of Double Arm to Carousel

9. Rotate the cam box pulley counter-clockwise to raise the double arm into the split tool. Visually check the centerline alignment of the split tool to the centerline of the tool pocket.

10. In order to adjust the radial alignment of the split tool to the double arm, loosen the lock ring SHCS and adjust the double arm as shown above.

11. If the double arm is not aligned in the Y-axis with the centerline of the split tool, loosen the four cam box SHCS and insert a pry-bar between the slots. Adjust the cam box until the centerline of the split tool is aligned with the centerline of the tool pocket.

12. Torque the cam box SHCS to 100 ft-lbs.

Checking Parallelism of Double Arm to Table

13. Rotate the cam box pulley clockwise to lower the double arm. Remove the split tool from the double arm.

14. Rotate the cam box pulley counter-clockwise to raise the double arm back to its home position.

15. Remove the air supply line from the rear of the machine. **Switch the inlet and outlet airlines back to their original positions at the top of the ATC assembly.** Re-attach the air supply line (the tool pocket holder should retract to its home position).

16. Power On the machine and enter TCR mode. For more information on TCR mode refer to the TCR flow chart located in the Technical Reference section.

17. Press the ATC Forward button until the arm lowers and is parallel to the X-axis. Insert a split tool into the double arm by pressing the Tool Release button located near the shaft as shown above.

18. Place a magnetic base and indicator on to the machine table. Measure the bottom of the split tool to the nearest .001".

19. Move the split tool and indicator setup to the other end of the double arm. Measure the bottom of the split tool to the nearest .001". The maximum allowable height tolerance between the two ends is .030". Adjust the alignment as necessary. Repeat this test with the arm rotated 180^0.

20. Remove the split tool from the double arm. Return the double arm to the home position.

Setting the Double Arm Height

21. Press the Down Arrow to command the tool pocket down. Place the split tool **with** the pull stud into the tool pocket. In TCR mode, rotate the double arm near the tool pocket.

22. Visually check the height alignment of the double arm to the V-groove on the split tool. If necessary, loosen the lock ring SHCS and adjust the height of the double arm. Torque the lock ring SHCS to 15-17 ft-lbs.

23. Repeat steps 9 & 10 to re-check radial alignment.

24. Return the double arm to the home position.

Double Arm to Spindle Alignment

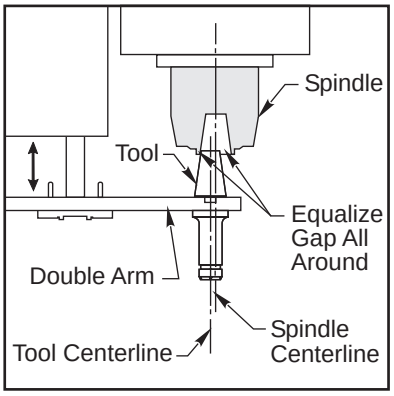
1. Zero Return the Z-axis.

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

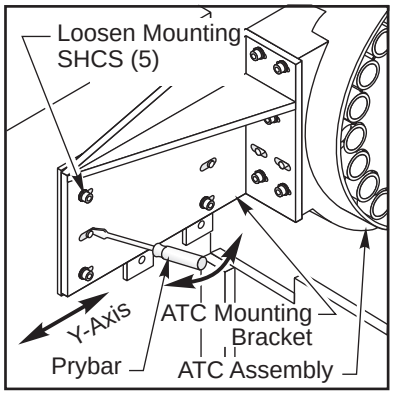
3. Raise and lower the double arm to move the tool in and out of the spindle and check for alignment.

4. Check the X-axis alignment of the split tool to the spindle center.

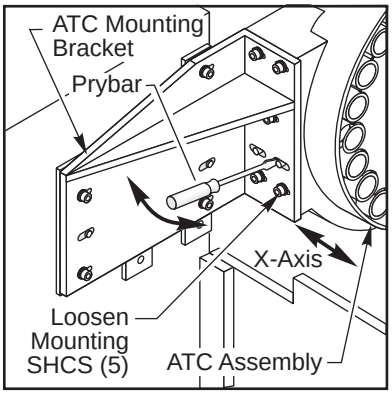
5. If necessary, loosen the five ATC mounting SHCS.



Double Arm to Spindle Center Alignment, Along the Y-Axis



ATC Assembly X-Axis Alignment



ATC Assembly Y-Axis Alignment

6. Insert a pry-bar between the locating pins and the ATC mounting bracket. Adjust the bracket to align the split tool in the double arm to the center of the spindle in the X-axis.

7. Torque the SHCS to 80 ft-lbs.

8. Check the Y-axis alignment of the split tool to the spindle.

9. If necessary, loosen the five ATC SHCS (shown above). Insert a small pry bar between the locating pins and the mounting bracket. Adjust the ATC along the mounting slots and align the tool and spindle's center.

10. Check the spindle tool change height. If the spindle tool change height has changed, reset Parameter 64.

11. Return to normal operation. Insert toolholders through the spindle and perform several tool changes. Observe the tool changer during operation and make any adjustments if necessary.

12. Torque the ATC mounting SHCS to 100 ft-lbs. Replace all cam box sheet metal covers and fasteners. Apply removable thread locking compound to the fasteners and tighten.

Double Arm Replacement

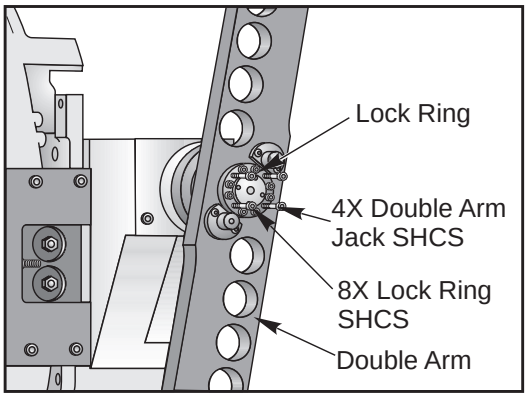
Removal

1. In TCR mode, lower the double arm. Power Off machine.

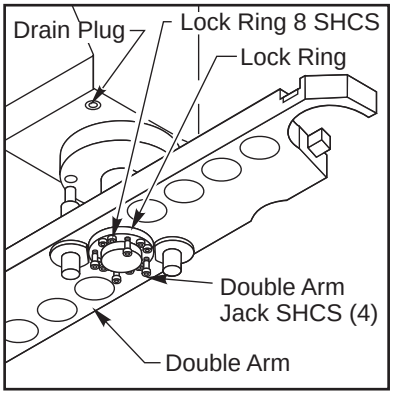
2. Underneath the double arm, loosen the six SHCS from the lock ring. Insert four new jackscrews into the lock ring (coat the jack screw threads and tips with moly grease).

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)



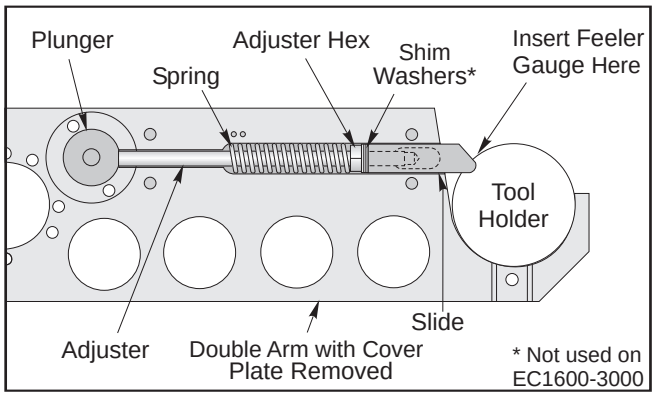
Double-Arm Removal (Vert)

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).

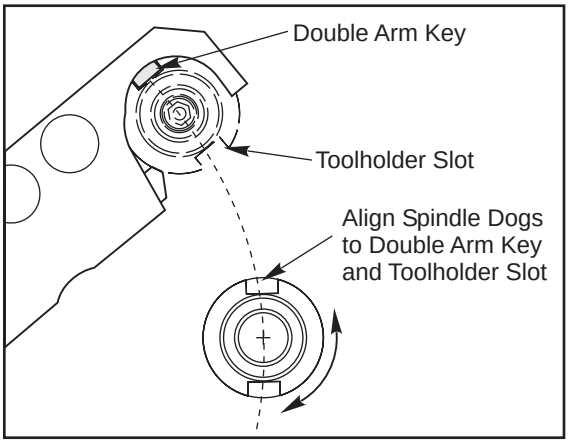
3. Enter Debug mode. Record the encoder value under “spindle orientation position”.

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.

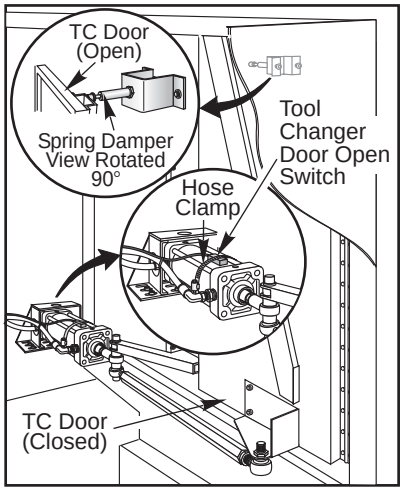
EC-300 Tool Changer Door Open Switch Adjustment

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

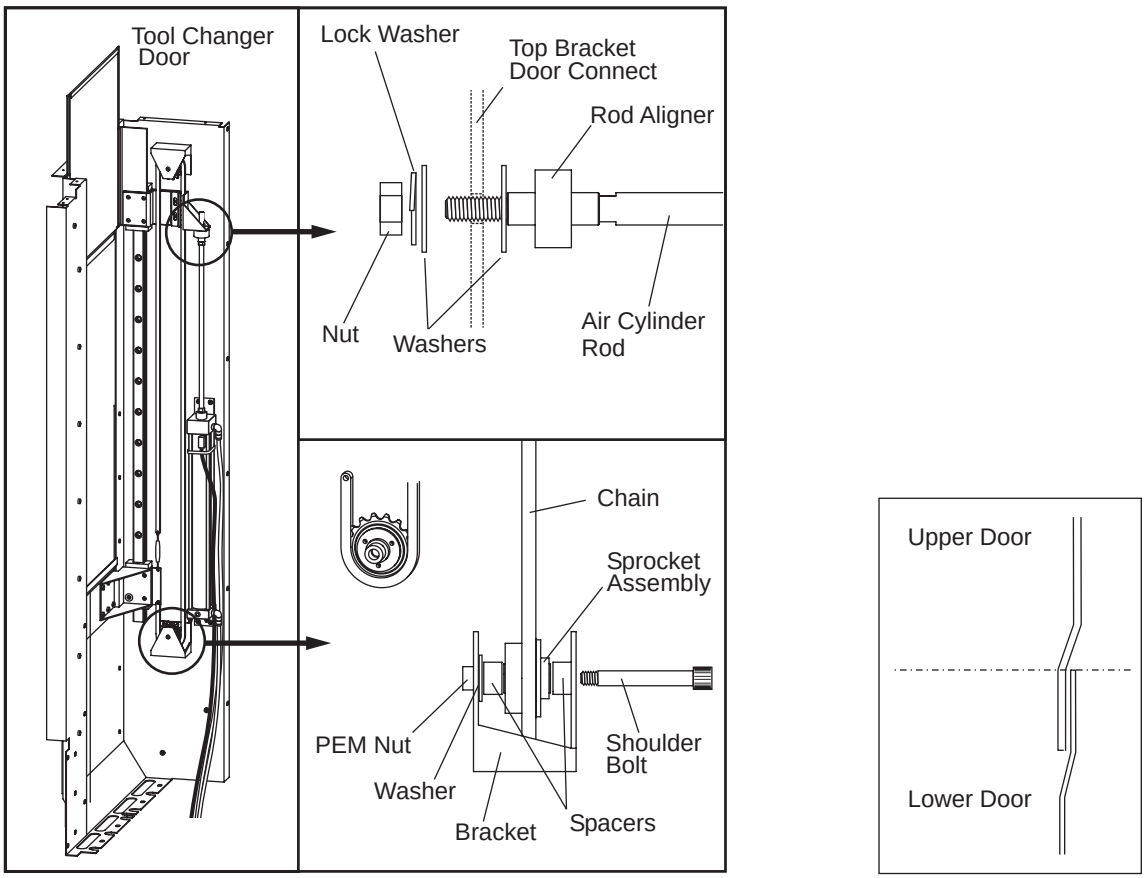
This procedure describes the installation of the complete door assembly. It may not be necessary to start the procedure from the beginning. Remove the damaged or inoperative parts and then rebuild the door assembly.

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

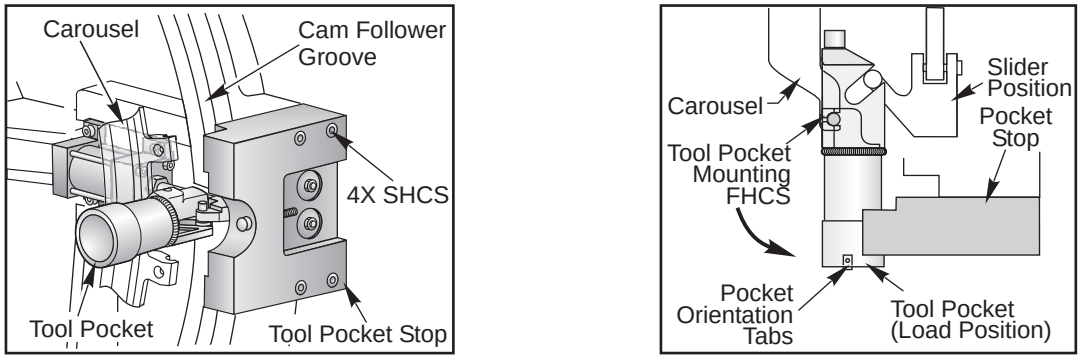
Removal

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.

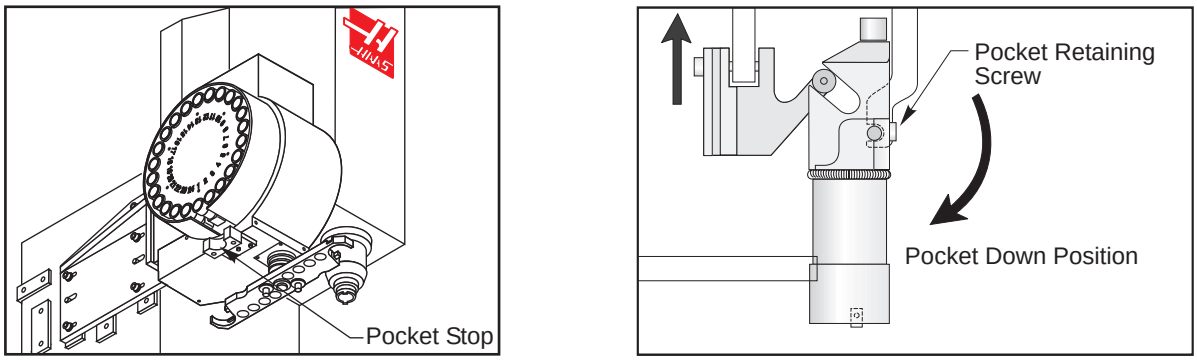
2. Press Tool Changer Restore. Press **Y** three times.

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.

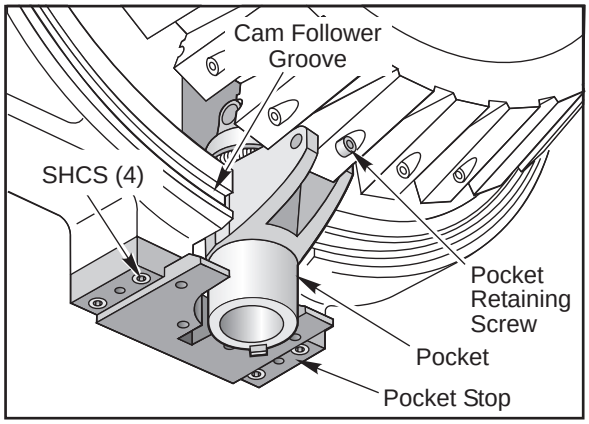
NOTE: If the carousel is to be replaced, skip to the Carousel Removal and Installation.

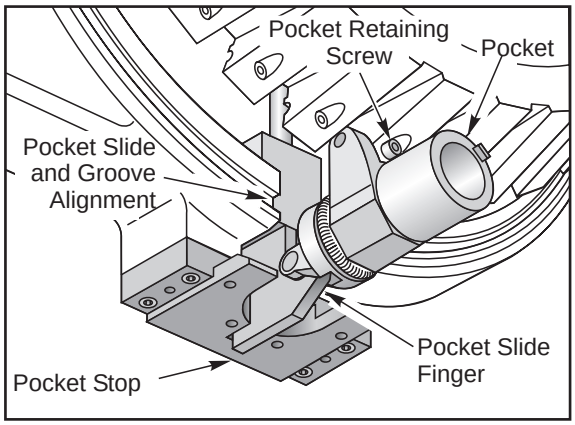
Installation

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

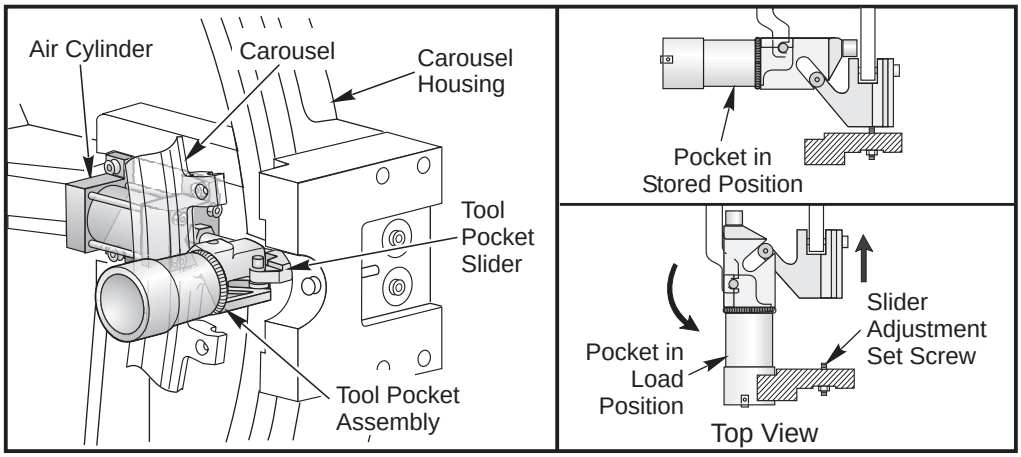
The slider set screw is used to adjust the tool pocket's end-of-stroke with the circular path on the carousel housing.

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

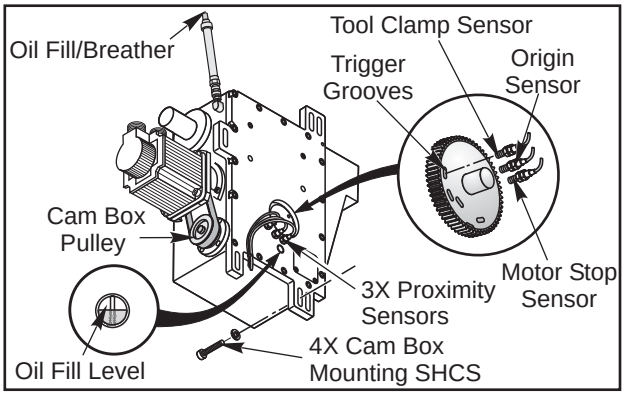
Removal

1. Power Off machine. Remove the carousel number disc and the top cover plate.

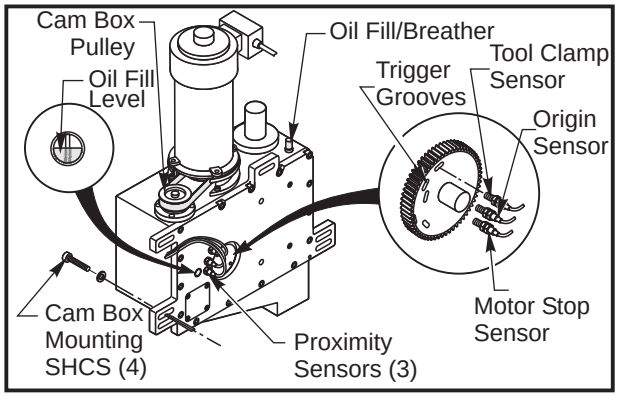
2. Remove the 1/4” NPT plug near the cam box output shaft and drain the cam box oil.

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



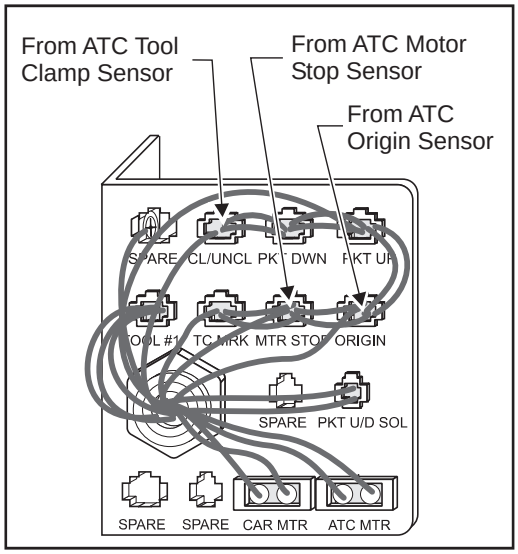
Vertical Machine Proximity Sensor Switch Location

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 full 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

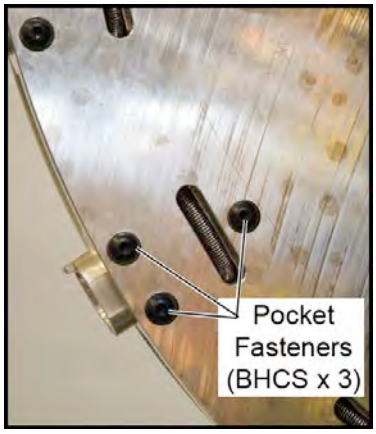
1. Remove the tool changer cover.

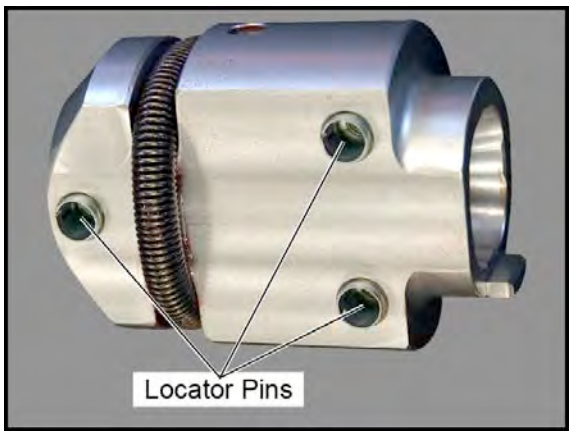
2. Make the V axis visible (Parameter 390 bit 18).

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

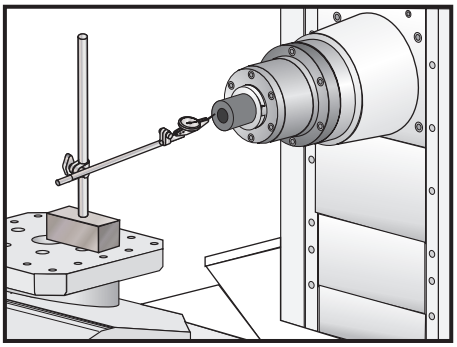
Example: .625 x 138718 = 861699

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

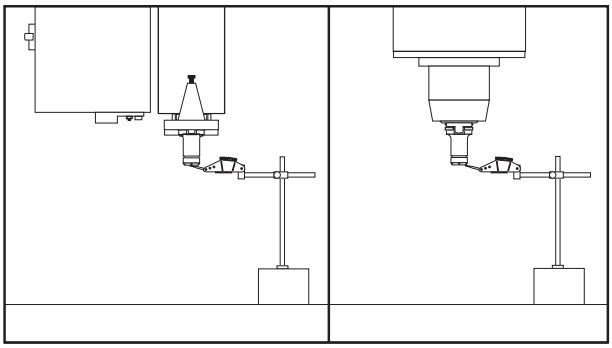
1. Enter debug mode.

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.

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.

Turret Crash Recovery Procedure (SL Turrets)

1. Change Setting 7, "Parameter Lock", to Off. Move to Parameter 43 on the Parameters display. This is the tool turret motor parameters. Change Invis Axis from “1” to “0” (zero).

2. Move to the Alarm display, type “Debug”, and press the Write key. Verify that the debug line is displayed.

NOTE: Ensure there is adequate clearance between the turret and chuck before performing the next step.

3. Press Prgrm/Cnvrs, then the MDI key. Type “M43” into MDI and press Write/Enter, then press Cycle Start. This will unlock the turret by pushing it in the Z-direction.

4. Press the Handle Jog key. The A-axis should be displayed below the X and Z axes.

5. Press the letter "A", then "Handle Jog", and then a jog speed other than ".1". A message should indicate that the A-axis is being jogged.

6. Position Pocket #1 in the cutting position, using the coolant nozzle to align the pocket. If an overcurrent alarm is received, press Reset and turn the Jog Handle in the opposite direction.

7. Press MDI, type M44, and press Alter. Press Cycle Start. The turret should clamp in the Pocket #1 position.

8. Press Param Dgnos twice to get to diagnostics. Verify that TT LOK = 1.

9. Move to Parameter 43 on the Parameter display and change Invis Axis to “1”. Change Setting 7 back to on.

10. Turn the control power off and then back on. The turret can now be positioned by pressing either Power Up/Restart or Auto All Axes.

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

NOTE: The turret is now at Tool #1 and clamped.

11. Remove the sliding tool changer cover. Go to Setting 7 and turn off the Parameter Lock. Go to Parameter 43, change “Z CH Only” to “1”.

12. Loosen the turret motor coupling clamp screw on either side of the motor (refer to the following figure).

13. Press the Zero Ret key, the A key, and the Zero Singl Axis key. This will cause the motor to go to the first encoder Z pulse.

14. With the servos on, move the turret motor coupling back and forth to find the center of its backlash, and torque the clamp screw as close to the center of the backlash as possible.

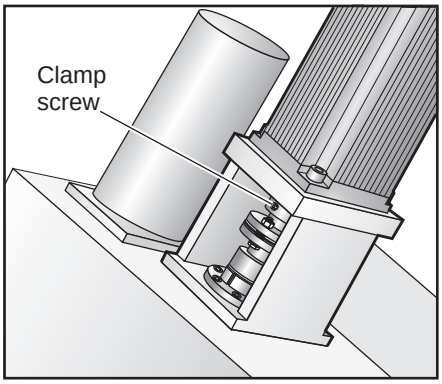
NOTE: If it is tight (no backlash) it will be necessary to force it in one direction or the other until it pops into its backlash area. If it gets tighter when it is turned, stop; this is the wrong direction.

15. Change Parameter 43, “Z CH Only” back to “0” (zero), and Invis Axis to 1. Go to Setting 7 and turn on the Parameter Lock.

16. Press the Zero Ret key, A key, and Zero Singl Axis key. This will home the turret at tool #1, or the pocket set in Setting 81.

17. Press the Emergency Stop button and turn the turret motor coupling back and forth to verify that the backlash is centered.

18. Replace the sliding tool changer cover.



Turret Motor Adjustment

Turret Crash Recovery Procedure (ST Turrets)

1. Change Setting 7, "Parameter Lock", to Off.

2. Set parameters 128 and 212 each to 0 (zero).

Set Parameter 128

1. Enter debug mode and press POSIT to view raw position data.

2. Zero return the A axis.

3. Type "GRID A" and press enter.

4. Check parameter 128 to see if it has a value. If not, repeat step 3.

5. Record the value for Parameter 128.

Set Parameter 212

1. Make sure that Parameter 212 is zero. If it is not, reset the parameter to zero and then zero return the A axis.

2. Run the tool change test program at 5% rapids.

3. Press Emergency Stop when the turret is unclamped at its current home position. Rotate the turret CCW until the turret is home at tool 1.

4. Enter debug mode and press POSIT to view raw position data. Look at the value for the A axis position. Make this a negative whole number (for example, 0.6612 becomes -6612) and enter it as Parameter 212.

5. If tool pocket 1 is still out of position after zero return, run the tool change test program again and press Emergency Stop when the turret is unclamped. Rotate tool pocket 1 into position and look at the "actual" position value. Subtract this value from the value previously determined for Parameter 212; for example, if the position is 0.0032, subtract 32 from the parameter value.

6. Repeat step 5 as necessary to bring tool pocket 1 into position. Once the pocket is in position, look at the A axis load. This should not be more than 4%. If the load is more than 4%, continue to adjust Parameter 212.

7. Record the value for Parameter 212.

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).

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 air lines?
      1) Yes: Ensure that the air is now dry and replace the solenoid.
      2) No: Proceed to the next step.

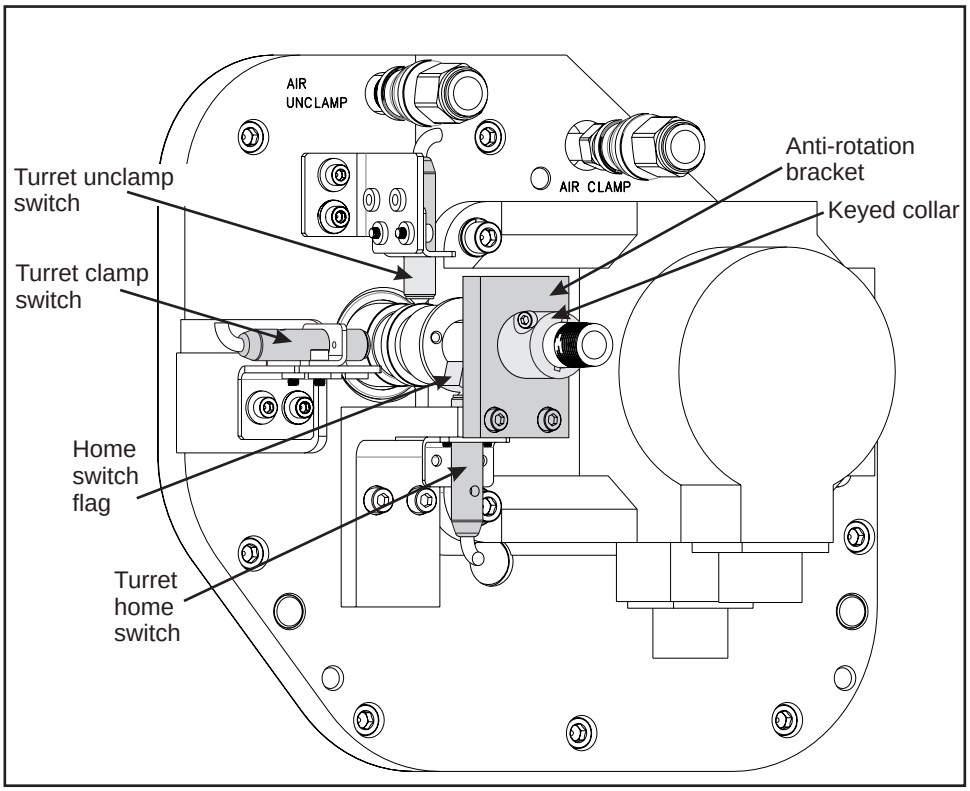
2. Check air pressure.
   a. Set the main regulator to a minimum 85 PSI.
   b. Does the air pressure drop more than 10 PSI during a tool change?
      1) No: Go to the next check.
      2) Yes: The lathe has insufficient air volume. 100 PSI at 4 sfm is required at the regulator. A small diameter air 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.

ST 20/30 Lathe Turret Service

This section explains the ST 20 & 30 (incl SS) lathe gearbox disassemble, reassemble and home switch adjustment.



View of turret with back cover removed

General steps of gearbox overhaul procedure:
1) Gearbox Disassemble
2) Inspect / Replace Internal Parts
3) Gearbox Reassemble
4) Home Switch Check and Adjustment

Preparation for procedure:

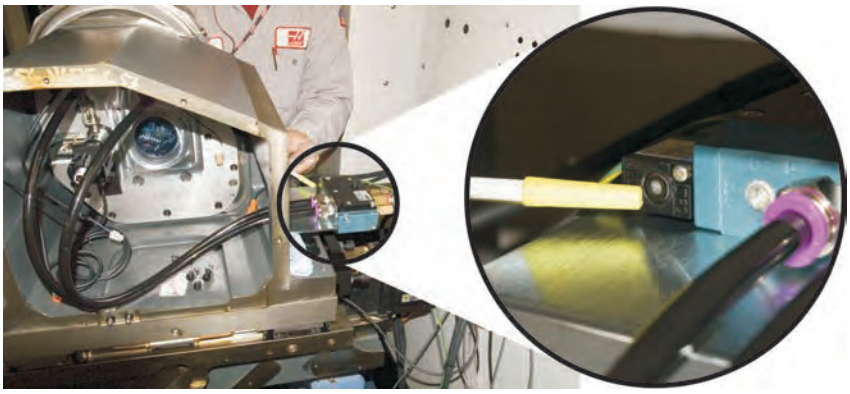
1) Power up the machine and home all axes. Jog the wedge assembly to a position where it can be worked on from the right side.

2) Index tool 1 to cutting position (can be verified on Current Command page). Press Emergency-Stop.

Turret at tool and press Emergency Stop

3) Disconnect the air supply from the machine.

4) Discharge the residual air pressure in the turret clamp/unclamp system by triggering the solenoid valve with a small screwdriver or a ball point pen several times until the air pressure has been released.



Solenoid valve - manual trigger location

Gearbox Disassemble

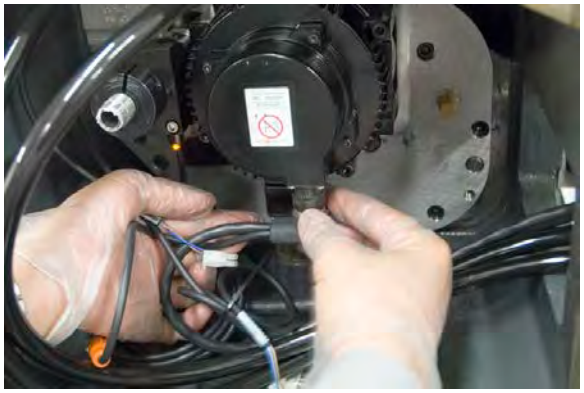
1) Disconnect the coolant hose and its fittings from the keyed coolant manifold tube.

Remove coolant fittings

2) Disconnect turret clamp and unclamp switch connectors. Disconnect all plugs from the connector bracket on the back of the turret, then. Remove the connector bracket from the casting.

Disconnect and remove bracket

3) Disconnect A-axis home switch connector, servo motor connectors and remove motor.



Disconnect and remove motor

4) Mark and disconnect turret clamp/unclamp air hoses.

Air hose marked with zip ties.

5) Remove the air hose fittings.

Note: It is possible that when the fitting is taken out, a short piece of pipe may come out with it.

Removing clamp and unclamp fittings.

6) Remove the keyed collar, and remove the key on the coolant tube.

Removing keyed collar.

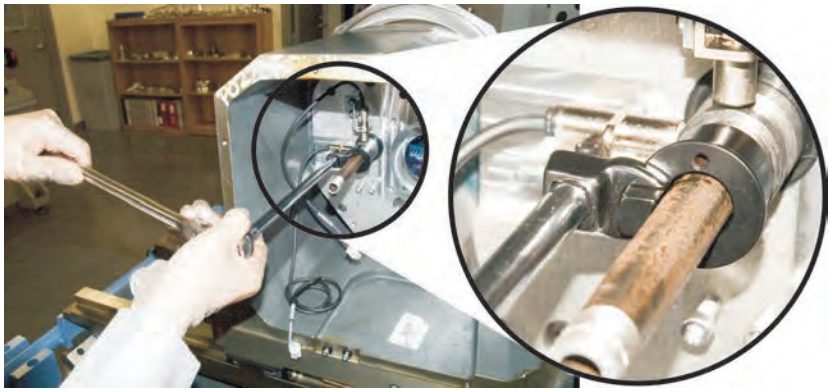
7) Remove coolant tube anti-rotation bracket.

Anti-rotation bracket.

8) Remove A-axis home switch bracket with home switch on it.

Removing home switch bracket.

9) Remove home switch flag from the main shaft using a 7/16" open end wrench or crow's foot wrench.



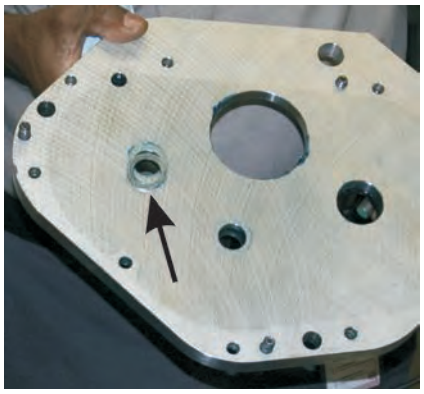
Home switch flag (Crow's foot wrench shown)

10) Remove the mounting bolts on the tool turret gearbox end plate.

Removing plate bolts.

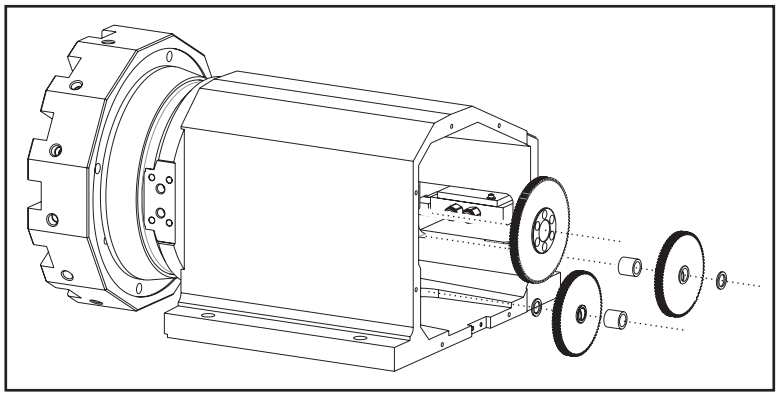
Note: Do not move the turret clamp and unclamp switches from their positions.

11) Use 3 5/16-18X11/2 SHCS (Haas p/n 40-1715) to evenly remove the end plate out from the gearbox housing.



Note: Once the plate is removed check for spacers that are stuck to the back-side of the plate. Remove and set aside with the other hardware.

12) Remove the gears from the gearbox.

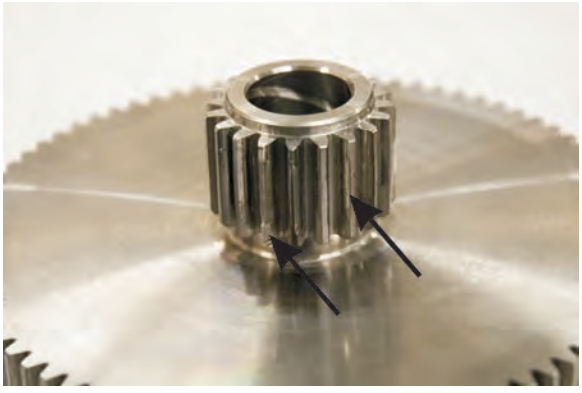


13) Clean the inside of the gearbox and all removed components.

Inspect / Replace Internal Parts

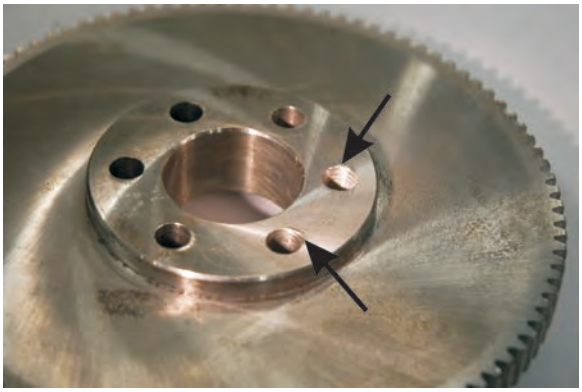
1) Inspect gears for signs of damage. inspect bolts for deformation.

The following below shows an impact that deformed the teeth on the smaller gear. When an impact is carried on the axis, the smaller gears will show more damage than the larger gears.



Smaller gear-teeth show damage of an impact

The following image shows a larger impact. This impact stressed the bolts that attach the turret shaft gear. in this case the bolts sheared off and left an imprint on the bolt holes as well as deforming the mating surfaces.

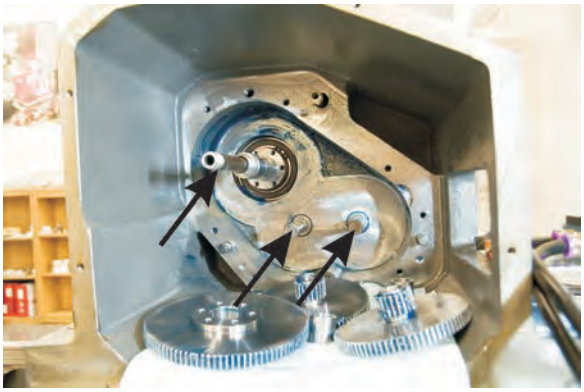


Turret shaft gear.

2) Finally inspect that the gasket, seals and O-rings for damage.

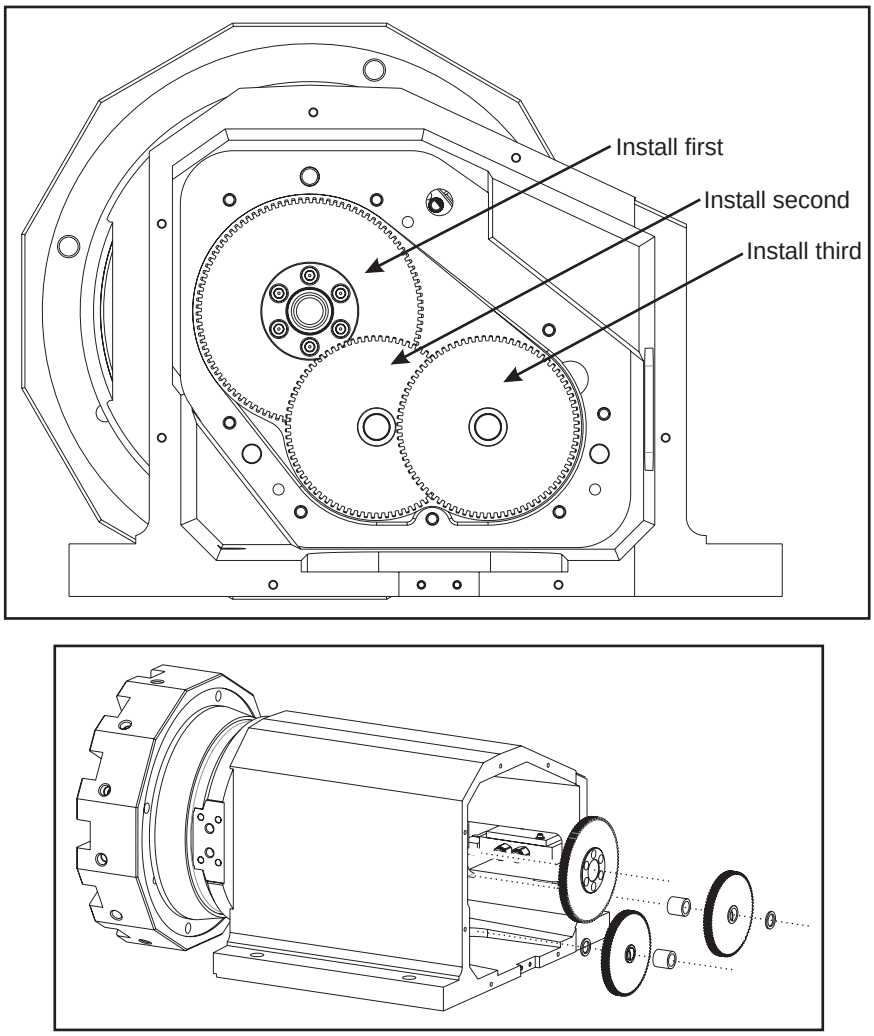
Gearbox Reassemble

1) Lightly grease all 3 shafts in the gearbox, end plate shaft seal, O-rings, and dowel pins. Lightly grease the gearbox housing end surface and install the end plate paper gasket on it.



Lubricate the three gearbox shafts

2) Install the gears and spacers into the gearbox.



Gear installation

A - Install the first gear onto the piston shaft. Torque bolts to 27 ft lb (37Nm).

Install and torque first gear

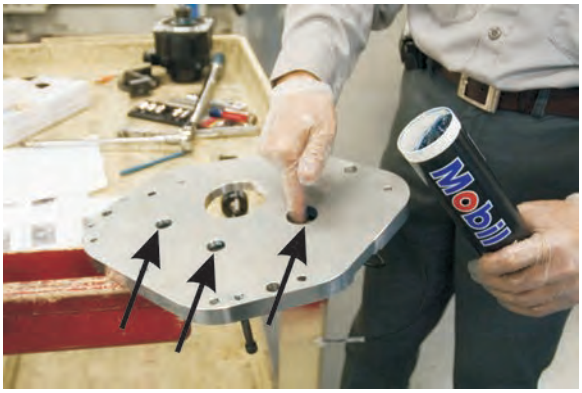
B - Install small washer, the second gear, and then the large spacer.

Install spacers and gear on second shaft

C - On the third shaft, install the large spacer, then the gear, followed by the small spacer.

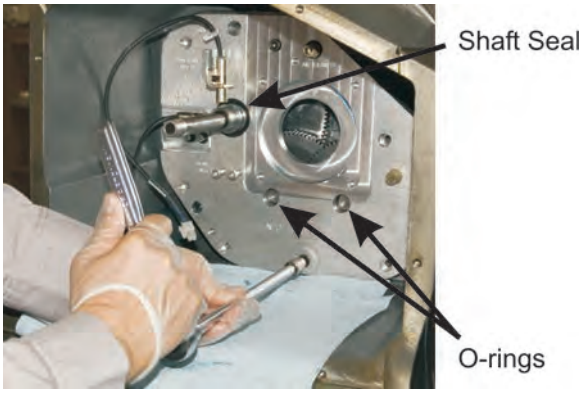
Install spacers and gear on the third shaft.

3) On the end-plate, grease the shaft seal, and the O-ring seals.



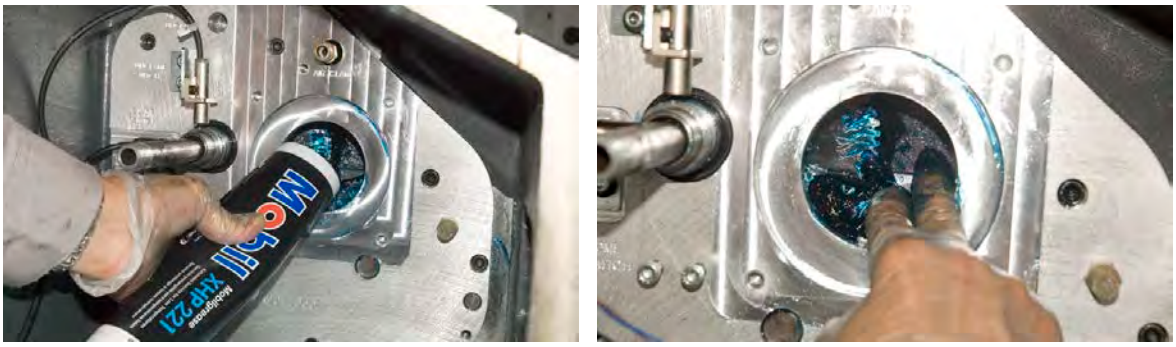
4) On the gear box casting, lightly grease the gasket area. This will hold the gasket in place. Install gasket.

5) Carefully reinstall the end plate. Be careful not to damage the shaft seal or O-rings. Evenly tighten and torque the end plate bolts to 27 ft-lb (37 Nm) on the gearbox housing.



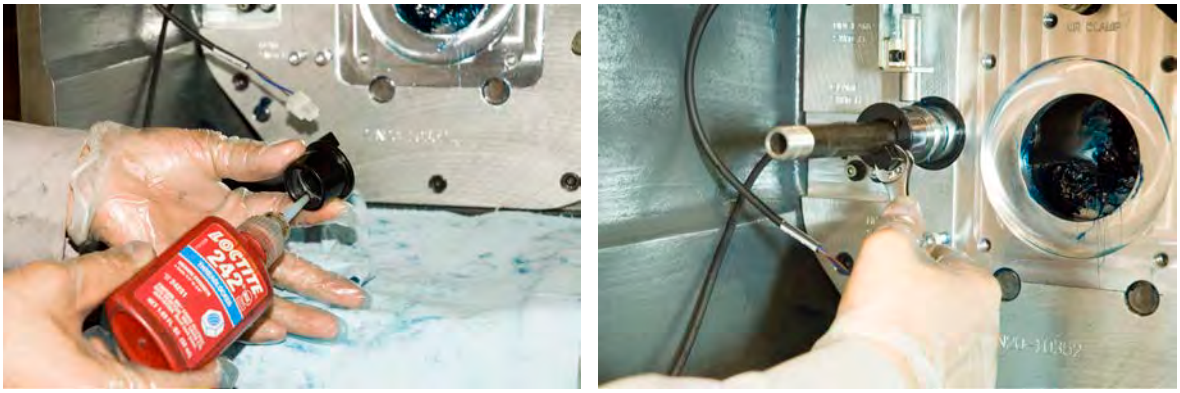
Carefully re-install plate.

6) Fill the gearbox with 28 ounces (794 grams) of Mobil XHP 221 grease through the motor hole.



Fill gearbox with grease.

7) Reinstall home switch flag. Use removable thread locker on the threads.



Install home switch flag

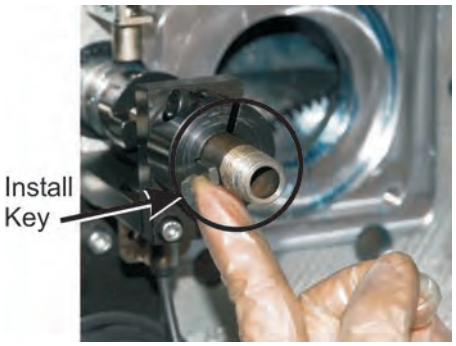
8) Install the home switch bracket onto the gearbox plate, but leave screws loose for adjustment.

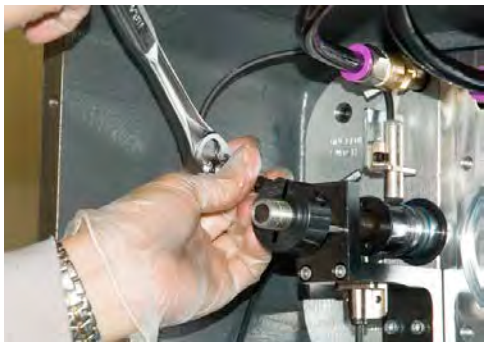
9) Press the keyed collar (with dowel pins) into the anti-rotation bracket. Slide the collar assembly onto the coolant tube.

10) Install the anti-rotation bracket screws, but leave the screws loose.




11) Reinstall the alignment key 1/8 X ¼ X ½ onto the keyway of the coolant tube, then align and slide the keyed collar into the alignment key. Be sure the dowels of the keyed collar are flush with the backside of the anti-rotation coolant tube bracket.

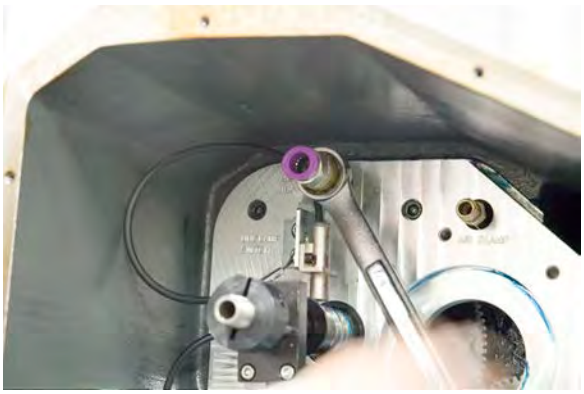


Install the key and set collar position *Tighten keyed collar*

12) Tighten the SHCS 5/16 -18 X ¾ on the keyed collar. Tighten the 2 SHCS that mount the anti-rotation bracket onto the home switch bracket. Tighten the home switch bracket bolts. Reinstall the coolant coupler. use sealant on the threads.

13) Reinstall the air fittings. Use sealant on the threads.

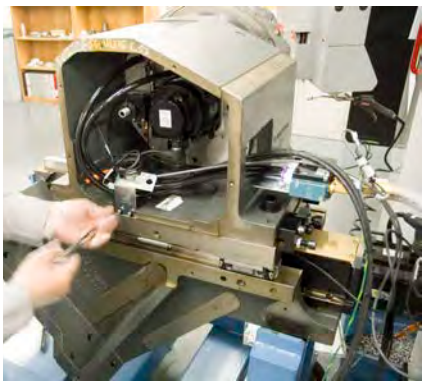



Re-install air fittings.

14) Reinstall the A-axis servo motor. Torque all mounting bolts to 27 ft-lb (37 Nm). Grease (Mobil XHP 221) the motor gear before installing.

Install motor

Connect motor cables



Connector bracket

15) Reconnect motor power cable, encoder cable and home switch cable.

16) Reinstall connector bracket onto the casting. Reconnect turret clamp and unclamp switch connectors as well as all connectors to the connector bracket. Reconnect air hoses. Turn the air supply on to the machine.

4) Home Switch Check and Adjustment

1) Reset E-stop and clear alarms.

2) Zero-return the A-axis,

If there are no alarms the home switch position does not need adjustment
If A-axis alarms come up, parameters 128 and 212 need adjustment.

Set parameter 128 and 212

Reset all alarms and zero-return the A axis. The tool 1 pocket will be out of position.

3). Set parameters 128 and 212 to values of 0.

-Enter DEBUG mode
-Go to POS-RAW DATA screen
-Zero-return the A axis
-Enter, “GRID A” and press write
-Verify that parameter 128 now has a value. If not repeat step 3.

4. Unclamp the turret and press E-stop. To do this home the A-axis (zero return single axis). Press E-stop once the turret is unclamped.

5. Manually rotate the turret counter-clockwise (CCW) to pocket 1 and clamp.

6. Enter DEBUG mode and note the number displayed for the A axis in the "Actual" column in the POS-RAW-DATA screen. Take this number and make it a whole, negative value for Parameter 212. For example, if the value, on the screen is 0.6612, enter –6612 for parameter 212. E-stop must be pressed to change a parameter value.

7. Zero return the A axis again. Tool 1 should be in the correct position. If tool 1 is still out position repeat steps 4-5.

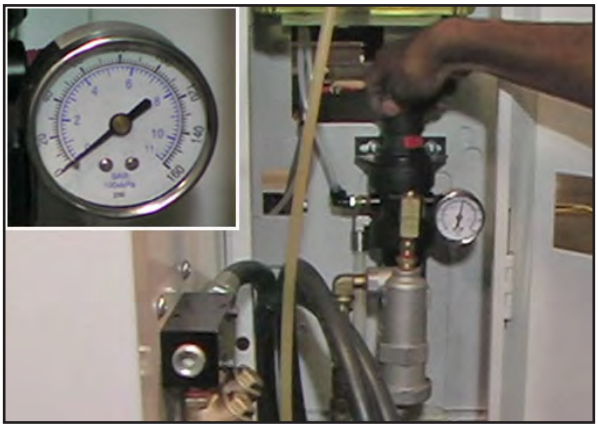
8. Once tool pocket 1 is in position, be sure that the A-axis load is no more than 4%. If the load is more than 4% look at the value in the "Actual" column. Add or subtract a value as a whole number, (e.g .0032 becomes 32) from parameter 212.

ST /DS Tuttet Removal

1. Remove the Front Right Panel.

Lower Main Air Pressure

1. Close the main air pressure regulator until pressure gauges reads 0 psi.



CAUTION! Turn off and lock out system power.

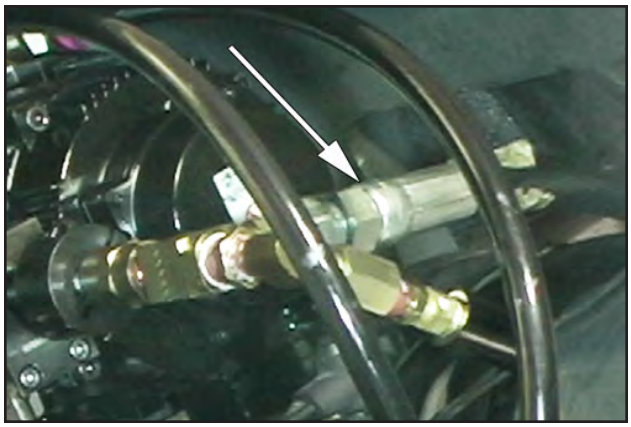
Remove Tool Changer Cover

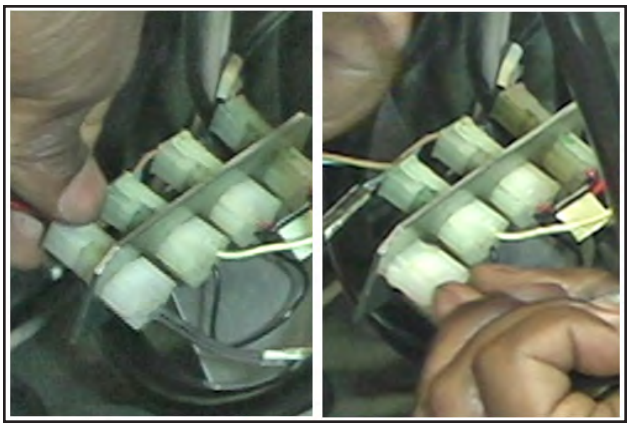
1. Remove the tool changer back cover.

Remove Coolant Fitting Assembly

1. Remove the coolant hose from the coolant fitting assembly.

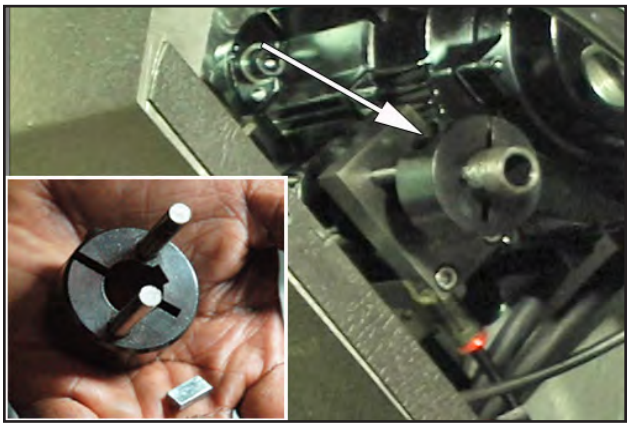
2. Disconnect the coolant pressure sensor wire and un-clip from clip bracket.





3. Remove the coolant fitting assembly.

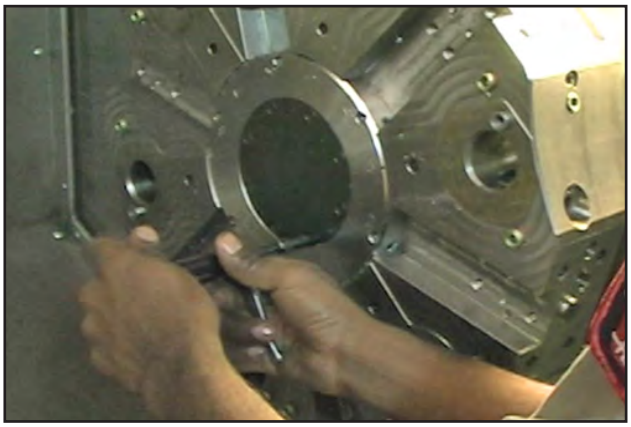
4. Loosen the collar screw and remove the collar and machined key.

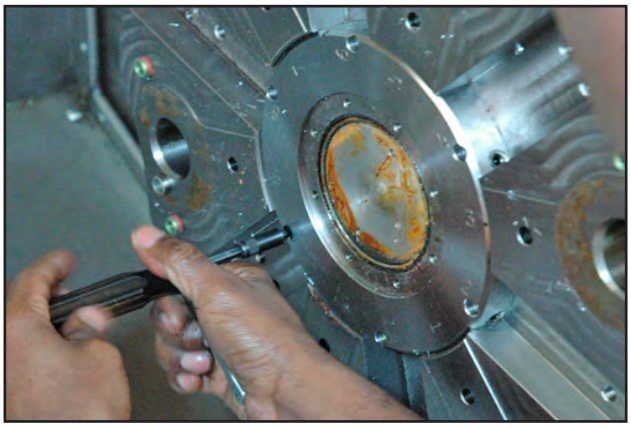


Remove Coolant Shaft Cover & Coollant Shaft

1. Remove coolant tube cover screws.

2. Remove the manifold assembly screws.

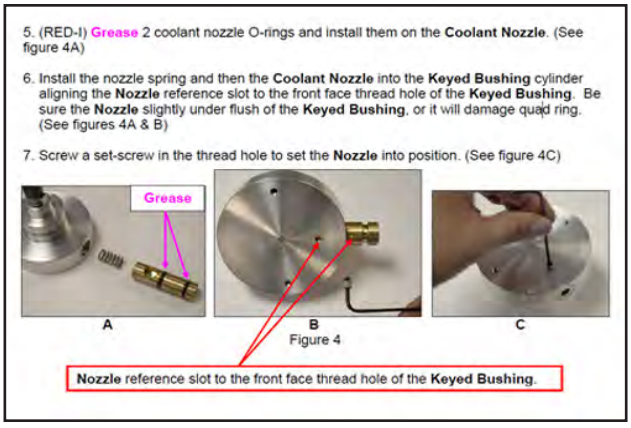




3. Carefully slide the coolant manifold assembly out of the turret.

CAUTION! Remove with care to ensure the coolant nozzle does not slip out of the manifold.

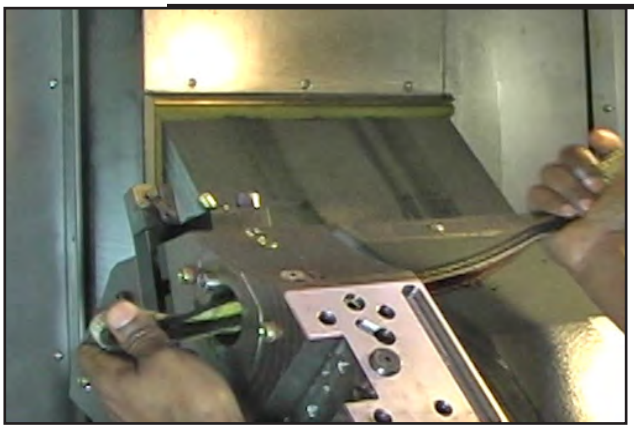
4. If coolant nozzle separates from the manifold during disassembly, refer to Keyed Coolant Manifold Installation documentation.

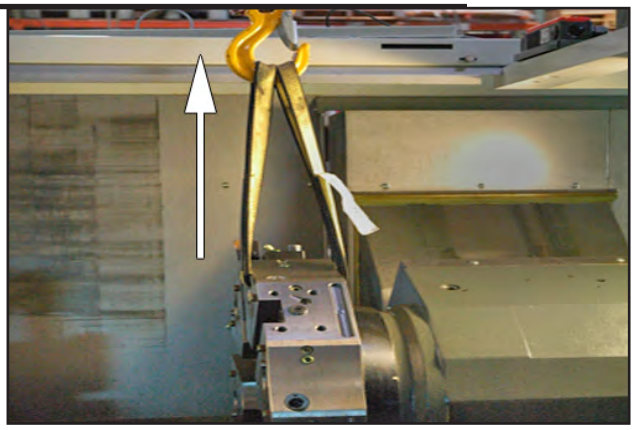


Remove Turret

1. Pass a lifting strap rated for 500 lb/kgs through the tool mounting hole near the 12 o'clock position. For BOT style turrets attach an appropriately rated eye bolt to the turret. Attach the lifting strap to an appropriately rated shop crane or hoist and tack the slack out of the strap.

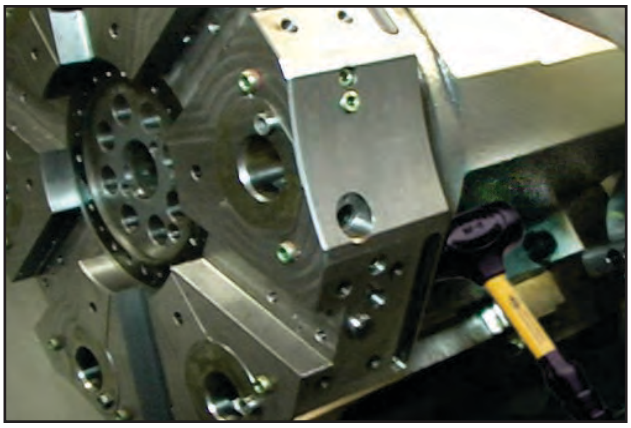
CAUTION! Do not apply upward force! Just keep the lifting strap taut.





2. Remove the turret mounting bolts.

3. Gently tap the turret with a dead blow hammer to loosen the turret and clear registration pin. Then wiggle and pull the turret off the turret mount.



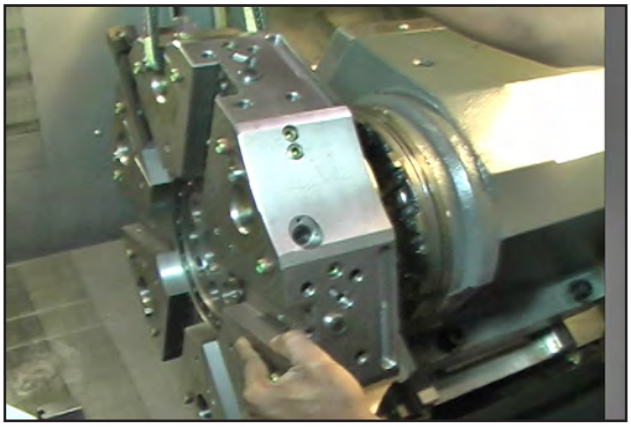
4. Using the crane, lift the turret free of the lathe enclosure.

ST /DS Turret Installation

Mount Turret

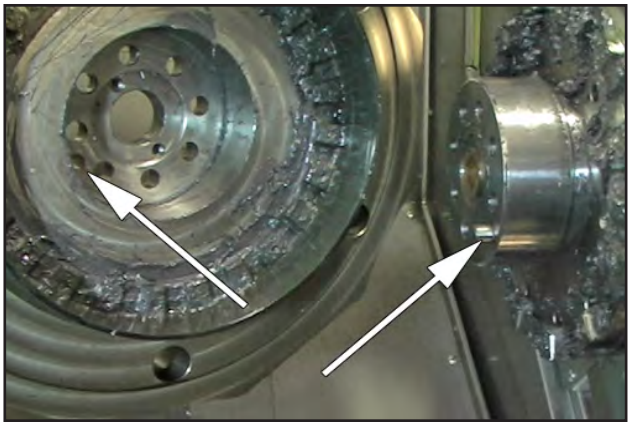
1. Clean and Inspect the turret mount. Re-grease the turret mount with Mobilgrease CM-P.

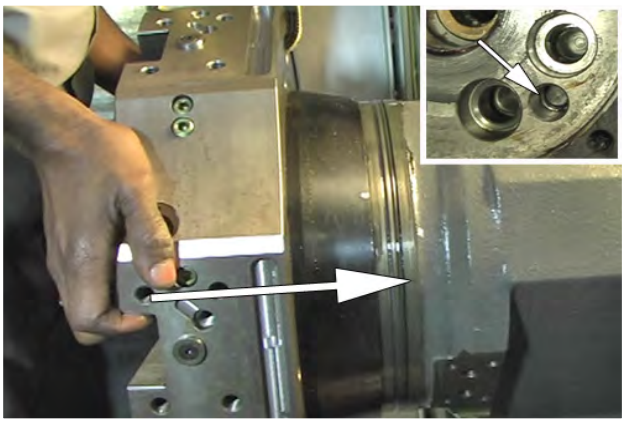
2. Pass a lifting strap rated for 500 lb/kgs through the tool mounting hole or eyebolt near the 12 o'clock position. Attach the lifting strap to an appropriately rated shop crane or hoist and position the new turret.



3. Note the location of the registration pin and hole

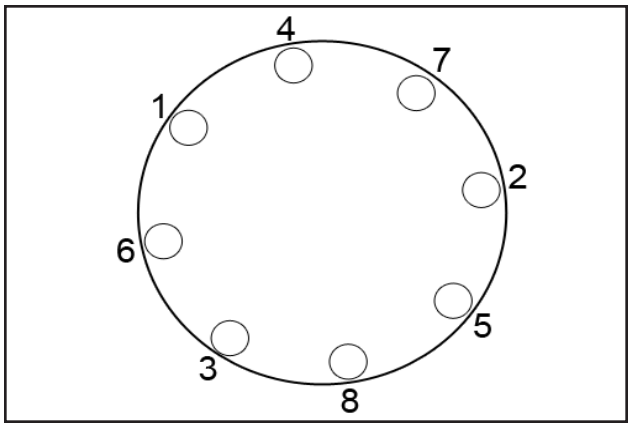
4. Align the registration pin and hole as the turret is placed on the turret mount.



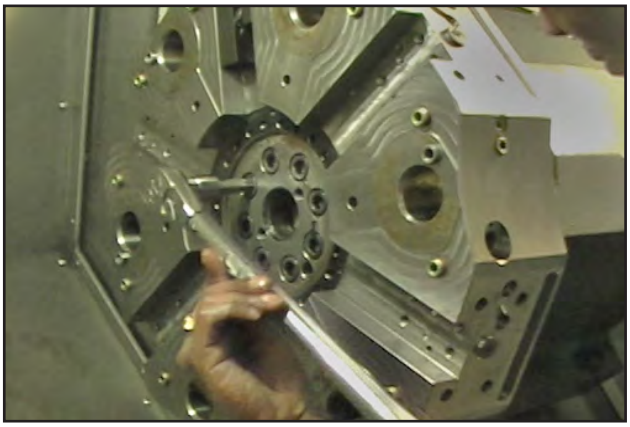


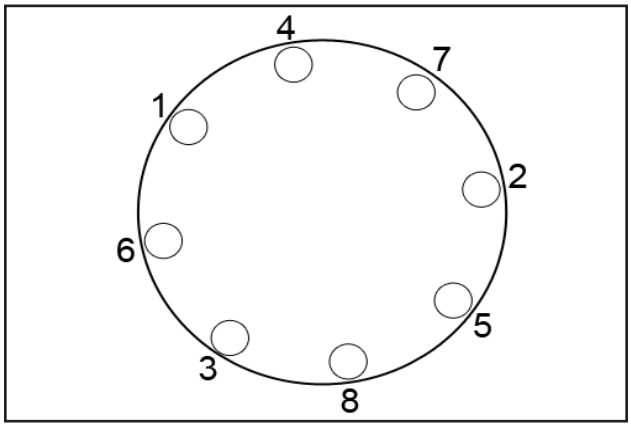
5. Loosen the tension on the lifting strap, but keep the strap in place until all turret mounting bolts are tightened.

6. Install and loosely tighten the turret mounting bolts in the order described.



7. Torque the turret mounting bolts to 200 ft-lbs. in the order described.

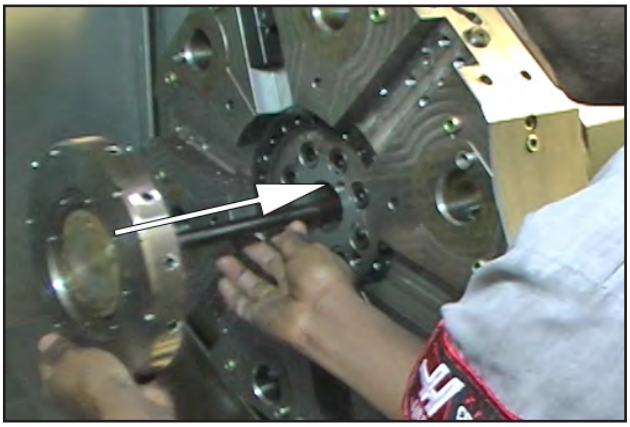


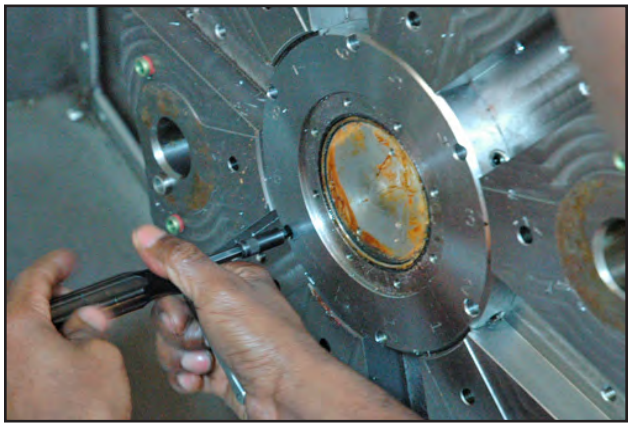


Install Coolant Fitting Assembly

1. Carefully slide the coolant shaft assembly into the center of the turret. (Refer to Keyed Coolant Manifold Installation documentation.)

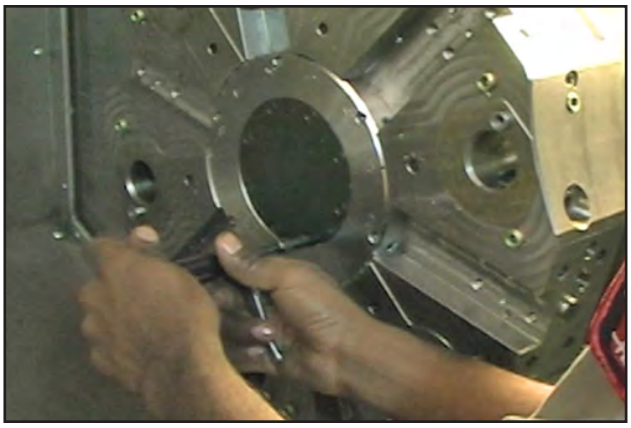
2. Install and tighten the coolant shaft assembly screws using a star pattern described previously.





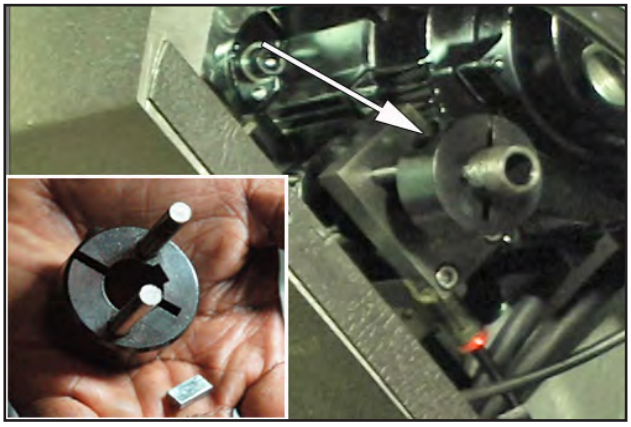
3. Install and tighten the coolant shaft cover screws using a star pattern described previously.

4. Install the machined key in the coolant shaft



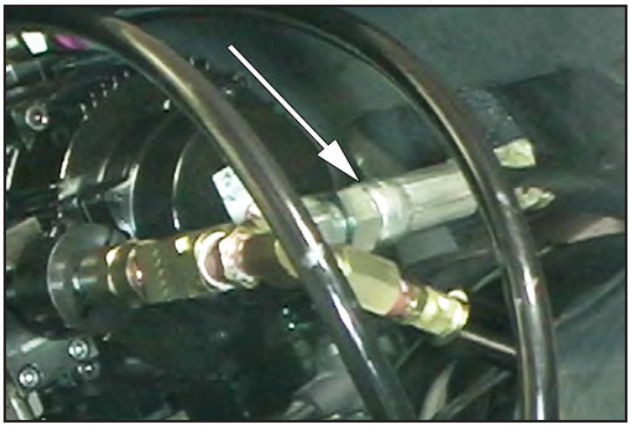
5. Install and tighten the collar on the end of the coolant shaft.

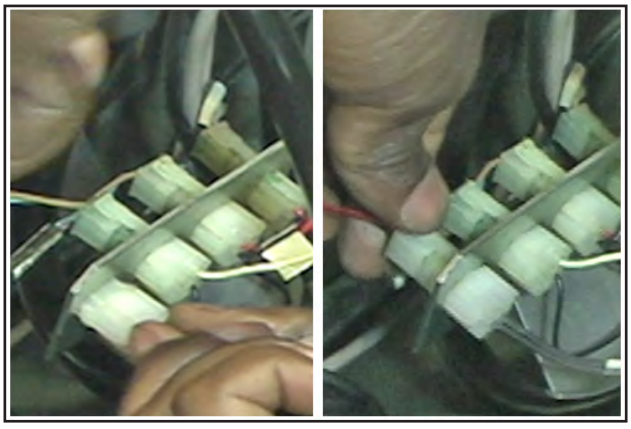
6. Attach the coolant fitting assembly to the coolant shaft.



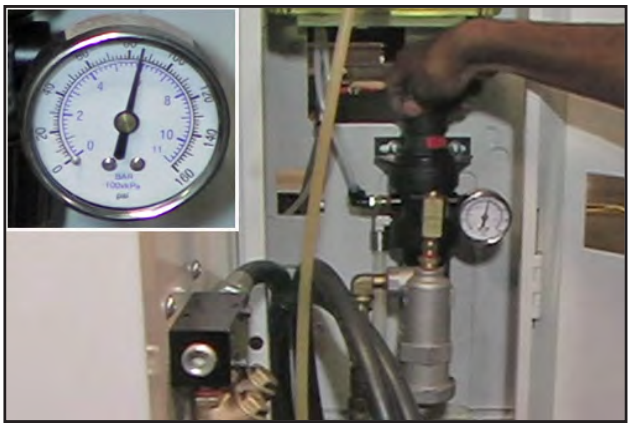
7. Attach the coolant hose to the coolant shaft.

8 Install the coolant sensor wire clip into the clip bracket and connect the coolant pressure sensor wire lead.





9. Open the main air pressure regulator until pressure gauges reads 85 psi.



Check A-axis Load

1. Check A- Axis Load

1. Press: **E- Stop**
2. Press: **“SETNG GRAPH**”;
3. Press: “**Cursor - Down Arrow”;**“**Cursor - Right Arrow**”
4. Change **Setting 7 Parameter Lock** to “**OFF”**
5. Press: **“WRITE /ENTER”**
6. Press: “**PARAM DGNOS”; “43”; BIt “18”**
7. “**INVIS AXIS”** Value = 1
8. Press:**“0” ; “WRITE /ENTER”**
9. **“INVIS AXIS”** Value = 0
10. Pull / twist **E stop**; **“ RESET” “RESET”**
11. Press “**A**” ; **‘ZERO RET”; “SINGL”**
12. Zero Return the A-Axis
13. “**A-AXIS Load**” values must be < 4%.
14. If the A -Axis load is greater than 4%, look at the value in the “Actual Column”. Add or subtract a value as a whole number, (e.g. .0032 becomes 32) from parameter “212”.
15. Press: **E- Stop**
16. Press: “**PARAM DGNOS”; “43”; BIt “18”**
17. “**INVIS AXIS”** Value = 0
18. Press:**“1” ; “WRITE /ENTER”**
19. “**INVIS AXIS**” Value = 1

2. Inspect work areas, then attach the tool changer back cover and tighten screws.

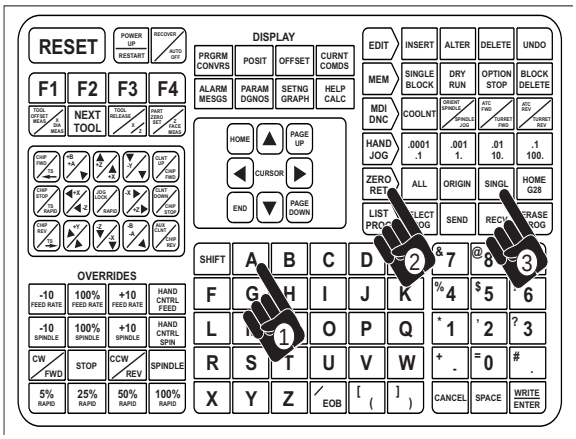
3. Install the front right panel.

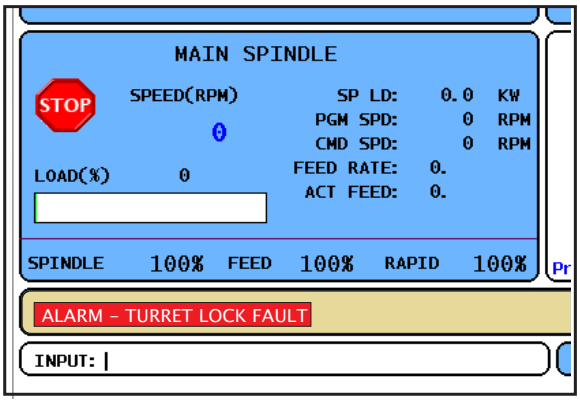
ST-10 / 10 Y Turret Lock / Unlock Sensors Adjustment

Turret Lock Sensor Check and Adjustment

1. Confirm presence of “ALARM- TURRET LOCK FAULT” (alarm number 114) Press: “A”, “ZERO RET”, “SINGL”.

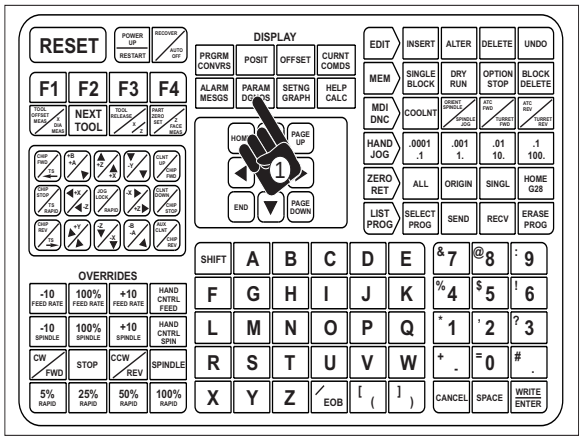
2. Confirm display of “ ALARM- TURRET LOCK FAULT”.

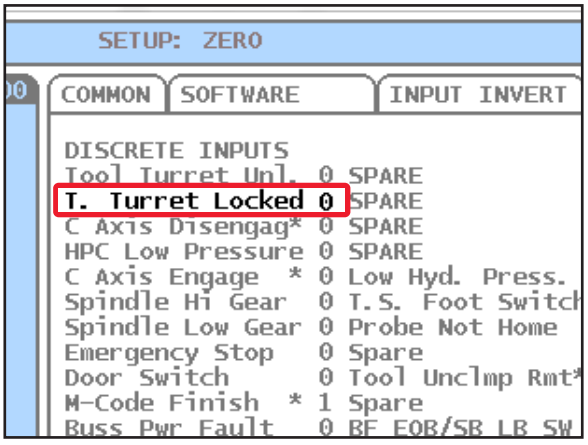




3. Press: “EMERGENCY STOP”, then “PARAM DGNOS”

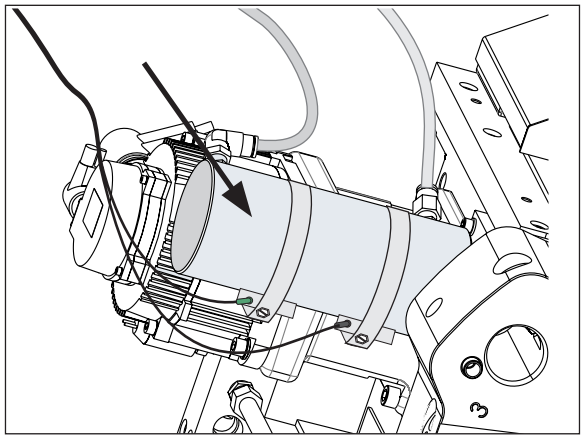
4. Look for “T. Turret Locked”. It will be “0”.

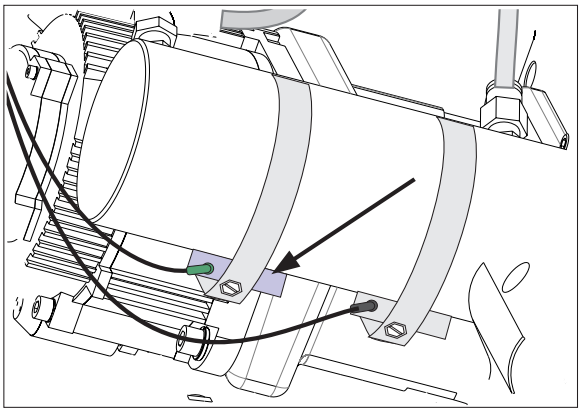




5. The turret lock and unlock sensors are located on the turret lock / unlock air cylinder.

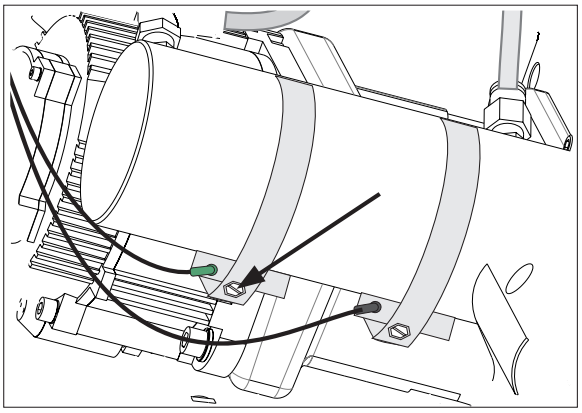
6. The lock sensor is the upper sensor.

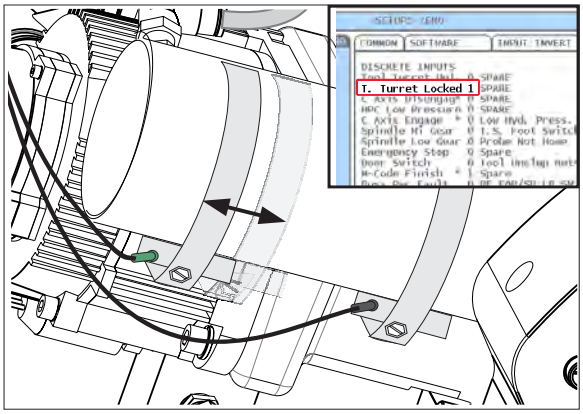




7. Loosen the lock sensor clamp.

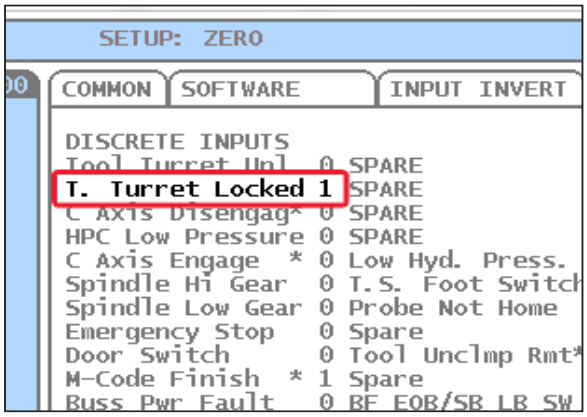
8. While viewing the “PARAM DGNOS” screen, move the lock sensor and clamp up until the bit changes to “1”.

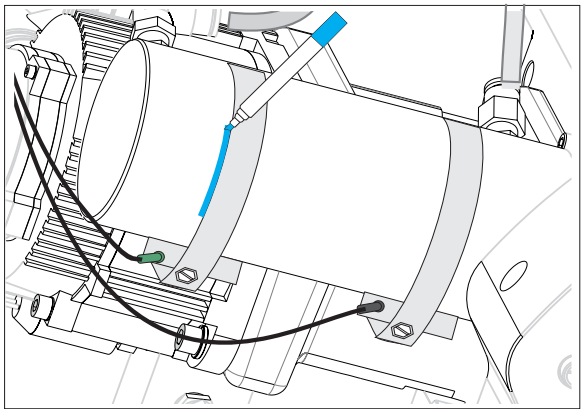




9. Find the spot where the T. Turret Locked bit just changes to “1”.

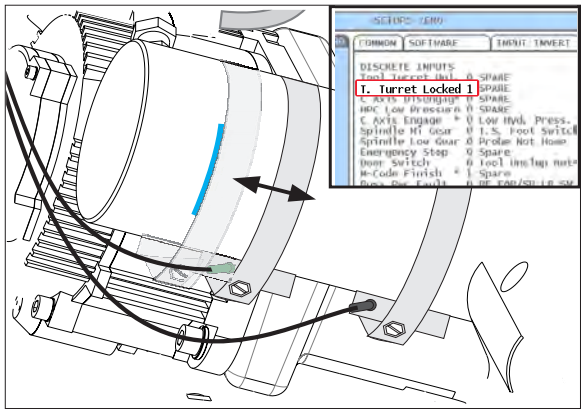
10. Mark the turret lock cylinder on the outside of the lock sensor clamp.

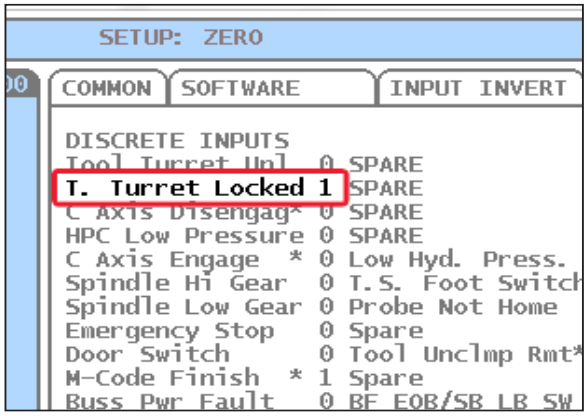




11. While viewing the “PARAM DGNOS” screen, move the lock sensor and clamp down until the bit changes to “1”.

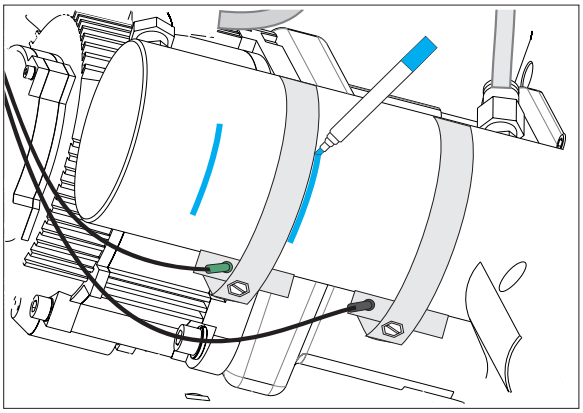
12. Find the spot where the T. Turret Locked bit just changes to “1”.

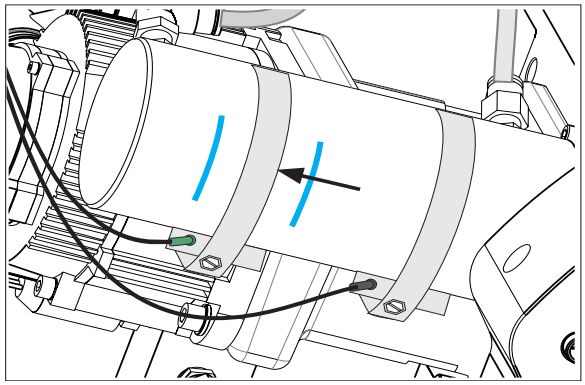




13. Mark the turret lock cylinder on the outside of the lock sensor clamp.

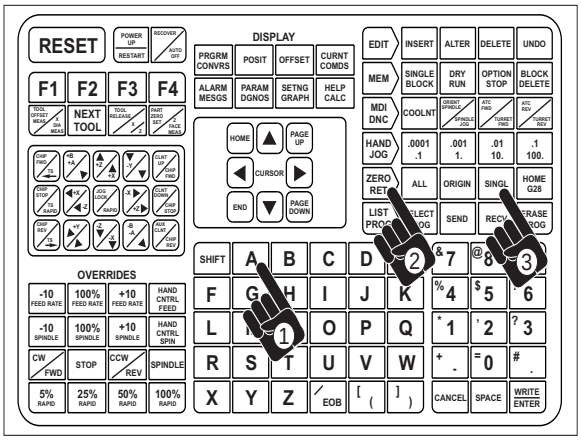
14. Move the lock sensor and clamp to the center point between the two marks and tighten the clamp.

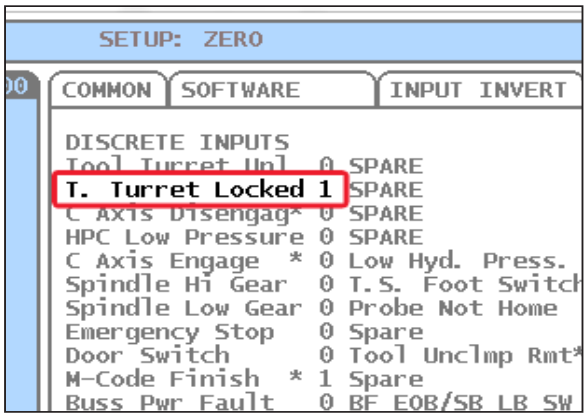




15. Press “A”, “ZERO RET”, “SINGL”

16. Look for “T. Turret Locked”. It will be “1”.

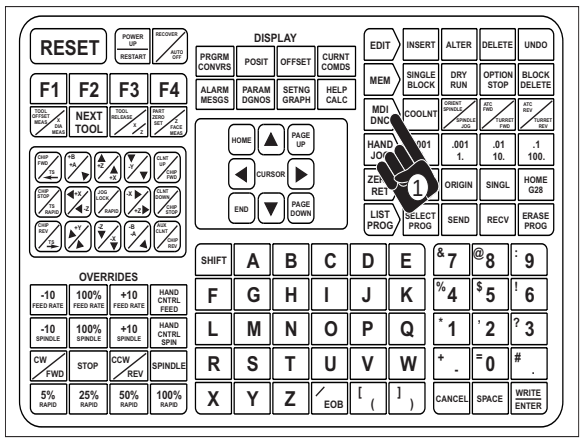


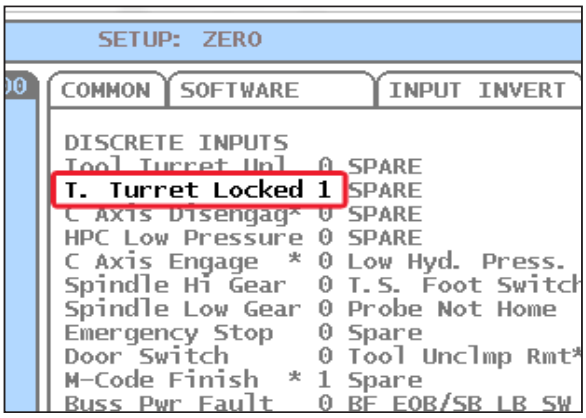


17. Enter this program in MDI mode and Run to the check operation of the turret lock sensor.

```
T1 ;

G04 P1 ;

T2 ;

G04 P1. ;

M99 ;
```

18. Press “PARAM DGNOS”. The “T. Turret Locked” bit should change to “1” when program activates the tool turret lock.

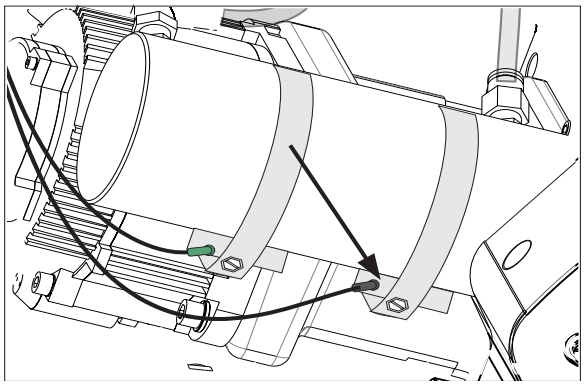


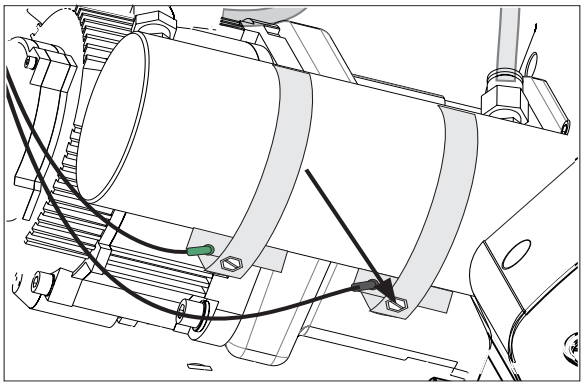


Turret Un-Lock Sensor Check and Adjustment

1. The unlock sensor is the lower sensor. Command 43 to unclamp the turret.

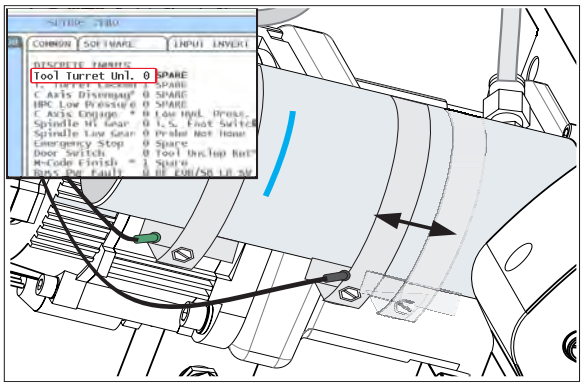
2. Loosen the unlock sensor clamp.

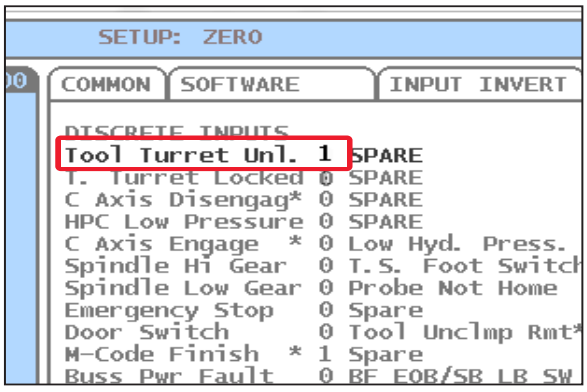




3. While viewing the “PARAM DGNOS” screen, move the unlock sensor and clamp up until the bit changes to “1”.

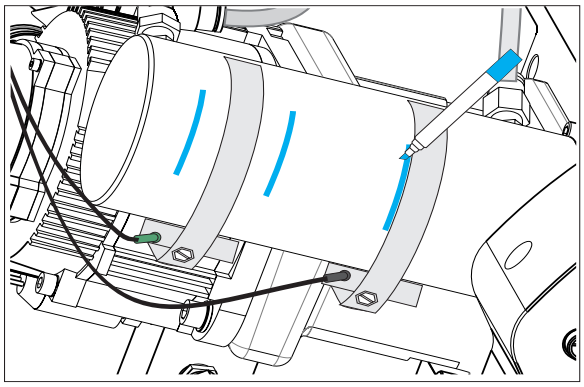
4. Find the spot where the “Tool Turret Unl.” bit just changes to “1”.

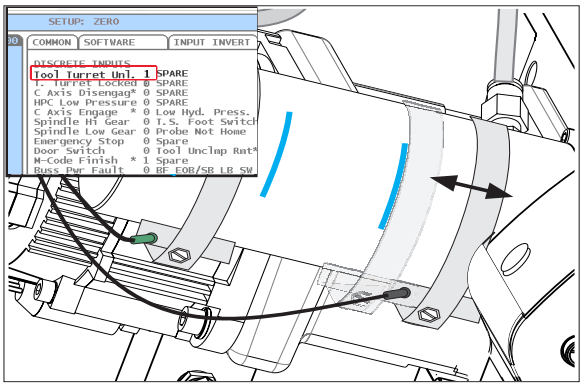




5. Mark the turret lock cylinder on the outside of the unlock sensor clamp.

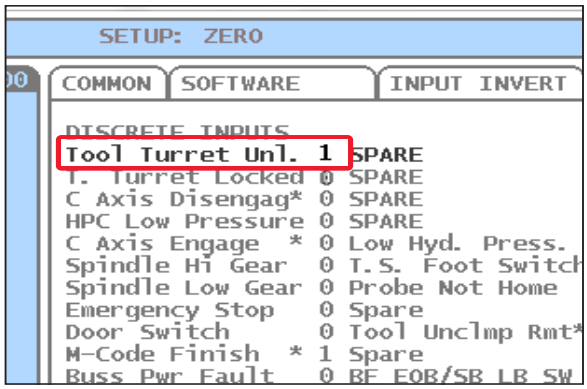
6. While viewing the “PARAM DGNOS”, move the unlock sensor and clamp down until the parameter changes to “1”.

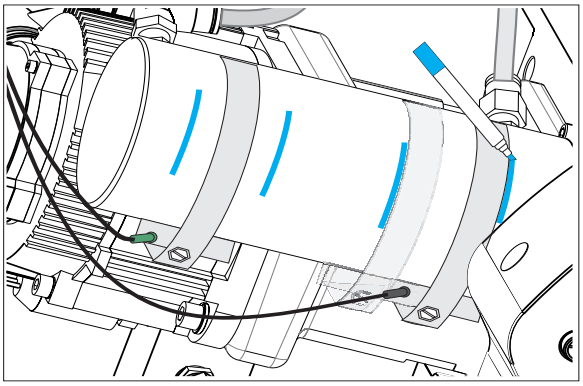




7. Find the spot where the T. Turret Locked bit just changes to “1”.

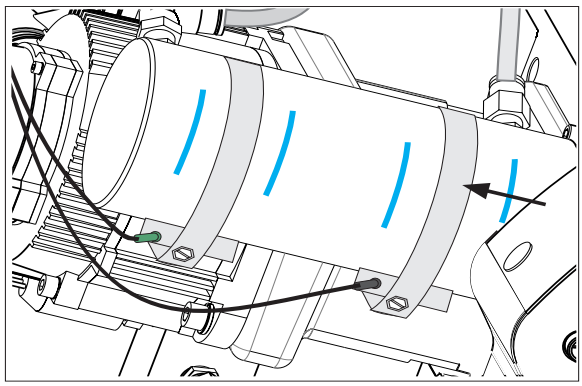
8. Mark the turret lock cylinder on the outside of the unlock sensor clamp.

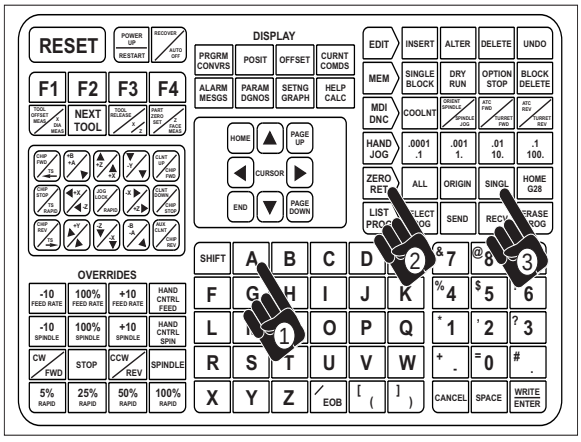




9. Move the lock sensor and clamp to the center point between the two marks and tighten the clamp.

10. Press, “A”, “ZERO RET”, “SINGL

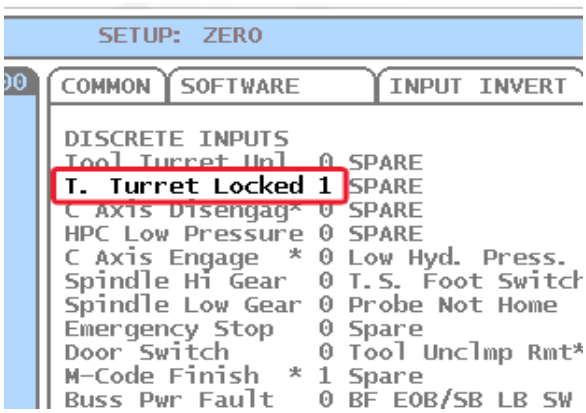


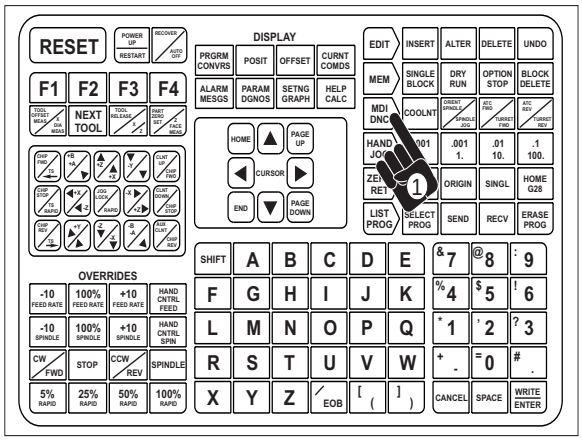


11. Look for “T. Turret Locked”. It will be “1”.

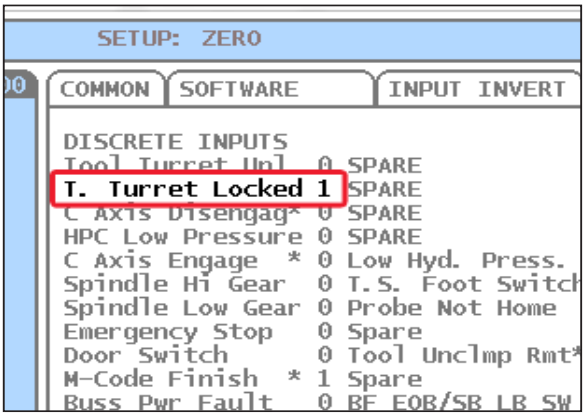
12.Enter this program in MDI mode and Run to the check operation of the turret lock sensor.

```
T1 ;
G04 P1 ;
T2 ;
G04 P1. ;
M99 ;
```

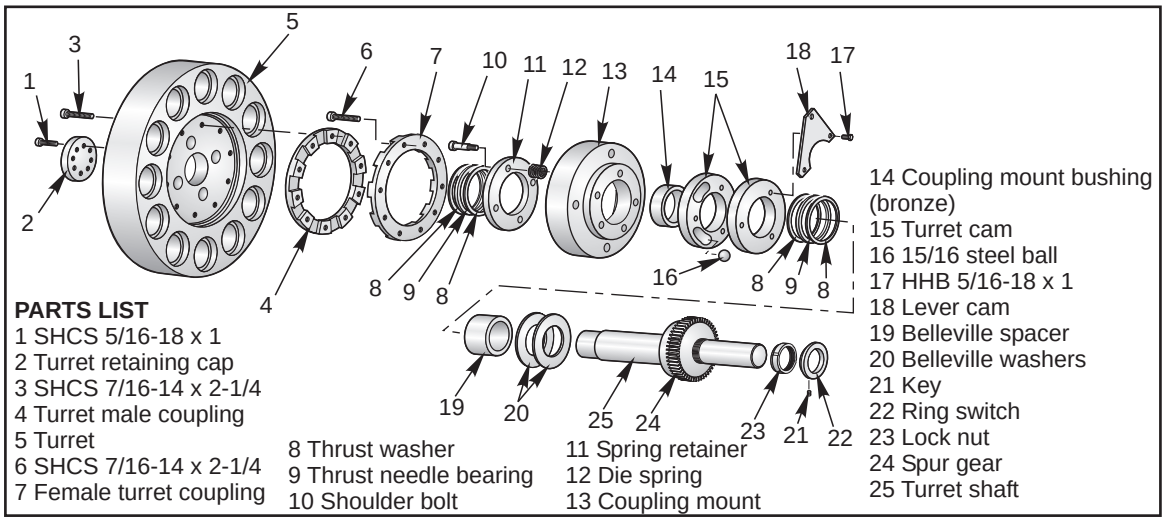




13. Press, “PARAM DGNOS”. The “T. Turret Locked” bit should change to “1” when program activates the tool turret lock.



SL 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.

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.

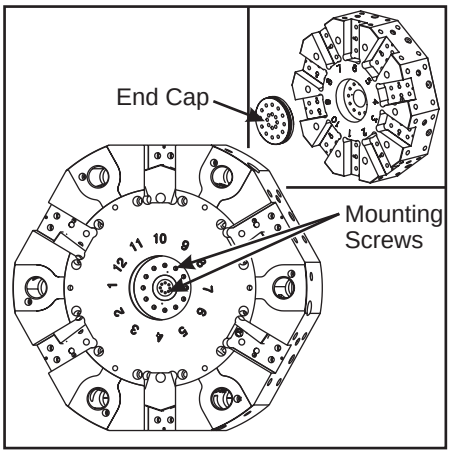
15. Replace the turret assembly and sliding tool change covers.

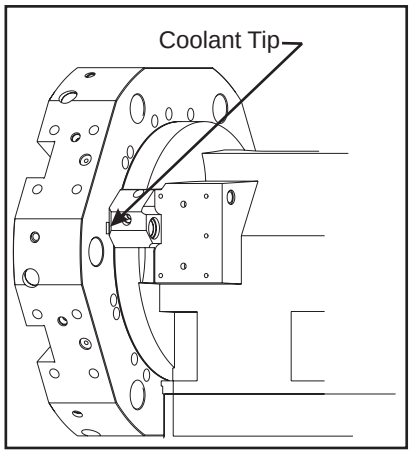
Hydraulic Turret

Removal

1. Rotate the turret to the pocket 1 position.

2. With the turret unclamped, 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 following to the turret shaft, in order: four (4) thrust washers, six (6) wave springs (P/N 59-0670), one (1) thrust washer, one (1) thrust bearing, and one (1) thrust washer.

2. Install the turret, lining up the coolant tip in the pocket 1 position. Use an alignment tool, P/N 15-0991, in every other mounting hole to help align the turret.

3. 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.

4. Install the end cap and snug the twelve (12) outer bolts.

5. Install the eight (8) inner bolts and snug.

6. Torque the twelve (12) outer bolts. to 30 ft-lbs.

7. Torque the eight (8) inner bolts. to 30 ft-lbs.

8. Repeat the torque process for 30 ft-lbs of torque.

9. Set Parameter 212 as described in the following section. This will correct alignment for clamping and unclamping the turret.

Turret Clamp Adjustment (Hydraulic Turret)

1. Enter Debug mode (type “DEBUG” in the alarms page and press enter).

2. Change parameter 43, Invis Axis to a 0 (zero).

3. Run a M43 (Turret Unlock) in MDI mode, and set Parameter 212 to 0 (zero).

4. Zero-return the A-axis.

5. Reset the turret clamp failure and command a M43 in MDI mode.

6. Use the Handle Jog and move the A-axis (jog speed 0.0001). Line up the coolant tube to the hole on the back of pocket 1.

7.Command a M44 and make sure the turret clamps properly. You may need to Handle Jog the A-axis into a better position until it clamps properly.

8. Write down the A-axis Actual value from the Pos-Raw Dat 1 page. Enter this value in Parameter 212 as a negative value, do not include the decimal point.

9. Zero-return the A-axis. Doing this will activate the new Parameter 212.

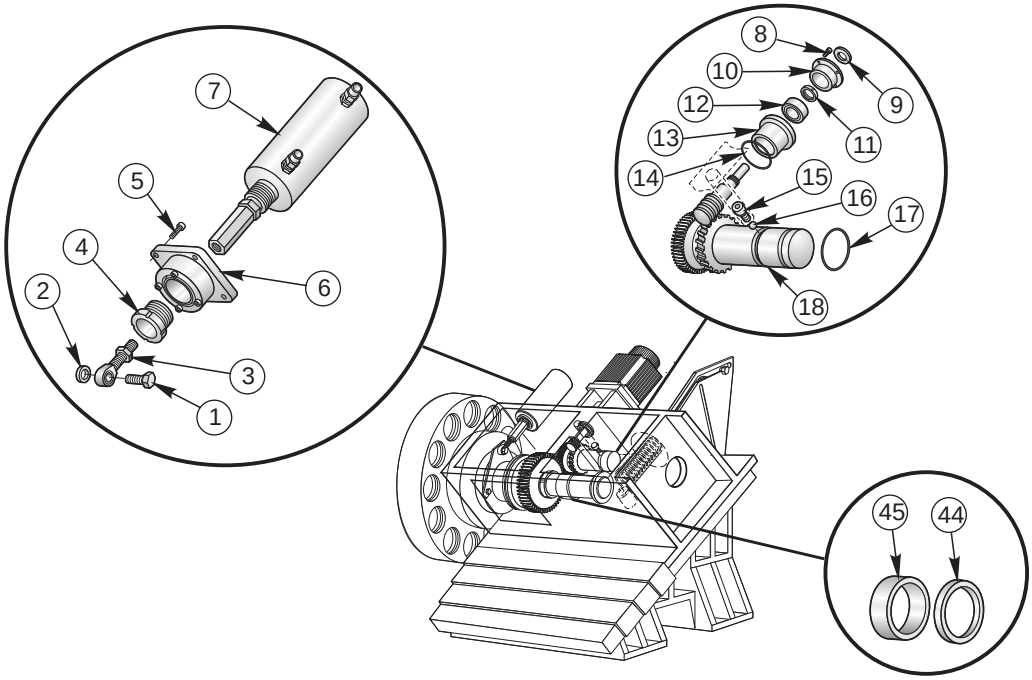
10. Return to the Pos-Raw Dat 1 screen.

11. With the turret clamped, jog the A-axis slowly (jog speed 0.0001) clockwise. Note the fuse level of the A-axis as the turret is jogged. When the fuse level starts to climb, write down the actual position for the A-axis.

12. Jog the A-axis in the counter-clockwise direction, repeat the procedure and write down the actual position for the A-axis.

13. Add the absolute values of each number together (ignore the minus sign), for example:
    a. -.1813 + .0113= .1926 (ignore the negative sign)
    b. Divide this value by 2= .0963
    c. Combine this number with the value in Parameter 212. As the negative value is larger (see line (a)) than the other value, subtract the calculated value (.0963) from the value in Parameter 212; this will make a larger negative number. For example; -410569 - .0963 = -411532 (ignore decimal point). If the line (a) positive value is larger, add this number to the value in Parameter 212 to make a smaller negative num ber. 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.

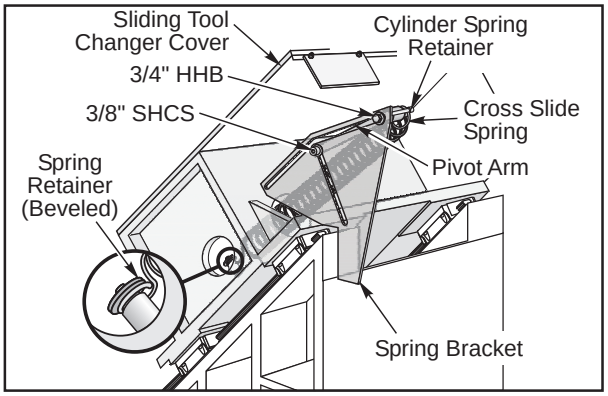
Turret motor coupling adjustment procedure must be completed for proper alignment.

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.

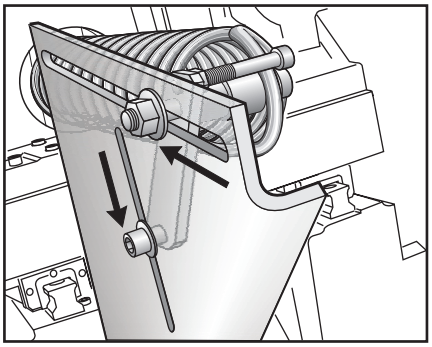


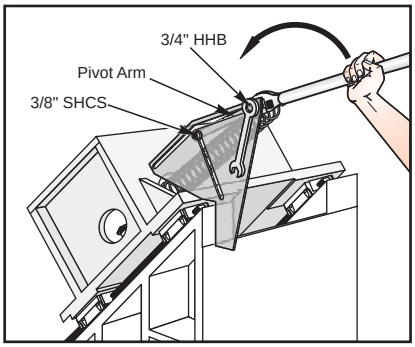
Cross-Slide Spring Components

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.

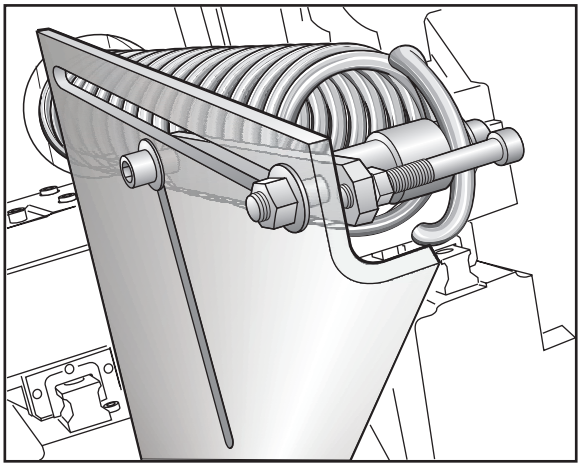
6. Remove cross slide spring and remove spring retainer located inside turret housing. Use access hole located on the opposite side of turret to remove spring retainer. Replace used spring retainer with new beveled spring retainer.

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.

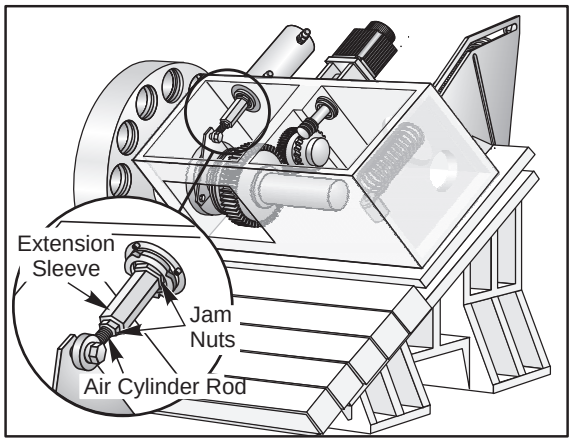
Example: Rotate the coupler and observe the indicated reading. The force used to rotate the coupler should be great enough so that when the force is removed you will see the indicated reading lessen; i.e. with little force T.I.R. is noted at .006 with more force T.I.R. is .012 (see note).

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

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

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

Turret In/Out Adjustment



Turret Travel Adjustment Components

NOTE: Alarms 113 and 114, "Turret Unlock Fault" and "Turret Lock Fault", indicate a turret in/out adjustment is necessary. Alarms occur when turret clamp and unclamp switches sense a turret positioning error.

1. If turret travel is not .150", ensure no mechanical problem or obstruction affects travel. If not, air cylinder rod travel needs adjusted. To do so, loosen the two jam nuts, and screw extension sleeve **away** from air cylinder to increase turret travel, or **toward** air cylinder to decrease turret travel. When adjustment is complete, tighten the jam nuts to the extension sleeve.

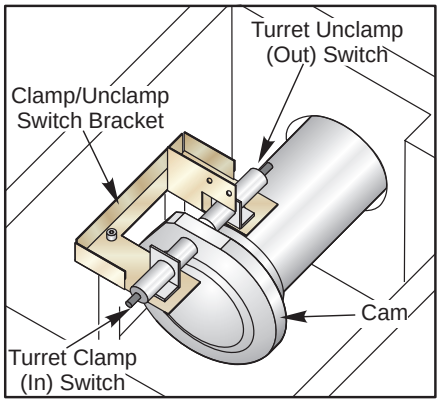
2. Once the turret travel is set, the Clamp/Unclamp switches must be adjusted. Enter the diagnostic data page in order to monitor the TT UNL (Turret Unlocked) and TT LOK (Turret Locked) discrete inputs.

For the following procedures follow:

Section I - Production units making turret in/out adjustments with trip switches.

Section II - Production units making turret in/out adjustments using air cylinder mounted reed switches.

Section I



Turret Clamp/Unclamp Switches

a. In MDI, enter an M43 (Unlock Turret). The turret unclamp switch should be tripped at this point, and discrete input TT UNL should read "1".

b. Place a 0.160" gage block between the turret clamp switch and side of the cam, ensuring it is flat against the cam. The switch should trip and discrete input TT LOK should read "1". Remove the gage block.

If either switch does not trip when the gage block is in place, the switches need to be adjusted. Adjust the switches by loosening the two SHCS and moving the entire switch bracket; Do not move the individual switches unless absolutely necessary.

c. Enter an M44 (Lock Turret). The turret clamp switch should be tripped at this point, and discrete input TT LOK should be "1".

d. Place a 0.160" gage block between the turret unclamp switch and the side of the cam, ensuring it is flat against the cam. The turret unclamp switch should trip and discrete input TT UNL should read "1". Remove the gage block.

e. If either switch does not trip when the gage block is in place, the switches need to be adjusted. Adjust the switches by loosening the two SHCS and moving the entire switch bracket; Do not move the individual switches unless absolutely necessary.

Section II

a. In MDI, enter an M43 (Unlock Turret). The turret unclamp switch should be tripped at this point, and discrete input TT UNL should read "1".

If this does not occur, the lower air cylinder mounted reed switch needs to be adjusted by loosening the worm drive clamp retaining the sensor and moving it until the input reads “1”. Mark the location. Move the sensor slowly in both directions until the input reads “0” and mark the location. Place the sensor in between the marks and tighten the worm-drive clamp. Retighten sensor. When the turret is in any other position than Unlock Turret, the discrete input should read "0."

b. In MDI, enter an M44 (Lock Turret). The turret clamp switch should be tripped at this point, and discrete input TT LOK should read "1".

If this does not occur, the upper air cylinder mounted reed switch needs to be adjusted by loosening the worm drive clamp retaining the sensor and moving it until the input reads “1”. Mark the location. Move the sensor slowly in both directions until the input reads “0” and mark the location. Place the sensor in between the marks and tighten the worm-drive clamp. Retighten sensor. When the turret is in any other position than Lock Turret, the discrete input should read "0."

Centering Inner Turret Coupling (Without Brass Plug)

Only perform this procedure if there is not enough adjustment to perform an outer coupling alignment.

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.

SL Series Turret Alignment (X-Axis)

Read the following sections in their entirety before starting the alignment procedures.

1. Remove the rear cover and the sliding toolchanger cover.

NOTE: Be sure to remove the 4 SHCS located behind the turret. The X-axis wiper may also need to be replaced if damaged.

2. Remove top plate cover to the turret housing. Be sure to check the gasket and see if it needs replacement.

3. Remove the SHCS that mount the coolant adapter block to the turret housing. The turret must be in the unclamped position (M43) in order to lift the coolant line over the black access plate.

4. Remove the black access plate. The plate may need to be pried off with a screwdriver.

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

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

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

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

NOTE: In order to help keep the turret housing from slipping down during the alignment procedure, keep the turret housing bolts as snug as possible.

Verify the turret alignment before continuing.

8. Apply 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)”.

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

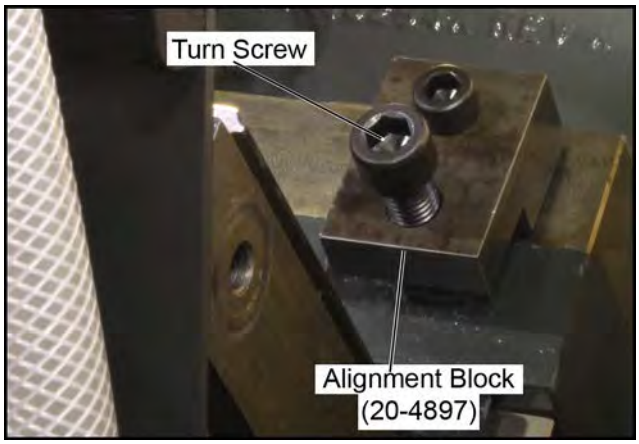
ST Series Turret-to-Wedge Alignment

1. Place an indicator against the side of the turret and jog the Z axis to measure misalignment.

2. Attach an alignment block (20-4897) to each side of the top of the turret as shown in the photograph.

3. Loosen the turret mounting bolts.

4. Turn the adjustment screws on the alignment blocks to pull the turret into alignment within 0.0004".



5. When complete, torque the mounting screws to 150 ft-lb and check alignment again.

Turret Alignment Verification (X-Axis)

Tools Required: Magnetic Base with a dial indicator (0.0005" or less resolution).

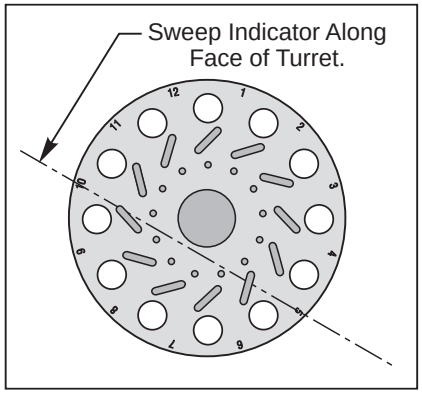
1. Remove all toolholders and fittings from the turret and Jog the X-axis to the center of its travel.

2. Place the magnetic indicator base on the spindle retainer ring. Position the indicator tip on the turret face so there is at least 3.5" of travel in each direction from the center of the X-axis and 1/4" below the center cap. Refer to the following figure.

3. Jog the X-axis so the indicator is at one end of its travel, then zero the indicator.

4. Jog the X-axis to the other end of its travel and check your reading (tolerance 0.0003" TIR).

5. If the reading is **greater** than the tolerance specified, the turret needs to be realigned.

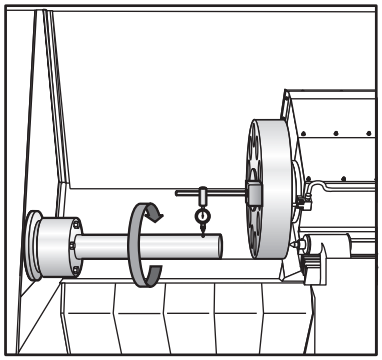


Turret Alignment Verification (X-Axis)

Spindle Alignment Verification

This procedure should be performed after the turret face has been realigned.
Tools Required: Spindle Alignment Test Bar (T-1312)

1. Mount a 0.0001" indicator (*short setup*) to face of turret.



Checking Runout

2. Install Spindle Alignment Test Bar. Take up any slack between bolts with washers.

3. Place the indicator tip onto the test bar near the spindle. Rotate the spindle to determine the runout. The tolerance is .0001". If the tolerance is greater than .0001, loosen the test bar mounting bolts, rotate the spindle and tap on the mounted end of the fixture until the runout is within tolerance.

4. Tighten the bolts to the test bar, being careful not to alter the alignment.

5. Move indicator tip to end of the test bar and check for runout. Tolerance should not exceed 0.0001".

NOTE: If reading is greater than 0.0001" remove test bar, and clean both surfaces.

6. Next rotate the test bar until the reading is 1/2 of the total runout. Using the Z-axis, jog the indicator tip over 10" of the test bar to determine if spindle is high or low. Tolerance should not exceed 0.0004/10".

NOTE: If the measurement is greater than allowable tolerance, the spindle head casting must be realigned. Before realignment, perform a Turret Alignment Verification - Parallelism of X-axis (Turrets section). If the measurement is within the allowable tolerance, go to step 7.

7. Position the indicator tip on the backside of the test bar. Jog the indicator tip over 10 inches of the test bar to determine spindle parallelism. The maximum allowable tolerance is 0.0004/10".

NOTE: If this tolerance is out, call Haas Automation Service Department. If the spindle is in alignment, proceed to "Turret Alignment Verification".

Turret Alignment Verification (Spindle)

This procedure should be performed after spindle alignment has been checked.
Tools Required: Spindle Alignment Tool, Dial Indicator (0.0005" or less resoultion)

1. Remove all toolholders and fittings from the turret.

2. Clean the turret pockets and toolholders.

3. Mount spindle alignment tool onto spindle retainer ring with dial indicator mounted to the end of the tool.

4. Jog the X-axis to the spindle center line. This is the value stored in Parameter 254, found on the "Position Raw Data" page (this page is entered through Debug mode).

5. Position the indicator tip just inside pocket #1 so that it is almost parallel to the X-axis. Zero the indicator, then rotate the spindle 180°. The indicator should read Zero.

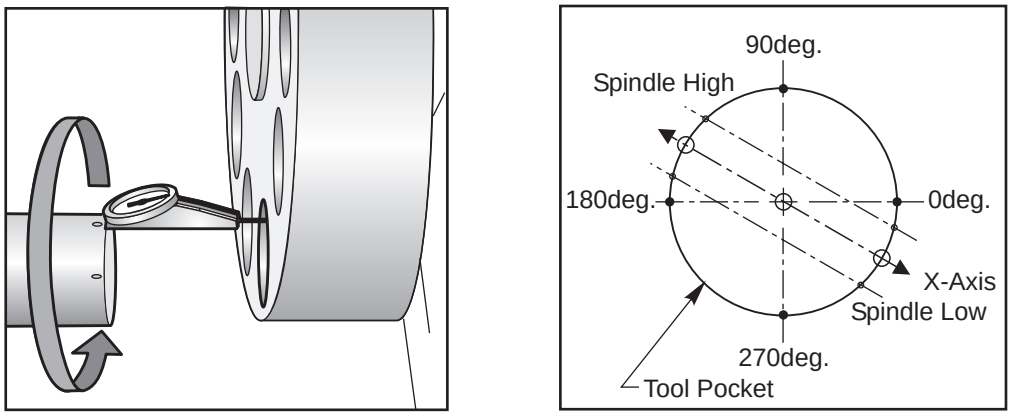
NOTE: Use the Jog Handle in tenths mode to zero the pocket.

6. Next, rotate the spindle and take readings at both the top and bottom of the pocket.

7. If the reading exceeds .0010" from the centerline or .0020" TIR, the inner coupling may need adjustment.

8. Perform turret motor coupling adjustment.

NOTE: If the reading is within specifications, but the X-axis position is different from Parameter 254, enter the new number in Parameter 254.



Turret Pocket Alignment

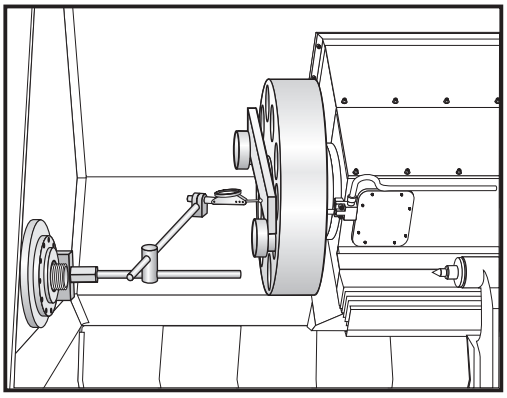
Converting Spindle Centerline to Encoder Step

1. Jog the X-axis to the spindle center.
2. Press Alarms, enter "Debug", press Write/Enter.
3. Press Posit, and Page Up until you see the debug screen Pos-Raw Dat 1.
4. Observe X-axis Command position. This is encoder steps. Ignore the negative sign and the decimal point.
5. Copy this number to Parameter 254 as a positive number with no decimal point.
6. Press Alarms, enter "Debug" and press Write/Enter, or turn the power off and back on to deactivate debug.

Turret Alignment Verification (Parallelism of X-Axis)

Tools Required: Magnetic Indicator Base**,** Dial Indicator (0.0005" or less resolution)**,** a bar approximately 12"x 4"x 1" (ground to within 0.0001" on the 1" width side)

1. Remove all toolholders and fittings from the turret.
2. Clean the turret pockets and toolholders, then command tool #1 to the cutting position.
3. Place a clean and undamaged toolholder loosely (do not thread nuts) in the nearest pocket to the spindle and the other in the opposite toolholder.
4. Place the 12" x 4" x 1" bar across the small diameter of the two toolholders (ground side down).



Turret Bar Sweep

5. Jog the X-axis to the center of its travel.
6. Mount the indicator to the spindle retainer ring. Position the indicator tip at the bottom edge of the bar.
7. Jog the X-axis so the indicator is at one end of the bar, and zero the indicator.
8. Jog the X-axis to the other end of the bar, and check your reading (tolerance is 0.0003" TIR).
9. If the reading is not within tolerance, loosen all (10) turret bolts with the turret in the clamped position.

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

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

If the reading is within tolerance, proceed to “Turret Alignment Verification (Spindle)”. If the reading is **greater** than the tolerance specified, proceed to the appropriate coupling adjustment procedure.

Bolt On Turret Alignment

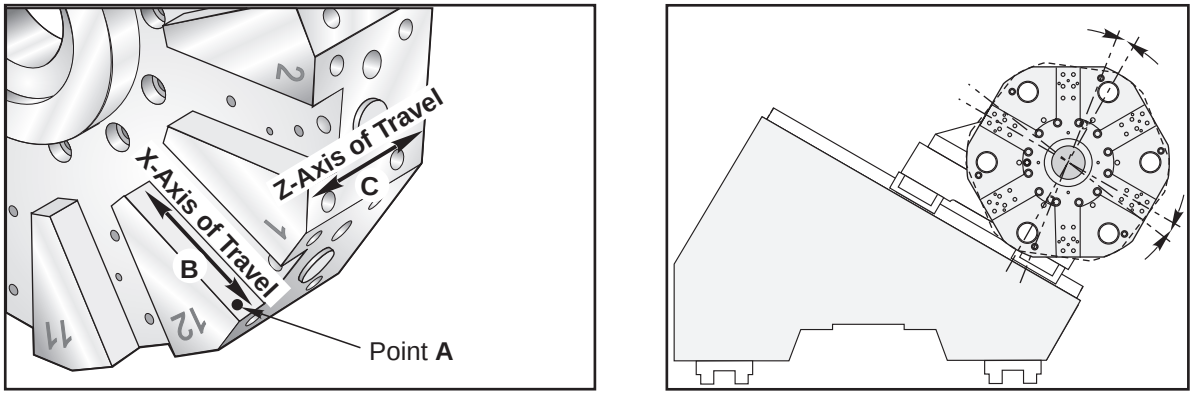
1. Clean the turret thoroughly before beginning alignment.

2. Index tool position #1 into the cutting position.

3. If the machine has a tailstock, move the turret and tailstock head next to each other and use the tailstock head as a secure mounting point for the indicator. If there is no tailstock, move the turret as close the fixed spindle bulkhead as possible. Assemble a short and rigid indicator mount as possible on the spindle retaining cap. A rigid setup is critical for proper turret indication.

4. Select four (4) equally spaced SHCS that secure the turret to the coupler and mark them with a felt pen. Loosen all the remaining bolts.

5. Place the indicator tip at the outside edge of the turret, point A in the following figure. Sweep the indicator along this edge by jogging the X-axis, direction B. This edge should be parallel to the X-axis within 0.0002” along its entire length and should be as close to zero as possible.



Hybrid Turret Shown

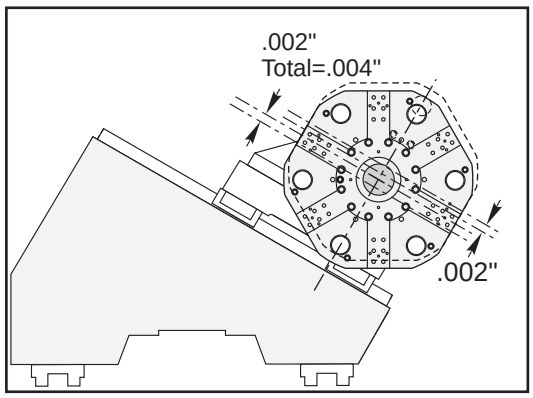
The previous illustrations shows a turret that is twisted about the coupler along direction “B” as described in step five. The turret flats should be parallel to the X-axis within 0.0002".

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.

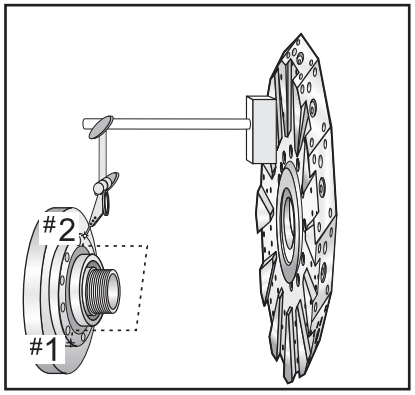
Wedge Alignment

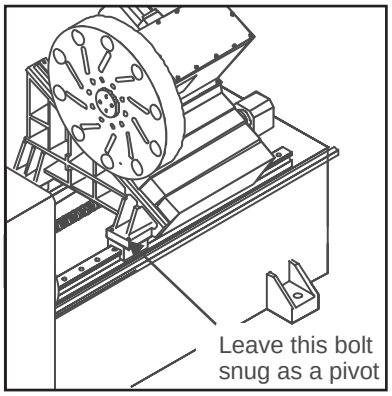
Using the data from the “Service Lathe Alignment” report as this procedure is followed. It is important that the form is filled out in its entirety before any adjustments of the wedge are attempted.

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.

8. Loosen the ball nut housing bolts and jog the machine through the full travel to align the ball nut housing

9. Tighten the bolts to the ball nut housing

10. Break loose and retorque the bolts from the ballscrew to the ball nut.

11. 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.

5. Loosen the ball nut housing bolts and jog the machine through the full travel to align the ball nut housing

6. Tighten the bolts to the ball nut housing

7. Break loose and retorque the bolts from the ballscrew to the ball nut.

Live Tooling Service

ST series live tooling systems vary between two different assemblies, one installed in machines manufactured before 1 November 2010 and another in machines manufactured later.

Motor Replacement

All Live Tooling Assemblies

Before servicing live tooling, disable Parameter 278 bit 24 and disconnect the motor cables.

When service is complete, reconnect the motor cables and enable Parameter 278 bit 24.

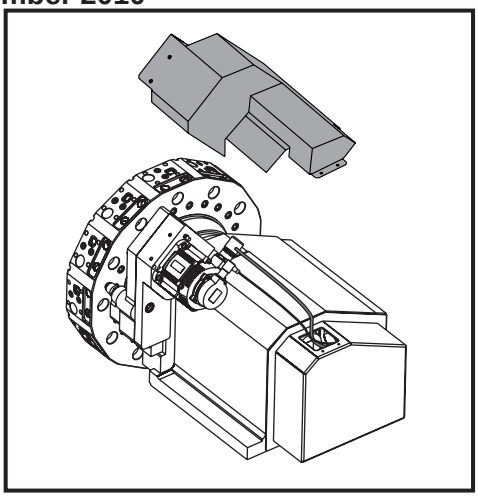
Assemblies built before November 2010

The motor is located at the rear of the live tooling gearbox assembly. The replacement motor assembly includes the live tooling drive gear.

Motor Assembly (Pre 11/2010)

1. Remove the four 5/16-18x1" SHCS securing the motor to the live tooling assembly.
2. Apply Mobil XHP 221 grease to the drive gear of the new motor assembly.
3. Install the new motor assembly and secure with four 5/16-18x1" SHCS.

Assemblies built after November 2010



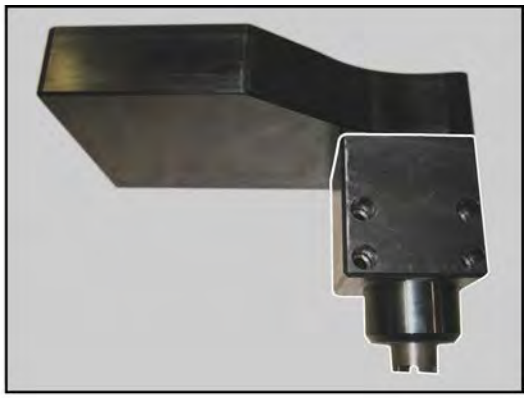
Live Tooling Motor Access

1. Remove the motor cover from the top of the turret to access the motor.
2. Remove the four 5/16-18x1” SHCS securing the motor to the live tooling assembly.
3. Apply Mobil XHP 221 grease to the drive gear of the new motor assembly.
4. Install the new motor assembly and secure with four 5/16-18x1” SHCS.

Drive Assembly Service

Assemblies built before November 2010

Pre 11/2010 Drive Assembly



Installed

1. Remove the existing drive assembly from the gearbox.
2. Check the grease in the gearbox assembly and add Mobil XHP 221 if necessary.
3. Place a gasket on the drive housing and mount to the gearbox assembly with the counterbored holes oriented as shown.
4. Secure with four 3/8-16x1.25" SHCS, torqued to 45 ft-lb.

Assemblies built after November 2010

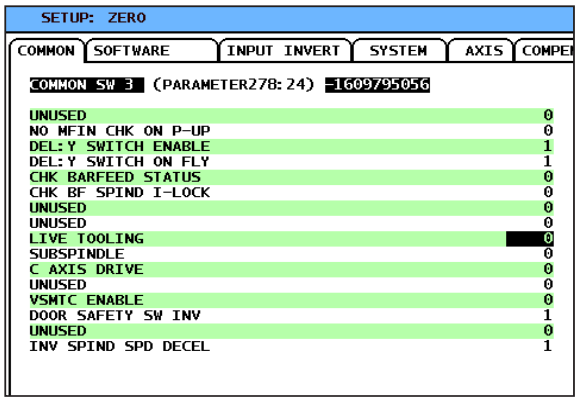
The gearbox and live tooling drive are not separate assemblies after November 2010.

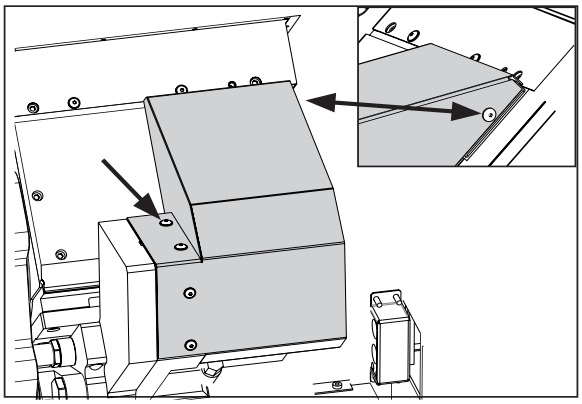
Live Tooling Removal

1. Press Emergency Stop

2. Before servicing live tooling, disable Parameter 278 bit 24, “LIVE TOOLING”.

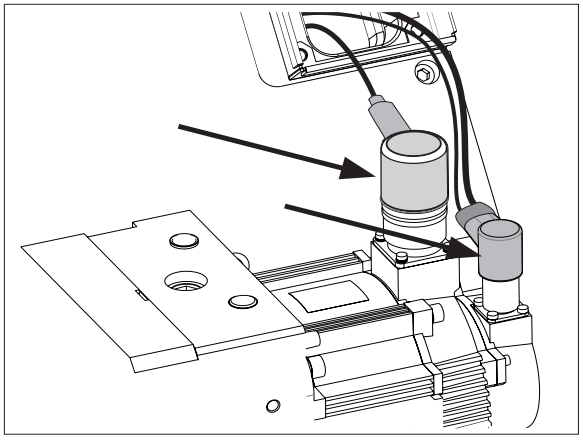
3. Remove the five live tooling option cover screws and remove the cover, lifting the cover up and to the right.

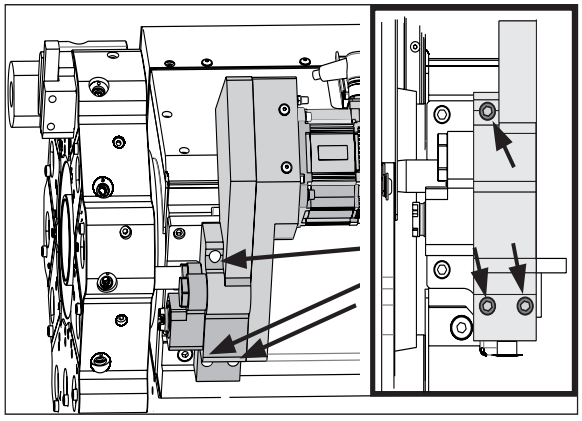




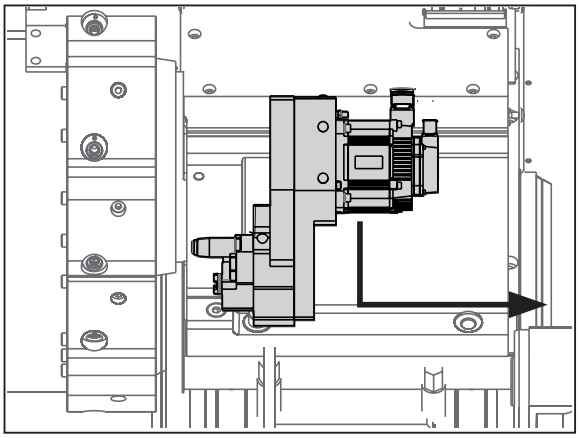
4. Disconnect the cables from the motor.

5. While supporting the weight of the live tooling option, remove the 3 SHCS.





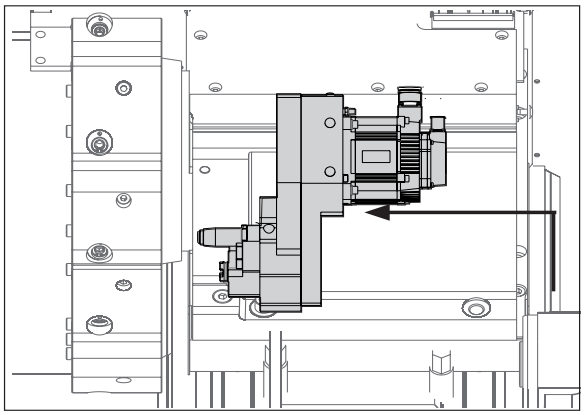
5. Move the live tooling down and to the right and remove.

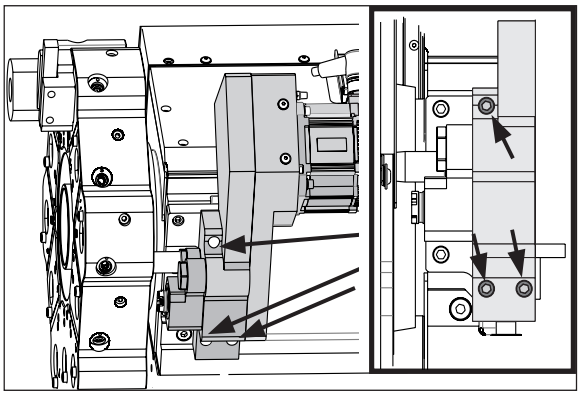


Live Tooling Installation

1. Move the live tooling up and to the left to align SHCS holes.

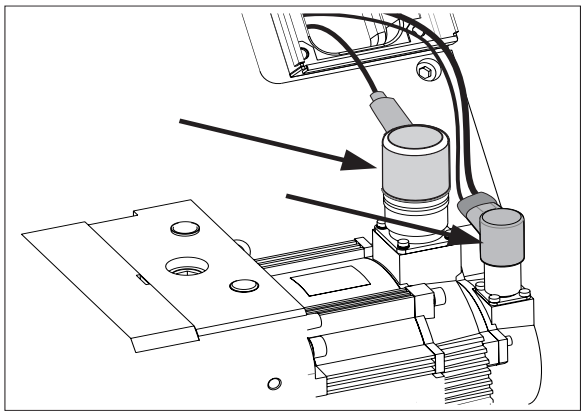
2. Continue to support the weight of the live tooling option. Install the 3 SHCS. Torque to 30-50ft/lbs

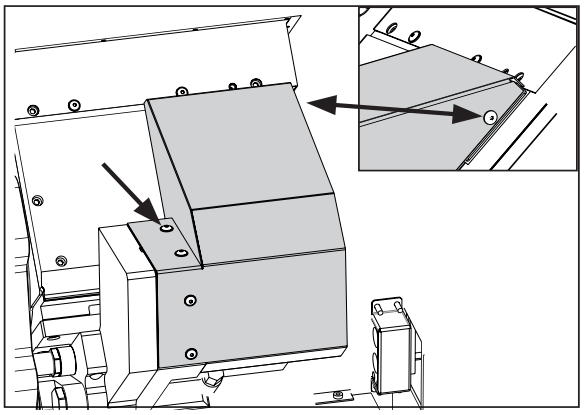




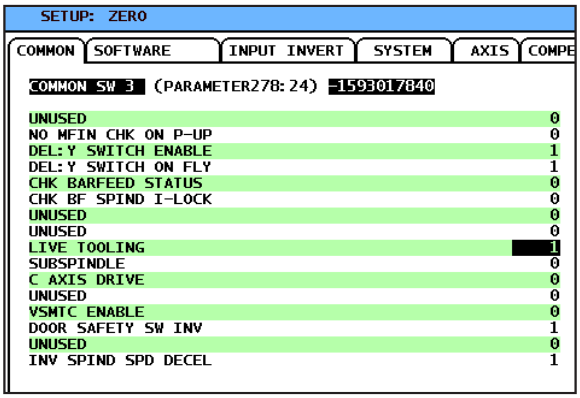
3. Connect the motor cables.

4. Install the cover and tighten the five live tooling option cover screws.





5. Before servicing live tooling, disable Parameter 278 bit 24, “LIVE TOOLING”. Test the live tooling option for proper operation.



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.

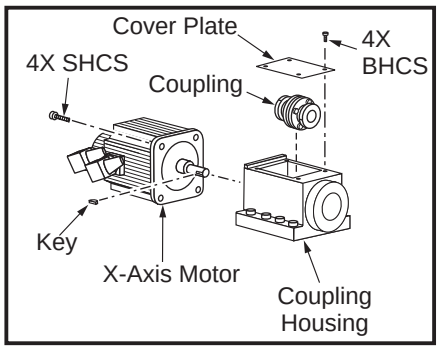
If removing a vertical axis, brace the spindle head. The spindle head will fall if this is not done. Use a cylinder Short Stop, block of wood, or shipping bolts (Horiz.) to secure the head.

WARNING! MILLS WITHOUT A COUNTERBALANCE

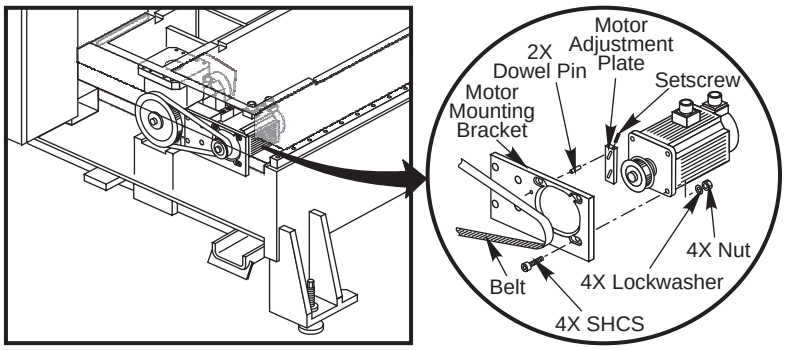
If debug is on and a vertical axis is disabled, the spindle head will fall. This is extremely dangerous and must be avoided.

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

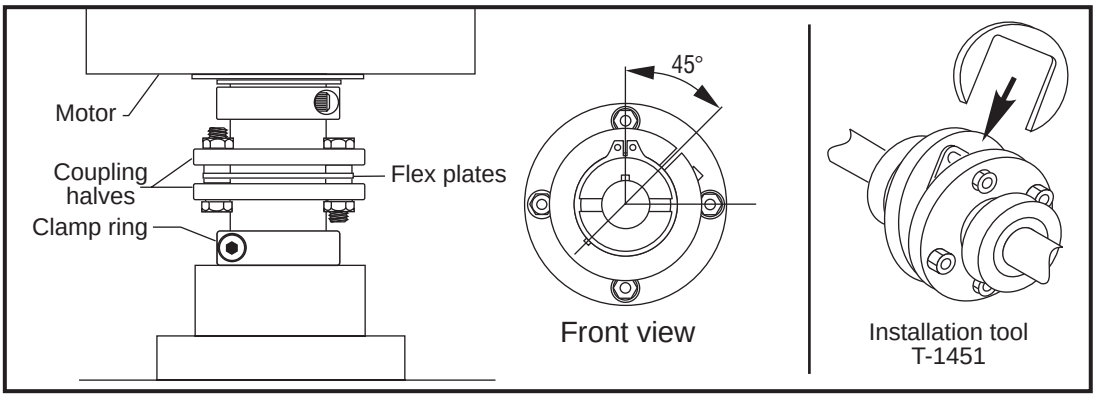
WARNING! MILLS WITHOUT A COUNTERBALANCE

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 45^0 between the bolt hole pattern of the coupler. If improperly aligned, the coupler will not have enough clamping force on the ballscrew or motor shaft.

3. Add one drop of 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)

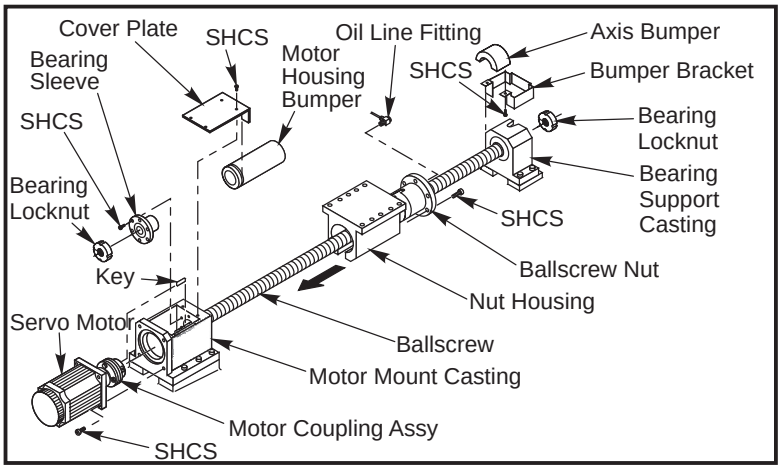
NOTE: For machines equipped with 40 or 50 mm ballscrews, the ballscrew must be removed in order to remove the bearing sleeve. Refer to the “Ballscrew Removal/Installation” section for instructions.

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!

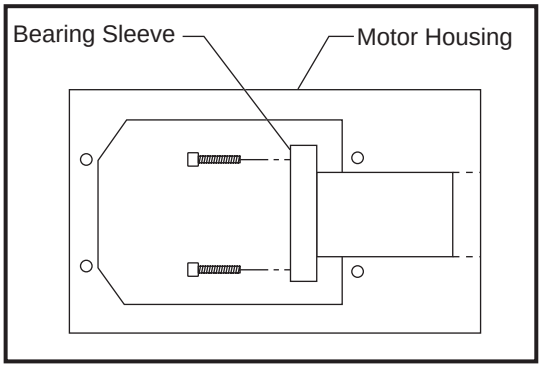
5. Remove the axis motor (“Axis Motor Removal/Installation” section).

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 ¼-20 x 1” SHCS attaching the bearing sleeve to the motor housing and retighten to 15 ft-lb. This step ensures that the ballscrew is installed and runs parallel and flat to the linear guides and saddle.

8. Tighten the ballscrew against the locknuts. An angular contact design bearing requires no pre-load. Tighten the locknut on the motor housing end of the ballscrew to 15 ft-lb. Tighten the SHCS on the locknut. Place a spanner nut over the locknut on the support bearing end of the ballscrew and slowly tighten to 4 in-lb. Remove the spanner nut. Tighten the SHCS on the locknut with 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.

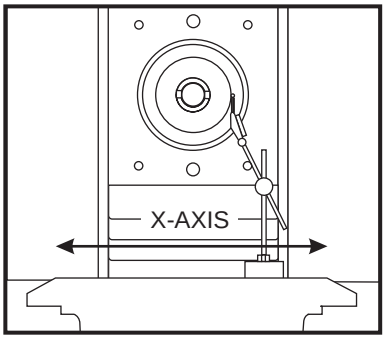
Initial Preparation

1. Turn the machine On and zero return the machine.

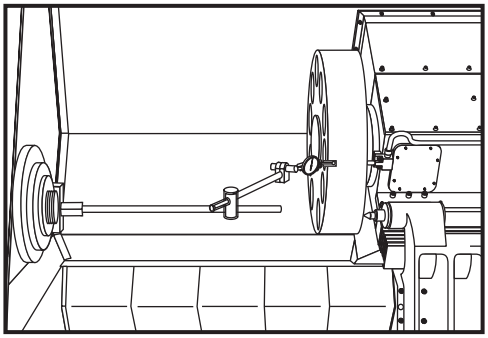
2. Center all the axes. (For Horizontal mills move the Z-axis so the spindle and the table are the closest to the end of travel toward the table.)

Checking X-axis

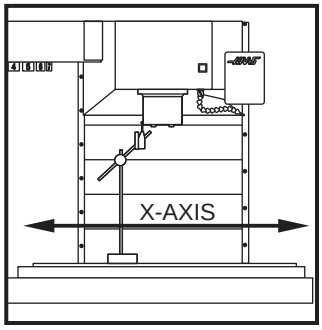
1. Set up a dial indicator and base as shown in the following figures.



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) ± .0001.

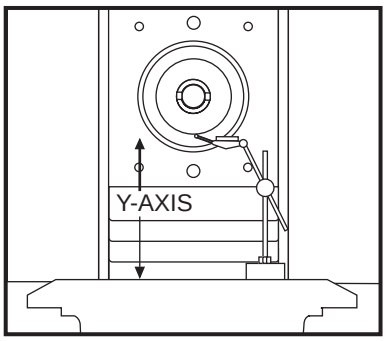
4. Repeat Step 3 in the negative (-) direction. Total deviation between the dial indicator and the control panel display should not exceed .0002.

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

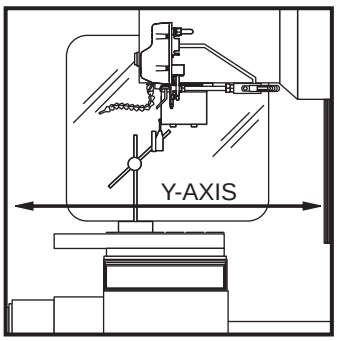
5. If backlash is found, refer to “Backlash - Possible Causes” in this section.

Checking Y-axis

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



Horizontal Y-axis



Vertical Y-axis

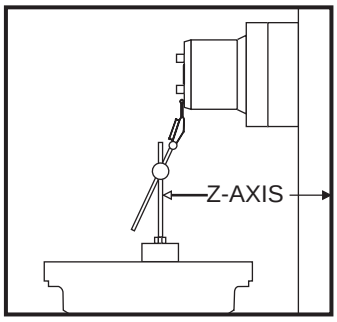
2. Follow the same procedure used for checking the X-axis.

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

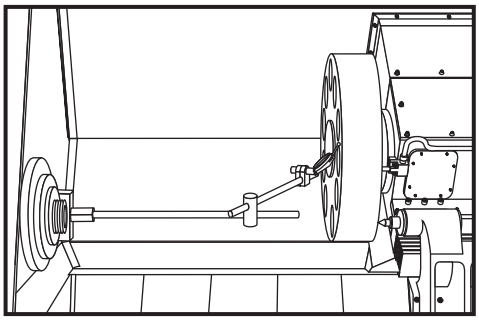
3. If backlash is found, refer to “Backlash - Possible Causes” in this section.

Checking Z-axis

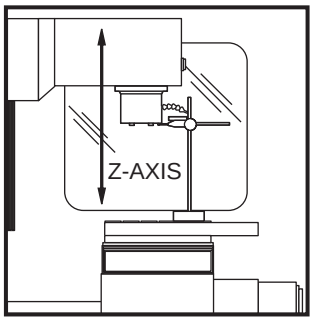
1. Set up a dial indicator and base as shown in the following figures.



Horizontal Z-axis



Lathe Z-axis



Vertical Z-axis

NOTE: For the Lathe, position the tip of the indicator on the face of the turret.

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

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

NOTE: Do not mistake deflection for backlash in the system.

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

Backlash - Possible Causes

If backlash is found in the system, check for the following possible causes:

- Loosen the SHCS attaching the ball nut to the nut housing. Tighten the SHCS as described.
- Loosen the SHCS attaching the nut housing to the axis. Tighten the SHCS as described.
- Loosen the clamp nut on the bearing sleeve. Tighten the SHCS on the clamp nut.
- Loosen the motor coupling. Tighten as described.
- Broken or loose flex plates on the motor coupling.

• Loosen the SHCS attaching the bearing sleeve to the motor housing or top of the column. Tighten as described in “Ballscrew Removal and Installation”.

• Defective thrust bearings in the bearing sleeve. Replace the bearing sleeve as outlined in “Bearing Sleeve Removal/Installation”.

• Loose SHCS attaching the axis motor to the motor housing. If the SHCS are found to be loose, inspect the motor for damage and if none is found, tighten the SHCS. If damage is found, replace the motor.

• Incorrect backlash compensation number in the machine parameter. Check Parameters 13, 27 (mills only), and 41.

• Worn ballscrew.

Ballscrews - Visual Inspection

The three main causes of ballscrew failure are loss of lubrication, contamination, and machine crash. Wear of the nut balls and the screw threads is generally a non-issue under proper operating conditions. Each type of suspect cause will leave telltale signs on the Ballscrew itself.

Loss of Lubrication:

The lubrication system of the machine provides a layer of oil for the ballscrew components to operate on, eliminating metal-to-metal contact. Problems with the lubrication system will accelerate all wear issues.

1. Dry metal-to-metal contact following lube breakdown will create intense heat at the contact points. The nut balls will weld to the nut races due to heat and pressure of the preload. When movement of the ballscrew continues, the welds will be broken, ripping off particles of both the balls and the races. This loss of diameter will reduce the preload, reducing machine accuracy.

2. Another cause of wear of ballscrews is material fatigue. Material fatigue typically occurs at the end of the ballscrew service life and includes black, contaminated coolant, pitting of the screw surface, loss of preload, and metal flakes on the ballscrew. Ballscrews damaged by material fatigue are not repairable.

Contamination:

Contamination of the lubrication and/or coolant systems of the machine will produce problems with the ballscrews. Check the condition of the lube on the ballscrew threads.

1. If the lube is wet and clean, it indicates a properly functioning lube system.

2. If the lube is thick and dark, but free of metal chips, the lube itself is old and must be changed out. The entire system should be cleaned of the old lube.

3. If lube is wet and black, lube system is contaminated by metal particles. Inspect the ballscrews for wear.

Contamination of lube and/or coolant systems can be caused by a wearing ballscrew, or metal chips entering the systems through open or loose way covers. Check all way covers and seals for excessive clearances.

Machine Crash

A hard machine crash can cause a ballscrew to lock up. The static overload created during a machine crash can break apart the ball nut balls, denting the thread surfaces. Turning the nut by hand will result in an obvious grinding feeling and/or sound.

1. Check the screw for straightness.

2. Look for ball dents at the ends of the screw length. These indents indicate a hard machine crash. The table inertia is transferred directly to the balls inside the ball nut, creating impressions on the screw surface.

Ballscrew Cleaning

In most cases, thorough cleaning of a suspect ballscrew will resolve many issues, including noise complaints.

1. Manually jog the ball nut to one end of the screw, and visually inspect the screw threads. Look for metal flakes, dark or thick lube, or contaminated coolant: See the previous “Contamination” section.

2. Use alcohol, or other approved cleaning agents, to wash the screw.

CAUTION! Do not use detergents, degreasers, or solvents to clean Ballscrews or their components. Do not use water-based cleaners, they may cause rust.

3. Jog ball nut to other end of travel. If metal flakes are present on screw threads, you may have wear issues.

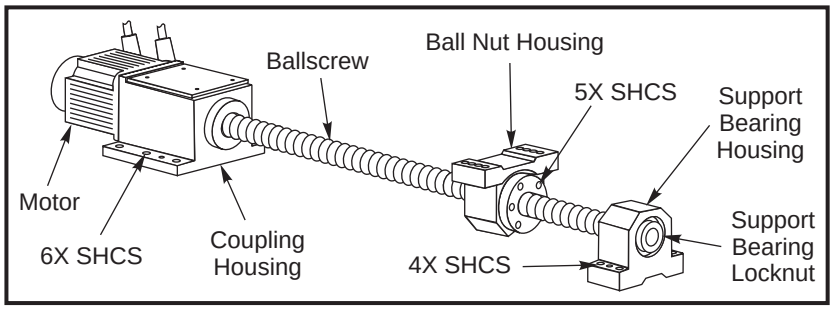
4. Re-lubricate screw threads before returning the machine to service.

Horizontal Axis Ballscrew Replacement

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

Tools Required: Horiz: Torque wrench, Spanner nut. **Lathe:** Spanner Wrench (32mm or 40/50mm), Shaft Lock (32mm or 40/50mm). **Vert:** Spanner wrench (32 mm or 40/50 mm), 2” x 4” wood block (21”-23$^{1}/_{2}$” long), Shaft lock (32 mm or 40/50 mm), Torque tester, Z-axis if it has a counterbalance system: Cylinder shaft stop (P/N 99-7562 - VF-1 through 4, P/N 93-9962 - VF-6 through 10)

NOTE: Certain following steps apply only to 40 and 50 mm ballscrews.



Removal

1. Turn the machine on. Zero return all axes and put the machine in Handle Jog mode.

2. Remove the sheet metal necessary to access the ballscrew and its components.

3. Jog the vertical axis to the bottom of its travel, and the horizontal axis to the center of travel.

4. Power off the machine.

5. If applicable, remove the hard stop from the bearing housing on the ballscrew.

6. Disconnect the oil line from the ball nut.

7. Loosen the 10-32 x ½” SHCS and remove the locknut on the ballscrew support bearing end.

8. Remove the axis motor in accordance with “Axis Motor Removal/Installation”.

9. Loosen the SHCS and remove the bearing sleeve from the motor mount in accordance with “Bearing Sleeve Removal/Installation”. Push on the opposite end of the ballscrew to loosen.

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

10. **Vert:** Loosen the 10-32 x ½" SHCS and remove the clamp nut on the ballscrew in the motor housing.

11. Loosen and remove the five SHCS attaching the ball nut to the nut housing.

12. a. **Vert:** Push the mill table towards the motor end until the ballscrew clears the bearing support. Remove the ballscrew by pulling from the bearing support end.

b. **Horiz:** Pull the ballscrew toward the control box side and out of the bearing in the bearing support. Lift the ballscrew up, forward, and to the side of the machine until the motor end of the ballscrew is free. Carefully remove the ballscrew.

c. **For 40 and 50 mm ballscrews:** Loosen the SHCS mounting the bearing support to the saddle and remove. Remove the pull pins from the bearing support. Loosen the five SHCS in the ball nut and remove the ballscrew by pulling from the bearing support end.

d. **For MDC-500 ballscrews:**

• **X-axis:** Jog the column to the middle of travel and turn the machine Off. Remove the eight (8) bolts securing the nut housing to the casting. The entire casting is now free to move by hand.

• **Y-axis:** This procedure is most efficiently completed if the column is jogged back until the nut housing is directly above the hole in the casting. Jog the column back until the bearing support housing is over the hole in the saddle and Power Off the machine. From the right hand side of the machine, remove the nut housing (8 bolts) that attach the ballscrew to the saddle. The casting is now free to move by hand.

• **Y-axis with no hole in casting:** Jog the column all the way forward and remove the bearing support housing (4 bolts, 2 alignment pins). Remove the nut housing by using an allen wrench to remove the 8 bolts. Note that at this point, the casting is free to move by hand. Take extreme caution when moving by hand as there are no safety stops to prohibit the column from sliding off of the linear guides. Finally, remove the motor support housing and remove the ballscrew through the back of the machine.

• **X & Y Axes Removal:** Now remove the six (6) bolts and two (2) alignment pins on the motor support housing and the four (4) bolts and two (2) alignment pins on the bearing support housing. Remove the oil line fitting (**X-Axis**) from the side of the ballscrew nut. Angle the ballscrew and pull it out the back of the machine (**X-Axis**) or slide the ballscrew out between the bottom of the column and the base casting to the back of the machine (**Y-Axis**).

If MDC-500 has to be turned On with ballscrew disconnected, the corresponding Parameter bit has to be changed to disable that axis. In Parameter 1, change bit from 0 to 1 to disable X-axis only. In Parameter 15, change bit from 0 to 1 to disable Y-axis only. When ballscrew is in place, change bit back to enable axis.

Installation

NOTE: For vertical machines, this procedure assumes that the nut and motor housing have not been removed.

1. Center the mill table on the saddle.

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

CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.

3. **Vert:** Insert the ballscrew through the nut housing and motor housing, taking care not to make contact with the screw threads, which will cause possible damage.

If 40 or 50 mm ballscrew:

• Mount the bearing support to the saddle with six SHCS, but do not tighten completely. Replace the pull pins in the bearing support.

• Install the spacer ring on the motor end of the ballscrew.

• Insert the 5/16-18 x 3/4" (or M10 x 25 mm) SHCS, attaching the ball nut to the nut housing, but do not tighten completely. (Place a drop of 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. Re tighten 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:** Loosen the ball nut housing bolts and jog the machine through the full travel to align the ball nut housing

    Tighten the bolts to the ball nut housing
    Break loose and retorque the bolts from the ballscrew to the ball nut.
    Check ballscrew torque at bearing support end with torque tester. Jog the table all the way to the right. Check the ballscrew torque again. It should be the same as the previous reading.

14. Jog the axis to check for free movement.

15. Check for backlash or noisy operation in the ballscrew (“Accuracy/Backlash” section).

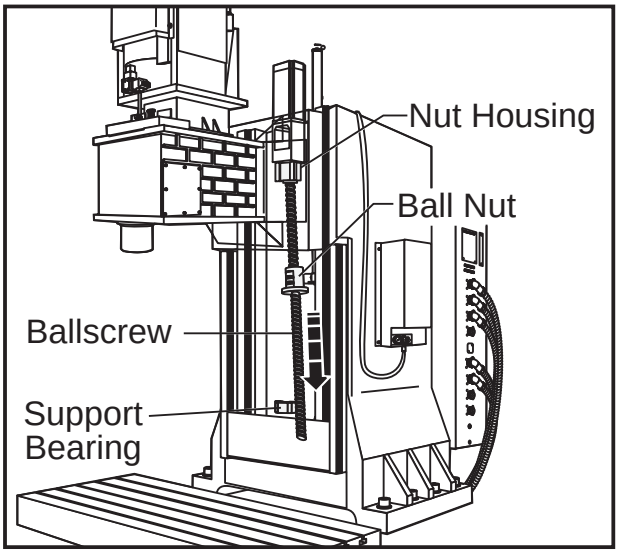
16. Replace appropriate sheet metal.

17. Zero return the axis and set grid offset.

Vertical Axis Ballscrew Replacement

Removal

Machines are currently equipped with either a hydraulic counterbalance system or an electric brake motor. Care must be taken, in either case, to avoid damaging the machine or severely injuring yourself. Heed all warnings and cautions, and read all the steps of the procedure before starting any disassembly.



VF-Series Ballscrew Replacement

WARNING!

If the machine is equipped with a hydraulic counterbalance, a shaft stop block must be used to secure the spindle head. Do not move the spindle during ballscrew service.

WARNING! MILLS WITHOUT A COUNTERBALANCE

If debug is on and the Z-axis is disabled the spindle head will fall. This is extremely dangerous and must be avoided.

1. Turn the machine on. Zero Return all axes and put the machine in Handle Jog mode.

2. Remove the sheet metal necessary to access the ballscrew and its components.

3. a. **Machines with counterbalances:** Lower the spindle head to its lowest position. Install cylinder shaft stop. Handle jog axis up until the shaft stop blocks the axis.

   b. **Machines with Brake motors:** Brace the spindle head up with a 4” x 4” x 14” block of wood.

4. Power off the machine.

5. If applicable, remove the hard stop from the bearing housing on the ballscrew.

6. Disconnect the oil line at the ball nut.

7. Loosen the 10-32 x ½” SHCS and remove the locknut on the ballscrew support bearing end.

8. Remove the axis motor in accordance with “Axis Motor Removal/Installation”.

9. Loosen the 10-32 x ½” SHCS and remove the locknut on the ballscrew in the motor housing.

10. **For 32 mm ballscrews:**

• Loosen the six ¼-20 x 1” SHCS and remove the bearing sleeve from the motor housing. Push on the opposite end of the ballscrew to loosen.

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

• Hand-turn the ballscrew to move the screw up until the bottom end clears the support bearing by approximately six inches (6”).

• Remove the SHCS from the ball nut remove. Lower the ballscrew down and to the right of the support bearing to remove. For the VF-6 and Horizontal machines, remove the ballscrew from top of column, being careful to not damage the threads on the ballscrew.

For 40 and 50 mm ballscrews:

• Loosen the SHCS that mount the bearing support to the column, and remove. Remove the pull pins from the bearing support.

• Loosen five SHCS in the ball nut and remove the ballscrew by pulling from the bearing support end.

For MDC-500 and ES-5 ballscrew:

• Remove the column enclosure components covering the ballscrew, bottom way cover, spindle head cover and the column frame cross brace.

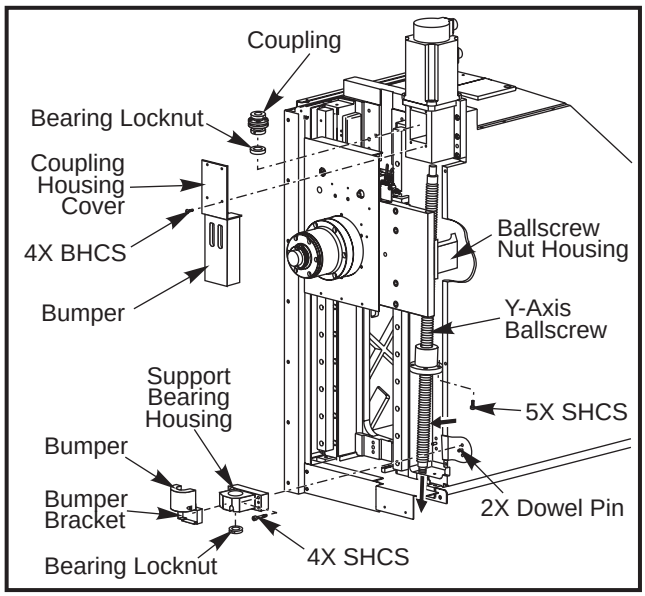
• Turn the machine On, Zero Return all axes and select Handle Jog mode. Block the spindle (using a 4” x 4” x 14” piece of wood) on the bottom of the column or the spindle face itself (lower is better) by lowering the spindle head on the wood, and turn the machine Off.

• Loosen all screws on the bearing support housing, nut housing, and motor support housing. First remove the four (4) bolts and two (2) alignment pins on the bearing support housing (the 10/32 pins are threaded, insert a screw into the opening and pull out). Then remove the eight (8) bolts securing the nut housing to the casting (these are accessed from the back of the machine through the column). Note that at this point the spindle column will be **resting entirely on the block**; make sure that the spindle is securely supported. Finally, remove the six (6) bolts and two (2) alignment pins that secure the motor support housing to the casting and remove the ballscrew assembly from the machine.

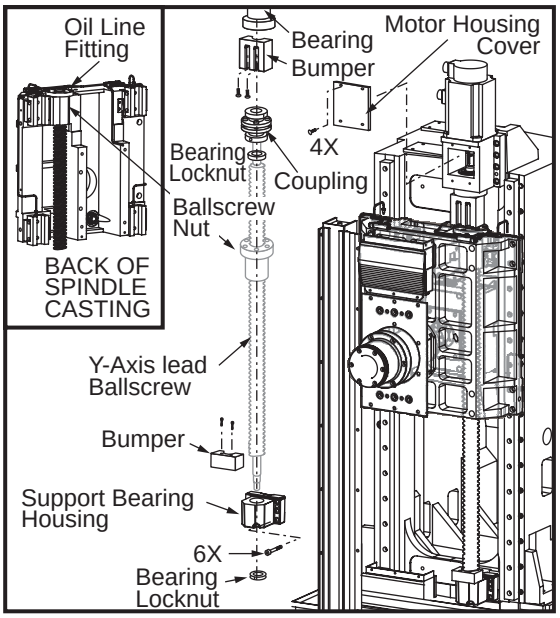
NOTE: Only when the machine is powered Off, can the motor cables be removed so that the entire ballscrew assembly can be disconnected from the machine.

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

Installation



EC-300 Ballscrew Assembly



EC-400 Ballscrew Assembly

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

CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.

2. Slide the ballscrew up into the nut housing and gently lower it until it is resting in the support bearing.

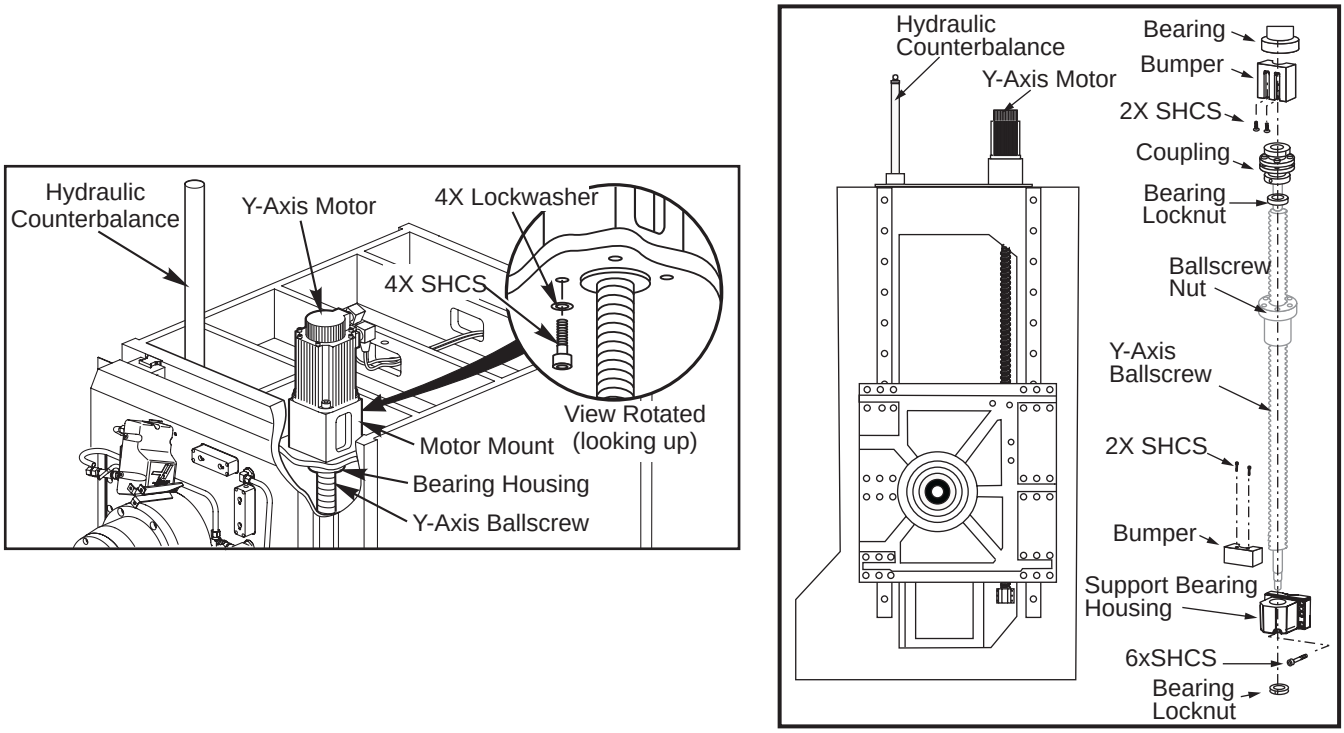
NOTE: Correct alignment is critical to sliding the ballscrew into the bearing. Binding will not occur if it is guided carefully and correctly into the bearing.

3. Insert the ballscrew into the bearing support. Screw the clamp nut on a few turns.

4. Insert the ballscrew, with the bearing support attached, into place. Ensure the ballscrew goes through the ball nut housing and the bearing sleeve.

5. Mount bearing support with SHCS, but do not tighten completely. Replace dowel pins in bearing support.

6. Install the spacer ring on the motor end of the ballscrew.



EC-1600 Ball Screw and Motor Components

7. Place the bearing sleeve in the motor housing. (It may be necessary to align the bearings in the sleeve to facilitate mounting on the ballscrew.)

8. Insert the six ¼-20 x 1" SHCS attaching the bearing sleeve to the motor housing (Place a drop of 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 ¼-20 x 1" (or ¼-20 x ¾") 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. Loosen the ball nut housing bolts and jog the machine through the full travel to align the ball nut housing

20. Tighten the bolts to the ball nut housing

21. Break loose and retorque the bolts from the ballscrew to the ball nut.

22. 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.

23. Check for backlash or noisy operation in the ballscrew (“Accuracy/Backlash” section).

24. Zero Return axis and set grid offset and Parameter 64.

25. Replace appropriate sheet metal.

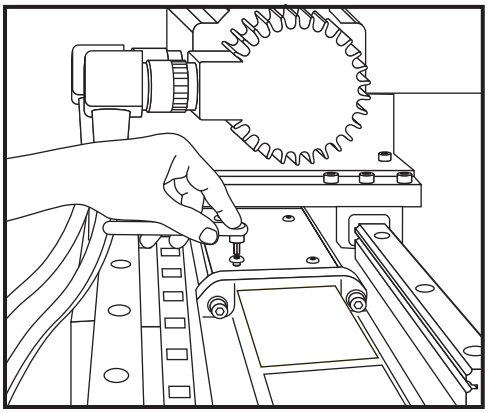
Lathe Ballscrew Replacement - X-Axis

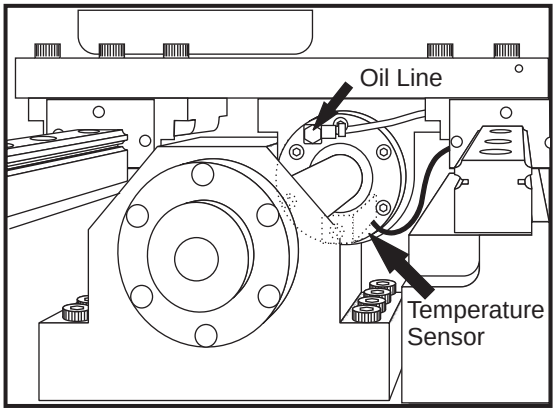
Removal

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.

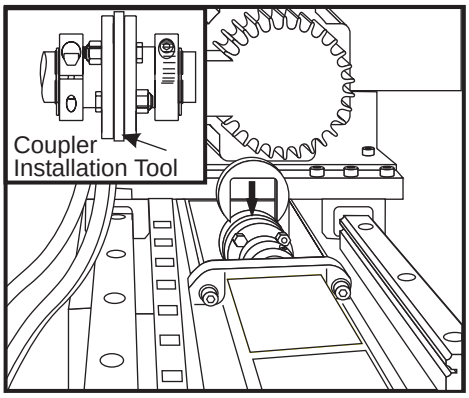


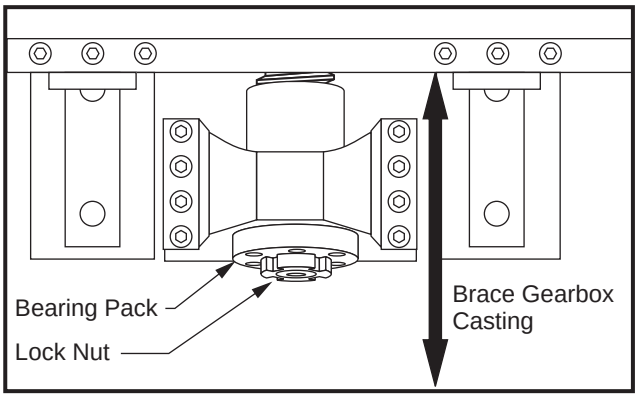


4. Remove the motor housing cover.

5. Loosen the clamp collar that ties the X-axis motor coupler to the ballscrew.

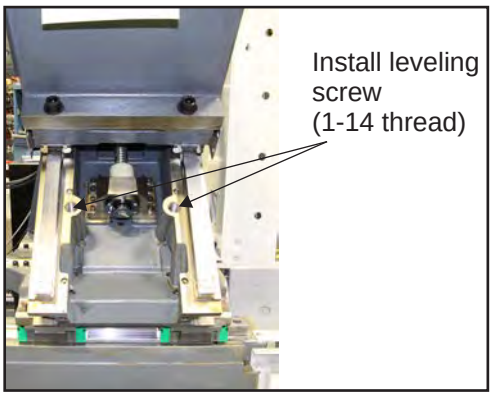
6. Jog the X-axis to the home position. Remove the temperature sensor and oil line. Remove all but one of the SHCS that secure the ball nut to the nut mount. Loosen the remaining SHCS to hand tight.





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 wedge 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. ST lathes: use a spare leveling screw to block the wedge.



Blocking for ST lathes

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):

a. Remove the last SHCS from the ball nut.

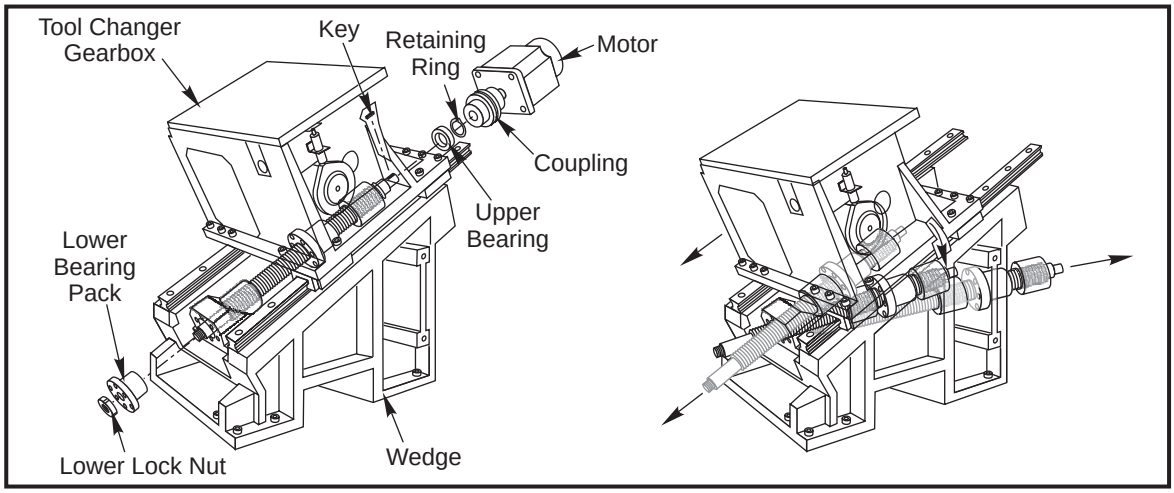
b. Slide the ballscrew down through the bearing support casting.

c. Thread the ball nut up the ballscrew toward the motor end, as you feed the ballscrew down through the bearing support casting.

d. Thread the nut up the ballscrew until the ballscrew can be swung down through the opening in the wedge casting.

e. Remove the ballscrew through the back side of the wedge casting.

f. Take extreme care not to damage the ballscrew while pulling it through the castings.



13. Ballscrew removal for (SL-20, SL-30, and SL-40):

a. Loosen the counterbalance spring nut at the motor end of the ballscrew. Using a crescent wrench, hold swing arm and loosen upper hex bolt to slowly release the spring tension.

b. Remove the last SHCS from the ball nut.

c. Guide the ballscrew out of the front of the machine

Installation

1. Reinstall the bumpers onto the ballscrew.

2. Replace the ballscrew into the wedge casting in the reverse order by which it was removed:

a. Thread the ball nut up the ballscrew toward the motor end until there is clearance to install the ballscrew through the wedge casting.

b. Slide the bearing support end of the ballscrew through the bearing support casting.

c. Swing the ballscrew up through the hole in the wedge casting.

d. Thread the ball nut down the ballscrew, toward the bearing support end, until the ballscrew can be reinserted into the motor end bearing.

3. Ensure that the upper bearing is properly seated and then install the retaining ring.

4. Reinstall the bearing support cartridge into the bearing support casting and over the ballscrew. Secure with the SHCS and torque in a crisscross pattern to 15 ft-lb.

5. **SL-20, 30, 40:** Retighten the counterbalance spring (see Turret Cross-slide Spring Replacement section).

6. Reinstall the lock nut onto the bearing support end of the ballscrew. Torque the lock nut to 50 ft-lb and then torque the SHCS in the lock nut to 15 in-lb.

7. Thread the ball nut up the ballscrew until the nut is back in alignment with the nut housing. Torque the SHCS to 15 ft-lb.

8. Reinstall the oil line and the temperature sensor.

9. Loosen the ball nut housing bolts and jog the machine through the full travel to align the ball nut housing

10. Tighten the bolts to the ball nut housing

11. Break loose and retorque the bolts from the ballscrew to the ball nut.

12. heck for binding in the beginning, middle and end of travel. Check for backlash or noisy operation.

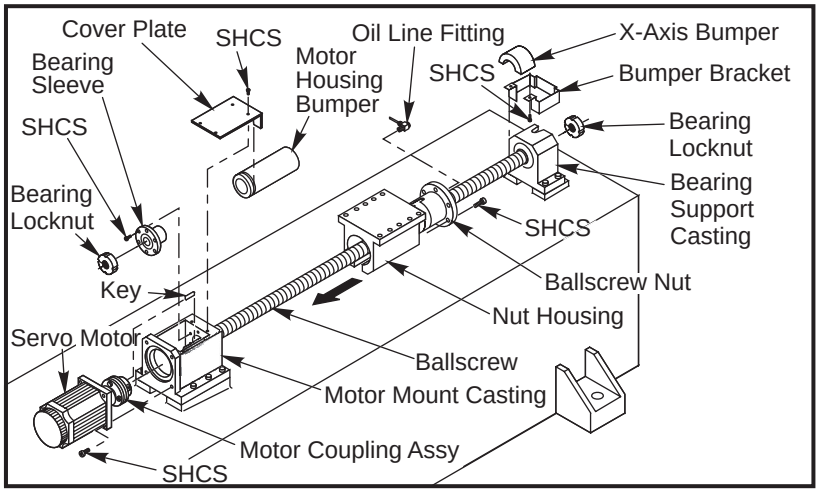
Lathe Ballscrew Replacement - Z-Axis

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 ¼-20 x 1” SHCS from the bearing sleeve and remove bearing sleeve from the motor housing. On bearing support side, remove bearing support locknut. Push wedge all the way toward motor end. Underneath wedge, remove SHCS that attach ballscrew nut to nut housing. Pull ballscrew forward to clear nut from housing and angle ballscrew toward right of the bearing support. Carefully remove ballscrew.

40mm: Underneath the wedge, remove the SHCS from the ballscrew nut and push the wedge toward the motor housing. On the bearing support side, remove the shaft lock tool and locknut. Remove the alignment pins and the SHCS from the bearing support casting. Make note of any shims. Hold the ballscrew in place and remove the bearing support. Pull forward on the ballscrew and carefully remove.

CAUTION! Be careful during ballscrew removal/installation, to protect surfaces.

Installation

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

CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.

1. a. **32mm:** Reinsert the ballscrew, with the motor housing bumper on it, from the right hand side of the bearing support into the motor housing. Align the ballscrew with the bearing support end and insert the ballscrew. Prevent contact with the screw threads, to avoid any possible damage.

   b. **40mm:** Reinsert the ballscrew with bumpers into the bearing sleeve in the motor housing. (Make sure the ballscrew nut will be able to slide in to the wedge nut housing.) Support the ballscrew on the bearing sup port end and re-attach the bearing support housing and bearing.

2. a. **32mm:** Hold ballscrew level on the motor side. Slide the bearing sleeve onto the ballscrew and insert bearing sleeve into motor housing. Attach bearing sleeve to the housing with six ¼-20 x 1” SHCS. Place a drop of 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. Loosen the ball nut housing bolts and jog the machine through the full travel to align the ball nut housing

6. Tighten the bolts to the ball nut housing

7. Break loose and retorque the bolts from the ballscrew to the ball nut.

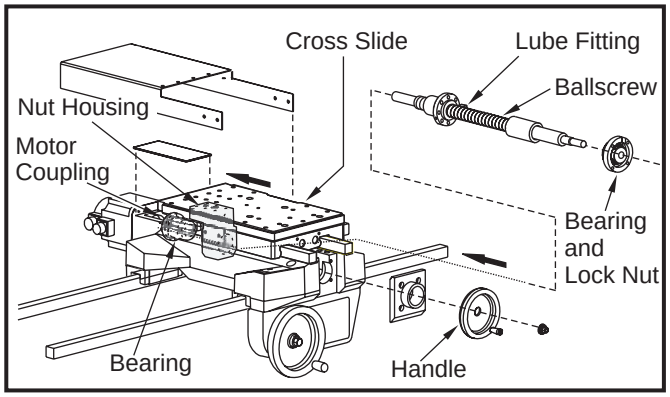
8. Check for binding in the beginning, middle, and end of travel. You should be able to rotate the ballscrew by hand when the servos are off. Check for backlash or noisy operation.

9. Replace the ballscrew hardstops and reconnect oil line to the ballscrew nut.

10. Zero Return the axis and set grid offset.

Toolroom Lathe Ballscrew Replacement

Removal



1. Remove the hand wheel.

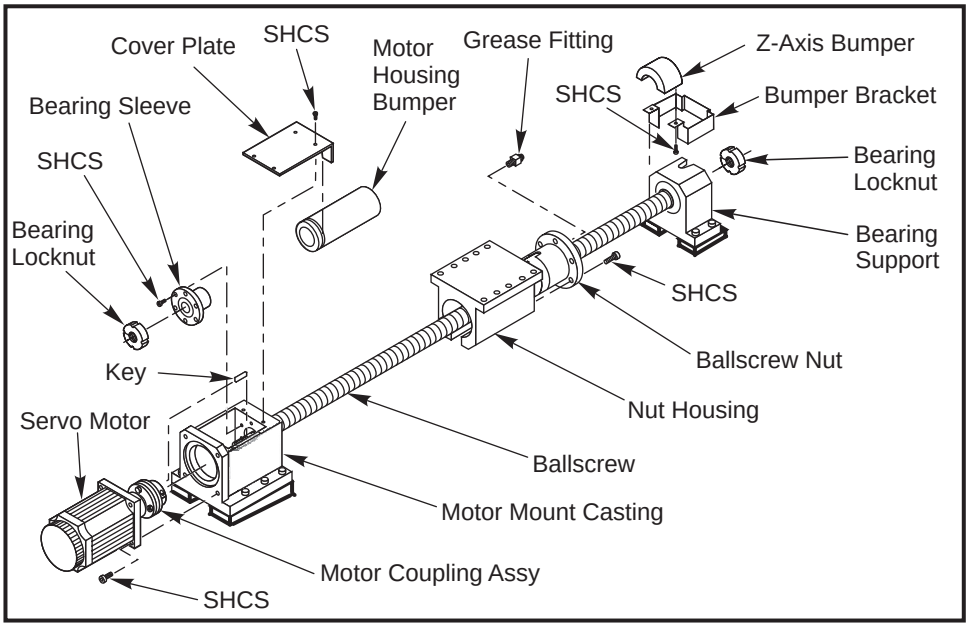
2. Remove all necessary sheet metal to gain access to the ballscrew, servo motor, and coupler. Remove the motor housing cover and loosen the coupling. Remove the lubrication line from the X-axis ball nut.

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. Loosen the ball nut housing bolts and jog the machine through the full travel to align the ball nut housing

13. Tighten the bolts to the ball nut housing

14. Break loose and retorque the bolts from the ballscrew to the ball nut.

15. Check for binding in the beginning, middle and end of travel. Check for backlash or noisy operation.

16. Reinstall the X-axis saddle covers.

Mini Mill Ballscrew Replacement

Replacement of the mini-mill ballscrews follows the same procedures as for the other mills. The ballscrews are only supported at the motor end, thereby simplifing the alignment procedure.

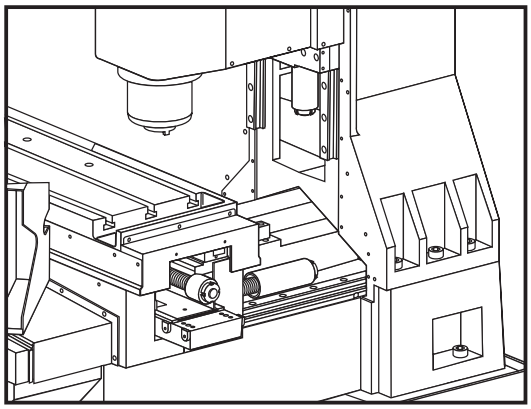
1. Use a standard ballscrew support bearing assembly to prevent the ballscrew for sagging, and to allow the use of the shaft lock for tightening the clamp nut at the motor end. Use only one screw to fasten the support bearing assembly (no dowel pins are necessary) to prevent it from rotating while the shaft lock is in place, and tighten the clamp nut at the motor end.

2. Remove the fastener from the support bearing assembly to allow it to float on its support surface. Position the ballscrew nut toward the motor end to allow it to self-align to the motor housing bearing assembly.

3. Tightening the five screws to the nut housing.

4. Install the ballscrew bumpers.

5. Install the shaft lock on the clamp nut at the motor end, allow it to wedge itself in the coupler cavity and torque the clamp nut to 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.

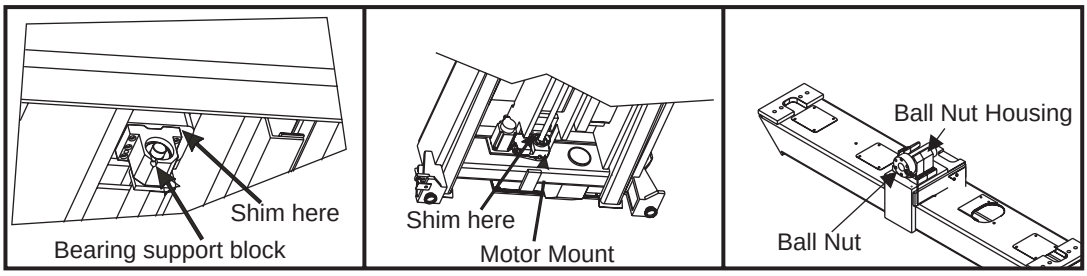
2. Remove any binding in the nut by slightly loosening the ball nut and ball nut housing and retightening them.

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. Handle jog the axis back and forth, through the full travel. 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.

ST-Series Hydraulic Tailstock Troubleshooting

The hydraulic tailstock does not utilize a home switch. It uses an encoder read head and encoder strip for positioning. When the tailstock is commanded to go to its home position, it will travel in the positive direction (away from spindle) until the tailstock hydraulic cylinder has been fully extended and without motion for the allotted time as specified by parameter 291 HYD TS NO MOT. TIME.

NOTE: If the tailstock is obstructed while homing and the allotted time is reached (parameter 291) the control will assume that the tailstock has reached its home position. If this occurs, the tailstock may crash into the part in the chuck because setting 106-TS ADVANCE DISTANCE and 107- TS HOLD POINT will be miscalculated.

Tailstock settings

105-TS RETRACT DISTANCE: The distance from the HOLD POINT (setting 107) the tailstock will retract when commanded. This setting should be a positive value. 3.0 is a good starting value.

106-TS ADVANCE DISTANCE: When the tailstock is moving toward the HOLD POINT (setting 107), this is the point where it will stop its rapid movement and begin a feed. This setting should be a positive value. 2.0 is a good starting value.

107-TS HOLD POINT: This setting is in absolute machine coordinates and should be a negative value. It is the point to advance to for holding when M21 is invoked or tailstock foot pedal is pressed. Usually this is inside of a part being held. It is determined by jogging to the part and adding some amount to the absolute position (face of part) .5" is suggested. Commanding M22 or pressing the tailstock foot pedal will retract the tailstock the distance specified in setting 105 (TS RETRACT DISTANCE)

Tailstock Programming

M21 will cause the tailstock quill to extend towards the spindle. **M22** will cause the tailstock quill to retract away from the spindle. When an M21 is commanded, the tailstock center will be commanded to move towards the spindle and maintain continuous pressure. Note that the program will not wait while this is completed, instead, the next block will be executed immediately. A dwell should be commanded to allow the tailstock center movement to complete, or the program should be run in Single Block mode. When an M22 is commanded, the tailstock center will move away from the spindle, and then stop.

CAUTION: Do not use an M21 in the program if the tailstock is positioned manually. If this is done, the tailstock will back away from the part and then reposition against the part, which may cause the work piece to drop.

Tailstock backing off of part in chuck. When dealing with a tailstock that is backing off of the part in the chuck, do not replace tailstock solenoid valves, hydraulic cylinder or hydraulic power unit before asking the following questions.

Material type and part length? It is assumed that steel is being machined. However, what if plastic or some exotic material is being used? This could play a role in how the part is clamped. It is important to know the length of the part in the chuck. If bar stock used is long, the part can "whip" causing the part to move. Therefore, the tailstock is not moving.

What is the chuck clamp pressure set to? Is the chuck clamping on the part adequately, according to the material type?

Is there a hard stop on the chuck jaws? If the chuck jaws have machined hard stops, and the part is resting against them, the part is not moving.

What is the max spindle RPM on this application? This is critical if long bar stock is being used. See Material Type and Part Length.

How far is the tailstock backing off (measured value)? Ask for specific values to get an idea how much movement is observed.

Can the tailstock be pushed manually? If the tailstock can be pushed manually, it is likely that the tailstock directional solenoid valve is not activated or faulty. This can be verified by looking at the DIAGNOSTIC screen. T.S. Forward, under DISCRETE OUPUTS must be 1 during tailstock use. If it is 0, the tailstock directional solenoid valve is not energized and the tailstock will drift.

A common mistake made by machinist is that they use the jog handle to bring the tailstock to the face of the part in the chuck and assume that the tailstock is locked in place. This is incorrect. a M21 command must be executed in order to engage the tailstock forward solenoid valve. The best practice for setting the TS HOLD POINT (setting 107) is using the tailstock (TS) forward button on the operator's keypad.

One-Piece Tailstock Alignment Verification

Tools Required: Spindle Alignment Test Bar (P/N T-1312), Tailstock Taper Bar (P/N T-1416), .0001" Indicator and Magnetic Base

1. Mount the spindle alignment test bar to the spindle.

NOTE: Make sure all contact surfaces, including the test bar, are clean.

2. Mount a .0001 indicator to the end of the alignment bar, and insert the tailstock taper alignment test bar.

3. Place the indicator tip at the base of the tailstock test bar (closest to the tailstock). Check the total runout at base of the test bar by rotating the indicator 360^0. Max. tolerance is .001" from centerline.

4. Jog the tailstock back and measure the runout at the end of the tailstock test bar.

NOTE: If measurements are out of tolerance from top to bottom (0^0 and 180^0), proceed to the Tailstock Leveling Procedure. If this measurement is out of tolerance from side to side (90^0 and 270^0), the insert needs to be replaced and realigned as described in the Tailstock Insert Removal and Installation section.

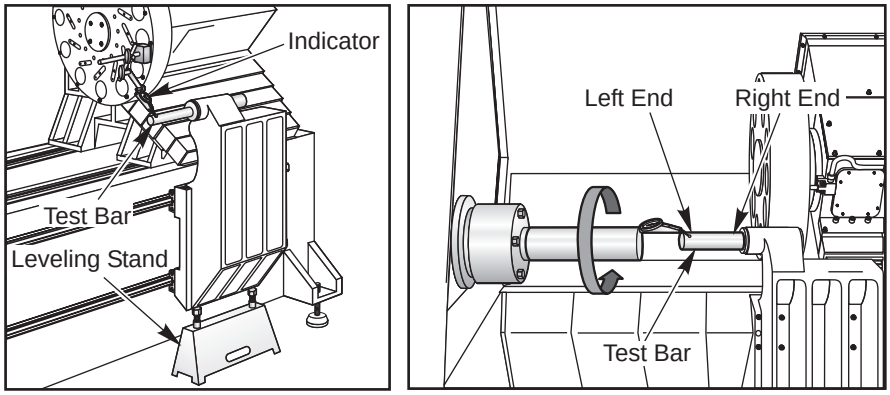
Tailstock Leveling Procedure

This procedure should only be performed after the tailstock alignment has been checked.
Tools Required: Tenths Indicator, Tailstock Alignment Tool (Test Bar P/N T-1416), Tailstock Leveling Assembly (Leveling Stand P/N 93-6001), Spindle Alignment Test Bar (P/N T-1312)

1. Loosen the mounting bolts that attach the tailstock to the linear guide trucks, allowing the tailstock to rest on bolts. Place the leveling stand under the bottom edge of the tailstock and manually raise the jack bolts. (Refer to figure).

2. Attach a tenths indicator to the face of the turret. Level the tailstock by jogging the indicator along the test bar in the Z-axis and level to within .001" by adjusting the jack bolts.

3. Sweep the diameter of the test bar and note the vertical runout.



Tailstock Leveling Indicator Setup

4. Raise the tailstock and bring up to center by equally turning the jack bolts (do not turn one jack bolt more than 1/4 turn without turning the other). Adjust to within .0003" and lightly snug bolts during procedure.

NOTE: Check tailstock parallelism each time the tailstock is raised.

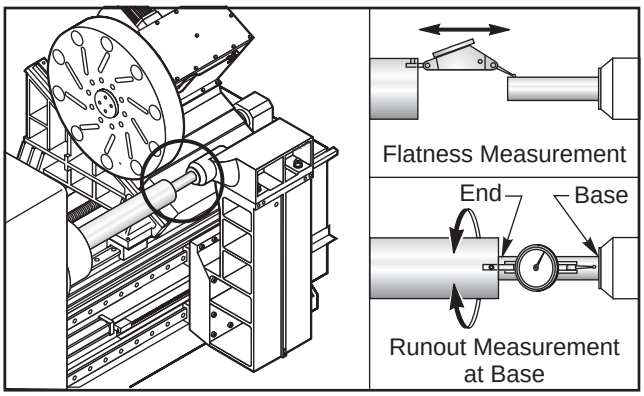
5. Check for tailstock level change. Adjust by setting the indicator to zero at the right end of the test bar and jog the indicator over to left end of bar. Snug bolts in upper left corner and loosen the others. Adjust the right-hand jack bolt only and bring the indicator to within .001”.

6. Once the tailstock is leveled, the mounting bolts should be torqued to 50 ft-lb in a clockwise fashion (first, the inner mounting bolts, then the outside). If the horizontal runout is unacceptable, the tapered insert may have to be reset as described in the following section

NOTE: These steps may have to be repeated to achieve proper alignment.

SL Series 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.

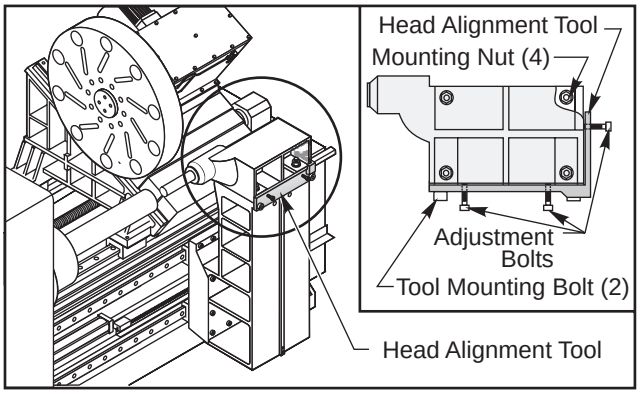
3. Check the top surface of the tailstock base for parallelism to the Z-axis. Check for dents and lightly stone the top mating surface of the tailstock. Indicate from the turret to the top of the tailstock base. Readings must be no more than +/- .0004” for 10 inches of travel.

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.

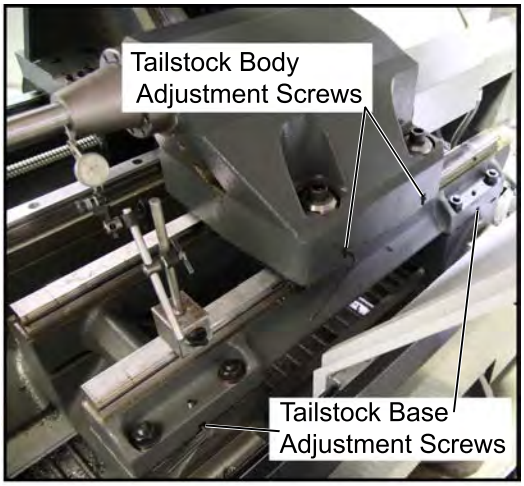
ST-20/30 Two-Piece Tailstock Alignment

These instructions refer to the tailstock “base” as the casting that sits on the linear guides and the tailstock “head” is the casting that sits on the base.

Tailstock Base to Spindle Centerline Parallelism

1. Insert the tailstock alignment tool (T-1416) in the tailstock bore. The spindle alignment tool (T-1312) should be installed and aligned as well.

2. Mount an indicator to the end of the spindle alignment tool and indicate runout at the end of the tailstock alignment tool. Left-to-right runout should not exceed 0.0002".



Tailstock Alignment Set Screws
(both sides of castings)

3. Loosen the tailstock base mounting screws, leaving one tight as a pivot.

4. Use the set screws in the tailstock base to correct alignment. When complete, torque the mounting screws to 250 ft-lb and check alignment again.

Tailstock Head to Base Alignment

1. With the tailstock alignment tool still in place, indicate the length of the tool along one side to measure misalignment. It should not exceed 0.001".

2. To adjust, loosen three of the tailstock head mounting screws, leaving one tight as a pivot.

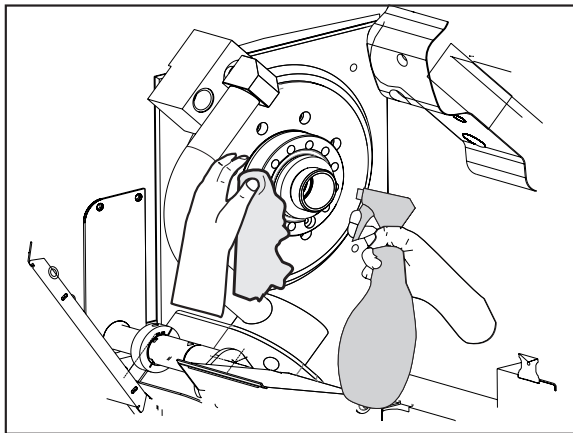
3. Use the set screws in the tailstock head to adjust alignment. When complete, torque the mounting screws to 200 ft-lb.

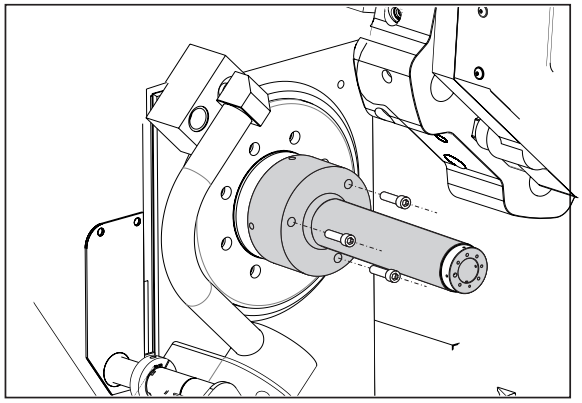
ST-10 /10Y Tailstock Alignment

Preparing for Alignment

1. Clean the face of the spindle with alcohol.

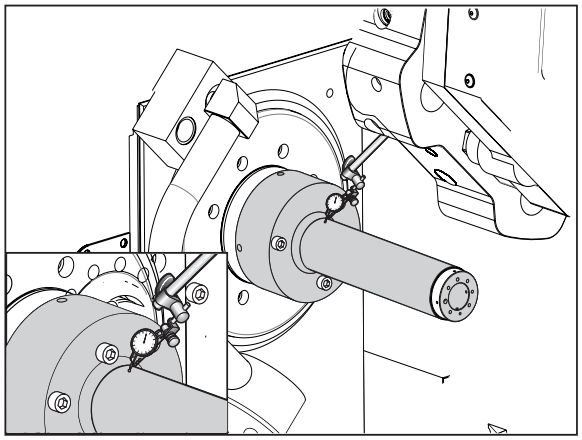
2. Mount the alignment tool onto the spindle.

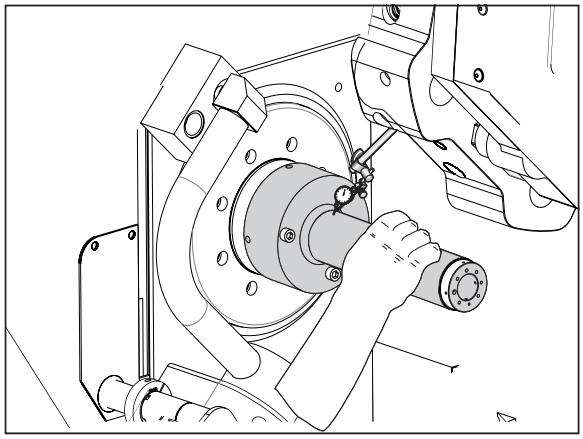




3. Jog the turret left. Mount a dial indicator on the turret to indicate the base of the alignment tool.

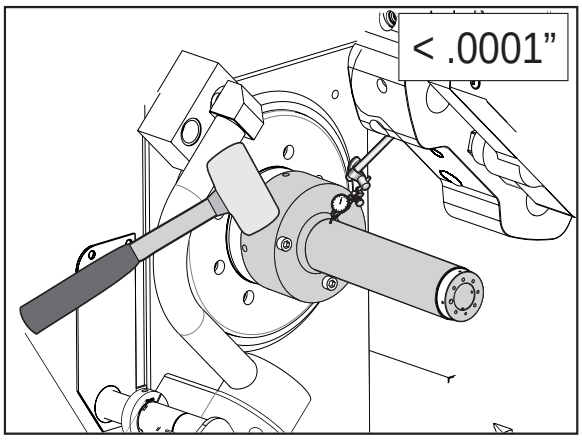
4. Rotate alignment tool by hand. Total Indicated Runout (TIR) <.0001”.

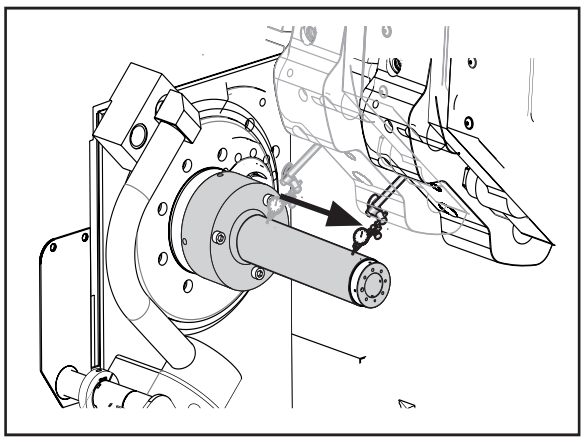




5. Gently tap the base of the alignment tool to adjust, until indicated <.0001” tolerance.

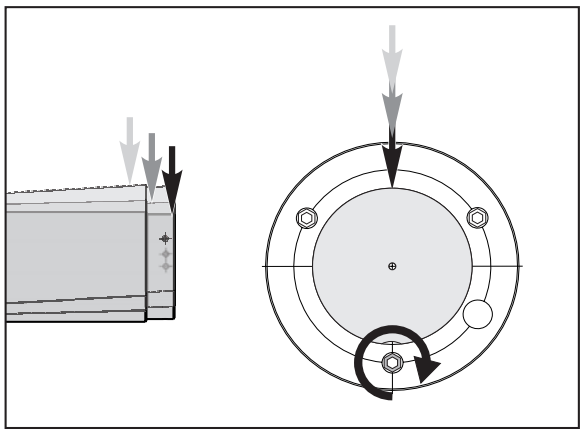
6. Jog indicator right to the end of the alignment tool to check runout.

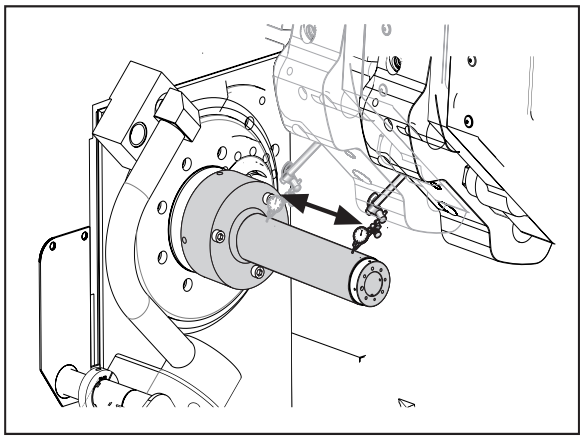




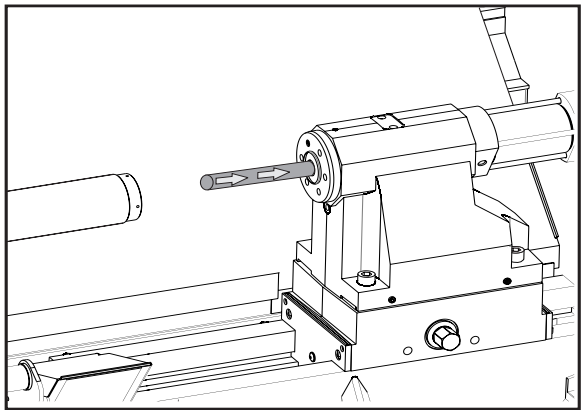
7. Adjust the bolt torque opposite the high spot until indicated runout is <.0001”.

8. Rotate alignment tool by hand and jog indicator to confirm TIR is <.0001”.





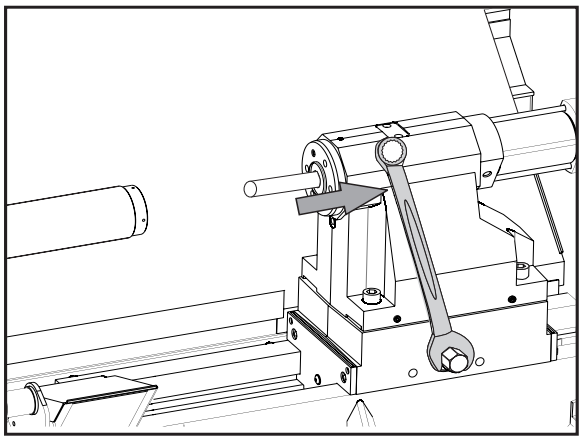
Clean the inside of the tailstock quill and the test bar with alcohol. Insert the test bar into the tailstock.

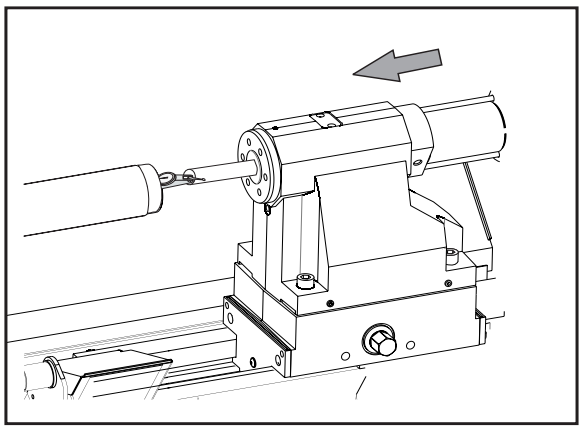


Checking and Adjusting Tailstock Parallelism

1. Loosen the tailstock lock bolt.

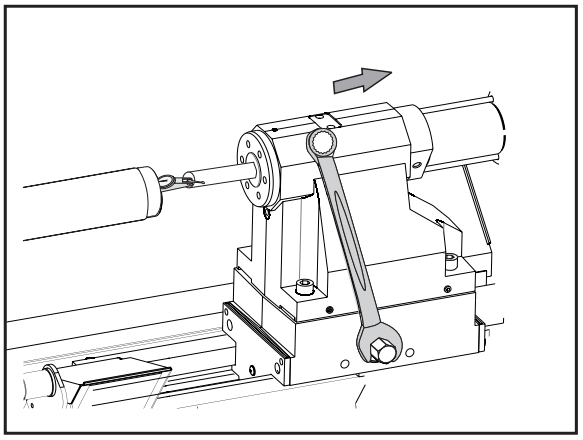
2. Push the tailstock towards the spindle head so that the tip of an indicator mounted on the alignment tool can make contact with the tailstock test bar.

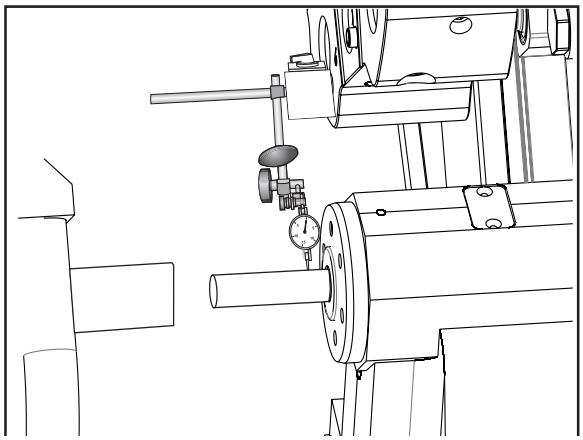




3. Tighten the tailstock lock bolt.

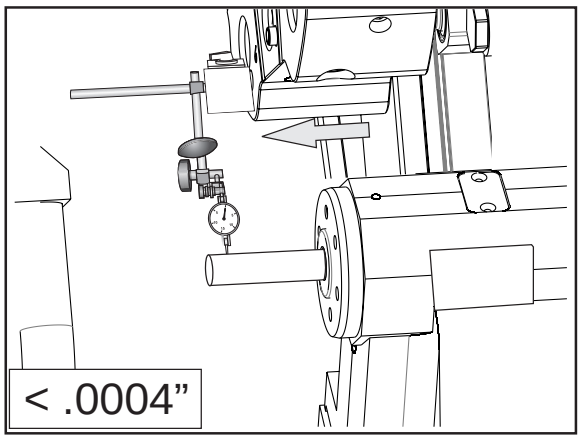
4. Mount a dial indicator on the turret to indicate the side of the base of the test bar.

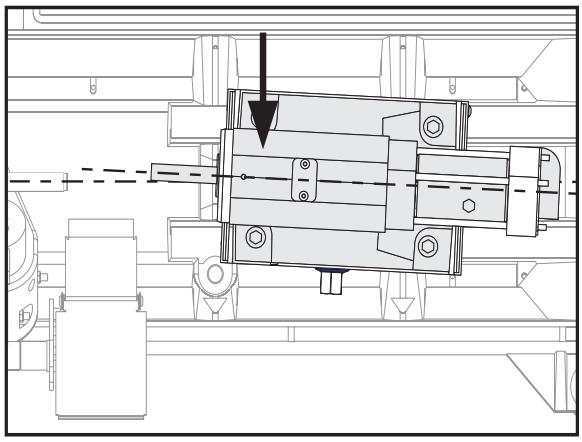




5. Jog the turret to move the indicator to the end of the test bar. Total tolerance should be .0004” over the length of the test bar.

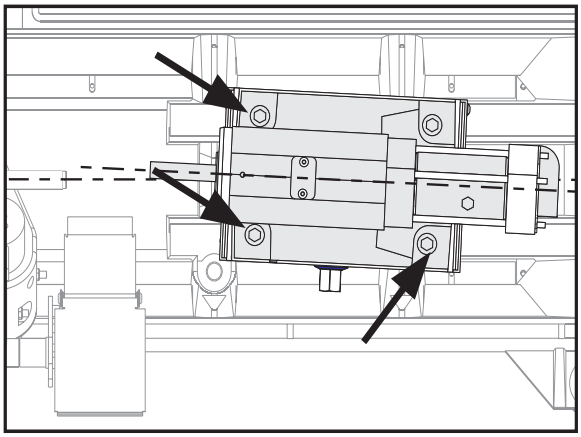
6. Determine which direction the tailstock base need to move.

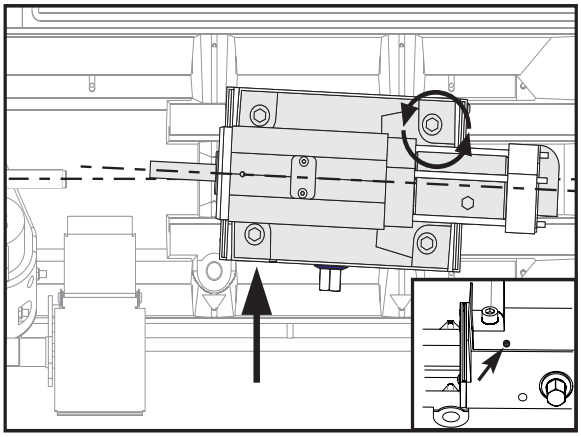




7. Loosen three of the tailstock mounting bolts. Leave one of the tailstock base mounting bolts tight to act as a pivot.

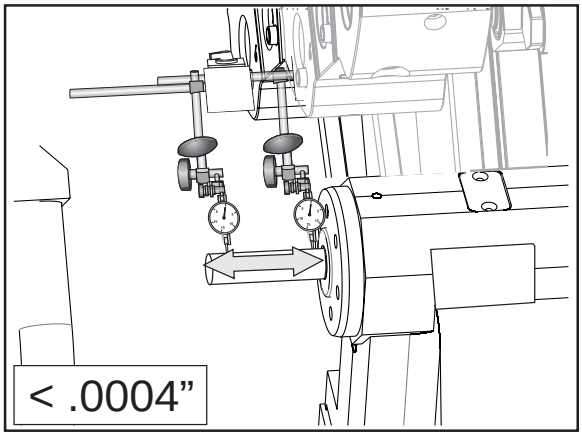
8. Tighten the horizontal jack screw diagonally opposite the bolt being used as the pivot point to bring the tailstock into alignment.

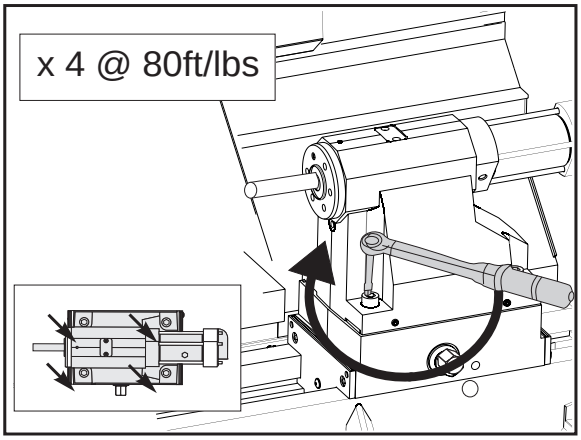




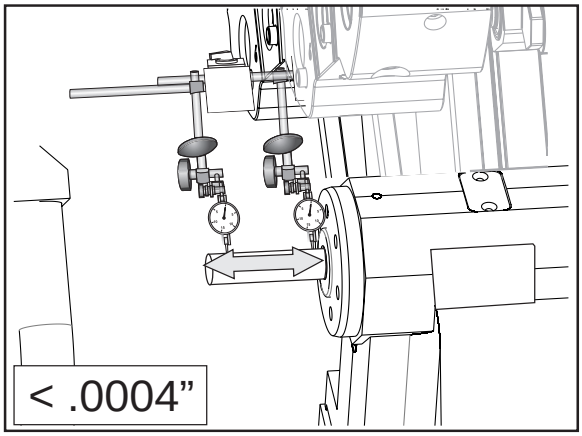
9. Jog the turret to move the indicator the length of the test bar. to recheck parallelism. Total tolerance should be .0004”.

10. Tighten the four tailstock mounting bolts to 80 ft/lbs.





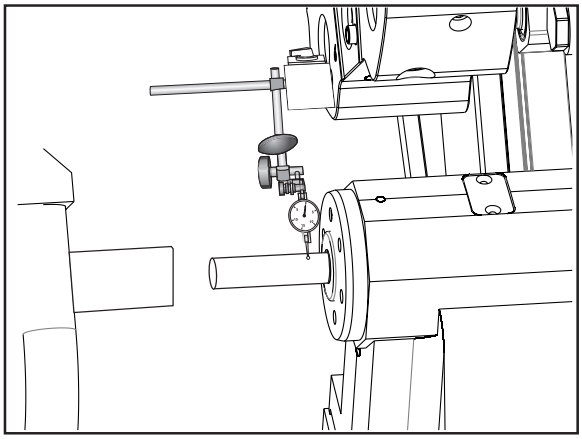
Recheck: Jog the turret to move the indicator the length of the test bar. to recheck parallelism. Total tolerance should be .0004” Repeat steps 5-11 if needed.

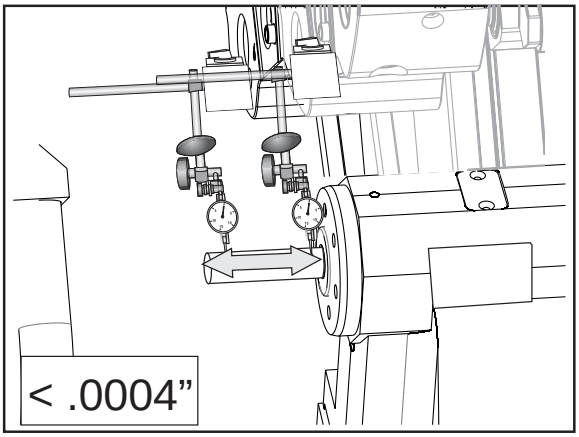


Checking and adjusting Tailstock Flatness

1. Mount a dial indicator on the turret to indicate the top of the base of the test bar

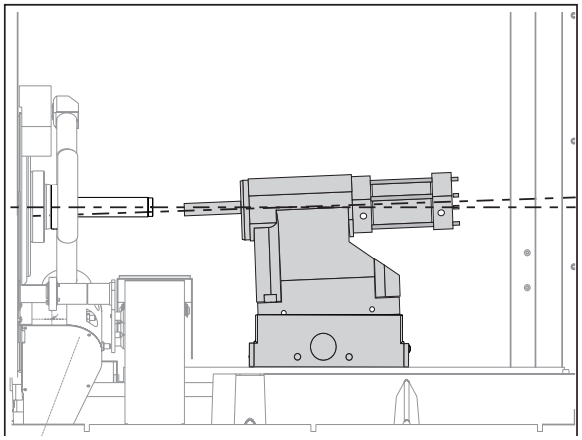
2. Jog the turret to move the indicator to the end of the test bar. Total tolerance should be .0004”.

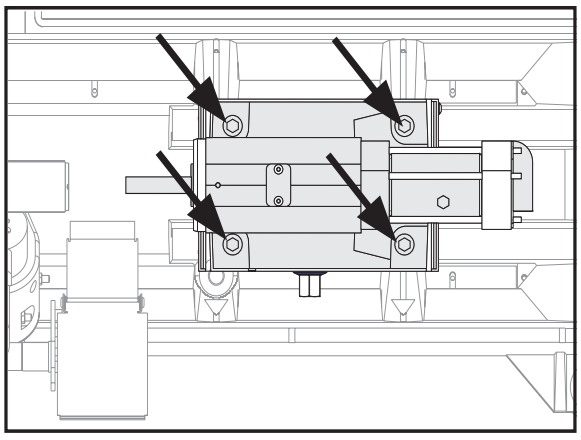




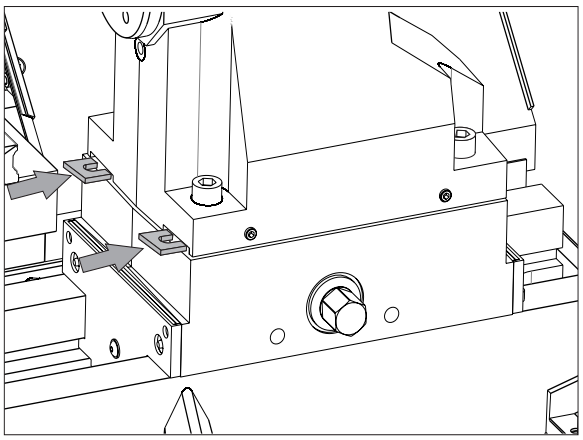
3. Determine which direction the tailstock base need to move.

4. Loosen all four of the tailstock mounting bolts.

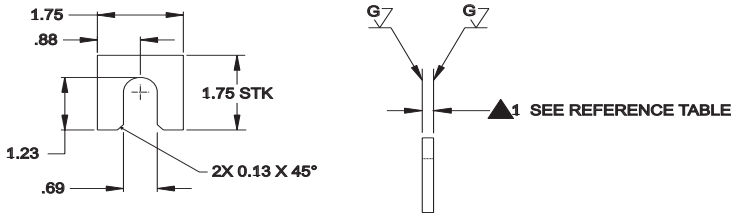




5. Remove or add shims as required to bring tailstock flat. See the following table.



THICKNESS TABLE			
PART NO.	1 REF DIM ±0.00015	PART NO.	1 REF DIM ±0.00015
20-1966	0.2300	20-1979	0.2305
20-1967	0.2240	20-1980	0.2310
20-1968	0.2245	20-1981	0.2315
20-1969	0.2250	20-1982	0.2320
20-1970	0.2255	20-1983	0.2325
20-1971	0.2260	20-1984	0.2330
20-1972	0.2265	20-1985	0.2335
20-1973	0.2270	20-1986	0.2340
20-1974	0.2275	20-1987	0.2345
20-1975	0.2280	20-1988	0.2350
20-1976	0.2285	20-1989	0.2355
20-1977	0.2290	20-1990	0.2360
20-1978	0.2295		



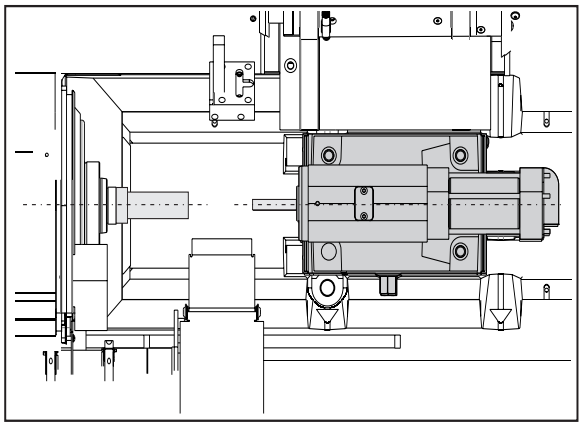
6. Tighten the four tailstock mounting bolts to 80 ft/lbs.
Jog the turret to move the indicator the length of the test bar. to recheck flatness. Total tolerance should be .0004”

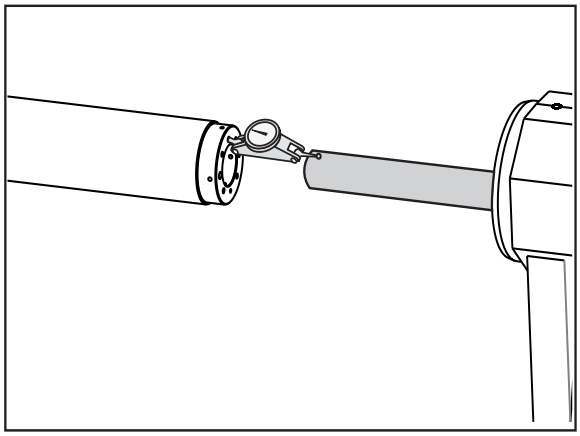
7. Repeat step 1- 7 if required.

Checking and Adjusting Tailstock to Spindle Alignment

1. Check spindle to tailstock concentricity. Spindle and tailstock center lines should be aligned horizontally.

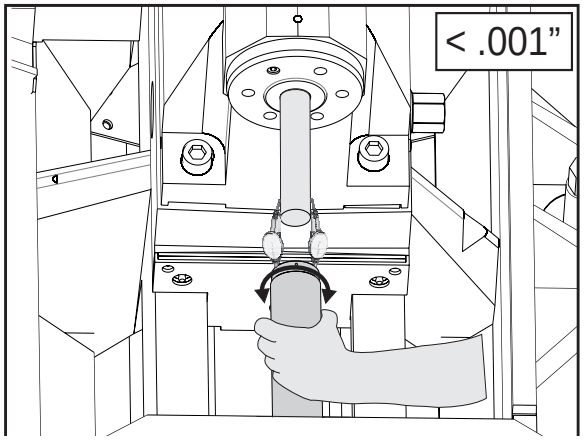
2. Mount a dial indicator on the face of the alignment tool to indicate the end of the test bar. Use an inspection mirror to facilitate reading the indicator.

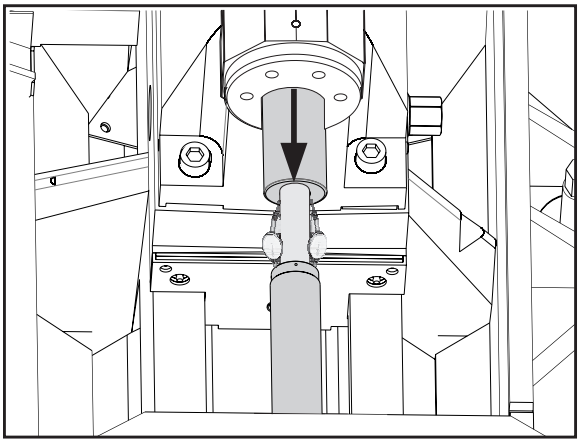




3. Rotate the alignment tool by hand and check the concentricity at the end of the test bar to the spindle alignment tool. The tolerance is .001” TIR.

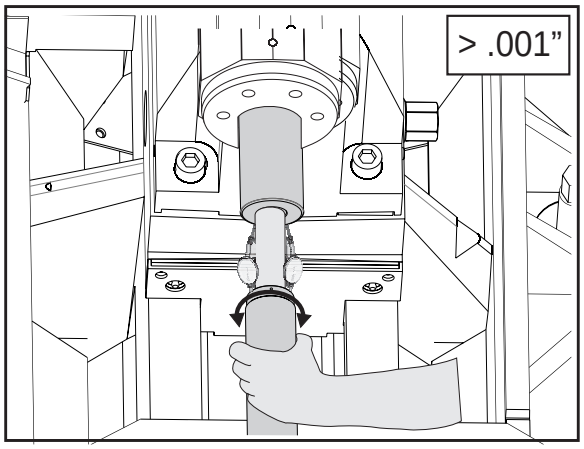
4. Press the foot pedal and extend the quill until the indicator on the alignment tool indicates the base of the test bar.

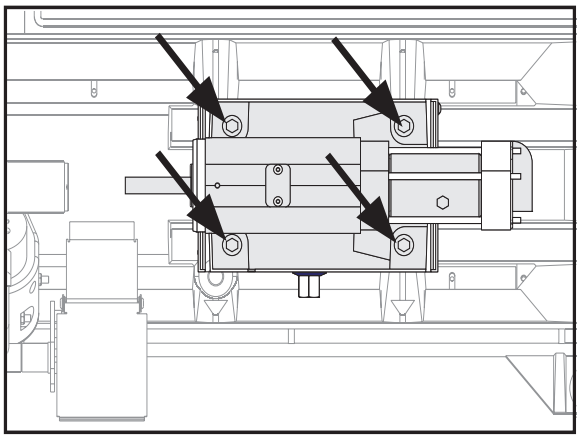




5. Rotate the alignment tool by hand and check the concentricity at the base of the test bar to the spindle alignment tool. The tolerance is .001” TIR.

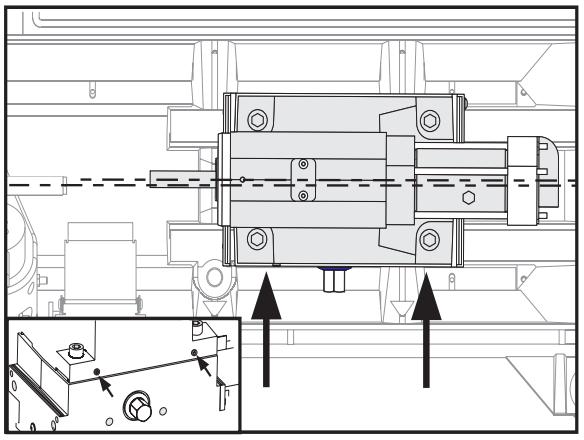
6. To adjust parallelism. Loosen all four of the tailstock mounting bolts.

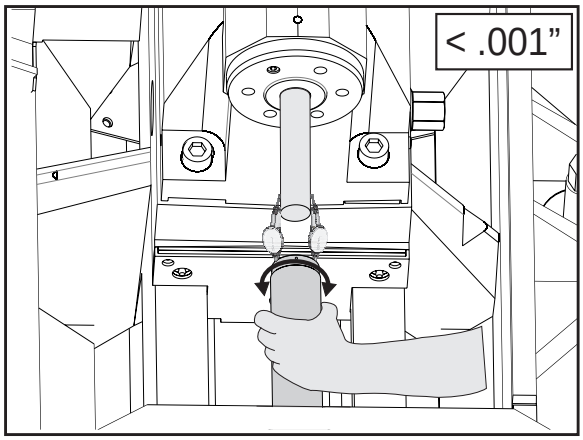




7. Move the tailstock side to side by adjusting **two** of the appropriate side jacking screws **equally**.

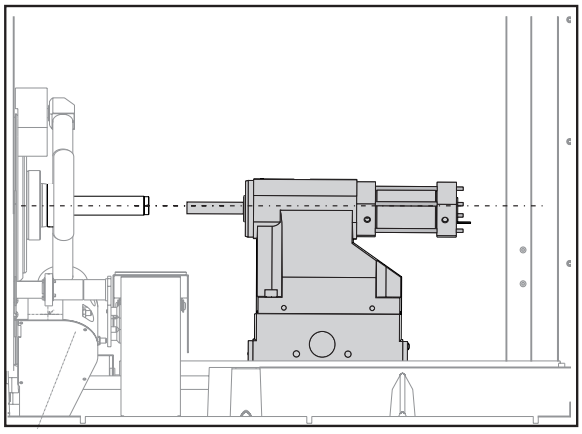
8. Recheck: Rotate the alignment tool by hand and check the concentricity of the test bar to the spindle alignment tool. The tolerance is .001” TIR. Repeat Steps one through five if necessary.

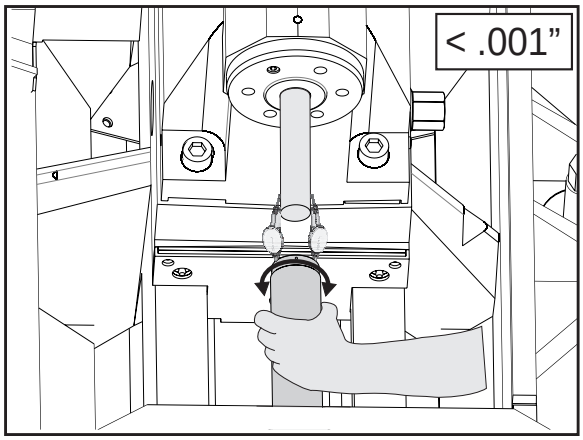




9. Check vertical concentricity. Spindle and tailstock center lines should be aligned vertically.

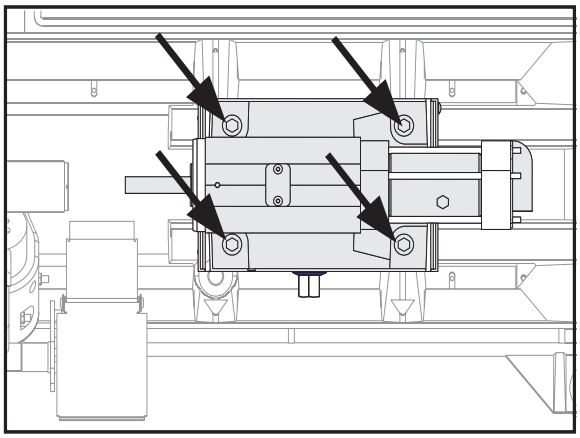
10.Rotate the alignment tool by hand and check the concentricity of the test bar to the spindle alignment tool. The tolerance is .001” TIR.

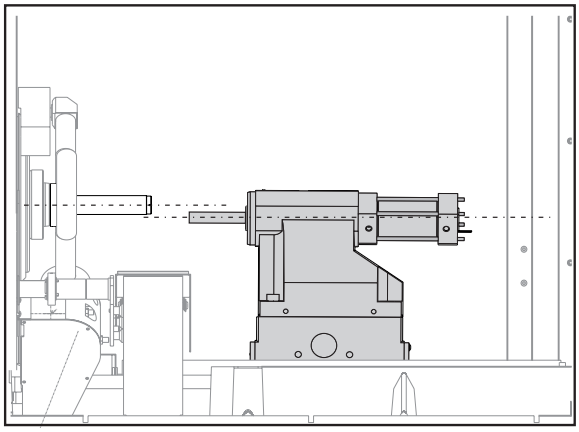




11. To adjust height. Loosen all four of the tailstock mounting bolts.

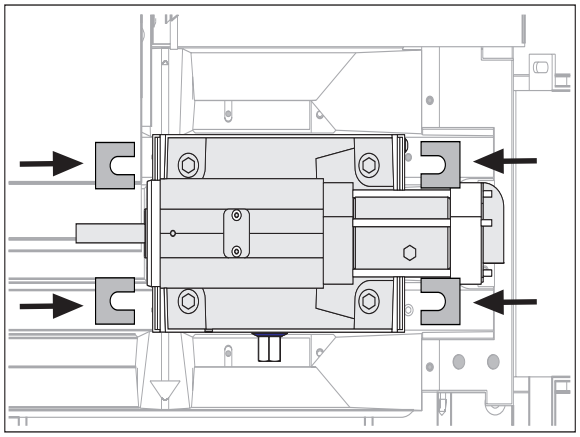
12. Determine whether tailstock needs to move up or down relative to the spindle.

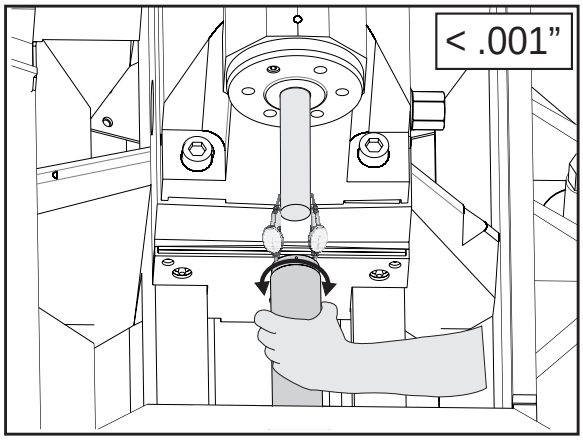




13. Raise or lower the tailstock by replacing or adding shims equally at **all four** shims locations.

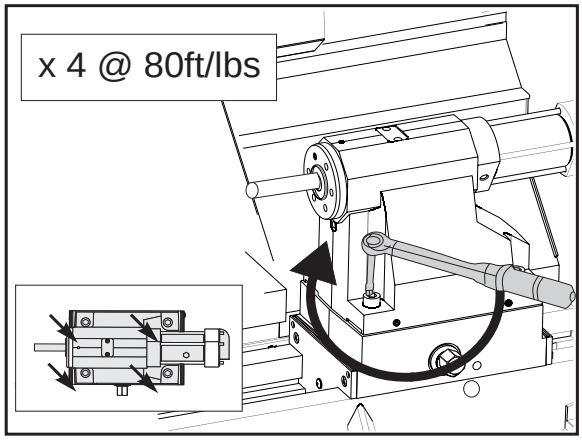
14. Recheck: Rotate the alignment tool by hand and check the concentricity of the test bar to the spindle alignment tool. The tolerance is .001” TIR. Repeat Steps 6 through 10 if necessary.

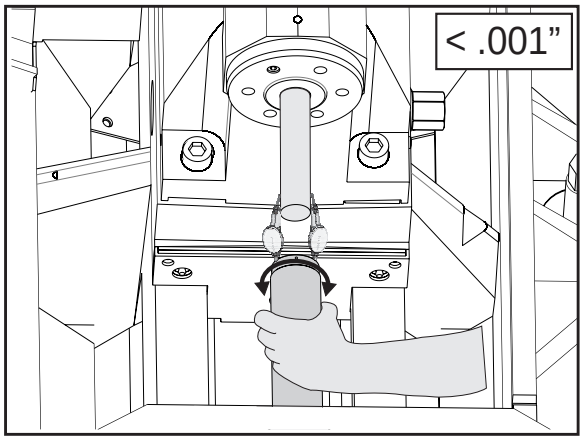




15. Tighten the four tailstock mounting bolts to 80 ft/lbs.

16. Recheck: Rotate the alignment tool by hand and check the concentricity of the test bar to the spindle alignment tool. The tolerance is .001” TIR. Recheck parallelism and flatness as outlined in the previous sections.





SL-10 Tailstock Alignment

1. Insert the tailstock alignment bar into the tailstock quill.

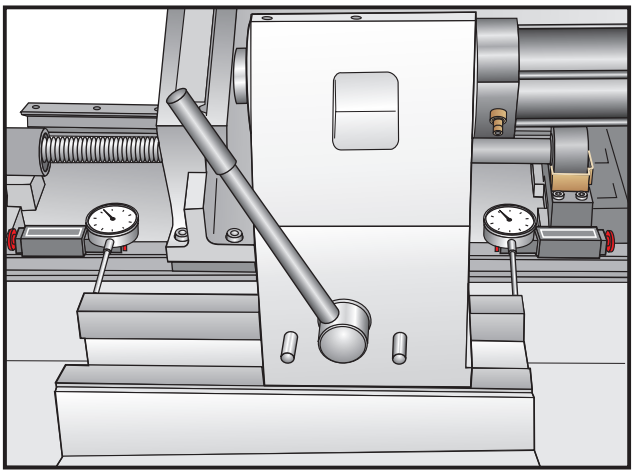
2. Place a 0.0001” indicator onto the turret. Position the X-axis so that the flatness and parallelism of the alignment bar can be measured.

3. Place the indicator stylus onto the side of the alignment bar and sweep along the Z-axis. The tailstock should be parallel with the Z-axis within 0.0004” over the length of the tailstock alignment bar. If the Z-axis parallelism is not within 0.0004”, the tailstock foot will need to be adjusted.

4. Loosen the four SHCS that attach the tailstock foot to the lathe base and back out the set screws at the base of the foot. Push the tailstock foot as close to the turret as possible. Place the indicator stylus onto the machined surface along the backside of the tailstock foot. Jog the Z-axis to sweep along this surface. Adjust the position of the tailstock foot until the runout along this machined surface is less than 0.0001” along the entire length.

5. Install the spindle alignment bar onto the end of the spindle. Install a 0.0001” dial indicator into the end of the spindle.

6. Set up two travel dial indicators at the extreme ends of the tailstock foot.



7. Measure the side to side runout of the concentricity of the spindle to the tailstock quill. The total side to side runout cannot exceed 0.0005”.

8. Using the set screws in the tailstock base, move the entire tailstock assembly until the total side to side runout does not exceed 0.0005”. Maintain the parallelism with the Z-axis by ensuring that the travel indicators move an equal amount.

9. Torque the SHCS that attach the foot to the lathe base in an even and gradual pattern to 200 ft-lb. Verify that the runout has been maintained after the tailstock foot is torqued.

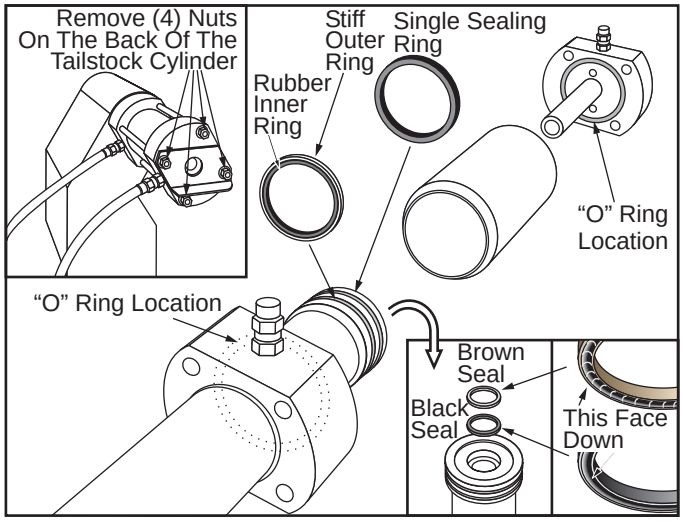
SL10 Tailstock Seal Replacement

Disassembly

1. Remove the 4 nuts on the back of the tailstock cylinder.

2. Remove the back of the cylinder and then the cylinder housing.

3. Remove the two seals from the end of the cylinder. One of the seals is inside the bore of the cylinder.



Assembly

1. Install two seals to the end of the cylinder. Note the differences between, and orientation of, the seals; there is an apparent thickness difference, and they must be installed facing the proper direction.

2. Reinstall the cylinder in the housing, replace the back of the tailstock cylinder and secure with 4 nuts.

Tailstock Insert Removal and Installation

The following procedure is for one-piece tailstocks only.

CAUTION! Contact Haas before attempting this procedure.

Tools Required:

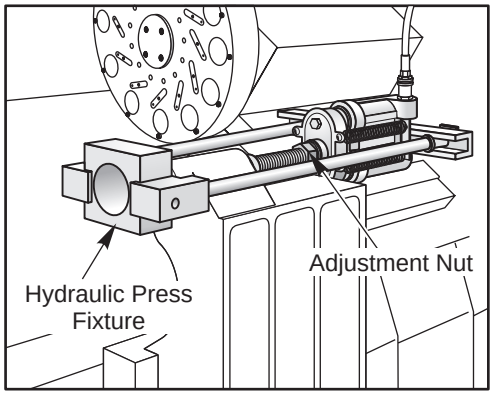
Press Fixture and Spacer
Spindle Alignment Test Bar (P/N T-1312)
Tailstock Taper Alignment Bar (P/N T-1416)
Blow torch
Devcon liquid steel (P/N 99-4530)

Removal

1. Remove the six screws that mount the back plate to the tailstock insert.

2. Remove the 3 screws that mount the insert to the casting.

3. Run the screw nut completely down to its farthest travel (far right).



Tailstock Insert Press

4. Mount the fixture to the tailstock casting as shown.

5. Pump the hydraulic press a few times so that the fixture stabilizes itself against the tailstock.

WARNING!

Keep hydraulic lines away from the blow torch flame or serious injury could result.

6. Use the blow torch to heat the insert casting. This will take approximately 30 minutes.

7. Pump the hydraulic press to its maximum pressure while continuing to heat the casting.

NOTE: When the pressure on the gauge begins to drop, the insert should begin to slip out. Once the press is fully extended, run the nut down and repeat step 6.

NOTE: Use a spacer if the adjustment screw on the press is not long enough to remove the insert.

8. Once insert is removed, use a small screwdriver or chisel to remove any Devcon. Ensure fill hole is clear.

Installation

1. Clean the tailstock bore and all mounting surfaces.

2. Mount the spindle alignment test bar onto the spindle.

3. Mount a tenths indicator to the nose of the test bar.

4. Make sure the fill hole at the back of the tailstock casting is not clogged.

5. Install the tailstock insert and three mounting screws.

6. Insert the tailstock taper alignment bar.

7. Position the indicator tip at the base of the tailstock test bar.

8. Adjust insert until the runout at the base of the test bar is less than .0003” TIR. Tighten all three screws.

9. Install the rear insert plate. Tighten the three 1/4 x 20 bolts, but leave the three 10 x 32 bolts loose.

10. Position the indicator at the end (far left) of the tailstock taper alignment bar.

11. Insert a pry bar into the rear of insert and adjust the runout at the end of the shaft until the reading is .001” or less from centerline. Tighten the remaining screws.

12. Inject the Devcon and let stand overnight.

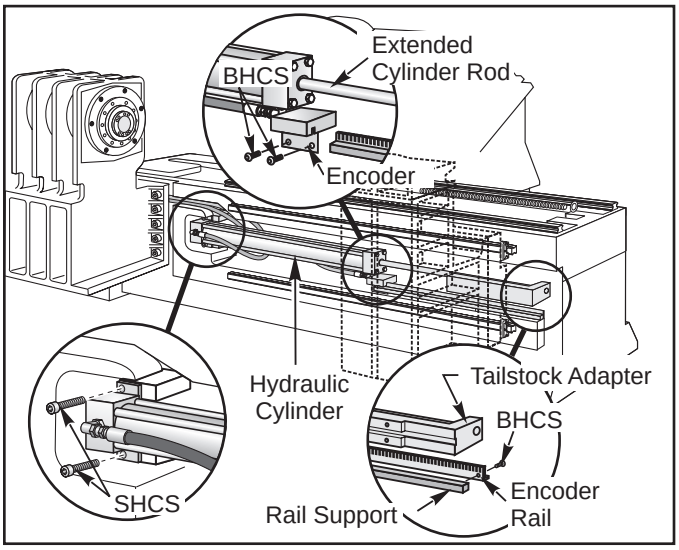
Hydraulic Tailstock Cylinder

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.

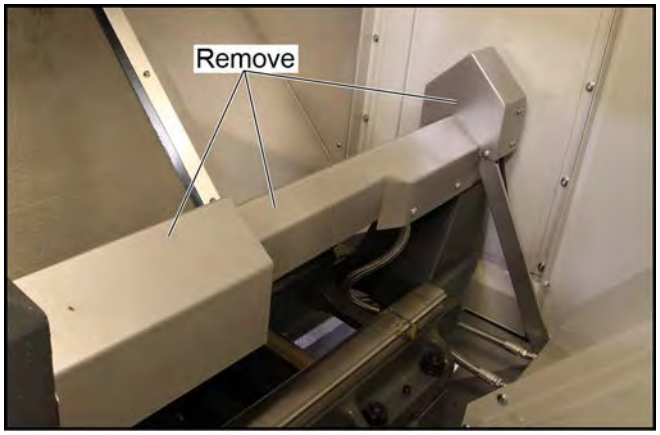
ST Series Hydraulic Tailstock Bleeding

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.



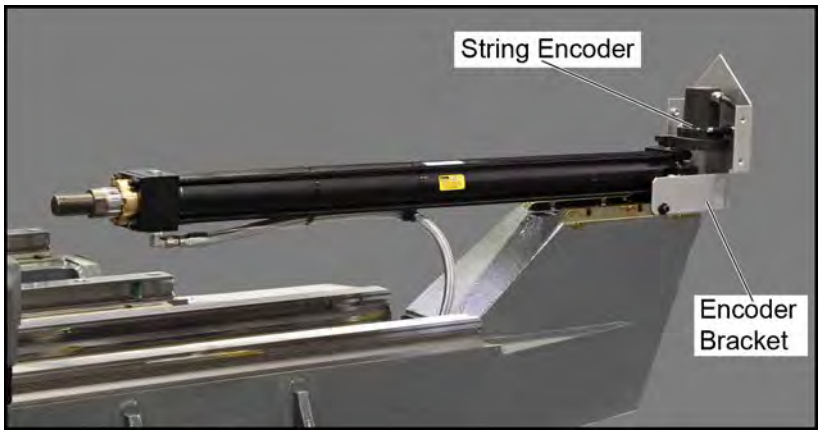
Tailstock Sheetmetal Covers

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.

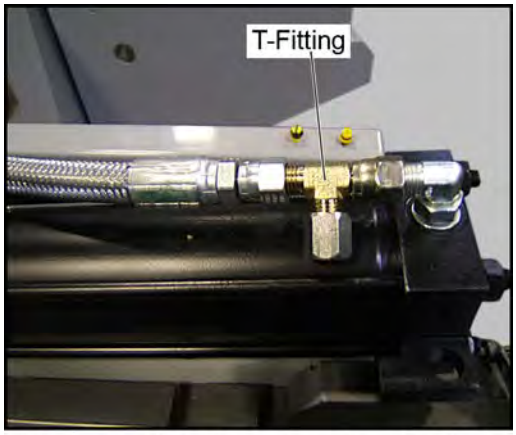
6. Reach into the tailstock body and push the string encoder bracket out the front. To prevent damage to the string encoder, keep hold on the encoder string as you remove the 10-32 bolt that secures the string to the bracket and carefully allow the string to retract slowly into the encoder.



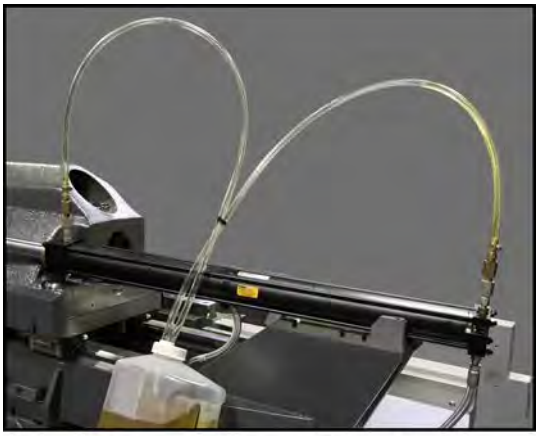
7. Remove the encoder and bracket from the end of the hydraulic cylinder. Remove the two 3/8-16 bolts that secure the cylinder to the tailstock base.

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 no bubbles appear.

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.

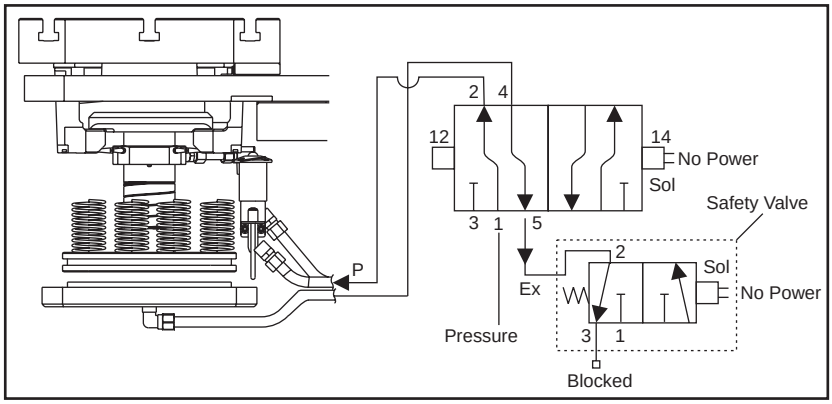
Air Supply Lines - The lifting cylinder has one large air supply line for lifting pallets and their loads. No return line is required because the cylinder is vented to the atmosphere and the assembly weight and load causes the cylinder to lower. The rotation cylinder is double-acting and has two smaller 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.

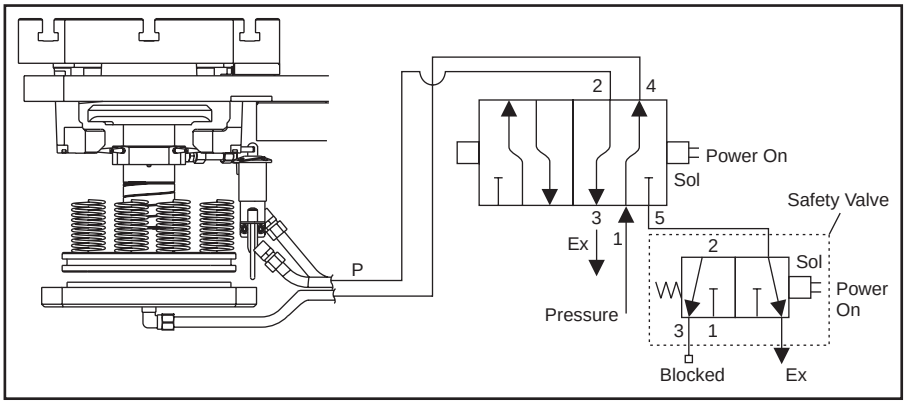
Table Clamping

Table Clamp Status Under Different Conditions

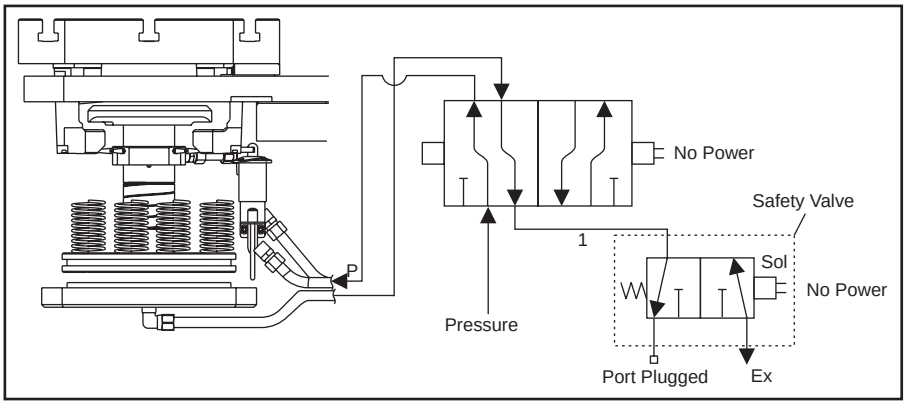
A. Condition is clamped when machine is normally powered off, first powered on or table index is complete.



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

1. **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.

2. **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.

3. **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.

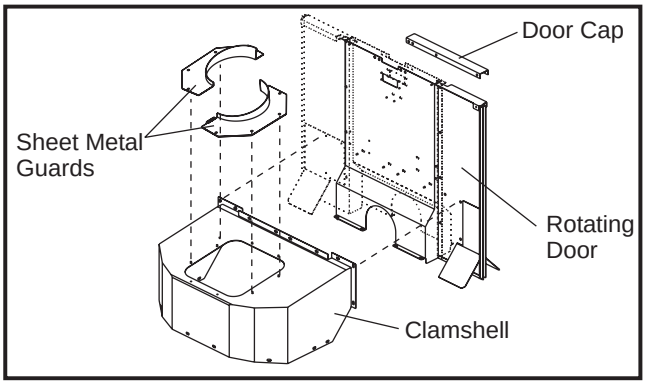
1. Enter M-17 in MDI mode and press Cycle Start to unclamp the pallet (recommend 25% rapid). Wait until the assembly has fully risen to its highest point and begins to rotate and press Emergency Stop. Rotate the pallet as required to remove the components.

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".

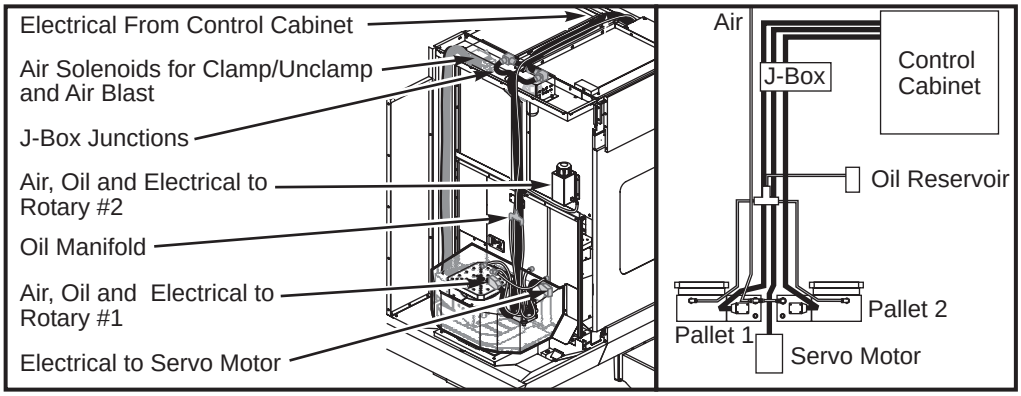
NOTE: Power off before disconnecting anything (and unscrew the power cables for the rotary tables from J-box for EC-300).

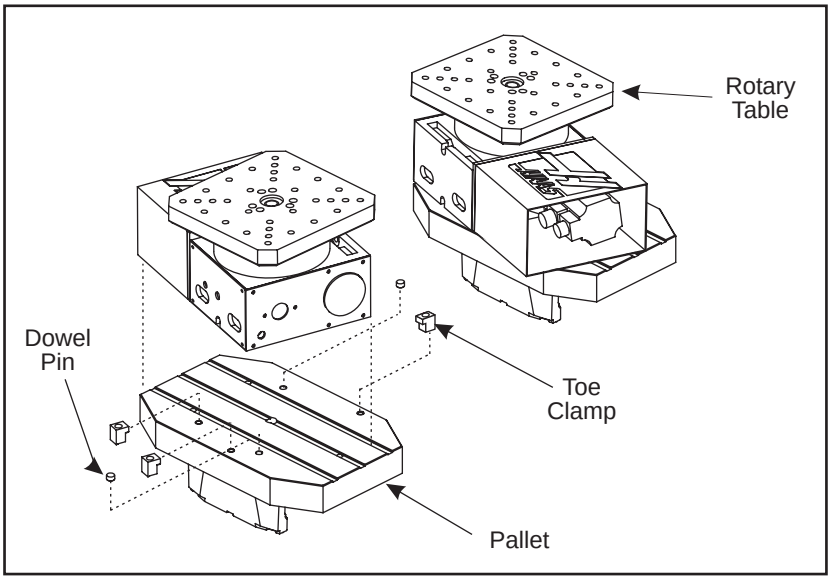
Steps 6-8 apply to the EC-300 only

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.

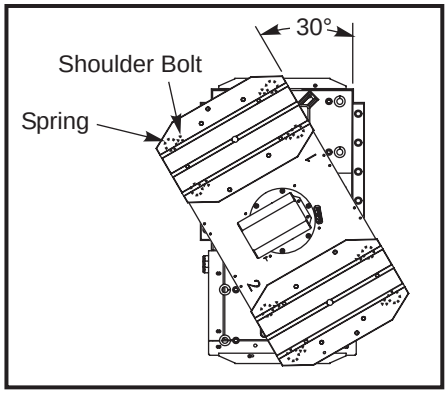


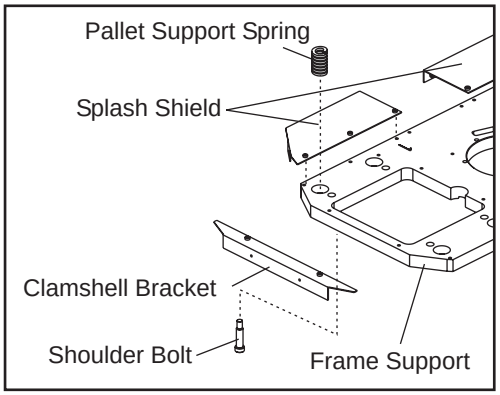


7. Remove the 3 toe clamps from the sides of the HRT-210 rotary tables and remove rotary tables with a lift.

8. Remove two ½" dowel pins (2 per pallet) that are seated in non-threaded holes in the pallet for proper orientation of the rotary tables. **Do not lose these pins.**

9. The pallet table assembly must be rotated approximately 30° away from 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.

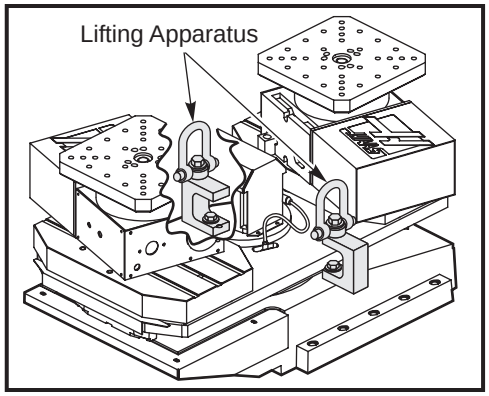
NOTE: Air pressure must stay connected throughout this process. **Do not** initiate a pallet change under any circumstance and only rotate assembly by hand.

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.

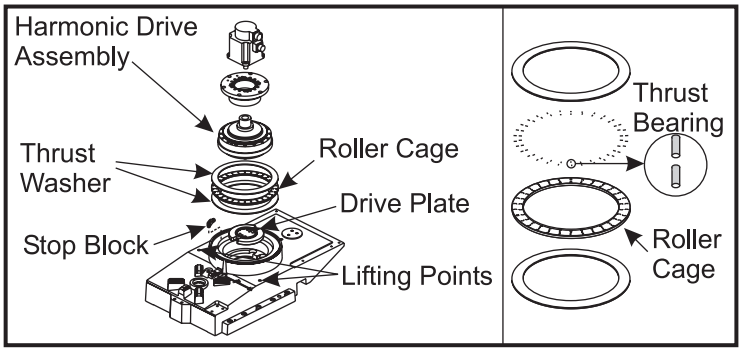
NOTE: Mark the air lines for proper re-assembly.

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

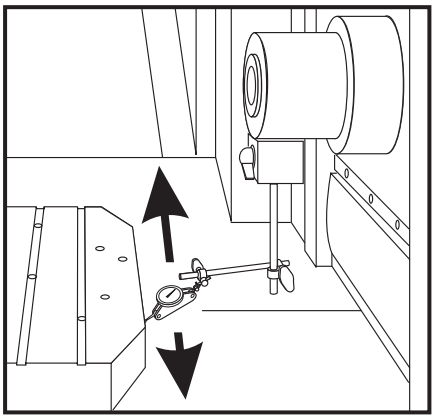
3. In single block mode, cycle the program to observe the direction of table movement.

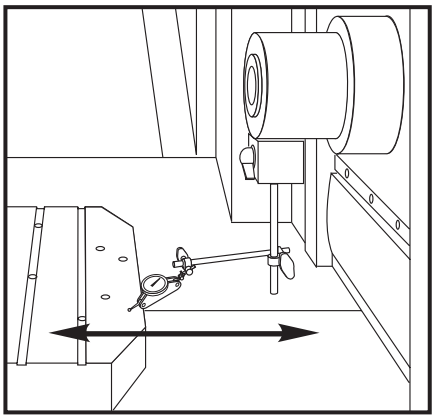
4. Adjust spring location by gently tapping springs in the opposite direction of the table movement. Run the program to verify adjustment.

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 212 (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 4th 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.

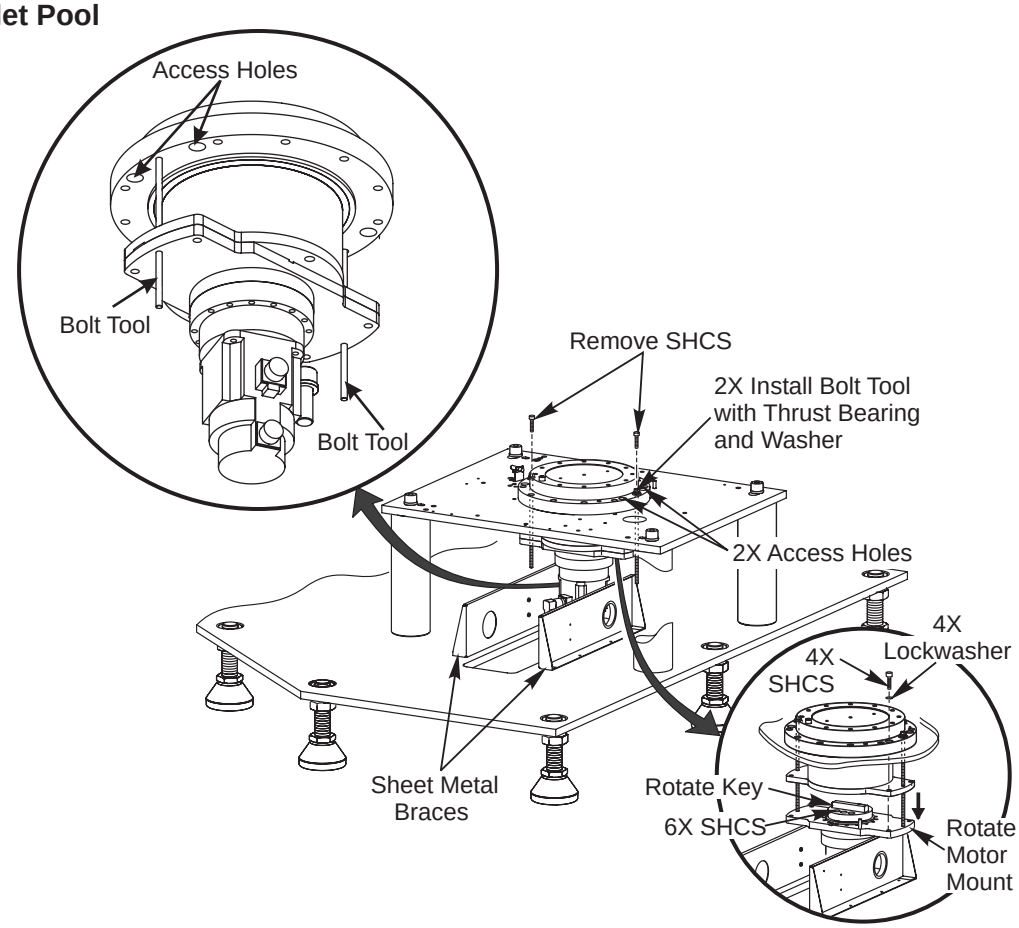
31. The clamp plate moves down to clamp the pallet. The clamp plate will move approximately .400" and clamp the pallet. It will trigger the pallet clamp sensor, indicating that the pallet is clamped. The clamp plate position is monitored by a sensor assembly located on the bottom of the A-axis.

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.

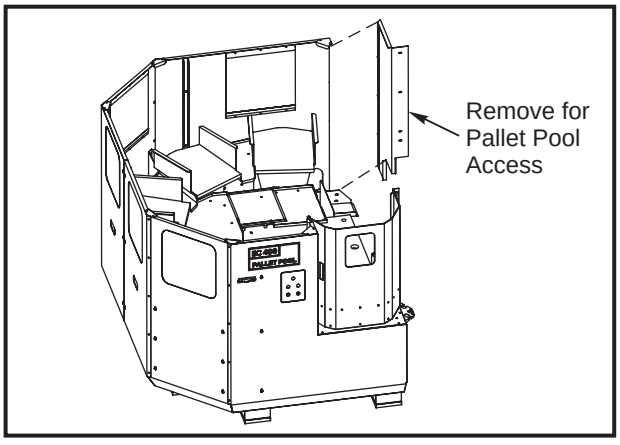
Pallet Pool Motor Replacement

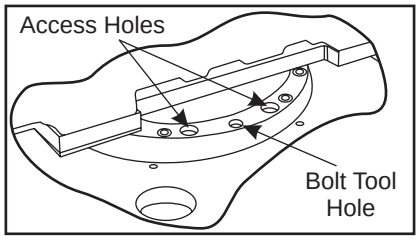
Pallet Pool Motor Replacement is accomplished from beneath the Rotator/Slider of the EC-400 Pallet Pool



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).

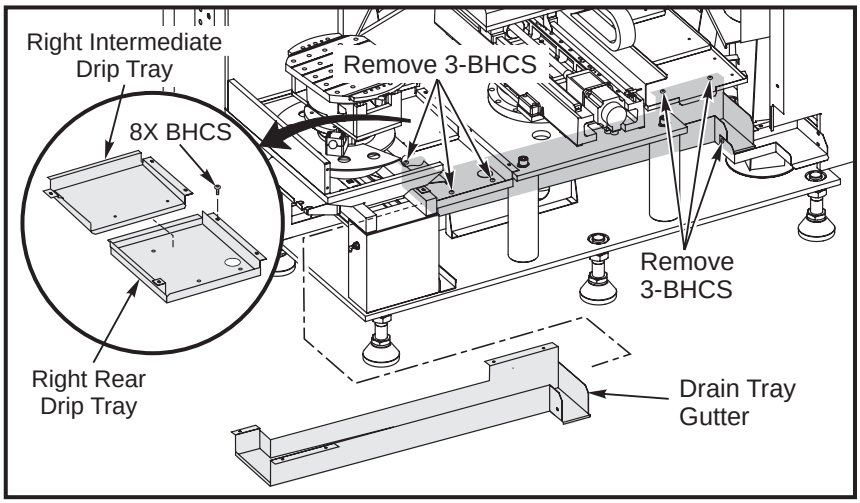
4. Insert a threaded bolt tool (contact Haas for tool) in the hole between the two access holes (one on each side of the rotator/slider to keep the motor from falling later in the procedure.

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.



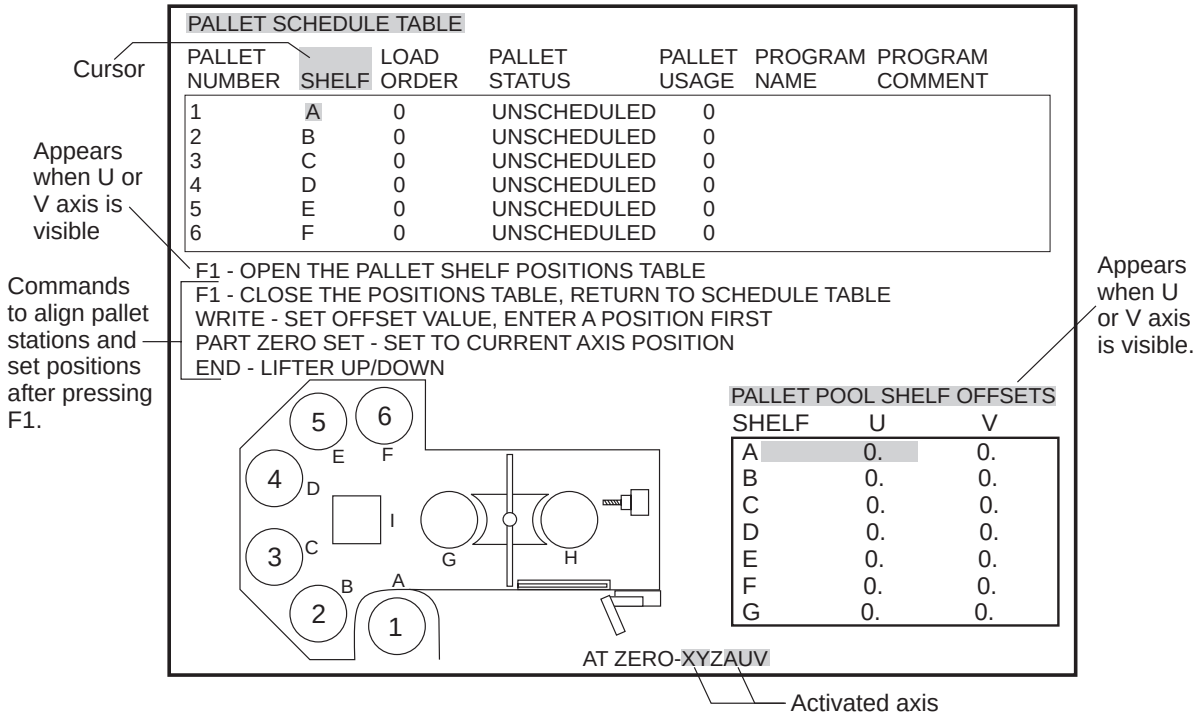
9. Enter the open area at the left side of the pallet pool by crawling into it, make your way to the motor, and disconnect any cables and wires holding the motor to the rotator/slider.

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 finshed 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.

H-Frame Alignment (EC-400, EC-500)

This procedure is necessary when the H frame motor is removed or replaced.

1. Record value on parameters 231 (B-axis) or 451 (W axis). NOTE: The pallet changer will be either the B or W axis. This depends on the tool changer. If the mill has a servo tool changer, the pallet changer is driven by the W axis. If the mill does not have a servo tool changer, the pallet changer is driven by the B axis.

2. Replace the pallet changer parameter value with 0 (zero) and cycle power.

3. Zero return A & Z-axis and enter 'Debug' mode.

4. Jog Z-axis away from the pallet changer so that H-frame will the clear z-axis if rotated.

5. Enter Pallet Changer Recovery and unclamp the pallet (press Page Up). Raise H-frame (arrow Up) and home the H-frame (press End).

6. In Pos Raw Data page enter "Grid B" or "Grid W" depending on pallet changer axis (see step 1).

7. Command the H-frame down (arrow down) and quickly press E-stop.

8. Manually rotate the H-frame to center pin over hole in block.

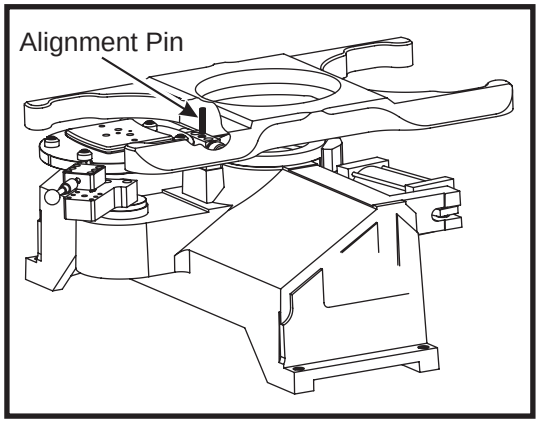
9. Go to Pos Raw Data Page and record values shown when manually rotating the H-frame to both extents (CCW and CW) of clearance in block.

10. Calculate mid-point value by adding CCW and CW values together. Divide the total by 2. Enter the result into Parameter 451 or 213. NOTE: Enter value with opposite sign than shown on display.

11. Cycle power, enter PC recovery, home H-frame (Press End) and verify that the pin is aligned with hole in block.

12. Lower H-frame (arrow down) and quickly press E-stop. Verify that the values (Pos Raw Data page) in both (+) and (-) directions are within 200 encoder counts.

13. Repeat steps above as necessary.



Air Cylinder

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

2. Disconnect the machine's air.

3. Remove the APC cylinder cover.

4. Remove the H-frame up reed switch. Disconnecting it is not necessary.

5. Disconnect the two air hoses.

6. Remove the shoulder bolts and washers that retain the air cylinder and remove the air cylinder..

7. Remove the air fittings, rod end, and jam nut and assemble them on to the new air filter. Leave the rod end loose.

8. Wrap the air fittings with teflon tape.

9. Mount the fixed end of the air cylinder to the bridge using a shoulder bolt and two washers on either side of the spherical bearing.

10. Rotate the APC cam lever, cams, and seal housing clockwise as viewed from the top, until it stops.

11. Adjust the rod end, as required, to easily insert the shoulder bolt with the cylinder fully retracted.

12. Unscrew the rod one full turn and tighten the jam nut. The air cylinder should reach the end of its travel before the cams do.

13. Attach rod end to the cylinder lever using the shoulder screw with one washer on each side of the rod end.

14. Torque both of the shoulder screws to 100 ft-lb.

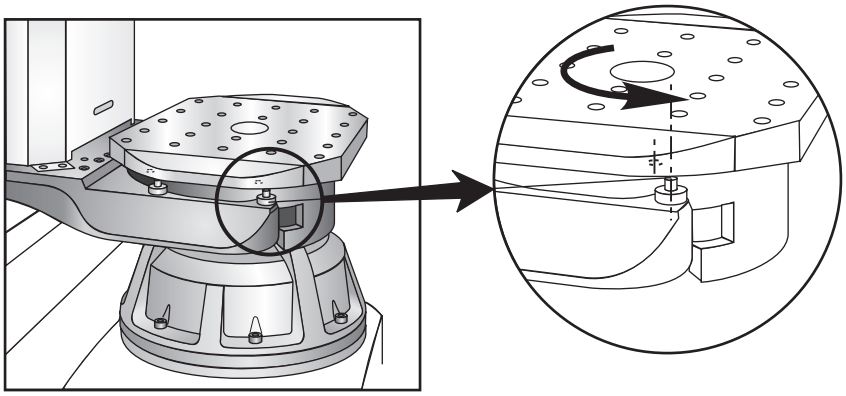
15. Reinstall and adjust the H-frame up switch.

16. Reinstall the air lines and the cylinder shield.

17. After completion, run a sample program to test for proper operation.

Pallet Changer H-frame to Pallet Alignment

There are two stages to properly aligning the pallet changer H-frame and the pallets. The first is to align the pallets to the H-frame. The second is to align the pallet load station to the H-frame.



Stage 1

1. Go to the parameter page and scroll to find Parameter 76. Write down the current value. Adjust Parameter 76 to a large number (e.g. 99999999999), to delay the low air alarm.

2. Enter Debug mode (go to Alarms page, key in Debug and press Write/Enter) and scroll to Pos Raw Data.

3. Jog the Z-axis until the pins on the H-frame are aligned with the holes in the pallet. Enter the value of Z-axis Actual into Parameter 64.

4. Enter Pallet Changer Restore (press Tool Changer Restore and select the Pallet Changer Restore option).

5. Home the Z-axis and verify the pallet to H-frame alignment.

6. Unclamp the pallet and turn down the main air pressure regulator to approximately 10 PSI.

7. Press the key to raise the pallet. Turn up air pressure (at air regulator) slowly and verify that the H-frame and pallet are aligned. To lower the H-frame and pallet raise air pressure and press the pallet down button.

8. If the alignment is incorrect repeat the steps to set Parameter 64.

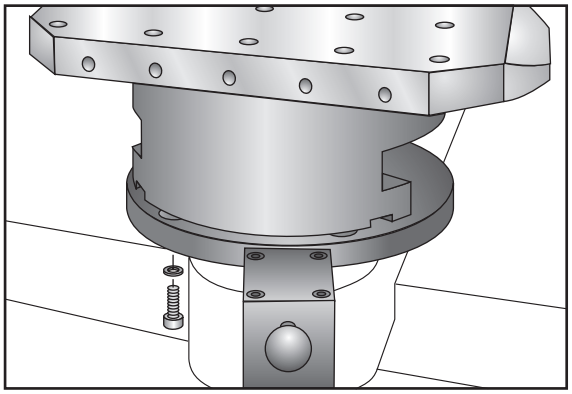
9. Once the alignment is complete, restore the main air pressure regulator to the correct pressure (85 PSI) and finish the pallet changer restore sequence.

10. Exit Debug (type Debug and press Enter from the alarms page).

Stage 2

Alignment of the pallet load station pins to the H-Frame. At this stage the H-frame has been aligned to the rotary axis (Stage 1 has been completed).

1. Loosen the four alignment pin bolts on the load station. Rotate the pallet at the load station to access all the bolts.



2. Rotate the pallet load station to home. Enter pallet changer recovery

3. Unclamp the pallet and raise the H-frame.

4. Reduce the main air pressure regulator to approximately 10 PSI.

5. Enter pallet changer restore and command the H-frame down.

6. Increase the air pressure at the main pressure regulator until the H-frame starts to lower. Verify the pallet is engaging the alignment pins.

7. Once the pallet is seated on the alignment pins, tighten them.

8. Increase the main air pressure regulator to 85 PSI and finish the pallet changer restore sequence.

9. Close doors and command several pallet changes to verify smooth operation.

10. Set Parameter 76 to the original number.

Note that pallet changer recovery reduces rapids to 25%. The pallet at the load station must always be 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.

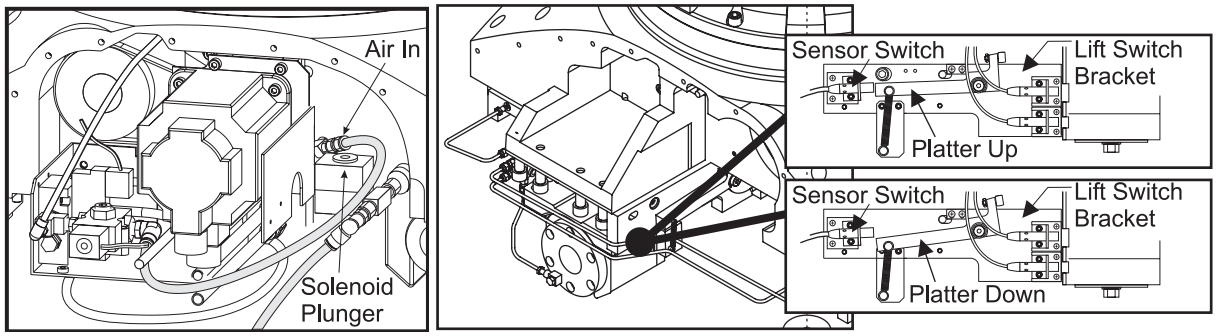
A-axis Indexer Lift Switch Setup

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.

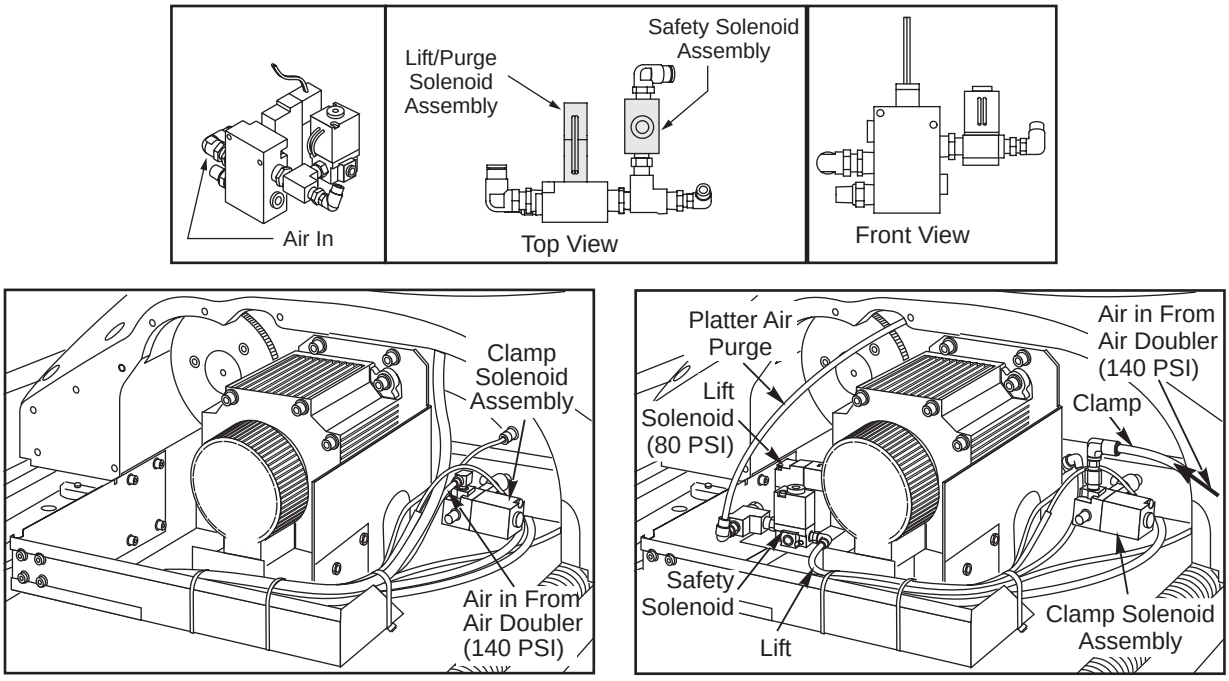
8. Remove tool T-2150 and replace the hoses.

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.

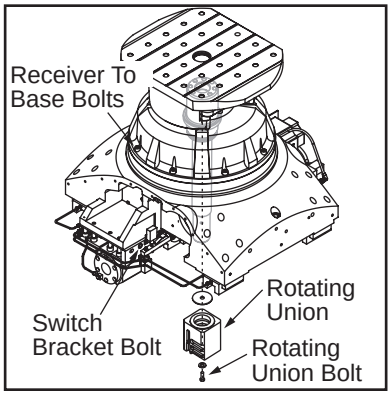
2. Remove the screws from the front and rear Z-axis way covers and slide them away from the rotary base.

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.

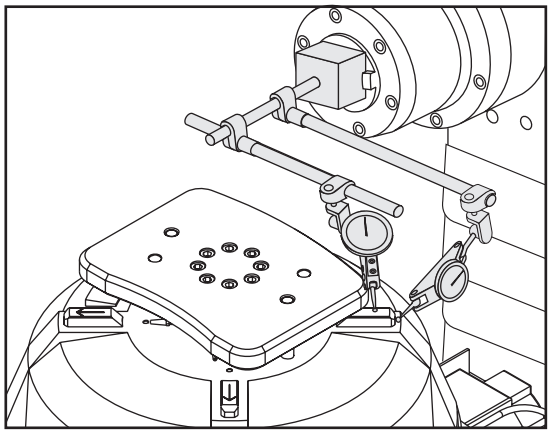
3. Loosely install the eight bolts in the receiver.

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 magentic base to the spindle nose and using a .0001” or .0005” indicator, indicate down the center of the pallet and note the reading at the front and back edge, about 1” from the edge of the pallet in the Z-axis. Repeat this in the X-axis and note the reading.

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

3. With magnetic base still on the spindle nose, place the indicator on the face of the pallet at the center and 1” from the front edge, toward the spindle. Zero the indicator dial and set the Z-axis position to zero.

4. Jog the Z-axis off of the pallet far enough to allow rotation of the A-axis.

5. Jog the A-axis 90° and return the Z-axis to zero position.

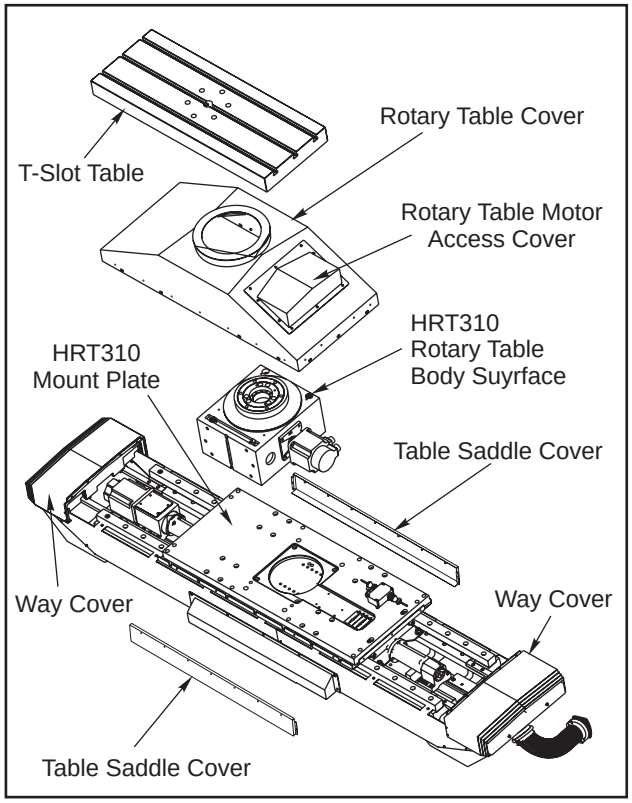
6. Repeat step 5 until you have indicated and noted the pallet runout at 0, 90, 180, and 270°.

7. If the flatness is correct, skip to step 9.

8. Pallet flatness is adjusted by shimming under the rotary, between the rotary casting and on top of the Z-axis linear guide pads. Note that any time adjustments are made in this area, the ball nut and ball nut housing need to be realigned, which is also true for the next step.

9. The pallet square in relation to X-axis is adjusted on the full 4th axis, by indicating the front edge of the pallet until parallel and adjusting Parameter 212. On the 1 and 45° indexers, the entire rotary casting needs to be rotated until the pallet is parallel. To do this, it is necessary to loosen the Z-axis ball nut housing, then the 16 bolts on the Z-axis linear guide pads, and physically shift the position of the casting. The specification when indicating the front of the pallet is .0005” (.0127mm) or less. Once this is achieved it is necessary to torque the 16 linear guide bolts, realign the ball nut housing and ball nut, and verify alignment.

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.

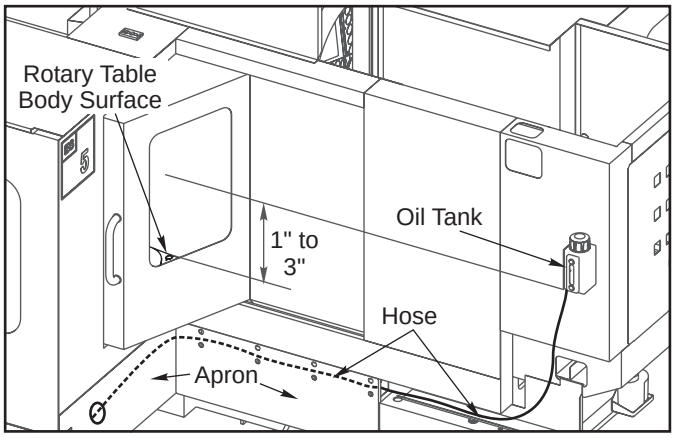
a. Indicate across the T-slot table surface along the X and the Z axes. If necessary, adjust shims under the T-slot table to align the rotary axis not to exceed 0.0001” in the Z-axis and .0015” in the X-axis.

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

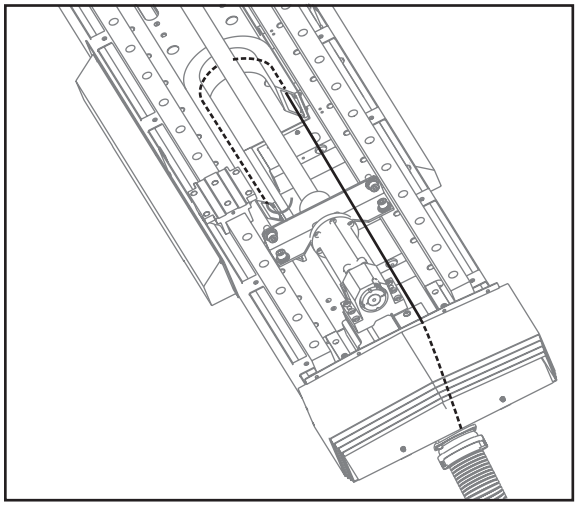
Oil Tank Assembly Hose Routing

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.

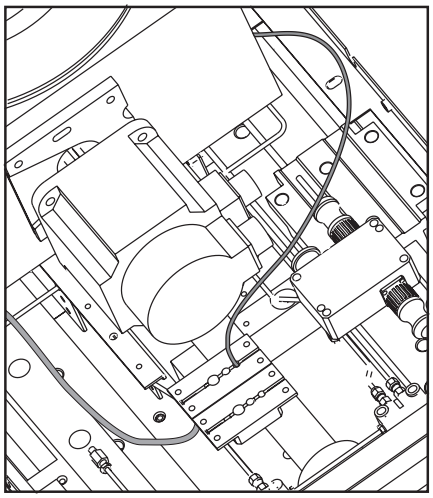
A bracket has been provided (if necessary) upon which to mount the oil tank. The bracket should be mounted at a height of approximately 60”. Remove the machine aprons to reveal the cabling trough, connect the fitting on one end of the hose to the oil tank, and route the hose down the sheetmetal and into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

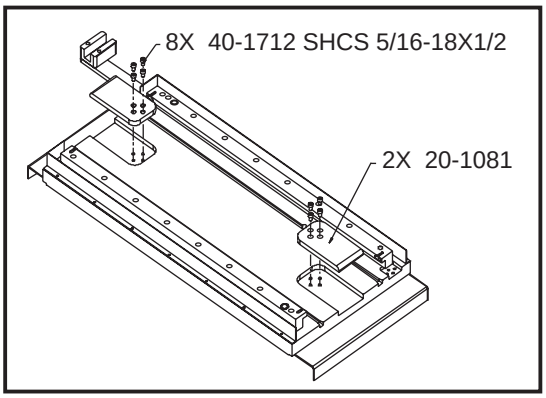


Route the oil hose out from the cable carrier and up through the strain relief conduit to the fitting on the side of the HRT310. Connect the hose to the fitting.

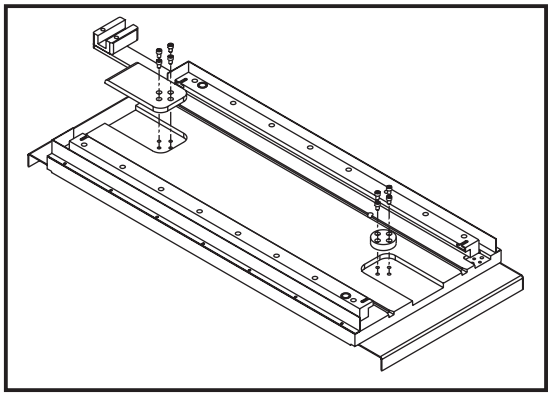


APC PALLET TROUBLESHOOTING

There are two different designs of pallets for use with the APC. This difference in design is for locating the pallet onto the receiver. The earlier method uses two friction blocks to slow the pallet and locate it correctly as it enters the machine (20-0053, or 20-0579 for a metric pallet). The current design uses a pin and latch to locate the pallet (20-0053A, or metric 20-0579A). Current method pallets can be used on earlier machines by replacing the location stub (20-1082), with a friction block (20-1081). See the following figures.



Pallet Part number 20-0053 (metric 20-0579)



Pallet Part number 20-0053A (metric 20-0579A)

The spare pallet, PAL40, is shipped with two filler blocks (20-1081) and one APC Location Stub (20-1082). If the machine has an existing pallet with part number 20-0053 (Metric 20-0579), the two filler blocks (20-1081) will be used and the Location Stub (20-1082) will not be used. See the figures.

If the machine has an existing pallet with a part number 20-0053A (Metric 20-0579A), one filler block (20-1081), one Location Stub (20-1082) will be used. See the figures.

NOTE: Bolts for filler block are 40-1712 SHCS 5/16-18 X ½ (4). Torque to 35 ft-lb. Bolts for Location Stub are 40-16385 SHCS 5/16-18 X ¾ (4). Torque to 35 ft-lb.

Checking pallet repeatability on to the receiver

- Maximum tolerance is .+/-0005”.
- Pallets are not considered repeatable from one to the other. Pallets should use separate offsets.
- If pallet is out of tolerance, check alignment pins on receiver base and bushings on bottom side of clamp rails for damage.
- Check the height of the alignment pins on the receiver base. The top of the pin should be .450” to .490” (11 to 12.5mm) 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).

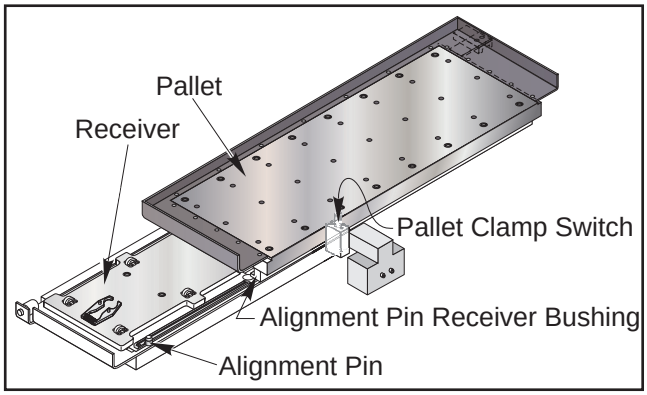
Sticking Pallet

- 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

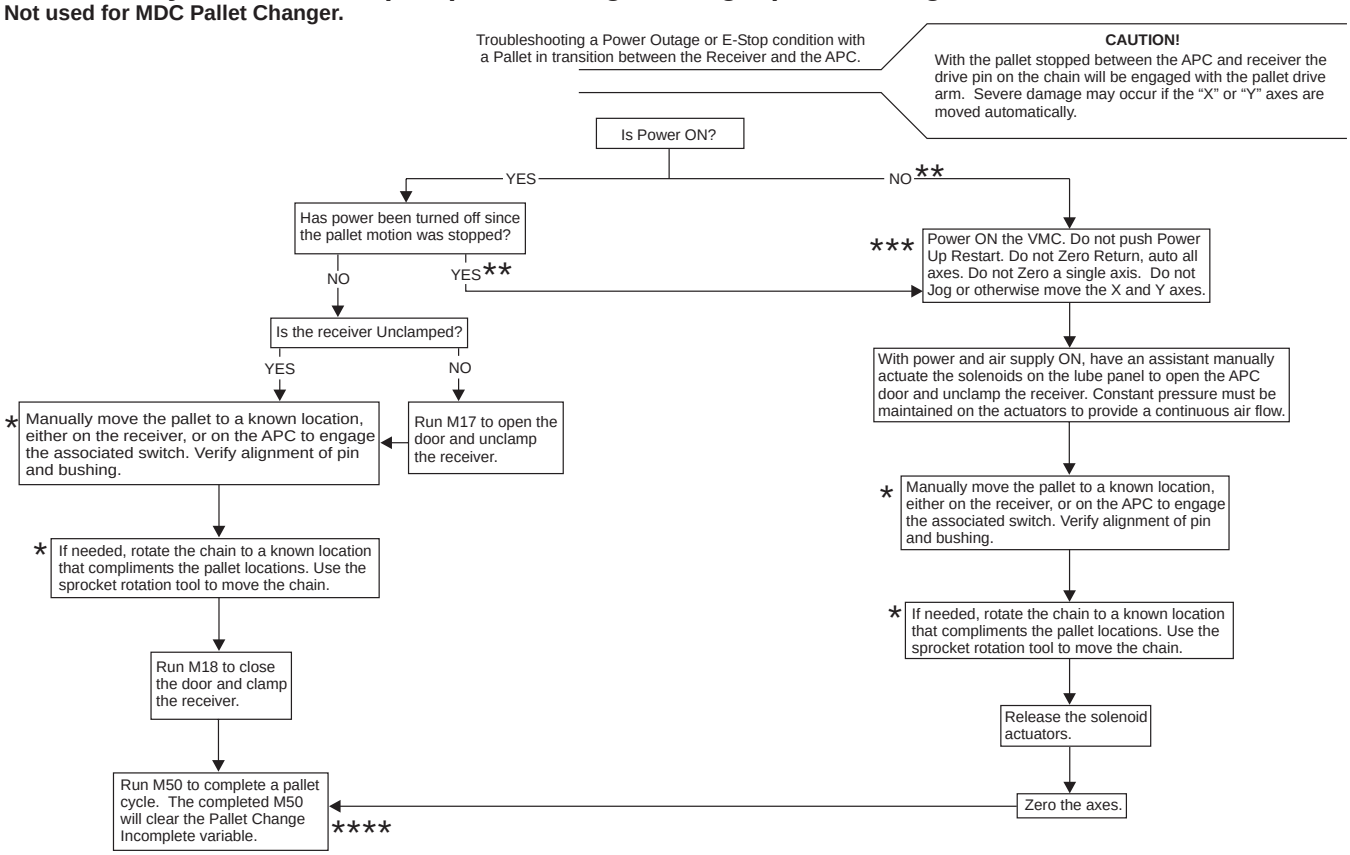
- If the APC does not run, but the mill does, check the APC control cable.
- Be sure the E-Stop jumper is removed and the APC control cable is plugged tightly into the 5th axis port.

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.

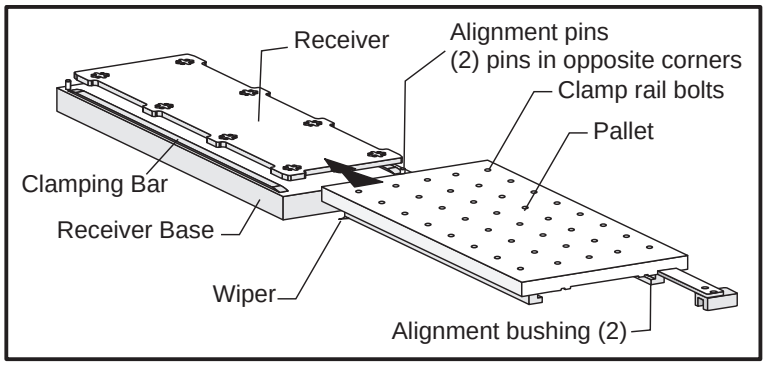
NOTE: Replaced pallets must be re-aligned to receiver. Pallets shipped with mill from the factory are machined perpendicular to the spindle. It is recommended that replacement pallets be machined after aligning them to the receiver.

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

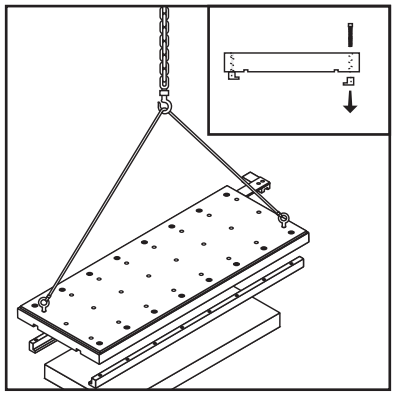
Pallet Clamp Rail Replacement

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)

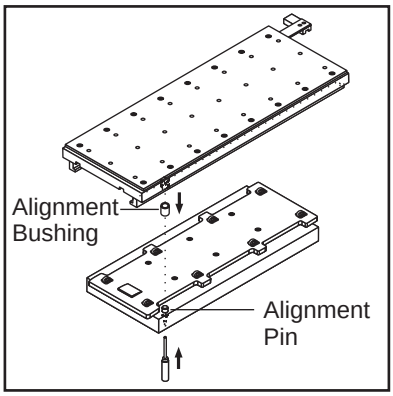
CAUTION! Be careful when changing out pallets, each weighs approx. 300 lbs.

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.

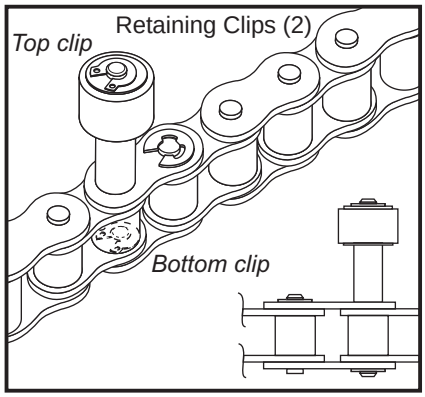
Drive Pin Replacement

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.



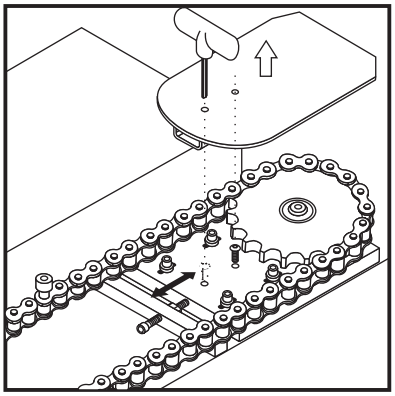
Drive Pin Assembly

3. Remove 5/16” washer.

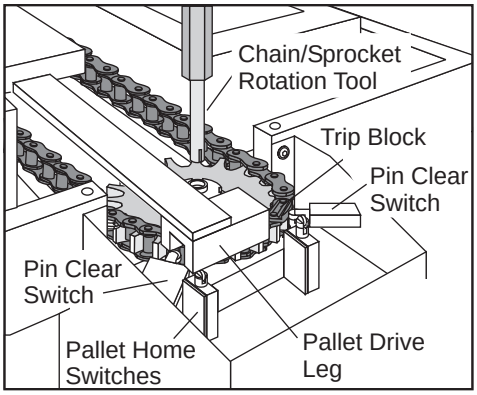
4. The cam follower is lightly pressed onto the pin. The spacer should slide off easily.

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 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 letter, 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.

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 Mobil DTE 25 using Hydraulic Hand Pump Kit.

      NOTE: Make sure its mixed with the red dye 99-4839). Use only 20ML of dye per drum. Mix the Oil for about 1 minute.

Machine Tank Size	Tank Height	Quarts of Oil	# of Pump Strokes
40 cubic feet	23”	2 per tank	93
80 cubic feet	36”	3 per tank	140
110 cubic feet	42”	3 per tank	140

      4) Pressurize with nitrogen using charge/discharge kit to specification at top of travel.

2. Machine alarms, pressure reading OK, alarm does not reset.

   Cause: I/O Board failure, bad cable or dirty contacts, switch setting too high and/or system is under pressurized due to inaccurate gauge.

   Corrective Action:

   a. Check I/O board and replace if necessary.

   b. If the counterbalance system pressure is correct and there is an E-Stop alarm that will not reset, check the cable for dirty contacts. Loose connections or a broken wire is tested by disconnecting the cable at the switch and adding a jumper across the connector pins of the cable and clear the alarm. If the alarm does not clear the cable is defective; repair or replace the cable if necessary.

3. No alarm, pressure reading low (at or below switch setting).

   Cause: Cylinder or Fitting leaks, shorted cable, switch setting too low and/or inaccurate system gauge.

   Corrective Action: As described for leaks in 1.

   a. Test for short in cable. Repair or replace if necessary.

4. Spindle Head drifts up.

   Cause: Over-pressurized due to inaccurate gauge.

   Corrective Action:

   a. Invert tank to bleed about 50 PSI of nitrogen gas. Re-evaluate machine condition.

5. Spindle Head drifts down, no alarm.

   Cause: Cylinder or fitting leaks, switch setting too low and/or system under-pressurized due to bad gauge.

   Corrective Action: As described for leaks in 1. above.

   a. Add 50 PSI of nitrogen to the system at top of travel. Does the alarm clear?

      1) **Yes:** Check if the spindle head drifts up more than 1” upon E-Stop at the bottom of travel. If it does, replace the switch.

      2) **No:** Add another 50 PSI to the system at top of travel. If the alarm still does not clear, replace the switch. If the alarm clears, check if the head drifts up more than 1” upon E-Stop at the bottom of travel. If it does, the switch is faulty.

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

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

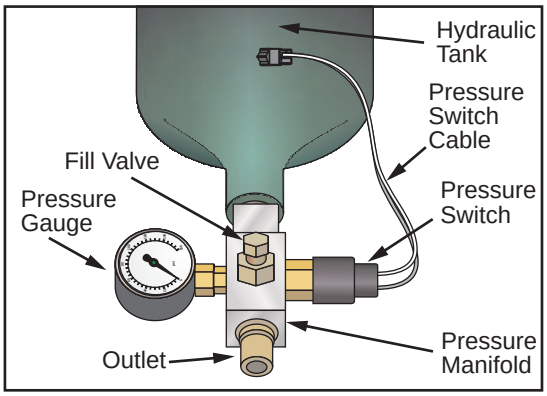
      2) **No:** Replace the pressure gauge.

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

Hydraulic counterbalance service kit, consisting of:

Pressure tank with manifold assembly, prefilled with (2) quarts DTE-25 hydraulic oil.

Hydraulic cylinder with hose attached (if necessary).



Hydraulic Tank Assembly

A placard on each machine states the correct pressure for each machine/system. Use this as a guide when troubleshooting the counterbalance system. The pressure must be set accurately in order for the system to function properly.

Leak Failures

Leaks can occur at any fitting connection, at the hydraulic cylinder’s rod seal (where the rod enters the cylinder), at the cylinder’s piston seal, or through hose failures. Inspections for leaks are visual, although rod seal leaks may be inconclusive because of way-oil spatter. Piston seal leaks, if advanced, exit the top end of the cylinder and oil can be seen at the vent area. Early piston leaks accumulate over time on top of the piston to about ¾” high before they are pushed out the cylinder at top of travel. Leaks are normally very slow and machines can operate until the pressure switch sends an E-Stop alarm.

Mechanical Diagnosis

Important! Hydraulic counterbalance oil contains red dye for easier recognition.

Noise in the system

- Slight moan or creaking at slow speeds is normal for rubber seals.
- While Z-axis is in motion, a whistle sound at tank location is normal fluid flow.
- Verify cylinder is seated correctly in counterbore. If not, reseat the cylinder.
- Bumping or grinding noise indicates a mechanical cylinder failure. Replace cylinder assembly.
- Look for galling and wear on cylinder shaft. If so, replace the cylinder assembly.

System is not holding pressure and/or has an E-Stop (Alarm 107) that cannot be reset. Check for accurate pressure readings. If low, the following items need to be checked:

- Check for leaks at all cylinder fittings. If leaking, replace cylinder assembly.
- Collapse the lower Z-axis way cover and look for any red oil pooled at the bottom of the base. If so, fittings or seals could be damaged. Replace cylinder assembly.
- Remove cylinder vent fitting. If red oil is inside the vent cavity, cylinder assembly needs replacement.
- Check for leaks at all hydraulic tank fittings. If leaking, tank assembly needs replacement.

Over Current alarms

- Pressure is set too high/low.
- Too much oil has been added (insufficient gas volume causes large pressure rise).
- Hydraulic cylinder is binding or is misaligned. Replace cylinder assembly.
- Length of replacement cylinder incorrect.

Hydraulic Tank Replacement

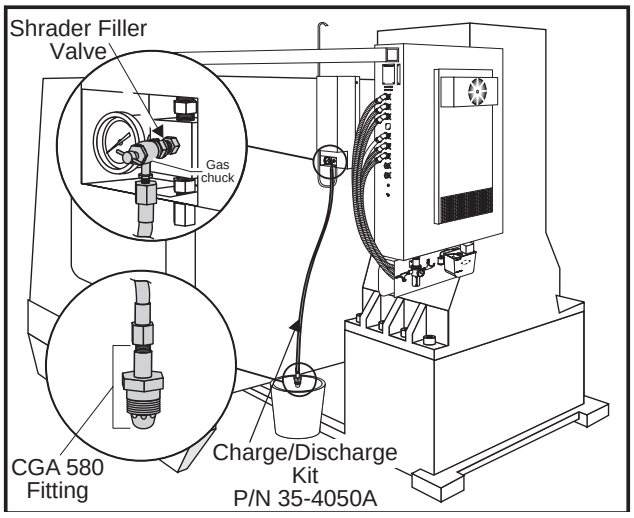
Removal

CAUTION! Spindle head may drop if the control loses power or alarms.

1. Handle Jog spindle head up to 14.5” above the table. Insert wood block and lower head casting onto it. Emergency Stop the machine. Head should rest securely on table block. Power off the mill.

NOTE: Do not lower spindle onto block.

2. Disconnect the two-pin end of the pressure sensor cable(s) to the pressure sensor(s), if equipped.



Hydraulic Counterbalance Charge/Discharge Kit (Shown in Place to Discharge System)

3. Remove cap to Schrader filler valve.

4. Ensure T-handle of the gas chuck is turned completely counterclockwise. Attach charge/discharge kit by tightening gas chuck to the Schrader valve finger tight, then wrench lightly to tighten (see previous figure).

5. Place CGA 580 end of charge/discharge kit into bucket to contain hydraulic oil while discharging system.

6. Slowly turn the T-handle clockwise until the system begins to discharge. Complete discharge may take up to 10 minutes. Verify tank gauge reads 0 PSI.

7. Turn T-handle completely counterclockwise and remove the charge/discharge kit from the Schrader valve.

8. Disconnect the hydraulic hose from the tank assembly 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.

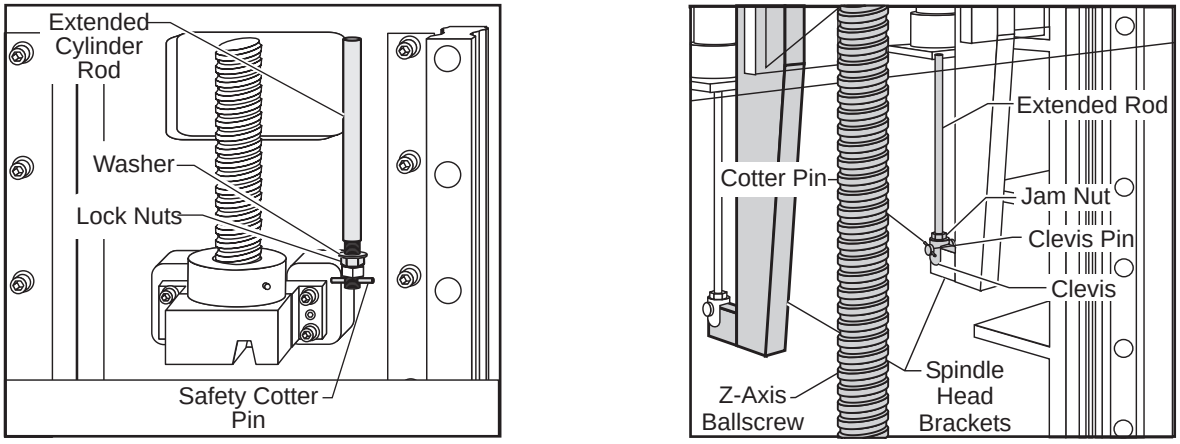
Hydraulic Cylinder Replacement

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.

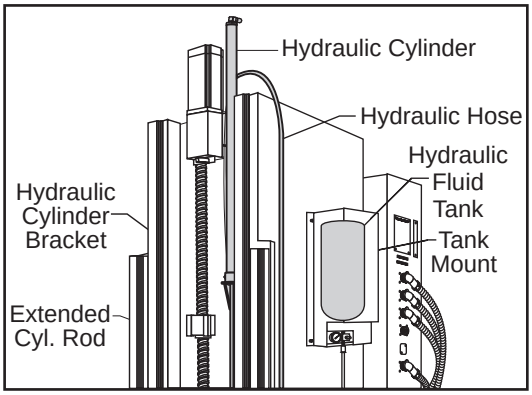
3. Remove the cotter pin and lock nuts from the threaded end of the cylinder rod.



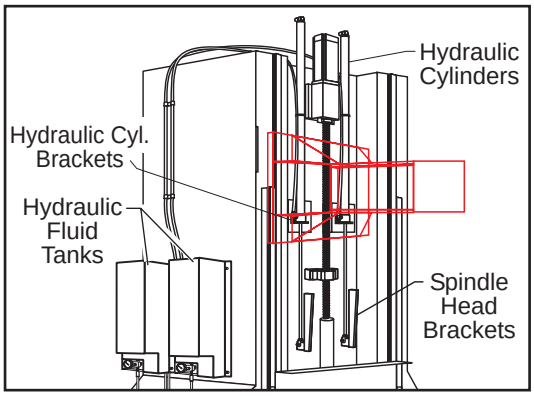
Hydraulic Cylinder Rod Installation for VF-1 through 4 and (VF-6/8)

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.

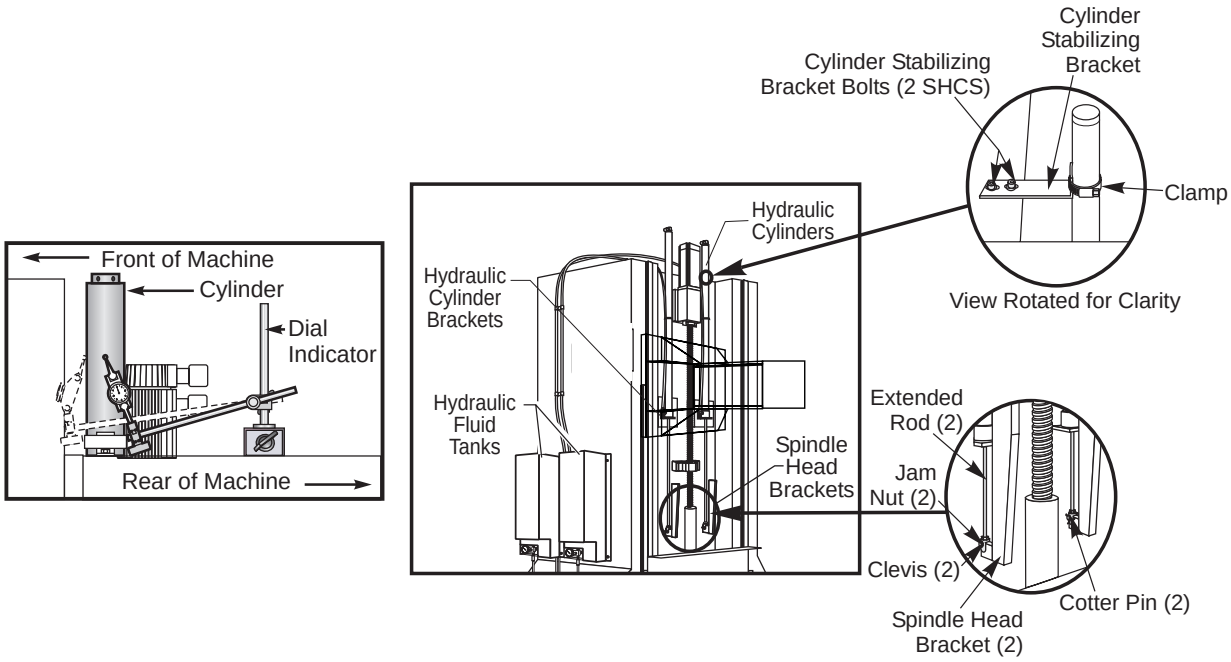
NOTE: For VF-6/8, install jam nut and clevis at end of cylinder rod, then attach to spindle head bracket with clevis pin. Install safety cotter pin and lock the clevis by tightening the jam nut.

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 indictor the same as in step 7 and position the tip of the indicator on the side of the cylinder. Jog the Z-axis up and down to verify alignment. Cylinder shift should not exceed .015 in.

9. When the side to side alignment of the cylinder is correct, tightening the spindle head brackets. Be careful not to move the cylinder out of alignment while tightening the spindle head brackets.

10. When the cylinder has been aligned correctly, finish tightening the band clamp. Be careful not to move the cylinder out of alignment while tightening the band clamp.

11. Zero return (Zero Ret) machine. Handle Jog Z-axis in 0.1 increments. Verify full Z travel.

12. Cycle Z-axis, using the following program, for five minutes, and check for oil leaking at top of cylinder and cylinder rod.

G28, G54, Z-14.
M99
50% Rapid

13. If Z-axis overcurrent alarms occur during travel, verify and correct system pressure.

NOTE: If Z-axis overcurrent alarm at top or bottom of travel, call Haas Automation Service Department immediately for assistance. If fluid leaks from hydraulic fittings, check that fittings are tight. If leaking continues, call Haas Automation Service Department for assistance.

14. Reinstall Z-axis way cover with three SHCS that hold it to the spindle head.

Hydraulic Power Unit (HPU) (Lathe)

Troubleshooting

Hydraulic Pressure - "Low hydraulic pressure" Alarm (134)
- Check for any leaks.
- Check that the oil level is above the fill line.
- Check that the temperature is less than 150°.
- Voltage phasing changes cause the HPU to change directions, resulting in Alarm 134.
- Make sure the filter has been replaced within the last 6 months.
- If pressure drops below 40 PSI during activation of chuck or tailstock, an alarm will occur.

Hydraulic Chuck - Chuck won't clamp/unclamp.
- Check for alarm condition.
- Check display for "Low Hydraulic Pressure" Alarm (134).
- Use a voltage meter to check the solenoid circuit breaker; replace if faulty.

Noise in HPU

NOTE: Noise in HPU should decrease a few minutes after start up

- Check for leaks in hose.
- Check that the oil level is above the fill line.
- Check for loose pieces/hardware, or debris in motor/cooling fins.
- Remove, clean, and reinstall adjustment valves.

Tailstock pulsates as it moves
- Check operating pressure (**minimum operating pressure is 120 PSI.**).
- Check for leaks at hydraulic cylinder.
- Check for leaks at hose fittings.

HPU Removal/Installation

CAUTION! **Power off** the machine before removal or installation.

Removal
1. Remove necessary panels to access the HPU and Drain the hydraulic fluid.

2. Disconnect the hydraulic hoses. Be sure to mark the positions of the hoses so they can be put back to their original fittings

3. Disconnect the cables.

4. Remove the four bolts from base of unit, then slide HPU out.

Installation
1. Position the HPU in place, and secure with four mounting bolts.

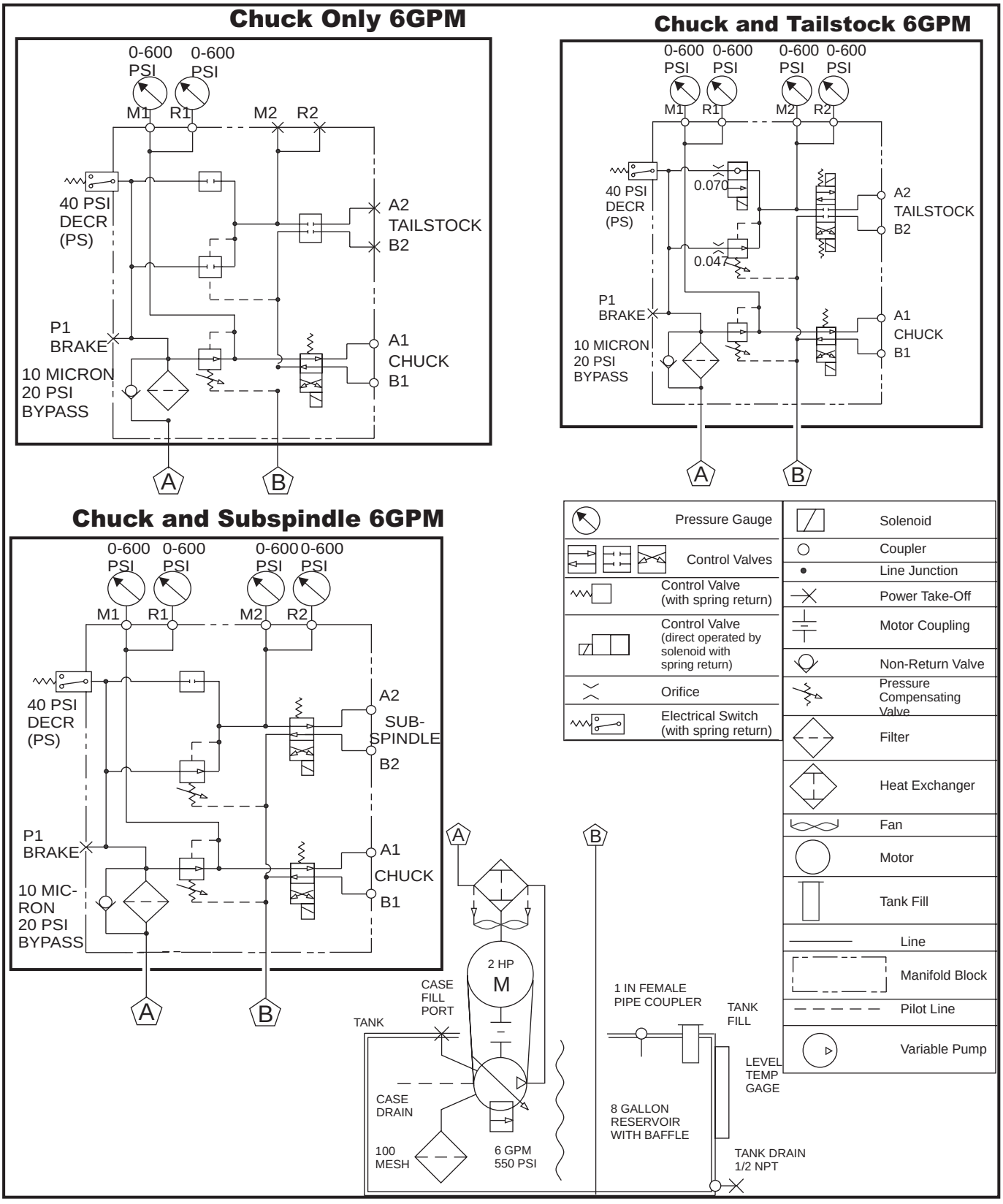
2. Connect pump motor, pressure switch, and solenoid valve cables

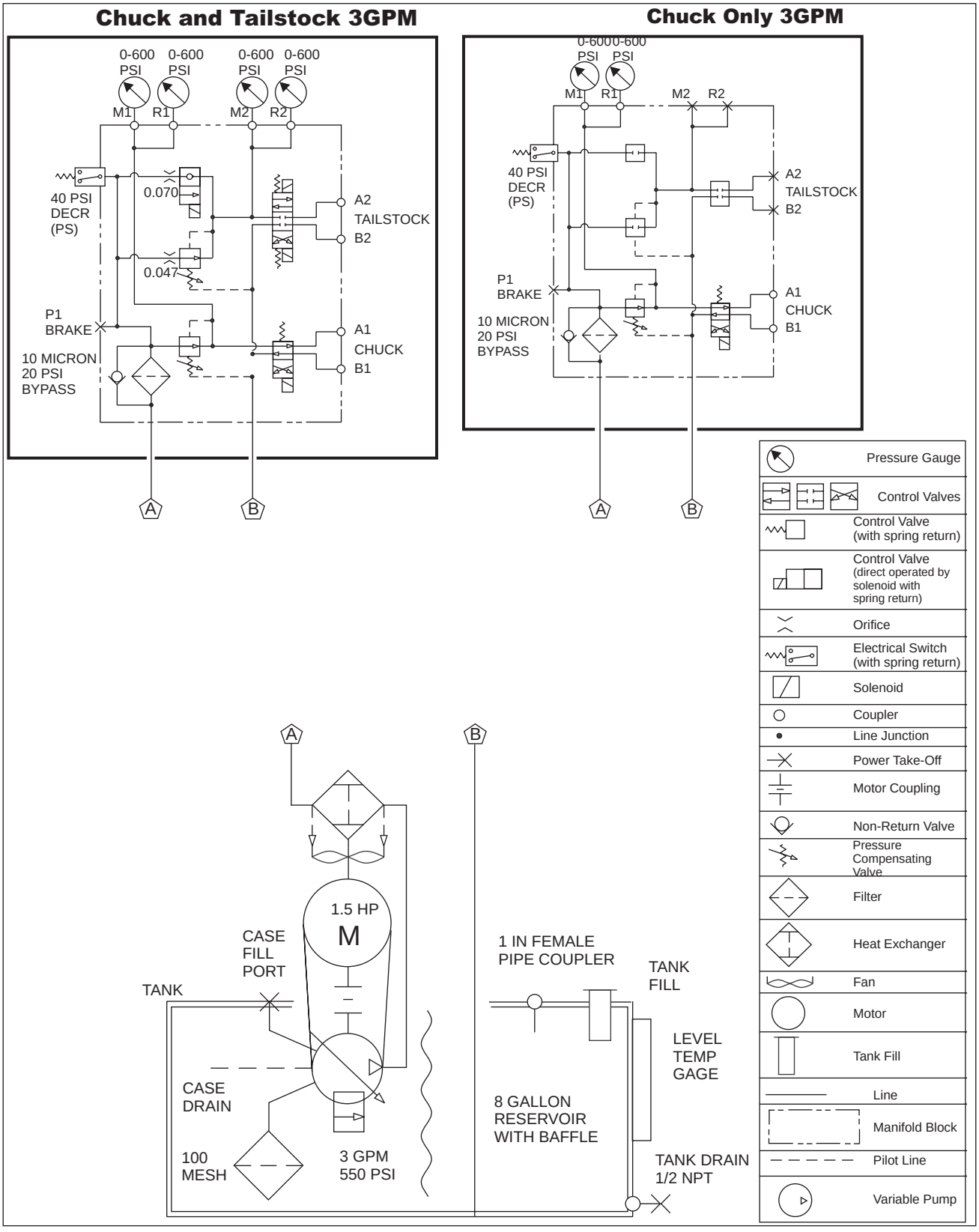
3. Replace the hydraulic hoses.

4. Fill the HPU with DTE25 to the top of the sight glass.

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

SL-Series Hydraulic Schematics





4th Axis Repair (Horiz.)

Ring Gear Installation

1. Lubricate and stone the mating surfaces of the platter and ring gear. Wipe clean to remove grease and contaminents.

2. Clean the mating surfaces of the platter and ring gear with alcohol.

CAUTION! The ring gear is a precision-machined piece. Take care in handling it. Do not drop it or set it heavily on the teeth.

3. Install eyebolts into the top of the ring gear. With an assistant, lift the ring gear by the eyebolts and place over the platter.

4. The ring gear is an interference-fit item and will need to be clocked properly prior to the next step. If necessary, adjust the position of the ring gear so that all the bolt holes line up exactly.

5. Apply a drop of 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 machine air. 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 connect fitting. 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 inside the rotary assembly ring gear, making sure the hose is routed through the hole in the bottom of the saddle.

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.

Caution: Do not actuate the brake assembly outside of the ring gear. The brake ring will permanently deform and become unusable.

11.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.

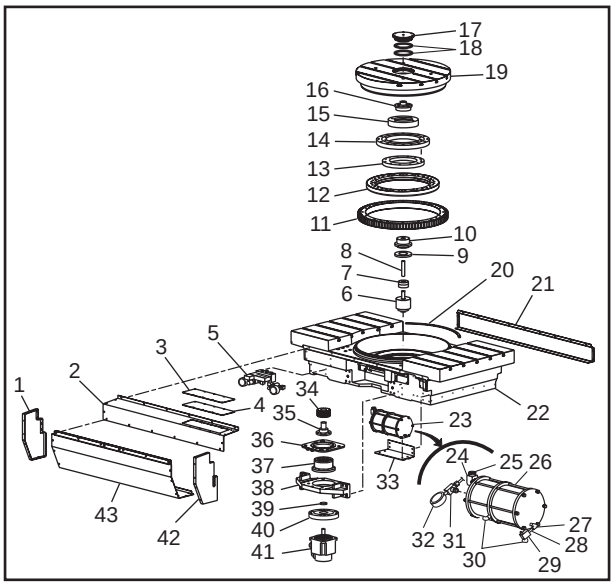
1. Power off the machine and remove the indexing platter from the table using a proper lift and lifting plates. The brake assembly and fly-wheel will be exposed underneath.

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. Air pressure higher than 1000 PSI will permanently damage the clamp ring.

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. Tighten the bleed valve.



4th Axis Air Valve Assembly

This section applies to machines with serial number 51004 and later.
The Air Valve Assembly has three main components: 3-Way Air Valve, High-Pressure Fixed Regulator, and Low-Pressure Regulator.

The air valve assembly actuates the rotary table brake. Supplied air flows though the high-pressure regulator (45 PSI) to supply the high-side of the brake valve pressure booster. This supplies 40:1 hydraulic pressure boost to expand the hydraulic pump. When the clamp is released, a valve switches the supplied air into the low-side of the pressure booster. This action returns the pressure booster piston to its original position and refills the hydraulic cylinder from the reservoir. This is a closed hydraulic system. A 45/20 PSI pressure differential is used to prevent air leaking into the pressure booster.

Assembly

Individual assembly of the 3-Way Air Valve, the High-Pressure Regulator, and the Low-Pressure Regulator component parts is necessary and is not detailed in this Service Manual.

1. Apply a small amount of thread sealant to the threads of the high-pressure regulator assembly and attach to the 3-way air valve. Orient the regulator to match the position of the part removed.

2. Apply a small amount of thread sealant to the threads of the low-pressure regulator assembly and attach to the 3-way air valve. Orient the regulator to match the position of the part removed.

3. Attach this assembly to the mounting plate using 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 (25 PSI) to the air valve assembly. Supplied air is preset to 25 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.

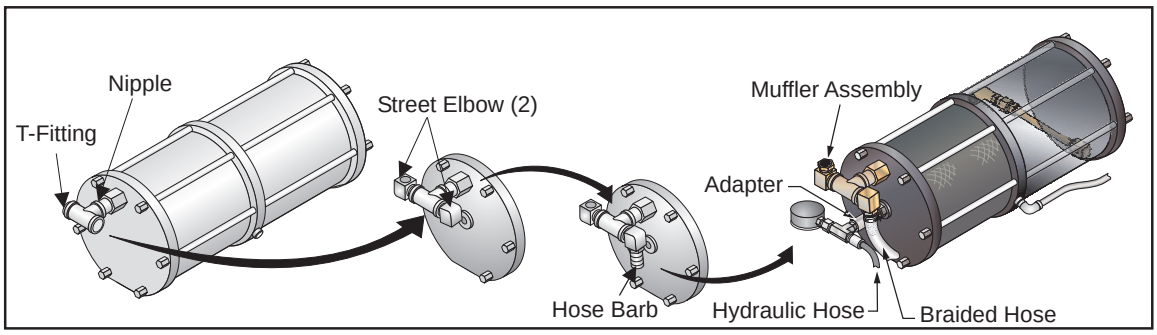
The pressure booster comes packaged with extra components not needed for its proper operation in this application. Where applicable in the following steps, use a small amount of thread sealer on all pipe threads.

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.

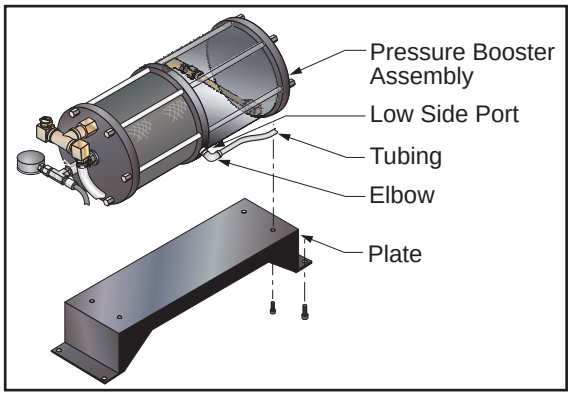
9. Remove the plug in the center hole of the pressure booster. Thread a #4 SAE to NPT female adapter (new part) into the center hole.

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.

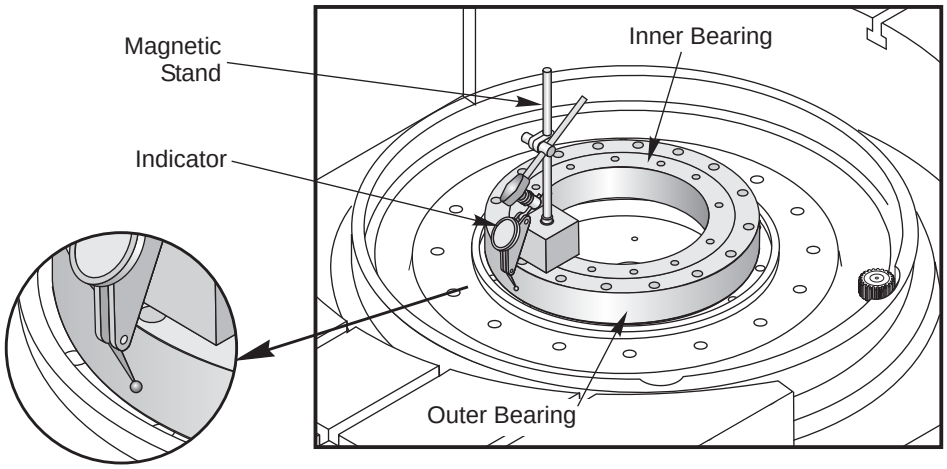
5. Insert the SHCS by hand through the bearing and into the table.

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.

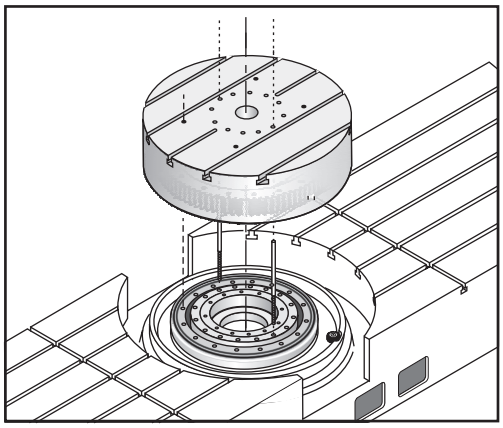
Installation

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:

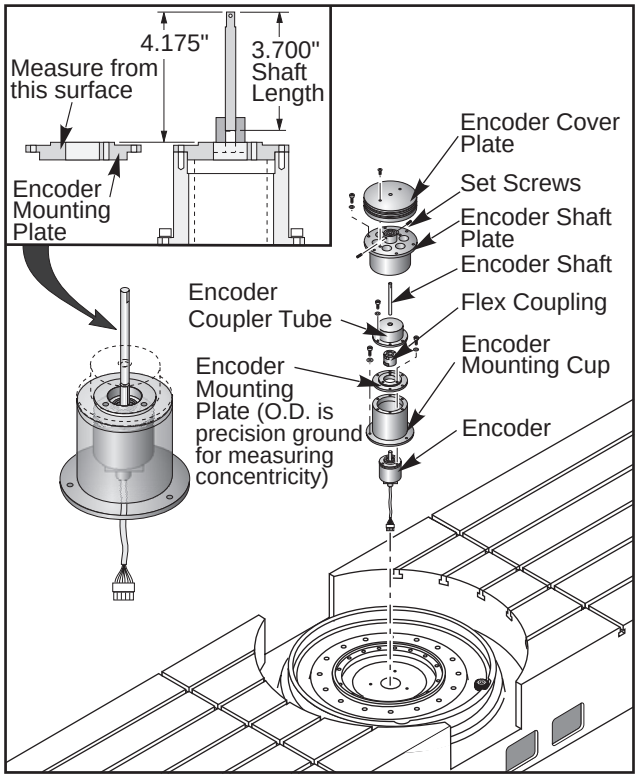
1. Verify the encoder mounting plate inserts into the encoder mounting cup without binding. The contacting surfaces must be burr-free.

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

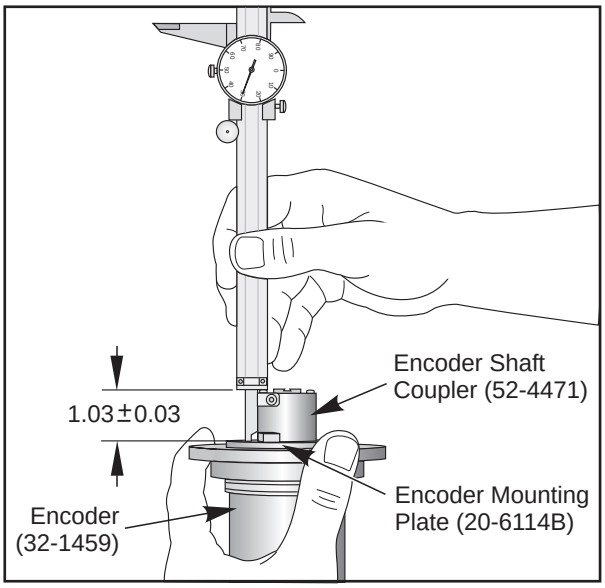
1. Install the encoder mounting cup with one 0.005 shim washer (45-0057) under each screw location.

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 reciever will be parallel to the X-axis. See the "Receiver Replacement" section

3. Tighten, then torque, the sixteen (16) SCHS that fasten the rotary body to the trucks. Tighten the 5 ball nut bolts allowing the housing to re-align, then torque the 10 housing bolts. After the housing bolts have been torqued, loosen the 5 ball nut bolts and run the ball nut away from and back to the motor. If no binding occurs, re-tighten the ball nut bolts.

EC-1600/2000/3000 5-degree Indexer Fine Adjustment

1. Tap the platter into position within .001" alignment between the platter and the table T-slots.

2. Torque the sixteen (16) SHCS to 45 ft-lbs in a star pattern and re-verify alignment.

3. Place plugs in the fastener holes in the platter to prevent coolant and chips from contaminating the encoder/clamp area.

Full 4th A Axis Offset (EC-400/500/630/1600/2000/3000, HS-3R/4R/6R/7R)

1. In Debug mode (Pos-Raw Dat screen), go to Parameter 212 (224 for EC-630/1600/2000/3000), enter "0" and press Write/Enter.

2. Zero the A-axis only by pressing the Zero Ret key, then the A key, then the Zero Singl Axis key.

3. Go to debug mode and type "GRID" followed by a space and then "A".

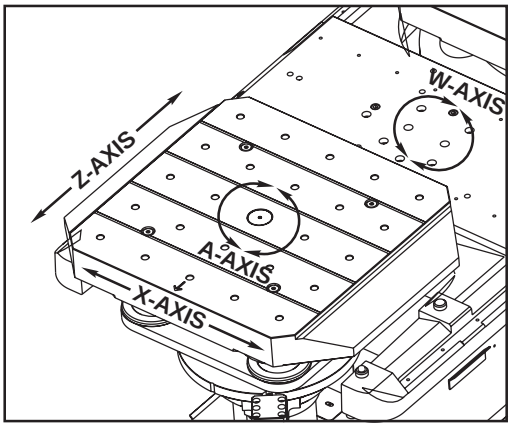
4. Jog the A-axis to line up the front edge of the pallet (EC-400/500) or the T-slots (EC-630/1600/2000/3000, HS-3R/4R/6R/7R) with the X-axis to a value of .0005/10.00".

5. Enter actual value from Pos-Raw Dat screen into Parameter 212 (224 for EC-630/1600/2000/3000).

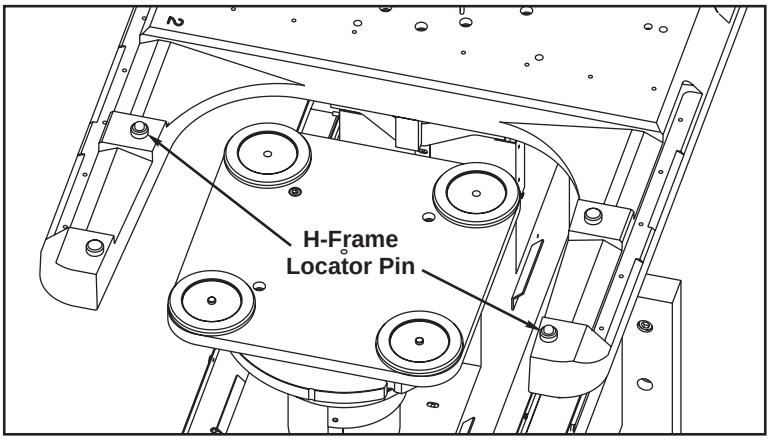
H-Frame Pallet Alignment (EC-630)

Horizontal machine axes:

X, Y, Z -Traditional HMC machine axes. A - Rotary table rotation. W - APC H-Frame rotation.



CAUTION! A, W and Z axes must be zeroed as described. Zero-position greatly influences pallet location relative to the H-Frame. Machine damage results if the H-Frame attempts to lift a pallet without being properly aligned.



A-Axis Alignment and Parameter Settings (EC-630)

Prior to aligning an A-Axis, verify and record Setting and Parameters for the appropriate configuration.

- Run Parameter Checker to call out any incorrect parameter settings for the machine's configuration.
- Verify that the Setting 30 value is USER1 for all configurations (1 and 45 deg. indexers and Full 4th).
- Verify Parameter 647 for Indexers (1 deg. = 1000; 45 deg. = 45000).
- Set Parameters 128 & 224 to zero for all configurations.

NOTE: For Full 4th Rotary Axis Alignment, see Full 4th A Axis Offset on previous page.

Indexer Rotary Axis Alignment

The rotary indexer incorporates a 1 deg. Hirth coupling to accurately position the pallet in 1 deg. increments. This alignment procedure must be followed to properly align the teeth on the 2-piece coupling so that they engage smoothly without any noise or jerky motion.

1. Attach the Lift Fixture

   • Tool 15-1604 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.

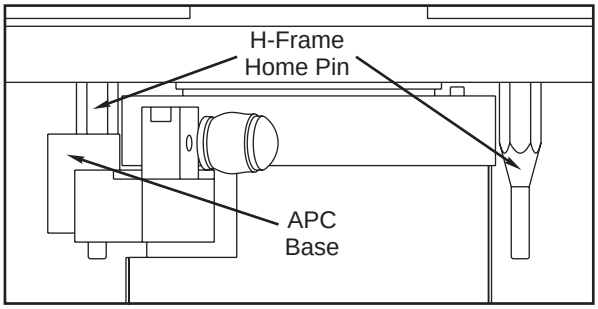
- When the value begins to increase, stop and back up until the fuse value stays constant and record the A-Axis actual encoder count.
- Add the two readings, divide by two, and subtract or add as required to the value in Parameter 224.
- Repeat the handle jogging until the difference between encoder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

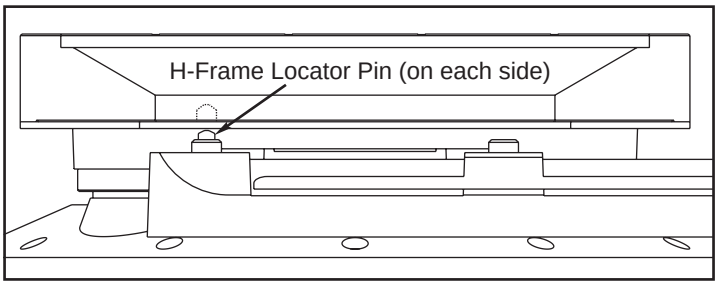
Calculate the number midway between these two values and enter it as the tool change offset parameter.

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.

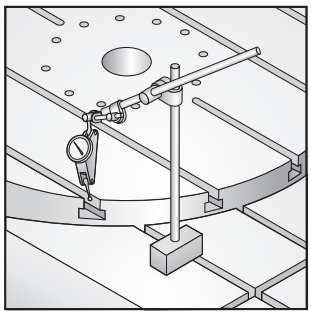
A-axis Backlash

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° for 360°. Reposition the indicator each time. Backlash should be between .0005” and .0007”. If it is not within this range, perform the following adjustment procedure.

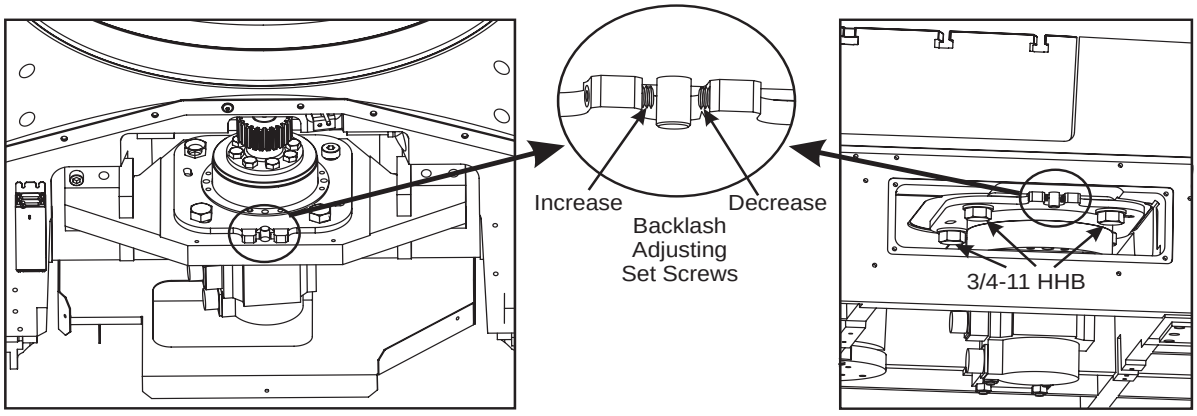
Backlash Adjustment (EC630-1600-3000)

1. Command A-axis brake to disengage. Enter MDI and command an M11. Do not disconnect air to machine.

2. Disable the A-axis encoder by setting the Parameter 269 bit 1 (lin scale en) to 0. 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° for 360°. Find tightest of spots and set indicator up as before.

9. Tighten the left adjusting set screw until the backlash is between .0005” and .0007”.

10. Snug the right adjusting set screw against the pin.

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

11. Tighten the 3/4-11 hex bolts that mount the cam backlash adjuster (motor plate).

12. Recheck backlash. If adjustment is necessary, loosen the plate’s hex bolts and adjust with the set screws.

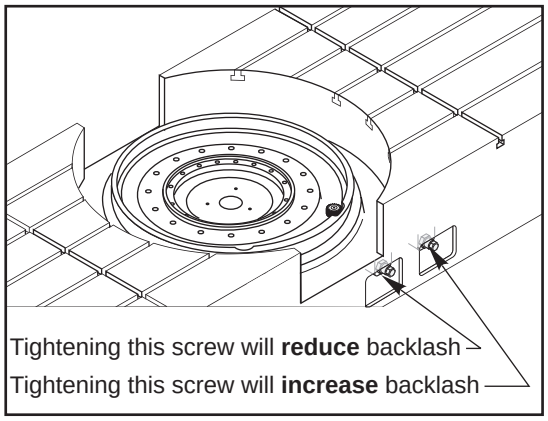
A-axis Backlash adjustment (HS 3R-7R)

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 269 bit 1 (lin scale en) to 0. 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.

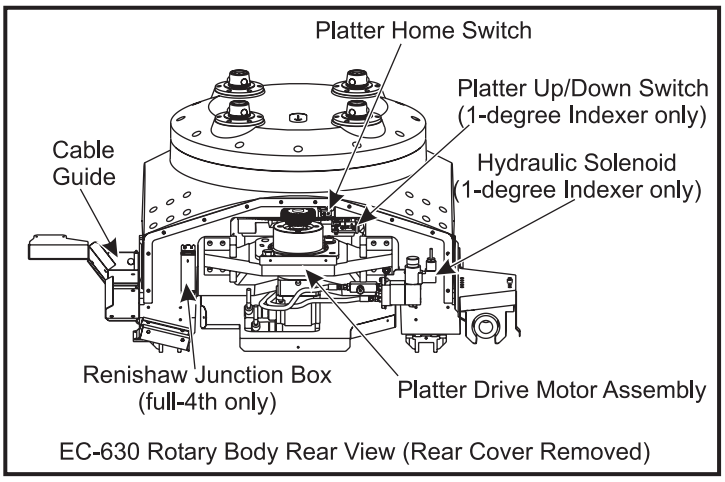
5. Index bearing housing one set of holes. Move to next set of holes by rotating hole set upward (toward the platter), either CW or CCW. Bolt bearing housing flange down. Torque bolts to 25 ft-lb. Check backlash in each of the four quadrants. Factory specification is 0.0003” to 0.0007”. If necessary, 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.

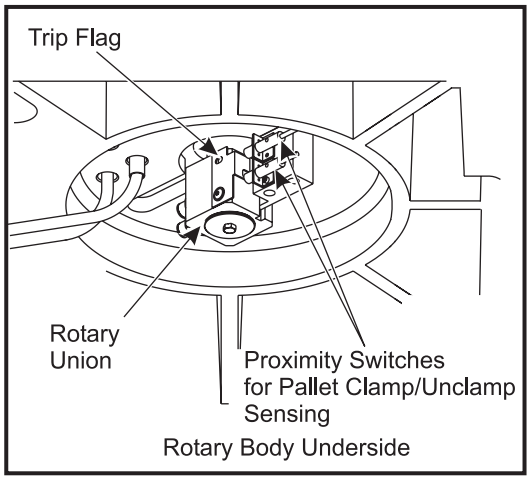
7. Remove the oil filler pipe plug. If the oil level covers less than half of the sight glass, refill the gear case with Mobil SHC-630 gear oil to the midpoint of the oil level eye and reinstall the oil filler pipe plug.

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 Rotary Body Rear View (Rear Cover Removed)



Rotary Body Underside

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 4th rotary only), backlash plate and pinion gear are removed as a unit along with the platter drive motor mount. Disconnect the motor cables, remove the eight 1/2-13 x 1.75” SHCS that hold the motor mount in place, and slide the assembly back, off of the alignment dowel pins.

CAUTION! This assembly weighs over 100 lbs. Do not attempt to remove it without assistance.

Pallet receiver clamp/unclamp solenoid (52-0159) (1° indexer only)

This solenoid is mounted to the main casting of the rotary body, to the right of the platter drive motor assembly. The hydraulic flow control valve, mounted between the hydraulic pressure line and the solenoid, is factory-set and should not require adjustment.

Replacing the solenoid:

1. Shut off hydraulic power and ensure that no pressure remains in the system.

2. Disconnect the pressure and return lines from the solenoid.

3. Remove 1/4-20 x .75” SHCS that secure the solenoid to the mounting bracket. Install the new solenoid.

4. Reattach hydraulic lines and bleed the hydraulic system.

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

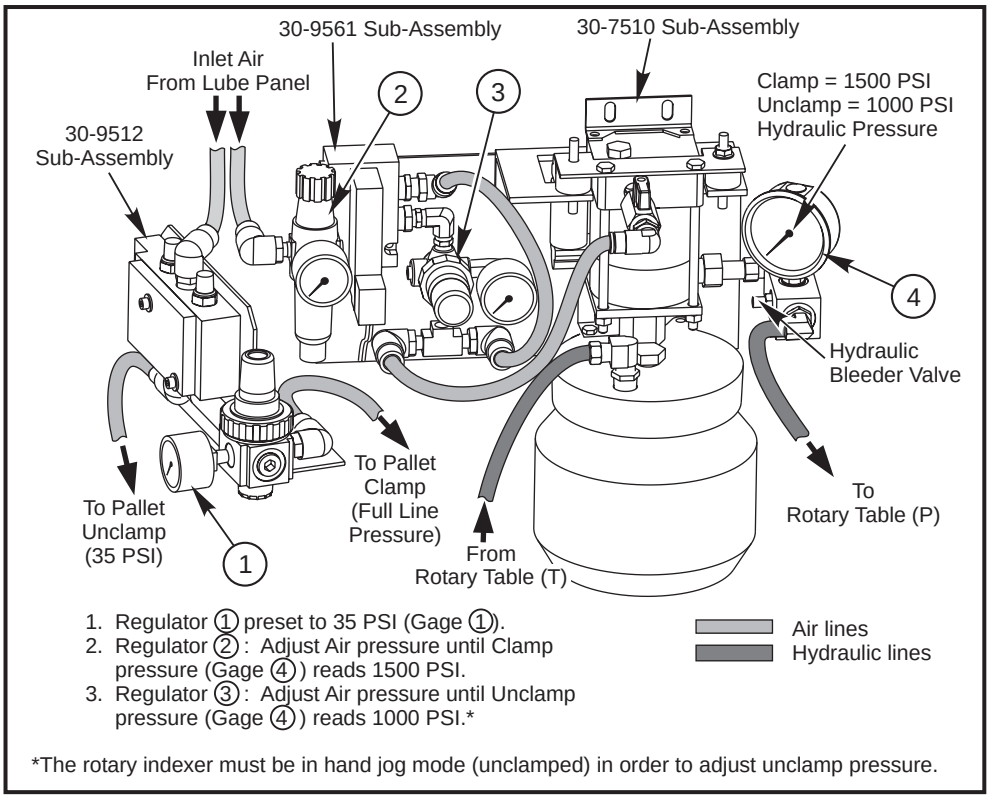
This switch is located at the bottom end of the pallet receiver shaft. Two switches are activated by a trip flag attached to the rotary union at the end of the shaft to indicate pallet clamped or unclamped conditions. Adjust the switch trip flag by loosening the 1/4-20 x 0.5” BHCS, moving the trip flag, 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.

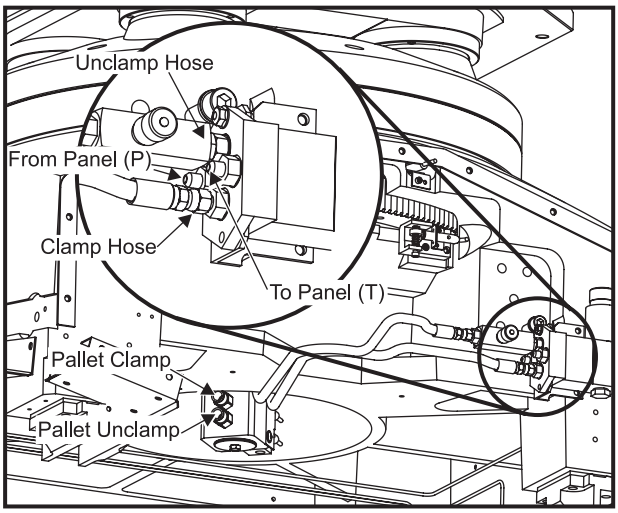
Hydraulic / Pneumatic Connections

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

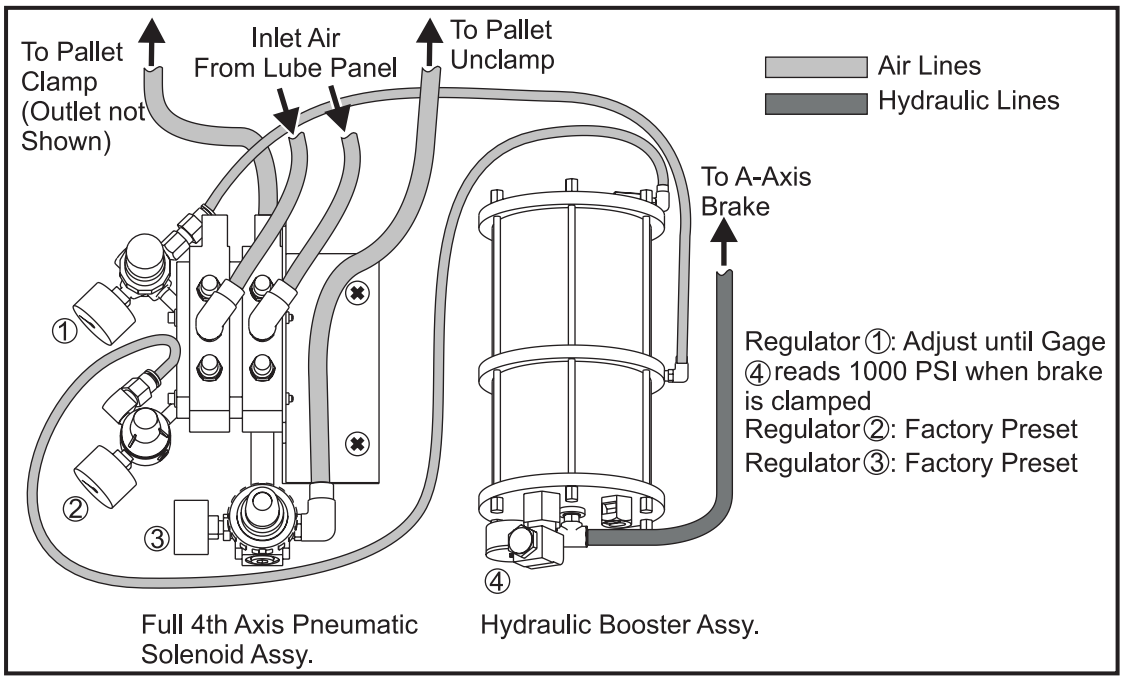


The 1-degree indexer panel consists of three discrete assemblies: A clamp/unclamp solenoid valve assembly (30-9512), an air solenoid assembly (30-9561), and a liquid pump assembly (30-7510). Reconnect hoses to the rotary body according to the following illustration. Ensure that hydraulic lines are properly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

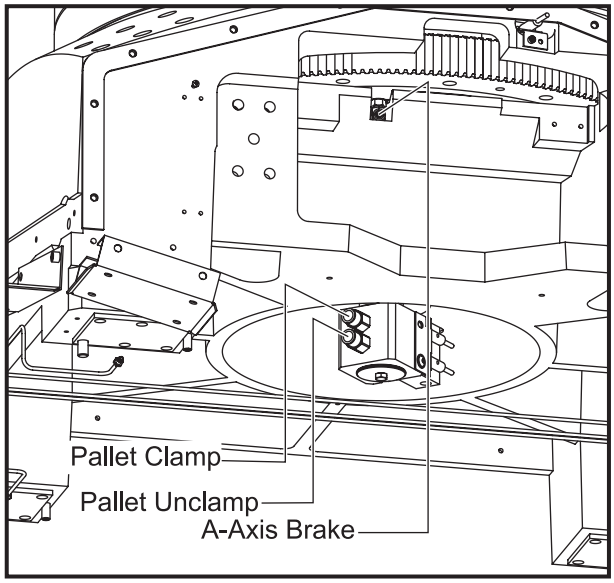


Full 4th Axis

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:



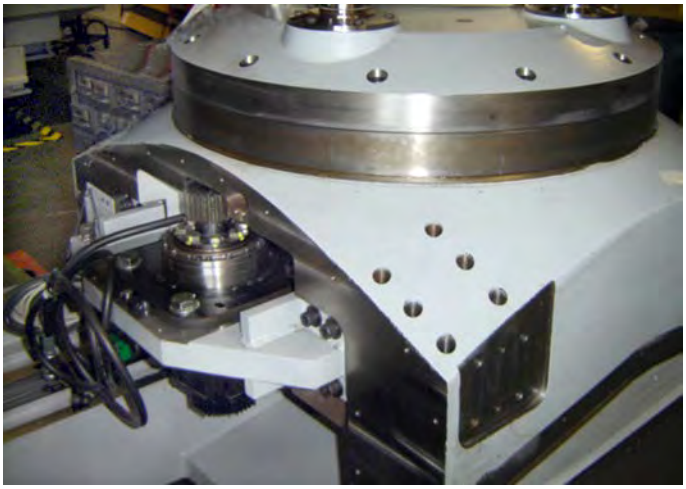
Connect full 4th hoses to the rotary body as shown. Ensure that hydraulic lines are properly bled.



Full 4th Axis Service /Platter Remoal

1. Disable A-axis scale encoder. Change parameter 269 bit 0 (Enable Linear Scale) to 0 (zero). Cycle power so the parameter change will take effect.

2. Remove the two rotary covers. There is one over the motor and one under the rotary axis.

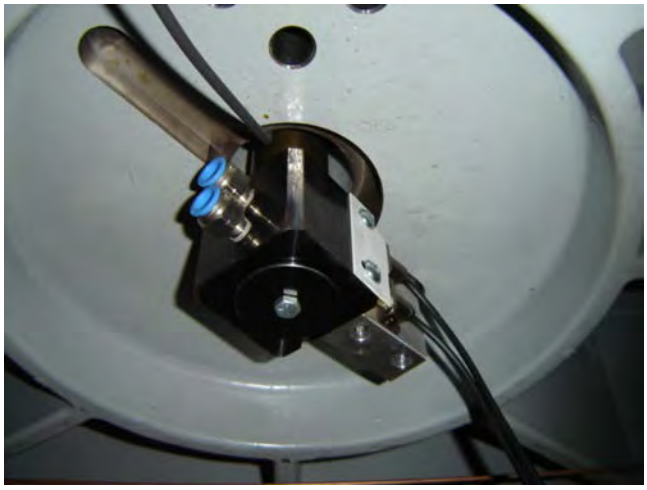


4th axis with covers removed

3. In MDI mode command M11 to unclamp the brake.

4. Disconnect the air to the machine.

5. Loosen the three 3/4-11 hex head bolts that attach the motor plate. Do not loosen the shoulder bolt (it acts as a pivot for the adjusting backlash).



Clamp/Unclamp Switch Block

6. Use the backlash adjusting setscrews to loosen the backlash as far as possible.

7. On the bottom side of the rotary, remove the pallet clamp/unclamp switch block and rotating union from the clamp shaft. Make sure to remove the thrust washer that is installed above the union.

8. Remove the twelve retention balls from the four clamping cones using a magnet.

9. Remove the twelve 5/8-11 bolts that fasten the cap to the platter.

10. Use 1/2-13 swivel shackles or eye bolts, to lift and remove the cap. Note: the clamp cylinder may come up with the cap. The cylinder is not fastened to the cap and should be removed separately.

Axis Cap

Clamp Assembly

11. Use 1/2-13 swivel shackles or eye bolts, to lift and remove the clamp assembly.

12. Remove the twelve 3/8-16 platter bolts.

13. Install two 3/8-16 x 10” guide pins, such as a 3/8 bolt with the head removed or a length of threaded rod. This will help guide the platter up and off of the brake assembly with minimal binding.

14. Using 5/8 lifting shackles or eye bolts, rig and lift the platter. Set up the lifting bolts and chains so that the platter will lift as level as possible. If the platter is binding it may be necessary to tap the platter with a large wood block, or a mallet with a piece of wood between the platter and the mallet.

Clean and inspect the area under the platter. Make sure there is no damage to the brake and that the bearing turns freely.

Replace all O-rings and re-assemble the A-axis components in reverse order.

15. Enable A-axis scale encoder. Change parameter 269 bit 0 (Enable Linear Scale) to 1. Cycle power so the parameter change will take affect.

Note: When the platter is installed it is necessary to align the encoder scale to insure it is concentric to the bearing/platter rotation. If this is not verified and the scale is not properly aligned (concentric), damage to the scale and read head will occur. See the Rotary Scales section of the service manual.

16. After the platter is bolted in and the scale concentricity is verified, A-axis backlash can be adjusted.

17. Check backlash every 20 degrees. Adjust the A-axis backlash to .0005-.0007” at the tightest point.

Note: If a new ring gear is installed, run in the A-axis for 8 hours to run-in the new ring gear. Verify and adjust the backlash as needed.

EC-550 and EC-630 Rotary Scale Service

The EC-550 rotary assembly uses a scale system to correct for eccentricity in the assembly. This document details installation and calibration of the system for service.

Inspection / Replacement

1. Jog the Z Axis to its full extent away from the spindle.

2. Disassemble the pallet receiver assembly down to the inner surface of the rotary platter (see mechanical service manual).

3. Inspect the rotary scales system. Check for damage to the read head and scale ring. Open the small access door located below and to the left of the operator door. Locate the rotary scale control box mounted on the bracket at the end of the Z-axis carrier cable. Inspect the box and all cabling for damage. If any part of the system is damaged, the entire system must be replaced.

Removing the installed scale

1. **IMPORTANT:** Note the orientation of the installed rotary scale ring and read head. The new scale ring and read head must be installed in this same orientation.

2. Remove the read head, read head mount, and scale ring from the hub of the rotary platter.

3. Through the small access door located below and to the left of the operator door, disconnect the signal and power cables from the interpolation box and remove the interpolation box from the bracket.

Installing the new scale

1. Install the new rotary scale to the top of the bearing ring, matching the orientation previously noted. Install all fasteners but leave them loose.

2. Install the read head mount to the top of the read head bracket with two 1/4-20 screws.

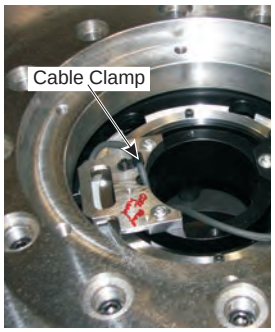
3. Secure a magnetic base and indicator to the read head mount, and indicate the outer diameter of the scale ring. Adjust the scale ring until it is concentric to the cross roller bearing to within 0.0004” total indicated runout.

4. When concentricity is achieved, tighten the ring fasteners to 8 ft-lbs and recheck runout.

5. Install the read head to the read head mount and evenly gap it to the rotary scale ring with a .006” shim.

6. Install the cable clamp to the top of the read head and route the cable through the center of the rotary platter and out to the bracket at the end of the Z Axis cable carrier.

Indicating the OD of the scale ring



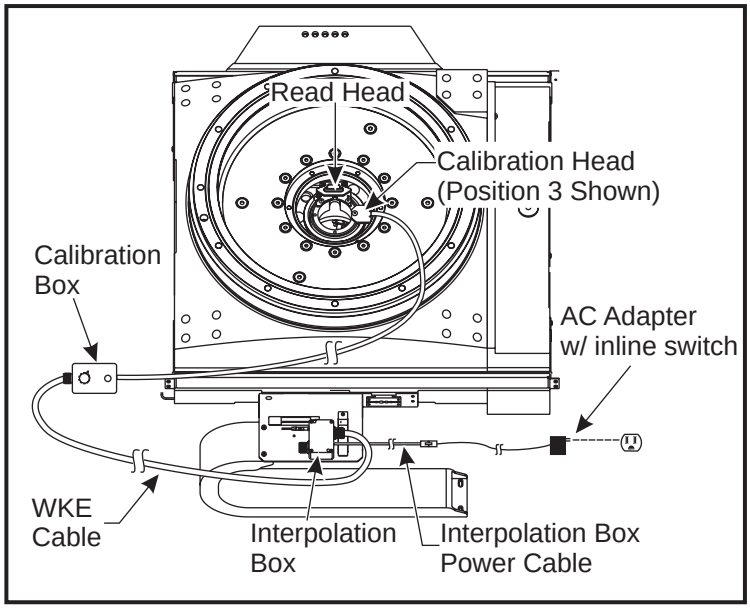
Read Head Cable Clamp

7. Secure the new interpolation box to the bracket and connect the read head and power cables.

Calibration

Rotary scales must be calibrated before initial use and at any time that the rotary assembly is disassembled for service or if the system is not providing adequate correction.

Calibration Head Installation



Calibration Setup

The calibration kit includes:

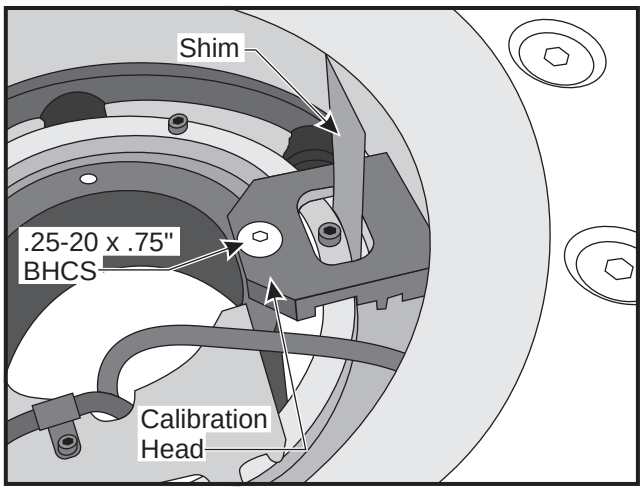
Calibration Head with cable to Calibration Box
WKE cable to connect Calibration Box to Interpolation Box
Shim material (.0059”)
AC Power Adapter

1. Jog the Z-axis to its full extent away from the spindle.

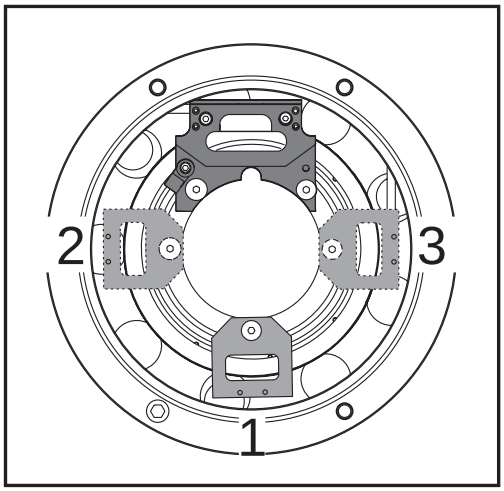
2. Power off the machine.

3. Disassemble the pallet receiver assembly down to the inner surface of the rotary platter. Remove the center seal disk.

4. Install the calibration head in calibration position 1, directly opposite the read head. Gap the calibration head and rotary scale ring with the .0059” shim included in the kit (see illustration). Secure the calibration head with one .25-20 x .75” BHCS until snug but allowing the shim to be removed easily.



Calibration Head Installation



Calibration Positions

Caution: Make sure the calibration head cable clears the socket heads in the rotary scale ring. Also ensure that the cables will not become entangled.

5. Disconnect the cable (33-10027) from the port marked “Output 1” on the interpolation box.

6. Connect the cable marked “WKE Adapter” between the calibration box and the port marked “Input WKE” on the interpolation box. Keep the cap for the WKE port on the scale control box in a safe place.

7. Trace the white power cable from the interpolation box along the Z-Axis cable carrier to its end, then disconnect the cable and pull the plug out of the cable carrier. Connect the power adapter to the end of the interpolation box power cable, then plug the adapter into an AC outlet (The GFCI outlet on the mill’s control cabinet may be used, if available).

Calibration Procedure

1. Power on the machine.

2. Change Parameter 269 bit 0 to “0”.

3. Copy the program given at the end of this document into the control into MDI.

Note: The sequence of operations in this procedure is very important to ensure that the calibration is successful. Deviating from the sequence will result in errors, requiring that the entire procedure be repeated.

4. Rotate the knob on the rotary scale calibration box to the position marked “Cal_Pos_1”.

5. Cycle power to the calibration box five times using the inline AC adapter switch, leaving it in the ON position. Verify that the LED on the calibration box blinks steadily.

6. Set rapids to 5%.

7. Run the program. The rotary platter will begin to rotate 720° after a short dwell. Watch the LED on the calibration box; it will begin to blink rapidly when data starts recording. When complete, the LED will go dark, but allow the program to complete before continuing.

Note: Avoid impact with or vibration of the rotary body while calibration takes place.

8.When the program is complete, turn off the calibration box using the inline AC adapter switch.

9. Move the calibration head to position 2, installing as described in the Installation section.

10. Rotate the knob on the calibration box to the position marked “Cal_Pos_2”.

11. Turn on power to the calibration box using the inline AC Adapter switch. Verify that the LED blinks steadily. If it does not blink, an error has occurred and the entire calibration procedure must be repeated.

12. Run the program. Verify that the LED begins to blink rapidly, then goes dark when complete. Allow the program to complete.

13. Turn off the calibration box.

14. Move the calibration head to position 3, installing as described in the Installation section.

15. Rotate the knob on the calibration box to the position marked “Cal_Pos_3”.

16. Turn on power to the calibration box. Verify that the LED blinks steadily. If it does not blink, an error has occurred and the entire calibration procedure must be repeated.

17. Run the program. Verify that the LED begins to blink rapidly, then goes dark when complete. Allow the program to complete.

18. Turn off the calibration box.

19. Calibration is complete. Remove the calibration head and disconnect the calibration box from the interpolation box. Reinstall the cap to port “Input WKE” on the control box, and reconnect cable 33-10027 to port “Output 1”.

20. Disconnect the AC adapter from the control box power cable, but do not reconnect it to the machine cable yet.

21. On the control, set Parameter 269 bit 0 to “1”, and verify that Parameter 269 bit 16 is set to “1”. Route the interpolation box power cable back through the Z-Axis cable carrier to the machine power cable and reconnect.

Validation Procedure

1. Zero return the A-Axis.

2. Install a dowel pin in one of the threaded holes on the rim of the rotary platter.

3. Set a dial indicator against one side of the dowel pin.

4. Zero the indicator.

5. Copy the validation program given at the end of this document into MDI.

6. Press “Optional Stop, then press cycle start to run the program. Check the dial indicator at each stop (with each section of the program, the platter will rotate 90°, then 180°, then 270° away, then back) and record any position error.

7. Repeat steps 3 through 6 three times.

8. If A-Axis position error varies by more than ±0.0002”, or if the correction by the scales is inconsistent, recalibrate the system.

9. When validation results are within specifications, remove all calibration equipment from the machine and reassemble the rotary platter/pallet receiver.

Calibration Program

Use the following program in the calibration procedure:

```
G00 G91 G54 A0;
G04 P5.;
A-720.;
M30;
;
```

Validation Program

```
G00 G90 G54 A0.0;
M01;
A-90.0;
M01;
A0;
M01;
A-180.0;
M01;
A0.0;
M01;
A-270.0;
M01;
A0.0;
M01;
M30;
;
```

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:

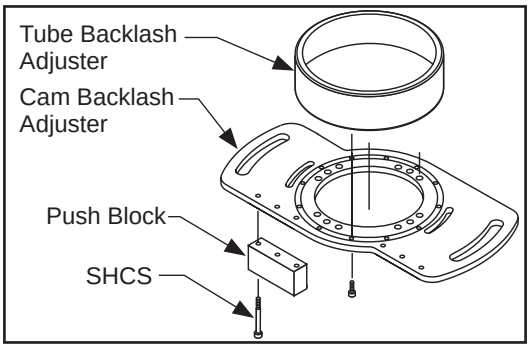
Housed Harmonic	DriveGearbox Adapter	O-Ring Pack	Pinion Gear, 22 Tooth
Wave Generator	Cam Backlash Adjuster	Yaskawa Sigma Motor	

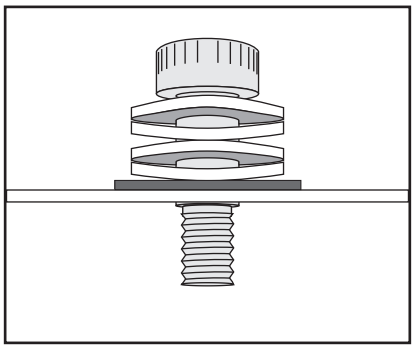
Backlash Tube and Plate Assembly

1. Place the tube backlash adjuster onto the cam backlash adjuster plate. Turn the tube so that the holes line up with the holes in the plate. This is an interference-fit item. Insert the 12 SCHS into the tube and thread into the plate. Tighten the SCHS in a star-pattern to ensure proper positioning of the tube.

2. Attach one push block to each side of the plate, using existing drilled holes and six supplied SCHS.

NOTE: The backlash plate assembly is not attached to the motor at this point to ease assembly into the table during installation.





Spring Washers

Installation

1. Apply grease to the outer side of the tube and top side (as installed) of the plate. Also apply grease to the counterbore for the tube and the machined surface underneath the table the plate will move against.

2. Assemble four Spring Washers in series and one 3/8” hard washer onto each shoulder screw. They should be assembled so that a small space appears between the top and bottom pairs of washers.

3. Orient the backlash plate so the push blocks face the access holes of the table. Insert the backlash tube/plate assembly into the counterbore from under the table. Be careful to not mar the tube surface.

4. Insert the shoulder screws through the slots in the plate closest to the tube (place the hard washer against this plate) and thread into the table. Tighten with a hex wrench to standard torque.

5. Place a flat washer (45-1725) and a lock washer (45-1720) onto each HHB. Thread the HHB up into the table through the outer slots of the plate. Leave loose until final adjustment.

Motor/Wave Generator Assembly

1. Sweat pinion gear (positioned so groove is away from flange) over shaft of sigma adapter and set aside.

2. Examine the spindle of your Yaskawa sigma motor. If your motor has the motor shaft spacer already sweated onto the shaft, skip to step 4.

3. Sweat the motor shaft spacer over the shaft of the motor. Ensure the chamfer on the inner diameter spacer faces the motor.

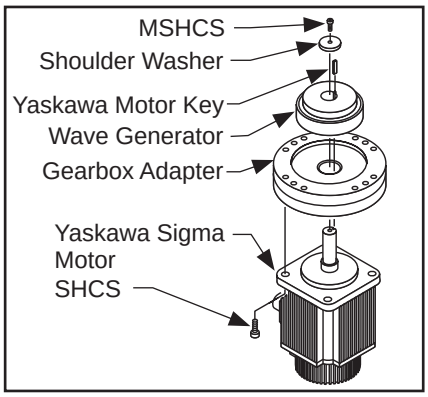
4. Turn the motor so that the shaft faces upward. Place the gearbox adapter over the motor shaft. Insert the four SHCS through the tabs of the motor case into the gearbox adapter and tighten.

5. Place 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.



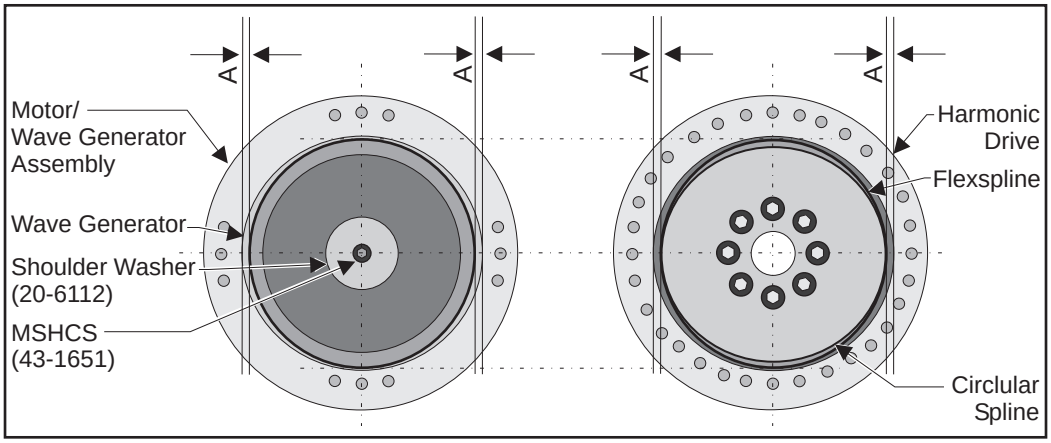
Harmonic Drive Assembly

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.

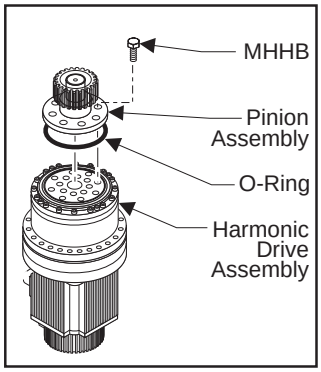
5. Bolt gearbox adapter to harmonic drive by inserting four SHCS into countersunk holes in gearbox adapter.

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 contaminents. Lightly grease and install remaining o-ring into groove. O-ring seals harmonic drive from coolant during machine operation.

7. Install the pinion assembly (“Motor/Wave Generator Assembly”) onto the harmonic drive. Be sure to orient the pinion assembly so that the bolt holes line up with the holes in the harmonic drive (interference-fit item).

8. Place sealer on the eight MHHB and thread into the holes of the pinion assembly. Tighten in a star pattern.



Installation

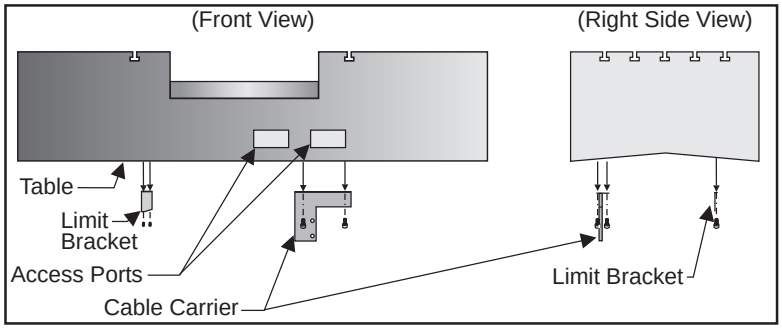
1. Thread an eyebolt into the pilot hole in the shaft of the harmonic drive assembly.

2. Connect a rope or hoist line to the eyebolt. Have an assistant lift the rope up through the counterbore and raise the harmonic drive.

3. Orient the harmonic drive so that the motor connectors can be accessed from the right of the table. Insert eight 70mm SHCS through the gearbox adapter into the table. Torque to 35 ft-lb.

Carrier Mount Bracket Installation

1. Orient the carrier mount bracket so the edge side faces forward and the flush side is toward the center of the table. Turn the carrier bracket so the mounting holes face the table’s bottom surface (shown below).



Cable Carrier and Bracket Installation

2. Place the carrier bracket against the bottom side of the table where indicated and insert the four SHCS through the bracket, to the table, and tighten.

3. Orient the limit bracket so that the angled bottom edge faces to the right and the mounting tab faces toward the rear of the table as shown in the previous figure. Mount using two SHCS.

Cable Box Encoder Installation

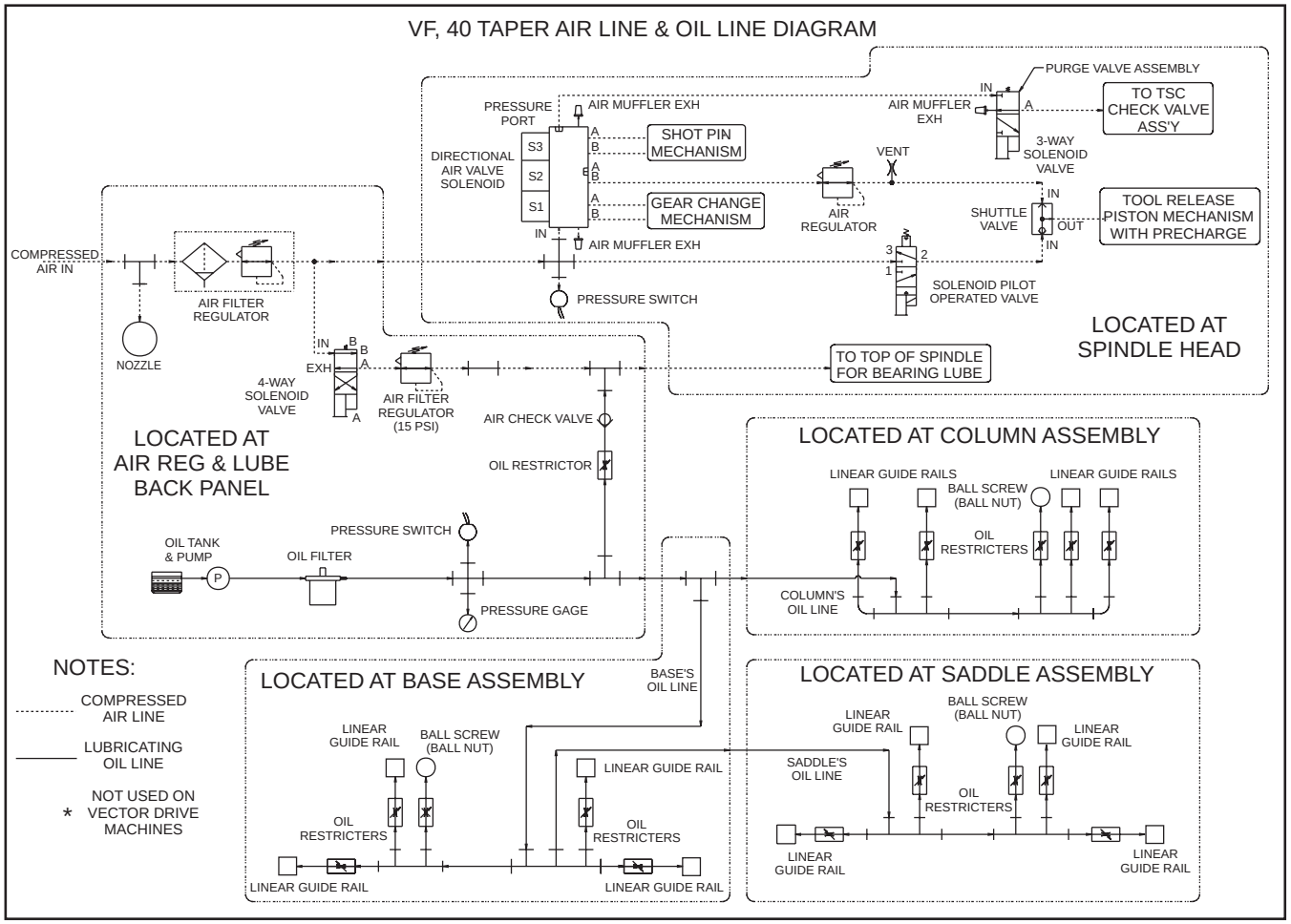
1. Place the cable box encoder into the left rear corner of the accessory box of the table. Orient the cable box with the open sides against the casting of the table for the encoder cable.

2. Install the three SHCS and insert through the cable box into the table. Tighten.

3. Apply Sikaflex around any gaps to prevent encoder cable from popping out when pushed down into box.

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 and external pressure switch on the lube panel.



The lube pump and spindle fan are on the same circuit, which is turned on whenever a program is running, and remains on after a program is stopped for the time specified by Spin Fan Off Delay (Parameter 208).

Low Lubrication/Pressure Sense Switches

There is a low lube sense switch in the oil tank. When the oil is low, an alarm will be generated. This alarm will not occur until the end of a program is reached. There is also a lube pressure switch that senses the lube pressure. Parameter 117, Lube Cycle Time, controls the lube pressure check. If Parameter 117 is not zero, the lube pressure is checked for cycling high within that period. Parameter 117 has units of 1/50 seconds; so 30 minutes gives a value of 108000 (at 60Hz - the time interval will be 36 minutes at 50Hz). Parameter 57, Oiler on/off, indicates the lube pump is only powered when the spindle fan is powered. The lube pressure is only checked when the pump is on.

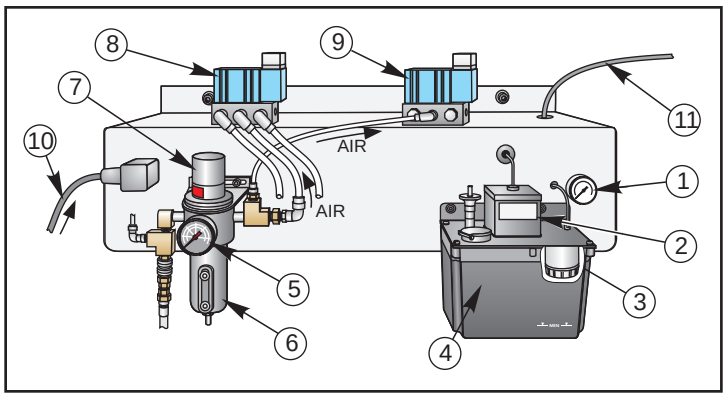
Air Supply Lines

The lifting cylinder has one large air supply line for lifting the pallets and their loads. No return line is required because the cylinder is vented to the atmosphere and the weight of the assembly and load causes the cylinder to lower. The rotation cylinder is double-acting and has two smaller air supply lines for clockwise and 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.

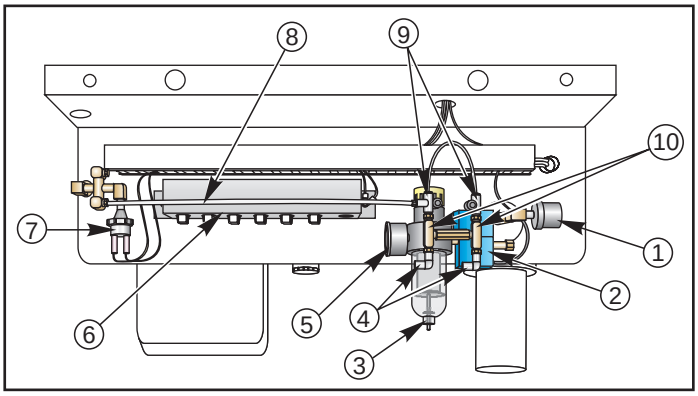
7. **Air Pressure Regulator** - Maintains the air supplied from the outside source (via the main air line) at a constant, desired pressure (approximately 85-90 PSI).

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.

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

NOTE: Use mineral based grease or oil only. Do Not use synthetics or silicones.

NOTE: After servicing unit, turn on air supply and adjust regulator to the desired downstream pressure. Check for leaks. If leakage occurs, do not operate – conduct repairs.

Servicing the Filter Element and Cleaning the Bowl Assembly

1. Unscrew the bottom threaded collar and remove the bowl assembly. Use care as not to lose the o-ring.

2. Unscrew the baffle and then remove the element.

3. Clean the internal parts and bowl assembly before reassembling. To clean the bowl assembly use mild soap and water only! Do not blow with air as loss or damage may occur to o-rings.

   a. Remove the drain nut from the dump valve and remove it from the bowl assembly. Use care to not lose the o-ring.

   b. Soak the dump valve in a mild soap and water mix to clean. Rinse in water and allow to air dry.

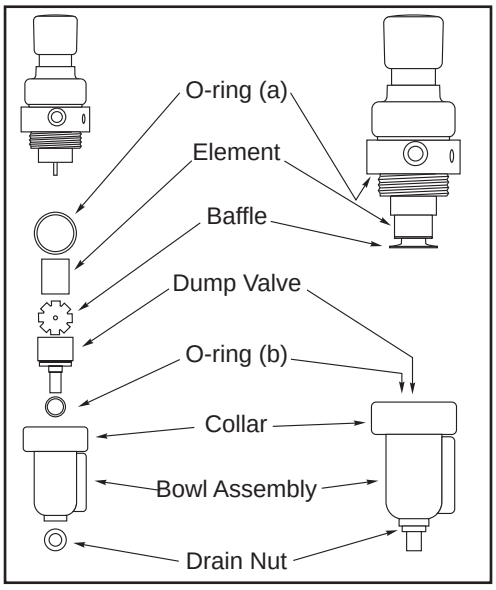
   c. After cleaning the bowl assembly, reassemble the dump valve in the bowl assembly. Care should be taken to not pinch the o-ring. Do not over tighten the plastic drain nut.

4. Install the new element.

5. Attach the baffle and finger tighten firmly.

6. Inspect/replace o-ring. Lightly lubricate o-ring to assist with retaining it in position.

7. Install the bowl assembly into the body and tighten the collar; hand tight, plus ¼ turn

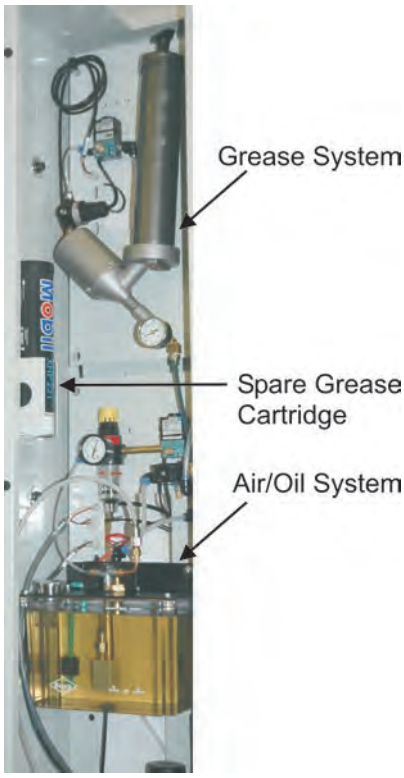


Minimal Lubrication System

The Minimal Lube System consists of two parts:

1. The axis lube grease system which supplies grease to the linear guides and ballscrews.

2. The spindle air/oil 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: Grease System

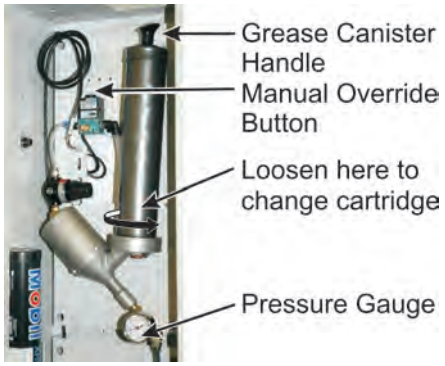
This is a balanced system, which means that all grease tubes are the same length. The grease is pushed to a distribution block, the equal-length tubes then deliver the grease to each of the ballscrews and linear guides. **Do not change the length of the grease tubes**. Changing the length of one tube 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.

Grease-Gun Style Axis Grease System (Pre-April 2010)
Grease system components and maintenance:

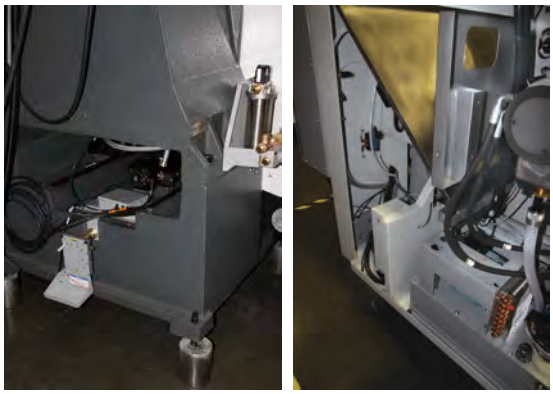
The grease gun consists of two major operating parts.

(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.



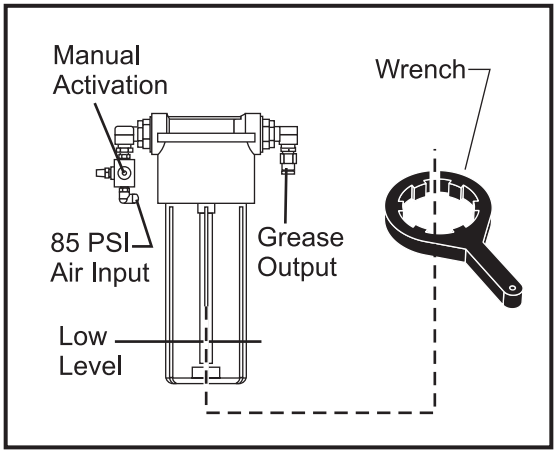
Grease System Assembly



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

Grease Reservoir-Style Axis Grease System (April 2010 and later)

Later models with minimal lubrication use a canister-style grease reservoir instead of the grease gun. A solenoid controls pneumatic pressure that pushes grease through the system. The reservoir screws into the bottom of the head assembly. Use the included wrench to remove and install the reservoir when refilling.



Grease Reservoir

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/refill an empty canister/reservoir 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.

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.

Use macro code #1152=1 or M59 P1152 to turn on the grease pump for testing and priming purposes.

Use macro code #1152=0 or M69 P1152 to turn off the grease pump.

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/refill 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.

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.

Minimal Lubrication Grease System Priming

If the minimal lubrication grease system has been allowed to run completely dry, you must prime the system before operating the machine further. Machine components that do not receive sufficient lubrication can fail.

1. Disconnect machine air and remove the reservoir using the provided wrench.

2. Fill the reservoir from the grease bag. A full bag will fill an empty reservoir to within about 2” from the top of the reservoir. Install the reservoir and connect machine air.

3. Run this program in MDI.

```
M59 P1152;
G04 P900.;
M69 P1152;
```

NOTE: The program will turn on the pump and fill the grease lines to their delivery points. It will take 15 minutes to complete.

4. Wait five minutes, then run the program a second time.

5. Press Reset, then Emergency Stop when the program stops.

Priming Verification

To make sure that the grease system is working correctly after alarms occur:

1. Check the software version. 17.01C (mill with Maincon), 10.01B (lathe with maincon), 16.08C (mill with mocon) or 9.08B (lathe with mocon) or later are necessary for this system to work correctly. If the machine has an earlier software version, update the software. Use the correct software for the motion control board that the machine has.

2. Go to the diagnostics page. Make sure that the pressure switch signal is open (1).

```
Ax Grease Press = 1 (open) = no pressure
Ax Grease Press = 0 (closed) = high pressure
```

3. Change Parameter 811 from 1000 to 15.

4. Put this program in MDI:

```
G00 G58 G28 X-10.
M99;
```

5. Set the rapid rate to 25%.

6. Push Cycle Start.

7. Monitor the diagnostics page and look for the pressure switch to change state from open (1) to closed (0), then push Reset.

8. The pressure switch should go back to the open state after 15-30 minutes. When you see this, you know that the system is working correctly.

9. Change parameter 811 back to 1000.

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.

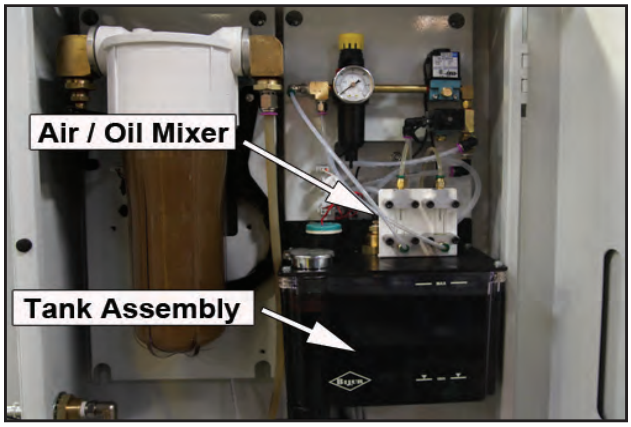
18. Change Parameter 818 to 112.

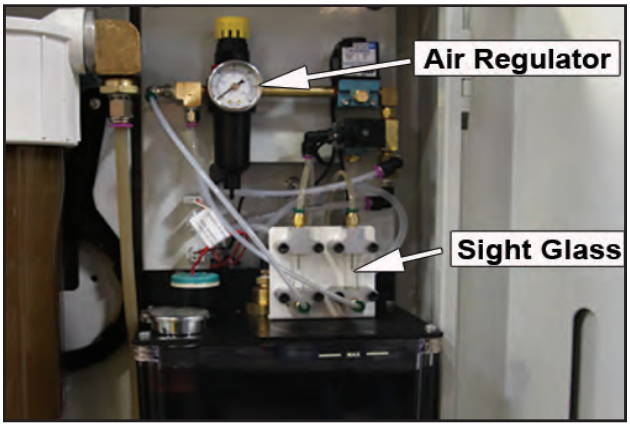
Spindle Air/Oil System Components (Post 10-1-2010)

The air/oil system consists of two major operating parts.

(1) **The tank assembly and oil pump.** 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** is located 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. Haas Automation has now added a site glass to make it very clear if the lube system is working or not.





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.

CAUTION: The air/oil system cannot work without an air pressure supply to the machine.

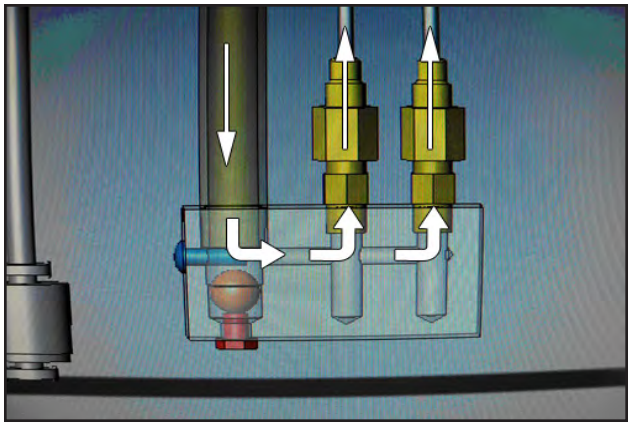
Air/Oil Operation

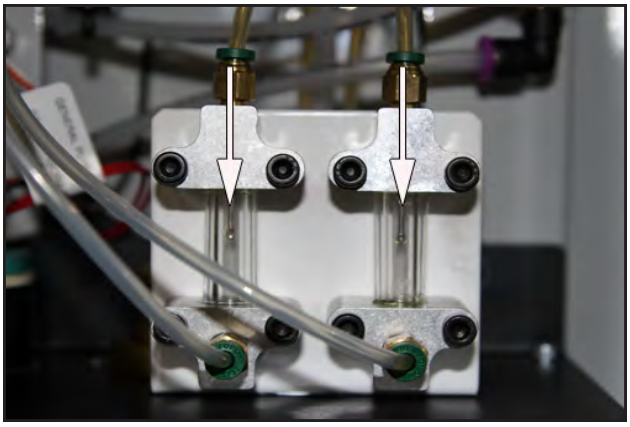
When the spindle is commanded to run, the main spindle solenoid activates the 15 psi (25 psi for EC and 15 psi for ST) constant air flow.

Every 30 minutes the control will activate the spindle lube solenoid for 10 seconds. The air enters the main line into the manifold pushing oil through the system. A hollow aluminum ball is used as a check valve to close the oil fill port and force the oil out through the check valve/flow meter assembly.

As the manifold sits in the tank it is full of oil. When the lube solenoid is activated the air enters through the main line pushing the oil through the system. A hollow aluminum ball is used as a check valve and is pushed down by the oil to close the oil vent port. When the cycle is complete the hollow aluminum ball floats up and allows oil to refill the manifold.

Oil is then pushed through the check valve/flow meters and delivered up to the dripper in the sight glass. This creates a drop of oil that will fall into the air stream and be driven up to the spindle. Some machine models will have multiple sight glasses. Each one should supply the same amount of oil at the same time.





Air /Oil system alarms

If an alarm event should occur take steps to resolve the problem in a reasonable amount of time. If the alarm is ignored for a long period of time, damage to the machine will result.

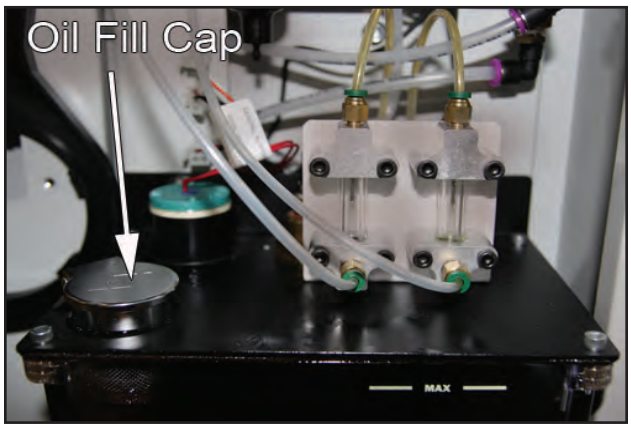
Alarm 805 (oil system alarm): Low Spindle Lubrication level. The spindle oil reservoir is low or empty. If necessary fill the reservoir. If the reservoir is full check that the level float sensor is free to move, plugged in, or whether the wires are damaged.

Filling the oil reservoir

1. Clean the top of the tank.

2. Open the fill cap and pour oil into the reservoir until the level reaches the maximum fill line.

NOTE: Do not mix oil types. Prior to July 2010:use DTE-25 Oil ; After July 1, 2010 use Mobil Vactra #2.



Troubleshooting Air /Oil System

Validating operation of the Air/Oil system:

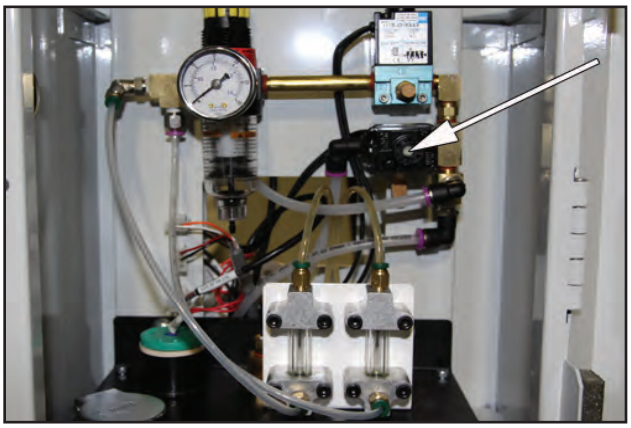
The air/oil lubrication system operation can be checked by visually confirming release of oil at the site glass(es).

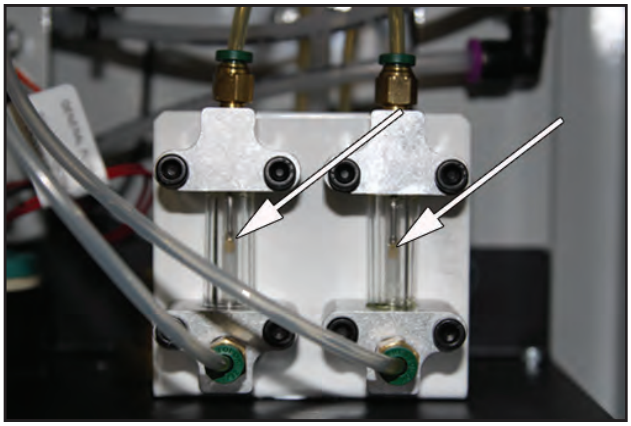
1. Run spindle at low speed,

2. Depress the manual over ride button on the solenoid operated air valve that supplies air pressure to the oil pump for 10 seconds, then release.

3. You will be able to see oil getting injected into the air line in small drops at the injector tubes inside the sight glass.

NOTE: It may take several seconds before being able to see traces of the oil.





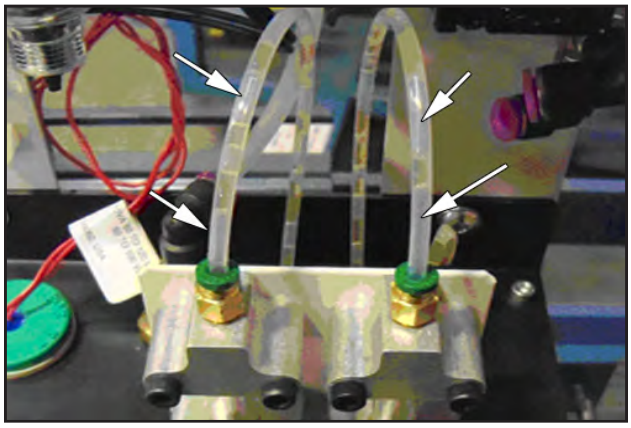
5. Count the amount of drops seen in the sight glass during the test. If testing a multiple sight glass system make sure all function equally. Proper rate: Minimum 3 drops per 30 seconds.

4. If no drops or less than 3 drops per 30 seconds are seen at the site glass. Continue trouble shooting using the procedures outlined below.

Further trouble shooting procedures for the oiling system:

1. Inspect the lube tank assembly for leaks, loose fittings and loose electrical connections

2. Check for bubbles in the oil delivery tube. Multiple bubbles are signs of a leak internal to the tank assembly and it should be replaced.



3. Check spindle lube parameters.

Par 817 Spindle Lube Type: 2 (Minimum lube type)

Par 819 Spindle Lube Time Interval: 15 (Lube cycles every 15 minutes of spindle run time)

Par 820 Spindle Time: 10000 (10 seconds of lube solenoid time per cycle)

Par 821 Spindle Lube Input: 12 (What plug on the I/O the level sensor is plugged into)

Par 822 Spindle Lube Output: 28 (What plug on the I/O the solenoid is plugged into)

4. Run the spindle lube test in MDI mode to check function of the I/O board, lube solenoid, and the amount of oil delivered.

G103 P1; (cancel block look ahead)

G04 P10.; (10 sec dwell to get to the lube pump)

M59 P1124; (turn on lube solenoid) (For machines with Min Lube prior to 12-15-2009, use P1128)

G04 P30.; (30 sec dwell to count drops)

M69 P1124; (turn off lube solenoid)

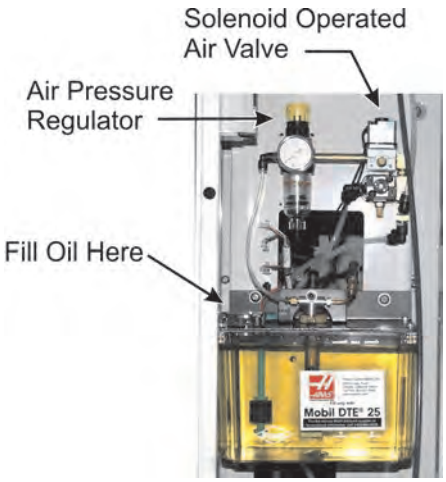
5. Count the amount of drops seen in the sight glass during the test. If testing a multiple sight glass system make sure all function equally. Proper rate: Minimum 3 drops per 30 seconds.

6. Repeat the test multiple times to confirm consistent operation.

6. Remove the head cover and disconnect the spindle lube line. Use a piece of paper to check for lube at the spindle.

Technical Reference: Spindle Air/Oil System Components (Pre 1-10-2010)

The oil system consists of two major operating parts.



(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.

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.

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.

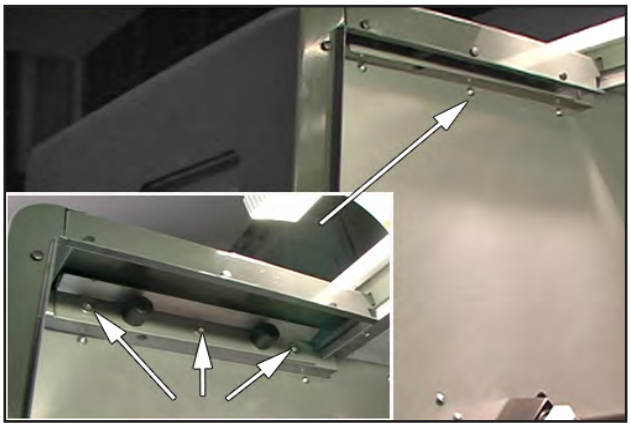
NOTE: The lubrication system continues to run when an alarm is generated.

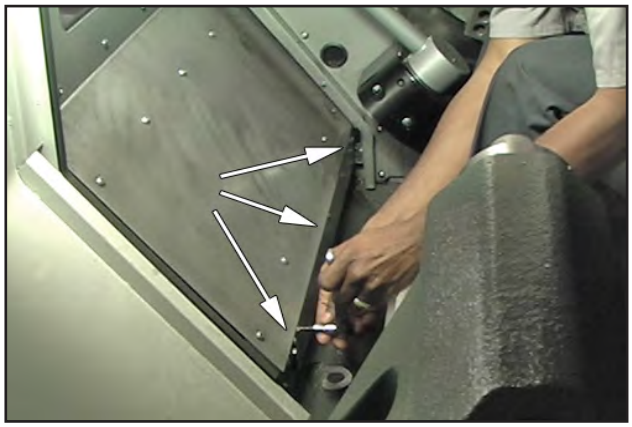
NOTE: Rarely will a line be clogged; more likely there is a leak at a fitting, or a split in the line. Tighten/replace the fitting or replace the line. The line must **not** be reduced in length.

Door Removal

CAUTION! Press the Emergency Stop Button & Lock Out /Tag Out Emergency Stop Button.

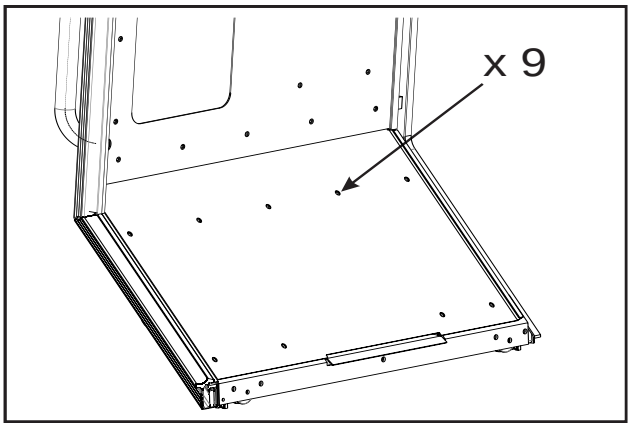
1. Remove the upper inner door wiper and bumper.
2. From inside with the door closed, remove the door keeper.

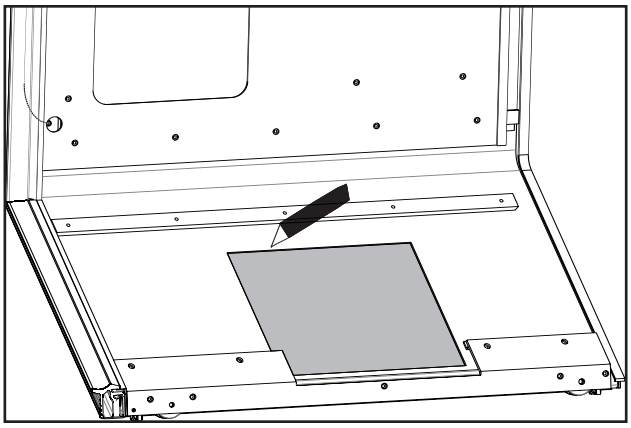




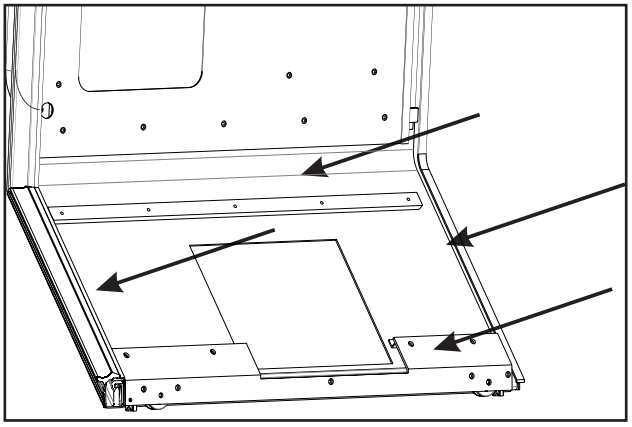
3. Remove upper door roller guide screws and remove guide.
4. Remove door by lifting up first, then out. Support the lower part door with a knee or use an assistant.

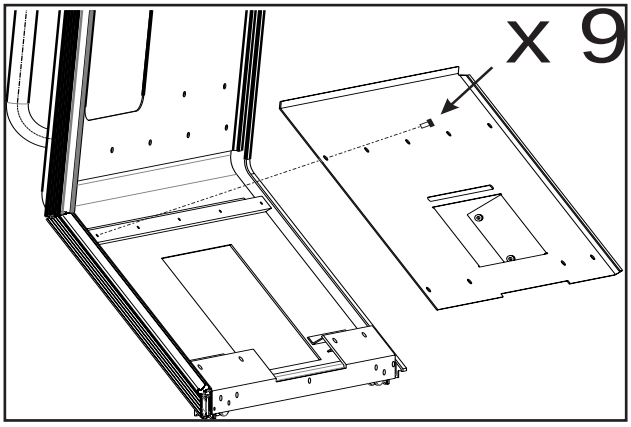
5. Place the door on a suitable work surface.
6. Remove the lower door liner.
7. Use a sharp knife to cut through any adhesive along the edges of outer door plug. Scrape any adhesive residue from the inside of the door.



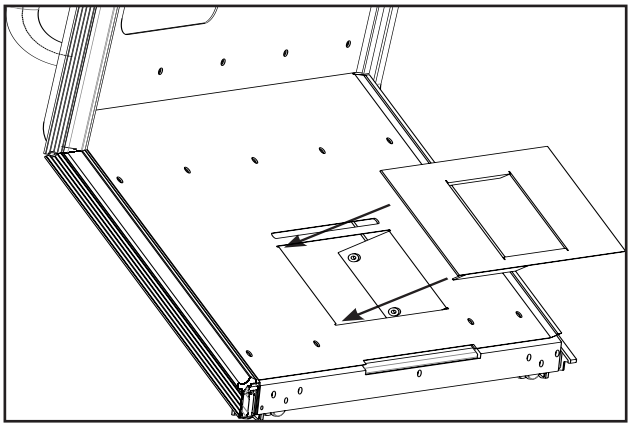


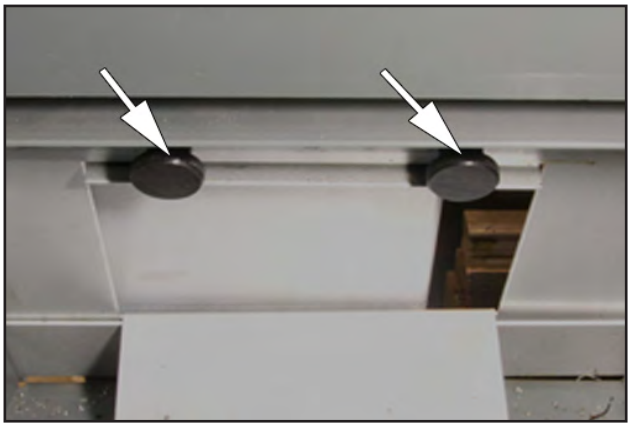
8. Apply a 1/4” bead of new sealant / adhesive around the edge of the new liner.
9. Install the new inner door liner.



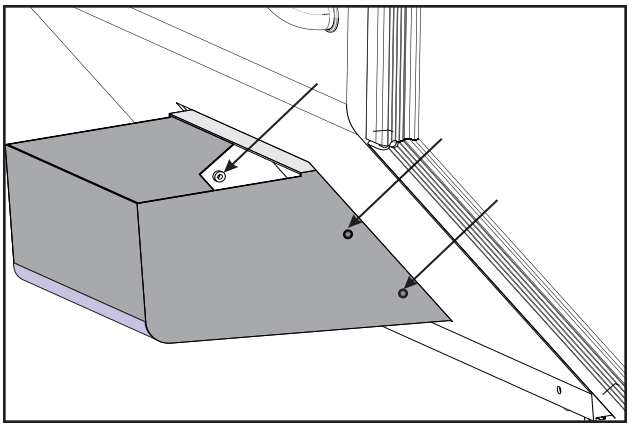


10. Install the sliding door.
11. Screw on the sliding door adjustment knobs.





12. Attach the parts catcher bin to the front of the door assembly.



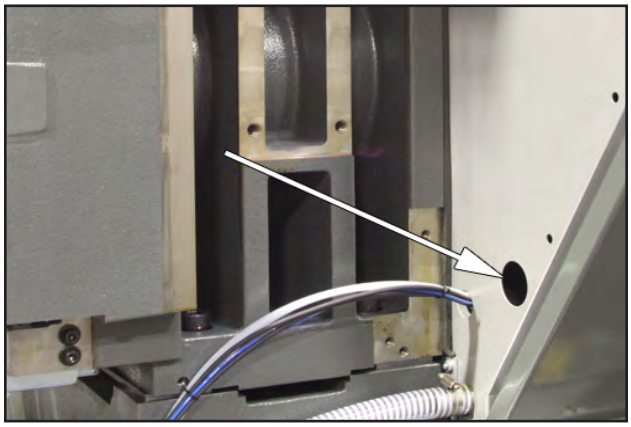
Remove Cover Panels

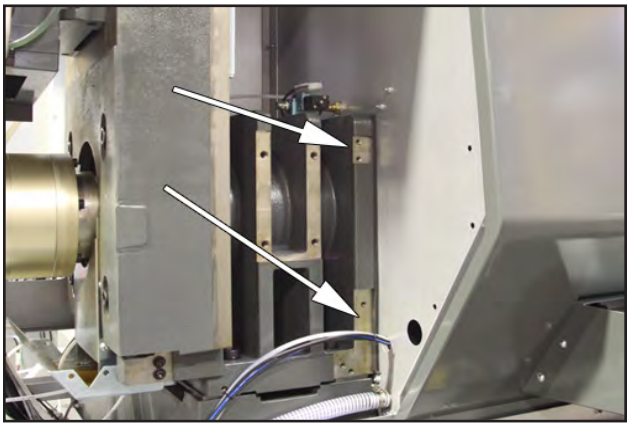
CAUTION! Press the Emergency Stop Button & Lock Out /Tag Out Emergency Stop Button.

1. Remove the front panel.
2. Remove the left end panel.
3. Remove the rear cover.

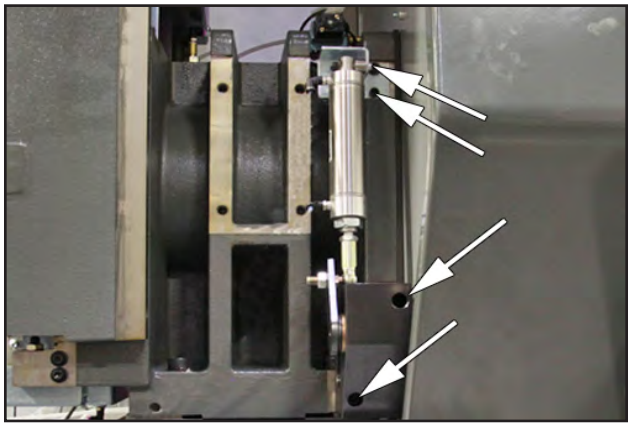
Install Air Cylinder Assembly

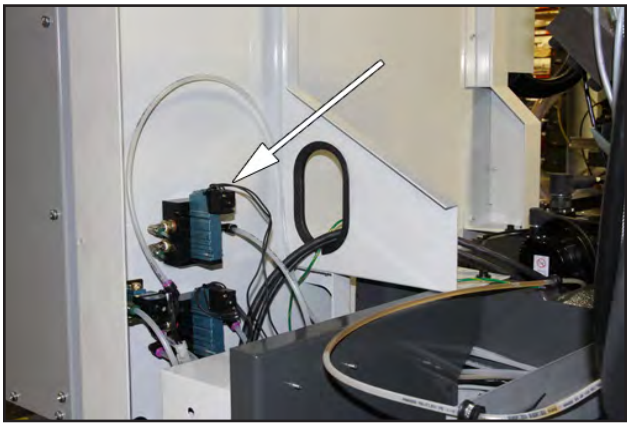
1. Remove the plug from the inside of the front end panel.
2. The parts catcher air cylinder assembly mounts to the main spindle casting at two locations.





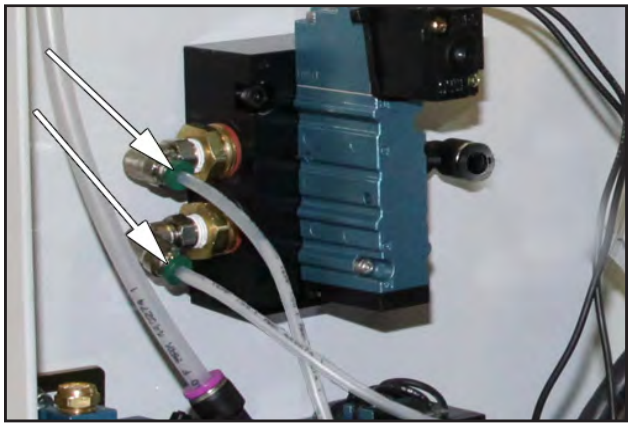
3. Slide the parts catcher shaft through the hole in the front end panel and bolt on the air cylinder assembly with four socket head cap screws.
4. Mount the air valve to the left rear panel as shown.

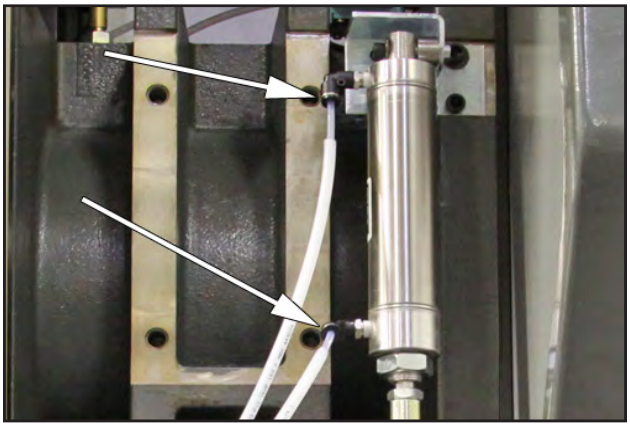




5 Connect two segments of the 1/8” air line to the air valve, and route both air lines to the air cylinder.

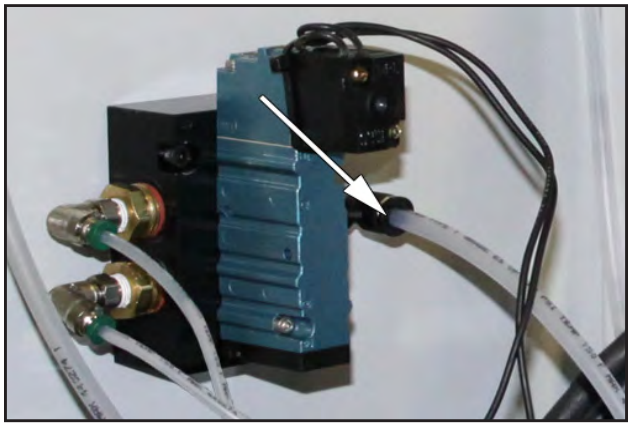
6. Connect the other end to either of the ports on the air cylinder.

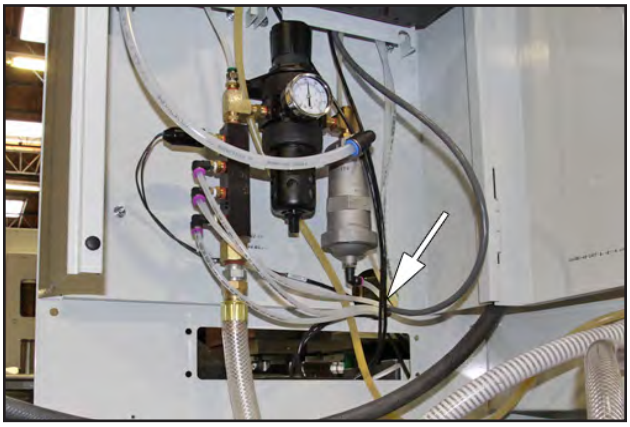




7. Connect a segment of 1/4” air line to the in port of the air valve.

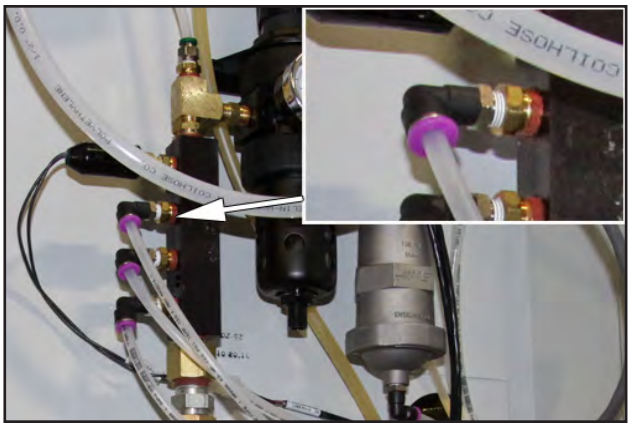
8. Route the air line through the channel in the rear towards the main air regulator in the right rear control panel.

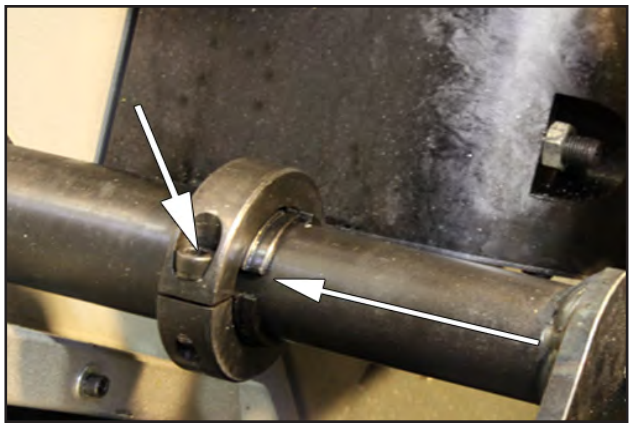




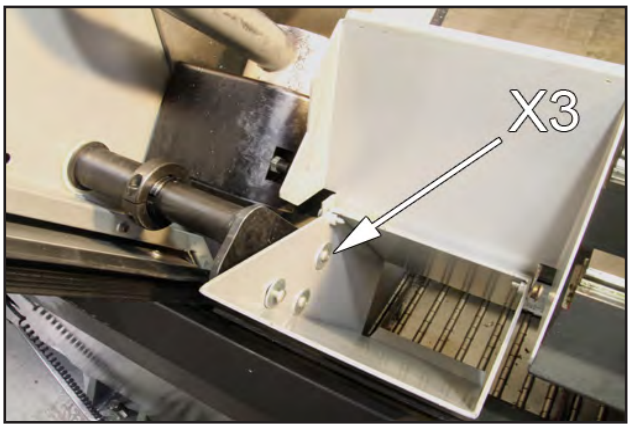
9. Route the 1/4” air line through the rear channel to the air manifold box. Remove one of the plugs in the manifold and screw in a 90* air fitting and reducer. Use teflon tape? and ?/ on the fittings.

10. Slide the shaft collar over the shaft and slide the parts tray shaft into the shaft. Hand tighten the cap screw in the shaft collar on the outer parts catcher shaft.





11. Attach the parts bin to the shaft with three flat washer and cap screws.



12. Check the operation of the parts catcher.

Power on the machine. In MDI mode, activate the parts catcher.

M-36 Flips Parts Catcher up

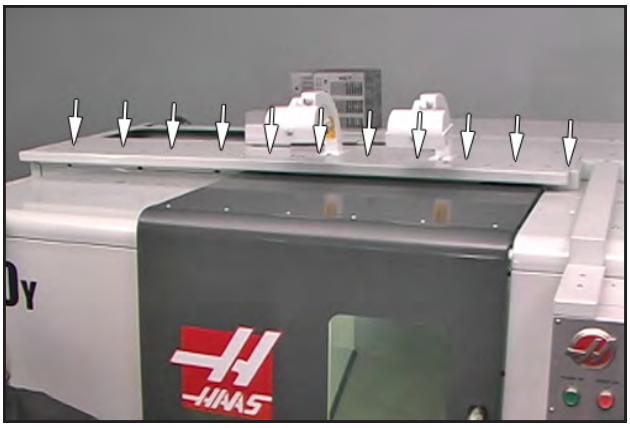
M-37 Flips Parts Catcher down.

If parts catcher operation is reversed. Swap positions of the 1/8” air lines on the air valve. Recheck operation.

Door Installation

1. Lift the new door into position aligning the bottom rollers first. Support the lower part of the door with a knee or use an assistant to remove the door.

2. Install the upper roller guide, loosely tighten the upper roller guide screws.



3. Reset the **Emergency Stop.** Press " **Reset**"

   Navigate to the "DNGOS" tab to view doors switch status.

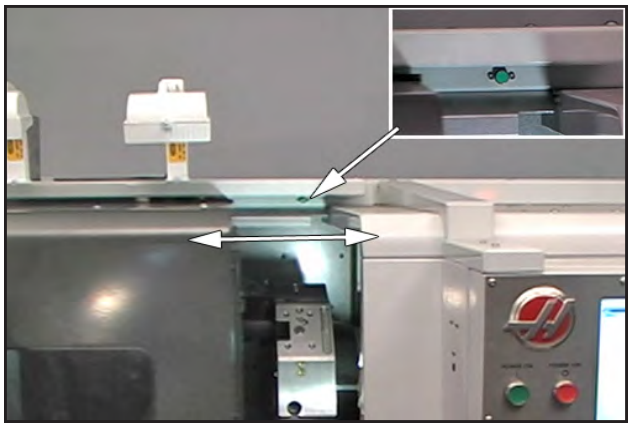
   Press: "PARAM DGNOS"

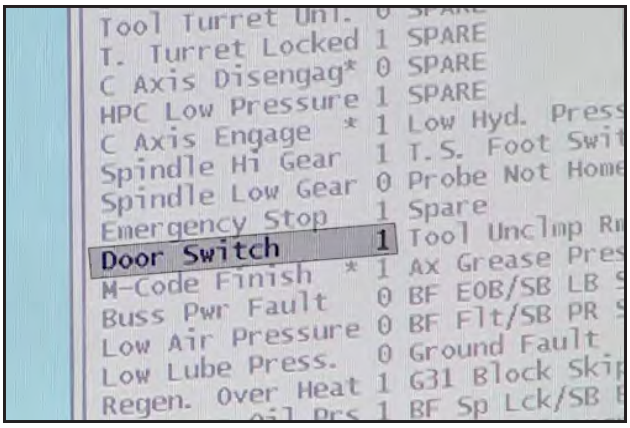
   Press: Arrow key to move to "DGNOS" Tab.

   Press: "WRITE ENTER"

4. Verify the door switch operation, by opening and closing the door and noting door switch status change.
5. View screen to verify door switch operation. Door Switch: Open = 1. Door Switch: Closed = 0 .

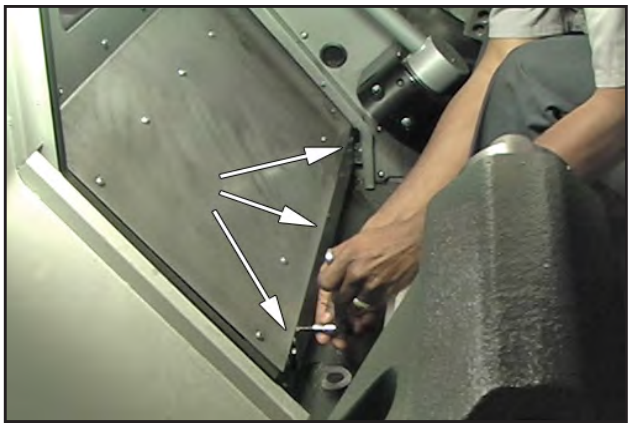
   Adjust switch if required.



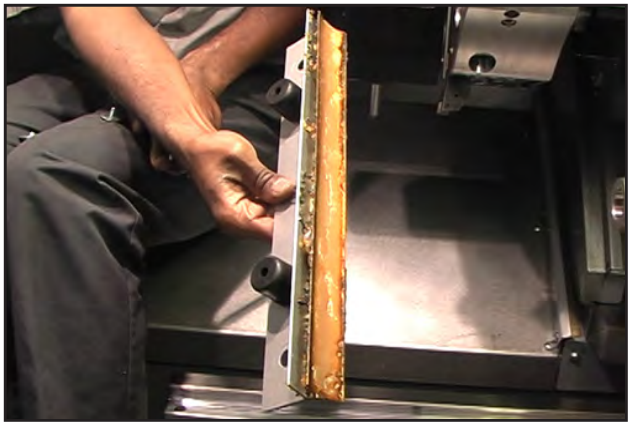


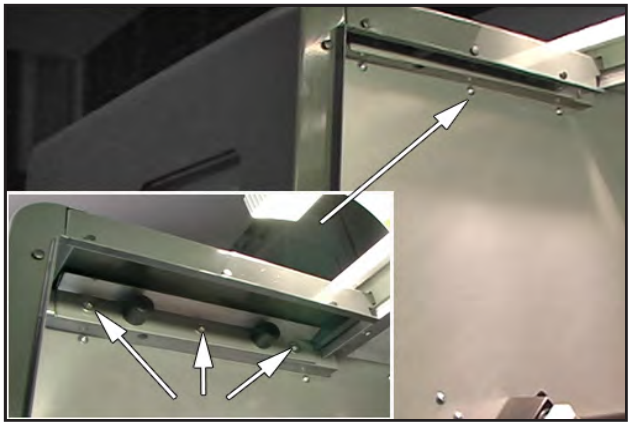
CAUTION! Press the Emergency Stop Button and Lock Out E- Stop Button.

6. Tighten the upper roller guide screws.
7. From inside with the door closed, install the door keeper.



8. Clean and re-grease the upper door wiper with general purpose grease.
9. Install the inner upper door wiper / bumper, applying moderate upward pressure to insure snug seal.





PARTS CATCHER ALIGNMENT

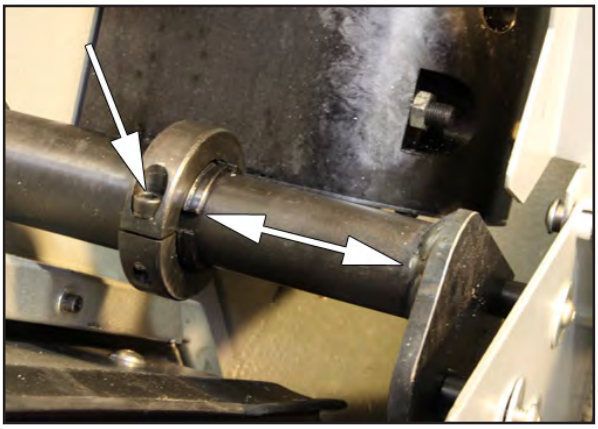
Horizontal Alignment

1. Power on the machine. In MDI mode, activate the parts catcher.

   M-36 Flips Parts Catcher up

   M-37 Flips Parts Catcher down.

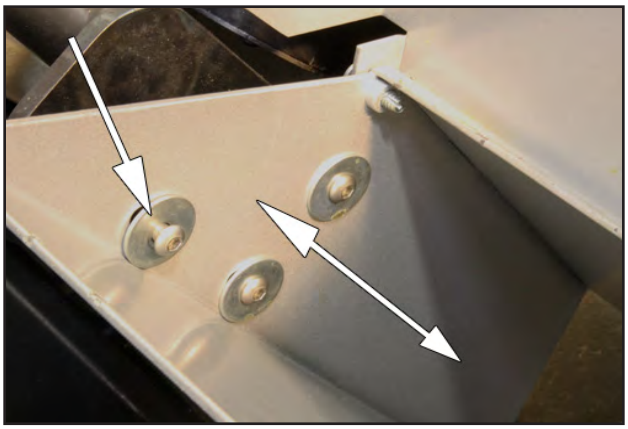
2. Loosen the screw in the shaft collar on the outer parts catcher shaft.



3. Adjust the parts catcher tray in to or out of the shaft to catch the part and remain clear of the chuck.

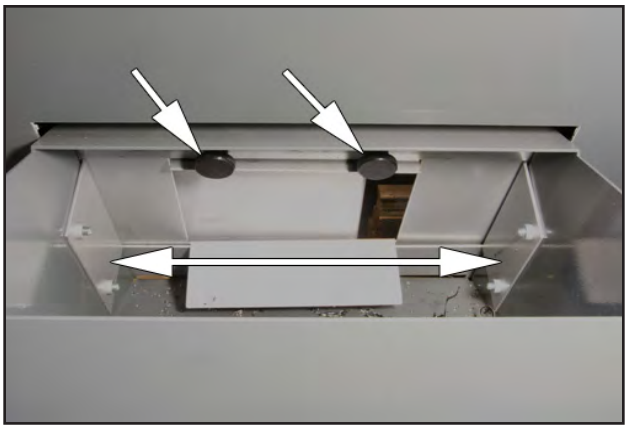
Vertical Alignment

1. Adjust the height of the parts tray by loosening the tray screws and adjusting the tray up or down as required.



Parts Catcher Door Alignment

1. Once the parts tray is positioned properly close the door and adjust the parts collector door to align with the part catcher tray.



3. Rotate the tray to open the sliding cover of the parts collector mounted in the door and tighten the shaft collar on the parts catcher

WARNING! Check the Z-axis, y-axis, tool and turret position during parts catcher actuation to avoid possible collisions during operation.

WARNING! If Bar Feeding Option is installed check the remnant push and new bar feed.

4. Install the front panel.

5. Install the left end panel.

6. Install the rear cover.

Parts Catcher (ST - SL 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.

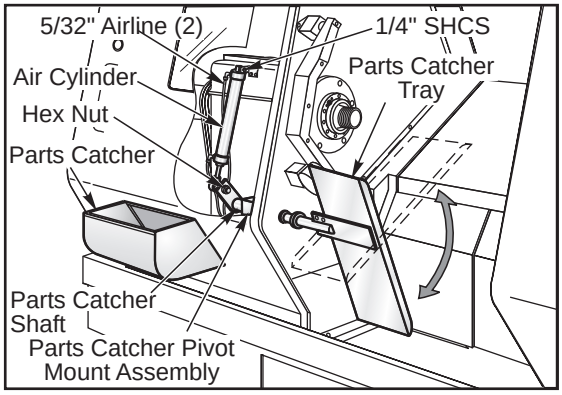
3. Unclamp outer retaining ring that retains the shaft collar on the outer shaft, remove shaft collar and inner retaining ring. Remove rubber seal from outer shaft.

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.

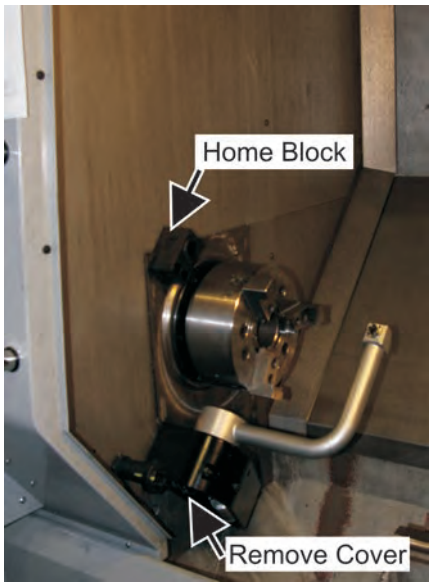
5. Rotate the tray position to open the sliding door of the collector. Tighten the shaft collar to the parts catcher shaft. Step through MDI program and check tray operation

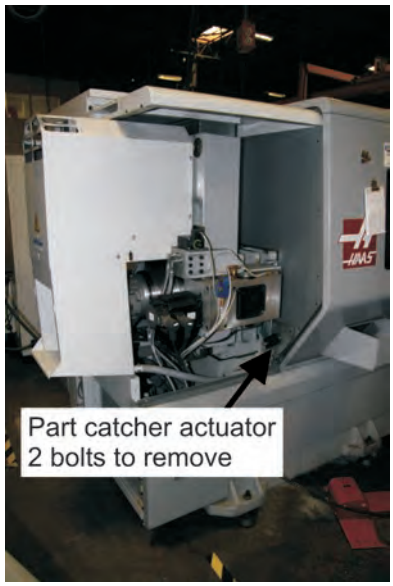
6. Install necessary panels that were removed.

Adjustment (ST Lathes)

Removal

1. Remove the lower left side panel and front left panel





2. Mark and remove the parts catcher, if equipped

3. Remove the bottom cover from the tool probe assembly and remove the three mounting screws (one is on the inside of the unit.

4. Cut cable ties from the tool probe air hoses and electrical cables.

5. Disconnect the hoses and cables (2 hoses and 3 cables). Trace these from the tool probe through the lathe to find the electrical plugs and air hose junctions.

6. Feed the cables and hoses through the bulk head as the tool probe assembly is removed. Remove the parts catcher pneumatic actuator (if equipped) from the spindle head casting and lift out of the way. This clears the area around the hole in the bulkhead so the tool probe electrical plug and air hoses can fit through the hole.

Installation

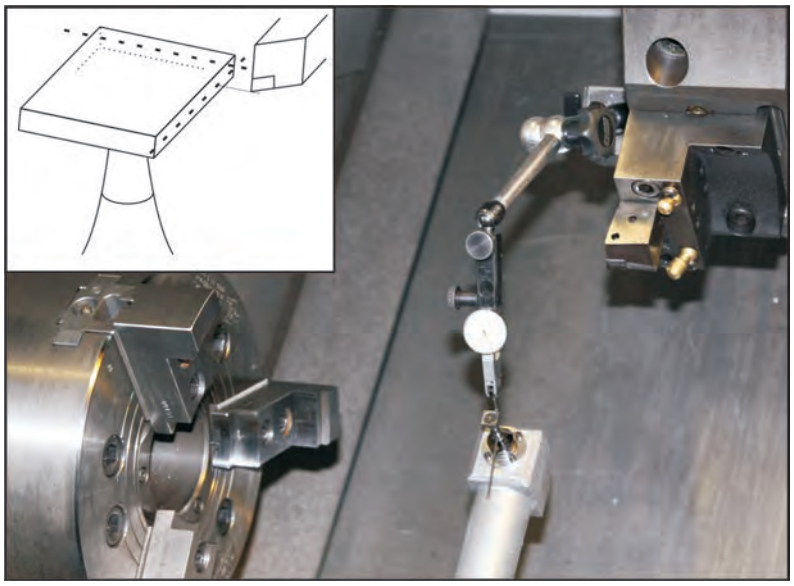
1. Clean mounting surface and feed the cables and air lines through the hole in the bulkhead.

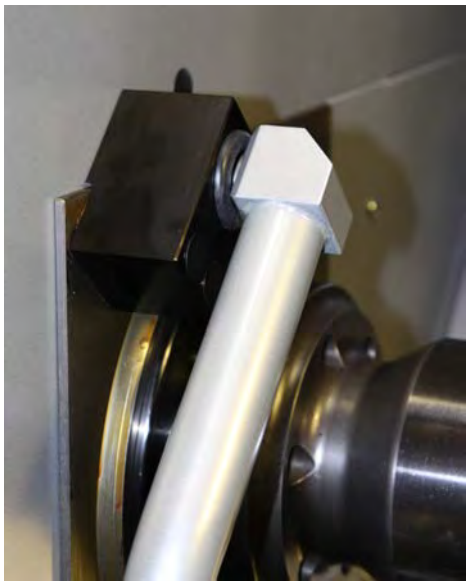
2. Fasten the tool probe to the bulkhead (3 bolts). Do not tighten as the assembly will be aligned later.

3. Remove the plastic caps and remove the bolts and probe home block.

4. Connect the electrical cables and extend the arm. Note: The air hoses will be connected later.

5. Stylus alignment: Jog the tool turret until the tool in the cutting position reaches the tool probe stylus. The tip of the tool should be in the middle of the stylus. To adjust the tool probe assembly, loosen the three mounting bolts and use the dowel pin to move the assembly. Doing so will insure that the correct height is set. Tighten the three bolts once the correct height is reached. This must be checked in two planes (top and side).





6. Set up an indicator on the turret and sweep the edge of the stylus. Rotate the stylus until it is parallel to the indicator (+/- .0002”).

7. Manually retract the arm and adjust the home block (see previous picture). Ensure the block is in position so the tool probe does not hit it. Tighten bolts and replace plastic plugs.

If the arm is not snug against the home switch block (when arm is in the up position), it is necessary to adjust the arm. Loosen the lower set screw. This will allow the arm to close snug into the home switch box. Keep in mind that you may need to readjust the home switch block (repeat this step). Be sure to tighten the jam nut after the adjustments.

NOTE: Make sure the stop plate does not hit the PROX sensor face. A .020 shim should fit between stop plate and switch.

8. If equipped, replace the parts catcher pneumatic actuator and the parts catcher tray. Test the assembly.

9. Connect the air hoses to the tool probe assembly and test. Use M104 in MDI to lower the arm and M105 to retract the arm.

10. When the arm is down, it should have no backlash, if the arm has backlash tighten the upper set screw this will insure all backlash is out of the arm assembly, backlash should only be adjusted with arm down. Insure to retighten the jam nut.

11. Replace the left front and lower left side covers.

Adjustment (SL Lathes)

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 (SL Lathes)

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 (SL Lathes)

This procedure measures probe faces and sets parameters based on the actual distances. If a diameter difference greater than the tolerance of +/- 0.002" is noticed, preforming this procedure will correct the setup without any mechanical changes.

1. Parameter 254, Spindle Center Distance, must be set correctly before setting LTP.

2. Install 1" diameter axial reference tool in position 1. Select YASNAC for Setting 33 coordinate system. Offset G54 must be set X = 0, Z = 0. Tool wear #1 must be set to 0.

3. Handle Jog to a position for clear X travel. In Offset page, use F2 to set tool 1 work shift to centerline.

4. Enter this program in MDI:

```
G54
G50 T5100
X0
```

Run the MDI program; the tool will move to spindle center

5. Select Handle Jog mode, Distance to go will read X = 0.0000, Z = 0.0000. Manually jog in Z to a position clear of the LTP arm. **Don't move the X-axis.**

6. Lower the LTP arm, the display will switch to Offsets. Select Position display again in order to view Distance to Go Display.

7. Manually jog to probe tip and "probe" the 1" dia reference tool in the -X direction (move down) using 0.0001 feed rate. Record the X distance to go. (e.g.; 4.9993). Subtract 1" from the number (e.g.; 4.9993 - 1.0000 = 3.9993). Enter this number in Setting 59 (**Probe Offset X+**).

8. Manually jog the tool and "probe" the 1" reference tool in the X+ direction (move up) using 0.0001 feed rate. Record the X distance to go for this position. (e.g. 2.2309). Add 1" to the number (e.g. 2.2309 + 1.0000 = 3.2309). Enter this number in Setting 60 (**Probe Offset X-**).

9. Subtract the number in Setting 60 from Setting 59 (e.g. 3.9993 - 3.2309 = 0.7684). Divide this number by 2 (e.g. 0.7684/2 = 0.3842). This is the effective width of the probe head; the actual width is 10 mm or 0.3937. Enter this number (effective probe width, not actual) in Setting 62 and Setting 63.

Verification (SL Lathes)

(Method assumes cut geometry is smaller than tool probe setting diameters.)

O.D.

1. Using Handle Jog and an OD turning tool, OD turn a diameter. Set Distance to Go to X = 0.000. Measure the diameter (e.g. 2.125).

2. Jog away in Z direction and lower tool presetter. Jog to probe OD tool in X direction using 0.0001 feed rate.

3. Record X Distance to Go number (e.g. 1.8743). Add number to the measured diameter from step 1 (e.g. 2.125 + 1.8743 = 3.9993). The sum should equal the number in Setting 59 (**Probe Offset X+**) +/- 0.0020".

I.D.

1. Using Handle Jog and an ID boring tool, ID bore a diameter. Set Distance to Go to X = 0.000. Measure the bore diameter (e.g. 1.750).

2. Jog away in Z direction and lower the tool presetter. Jog to probe the ID tool in the X+ direction using the 0.0001 feed rate.

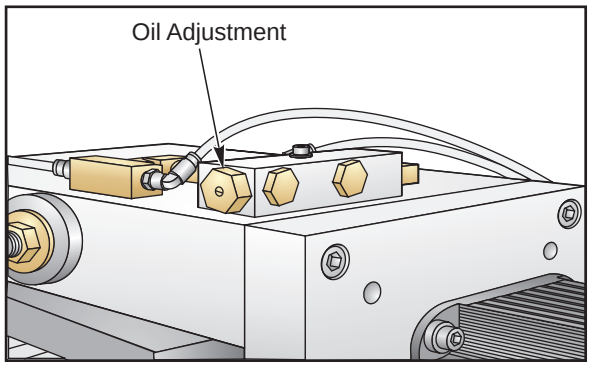
3. Record the X Distance to Go number (e.g. 1.4809). Add this number to the measured diameter (e.g. 2.125 + 1.4809 = 3.2309). The sum should equal the number in Setting 60 (**Probe Offset X-**) +/- 0.0020".

4. If verifying tool setter arm settings with cut diameters larger than tool probe setting diameter, subtract the X Distance to Go from the measured diameter and compare result to the appropriate X +/- Setting (59 or 60).

C-Axis (Lathe)

Lubrication

The C-axis gears are lubricated by the automatic lube system. The gears are lubricated with one drop of oil every ten engagements. The amount of oil used is adjusted by a slotted screw on the side of the oiler block. Turn the screw in (clockwise) for less oil. For a base line adjustment, turn the screw in completely, then back out 1/2 turn. Check lubrication frequency and adjust for approximately one drop every ten engagements.

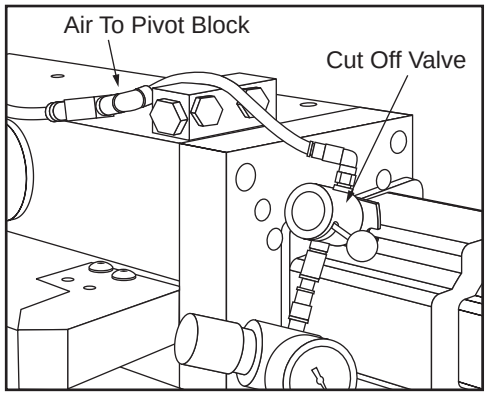


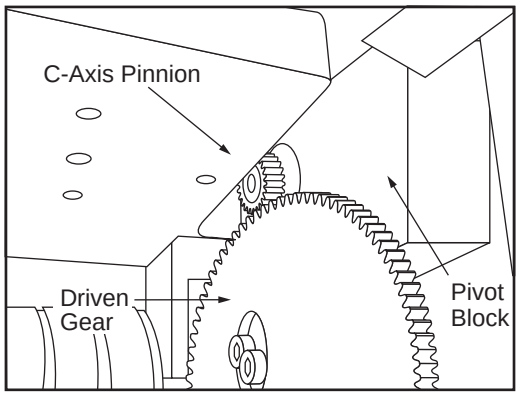
Setting Grid Offset

NOTE: This option uses a second MOCON PCB; take care tracing signals.

NOTE: Grid offset must be checked and reset if the drive gear or the "C" drive servo motor is replaced.

1. Disconnect air supply to C-axis actuator block and install an in-line regulator, with a cut off valve.





2. Press Setng/Graph and turn Setting #7 Off. Press Alarm/Mesgs, type Debug, and press Write/Enter. Change Parameter 517 to zero.

3. Press Zero Return, type “C” and press Zero Single Axis.

4. Set Parameter 278 (C-axis drive) to zero, which will prevent the actuator block from engaging the C-axis. Set Parameter 498 (C-axis Disable) to one.

5. Command M19 (spindle orient) in MDI mode.

6. Engage the actuator block by applying pressure to the in-line regulator. Set the pressure to 45 PSI. Observe the mesh gear contact, ensuring full contact and smooth mesh of gears. If necessary, move the drive gear by hand to ensure full gear mesh.

7. Press Posit, and use page up or down to find “Pos-Raw Dat 1 data page. Locate the “C” Axis Actual column and record the value. Replace the value in Parameter 517 (C-axis Grid Offset) with this number. This value should be between 0 and 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:

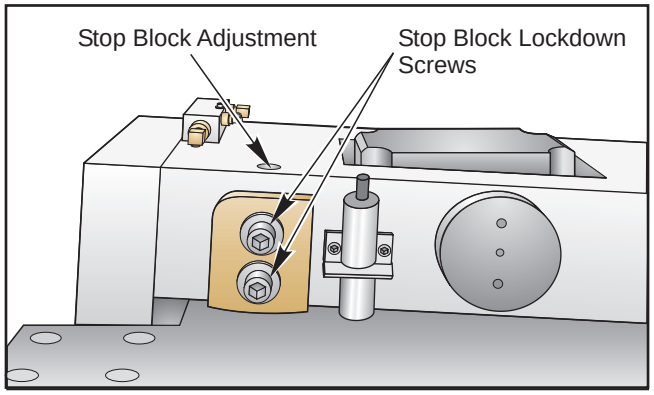
```
M154;
M155;
M99;
```

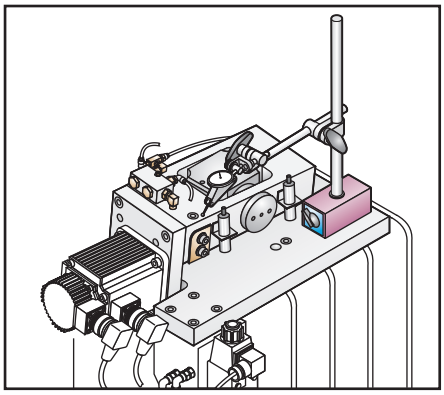
12. Press Reset then Cycle Start. The machine should orient the spindle, and engage and disengage the C-axis without fault. If the machine displays an alarm, double check the grid offset and spindle encoder pulley for proper operation.

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.

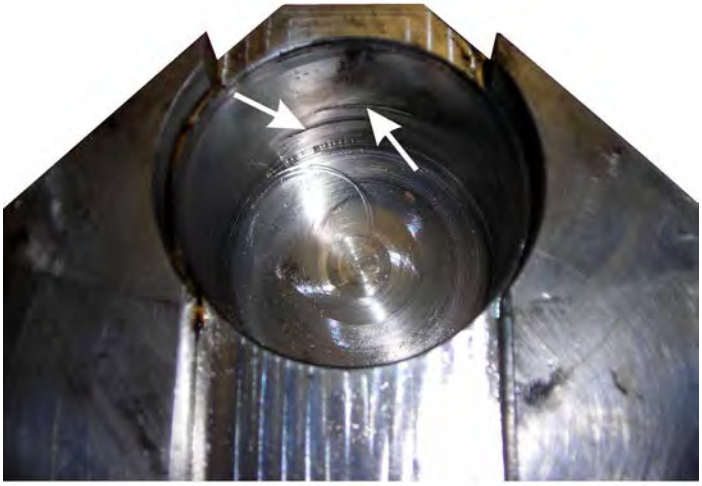
4. Handle Jog the C-axis and observe the indicator. If runout is over .0001” in 360° check the grid offset and/or servo motor installation. If the grid offset and servo motor installation are correct and the runout is still over .0001” in 360°, inspect the driven gear for damaged teeth.

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 though access door

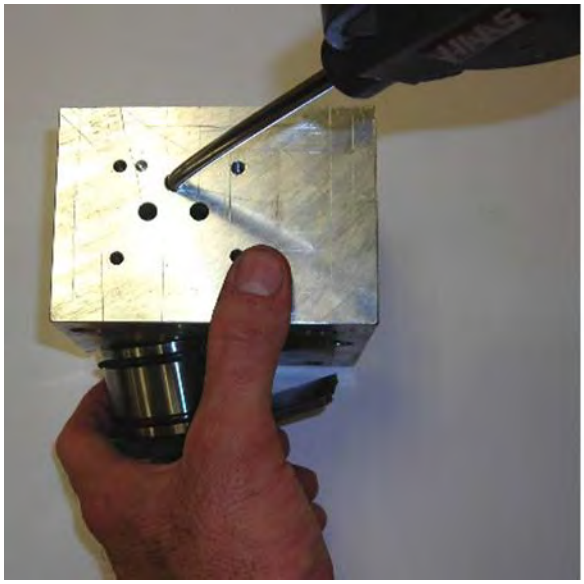
Four mounting bolts (SL-20 shown)

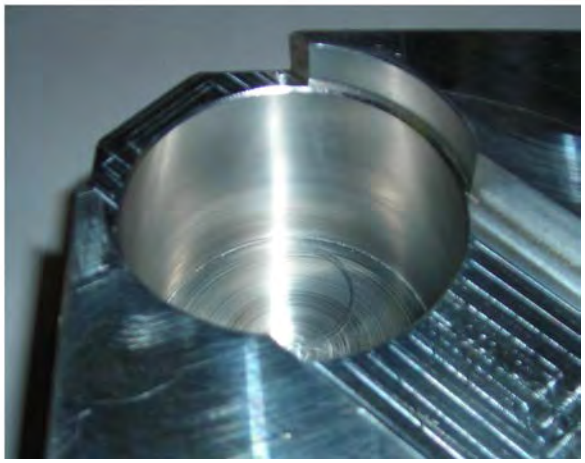
B. Before disconnecting the two hydraulic hoses from the brake caliper, label or mark them to ensure they do not get reversed during re-assembly. On most machines, the two hoses can be seen through the access door. On SL-30B machines, these hoses are on the opposite side.

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.

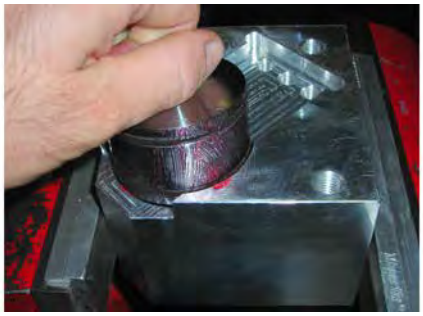
2.Remove all parts from the caliper and back-plate. Use care when removing the solenoid to prevent losing the solenoid O-rings. The piston can be removed by applying compressed air to the solenoid inlet port.

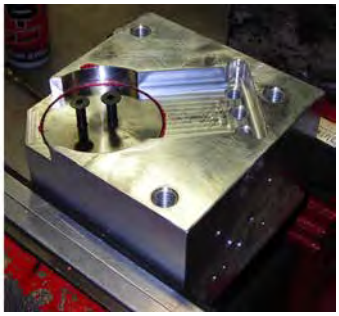




3.Lightly use a de-burring stone on all mating surfaces. Thoroughly clean the cylinder bore and piston. Use compressed air to remove debris from all ports in the caliper.

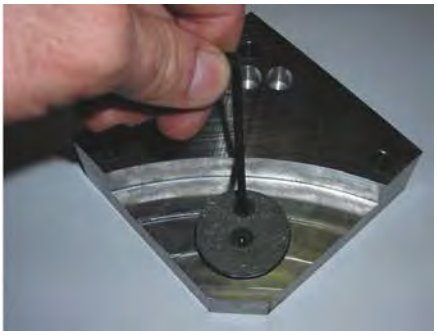
4. Install the two new O-rings onto the brake piston. Apply grease to the inside of the caliper bore and the outside of the piston. Note that one end of the piston has a pin machined into it. This pin identifies the topside of the piston. Carefully push the piston with O-rings into the caliper bore, topside first. Orient the piston using the two 10-32 X ¾ FHCS, so the screw holes on the bottom side will line up with the brake finger and pad.



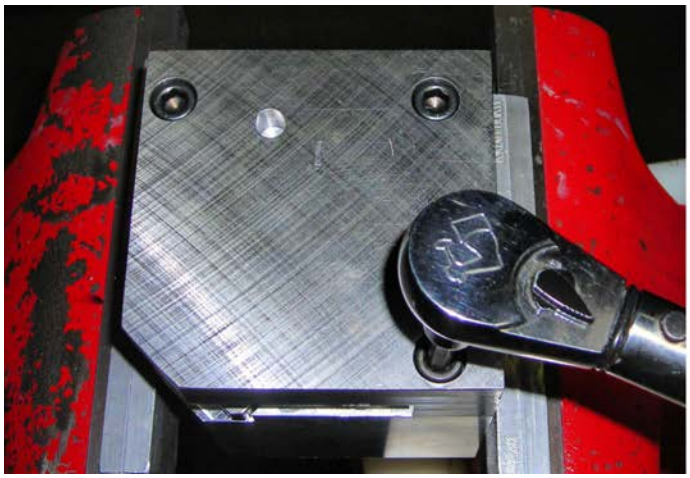
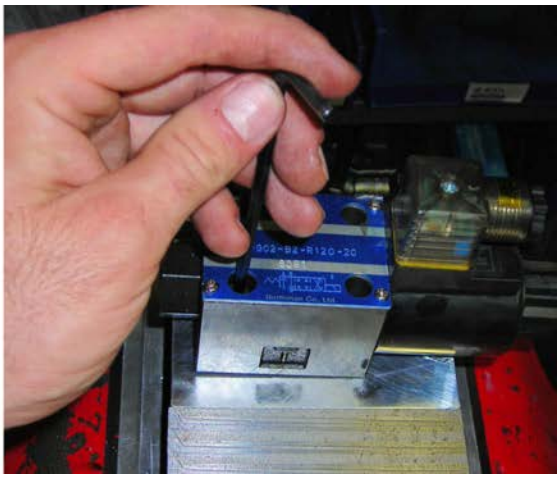


5. Attach the new brake finger and pad to the piston with the two FHCS (Over-tightening the screws will damage the brake pad). Fasten the new brake finger to the caliper using the three 5/16-18 X ¾ SHCS supplied. Torque the bolts to 20 ft lbs. Install the second new brake pad to the back-plate using the two 10-32 X ½ FHCS.





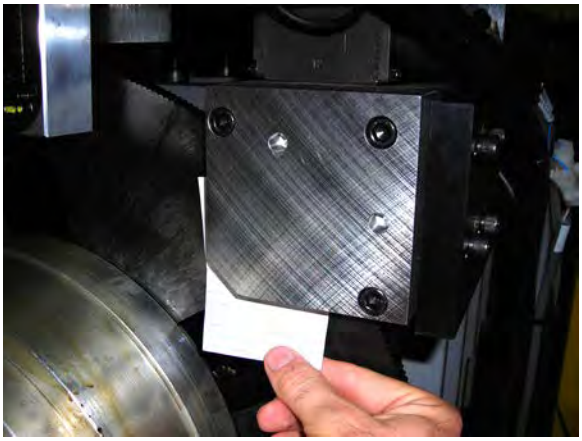
6. Assemble the back-plate and caliper using the three 3-16 X 1 ½ bolts. Tighten to 35ft lbs. Re-install the hydraulic valve to the caliper.

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.

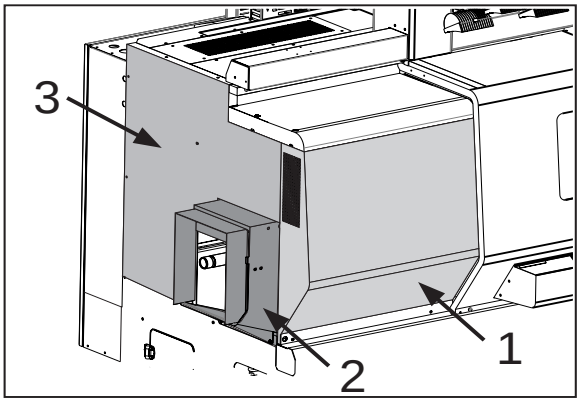
D. Zero-return the machine and use M14 in MDI to apply brake pressure and M15 to release. This step may need to be repeated a few times to allow air in system to escape. Continue to check for leaks. The spindle should rotate freely by hand when brake is released and not rotate when brake pressure is applied.

ST-10 /10 Y C- Axis Motor and Brake Service

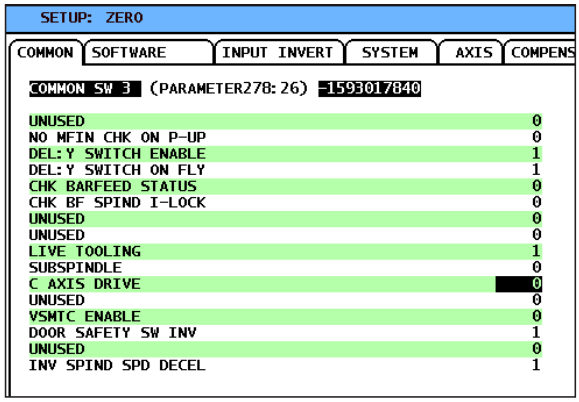
Tools Required:

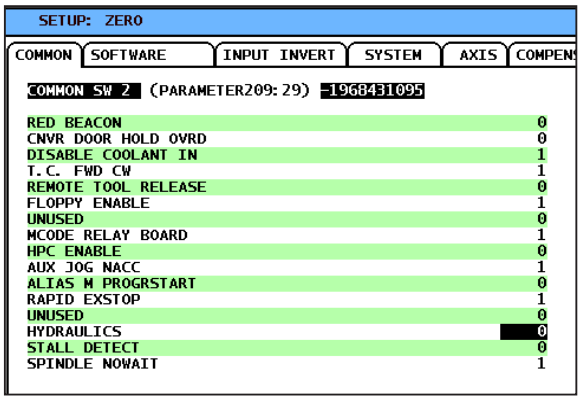
Gates Sonic Tension Meter Model # 505C or 507C

1. Press emegency stop. Remove the enclosure panels in the order indicated.



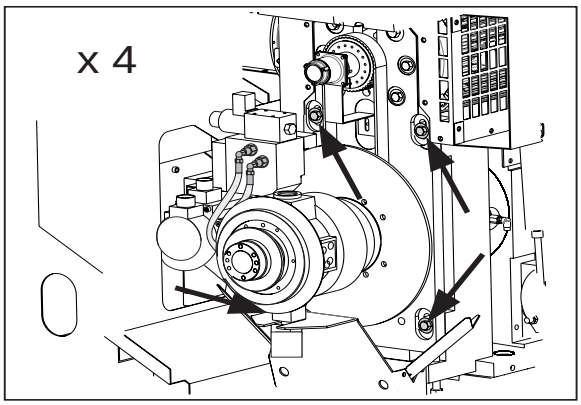
2. Set Parameter 278 bit 26; “C AXIS DRIVE” to “0” and Parameter 209 bit 29; “HYRDAULICS” to “0” .

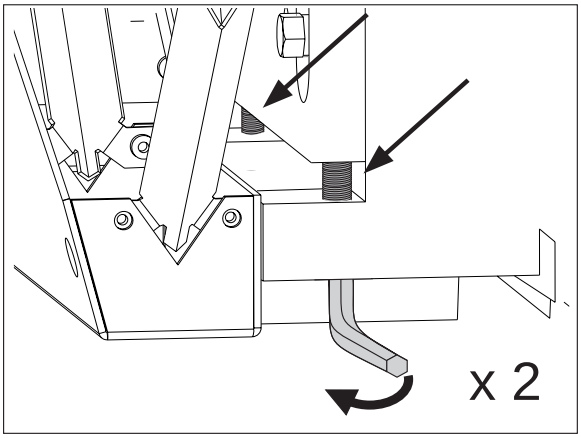




3. Loosen the four spindle drive belt lock bolts.

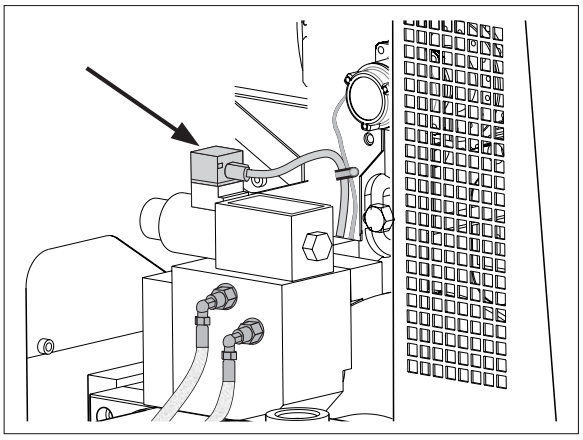
4. Loosen the tension on the spindle drive belt by adjusting the jacking screws.

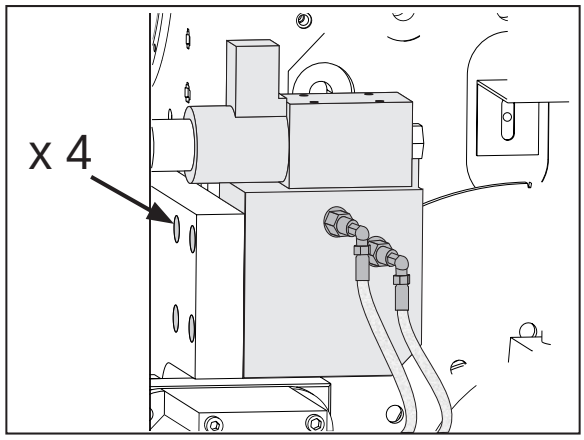




5. Disconnect the brake solenoid cable.

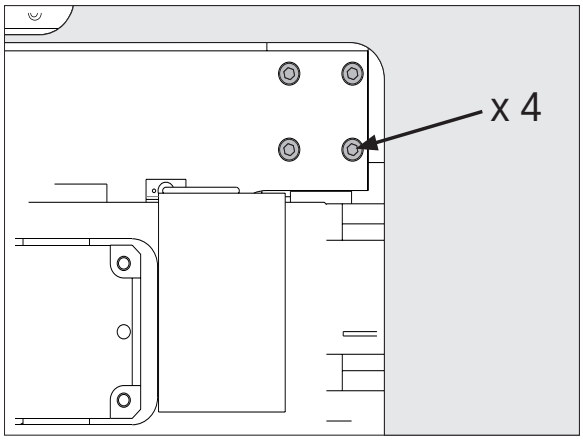
6. Remove the brake caliper mounting bolts.

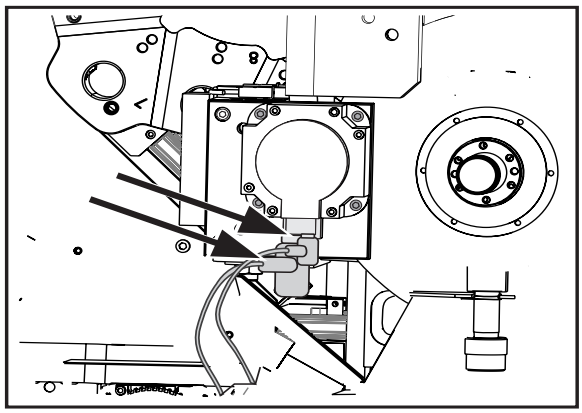




7. Access through the cutout in the sheet metal. Remove the brake caliper. (See Section on C-axis brake rebuild if required.)

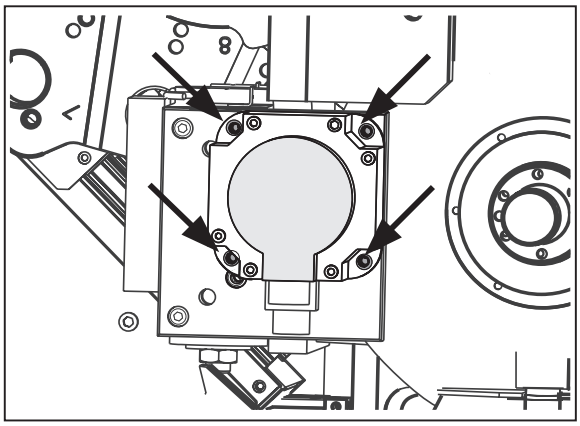
8. Disconnect the C-axis motor and encoder cables.

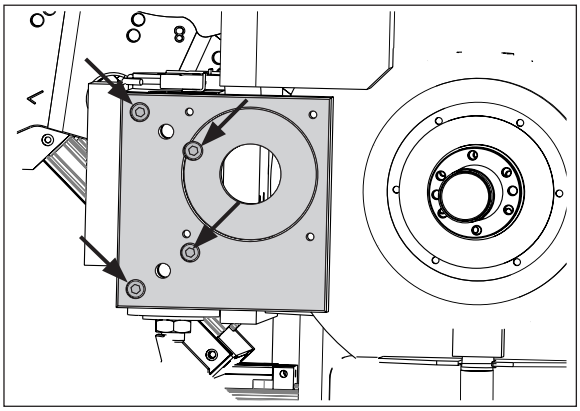




9. Remove the four C-axis motor mounting bolts. Remove the C-axis motor.

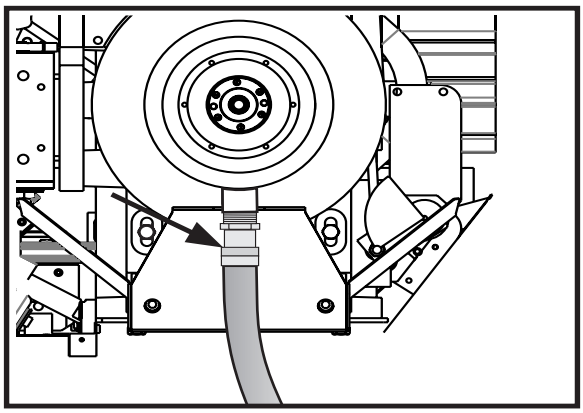
10. Remove the C-axis motor mounting plate bolts and remove the plate.

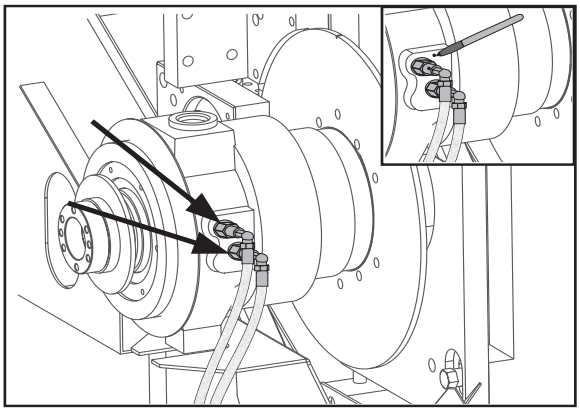




11. Disconnect the coolant return hose going to the actuator

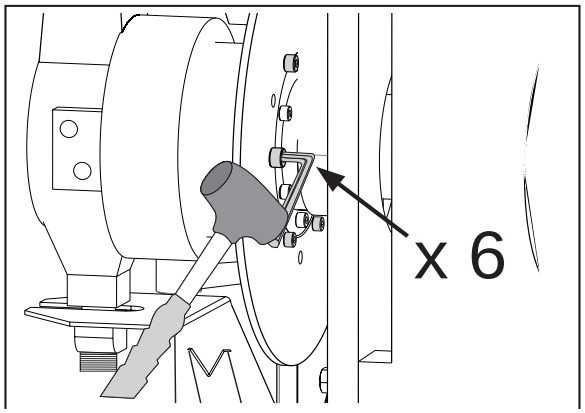
12. Mark one of the actuator hoses to ease re-connection. Disconnect the hydraulic lines going to the actuator.

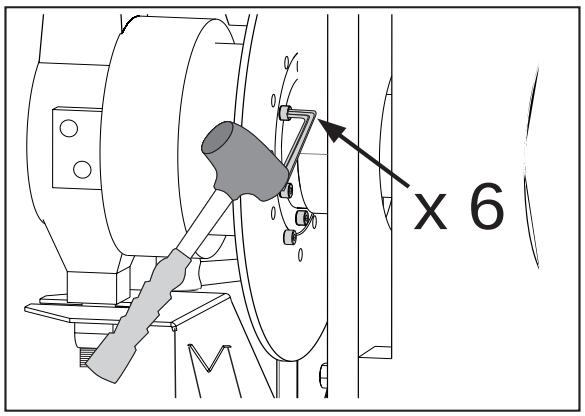




13. Remove the 6 brake rotor mounting SHCS. If required tap the allen wrench with a mallet to break the screws loose. The disc brake will be loose.

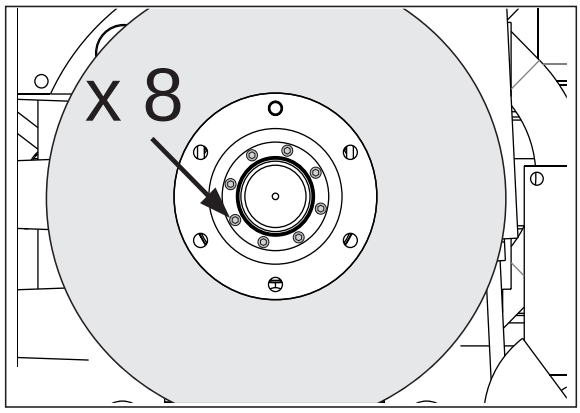
14. Support the weight of the Spindle actuator. Loosen the 6 actuator SHCS. If required tap the allen wrench with a mallet to break the screws loose. Remove the actuator.

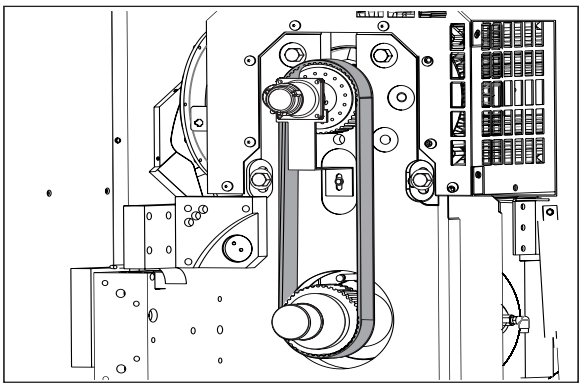




15. Remove the 8 actuator mounting plate SHCS. Remove the plate and the brake rotor.

16. Remove the spindle drive belt.



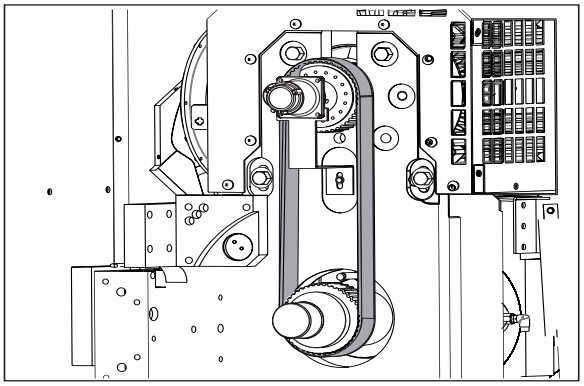


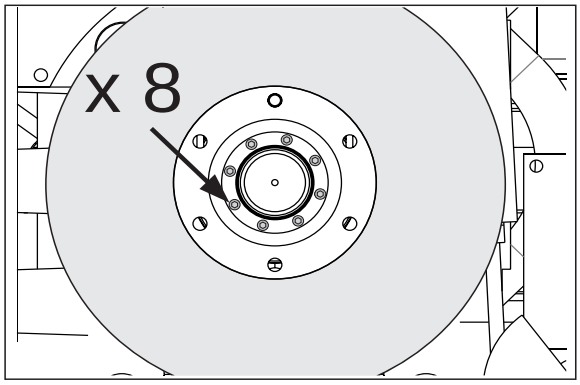
C-Axis Motor, Brake Caliper & Rotor Installation

1. Inspect brake rotor, caliper, pads and spindle drive belt. Replace or rebuild as required.

2. Install the spindle drive belt onto the pulleys.

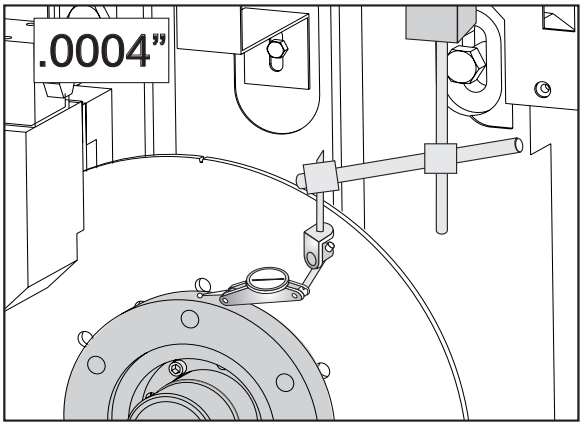
3. Slide the new rotor over the spindle and mount the actuator plate. Hand tighten the screws.

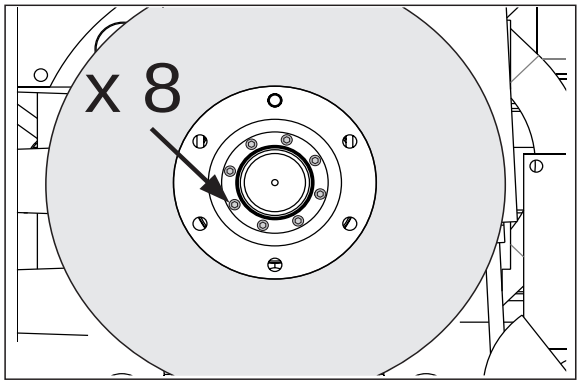




4. Indicate the outside edge of the actuator mounting plate and center the adaptor plate. TIR <.0004”

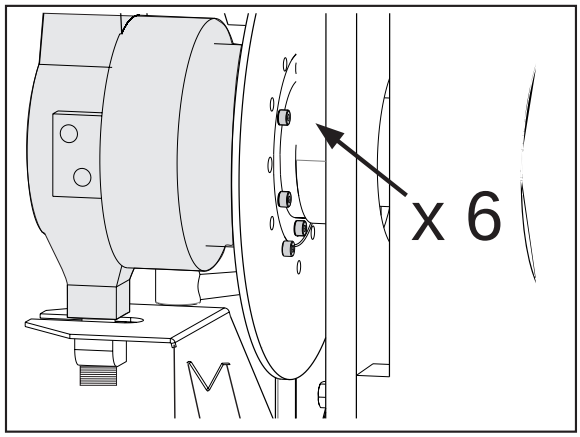
5. Torque the actuator mounting plate to 15 ft/lbs.

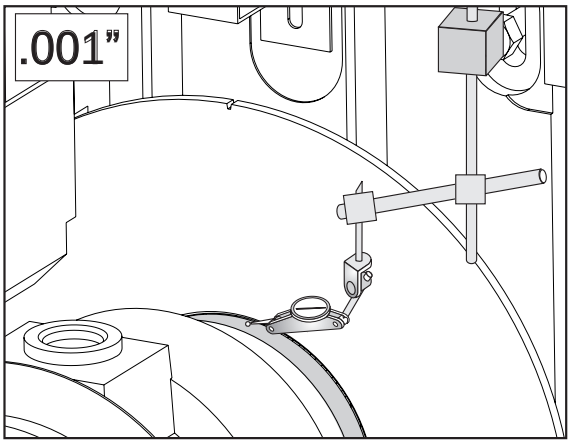




6. Support the weight of the Spindle actuator. Install and hand tighten the 6 actuator SHCS.

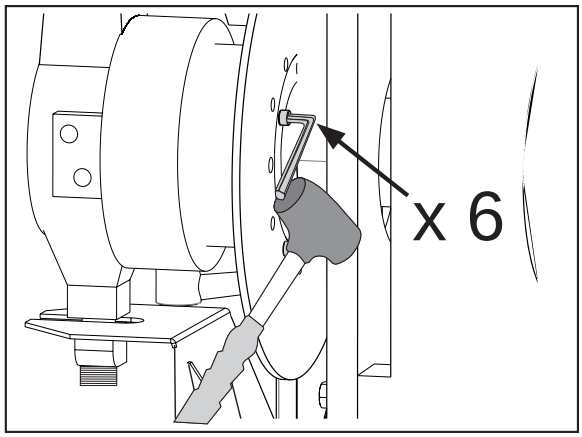
7. Indicate the outside edge of the actuator and align. TIR <.001”

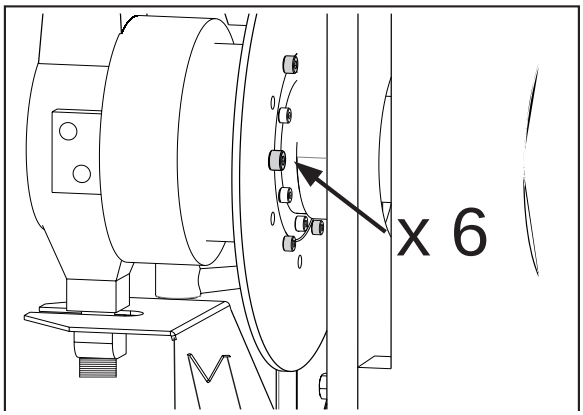




8. Tighten the 6 actuator SHCS by tapping the allen wrench with a mallet.

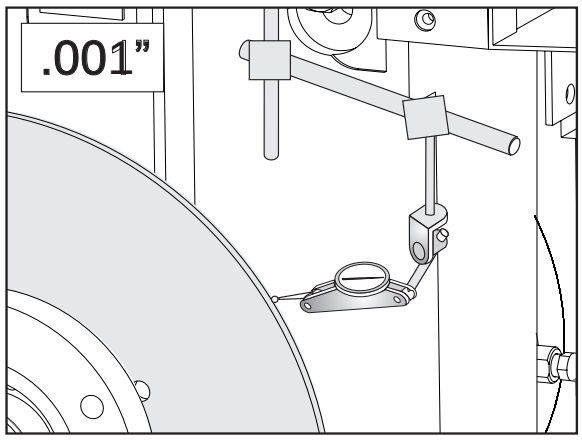
9. Line up the brake rotor and hand tighten the mounting SHCS.

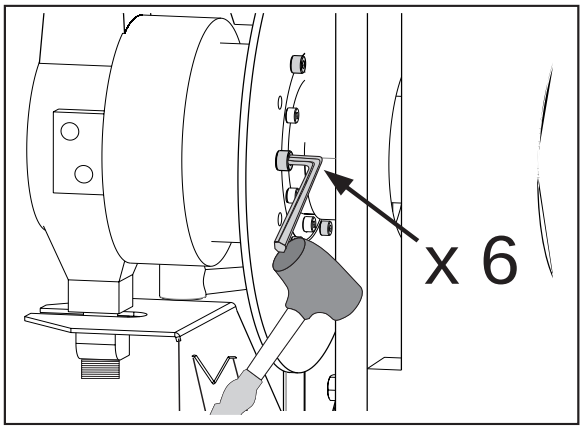




10. Indicate the outside edge of the brake rotor and center the brake rotor TIR <.001”

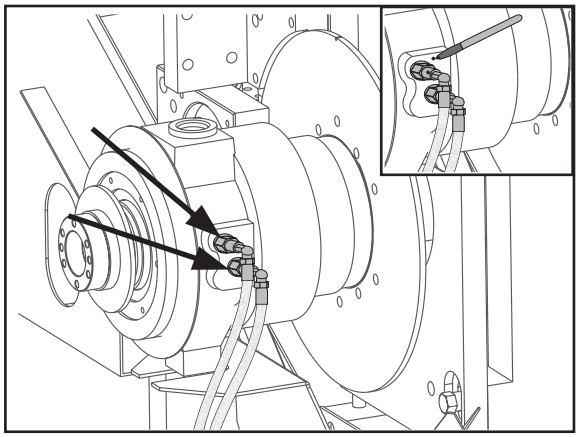
11. Tighten the rotor mounting SHCS by tapping the allen wrench with a mallet.

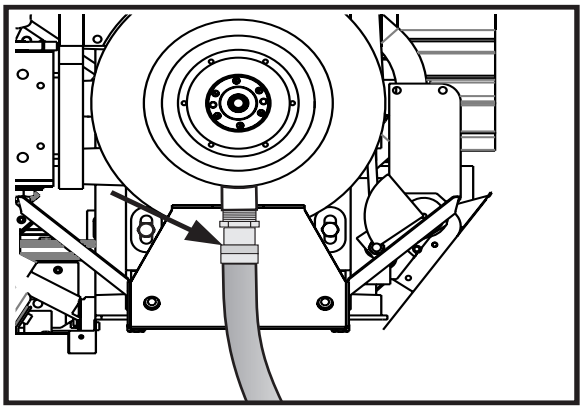




12. Refer to the markings made previously and connect the actuator pressure and return hydraulic lines.

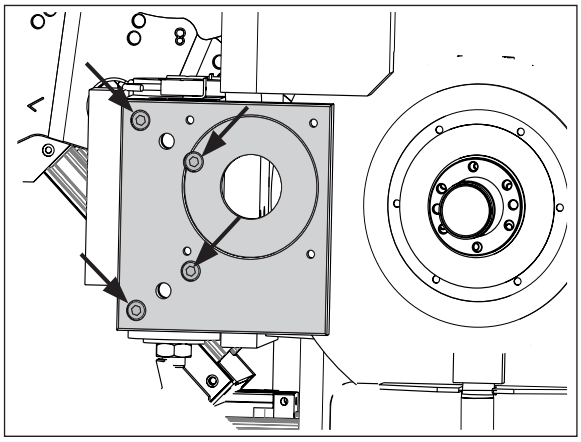
13. Connect the hydraulic return hose.

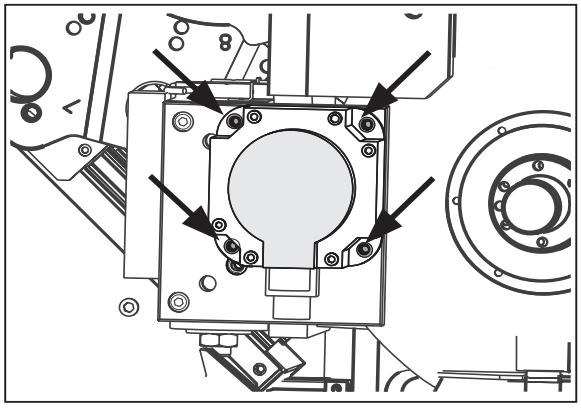




14. Install the C-axis motor mounting plate, torque the SHCS to 30 ft/lbs.

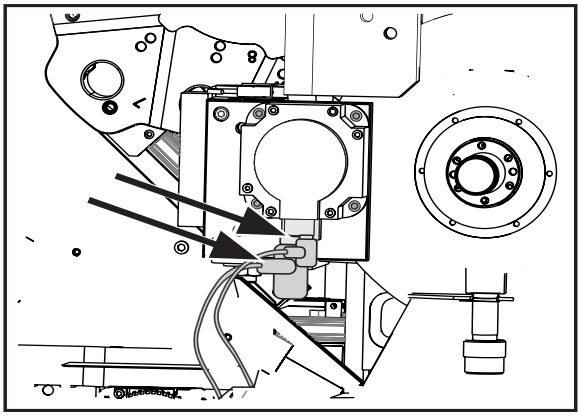
15. Install the C-axis motor, torque the four SHCS to 30 f/lbs.

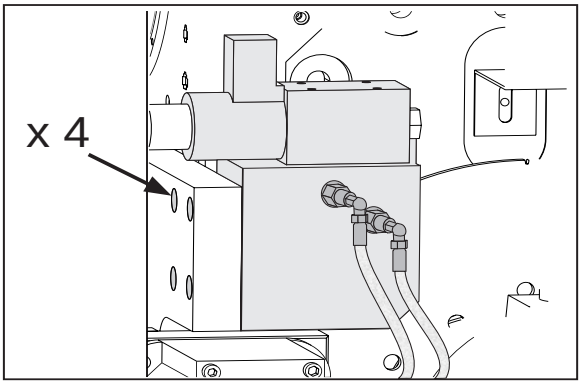




16. Connect the two C- axis motor cables.

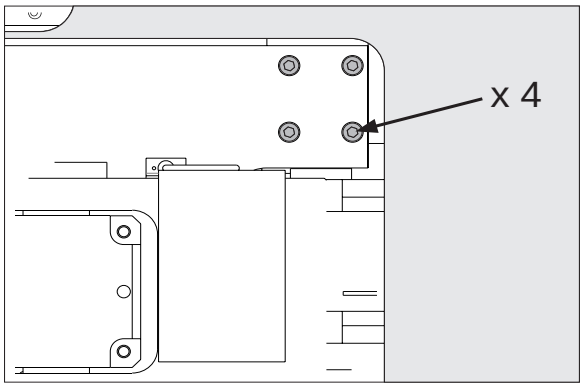
17. Install the brake caliper using the 4 mounting SHCS.

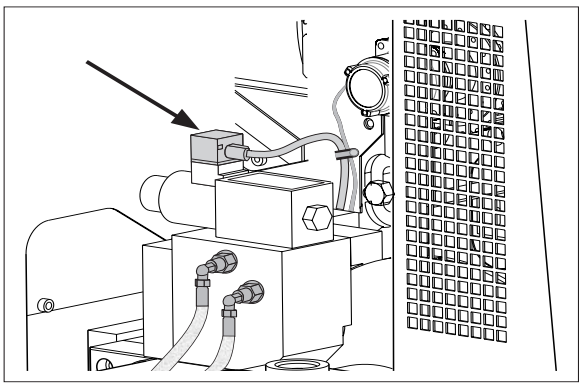




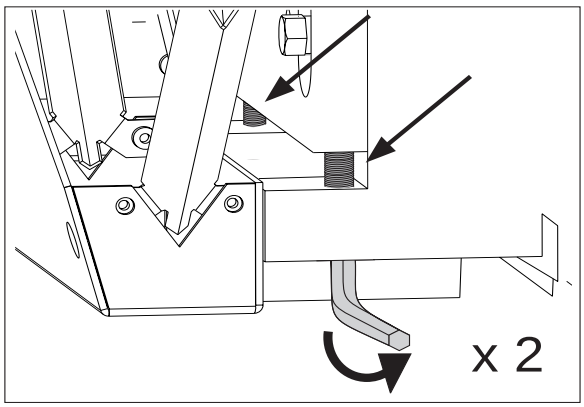
18. Access through the cutout in the sheet metal. Torque the 4 SHCS to 50 ft/lbs.

19. Connect the brake solenoid cable.





20. Adjust the tension on the spindle drive belt with the jacking screws using the procedure below.



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

    A. Set the Gates Sonic Tension Meter so that it is reading Hertz (Hz).

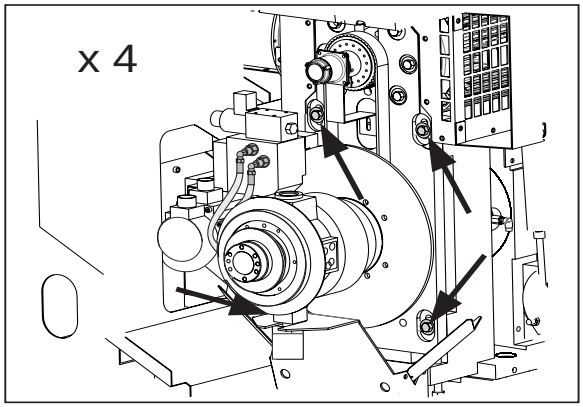
    B. Place the meter's sensor within 3/8" of the belt, and pluck the belt like a guitar string, taking care that the sensor does not touch the belt.

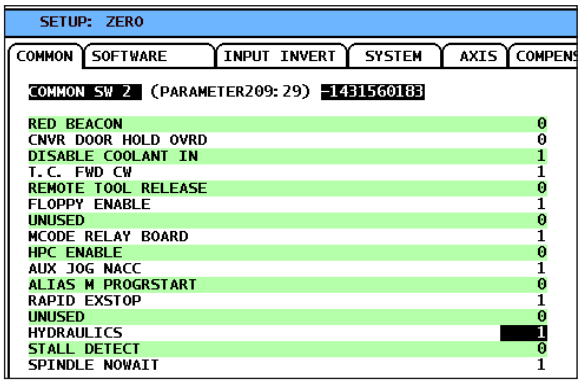
    C. Take belt tension measurements at 6 locations through one revolution of the motor pulley by rotating the spindle shaft one half turn, 5 times (the starting point is the 6th). Take 2 readings at each point.

    D. Adjust the assembly until the belt tension is between 70 and 75 Hz.

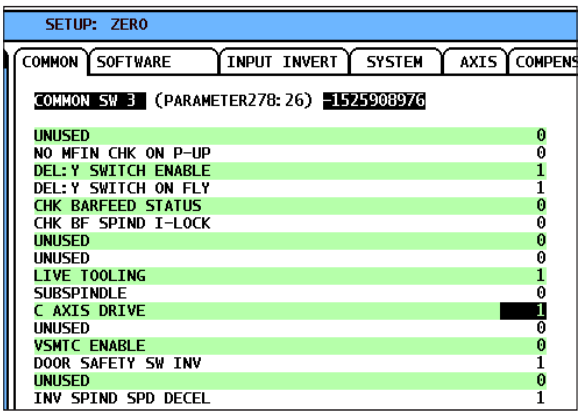
22. Tighten the spindle drive belt lock bolts, torque to 70 ft/lbs.

23. Set: "Parameter 209 -29; HYRAULICS" to "0" .





Set: "Parameter 278 -26; C AXIS DRIVE" to "0" .



Test the operation of the Actuator, C-axis, and Brake.

Check the grid offset and gear mesh.

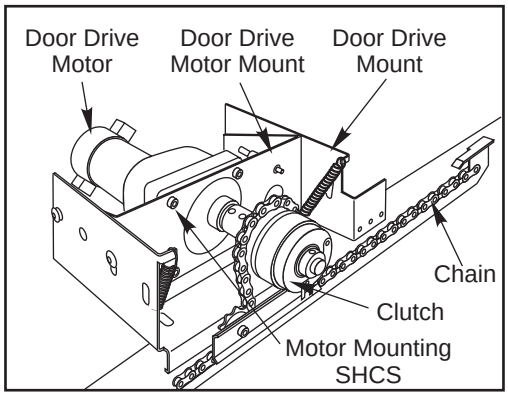
Auto Door Removal and Replacement (Lathe & Vert.)

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.

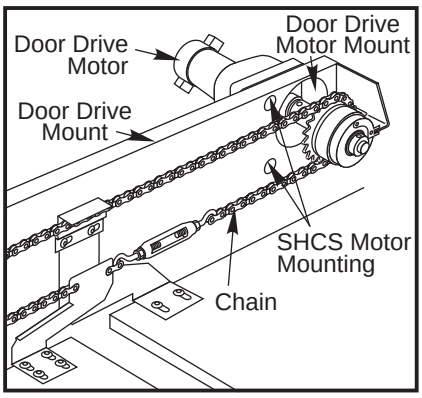
Motor Replacement

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

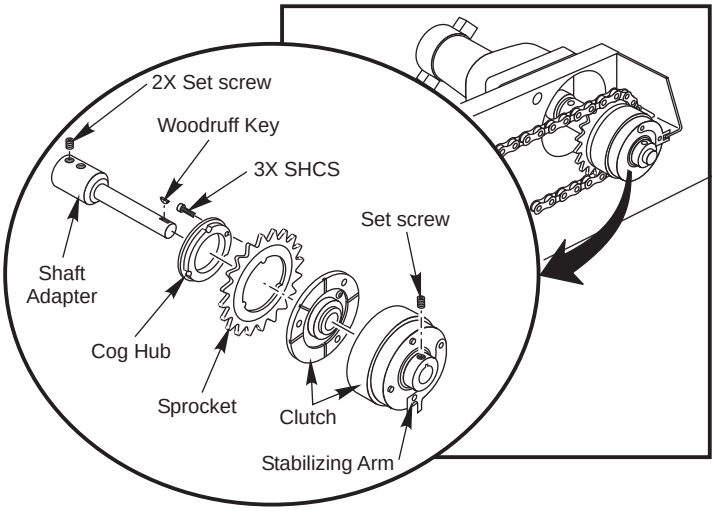
1. Turn off power to machine. Unplug both of the clutch cables from the bridge rectifier on the motor mount.

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.

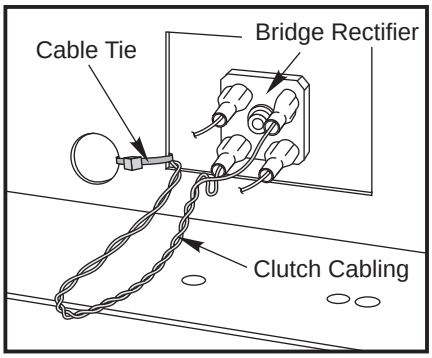
3. Cut the cable ties that fasten the clutch cable to the motor mount. Loosen the two set screws on the shaft adapter and remove the clutch assembly.

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.

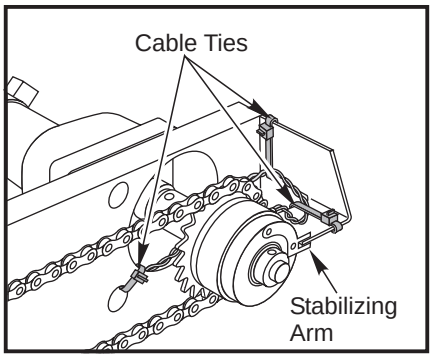
5. Remove the three SHCS that fasten the sprocket and cog hub to the clutch (the clutch is in two parts).



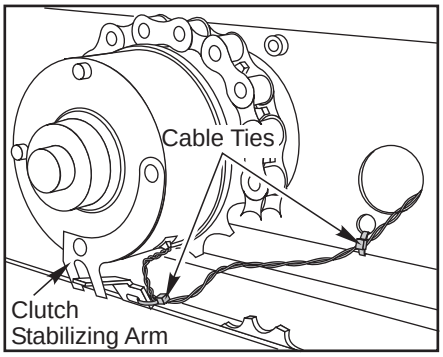
Vertical Machine Clutch Replacement



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

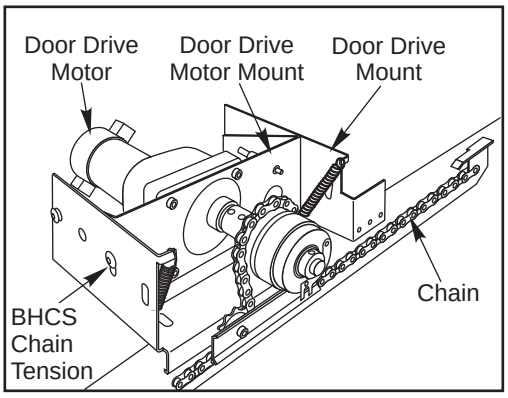
1. Shut off power to the machine.

2. a. **Lathe:** Loosen the front two FBHCS on the door drive mount. This will loosen the tension on the chain.

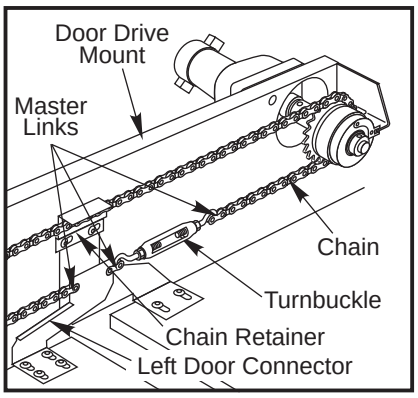
   b. **Vert:** Remove the two FBHCS that fasten the chain retainer to the right door connector.

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.

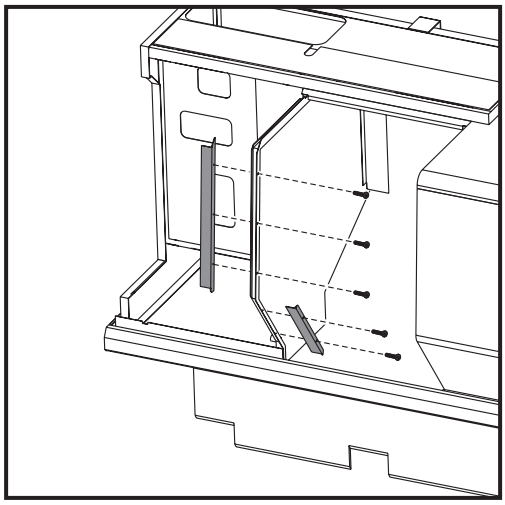
4. Test the door by running a short program:
```
G04 P3.;
M30;
```

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.

Servo Autodoor Service

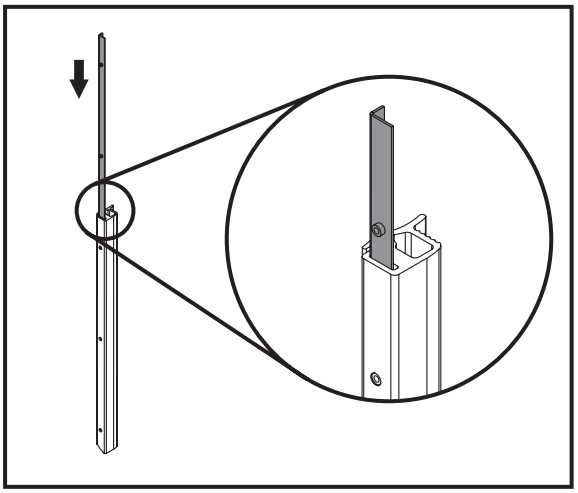
Replacing Splash Guards (Lathe)



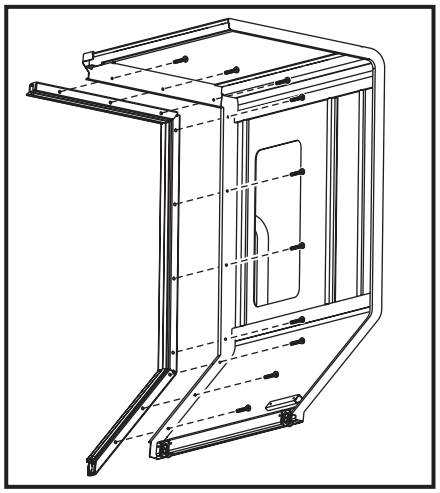
Install Splash Guards
(Only enclosure parts shown for clarity)

1. Remove the front-left enclosure panel
2. Remove the existing splash guards from the edge of the spindle bulkhead.
3. Install the autodoor splash guards as shown in the previous illustration. The lathe door is removed from the illustration for clarity; there is no need to remove the door to install the guards.

Replacing the Safety Seal



Install Back Bars

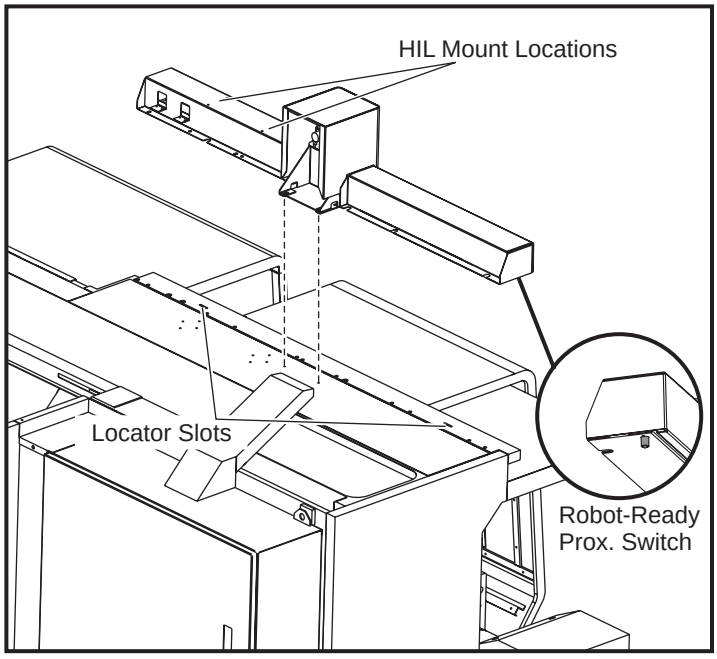


Install Seal to Door

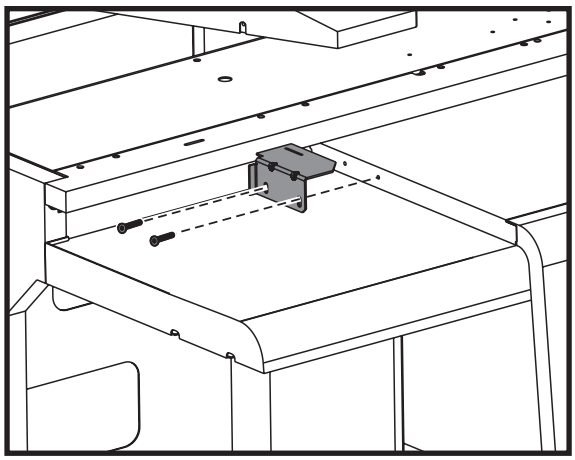
1. Remove the existing safety seal from the door.
2. Install the back bars to the replacement safety seal pieces.
3. Install the safety seal to the door as shown in the illustration using 10 10-32 SHCS. The illustration depicts installation on a lathe; mill installation is similar.

Replace Autodoor Drive Assembly

The autodoor assembly is replaced as a unit. Illustrations depict lathe installation; mill installation is similar.



Install Autodoor Assembly



1. Turn off the machine at the breaker and lock out power.
2. Remove the motor cover from the existing autodoor assembly and disconnect the motor and encoder cables.
3. Remove the existing autodoor assembly. If the machine has high-intensity lights installed, remove the light assemblies and set them aside. Do not disconnect the lights.
4. Use the locator slots to position the drive assembly and secure in place.
5. Inspect the link bracket(s) on the door(s) and replace if necessary.
6. **Robot Ready Option:** If the machine has or will use the Haas Robot Ready option, install a proximity sensor (69-1700) to the switch mount at the left end of the drive assembly. The cable exits the rear of the drive assembly and routes to the Robot Ready module. During testing and setup when autodoor installation is complete, be sure to test this switch as well.
7. **High-Intensity Lights:** If equipped, reinstall the light fixtures to the locations at the top of the autodoor drive assembly.

   Make sure the HIL switch is correctly tripped (but not overrun) when the door reaches the fully open position.
8. Make sure the door(s) open and closes smoothly. If there is binding or rough travel, disengage the link bracket(s) from the door driver(s) and determine the cause of the problem. When the door travels smoothly, re-engage the link bracket(s) and door driver(s).
9. Make sure the machine is shut off and power is locked out. Remove the motor cover from the autodoor drive assembly and connect the power and encoder cables. Reinstall the motor cover and power on the machine.

Control Setup

1. Change Setting 51 (Door Hold Override) to ON, or turn the setup mode keyswitch to the “Unlocked” position (software versions 11 (lathe) and 18 (mill) or later).
2. Enter Debug mode.

Note: The lathe Parameters specified here are for lathes with the servo autodoor assigned to the Y Axis. If the autodoor is assigned to a different axis (as with a Y-Axis lathe), change the equivalent Parameter for that axis.

3a **Lathe:** Set Parameter 211 (Y Tool Change Offset) to 0.

3b **Mill:** Set Parameter 379 (U Tool Change Offset) to 0.

4. Zero return the servo autodoor axis, then fully open and fully close the door(s) by hand. In POS RAW DATA, note the “actual” value for the autodoor axis.
5. Multiply the value you noted in the previous step by 10,000. For example, 1.2048 becomes 12048. Enter this value in Parameter 211 (lathe) or 379 (mill).
6. Check Parameter 826 (Servo Dr Decel). The value should be 400000.

   Check Parameter 827 (Servo Dr Safe Zone). The value should be 180000.
7. Zero return the autodoor axis. The control should display the message CYCLE DOOR.
8. Open, then close the door(s) by hand a few inches. The CYCLE DOOR message should disappear.
9. Press the autodoor button to make sure the door(s) travel to the correct positions (just at the bump stops when open; seal in slight contact with the right door jamb (lathes) or second door (mills) when closed). If the door jumps back at either position, repeat the Parameter adjustment steps.

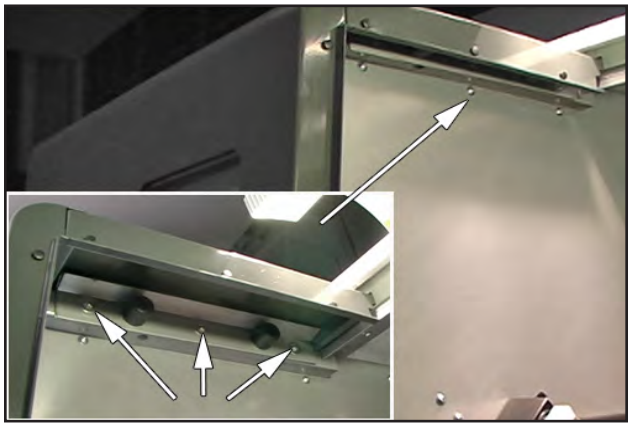
Enclosure Replacement

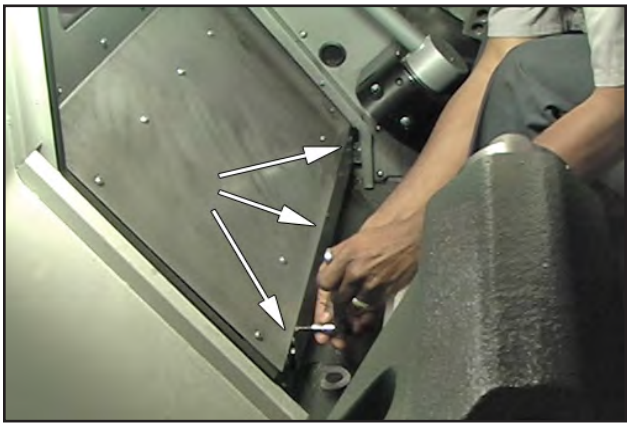
Enclosure Replacement (DS- lathe.)

Door Removal

CAUTION! Press the Emergency Stop Button & Lock Out/Tag Out Emergency Stop Button.

1. Remove the upper inner door wiper and bumper.
2. From inside with the door closed, remove the door keeper.





3. Remove upper door roller guide screws and remove guide.
4. Remove door by lifting up first, then out. Support the lower part door with a knee or use an assistant.

Door Installation

1. Lift the new door into position aligning the bottom rollers first. Support the lower part of the door with a knee or use an assistant to remove the door.

2. Install the upper roller guide, loosely tighten the upper roller guide screws.

3. Reset the **Emergency Stop.** Press " **Reset**"

   Navigate to the "**DNGOS**" tab to view doors switch status.

   Press: "PARAM DGNOS"

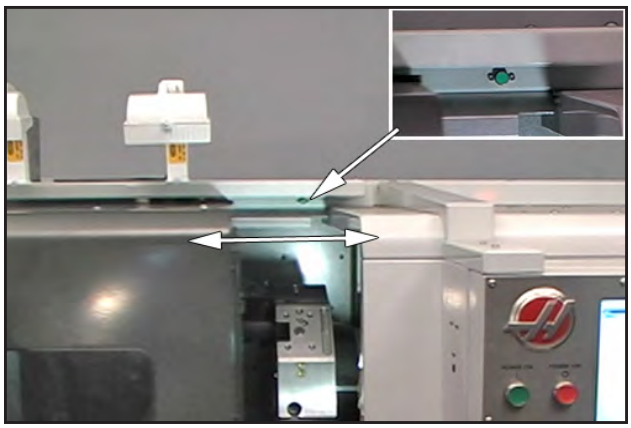
   Press: Arrow key to move to "DGNOS" Tab.

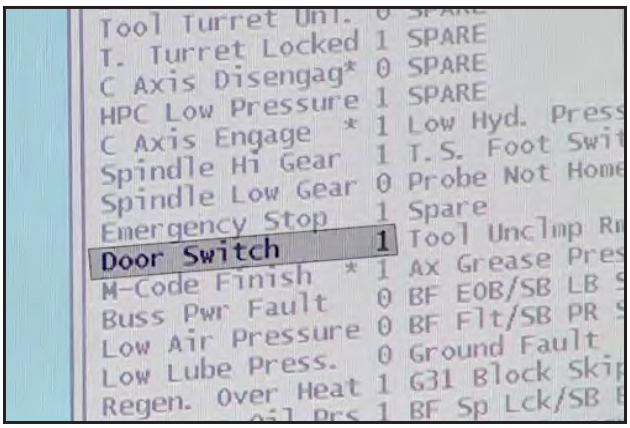
   Press: "WRITE ENTER"

4. Verify the door switch operation, by opening and closing the door and noting door switch status change.

5. View screen to verify door switch operation. Door Switch: Open = 1. Door Switch: Closed = 0 .

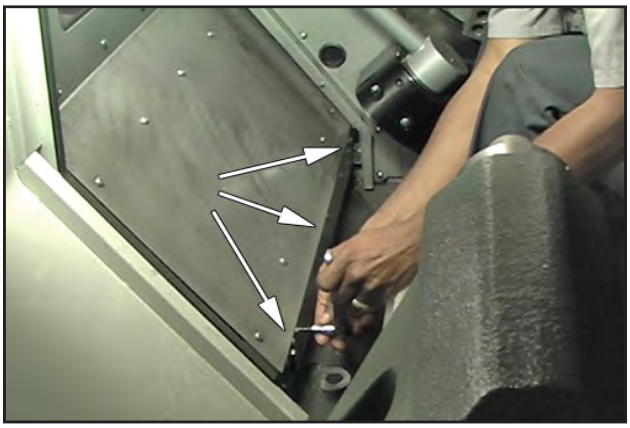
   Adjust switch if required.



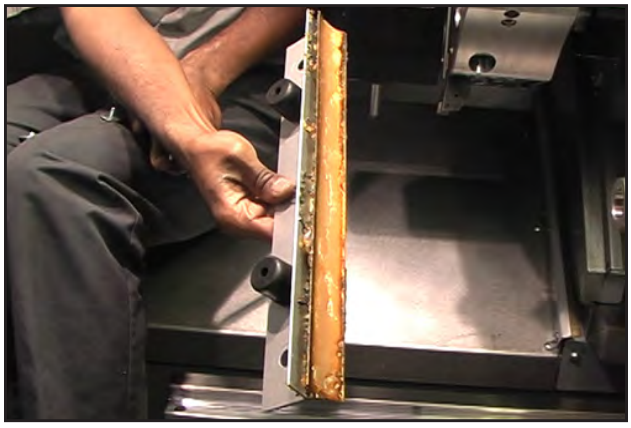


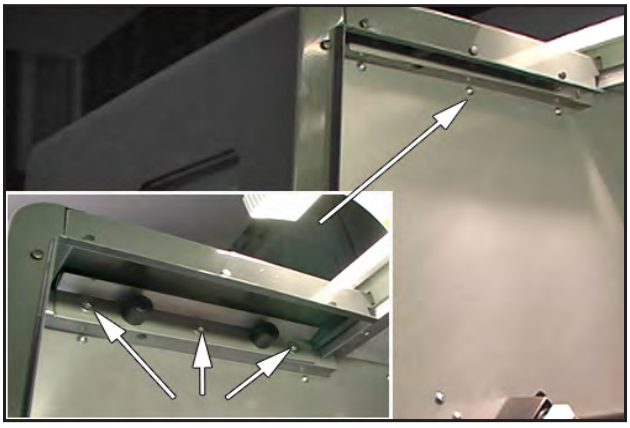
CAUTION! Press the Emergency Stop Button & Lock Out/ Tag Out Emergency Stop Button.

6. Tighten the upper roller guide screws.
7. From inside with the door closed, install the door keeper.



8. Clean and re-grease the upper door wiper with general purpose grease.
9. Install the inner upper door wiper / bumper, applying moderate upward pressure to insure snug seal.





Enclosure Replacement (Vert.)

Please read this section in its entirety before attempting to replace the doors or windows.
Tools Required: Trim installation tool (dull-edged knife or caulking spatula).

Door Replacement

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

Removal

1. Turn the machine power off.

2. Slide the doors to the full open position.

3. Remove the tension springs (2) connecting the two swivel roller brackets at the top and bottom of the door.

4. Slide the door to the fully closed position. Loosen the two upper roller hex nuts, and disengage the upper swivel roller brackets from the top roller guide.

5. Lift the door from the bottom roller guide and remove.

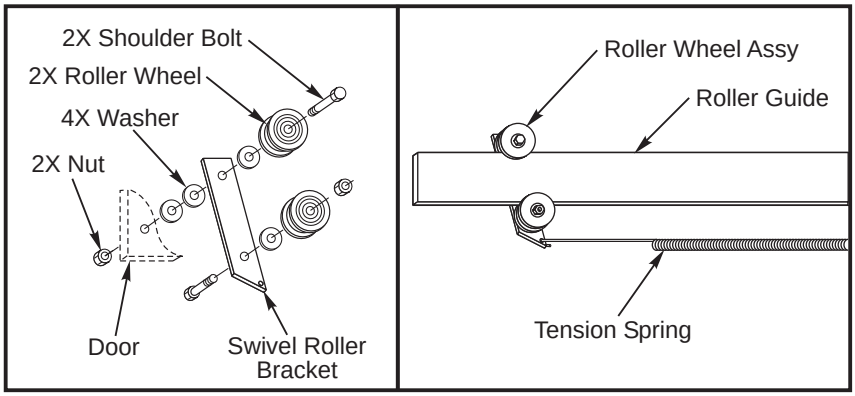
Installation

1. Ensure that the lower roller hex fasteners are tight and the upper roller fasteners are loose and in the middle of their adjusting slots. Place the door into the enclosure, and position with the lower rollers resting on the lower roller guide.

2. Rotate the door to the upright position, and engage the top rollers onto the top roller guide.

3. Replace the tension springs onto upper and lower roller swivel brackets. Tighten the upper roller fasteners.

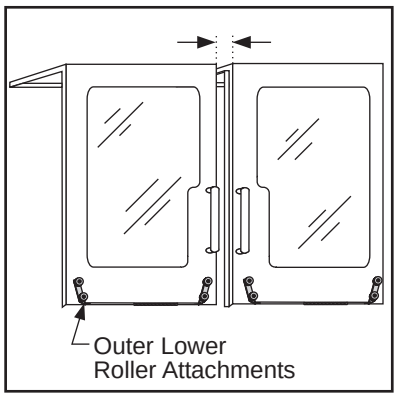
4. Verify that the door travels smoothly. If it does not:
   - Check that all roller wheels are seated and roll on their tracks.
   - If all roller wheels are seated on their tracks, it will be necessary to adjust the door travel by loosening the upper and lower roller hex fasteners.



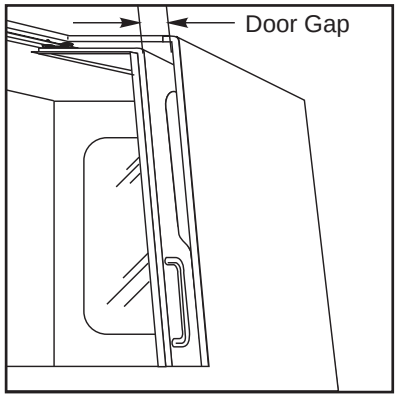
Roller/Roller Guide Assembly

Door Adjustments

5. Close both doors and check that the vertical gap between them is uniform. If it is not:
   - Determine which door must be adjusted.
   - Loosen the door's outer lower roller attachment and pivot the door on the inner lower roller wheel.
   - When door is in the desired position (the vertical gap is uniform), tighten the lower outer roller fastener.



Vertical Gap Between Front Doors



Gap Between Front of Door and Front Panel Flange

6. Check the gap between the door and the front panel flange, and verify it is 5/8” throughout the travel of the door. If it is not, loosen door’s upper roller fasteners and tilt door forward or back, as necessary, to adjust position.

Door Open Sense Switch

The Door Open sense switch is a magnetic reed switch type. These switches are normally closed and wired in series. When a door is open, the switch(es) will open and the machine will stop. When the door is closed again, operation will continue normally.

CAUTION! A door hold will not stop a tool change operation or a tapping operation, and will not turn off the coolant pump.

Also, if the doors are open, the spindle speed will be limited to 750 RPM (500 RPM for lathes).

The Door Hold function can be temporarily disabled with by turning Setting 51 **On**, if Parameter 57 bits Door Stop SP and Safety Circ are set to zero, but this setting will return to Off when the control is turned off.

Switch Adjustment

1. Move the door to the fully closed position. Go to the Diagnostics page on the control panel, and ensure Door S reads 0. Open the door, and ensure Door S reads 1. If either reading is incorrect:

- Loosen the SHCS that mounts the switch actuator bracket to the top of the door. Note that it is possible to access this bracket from the side window.
- Move the bracket in its slot to the proper position and tighten the SHCS.

Steady Rest Alignment and Adjustment

If the clamp handle does not properly lock the steady rest in place, the tension bar needs to be adjusted.

1. Remove the 1 1/8” cap nut from the clamp handle and orient the handle in the un-clamped (vertical) position.

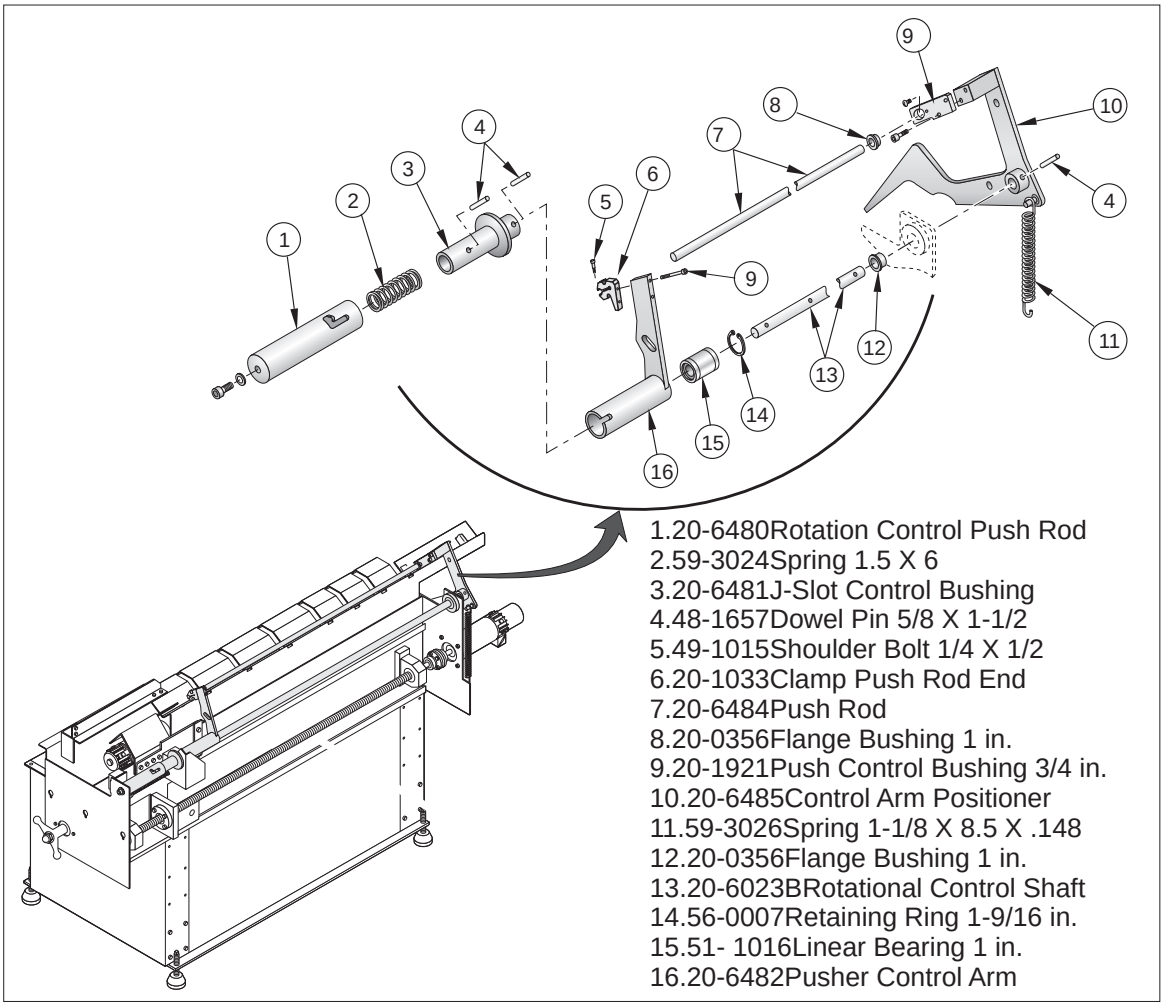
2. Grip the tension bar and adjust in a counterclockwise direction so that the clamp will move closer to the base, creating more tension.

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

3. Re-install the cap nut.

Push Bar Repair

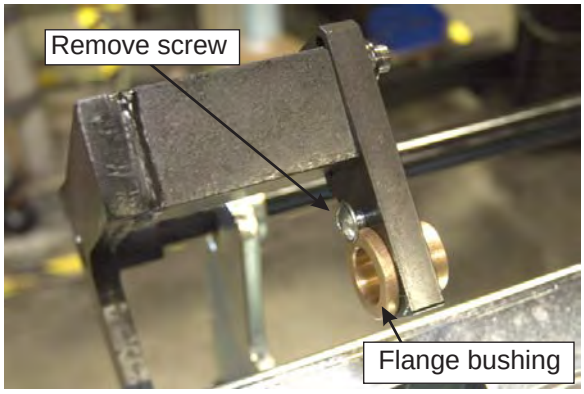
The push bar assembly is composed of the following components



Push Bar Assembly Diagram

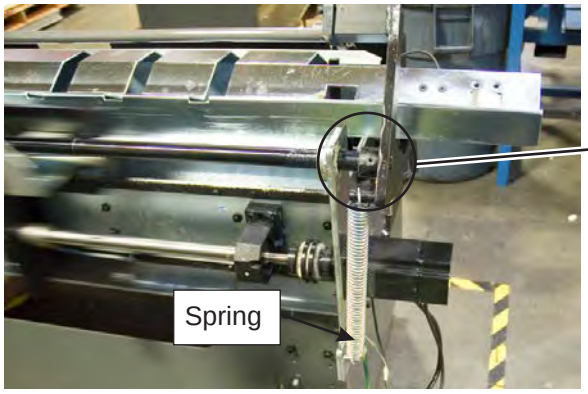
Disassembling the push-bar assembly.

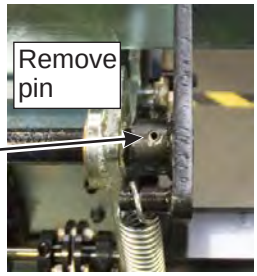
1. Loosen the shoulder bolt 1/4 X 1/2. Remove the push rod from pusher control arm.



NOTE: When replacing the push rod, the Flange Bushing must be inspected and replaced if it causes the push bar to bind.

2. Remove spring from the control arm positioner.



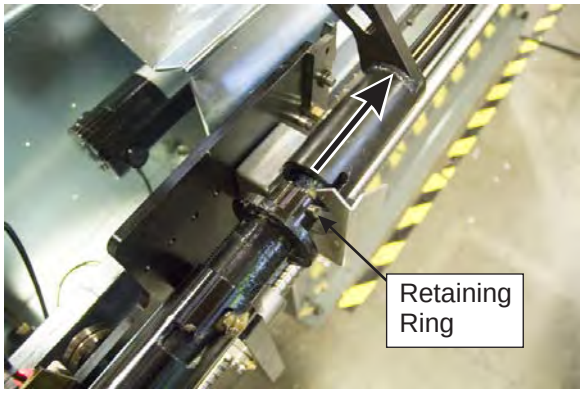


3. Use an appropriate punch to remove dowel pin 5/8 X 1-1/2 from the push rod.

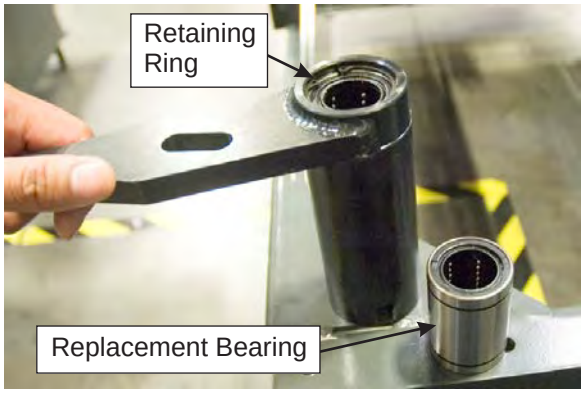
4. Remove control arm positioner from the rotational control shaft.

5. Slide pusher control arm out of the assembly.

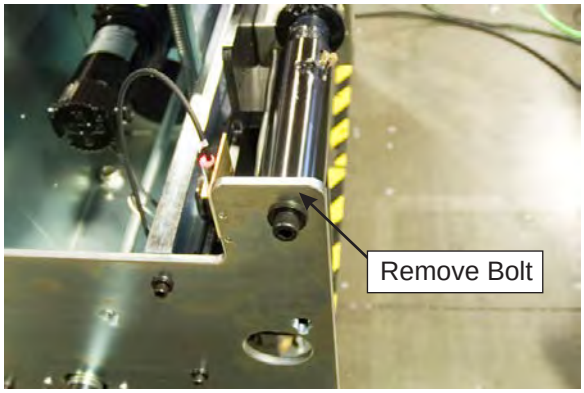
6. Use an appropriate punch to remove dowel pin 5/8 X 1-1/2 from the J-slot control bushing to release the rotational control shaft. Then remove the rotational control shaft.



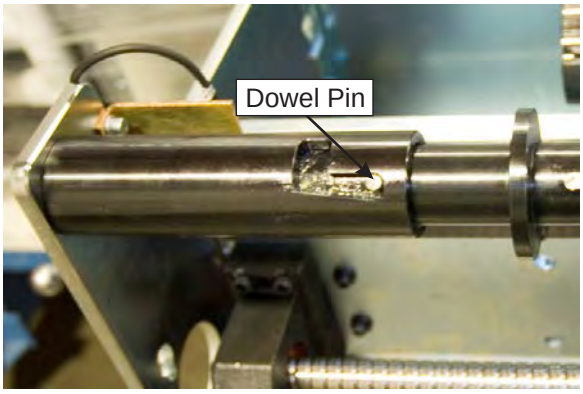
NOTE: When replacing the linear bearing from the pusher control arm, just remove the retaining ring from the control arm and remove the linear bearing replace retaining ring.



7. Remove the bolt that supports the rotation control push rod. Remove the rotation control push rod assembly.



8. To access the inner spring and remove the J-slot control bushing, place the rotation control push rod in a vise such that the J-slot control bushing is pressed slightly in so that tension from the inner spring is released from the pin. Locate the pin-removal access hole from the rear of the J-slot control bushing. Use an appropriate punch to remove dowel pin 5/8 X 1-1/2 from the J-slot control bushing.

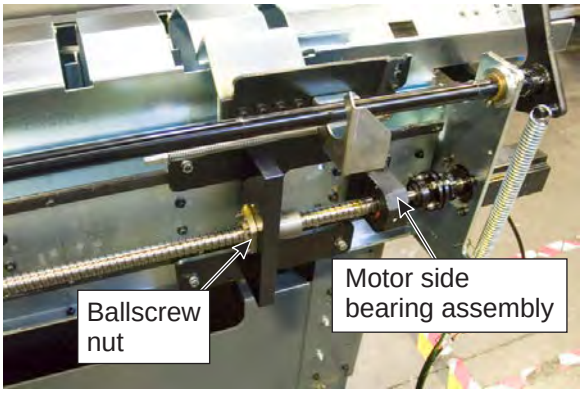


Note: Once the rotation control push rod is opened, verify that the inner chamber is well lubricated to avoid binding. The sliding surfaces must be free of scratches and defects. Replace damaged components.

Ballscrew Replacement

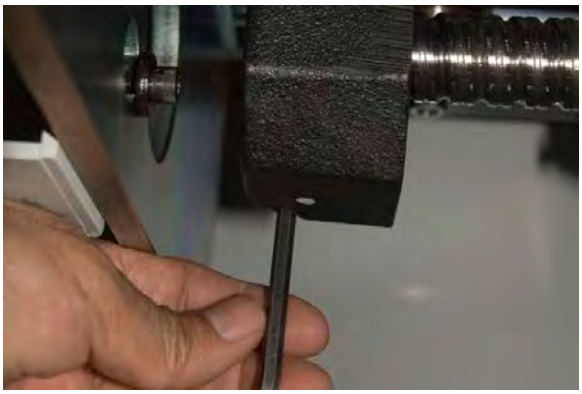
Removing the Ballscrew.

1. Jog the axis to a position such that the ball screw nut bearing is about 12” (305mm) from the axis motor-side support bearing assembly.



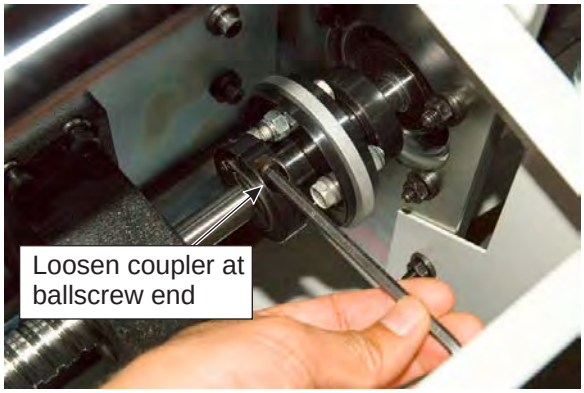
2. Disconnect the axis motor cables.

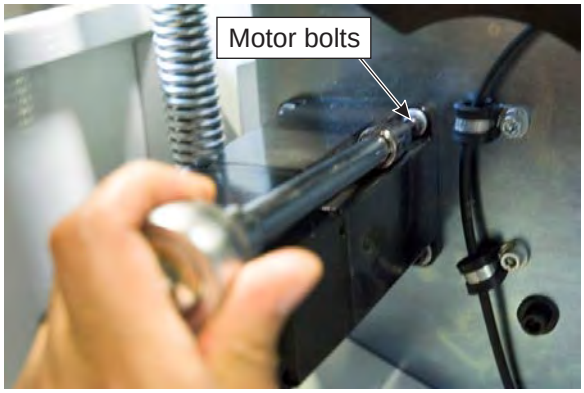
3. On the support side support bearing assembly, loosen the nut lock screw, back off the bearing locknut.



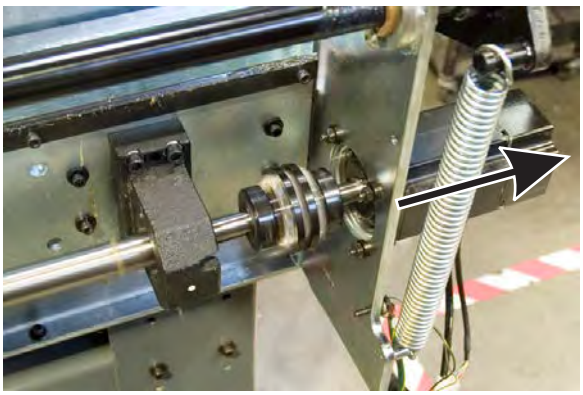
4. Install tool T-1451 in the motor coupler.

5. Loosen the coupling assembly at the ballscrew end, and remove the 4 bolts that support the servo motor.



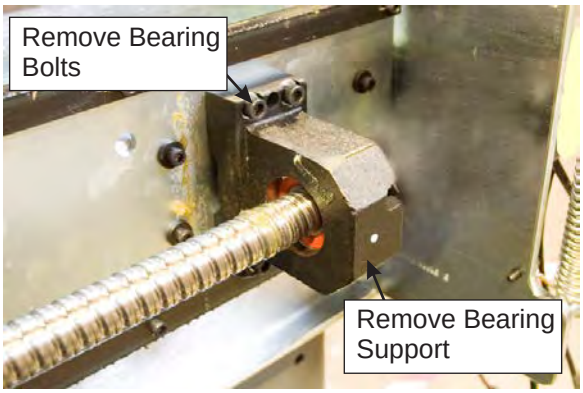


6. Remove motor with coupling.

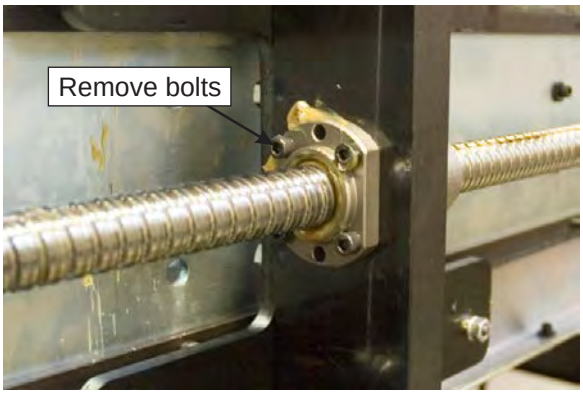


7. Loosen the screw for the bearing locknut and remove from the motor-end.

8. Remove the 4 bolts that attach the bearing support and remove bearing support from ballscrew.



9. Remove the 4 bolts that attach the ballscrew nut to the ballscrew bearing.



10. Push ballscrew bearing towards the motor side all the way, such that it clears the ballscrew nut.

11. Push the ballscrew towards the motor side so the ballscrew clears the support side bearing support.

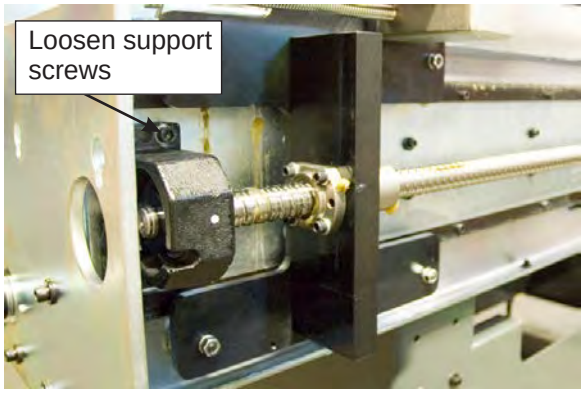
12. Remove the ballscrew.

Replacing the ballscrew.

1. Put the new ballscrew into machine. Position one end though the ballscrew bearing, then the other end through the support-side support bearing assembly.

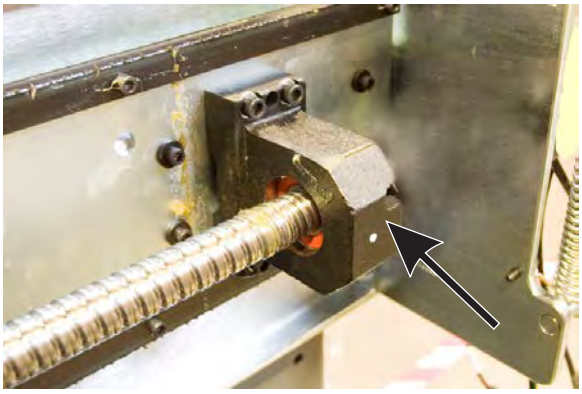
2. Attach the ballscrew nut to the ballscrew bearing with the 4 bolts. Leave the bolts loose for alignment.

3. Loosen the support side bearing support bolts.



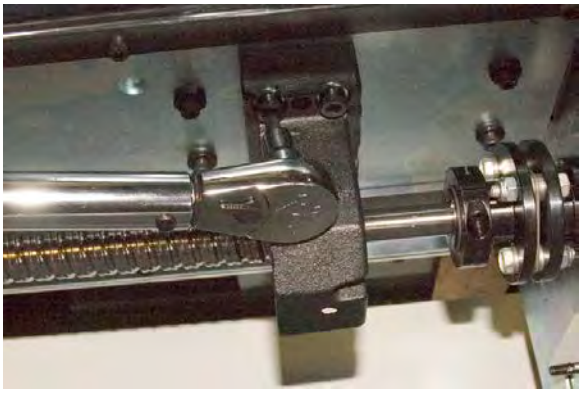
4. Install the bearing locknut finger tight, then loosen 1 turn.

5. Install the motor end bearing support and leave the 4 bolts loose enough for the bearing support to be aligned later.



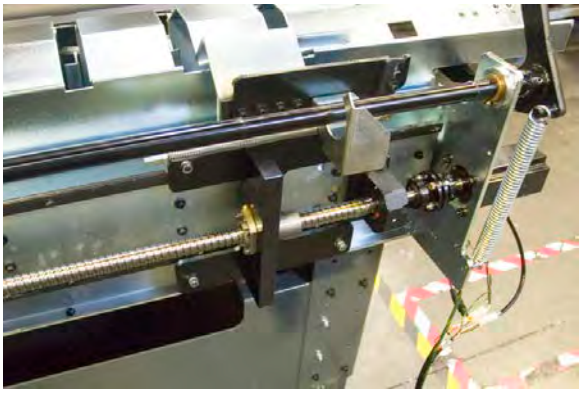
6. Install the motor end bearing locknut. Tighten the nut by hand until the ballscrew turns as you tighten the locknut, then loosen the nut 1/4 turn.

7. Torque the lock screw to 4 in-lb.

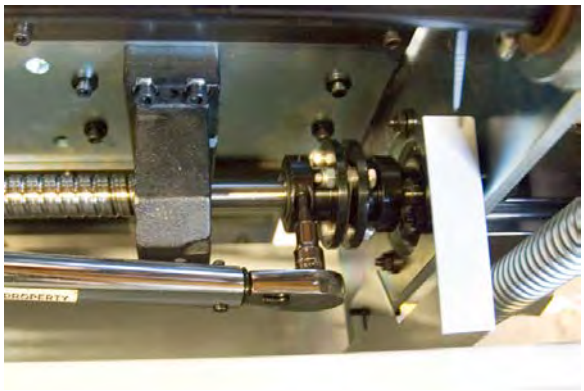


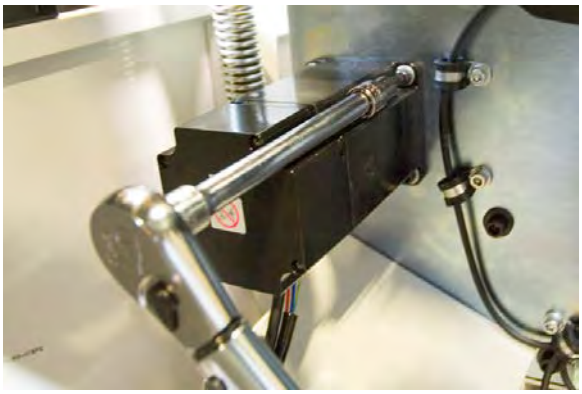
Tighten the ballscrew nut on the support side of the ballscrew with the following sequence,

8. Tighten the nut by hand until the ballscrew turns as you tighten, then loosen the nut 1/4 turn.
9. Torque the lock screw to 4 in-lb.
10. Install motor with coupling.



11. Tighten the coupling bolt. Torque Motor bolts to 30 ft-lb.





Aligning the Ballscrew

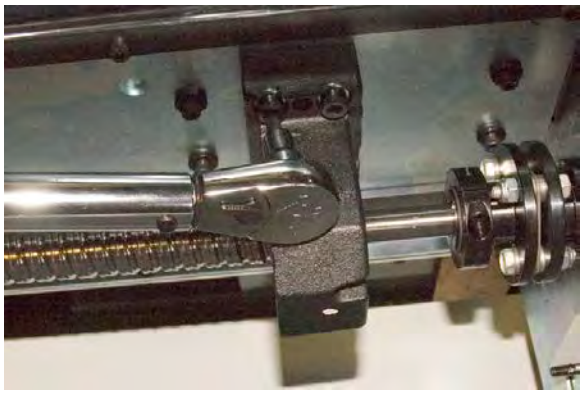
Adjust the position on the ballscrew nut to the ballscrew centerline.

Note: 3 components are loose:
a) The ballscrew nut to the ballscrew bearing bolts.
b) The motor-end ballscrew bearing to the base bolts.
c) The support end ballscrew bearing to the base bolts.

1. Remove tool T-1451 in the motor coupler.

2. To align the new ballscrew into position, Jog the ballscrew several times from right to left and back. This jogging will allow the ballscrew nut to center on the ballscrew bearing.

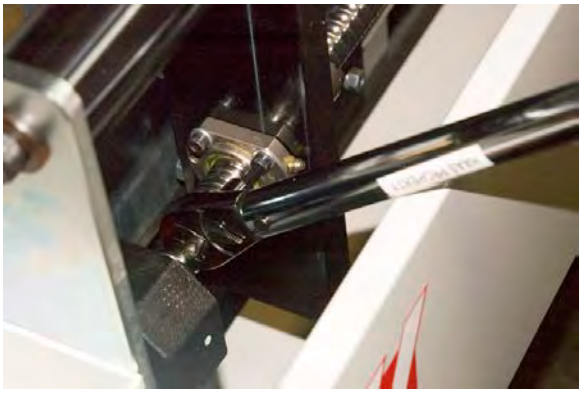
3. Jog the axis towards the motor end and torque the 4 motor end bearing support bolts to 30 ft-lb.



4. Jog the axis towards the support end and torque the 4 support end bearing support bolts to 30 ft-lb.

5. Lubricate the ballscrew with lithium grease. Jog the ballscrew back and forth several times.

6. Finally, torque the ballscrew nut screws to the ballscrew bearing to 15 ft-lb.



7. If the ballscrew pitch has changed from12.7mm (1/2 in) to 10mm (P/N 24-0007A) see Technical Bulletin #0001 to change the required parameters.

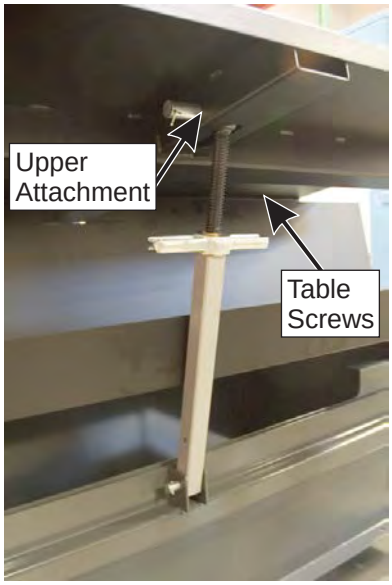
Bar Transfer Table (V-Tray) Service

The V-tray removal requires enclosure sheet metal to be removed so that a rear attachment point can be removed.

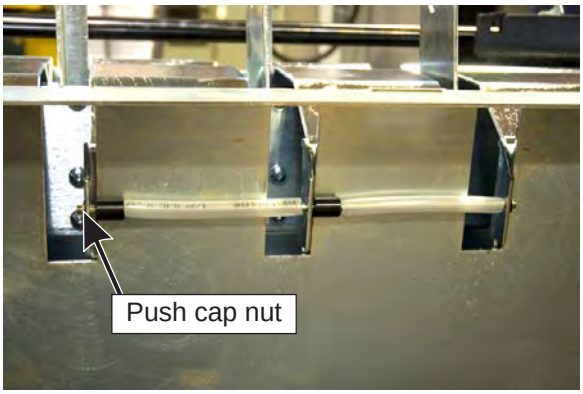
Note: The removal of sheet metal requires 2 people due to the weight of the panels.

1. Remove barfeeder door, cover, and storage pan.

2. To remove the charging table, remove the screws that attach it to the frame, and then remove the upper attachment of the support stand.



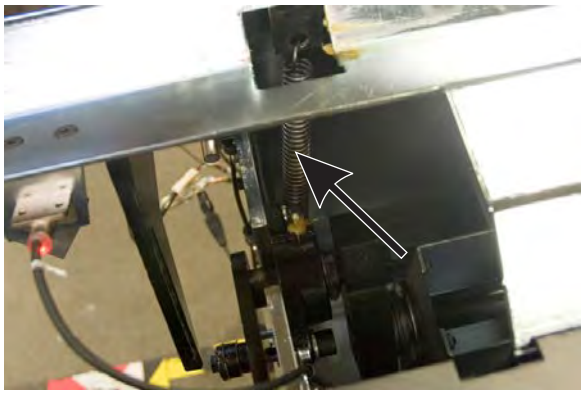
3. After the charging table is removed, locate the tensioning assembly at the rear of the V-tray. Remove one push cap nut to remove both of the tensioning assemblies. Note the sequence of the installation; it must be re-assembled the same way.

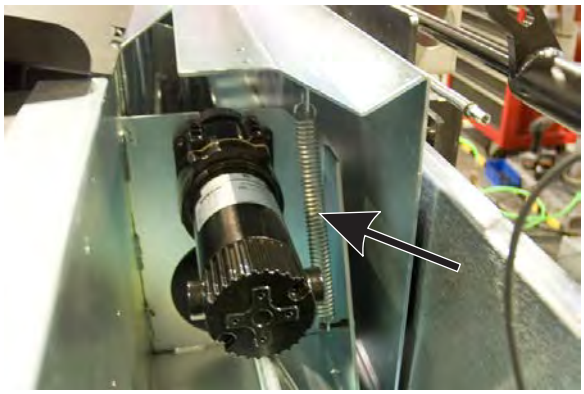


Note: It is possible that the push cap nut be damaged during removal, thus have a replacement cap.

4. Lower the table to its lowest position (smallest bar stock setting) using the height adjustment handle.

5. Remove the 2 springs holding the V-tray in place.





6. Remove the limit switch (end of bar) assembly from the V-tray.

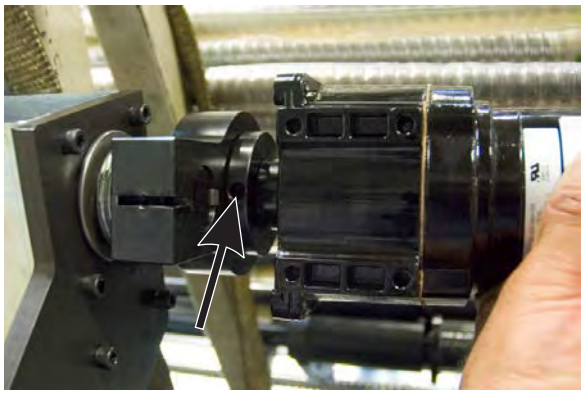
7. Remove the push rod from the push bar assembly (See the Push Bar Repair section).
8. Lift the V-tray straight out of the machine.

Install the tray in the reverse order

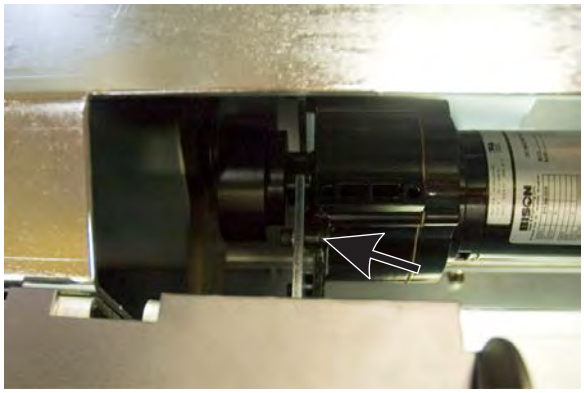
Replacement of the Bar-Loading Motor

Remove Bar Transfer Table (V-tray) before removing motor

1. Disconnect motor cables.
2. Locate the 2 set screws that lock the motor shaft to the clutch and remove them.



3. Remove the 4 bolts that attach the motor to the chassis.



4. Pull motor straight back while being careful to not loose the key.
5. Replace motor.

What can cause the barfeeder to push-out the wrong amount?

a) The length of a push can be affected by the previous push.

- If the previous part over-shoots then the next push will be short.
- If the previous part slides back into the chuck, then the next part will be long.

b) What happens with the pushrod moves away too soon?

- The push rod moves away before the chuck finishes closing can cause the bar to move back. This is more common with the collet chuck.
- Adjust parameter 249, Chuck Clamp Delay.

c) What can happen when the spindle liner is too big if there is no spindle liner?

- Material can pull to the side when the spindle rotates.
- Material can fall when unclamped.

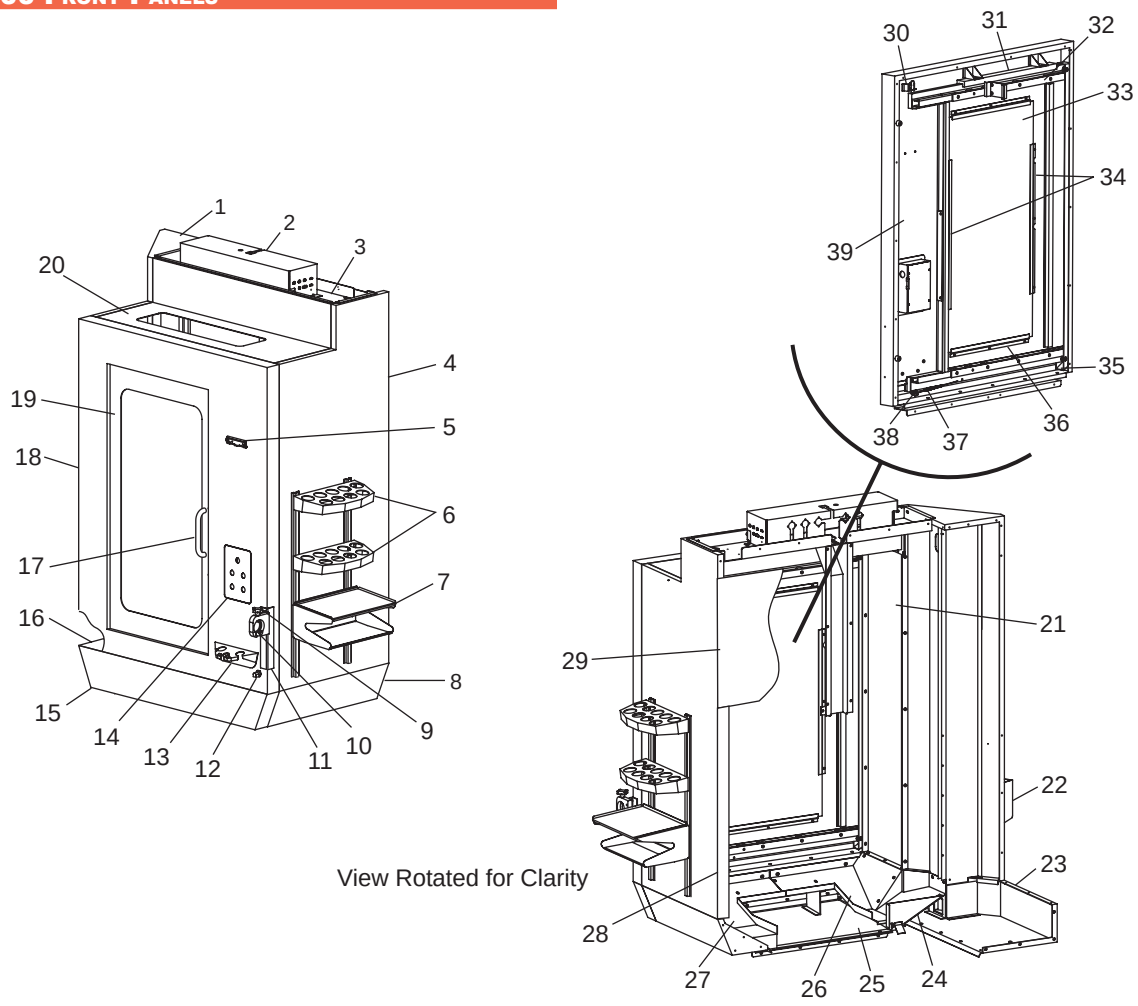
d) What can happen when using a chuck instead of the collet?

- Chuck does not pull the bar against the rod when clamping.
- Chuck jaws are thinner. The thin jaws can cause the material to rock on the open jaws and fall forward or backwards.
- Material can hit the back of the chuck and spring forward.

e) What will the BAR300 Push Test Form tell you?

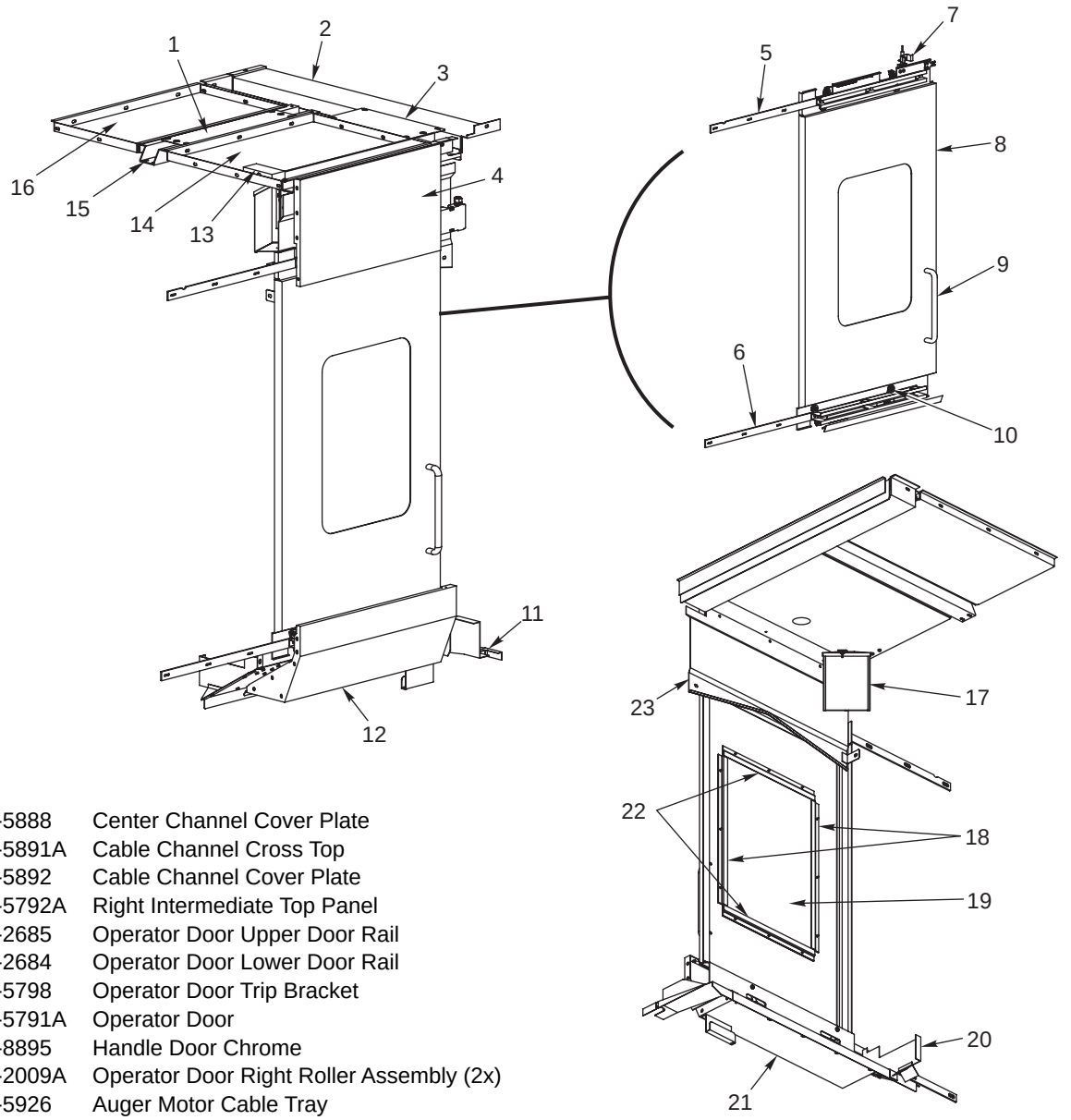
- Problem during the initial push.
    - o Bar has an uneven cut on either side of the bar.
    - o Bar is bent.
    - o Bar is hitting the back of the chuck.
    - o Pushrod is moving away too soon. P249 adjustment.
    - o EOB switch is loose or not working correctly.
    - o Small bar is lighter then the pressure it takes to push down the EOB switch.
- Problem after the initial push.
    - o Bar is sliding back during the cut.
    - o Uneven cut on the back of the bar.
    - o Bar is teetering on the jaws and falling backward or forwards.
- Jaws too short.
- Spindle liner too big.

EC-300 Front Panels



1.	25-5682A	Tool Trays Panel
2.	25-5683C	Intermediate J-Box Top Cover
3.	25-5681A	Intermediate Top Cover
4.	25-5678B	Front Right Panel
5.	59-0123	Sanders K 18 Wire Clip
6.	25-0440A	Tool Tray (2x)
7.	25-6182D	Front Table
8.	25-5740D	Front Right Pan
9.	59-0278	Knob Head 3/8-16 x 1-1/4 Dog Point Screw
10.	20-1341	Tool holder Block
11.	25-0798	Tool Holder Bracket
12.	58-1671	Nipple 1/8 NPT x2
	58-3618	Street Elbow ¼, 90 degree
13.	25-5412	Nozzle Holder Bracket
14.	25-1257A	Front Panel Switch Box
15.	25-5741B	Front Center Pan
16.	25-5739	Front Left Pan
17.	22-8895	Door Handle
18.	25-5809B	Center Front Panel
19.	30-8652	Front Door Assembly
20.	25-5680A	Front Panel Top Cover
21.	25-5679	Front Left Panel
22.	25-0563B	Tool Box Assembly
23.	25-5738D	Left Intermediate Pan
24.	25-5804C	Left Chip Shield Pan
25.	25-5742A	Center Bottom Pan
26.	25-5784C	Front Left Chip Shield Pan
27.	25-5785C	Front Right Chip Shield Pan
28.	25-5806A	Operator Door Tunnel
29.	25-5893B	Panel Top Partition
30.	32-2300	Proximity Limit Switch –Door Open
31.	20-2696	Front Door Guide Bar
32.	20-2317	Rail Load Station (2x)
33.	28-0165	Front Door Window
34.	25-0668	Side Window Retainer (2x)
35.	59-6400A	Guide Wheel
	49-2015	PTHS 1/4-20 x 7/8
	46-0015	Nut 1/4-20 Flange
	45-16390	Washer 1/4 Flat
36.	25-0669	Top-Bottom Window Retainer (2x)
37.	59-9743	Front Door Spring
38.	30-2009A	Lower Right Corner Roller Assembly
39.	25-5810A	Front Door

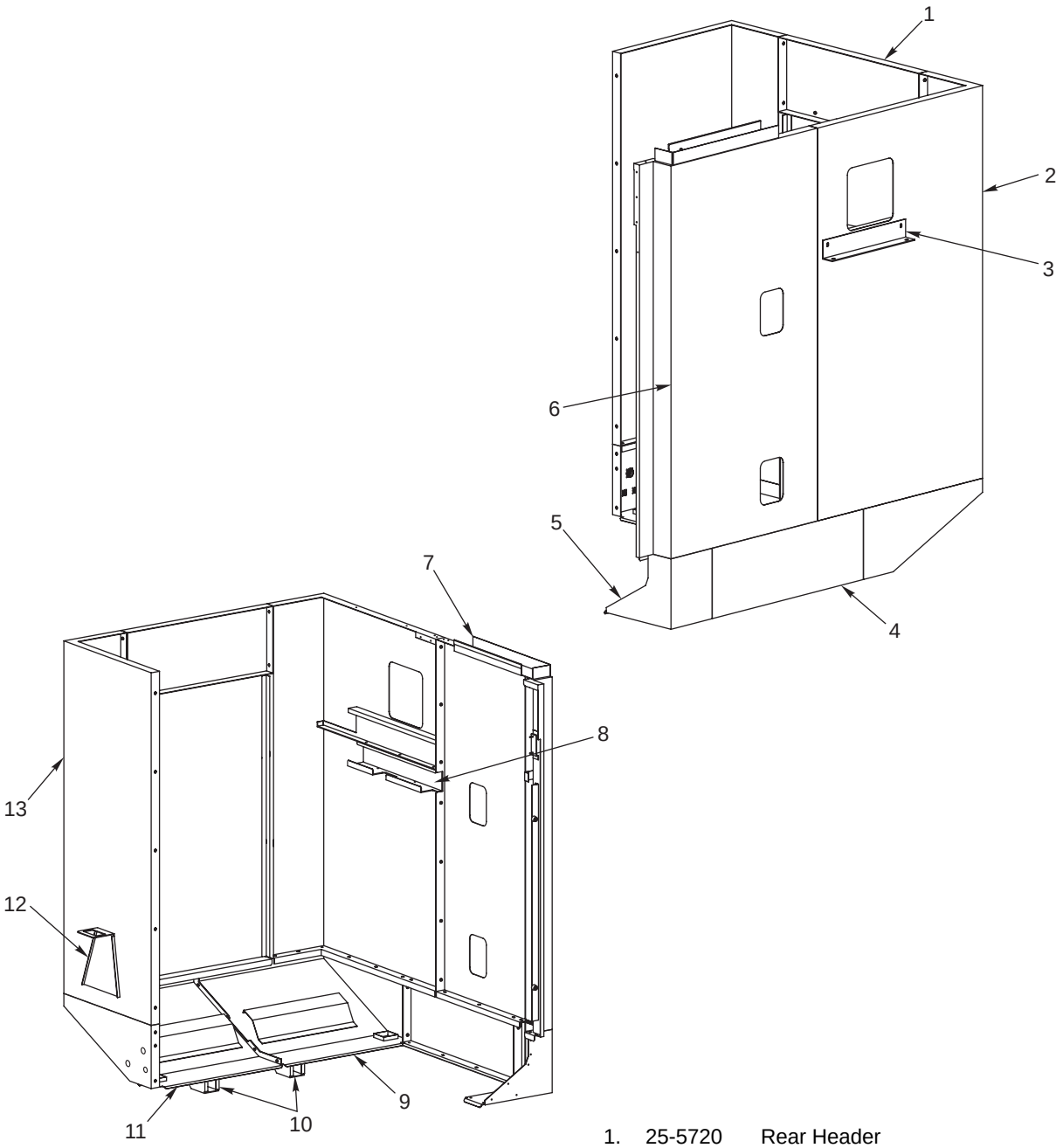
EC-300 Operator Door Panels



View Rotated 180° (Looking Up)

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

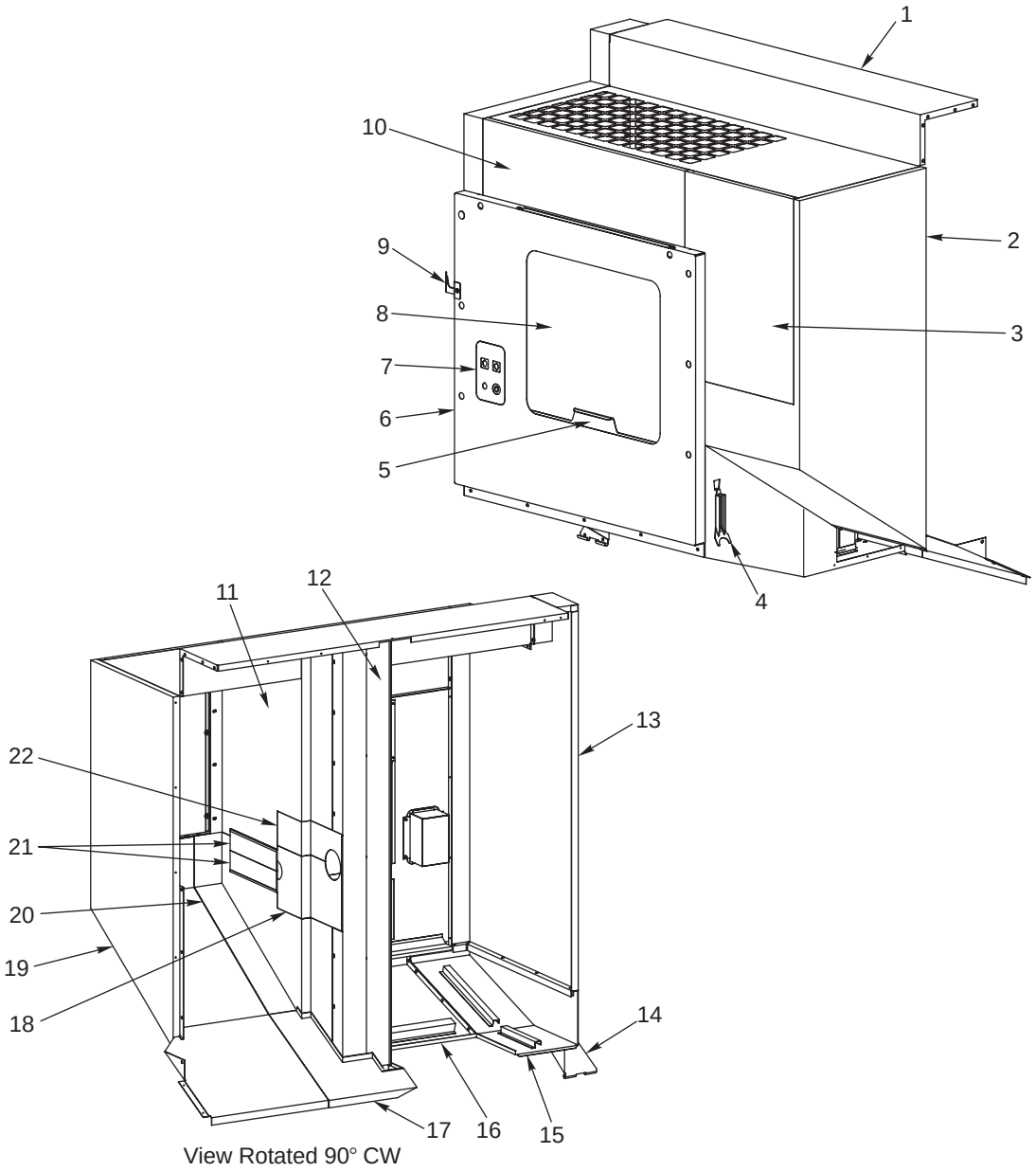
EC-300 Rear Panels



View Rotated 90° CCW

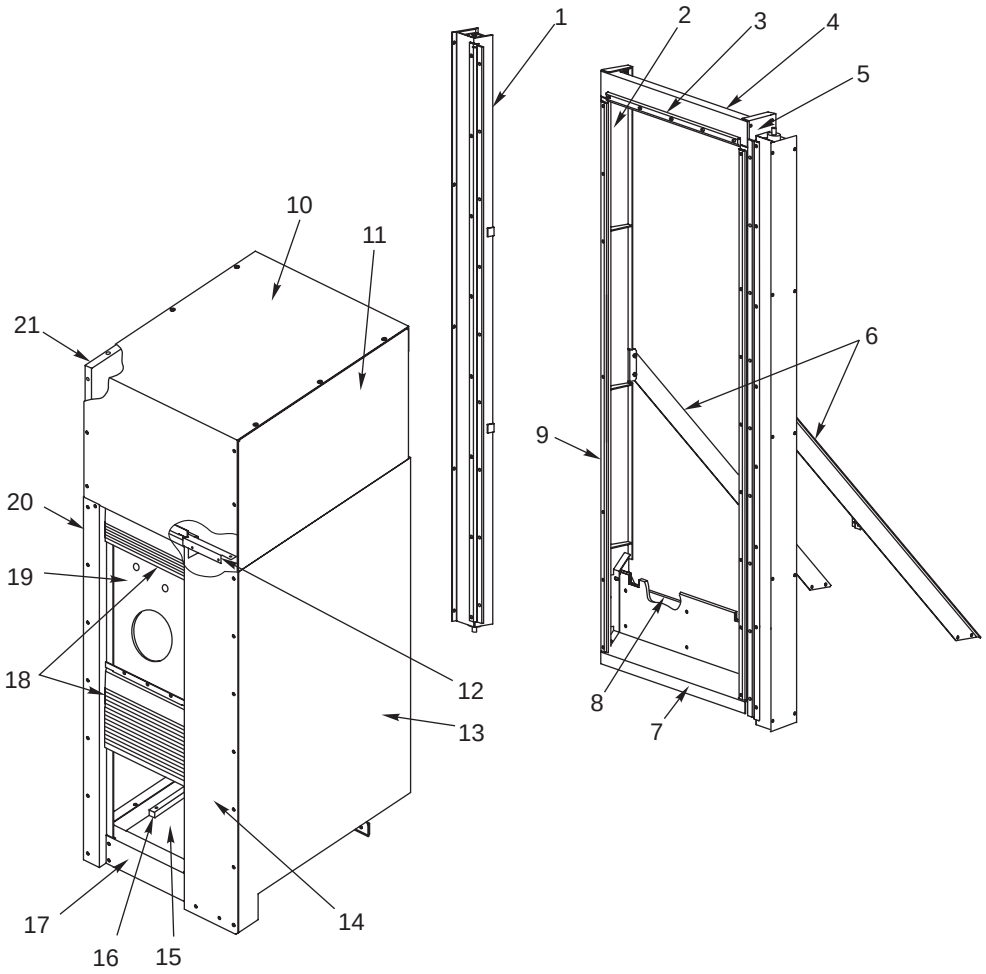
1.	25-5720	Rear Header
2.	25-5666A	Rear Control Box Panel
3.	25-5722	Control Support Mounting Bracket
4.	25-5924	Control Intermediate Pan
5.	25-5665C	Front Control Pan
6.	25-5667A	Front Control Box Panel
7.	25-5912	Control Top Panel Tray
8.	25-5896	Control Box Panel Tray
9.	25-5925B	Rear Control Pan
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



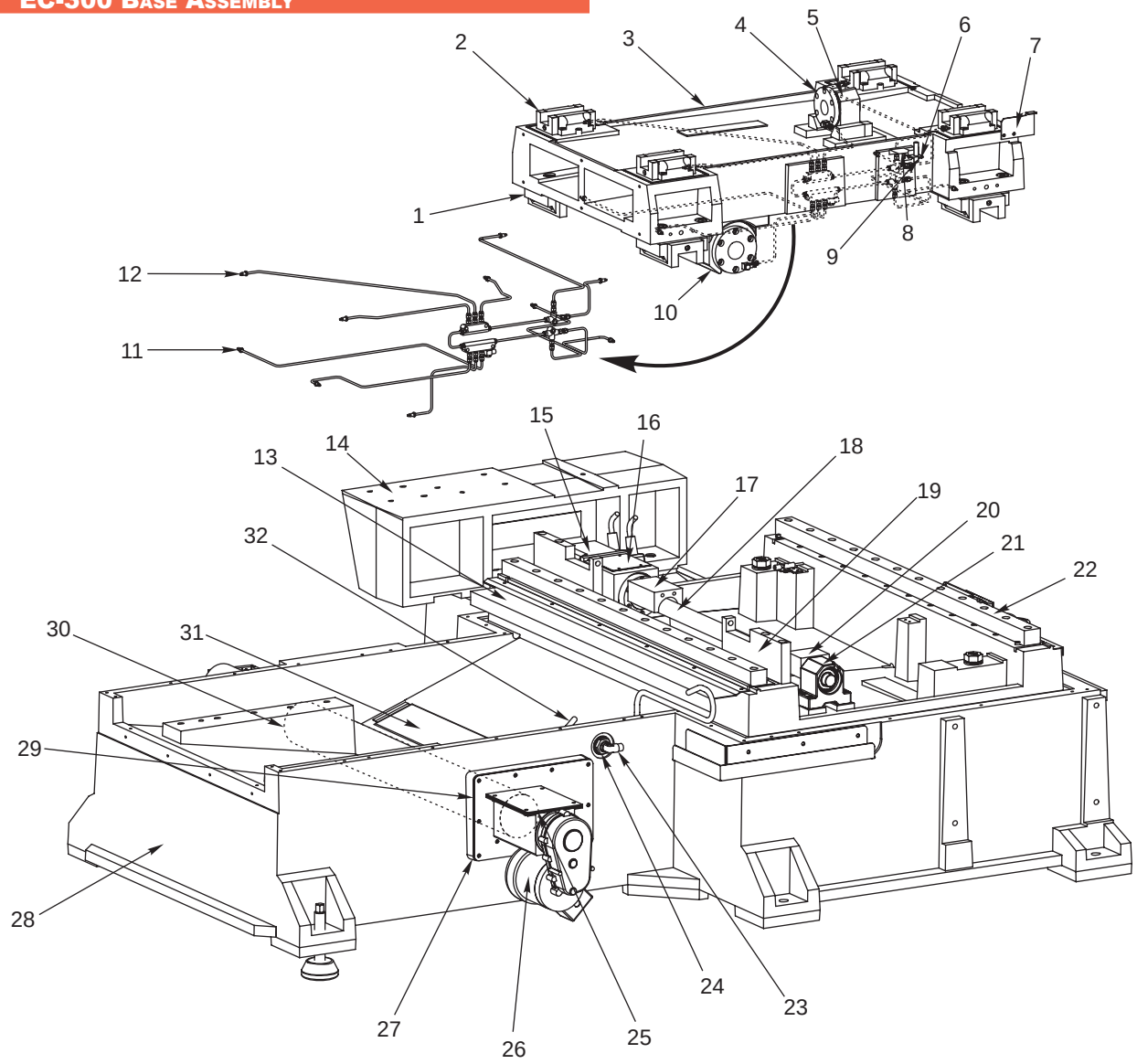
1.	25-5881	Tool Changer Top Cover
2.	25-5706A	T.C. Front Panel
3.	25-5779B	T.C. Side Panel
4.	25-6682A	Removal Tool 40T Holder
5.	25-9248A	Plate Window Handle
6.	25-5885B	T.C. Access Panel
7.	32-1107	Remote Switch Box
8.	28-0168	T.C. Access Window
9.	25-9262A	Wash Handle Holding Bracket
10.	25-5927A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

EC-300 Column and Frame Panels



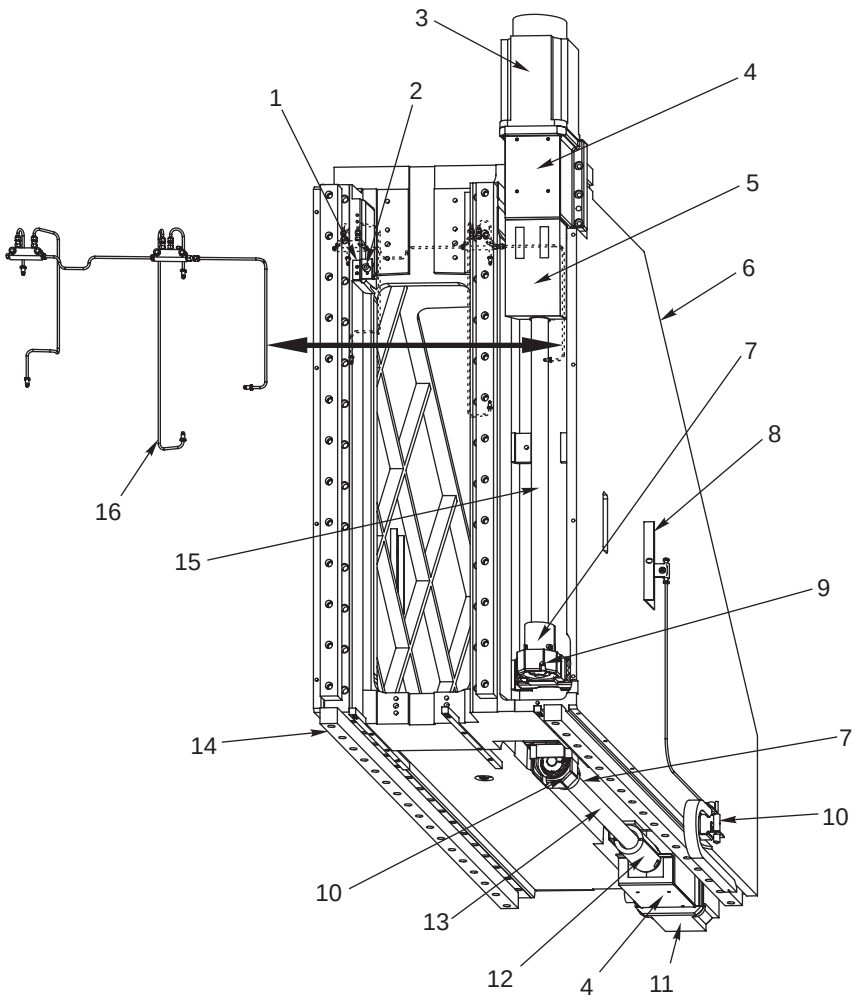
1.	59-0706	Shade Roller- 70.5" x 21" (2x)
2.	25-5833A	Shade Roller Left Frame
3.	25-5837	Top Column Clamp Wiper
	26-0173	Top Column Wiper Felt
4.	25-5834	Shade Roller Top Frame
5.	25-5832A	Shade Roller Right Frame
6.	25-5773	Shade Roller Frame Brace (2x)
7.	25-5765	Saddle Cover Front Seal
8.	25-5766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

EC-300 Base Assembly



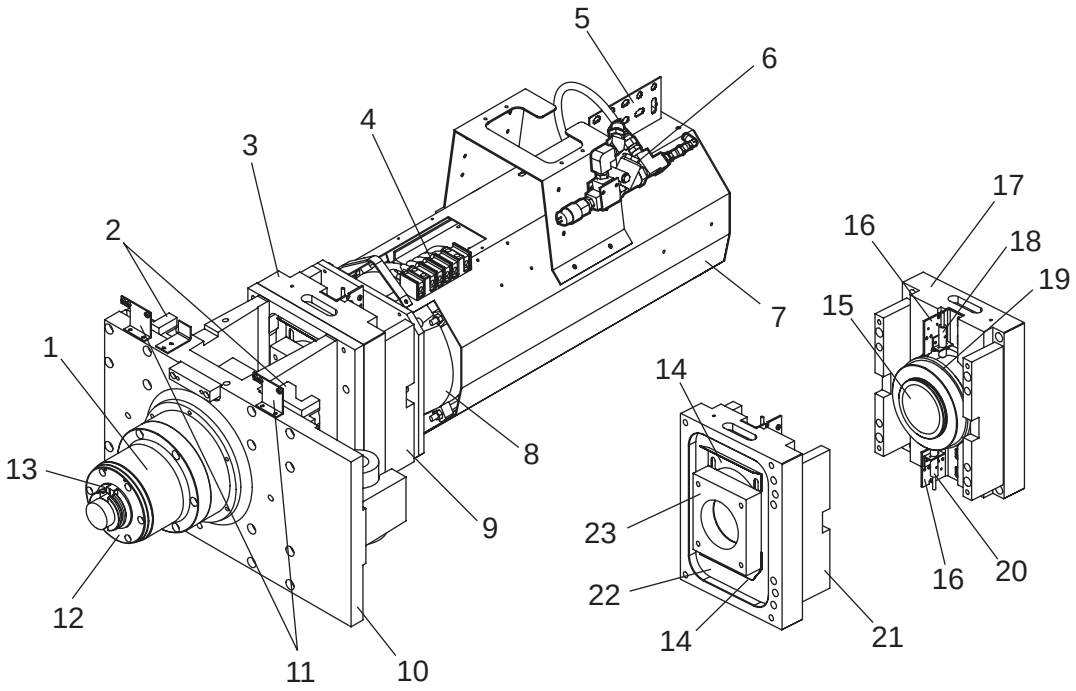
1.	50-9011	Linear Guide (truck)
2.	50-0017	Linear Guide (35mm truck)
3.	20-2587A	Saddle Casting
4.	58-3600	3/8" Nipple
5.	20-0150	Nut Housing
6.	25-7267	Prox. Switch Bracket
7.	25-5913	Y-Axis Trip Bracket
8.	25-5919	Cable Carrier Bracket
9.	20-2593	Prox. Switch
10.	20-0150	Nut Housing
11.	30-7140	Base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

EC-300 Column Assembly



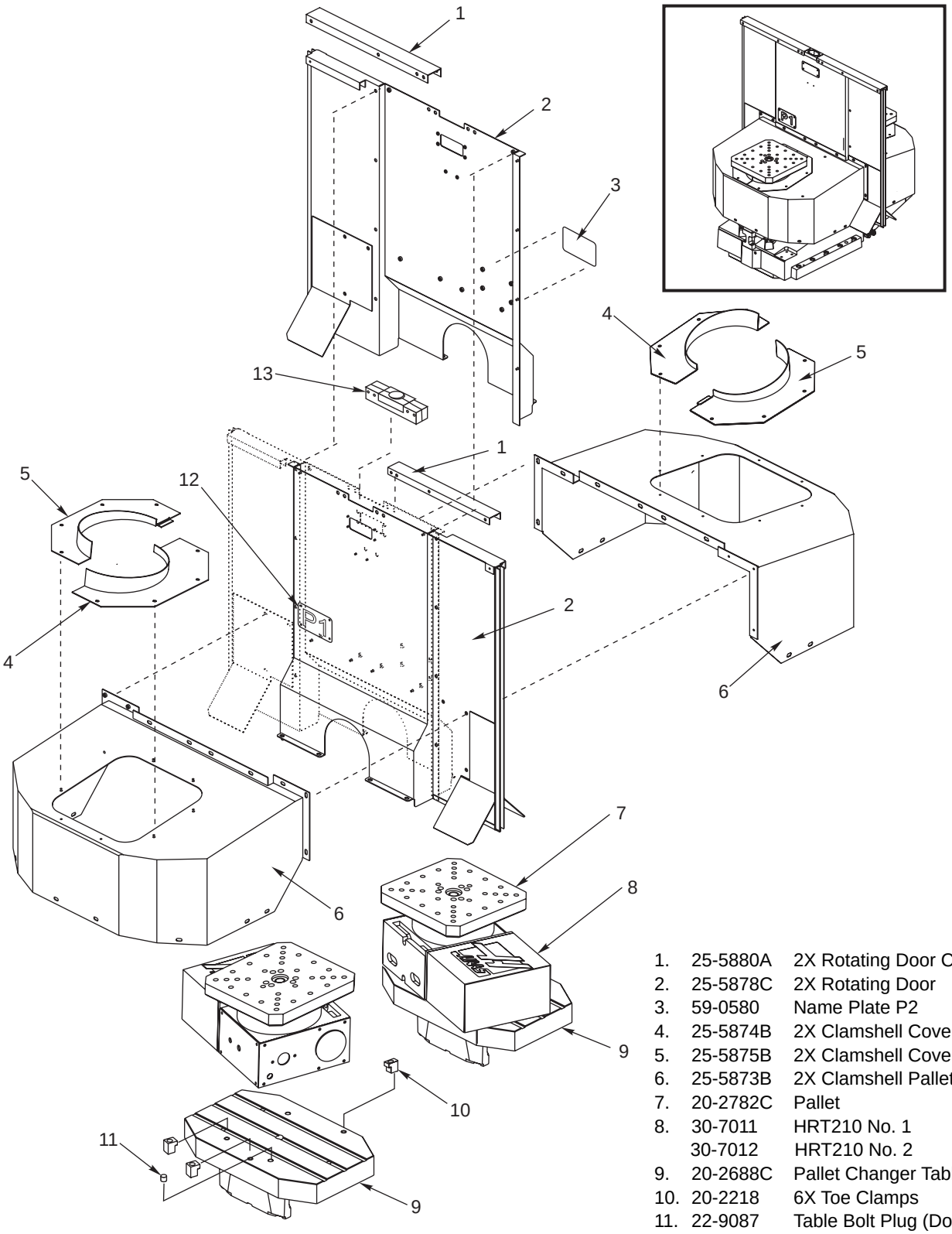
1.	25-7266	Mounting Bracket
2.	32-2130	Prox. Switch
3.	62-0035B	Servo Motor
4.	25-7042	Cover Plate
5.	28-0188	Ballscrew Bumper
6.	20-2588A	Column Casting
7.	28-0188	Y-Axis Bumper
8.	25-5732	Column Cover
9.	20-7009	Bearing Housing
10.	32-2132	Prox. Switch
11.	62-0036C	Servo Motor
12.	28-0188	Bumper Cover
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



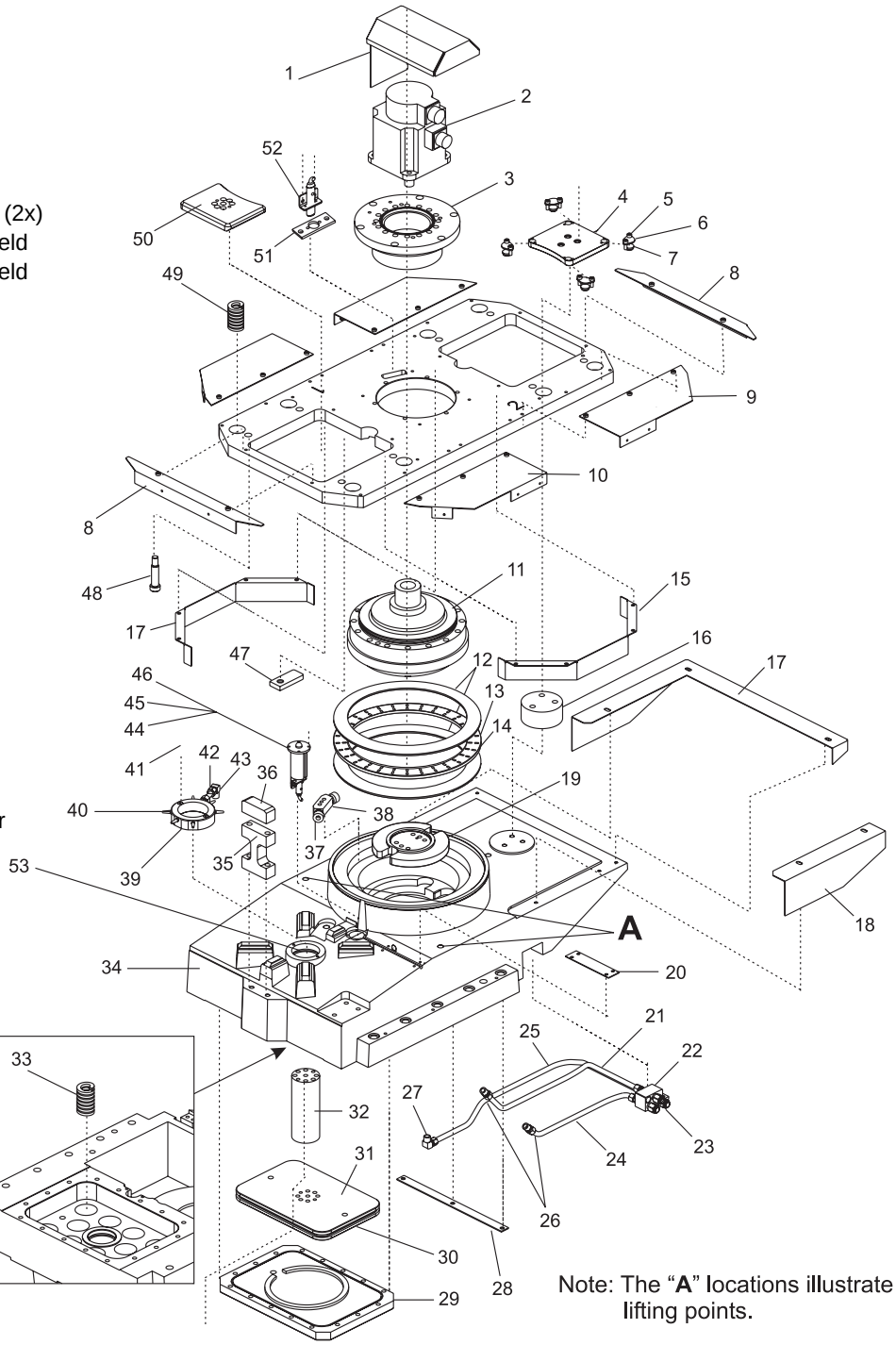
1.	20-7016C	Spindle Housing
2.	50-0017	Linear Guide (35mm Truck)
3.	30-7441	TRP
4.	73-3055	Terminal Buss
5.	25-5242	Shroud Bracket
6.	30-6465	TSC Fitting Assembly
7.	25-6733	Motor Shroud
8.	62-3019	Spindle Motor
9.	20-2520	Stand Off
10.	20-2674A	Spindle Head
11.	25-6592	Junction Bracket
12.	20-9763C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

EC-300 Pallet Changer



1.	25-5880A	2X Rotating Door Cap
2.	25-5878C	2X Rotating Door
3.	59-0580	Name Plate P2
4.	25-5874B	2X Clamshell Cover Access
5.	25-5875B	2X Clamshell Cover Access
6.	25-5873B	2X Clamshell Pallet Cover
7.	20-2782C	Pallet
8.	30-7011	HRT210 No. 1
	30-7012	HRT210 No. 2
9.	20-2688C	Pallet Changer Table
10.	20-2218	6X Toe Clamps
11.	22-9087	Table Bolt Plug (Dowel Pin)
12.	59-0579	Name Plate P1
13.	20-2695B	2X Rotating Door Fairlead

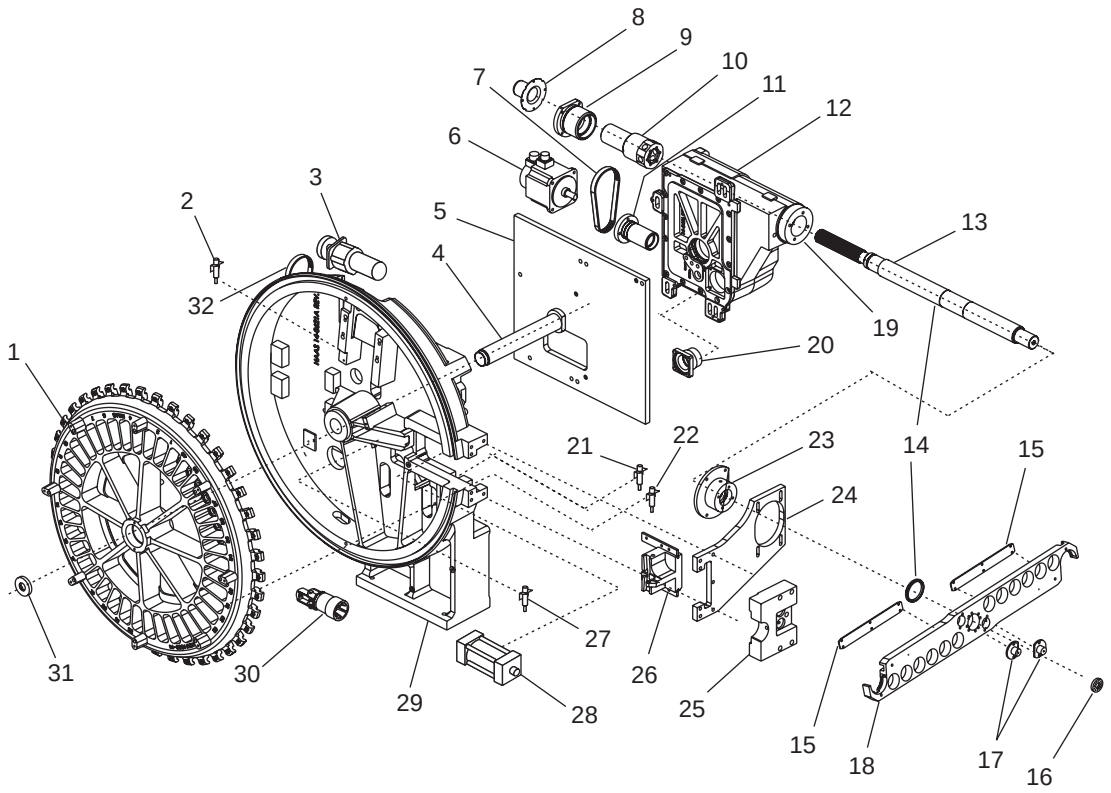
EC-300 Pallet Changer



1.	25-6845	Motor Cover
2.	62-0014	Servo Motor
3.	20-2724	Motor Flange
4.	20-2812	Stabilizer Plate
5.	25-5934	Retainer Button
6.	40-1640	SHCS 10-32 x ½
7.	20-2814	Stabilizer Button
8.	20-2729C	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
35.	20-2785A	“H” Frame Pad
36.	20-2809	Frame Button
37.	59-0725	Bumper
38.	20-2728	Stop Block
39.	20-2727B	Air Blast Ring
40.	20-2582B	Air Blast Nozzle
41.	40-1705	FHCS
42.	58-2070	Hex Fitting
43.	58-0780A	Tube Input Air Blast
44.	20-2699B	Pallet Up Plunger
45.	20-3073B	Clamp Switch Housing
46.	32-2236	Prox. Switch Unclamp
47.	20-2698	Pallet Flag
48.	49-0114	Shoulder Bolt (2x)
49.	59-0726	Pallet Support Spring
50.	20-2715	Pallet Clamp
51.	25-5903	Prox. Pallet Mount
52.	32-2130	Prox. Home 1.5’
53.	57-2157	O-ring 2-333 Viton (qty 2)

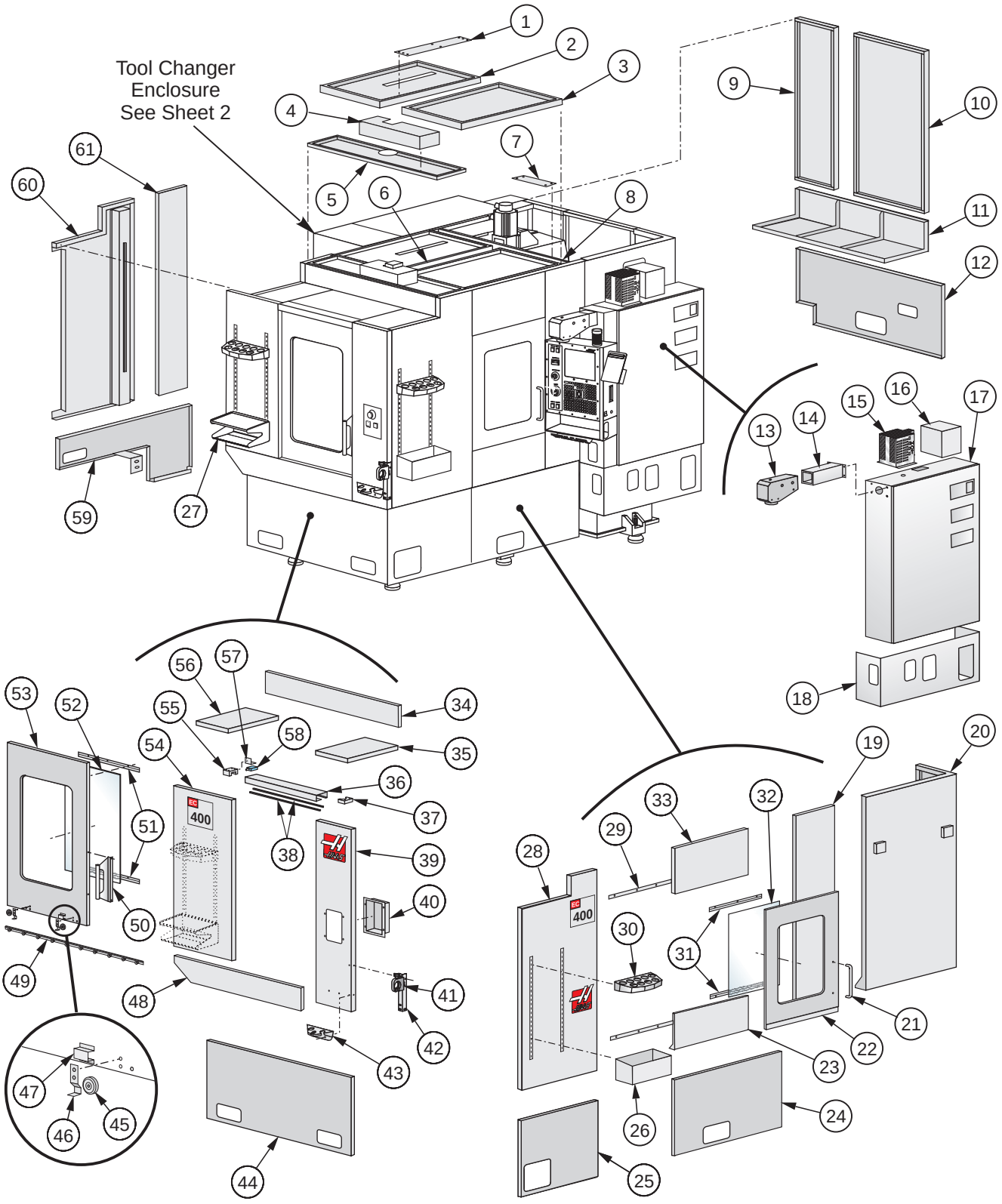
Note: The “**A**” locations illustrate lifting points.

EC-300 40-40 Tool changer



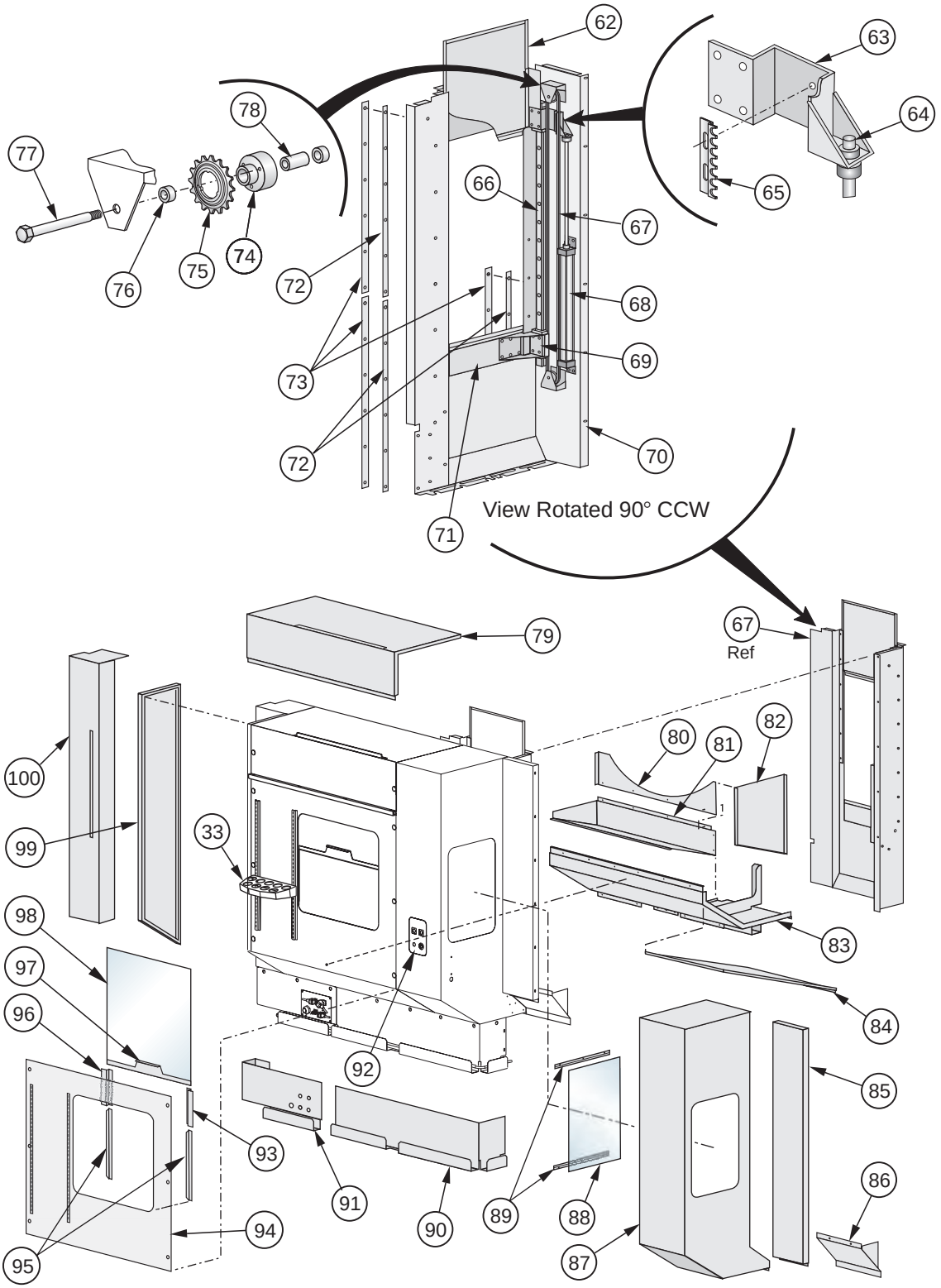
1.	20-0391B	Carousel
2.	32-2295	Prox. Carousel Mark
3.	62-0030A	Carousel Motor
4.	20-0387	Carousel Shaft
5.	20-0487	Mounting Plate
6.	62-0035B	Servo Motor
7.	54-0036	Drive Belt
8.	22-0001	Output Shaft Cad
9.	20-0224	Star Bearing Housing
10.	20-0223A	Star Gear
11.	20-0225	Bearing Housing
12.	30-4008A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

EC-400 Enclosure Sheet Metal



Sheet 1 of 2

EC-400 Enclosure Sheet Metal



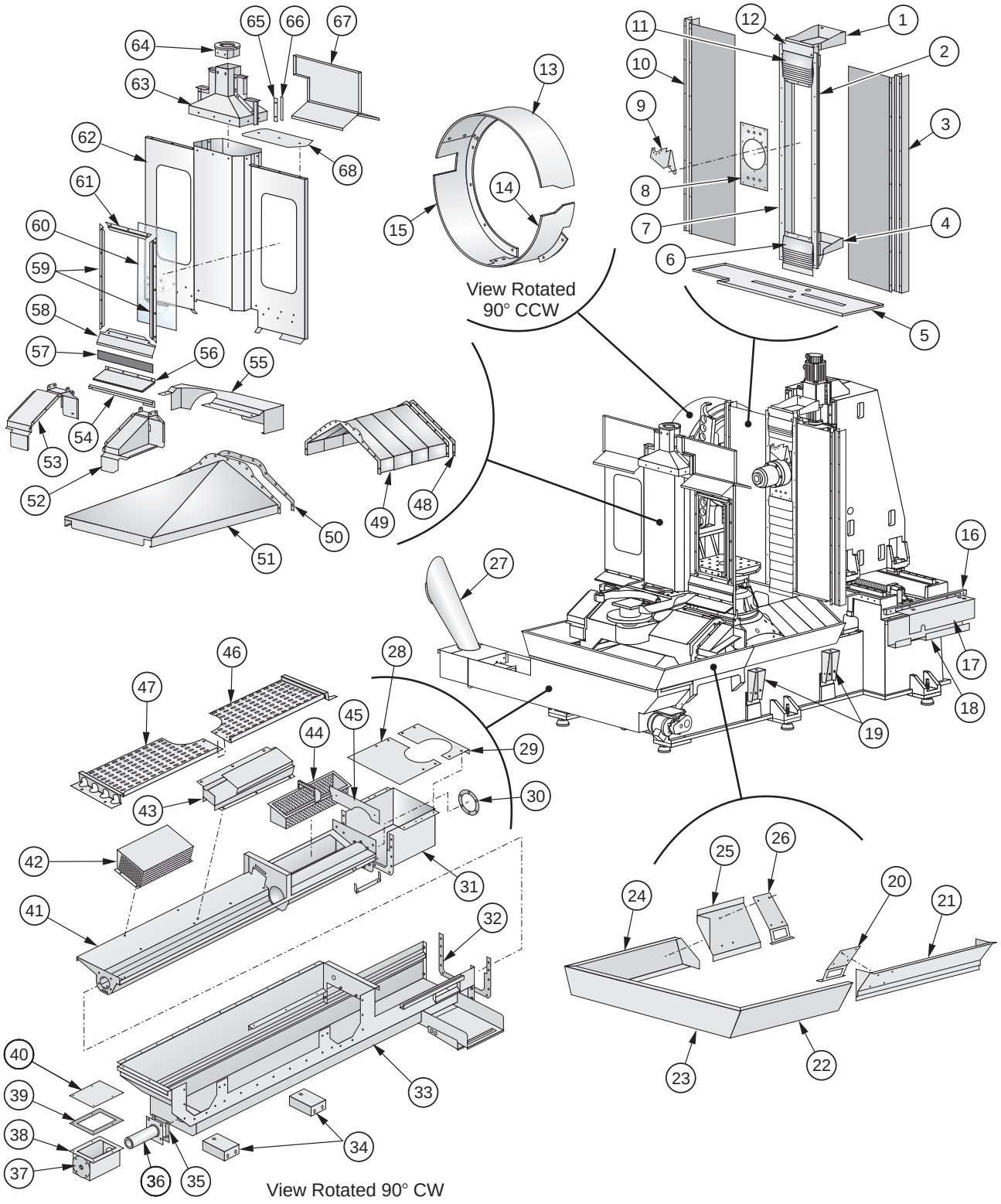
Tool Changer Enclosure

Sheet 2 of 2

EC-400 Enclosure Sheet Metal

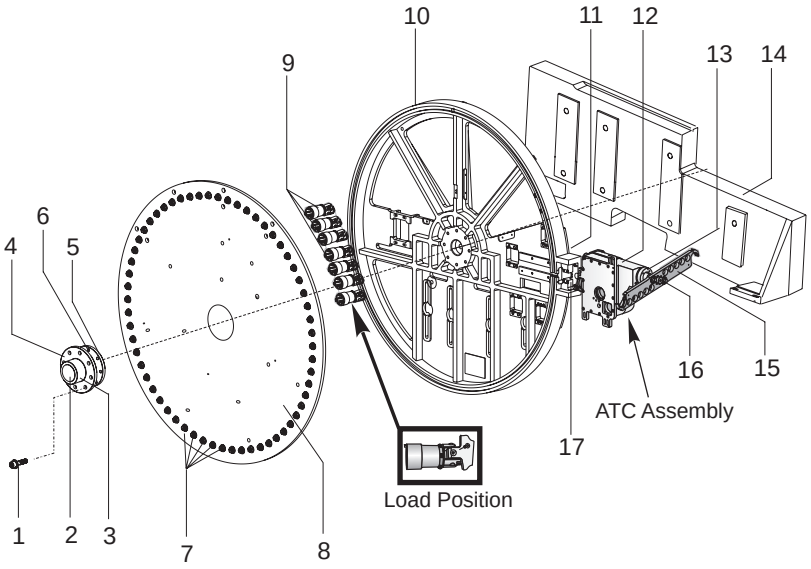
1.	25-4984	Wire Channel Top Cover
2.	25-4965B	Left Top Cover
3.	25-4964C	Right Top Cover
4.	25-4953B	J-Box Top Cover
5.	25-4952A	Front Top Cover
6.	25-4980	Wire Channel Top Cover
7.	25-5253	Brace Top Cover
8.	25-4963A	Intermediate Top Brace
9.	25-4957	Rear Center Panel
10.	25-4977	Rear Panel Access Cover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



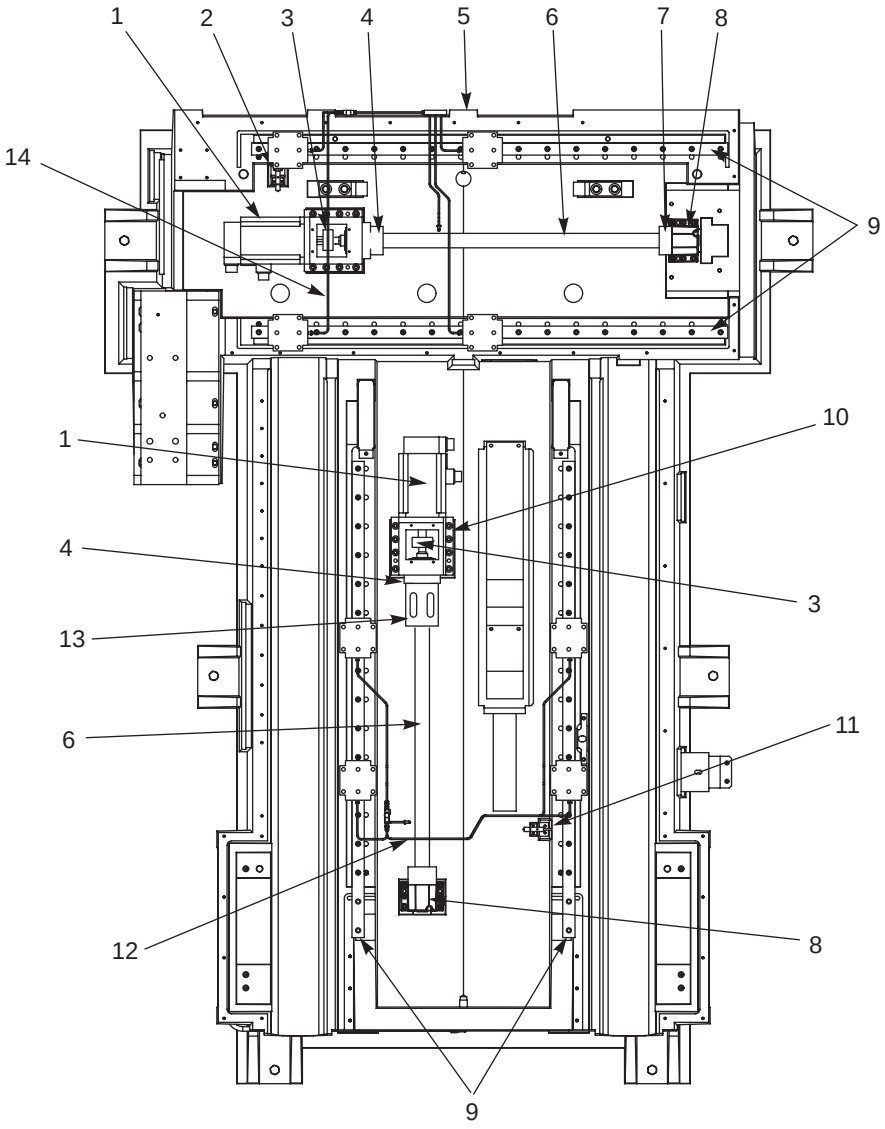
EC-400 Internal Sheet Metal

1.	25-5007	Y-Axis Frame Top Bracket
2.	25-5001B	Y-Axis Right Guide
3.	59-0806	Right Roll-up Waycover
4.	25-5008	Y-Axis Frame Bottom Bracket
5.	25-5006A	X-Axis Bottom Shield
6.	59-0606	Y-Axis Lower Waycover
7.	25-5000B	Y-Axis Left Guide
8.	25-5002A	Spindle Cover
9.	25-7858	P-Cool Mounting Bracket
10.	59-0805	Left Roll-up Waycover
11.	59-0605	Y-Axis Upper Waycover
12.	20-2319B	Y-Axis Frame Plate Filler
13.	25-4152B	SMTC 40-40 Front Cover
14.	25-0800C	SMTC 40-40 Corner Shroud
15.	25-4153B	SMTC 40-40 Rear Cover
16.	20-2035	Control Box Support Bar
17.	30-6316A	Lube Panel Assy
18.	25-4942A	Wire Channel Panel
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
51.	25-5549	Z-Axis Front Waycover
52.	25-5229A	Right Bridge Chip Shield
53.	25-5230A	Left Bridge Chip Shield
54.	25-5235	2X Rotating Door Right Step Shield
55.	25-5046	APC Cylinder Shield
56.	25-5237	4X Z-Axis Rotating Door Shade Seal
57.	20-2283A	2X Rotating DF Support Bar
58.	25-5233A	2X Rotating Door Z-Channel
59.	25-1262	4X Partition Top z-Frame
60.	28-0043	2X Window
61.	25-4149	4X Window Z-Frame
62.	25-5232C	Rotating Door Panel
63.	25-5234B	Rotating Door Cover
64.	20-2284	2X Rotating Door Cable Fairlead
65.	25-5239A	2X Rotating Door Retainer Seal
66.	57-0330A	2X Rotating Door Cover Seal
67.	25-4983C	2X Rotating Door Splash Shield
68.	25-5238A	2X Rotating Door Top Shade



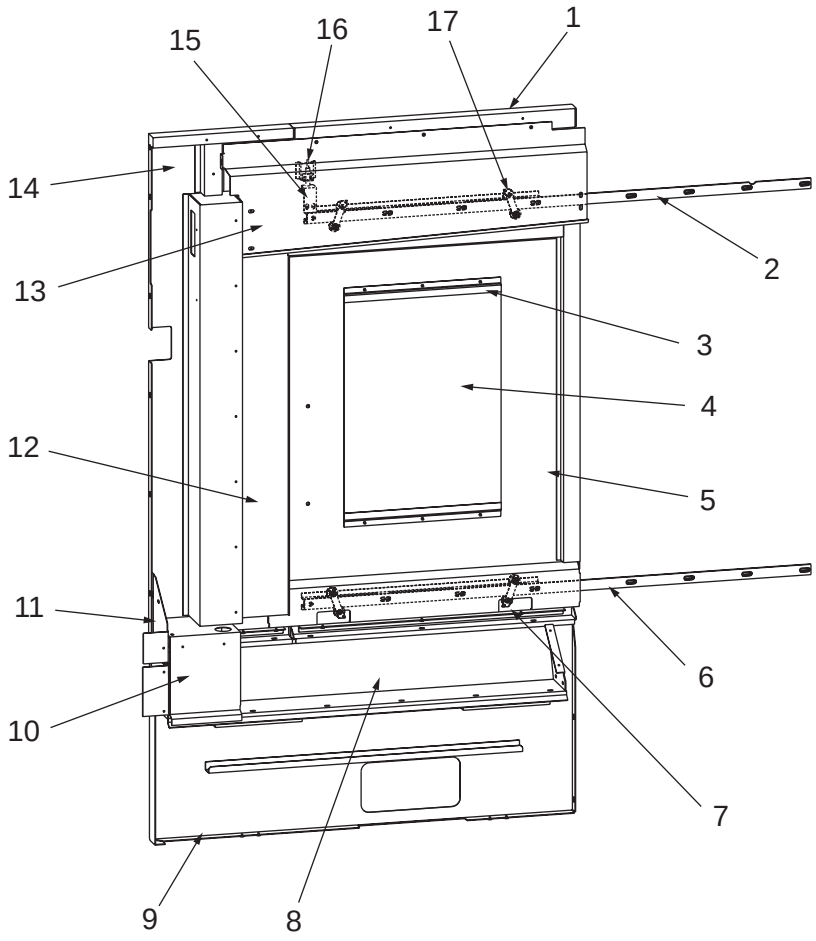
1.	40-0226	SHCS ¾”x3"
2.	59-0737	Plug Hole
3.	20-2911A	Hub Index Plate
4.	20-2911A	Hub Index Plate
5.	20-2868A	Shaft Assembly
6.	40-1663	SHCS ½”-13x1¾”
7.	51-0045	Cam Follower
8.	20-2022E	Plate Index
9.	20-0458	Tool Pockets
10.	20-0457C	Pocket Carousel
11.	30-0145A	Cambox Assembly
12.	20-0455C	ATC Cambox
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



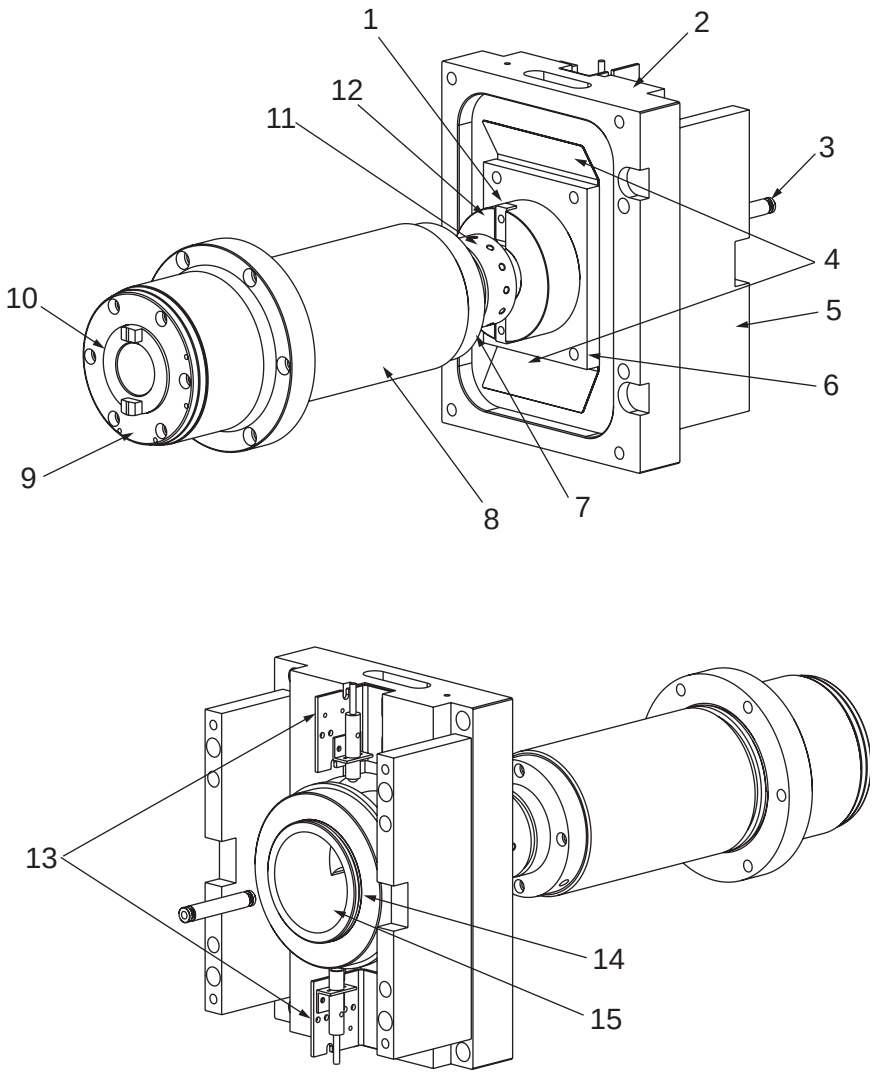
1. 62-0016 Motor
2. 32-2130 Limit Switch
3. 30-1225A Ball Screw Coupling
4. 20-9212 Bearing Housing
5. 20-2042G Casting
6. 24-0026A Ballscrew
7. 28-0206 Hard Stop X-Axis
8. 20-0152 Bearing Housing
9. 50-3400 Linear Guides
10. 20-0151A Motor Mount Assy.
11. 32-2134 Limit Switch
12. 30-6336 Z-Axis Lube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

EC-400 Operator's Door



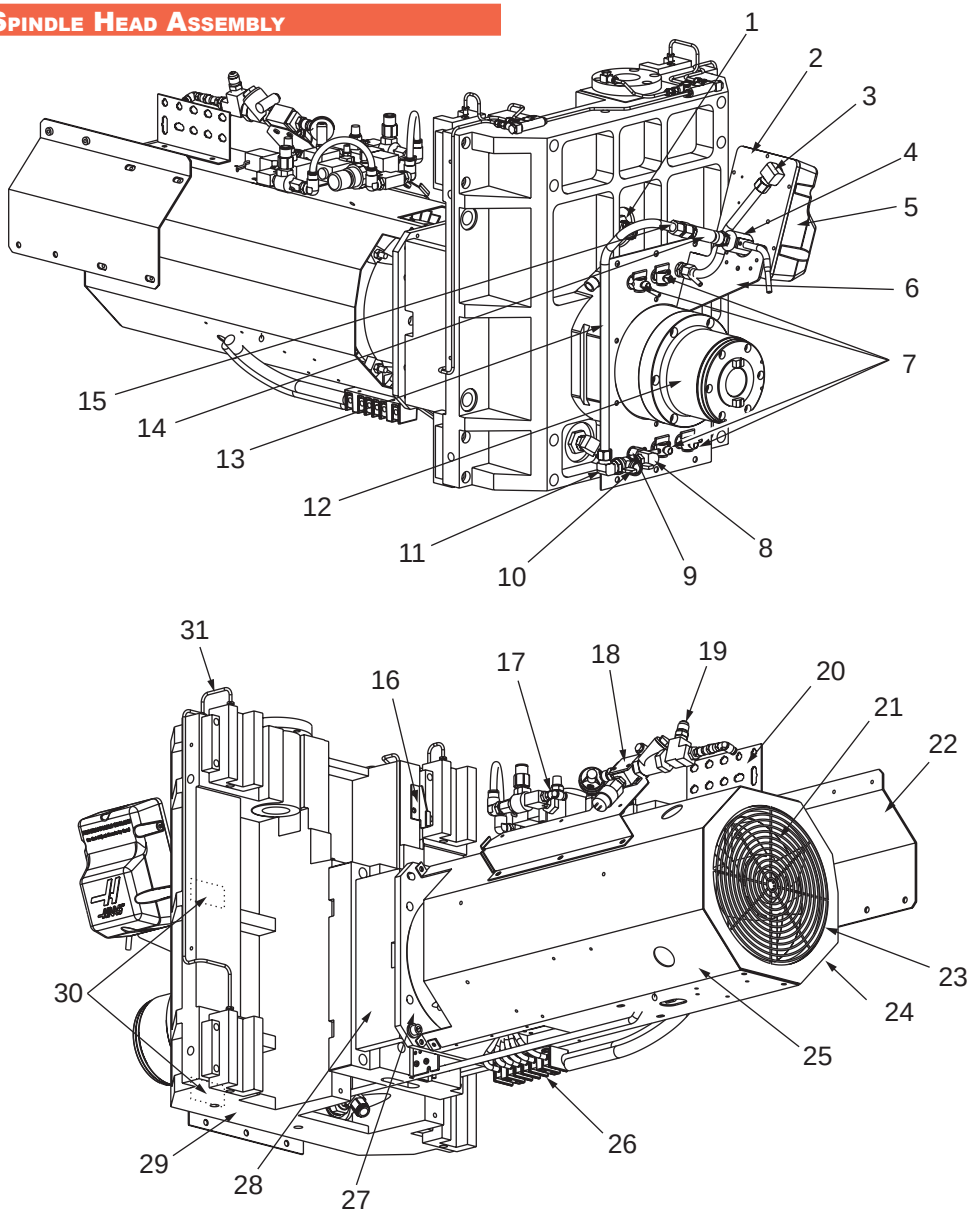
1.	25-4954	Right Side Header
2.	20-2036	Operator Door Upper Track
3.	25-5228	2X Operator Door Window Z-Frame
4.	28-0151	Operator Door Window
5.	25-4966	Operator Door
6.	20-2038	Door Track Lower
7.	25-5198	Operator Lower Panel
8.	25-4955	Right Intermediate Pan
9.	25-4982A	Right Rear Apron
10.	25-5246	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
2.	20-4269	TRP Cylinder In-Line
3.	20-2519	Transfer-Tube In-line
4.	25-5970	2X Shim TRP In-Line
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
12.	25-4648B	2X Bracket Switch Mounting In-line Spindle
13.	20-1696A	TRP Spring Retain Inline
14.	20-1691	TRP Shaft In-Line
15.	52-0155	Shaft Coupling

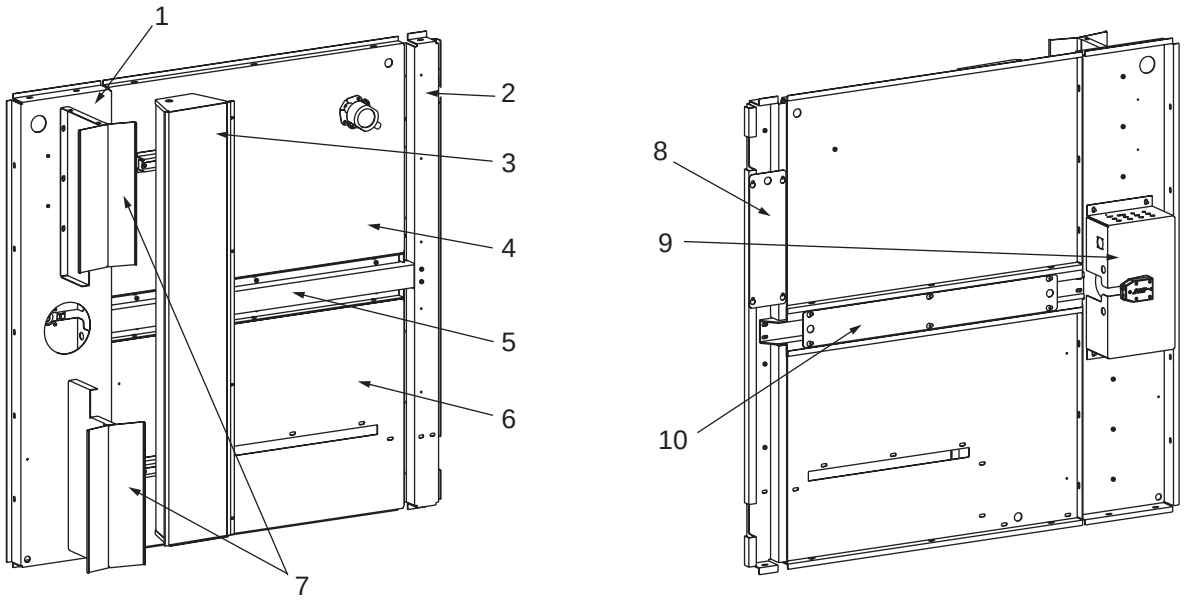
EC-400 Spindle Head Assembly



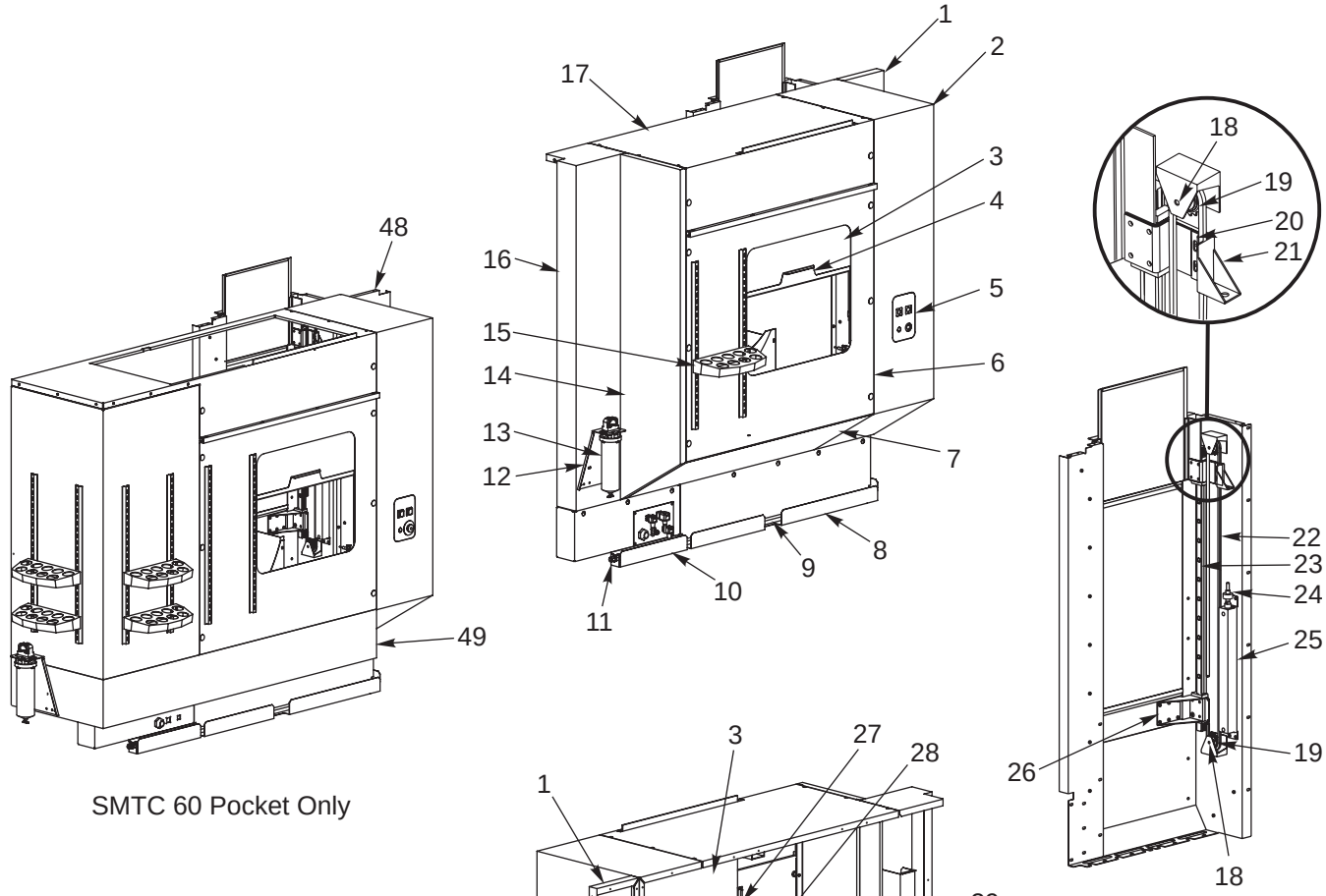
View Rotated 180° Looking Up

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

EC-400 Top Cover

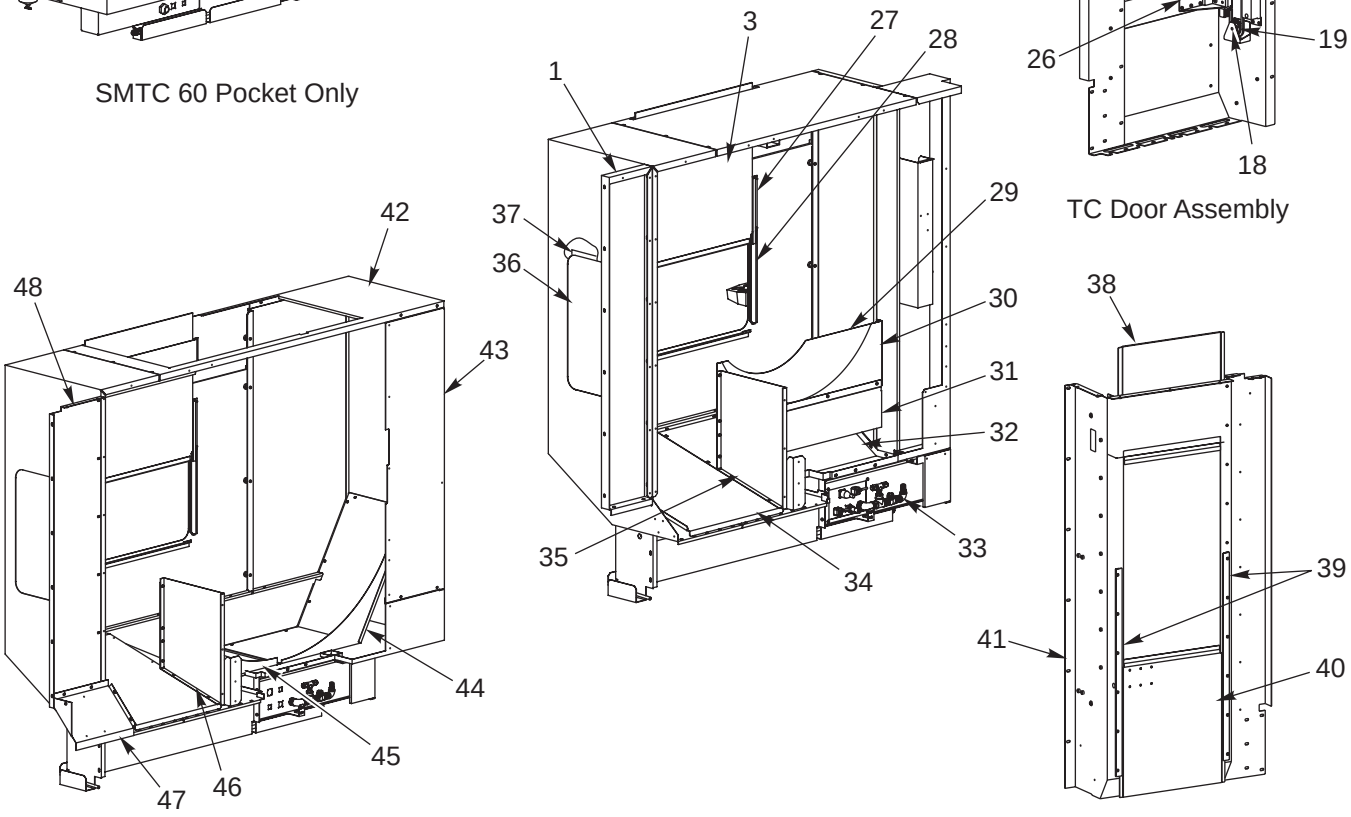


1.	25-4952A	Top Cover Front
2.	25-4963A	Brace Top Intermediate
3.	32-0196	Worklight Assembly
4.	25-4964C	Top Cover Right
5.	25-4980	Wire Channel Top Cover
6.	25-4965B	Top Cover Left
7.	25-4983C	Splash Shield Rotating
8.	25-5253	Cover Brace Top
9.	25-4953B	J-Box Top Cover
10.	25-4984	Cover Wire Channel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



SMTC 60 Pocket Only

TC Door Assembly



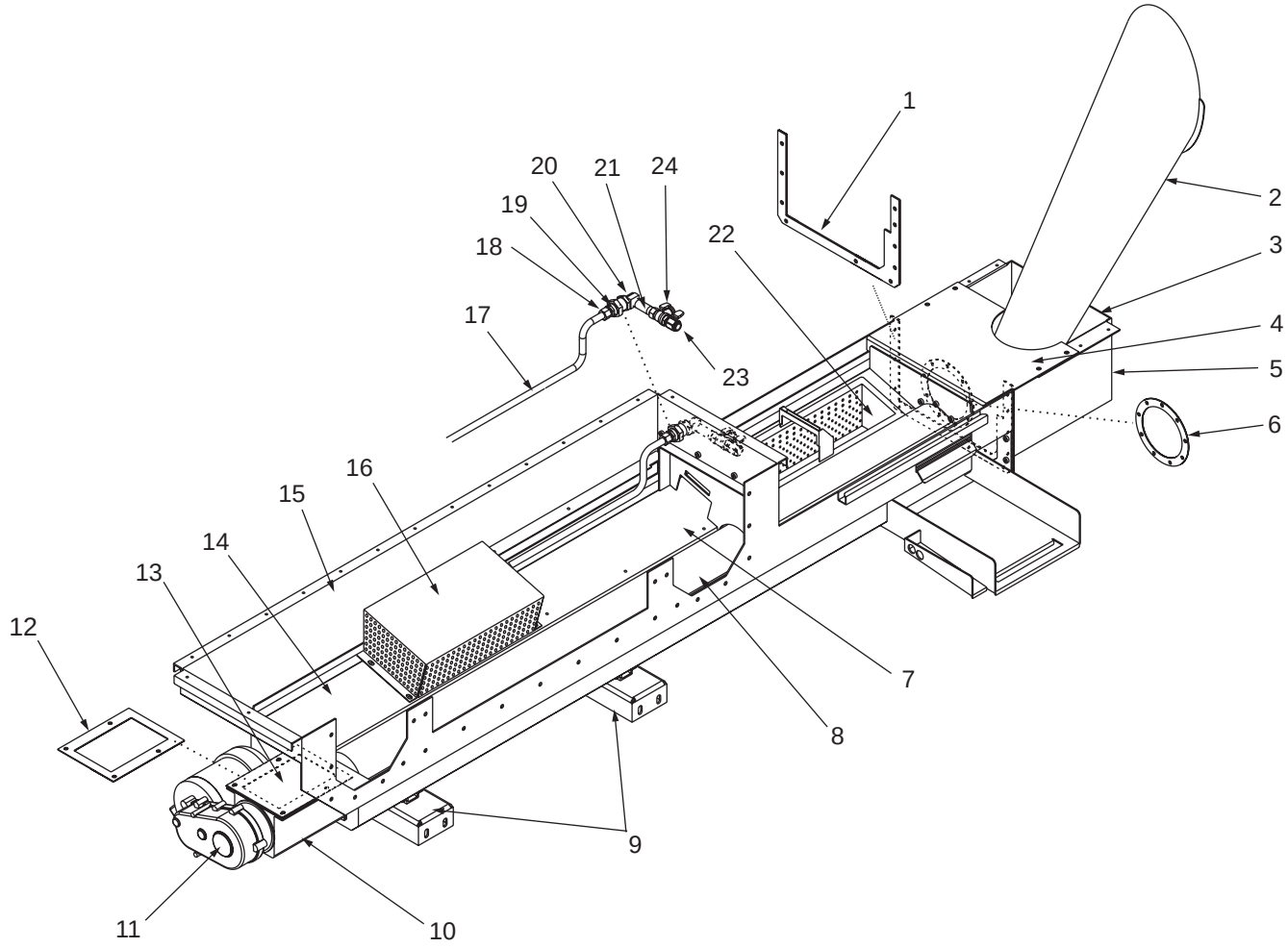
SMTC 60 Pocket Only
(View Rotated 180°)

TC Door Assembly
(View Rotated 180°)

EC-400 60- and 70-Tool Tool Changer Panels

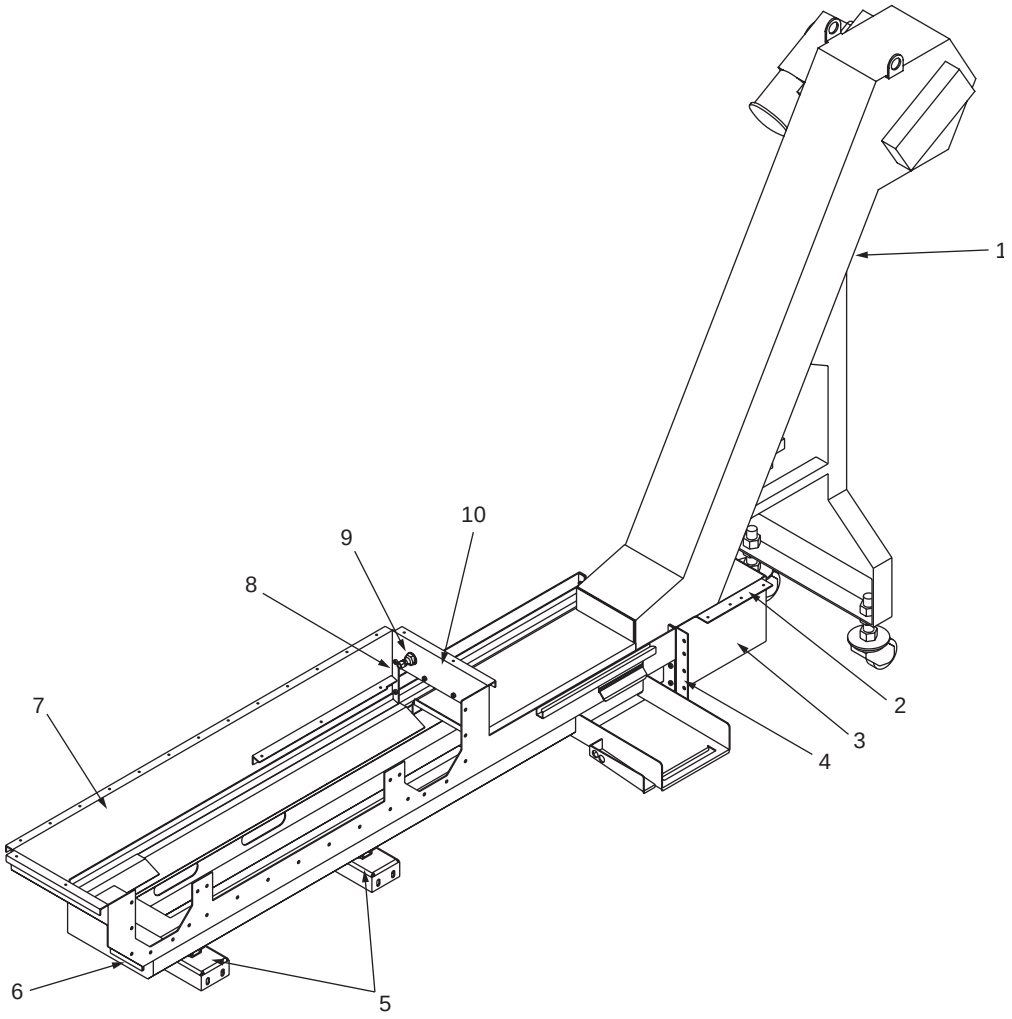
1.	25-4979	Left intermediate panel
2.	25-4962C	Tool changer panel
3.	28-0168	TC access window
4.	25-9248A	Plate window handle
5.	25-6718A	SMTC switch box
	25-6719	SMTC switch box cover
6.	25-5991B	SMTC side panel
7.	25-4961A	TC pan
8.	25-4972	Left rear apron
9.	58-0671	Coolant drain tube
10.	25-5247D	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)



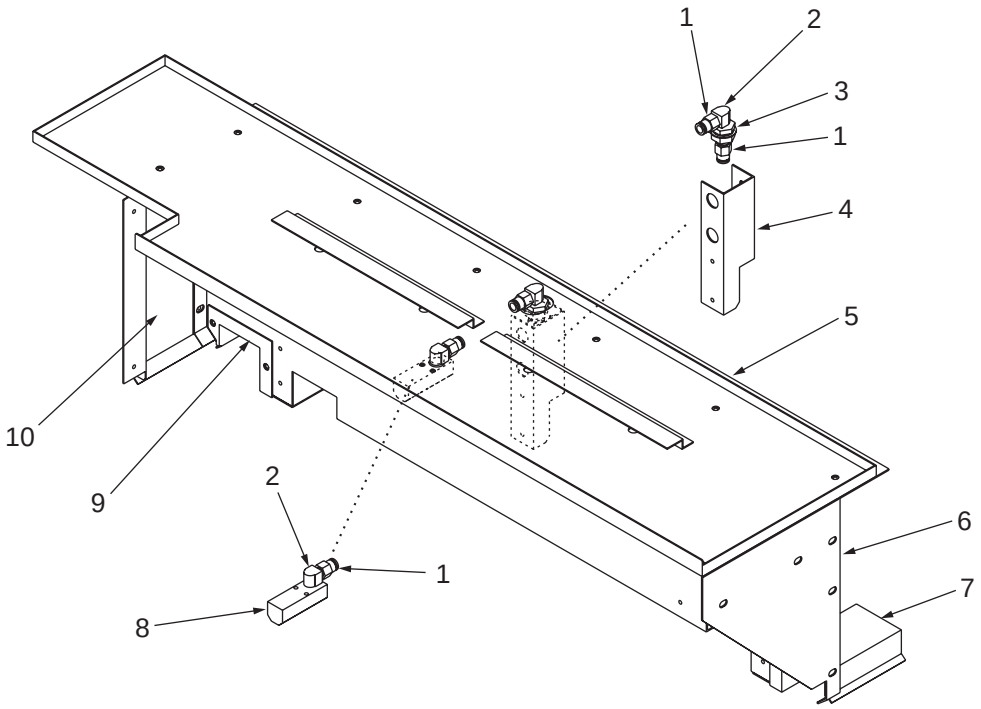
1.	57-0334A	Gasket Coolant Trough
2.	25-0548	Chute Discharge
3.	25-5300	End Chute Cover
4.	25-5301	Coolant Trough Extension Cover
5.	25-5025A	Extension Box Front Trough
6.	57-0048	Gasket Discharge
7.	25-5297A	Coolant Channel
8.	20-2039A	Auger Front
9.	25-4944	(2X) Brace Auger Trough
10.	25-5289	Extension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

EC-400 Front Trough Assembly (Chip Conveyor System)



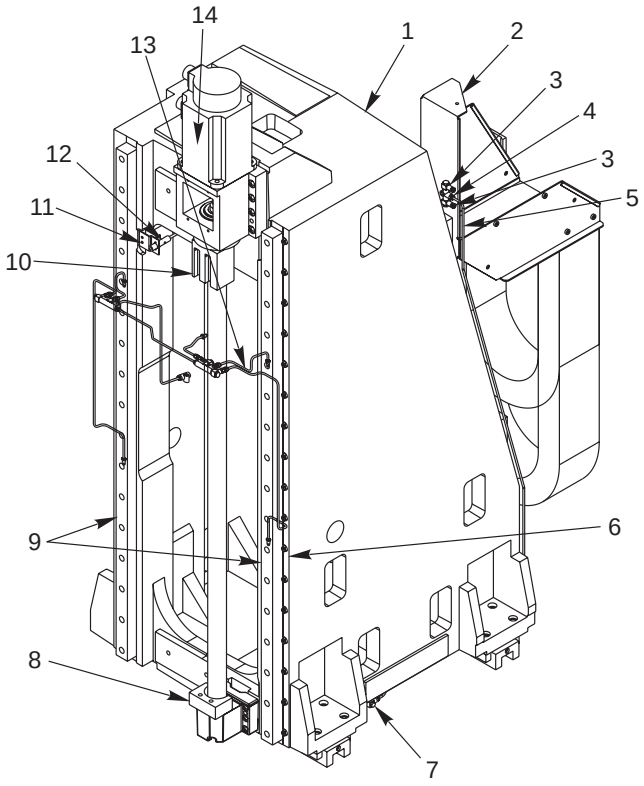
1.	30-6477E	Chip Conveyor
2.	25-5309	Chip Conveyor Extension Cover
3.	25-5025A	Coolant Trough Extension
4.	57-0334A	Coolant Trough Gasket
5.	25-4944	2X Auger Trough Brace
6.	25-5292	Motor Access Cover
	57-0333	Extension Box Gasket
7.	25-5288B	Coolant Trough
8.	58-0336	Pipe Plug 3/8 Brass
9.	58-1679	Fitting Bulkhead NPT 3/8 x 1
10.	25-5308A	Conveyor Chip Shield

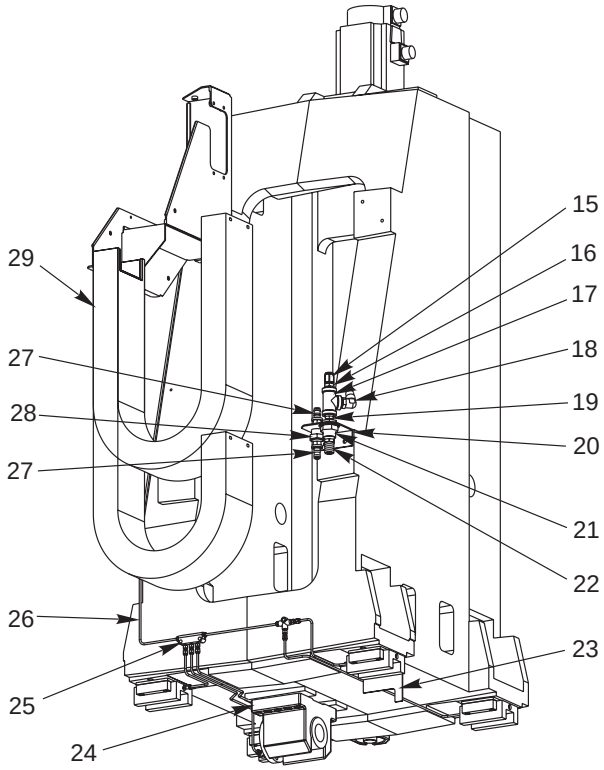
EC-400 Bulkhead



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

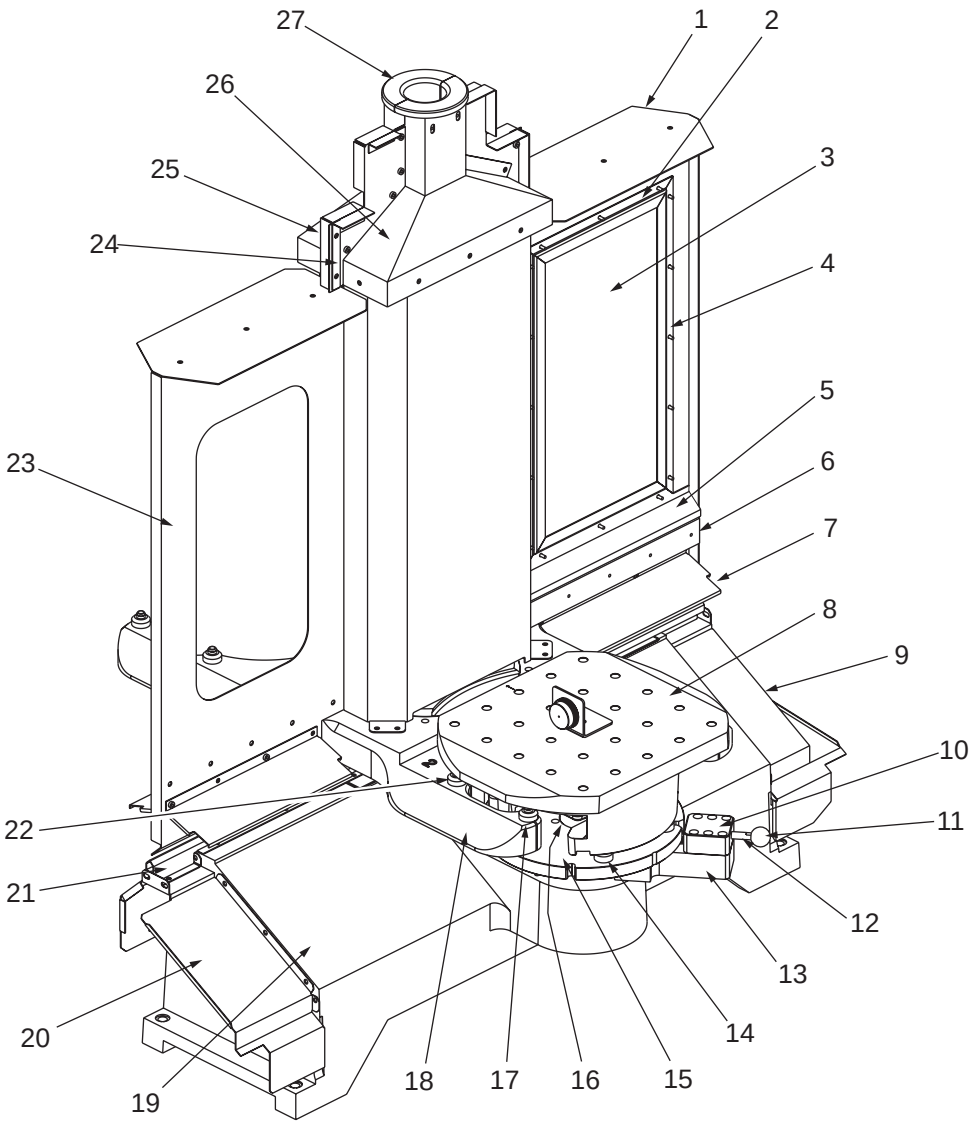




Back View (Looking Up)

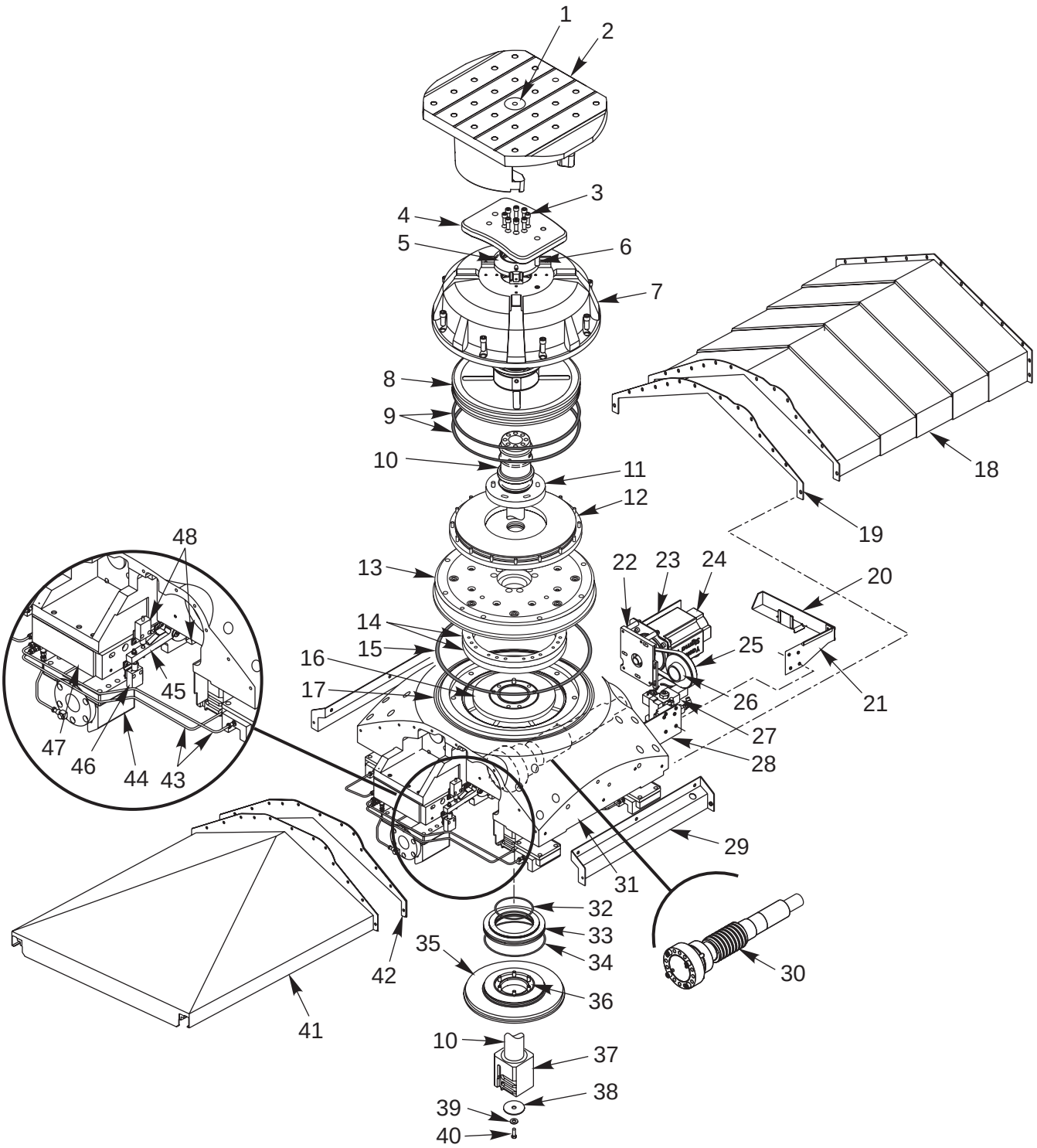
1.	20-2043D	Column Machined
2.	25-4996A	BRKT Carrier Column
3.	58-3031	Lube Fitg Adaptor
4.	58-3031	Lube Fitg Adaptor
5.	58-0634A	Copper Tubing Column
6.	22-7458A	Cam Linear Guide
7.	58-3031	Lube Fitg Adaptor
8.	28-0218	Bumper
9.	50-3400	Linear Guide
10.	28-0218	Hardstop Y-axis
11.	25-7267	Mounting Bracket
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
21.	58-1680	Fitg Bkhd
22.	58-2067	Fitg Hose Barb
23.	25-4937	Trip Bracket X-Axis
24.	20-0150	Nut Housing
25.	30-6337	Oil Line Assembly X-Axis
26.	58-0634A	Copper Tubing Column
27.	58-0029	Fitg Hose Barb
28.	58-1679	Fitg Bkhd
29.	59-0640	Cable Carrier Y-Axis

EC-400 Pallet Changer Assembly



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

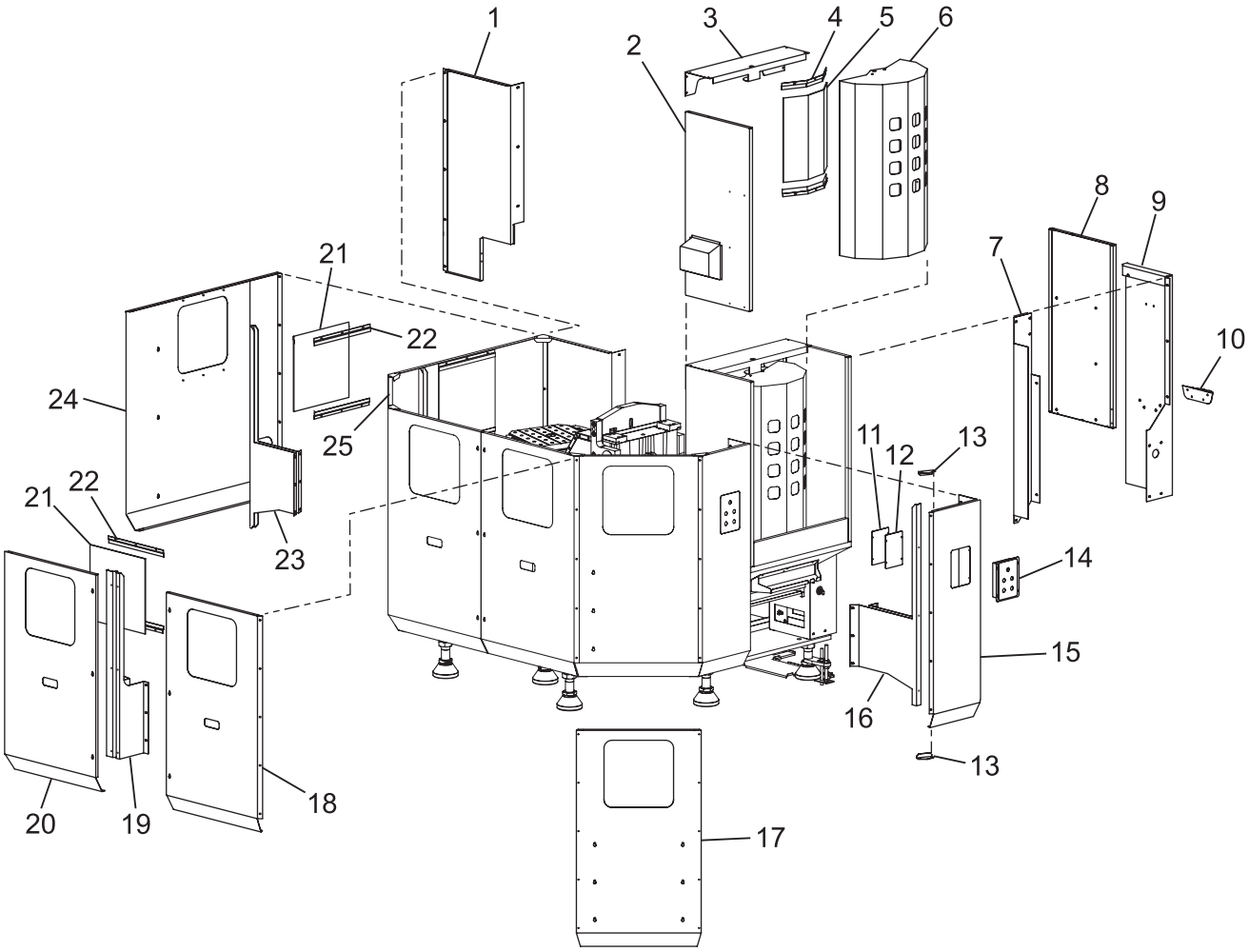
EC-400 Receiver Assembly



EC-400 Receiver Assembly

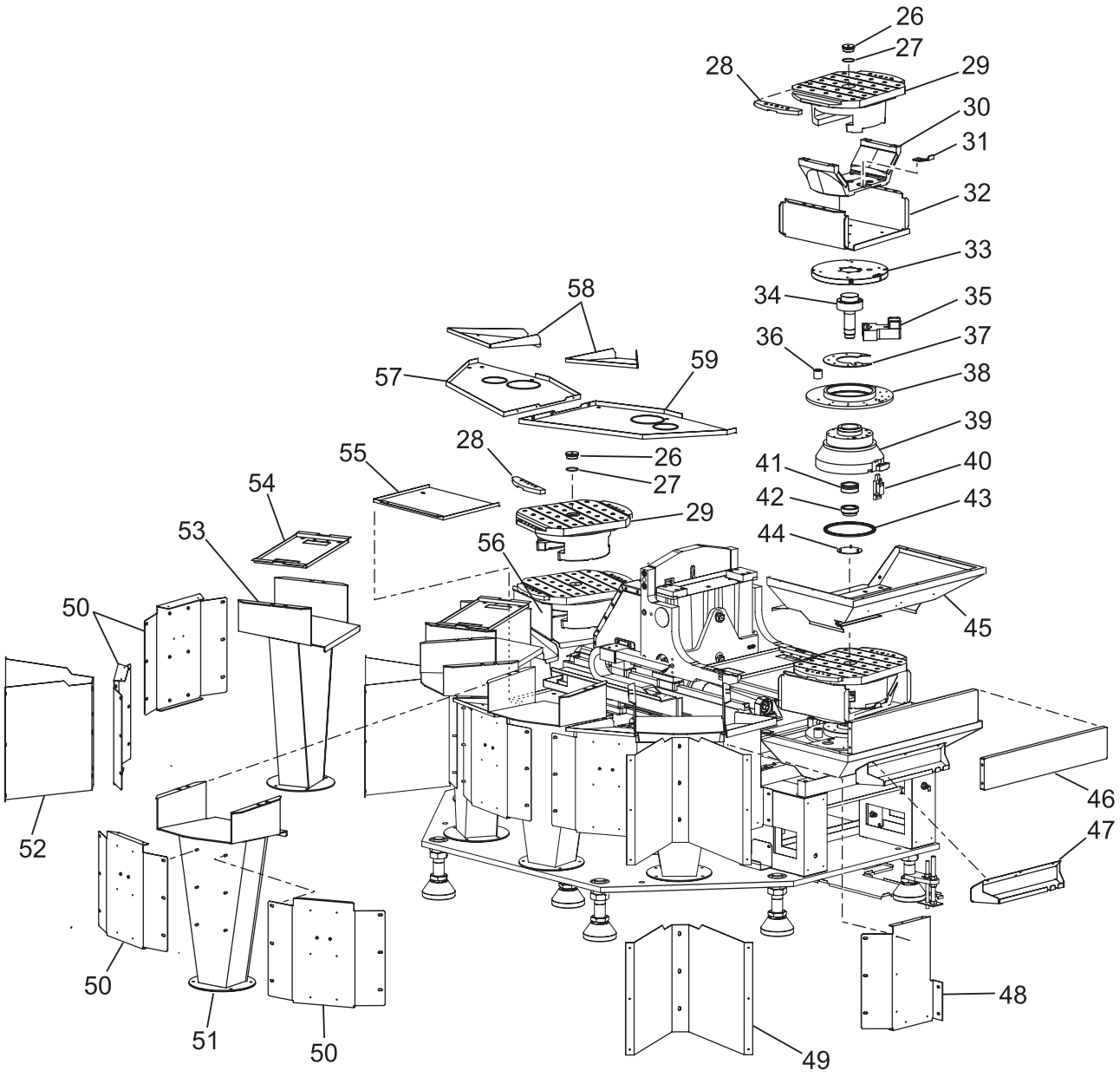
1.	20-1123B	Pallet plug
	57-0041	Parker O-ring 2-135
2.	20-2048F	Pallet machined
3.	40-1639	SHCS 3/8-16x1 (8)
4.	20-1995	Receiver clamp plate
5.	30-5005A	Air blast assembly
6.	48-1667	Dowel pin 1/2x3 ½ (2)
7.	20-2041E	Receiver body machined
	57-0328	O-ring 2-339 viton (2)
	25-5252	Receiver wear surface (2)
	57-0337	V-ring seal
	40-16575	SHCS (8)
8.	20-1994A	Receiver piston
	25-5250	Piston wear surface
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
36.	20-4236	Spindle spacer
	40-1636	SHCS (6)
37.	20-1998C	Receiver rotary union
38.	20-2344	Rotary union lower washer
39.	45-0075	Steel washer 5/16
40.	43-7004	HHB 5/16-18 x 7/8 pltd
41.	25-5549	Front way cover Z-axis
42.	57-0327	Fixed way cover gasket
43.	30-6336	Oil line assy Z-axis
44.	20-0150	Ballnut housing machined
45.	20-2330C	Rotary axis switch arm
46.	20-2473	Bar-spring mount assy
47.	20-2023A	Ballnut spacer Z-axis
48.	69-1700	Proximity switch (2)

EC-400 Pallet Pool External Sheet Metal



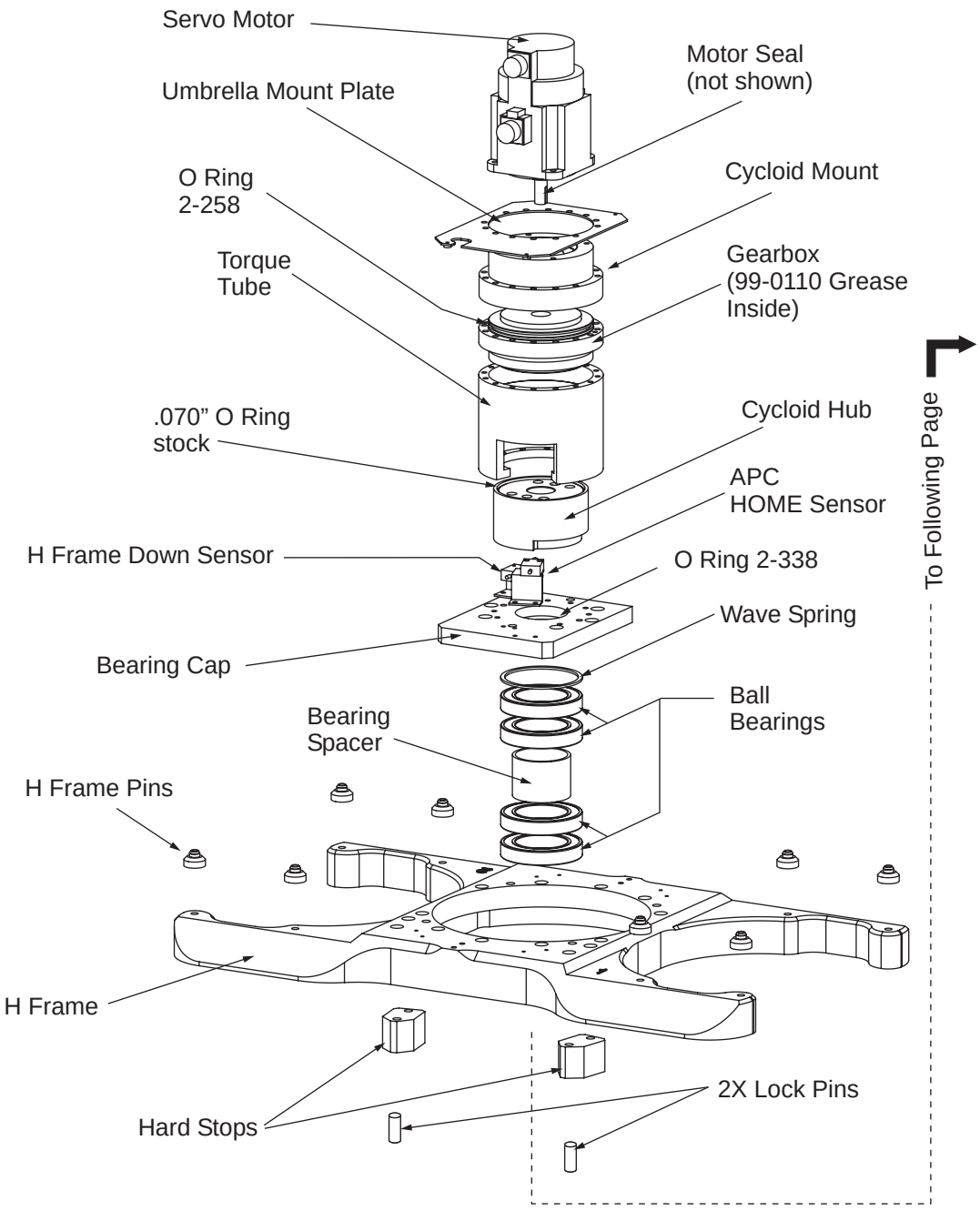
1.	25-7528	Enclosure Left Rear Panel
2.	25-7827	Left Load Station Side Panel
3.	25-7475A	Load Door Top Pivot
4.	25-8512	2x Load Door Station Window Z-Frame
5.	28-0263	3x Load Station Door Window
6.	25-7489C	Load Station Door
	59-0901	Chuck Guard handle
7.	25-7768A	Load Station Guard
8.	25-7474B	Right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

EC-400 Pallet Pool External Sheet Metal (continued)

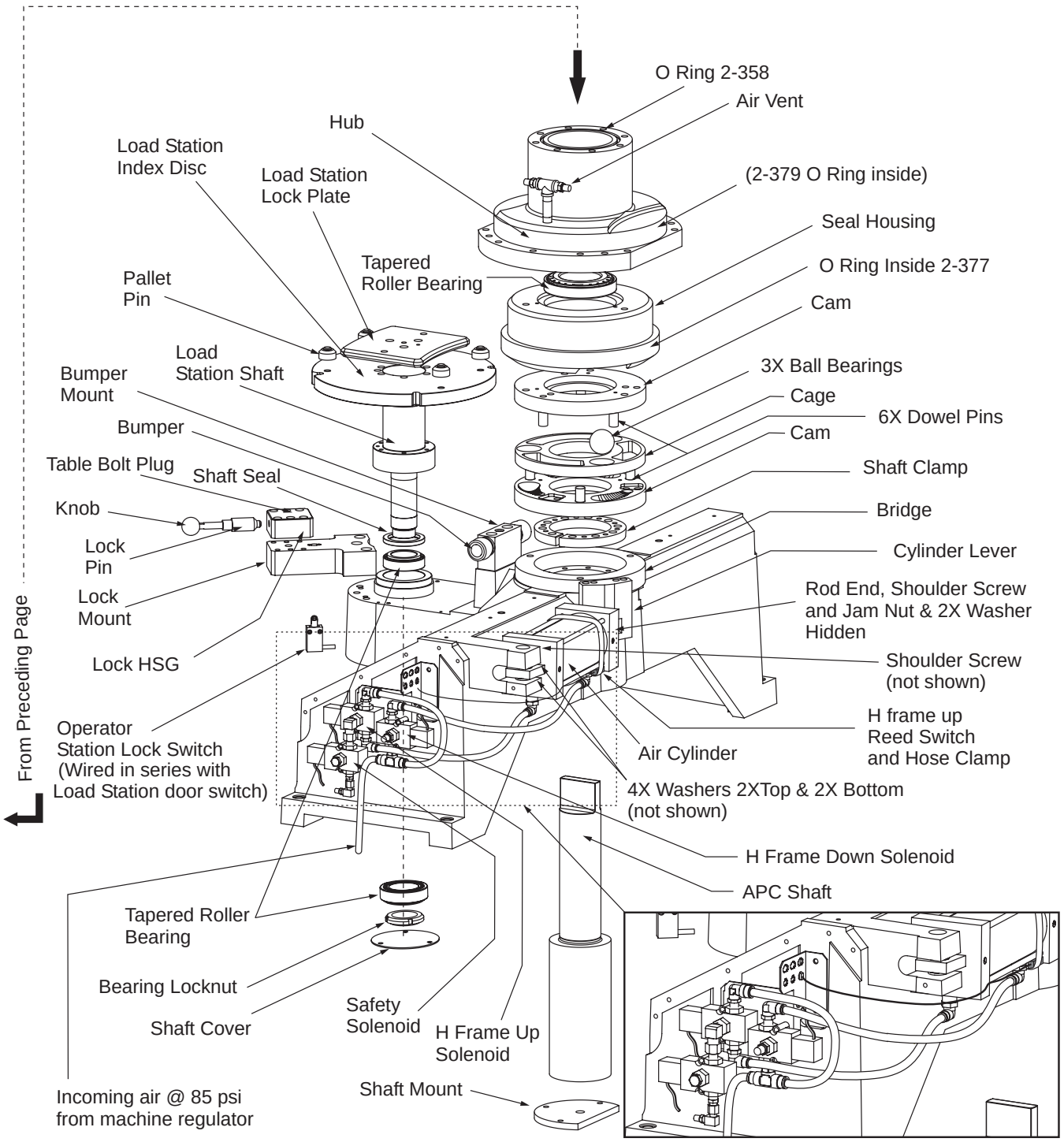


38.	20-3288B	Load Station Door Ring
39.	20-3284	Load Station Bearing Block
	20-3293A	Load Station Door Trip Bracket
40.	20-3292	Load Station Switch Bracket
	61-2125A	Limit Switch
41.	57-0034	Seal 2.500" National
42.	51-2043	Bearing Locknut
43.	20-3287A	Load Station Door Bearing
44.	25-5177	Load Station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

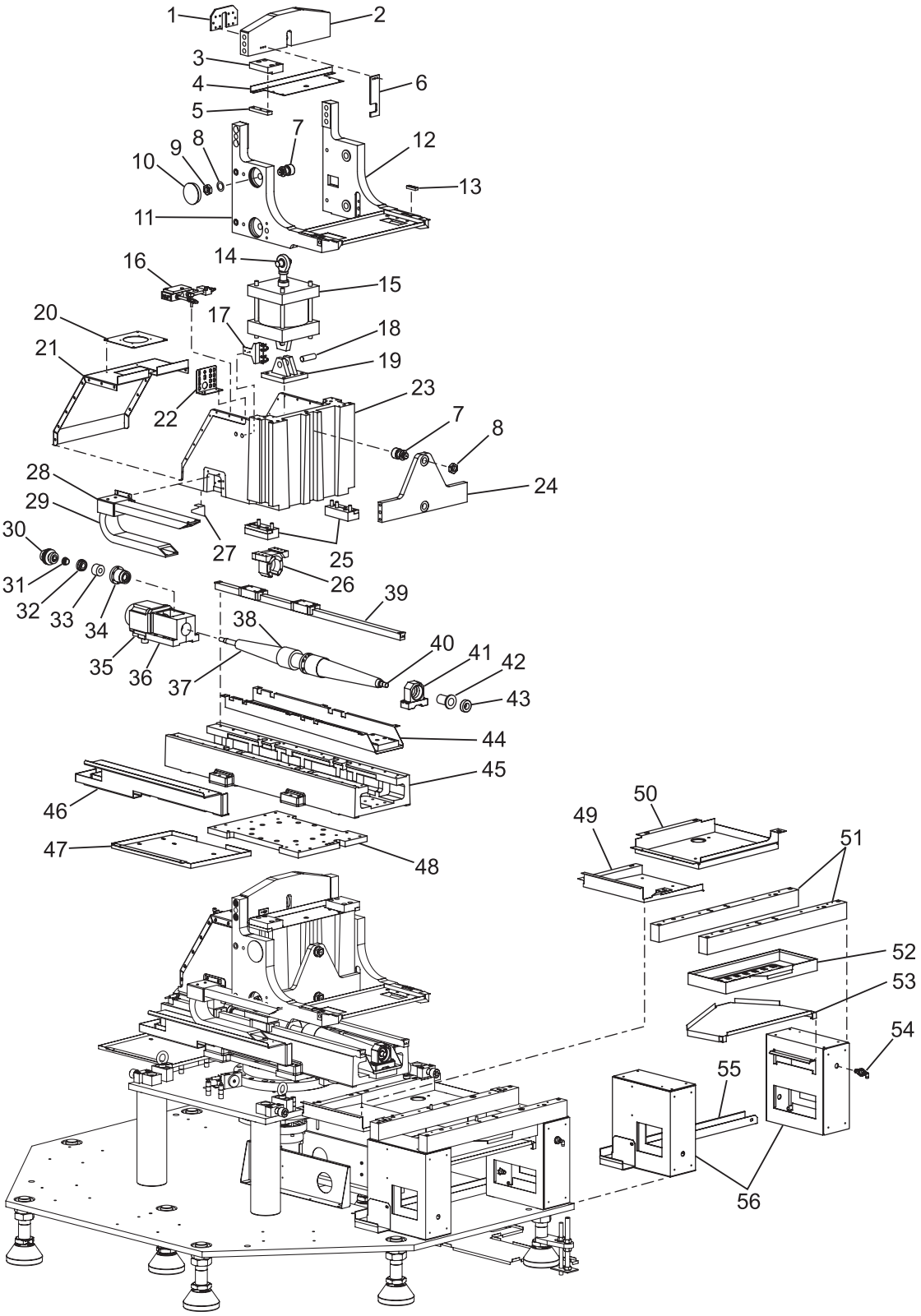
EC-400 Pallet Pool Exploded View



EC-400 Pallet Pool Exploded View



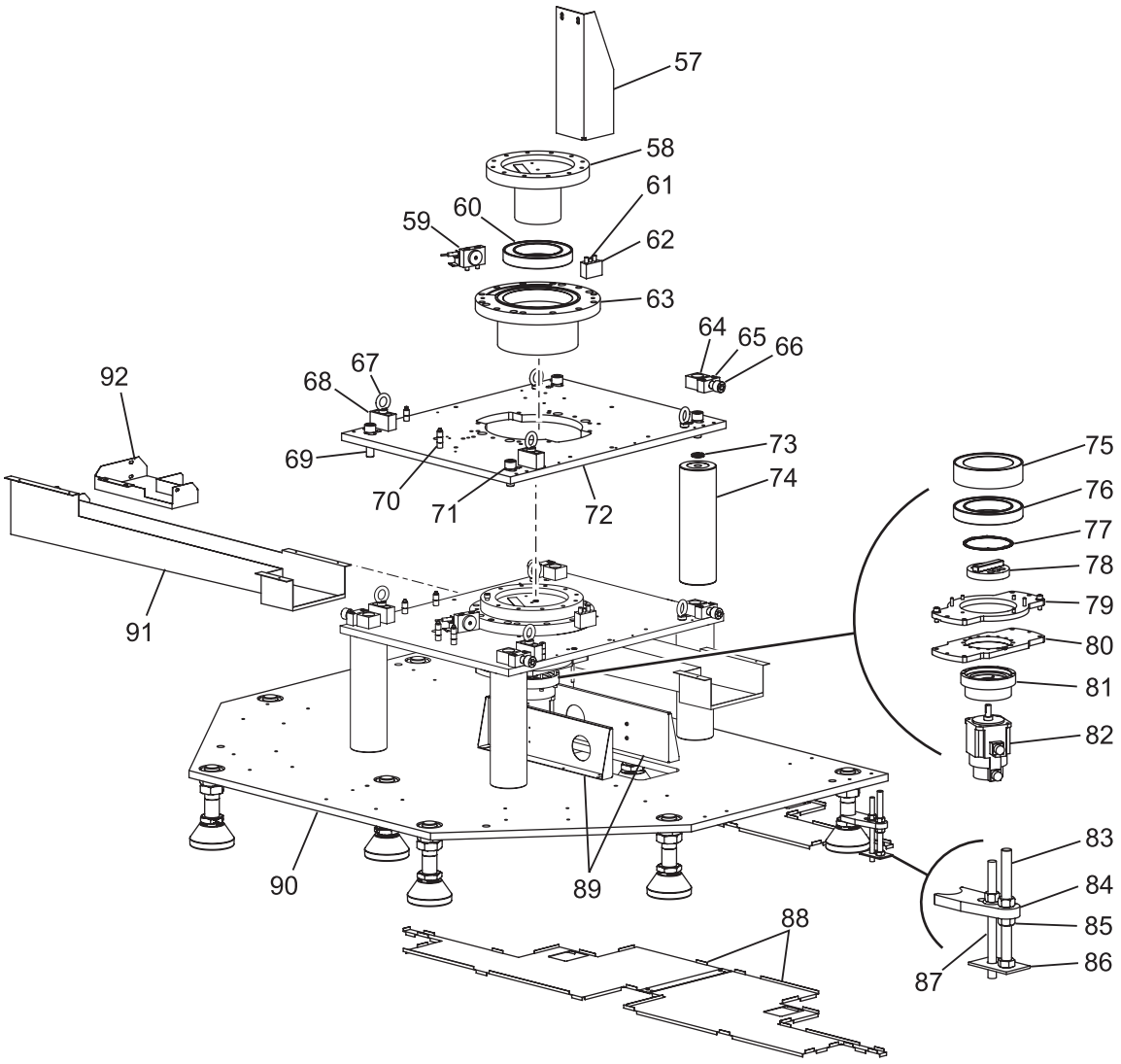
EC-400 Pallet Pool Slider-Saddle-Base Assembly



EC-400 Pallet Pool Slider-Saddle-Base Assembly

1.	20-3319	Slider Assembly Retaining Plate
2.	20-3315	Slider Assembly Cross Beam
3.	20-3327	2x Upper Slider Stop Block
4.	25-7506	Top Slide Guide Block Cover
5.	20-3326	2x Upper Delrin Slider Stop
6.	20-3329	Prox. Arm Position Flag
7.	51-0178	6x Cam Follower 1.75" Dia.
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
50.	25-7531B	Right Rear Drip Tray
51.	20-3282A	2x Load Station Beam
52.	25-7473	Load Station Drain Drawer
53.	25-7476	Load Station Drip Pan
54.	58-1677	2x Bulkhead Fitting NPT .25"x.750" dia.
55.	25-7536	Auxiliary Switch Box Cable Tray
56.	25-7470A	2x Load Station Load Base

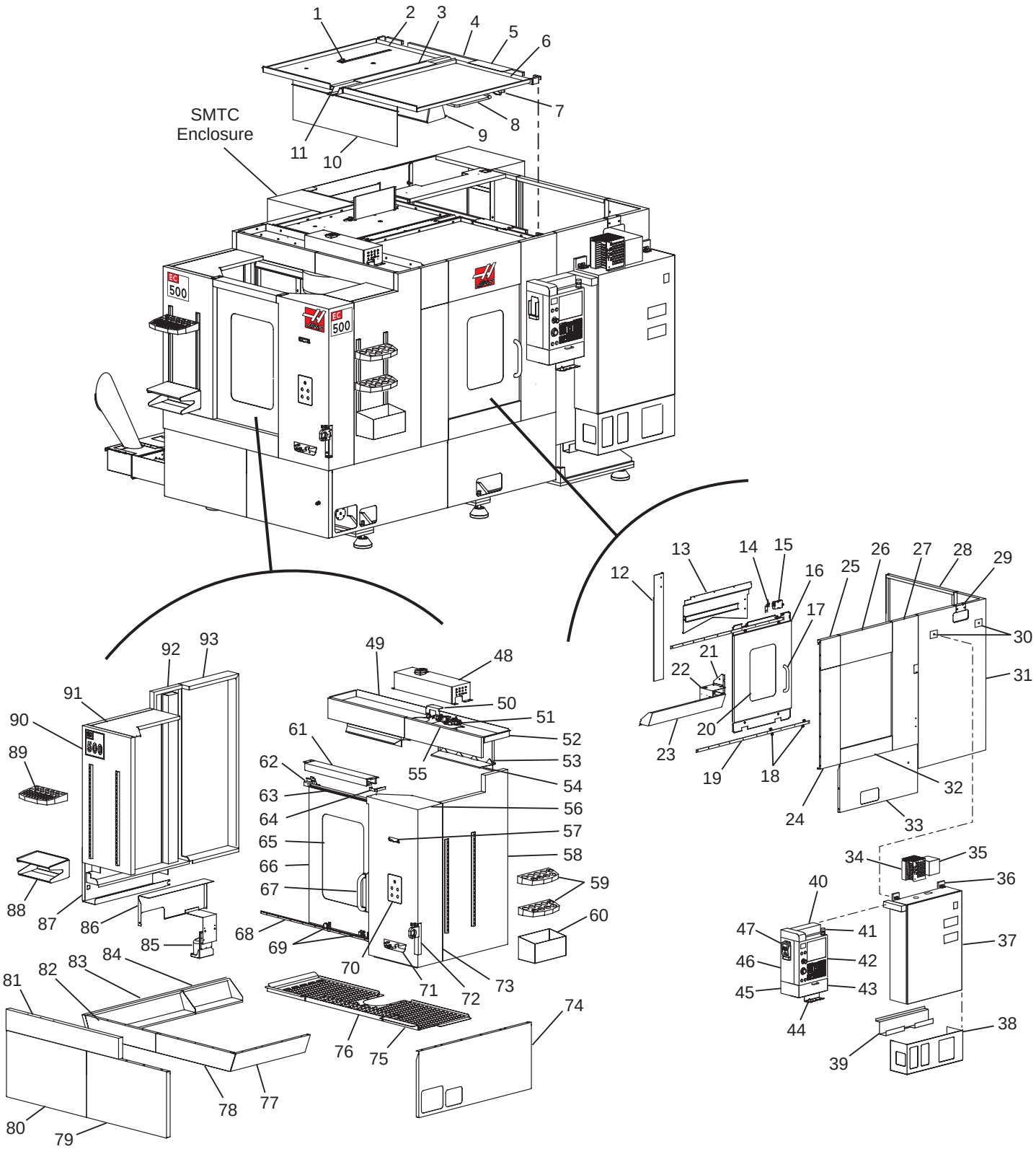
EC-400 Pallet Pool Slider-Saddle-Base Assembly (continued)



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

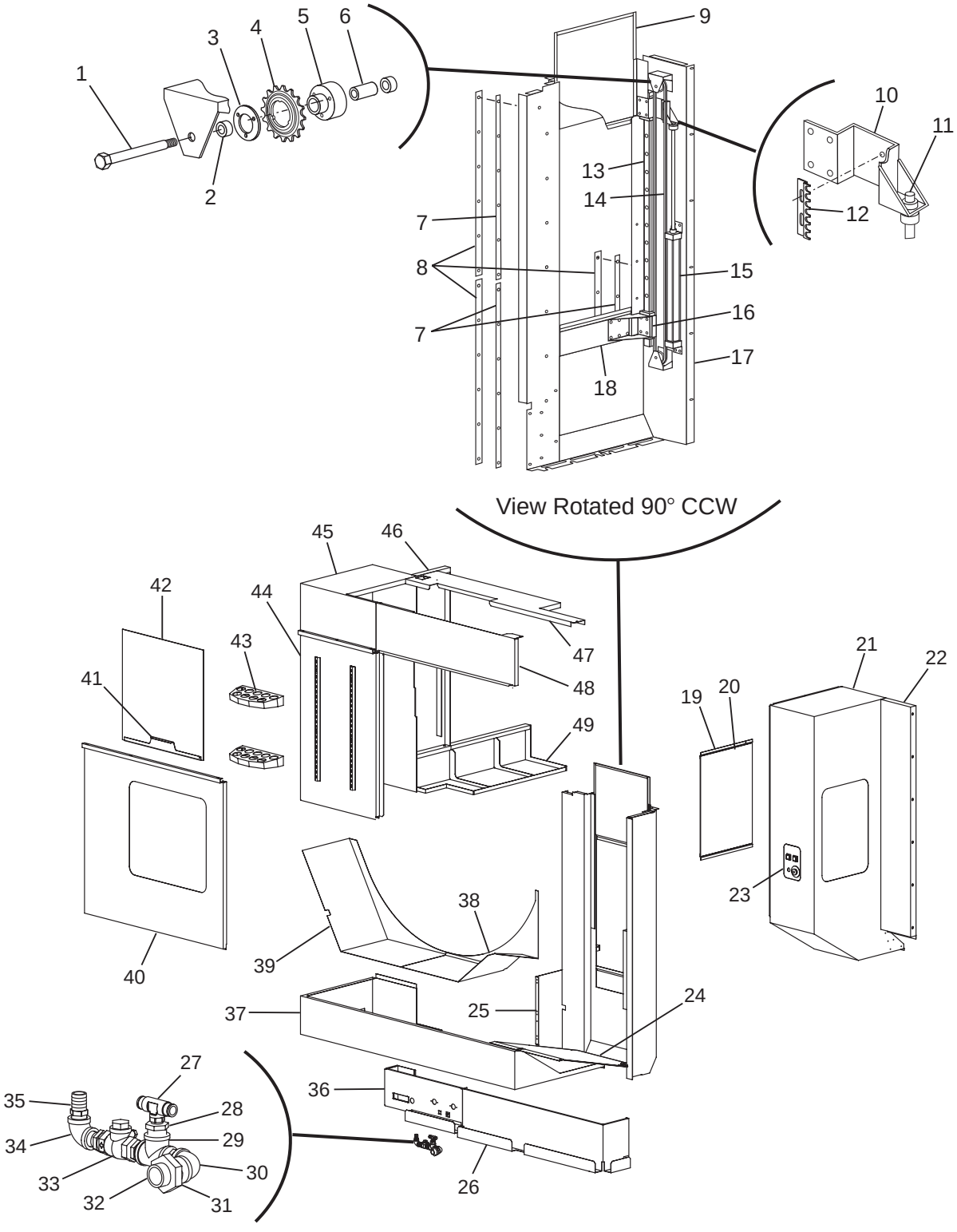
EC-500 External Sheet Metal



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 SMTC External Sheet Metal

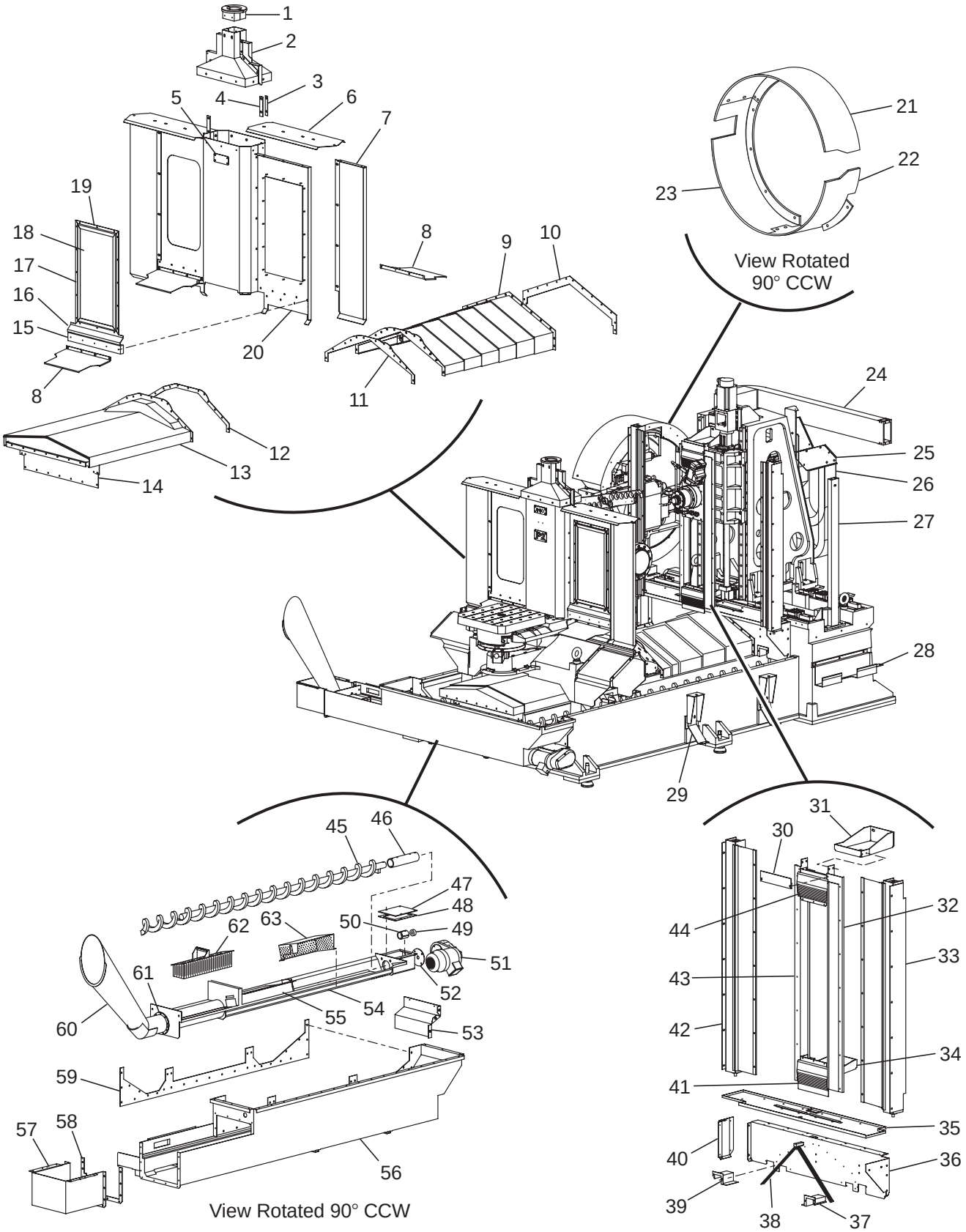


SMTC Enclosure

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

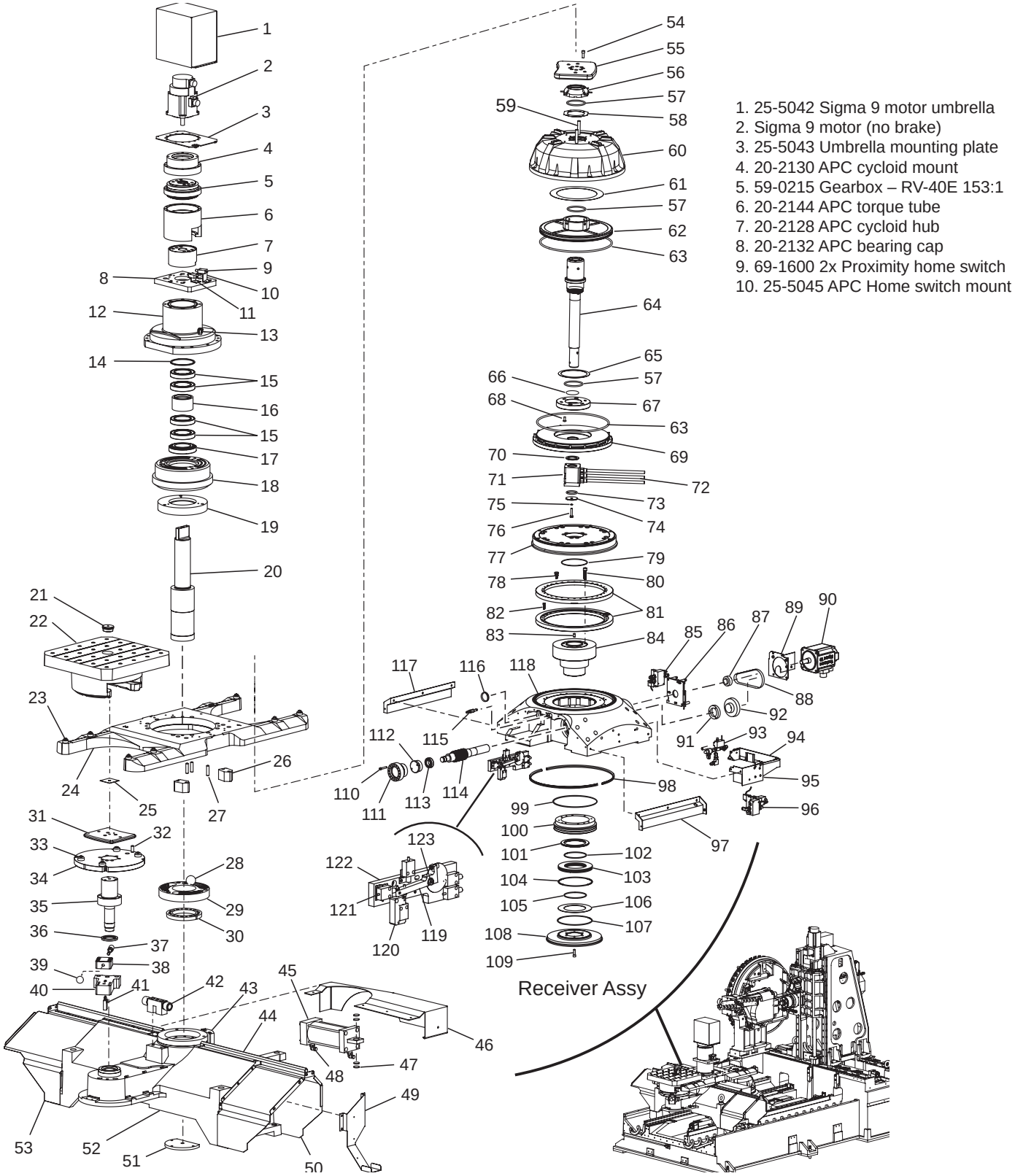
EC-500 Internal Sheet Metal



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 and Receiver



EC-500 APC and Receiver

11. 25-5044 APC H-frame down proximity mount
12. 20-2139B APC hub
13. 58-1693 straight fitting ½ x 3/8” NPT M
14. 59-0015 Ware spring – smally SB-0492
15. 51-0054 4x Deep grove 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 1/2 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 1/2 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 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 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 1/2x3-1/2in.
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

40-1500 16x SHCS 5/16-18x1in (Domestic only)

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

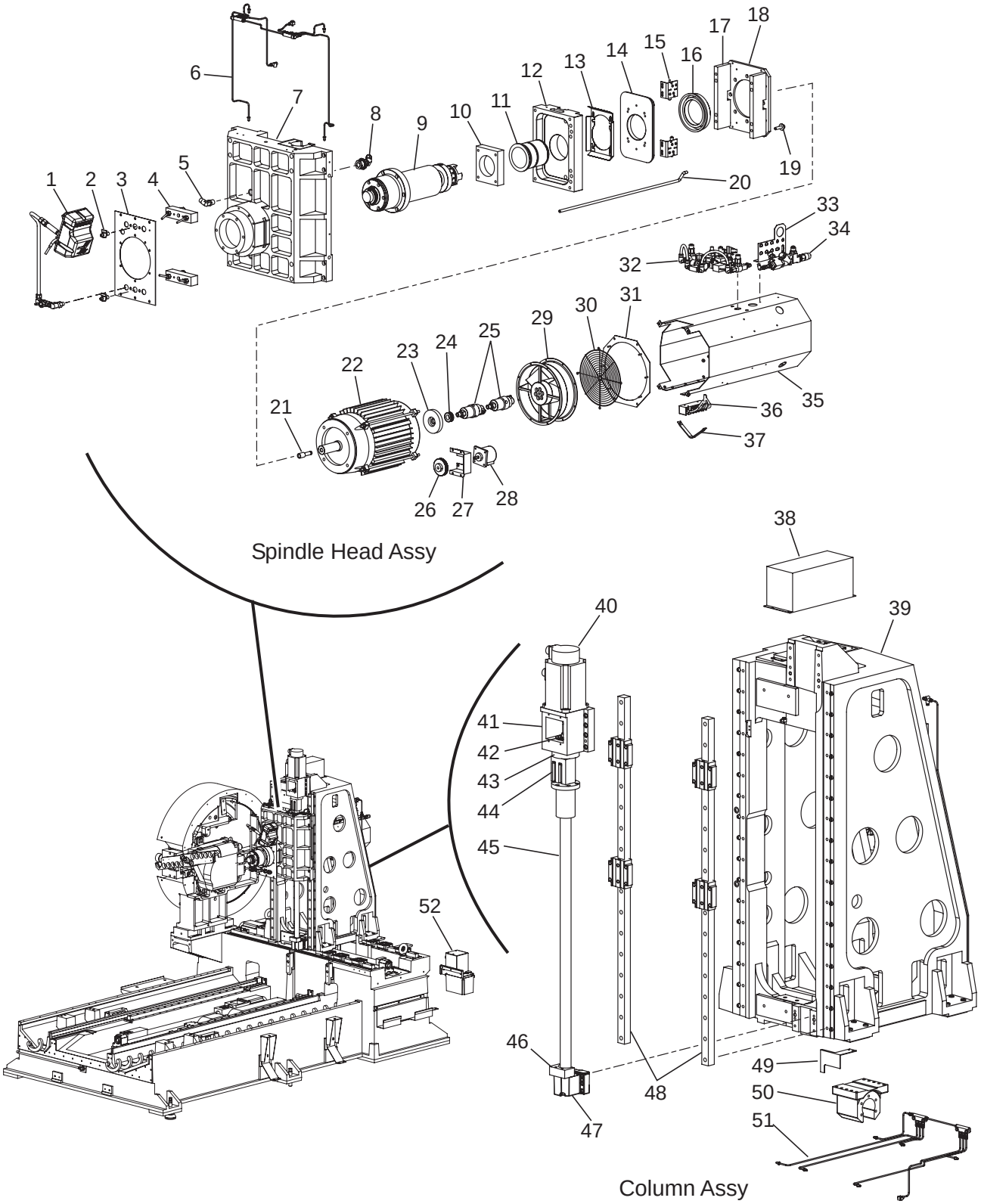
51-4286 Thrust Bearing AXK120155

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

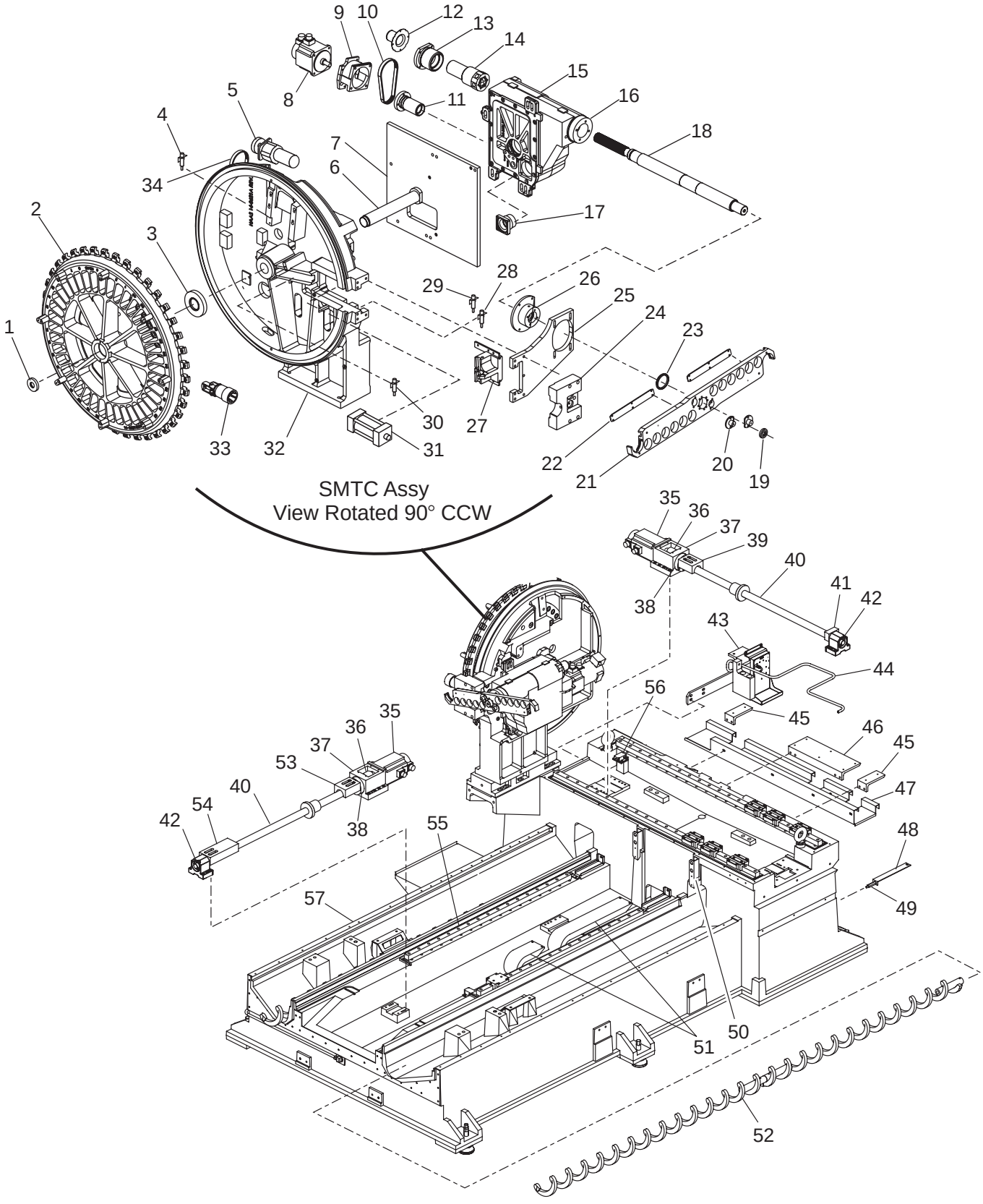
EC-500 Spindle Head and Column



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

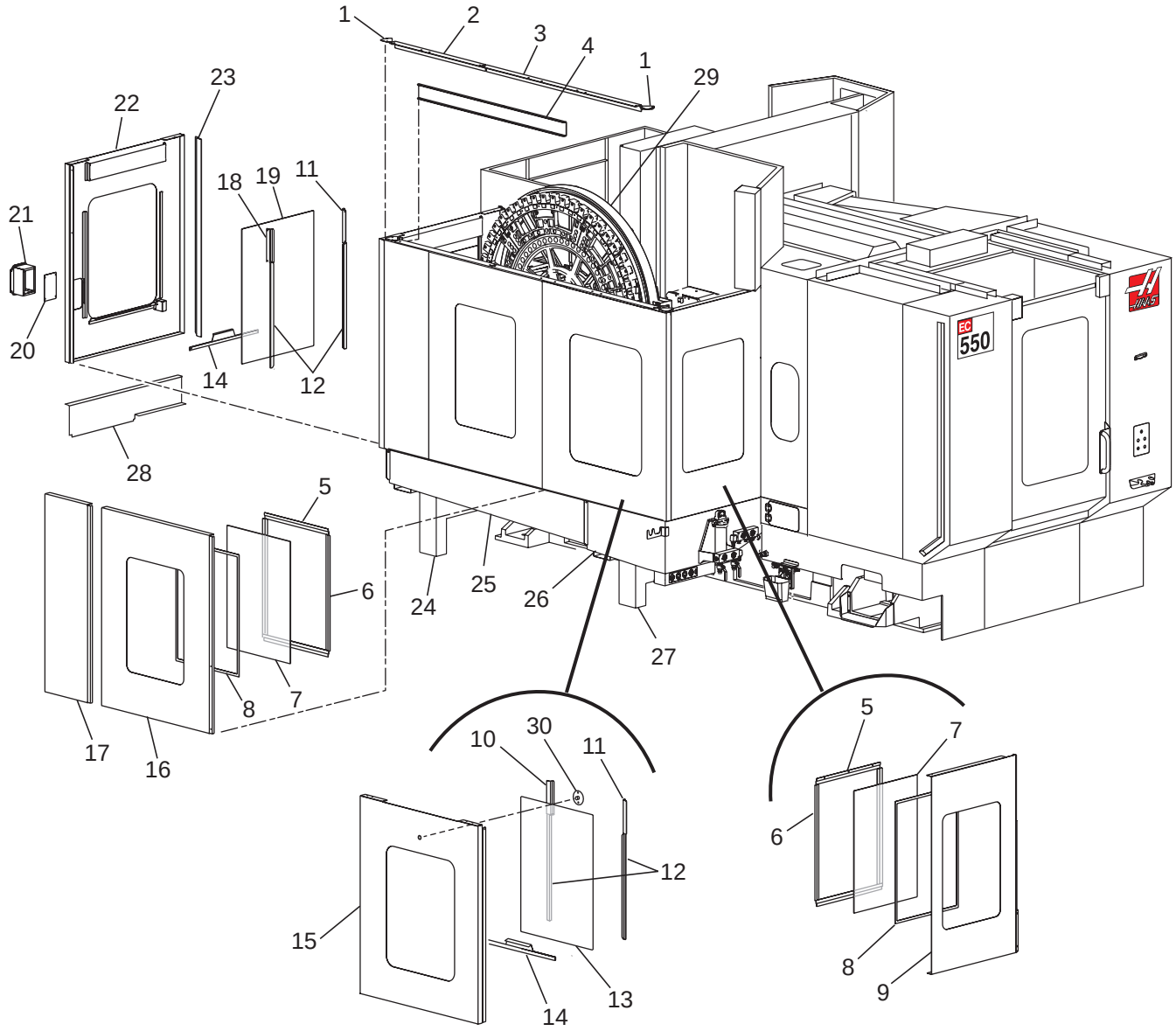
EC-500 Base and SMTC Assembly



EC-500 Base and SMTC Assembly

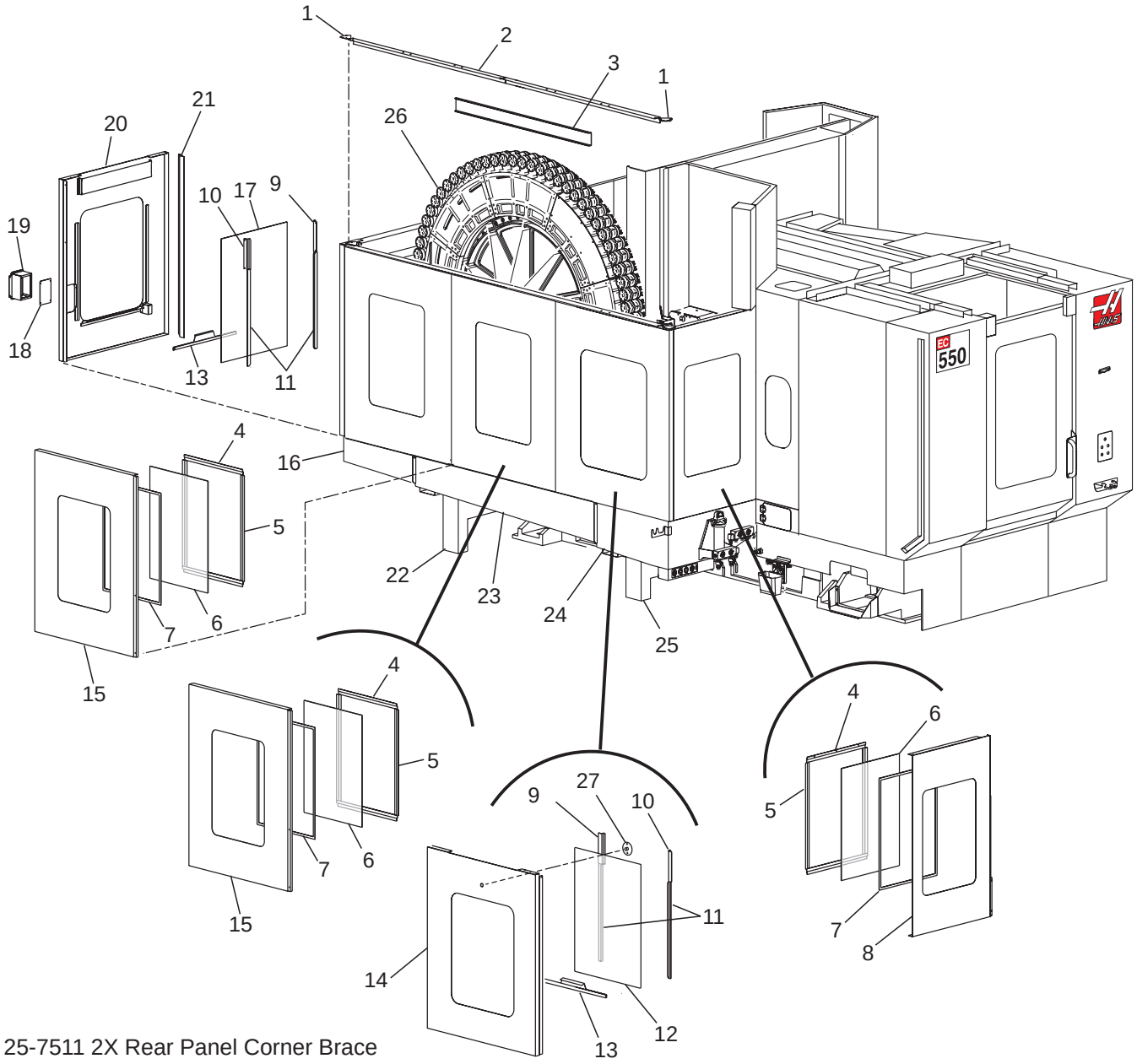
1. 20-0392 Carousel washer
2. 20-0731 Carousel
3. 59-0290 Locknut
4. 32-2295 Carousel mark proximity switch
5. 32-1875 Carousel motor
6. 20-0809 Carousel shaft
7. 20-2759 Mounting plate
8. 62-0014 Servo motor
9. 20-0772 Motor mount
10. 54-0036 Drive belt
11. 20-0225 Bearing housing
12. 22-0001 Output 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-550 SMTC 50-50 Cage Assembly



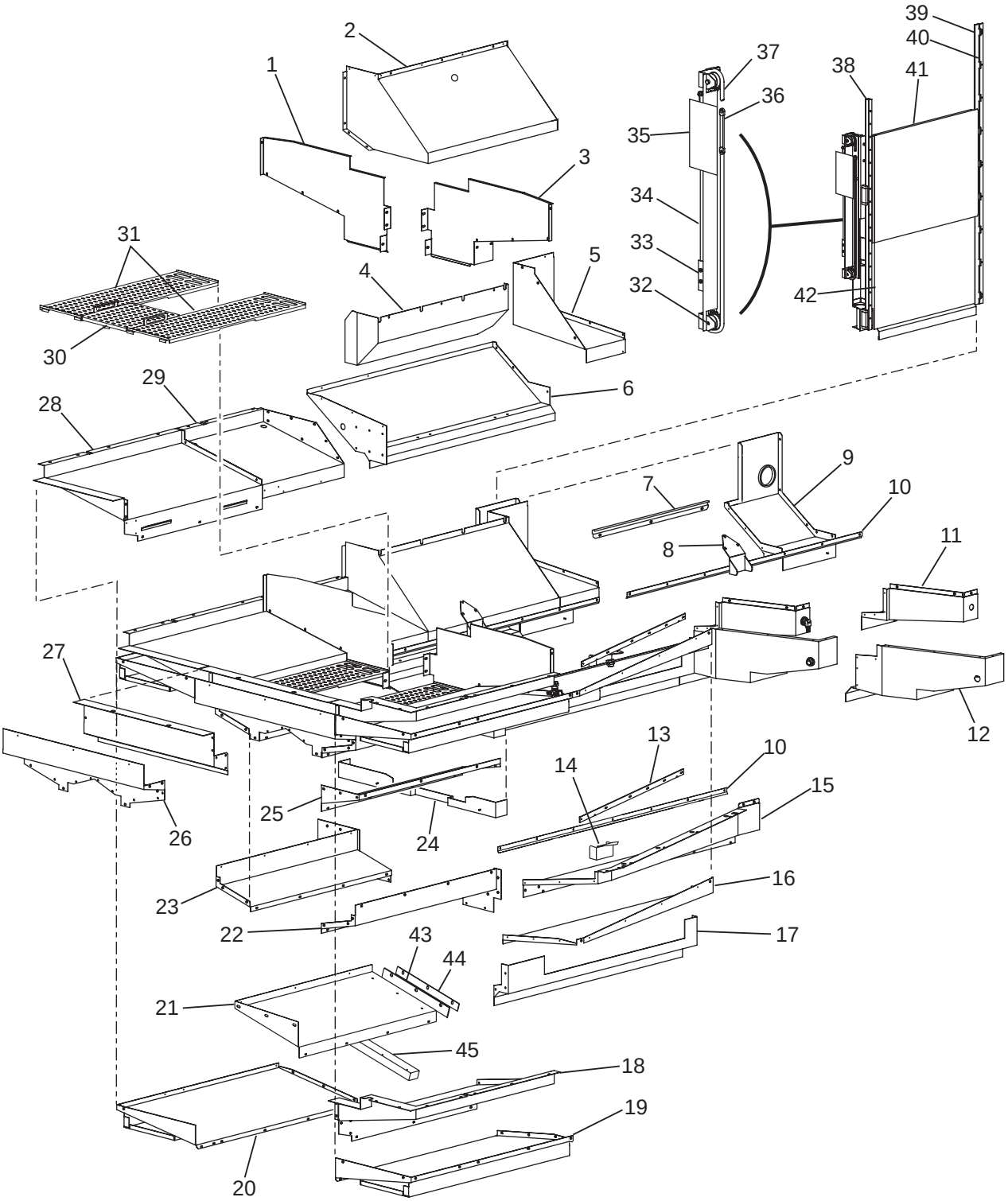
1. 25-7511 2x Rear Panel corner Brace
2. 25-11903 Cage Rear Stiffener Bracket
3. 25-11904 Cage Top Stiffener Bracket
4. 25-11720 Cage Stiffener Bracket
5. 25-0969 4X Top-Bottom Door Frame
6. 25-0970 4X Door Frame Sides
7. 28-0020 2x Door Window
8. 26-0042 2x Door Window Gasket
9. 25-11718 Cage Front Panel
10. 25-4220C Side Window Rest
11. 25-4221 2X Side Window Rest Opposite
12. 28-0036 4X Side Window Extrusion
13. 28-7472B Side Window
14. 25-9248A 2X Window Plate Handle
15. 25-11719 Side Front Cage Panel
16. 25-11712 Side Cage Panel
17. 25-11865 Rear Side Cage Panel
18. 25-4220 Rear Window Rest
19. 28-7472B Side Window
20. 25-6719 Switch Box Cover
21. 25-6718A Switch Box
    32-1114A Remote Switch Box
22. 25-11717 Cage Panel Rear
23. 25-11894 Rear Mounting Bracket
24. 25-11732 Cage Rear Pan Support
25. 25-11716 Cage Intermediate Drip Pan
26. 25-11715 Cage Front Drip Pan
27. 25-11734 Cage Front Pan Support
28. 25-11864 Rear Cage Drip Pan
29. 30-9118 SMTC 50-50
30. 25-7244 Window Lock Bracket

EC-550 SMTC 72-50 Cage Assembly



1. 25-7511 2X Rear Panel Corner Brace
2. 25-11903 2X Cage Rear Stiffener Bracket
3. 25-11720 Cage Stiffener
4. 25-0969 6X Top-Bottom Door Frame
5. 25-0970 6X Door Frame Sides
6. 28-0020 3X Door Window
7. 26-0042 3X Door Window Gasket
8. 25-11718 Cage Front Panel
9. 25-4221C 2X Side Window Rest
10. 25-4220C 2X Side Window Rest Opposite
11. 28-0036 4X Side Window Extrusion
12. 28-7472B Side Window
13. 25-9248A 2X Window Plate Handle
14. 25-11719 Side Front Cage Panel
15. 25-11712 2X Side Cage Panel
16. 25-11714 Rear Cage Drip Pan
17. 28-7472B Side Window
18. 25-6719 Switch Box Cover
19. 25-6718A Switch Box
    32-1114A Remote Switch Box
20. 25-11717 Cage Rear Panel
21. 25-11894 Rear Mounting Bracket
22. 25-11732 Cage Rear Pan Support
23. 25-11716 Cage Intermediate Drip Pan
24. 25-11715 Cage Front Drip Pan
25. 25-11734 Cage Front Pan Support
26. 30-4232 SMTC 72-50
27. 25-7244 Window Lock Bracket

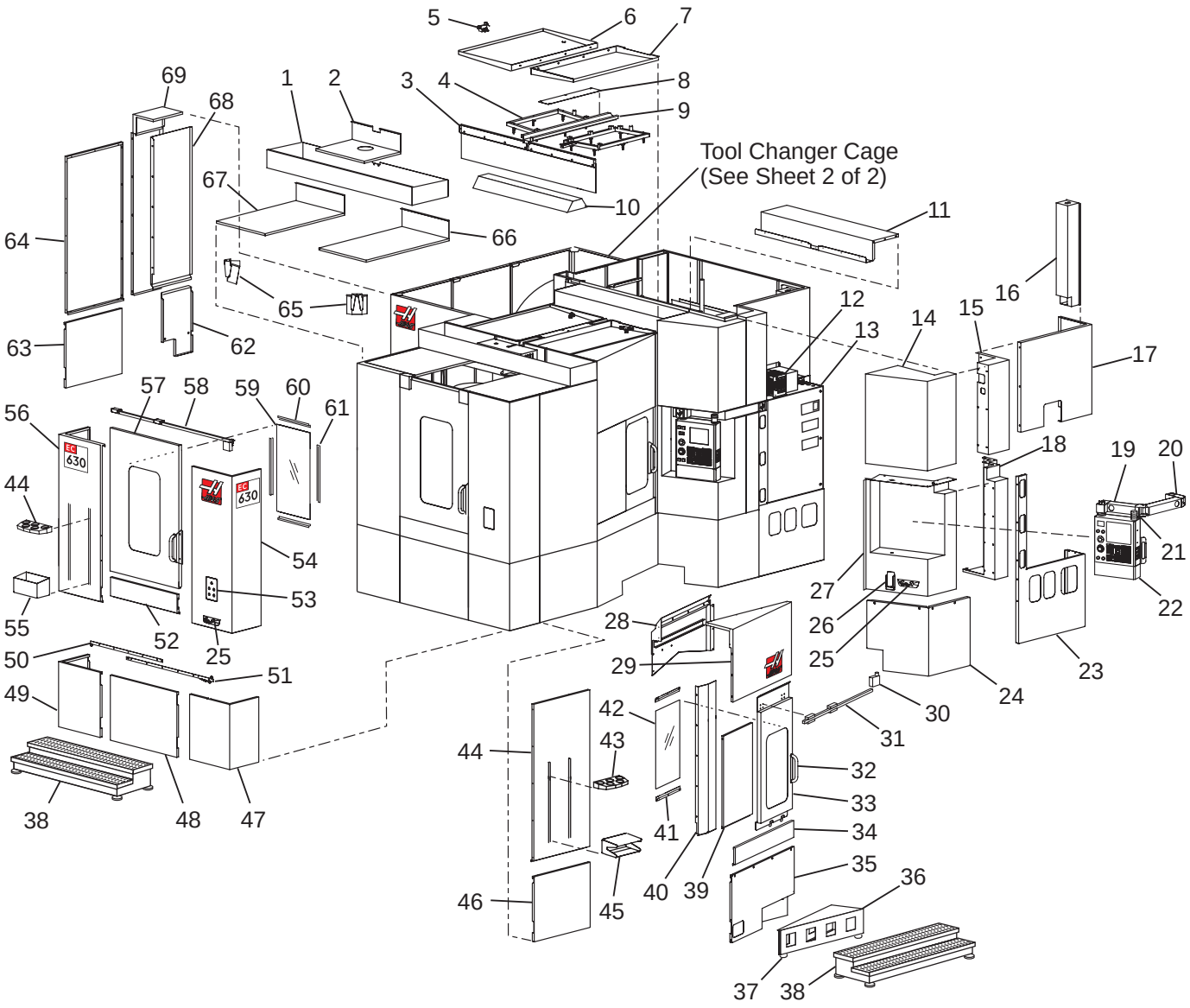
EC-630 Internal Sheet Metal



EC-630 Internal Sheet Metal

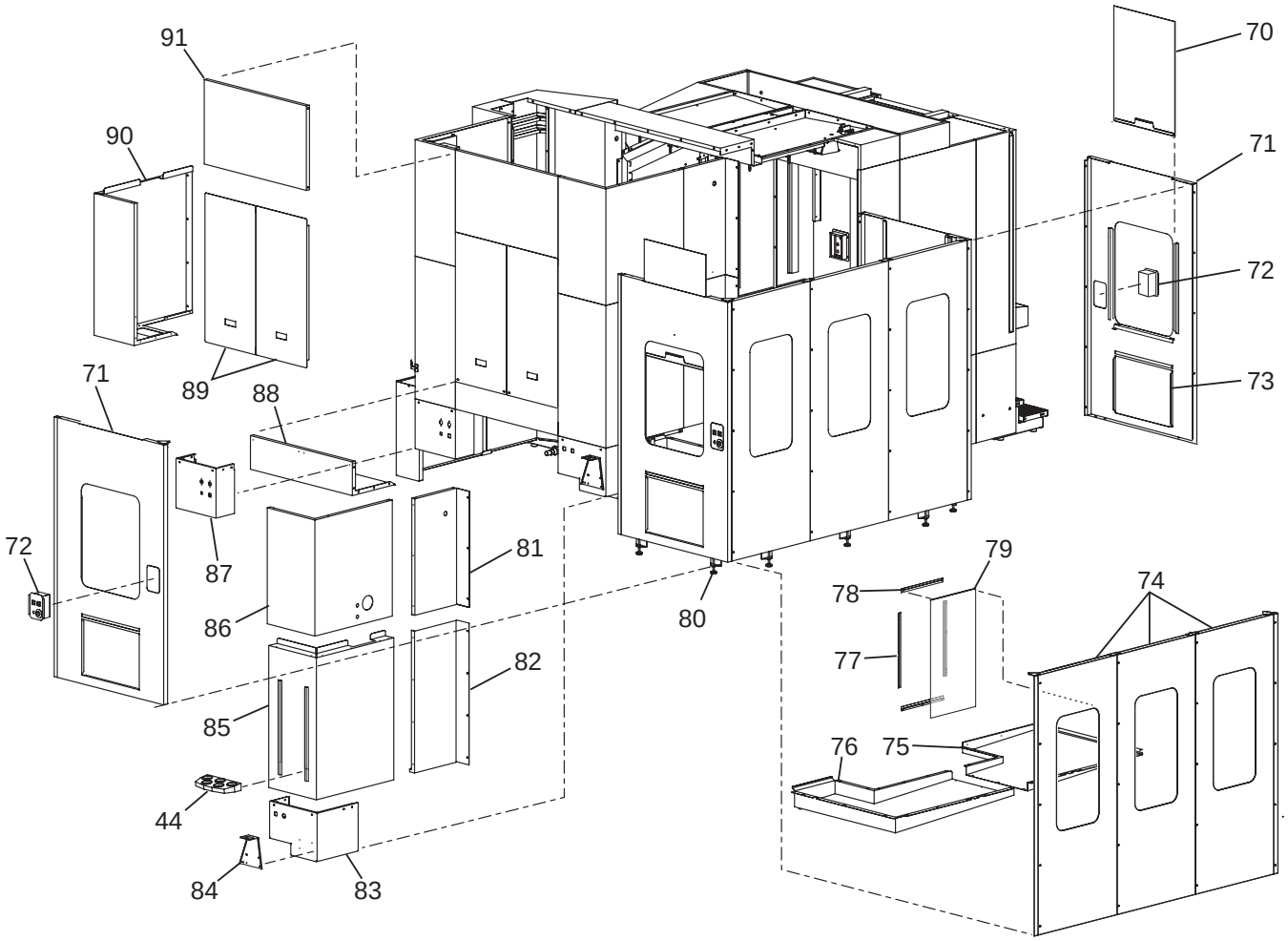
1.	25-8140	APC TC Splash Shield
2.	25-8205A	TC Door Lower Panel
3.	25-8139	APC Operator Splash Shield
4.	25-8131A	X-Axis TC ChiShield
5.	25-8220A	TC Door Frame Corner Panel
6.	25-8196	Base Casting TC Drip Pan
7.	25-8474B	X-Axis TC Drip Pan Mounting Bracket
8.	25-8996A	TC Side Chip Raker
9.	25-8198A	TC 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	OperatorSide 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

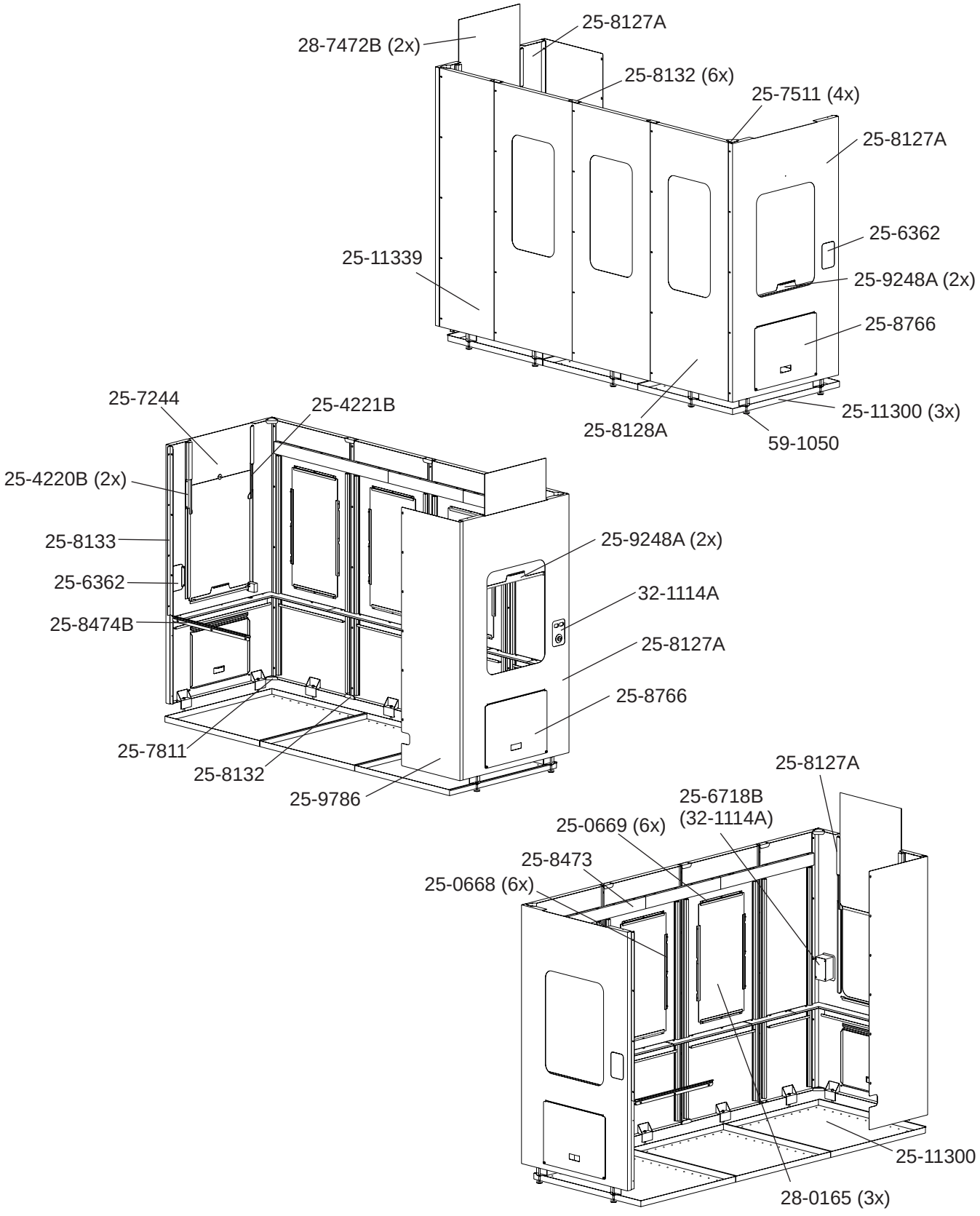


Sheet 2 of 2
(View Rotated 180°)

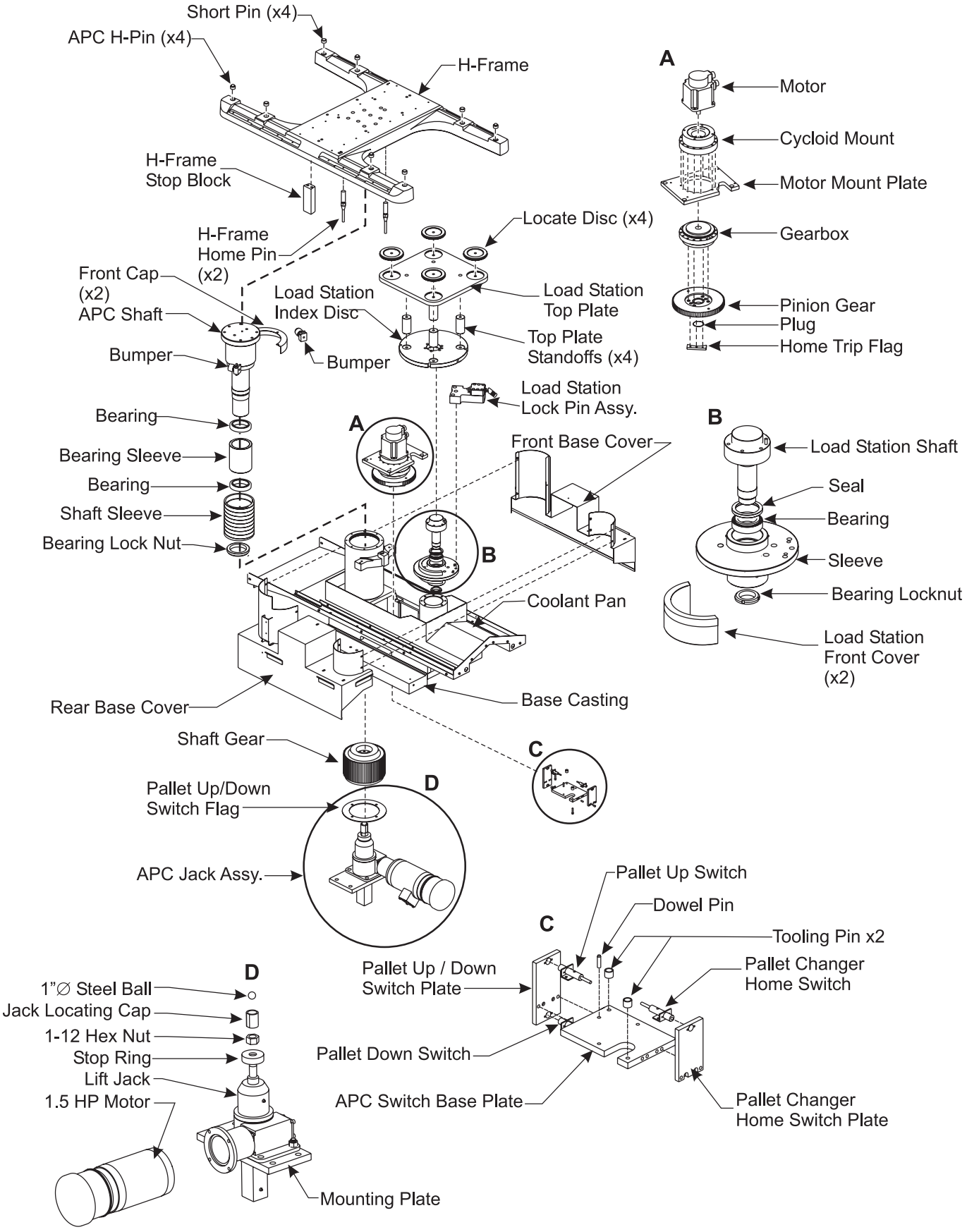
EC-630 External Sheet Metal

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 Pandant Support Arm
    20-7109A Arm Swivel Mount
    93-0282 Control Swivel Mount
20. 20-3803A Control Support Arm
21. 59-0990 Recessed Bumper O.D. 1.13 x 1" H
22. Control Pendant Assy
    25-9907 Monitor Handle
23. 25-8238 Control Box Access Panel
24. 25-8237 Control Panel Apron-Operator Side
25. 25-5412 2X Nozzle Holder Bracket
26. 25-8120A ERJH Cradle
27. 25-8185A Lower Pendant Panel
28. 25-8332A Top Splash Shield-Operator Side
29. 25-8327 Upper Panel -Operator Side
30. 61-0006B CE Door Interlock
31. 50-0102 X-Axis Linear Guide 30 x 1420
32. 25-7412 2X Door Handle Bracket
    22-8895 2X Door Handle-Chrome
33. 25-8326A Operator Door
    30-2009 2X Door Roller Assy
    59-9743 Door Spring
34. 25-8329 Lower Panel-Operator Side
35. 25-8200 Apron-Operator Side
36. 25-8349A Operator Loading Station
37. 59-0956 3X Recessed Bumper
    45-1665 3X Washer .375"
    40-1639 3X SHCS .375 x 1"
38. 30-9158 2X Platform Assy
39. 25-8328A Intermediate Top Side Panel
40. 25-8420A Operator Intermediate Splash Shield
41. 25-0818 2X Door Frame_Top-Bottom
42. 28-0015 Operator Door Window
    26-0041 Window Gasket
43. 30-1936 Tool Tray Assy 50T
44. 25-8276A Front Right Side Panel
45. 25-6182D Front Writing Table
46. 25-8236A Front Right Side Apron
47. 25-8233 Front Right Corner Apron
48. 25-8231 Front Center Apron
49. 25-8232 Front Left Corner Apron
50. 20-3094 Door Rail End
51. 22-9181A Door Lower Guide Rail
    30-2009 2X Door Roller Assy
    59-9743 Door Spring
52. 25-8277 Front Center Panel
53. 25-1257A 2X Switch Box
54. 25-8240A Front Right Corner Panel
55. 25-0563B Tool Box Assy
56. 25-8239A Front Left Corner Panel
57. 25-8278 Front Enclosure Door
58. 50-0101 Linear Guide 30 x 1930
    25-8280 Front Door Rail Support
59. 28-0165 Front Door Window
60. 25-0669 2X Window Retainer_Top-Bottom
61. 25-0668 2X Window Retainer_Side
62. 25-8201 TC Intermediate Apron
63. 25-8234 Front Left Side Apron
64. 25-8275A Front Left Side Panel
65. 25-6286 2X Twin Lamp Bracket
    32-0228 2X Lamp Assy Twin Mylar Reflector
66. 25-8311B Front Top Right Panel
67. 25-8312A Front Top Left Panel
68. 25-8419 TC Intermediate Panel Splash Shield
69. 25-8202 TC Lower Intermediate Panel
    25-8203 TC Upper Intermediate Panel
70. 28-7472 2X Side Panel Window-Plastic Enclosed
    25-9248A 2X Plate Window Handle
71. 25-8127A 2X TC Door Panel
72. 25-6718A 2X SMTC Switch Box
    25-6719 2X SMTC Switch Box Cover
73. 25-8766 TC Cage Access Cover
74. 25-8128A 3X TC Side Panel
75. 25-8129B Right TC Front Drip Pan
76. 25-8130A Left TC Front Drip Pan
77. 25-0668 6X Window Retainer_Side
78. 25-0669 6X Window Retainer_Top-Bottom
79. 28-0165 3X Window
80. 59-1050 7X Leveling Feet
    46-1721 9X Jam Nut .50-13
81. 25-8181A TC Panel Upper Frame
82. 25-8180 TC Panel Lower Frame
83. 25-8184 Rear Left Corner Apron
84. 25-7581C TSC Filter Bracket
85. 25-8176 Lower Rear TC Panel
86. 25-8177 Upper Rear TC Panel
87. 25-8183A Rear Right Corner Apron
88. 25-8174 Rear Lower Center Panel
89. 25-8189 2X Rear Access Panel
90. 25-8172A Rear Lower Control Panel
91. 25-8175 Rear Upper Center Panel

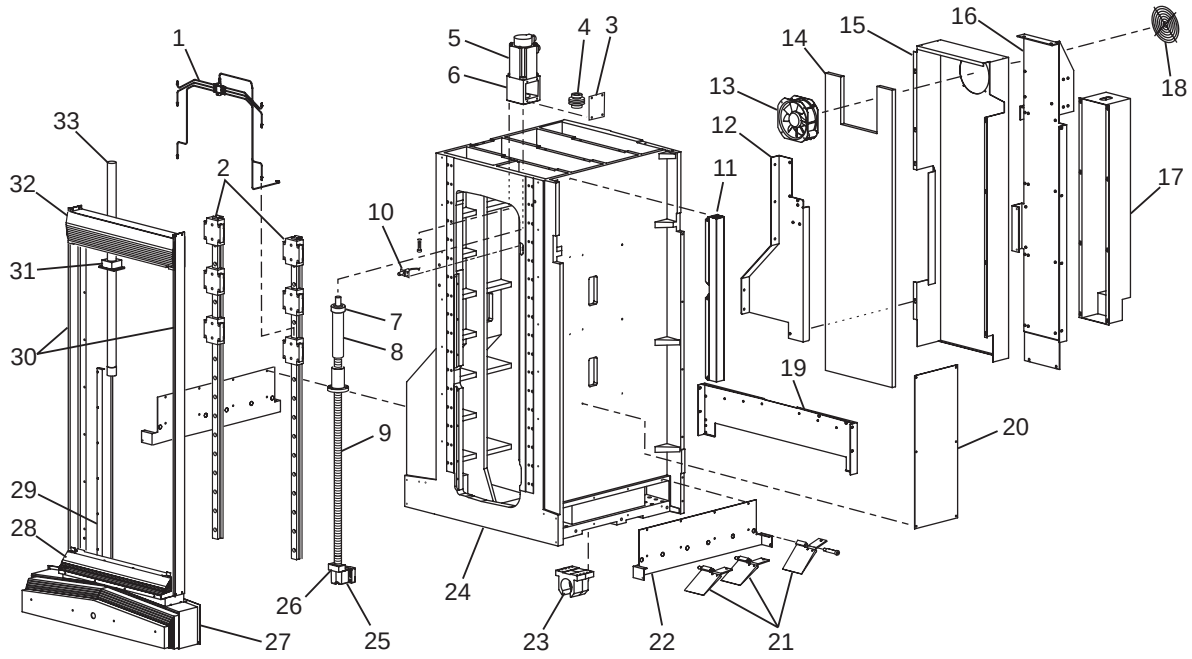
EC-630 Tool Changer Sheet Metal



EC-630 Pallet Changer Assembly

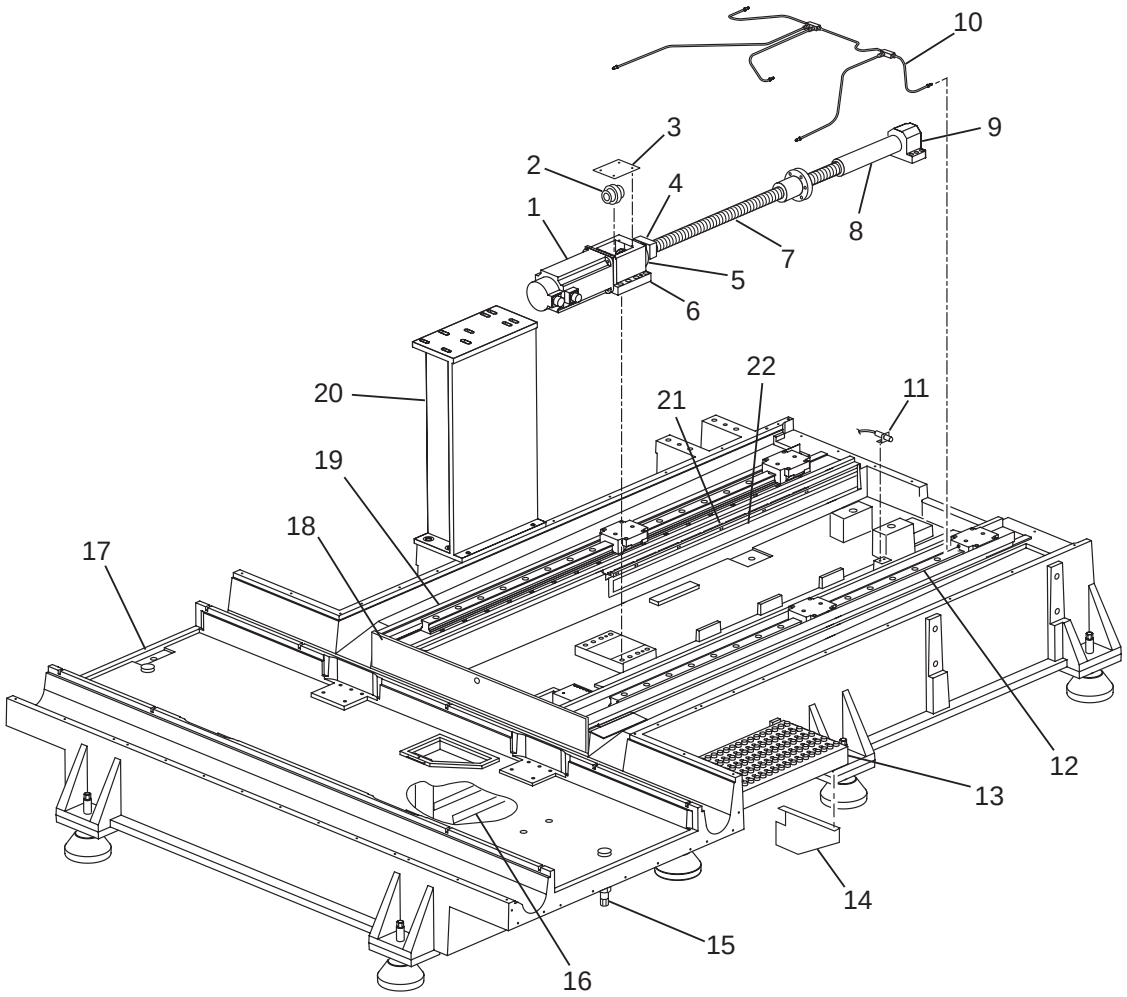


EC-1600 Column Assembly



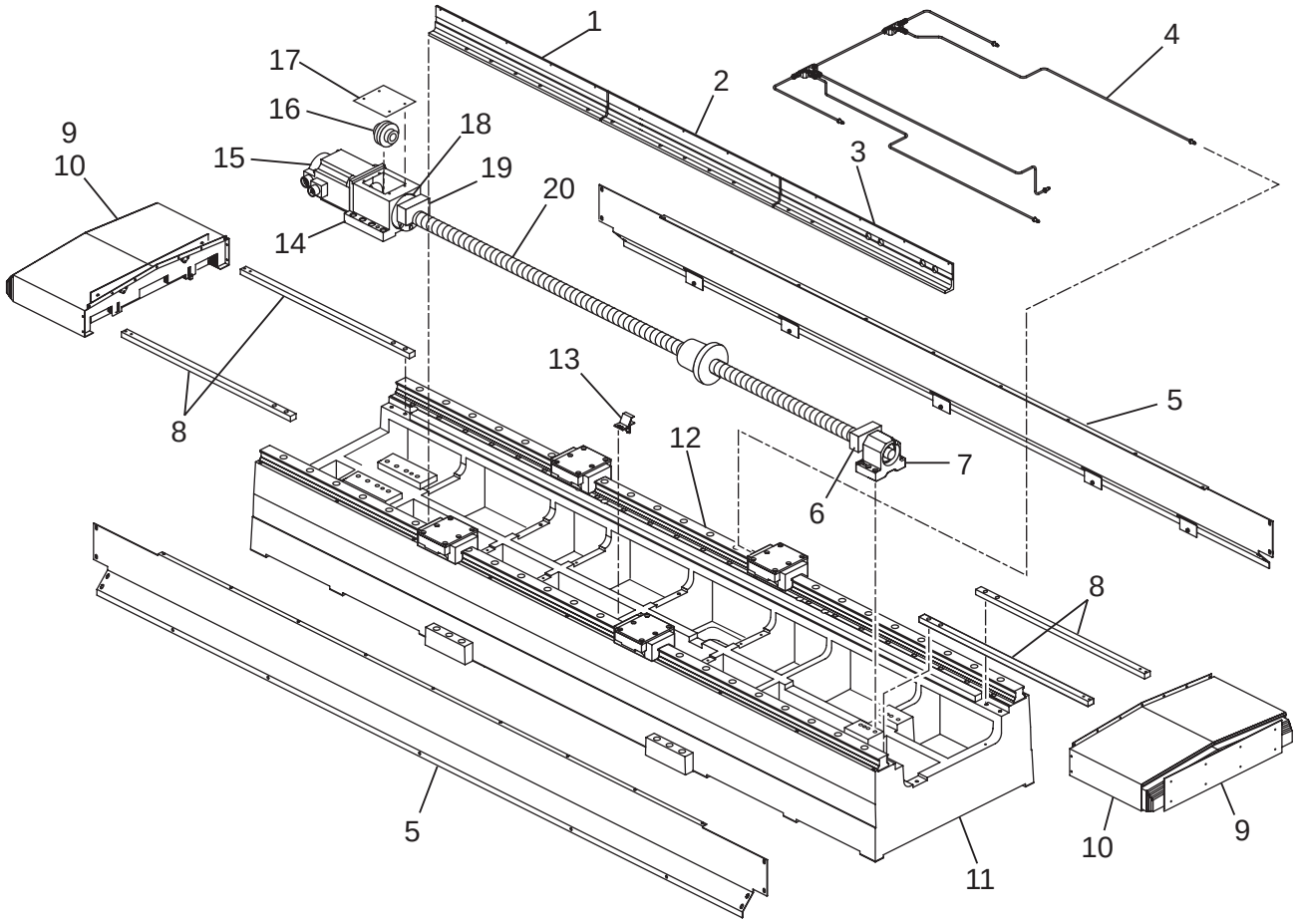
1. 30-6954 Lube Line Assy
2. 50-9010 2X Linear Guide
3. 25-9203 Motor Mount Cover
4. 30-3698 Coupling Assy
5. 62-0037B Motor
6. 20-6013 Motor Mount
7. 30-0764 Bearing Assy
   20-6253 Y-Axis Bearing Housing
   51-0093 2X Bearing
   20-9211 Housing Nut
8. 20-2677A Bumper (Motor End)
9. 24-0003B Y-Axis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

EC-1600 Base Assembly



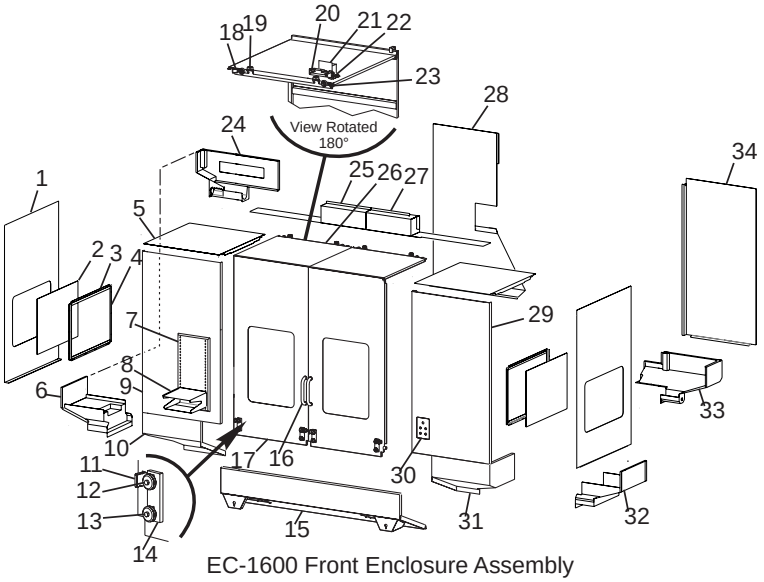
1. 62-0038 Serro Motor
2. 30-3698 Coupling Assy
3. 25-9203 Motor Mount Cover Plate
4. 28-0236 Y-Axis Motor End Bumper
5. 30-1222 Ballscrew Support Bearing Assy
6. 20-0151A Motor Mount
7. 24-9960D Y-Axis Ballscrew Assy
8. 28-0194 Lead Screw Bumper
9. 20-0152 Support Bearing Housing
   30-0472 Support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

EC-1600 Saddle Assembly

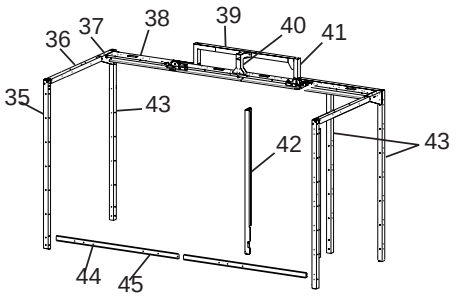


1.	20-3013	Scale Mount Section (Optional)
2.	20-3014	Scale Mount Section (Optional)
3.	20-3015	Scale Mount Section (Optional)
4.	30-7410	Lube Line Assy (EC-1600)
	30-9200	Lube Line Assy (EC-2000)
	30-0036	Oil Line Assembly X-Axis (EC-3000)
5.	25-5620	2X Saddle Cover
6.	28-0195	Bumper (Support End) (EC-1600)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

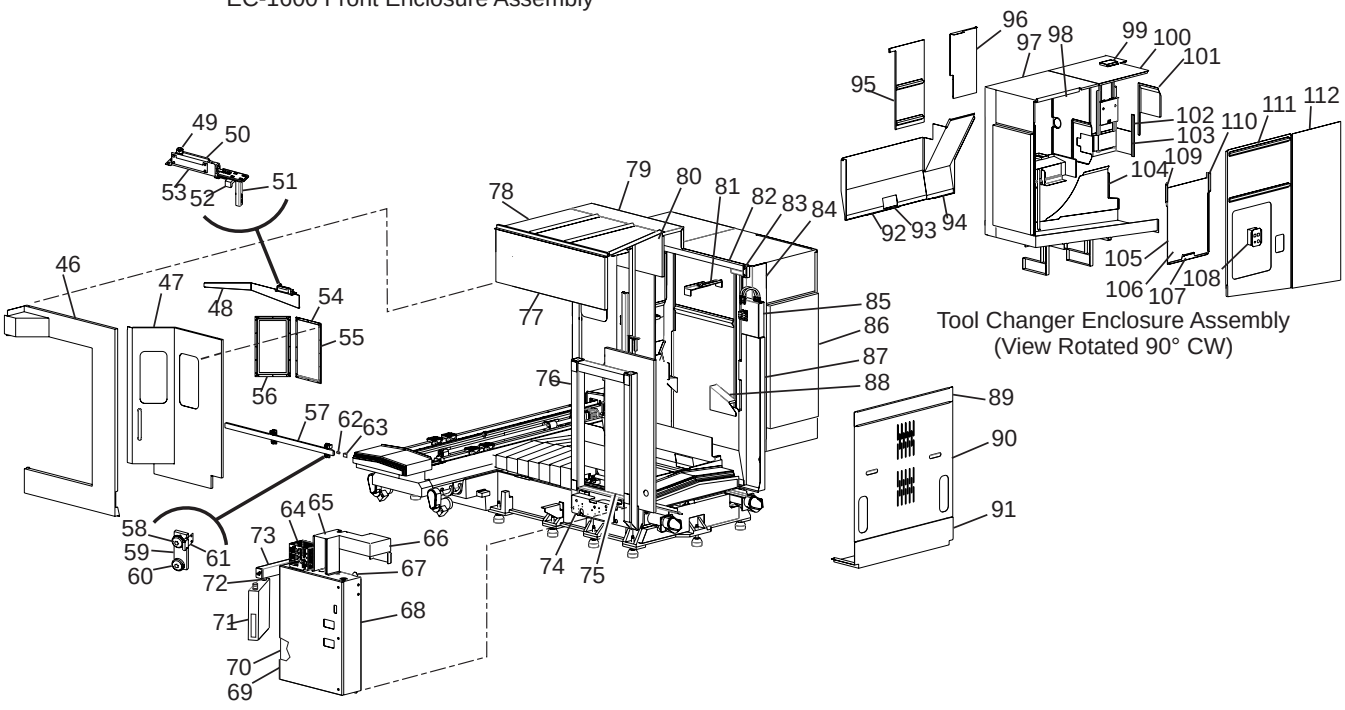
EC-1600 Enclosure Assembly



EC-1600 Front Enclosure Assembly



EC-1600 Front Enclosure Frame

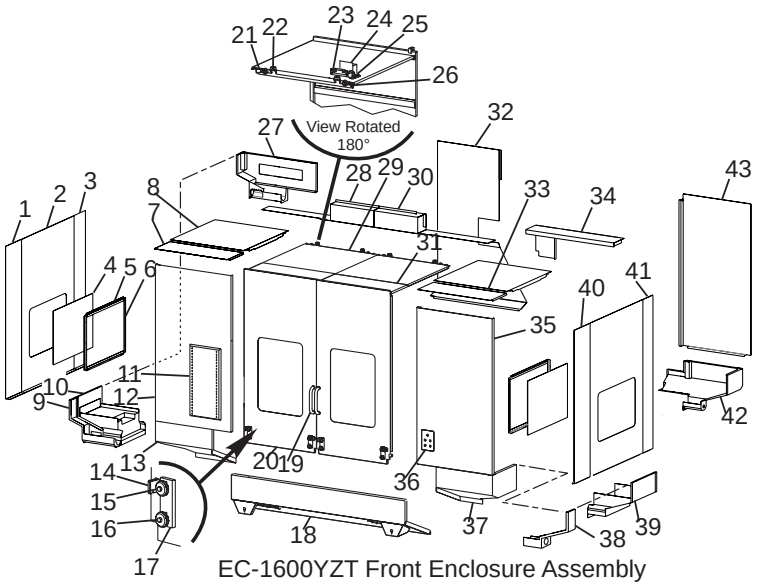


EC-1600 Right Rear Enclosure Assembly

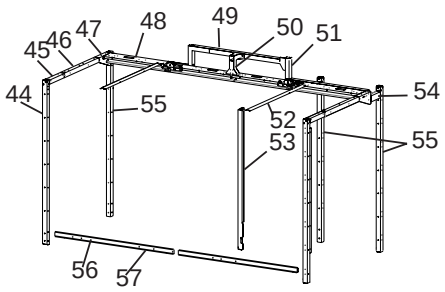
Tool Changer Enclosure Assembly
(View Rotated 90° CW)

1. 25-11950 (2X) Panel Encl Side 10/Plt
2. 28-0020 Window
3. 25-0970 (2X) Door Frame Sides
4. 25-0969 (2X) Door Frame Top/Bttm
5. 25-11975 (2X) Panel Top Front
6. 25-5609B Saddle End Cvr Lt
7. 25-6806 Rack Tool Tray
8. 25-6182E Front Writing Table
9. 25-11954 Front Lt Panel
10. 25-5612B Front Lt Saddle
11. 25-5653 (2X) Front Door V-Track Wiper Retainer
12. 54.0040 Standard Bushing Gd
13. 54-0030 (2X) Guide Wheel
43-7005 (2X) Hhb 5/16-18 X ½ In.
54-0087 Journal Eccentric
14. 20-2571 Oper Door Roller Plate
15. 25-5611B Front Middle Saddle
16. 22-8895 (3X) Chrome Door Handle
17. 25-11956 (2X) Front Door
18. 25-1804 (2X) Top Door Wiper Retainer
26-0110 (2X) Top Door Wiper Felt
19. 51-2020 (8X) R Rad Ball Bearing M17-47-14

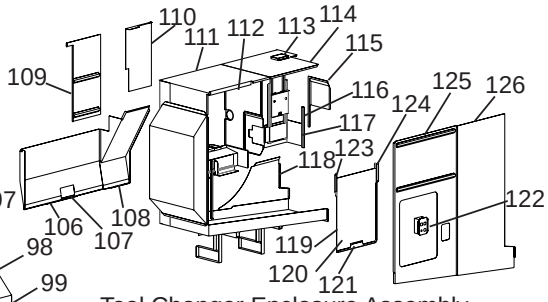
20-0260 (8X) Top Door Spacer
40-0069 (8X) Shcs ¼-20 X 1 In.
20. 25-3334 (2X) Lt Euchner Mntng Bracket
25-3335 (2X) Euchner Bracket Nut Plate
79-2048 Strn Relief .17-0 .35 In.
21. Omron D4nl_4cfa_b (2X)
25-3338 Brkt Nut Plate Omron Ec-1600
22. 25-3330 (2X) Lt Interlock Key Bracket
61-1011 (2X) Ce Interlock Switch
23. 25-1892 (2X) Opp Top Door Wiper Retainer
24. 25-5613B Lt Back Saddle
25. 25-11967A Top Rt Encl Cover
26. 25-1803 (2X) Front Door Roof
27. 25-11969A Top Lt Encl Cover
28. 25-1751 Lt Rear Encl Panel For Tc Door
29. 25-11953 Rt Front Panel
30. 25-1257A Front Panel Switch Box
25-1258A Switch Box Cover
25-9325 Aux Panel Cable Cover\
31. 25-5610A Rt Front Saddle
32. 25-5638 Rt Saddle End Cover
33. 25-5608A Rt Back Saddle
34. 25-11947 Rt Rear Encl Panel
35. 25-11966 (2X) Encl Main Post
36. 25-11968 (2X) Encl Top Cross Post
37. 25-1802 (2X) Encl Frame Knuckle
38. 25-1801A (2X) Front Door Encl Header
39. 25-11962 Lt Top Encl Post
40. 25-11958 Top Middle Brace
41. 25-11963 Rt Top Encl Post
42. 25-11973 Aux Panel Cable Channel
43. 25-11965 (3X) Encl Main Post
44. 25-2573A (2X) Front Rail
45. 25-2574 (4X) Front Panel Rt End
46. 25-9318B Rt Rear Panel
47. 25-9330A Oper Door
48. 25-9322A Oper Door Shield
49. 79-2048 Strn Relief .17-0.35 In.Id
50. 61-1015 Ce Interlock Straight Key 7Mm Ot
61-1017 Ce Interlock Switch With Spacer B
51. 25-9320A Oper Door Mtg Key
52. 20-0712A Door Guide Block
53. 25-3421 Euchner Oper Mntng Bracket
25-3335 Euchner Bracket Nut Plate
54. 25-4149 (3X) Smtc Window Z-Frame
55. 25-1262 (4X) Partition Top Z-Frame
56. 57-0371 Door Window Gasket
57. 20-2570 Oper Door V-Track Plate
20-2572 Oper Door V-Track
58. 54-0040 (2X) Standard Bushing Gd
59. 25-2571 (2X) Parts Catcher Lwr Door Liner
60. 54-0030 (4X) Tc Carriage Guide Wheel
43-7005 (4X) Hhb 5/16-18 X ½ In.
61. 25-5645 (2X) V-Track Wiper Retainer
62. 59-0214 Bumper 5/8 Od X 5/8 In. Ht
63. 25-5606 Oper Door Bumper Bracket
64. 25-4311A Front Regen Cover
65. 25-1759A Top J-Box Cover
66. 25-1761A J-Box Control
67. 25-10642 Top Control Box Panel
68. 25-3365 Control Box Rt Panel
69. 25-10645A Control Box Door, Vector Drive
70. 25-10641B Control Box Lt Panel
71. Control Pendant Assembly
72. 20-7109C Arm Mnt Swivel
20-7110C Control Mnt Swivel
73. 20-2556A Pendant Arm
59-0982A Control Isolator With Bonded Washer
74. 25-7195M Lube Mntng Bracket
75. 25. 1755 Rt Rear Side Encl Panel
76. 20-2551B Mach Control Mnt
77. 25-1758 Oper Door Upper Panel
78. 25-1748A Column Top Roof Access Panel
79. 25-1752 Tc Door Lt Top Rear Panel
80. 25-7147B Cambox Top Shroud
81. 25-1436 Smtc Shipping Bracket
82. 25-7127 Smtc Support Shroud
83. 25-1779 Rear Top Lt Frame Support
84. 25-1774 Lt Middle Rear Vertical Support Panel
85. 25-1527A Coolant Hose Mnt
86. 25-7146 Back Panel Shroud
87. 25-1773 Lt Rear Panel To Base
88. 25-3488 Smtc 30 Tc Cables Support Bracket
89. 25-5588A Rear Upper Access Encl Panel
90. 25-5587B Rear Middle Encl Panel
91. 25-1768A Extended Rear Base For Z-Waycover
92. 25-7144A Rt Front Shroud For Tc Door
93. 25-7689 Chip Scrpr Access Cover
94. 25-1753 Tc Lt Side Front Encl Panel
95. 25-7163 Rt Smtc Cambox Shroud
96. 25-8414 Fixed Side Tc Panel For Tc Door
97. 25-7124 To Rear Shroud
98. 25-11988 Tc Front Cambox Shroud
99. 25-1674A Jct Worklight Cover
100. 25-1749A Top Front Tc Door Shroud
101. 25-8415 Fixed Front Tc Panel For Tc Door
102. 25-0818 Top-Bottom Door Frame
103. 25-8946 Tc Door
104. 25-7165A Inside Front Shroud For Tc Door
105. 25-0036 (2X) X-Axis Guide Bar
106. 28-7472B Side Window
107. 25-9248A Window Plate Handle
108. 25-6718A Smtc Switch Box
25-6719 Smtc Switch Box Cover
109. 25-4220C Side Window Rest
110. 25-4221C Opposite Side Window Rest
111. 25-7119 Smtc Lt Rear Shroud
112. 25-7114 Smtc Lt Front Shroud



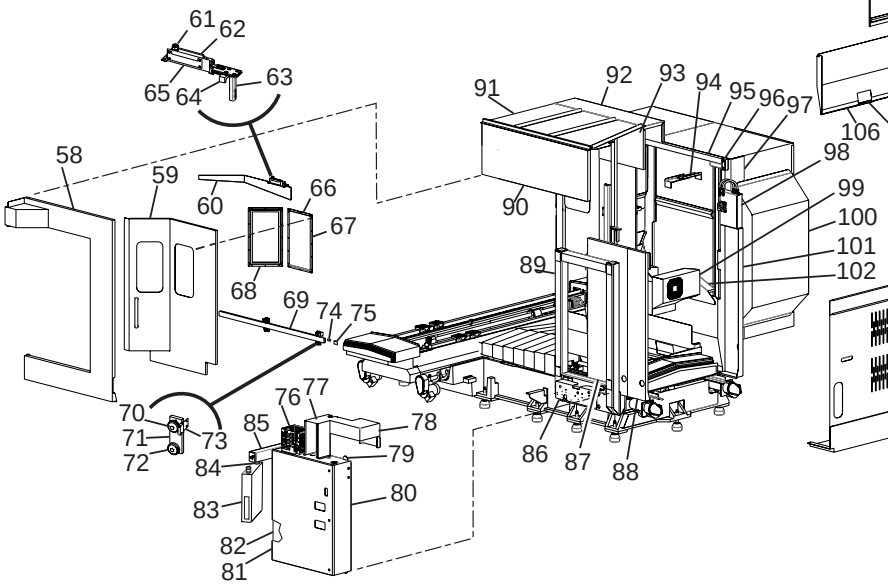
EC-1600YZT Front Enclosure Assembly



EC-1600YZT Front Enclosure Frame



Tool Changer Enclosure Assembly
(View Rotated 90° CW)

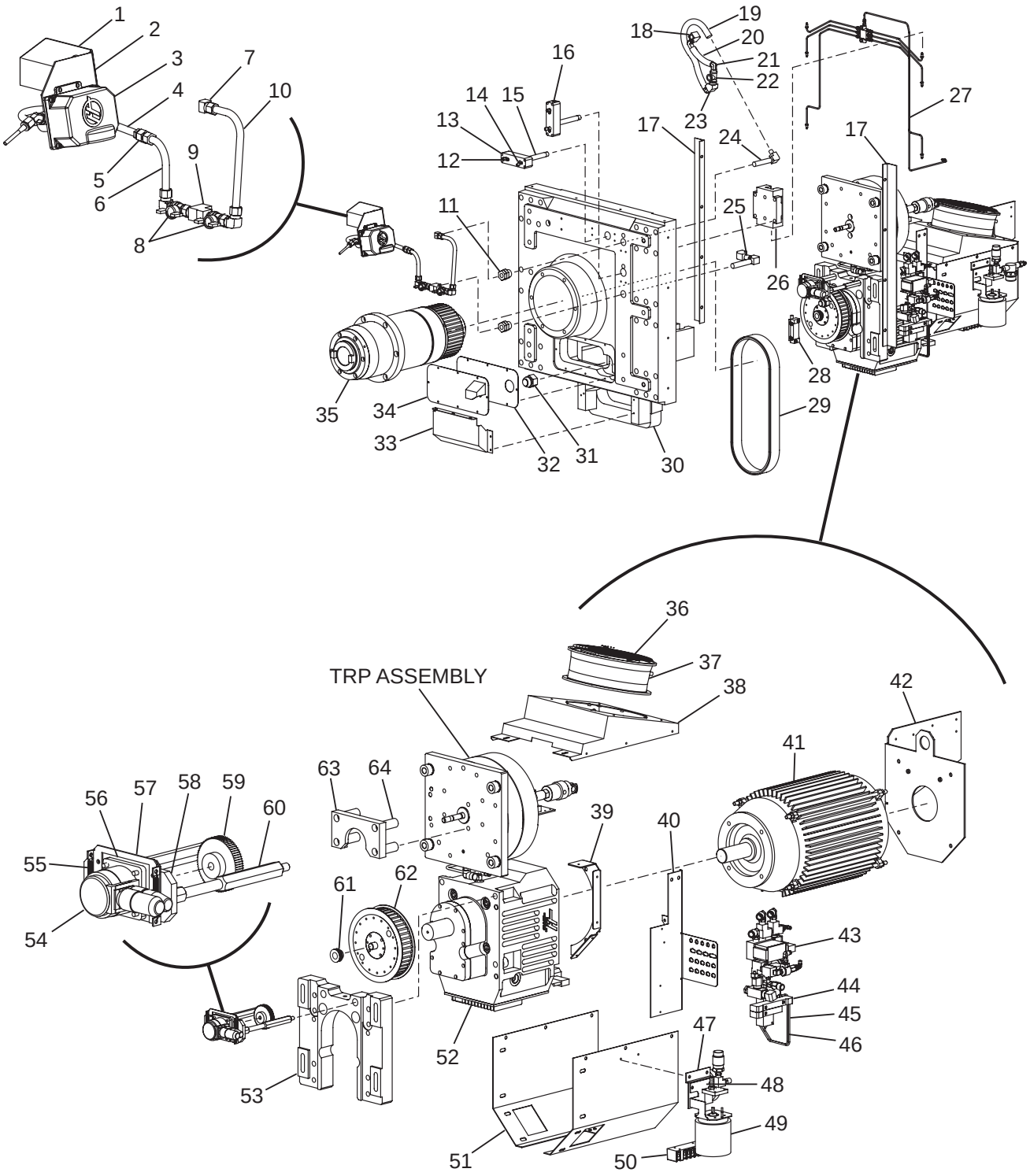


EC-1600YZT Right Rear Enclosure Assembly

1. 25-11952 Lt Side Panel Extension
2. 25-11950 (2X) Encl Side Panel
3. 25-11972 Lt Mid Filler Panel
4. 28-0020 Door Window
5. 25-0970 (2X) Door Frame Sides
6. 25-0969 (2X) Top-Bottom Door Frame
7. 25-11981 Front Lt Roof Extension
8. 25-11975 (2X) Top Front Panel
9. 25-9197 Lt Front Saddle
10. 25-5609B Lt Saddle End Cover
11. 25-6806 Tool Tray Rack
12. 25-11954 Lt Front Panel
13. 25-9216 Lt Front Saddle Extension
14. 25-5653 (2X) Front V-Track Wiper Retainer
15. 54-0040 Standard Bushing Gd
16. 54-0030 (2X) Tc Carriage Guide Wheel
    43-7005 (2X) Hhb 5/16-18 X ½ In.
    54-0087 Journal Eccentric Bishop-Wise #Mj
17. 20-2571 Oper Door Roller Plate
18. 25-9214B Front Mid Saddle
19. 22-8895 (3X) Chrome Door Handle.
20. 25-11956 (2X) Front Door
21. 25-1804 (2X) Top Door Wiper Retainer
    26-0110 (2X) Top Door Wiper Felt
22. 51-2020 (8X) R Rad Ball Bearing M17-47-14
    20-0260 (8X) Top Door Spacer
    40-0069 (8X) Shcs ¼-20 X 1 In.
23. 25-3334 (2X) Lt Euchner Mntng Bracket
    25-3335 (2X) Euchner Nut Plate Bracket
    79-2048 (2X) Strn Relief .17-0 .35 In. Id
24. Omron D4nl_4cfa_b (2X)
    25-3338 Omron Nut Plate Bracket
25. 25-3330 (2X) Lt Interlock Key Bracket
    61-1011 (2X) Ce Interlock Switch With Locking Key
26. 25-1892 (2X) Top Door Wiper Retainer

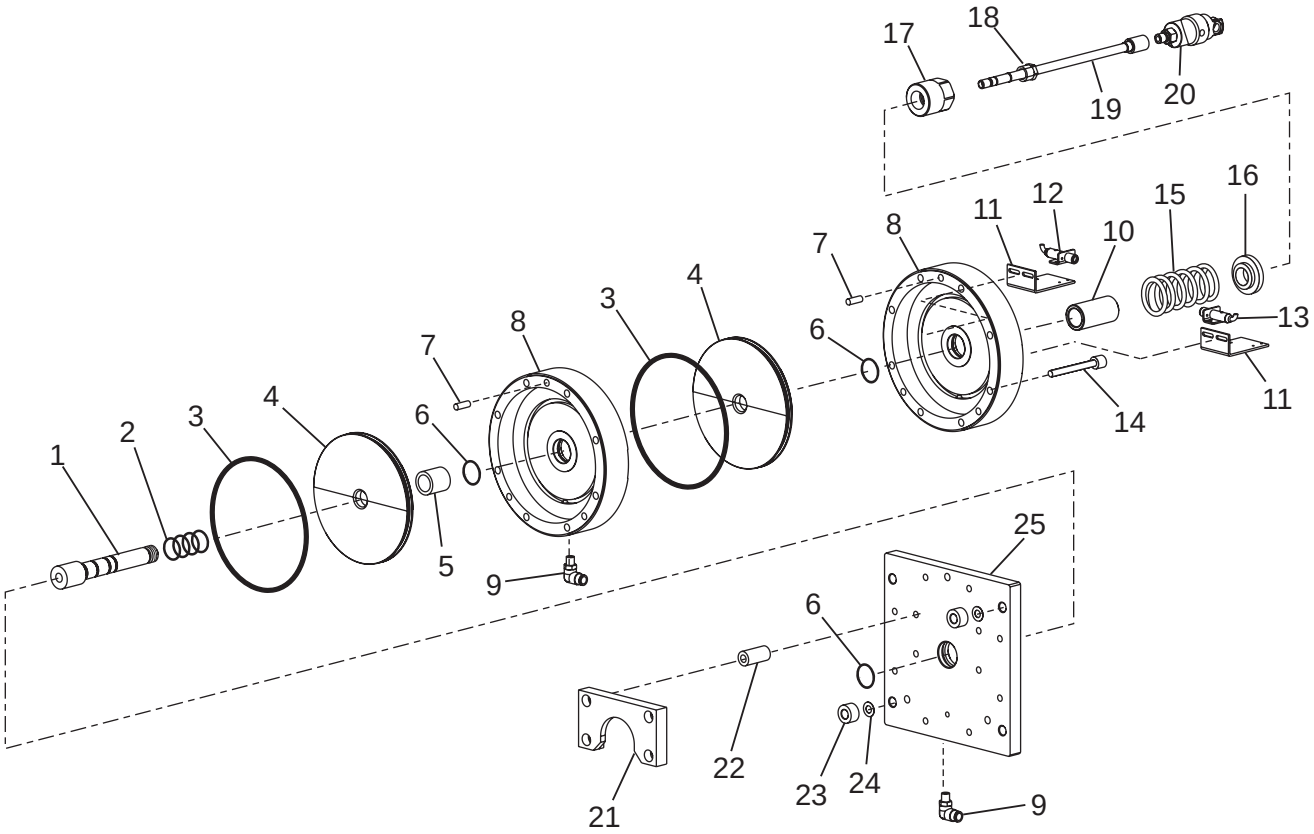
27. 25-9199 Lt Back Saddle
28. 25-11967A Top Rt Encl Cover
29. 25-1803 (2X) Front Door Roof
30. 25-11969A Top Lt Encl Cover
31. 25-11957 (2X) Door Top Extension
32. 25-11979 Lt Rear Panel For Tc Door
33. 25-11980 Rt Front Roof Extension
34. 25-11971 Rt Mid Roof Extension
35. 25-11953 Rt Front Panel
36. 25-1257A Front Panel Switch Box
    25-1258A Switch Box Cover
    25-9325 Aux Panel Cable Cover
37. 25-9215 Rt Front Saddle Extension
38. 25-9198 Rt Front Saddle
39. 25-5638 Rt Saddle End Cover
40. 25-11951 Rt Side Panel Extension
41. 25-11946 Rt Side Mid Panel Extension
42. 25-11978 Rt Back Saddle
43. 25-11947 Rt Rear Encl Panel
44. 25-11966 (2X) Encl Main Post
45. 25-9222 (2X) Top Cross Post Extension
46. 25-9268 (2X) Changed To 22-9268-Vce 750 Door Switch Rail
47. 25-1802 (2X) Encl Frame Knuckle
48. 25-1801A (2X) Encl Front Door Header
49. 25-11962 Encl Top Lt Post
50. 25-11958 Top Mid Brace
51. 25-11963 Encl Top Rt Post
52. 25-11984 (2X) Front Roof Stiffener
53. 25-11973 Aux Panel Cable Channel
54. 25-9252 (2X) Rt Back Top Post Extension
55. 25-11965 (3X) Encl Main Post
56. 25-2573A (2X) Front Rail
57. 20-2574 (4X) Encl Front Door V-Rail
58. 25-9318B Rt Rear Panel
59. 25-9330 Oper Door
60. 25-9322A Oper Door Shield
61. 79-2048 Strn Relief .17-0 .35 In. Id
62. 61-1015 Ce Interlock Straight Key 7Mm Ot
    61-1017 Ce Interlock Switch With Spacer B
63. 25-9320A Oper Door Mtg Key
64. 20-0712A Door Guide Block
65. 25-3421 Oper Euchner Mntng Bracket
    25-3335 Euchner Nut Plate Bracket
66. 25-4149 (3X) Smtc Window Z-Frame
67. 25-1262 (4X) Partition Top Z-Frame
68. 57-0371 Door Window Gasket
69. 20-2570 Oper Door V-Track Plate
    20-2572 Oper Door V-Track
70. 54-0040 (2X) Standard Bushing Gd
71. 25-2571 (2X) Parts Catcher Lwr Door Liner
72. 54-0030 (4X) Tc Carriage Guide Wheel
    43-7005 (4X) Hhb 5/16-18 X ½ In.
73. 25-5645 (2X) V-Track Wiper Retainer
74. 59-0214 Bumper 5/8 Od X 5/8 In. Ht
75. 25-5606 Oper Door Bumper Bracket
76. 25-4311A Front Regen Cover
77. 25-1759A Top J-Box Cover
78. 25-1761A J-Box Control
79. 25-10642 Top Control Box Panel
80. 25-3365 Control Box Rt Panel
81. 25-10645A Control Box Door, Vector Drive
82. 25-10641B Control Box Lt Panel
83. Control Pendant Assembly
84. 20-7109C Arm Mnt Swivel
    20-7110C Control Mnt Swivel
85. 20-2556A Pendant Arm
    59-0982A Control Isolator With Bonded Washer
86. 25-7195M Lube Mntng Bracket
87. 25-9273 Rt Back Panel
88. 25-9274 Rear Panel Shroud
89. 20-2551B Mach Control Mnt
90. 25-11982 Oper Door Upper Panel
91. 25-11986 Column Top Roof Access Panel
92. 25-11976 Tc Door Lt Top Rear Panel
93. 25-9303 Cam Box Top Shroud
94. 25-1436 Smtc Shipping Bracket
95. 25-7127 Smtc Support Shroud
96. 25-9323 Rear Top Lt Frame Support
97. 25-1774 Lt Mid Rear Vertical Support Panel
98. 25-1527A Coolant Hose Mnt
99. 25-12010 Fan Housing
100. 25-9305 Back Panel Shroud
101. 25-9275 Lt Back Filler Panel
102. 25-3488 Smtc 30 Tc Cables Support Bracket
103. 25-5588A Encl Rear Upper Access Panel
104. 25-5587B Encl Rear Mid Panel
105. 25-9271B Encl Rear Lwr Panel
106. 25-9292 Tc Door Rt Front Shroud
107. 25-7689 Chip Scrpr Access Cover
108. 25-11990 Front Lt Side Panel
109. 25-7163 Rt Smtc Cam Box Shroud
110. 25-8414 Fixed Side Tc Panel For Tc Door
111. 25-9306 Top Rear Shroud
112. 25-11988 Tc Front Cam Box Shroud
113. 25-1674A Jct Worklight Cover
114. 25-11960A Tc Front Lt Roof
115. 25-8415 Fixed Front Tc Panel For Tc Door
116. 25-0818 Top-Bottom Door Frame
117. 25-8946 Tc Door
118. 25-9297 Tc Door Inside Front Shroud
119. 25-0036 (2X) X-Axis Guide Bar
120. 28-7472B Side Window
121. 25-9248A Window Plate Handle
122. 25-6718A Smtc Switch Box
    25-6719 Smtc Switch Box Cover
123. 25-4221C Opposite Side Window Rest
124. 25-422Oc Side Window Rest
125. 25-9315 Lt Rear Shroud
126. 25-11983 Lt Front Shroud

EC-1600 Spindle Assembly



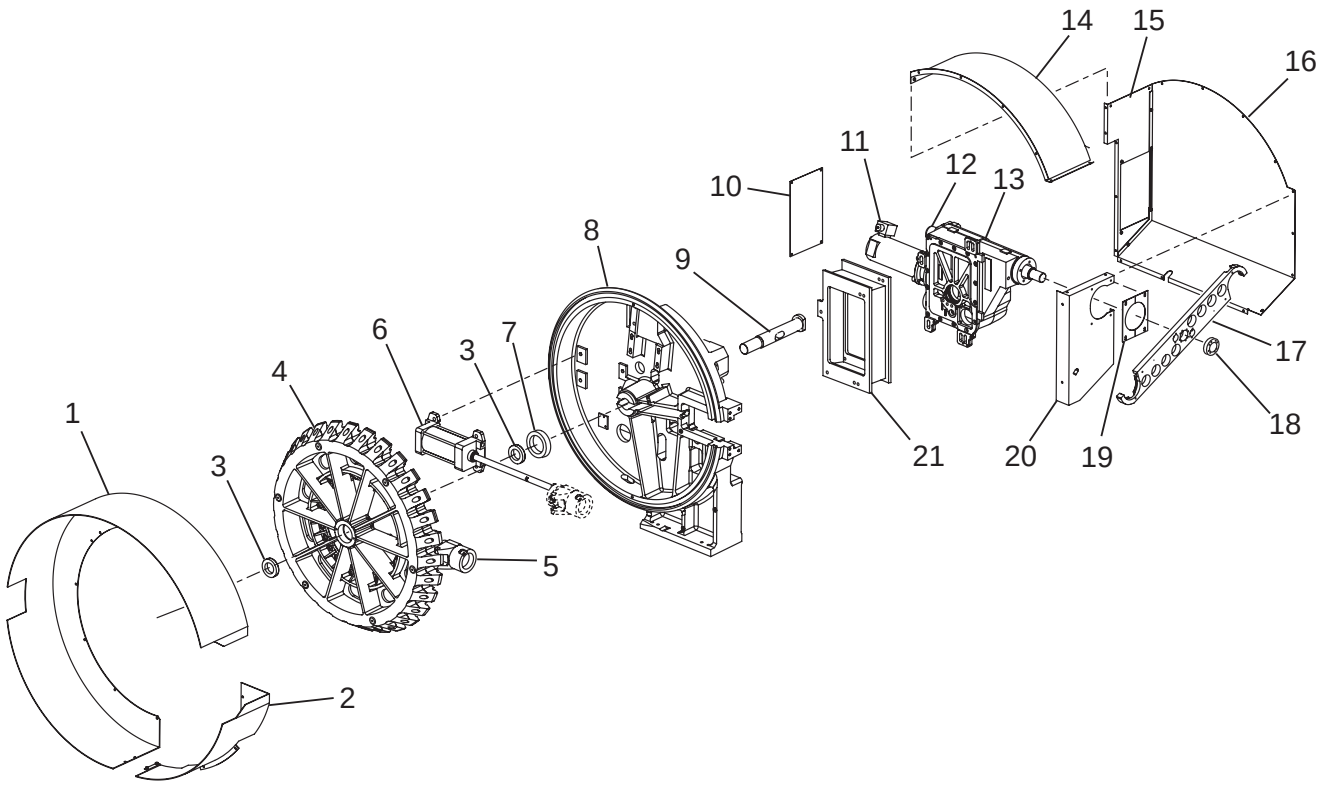
1. 25-8470 Cable Cover
2. 25-7859 PCool Bracket
3. PCOOL-E16 PCool Assy
   14-2149 PCool Cover
4. 52-0026A Straight Swivel Hose
5. 58-3049 Straight Fitting .50 x .375-F NPT
6. 58-0789A Tube
7. 58-3052 3X 90 Degree Elbow .50 x .375-M NPT
8. 58-0326 2X Ball Valve .375 NPT
9. 58-3003 Tee .375-M x .375-M x .375-F
   58-3601 Close Nipple .375 NPT
10. 58-0788 Manifold Tube
11. 58-1679 2X Bulkhead Fitting .375 NPT x 1.000 Dia.
12. 22-8739 2X Coolant Nozzle 45 Degree
13. 20-6097A 2X Coolant Manifold
    22-8749 4X Nozzle Clamp Bushing
    57-0026 4X O-Ring 2-109
14. 22-8730 2X Coolant Nozzle
15. 58-0790 2X Nipple .375 NPT x 5.00
16. 58-3105 2X Pipe plug .25-M NPT
17. 25-5566 2X Y-Axis Chip Guard
18. 58-3062 4X Elbow 90 Degree .375-F x .375-F NPT
19. 58-2050 Hose 1
20. 58-2050 Hose 2
21. 58-2060 3X Hose Barb Fitting .50 x .375-M NPT
22. 58-1725 Tee .375-F x .375-F x .375-F NPT
23. 58-1721 Elbow 45 Degree .375-F x .375-M NPT
24. 58-1723 2X Nipple .375 NPT x 4.00
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
41. 62-4025 Spindle Motor 20HP
42. 25-5650A Motor Backing Plate
43. 30-7280 Solenoid Valve Assy
44. 32-0083 Air Valve Solenoid Assy
45. 58-0499 Low Gear Air Line
46. 58-0498 High Gear Air Line
47. 25-5648 Oil Pump Assy Bracket
48. 25-6843 Oil Pump Bracket (25-6844)
49. 30-3260C Oil Gear Pump Assy
50. 73-3055 Terminal Block 6 Pole
51. 25-5647A Spindle Motor Shroud
52. 20-1824C Gearbox 7500_50T
    20-1705 Oil Pan
53. 20-2549 Transmission Plate
54. 30-30390 Encoder Assy
    30-9572A Encoder & Pulley Assy
55. 59-0742 2X Spring .290D x 1.5L
56. 25-6299A Encoder Spring Mount
57. 25-6298 Encoder Spring Mount Clamp
58. 20-2997 Encoder Spring Mount Plate
59. 20-0179 Timing Pulley .375 Bore
60. 20-2965B 2X Encoder Standoff
61. 20-4518 Encoder Drive Pulley
62. 20-1455A Pulley 45 Tooth
    20-0025 2X Pulley Flange
    20-1454 Encoder Pulley Mount
63. 20-0015 Spindle Fork Lift
64. 22-0013A 4X Spindle Fork Spacer

EC-1600 Tool Release Piston



1. 20-0018A Air Cylinder Shaft
2. 57-0027 4X O-Ring 2-121
3. 57-0082 2X O-Ring 2-448
4. 20-0019A 2X Air Cylinder Piston
5. 20-0020A Lower Air Cylinder Spacer
6. 57-0095 3X O-Ring 2-327
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
21. 20-0015 Spindle Fork Lift
22. 22-0013A 4X Spindle Fork Spacer
23. 22-0014 4X Spacer
24. 45-0014 Washer .010 in.
    45-0015 Washer .018 in.
25. 20-0017A Sub Plate

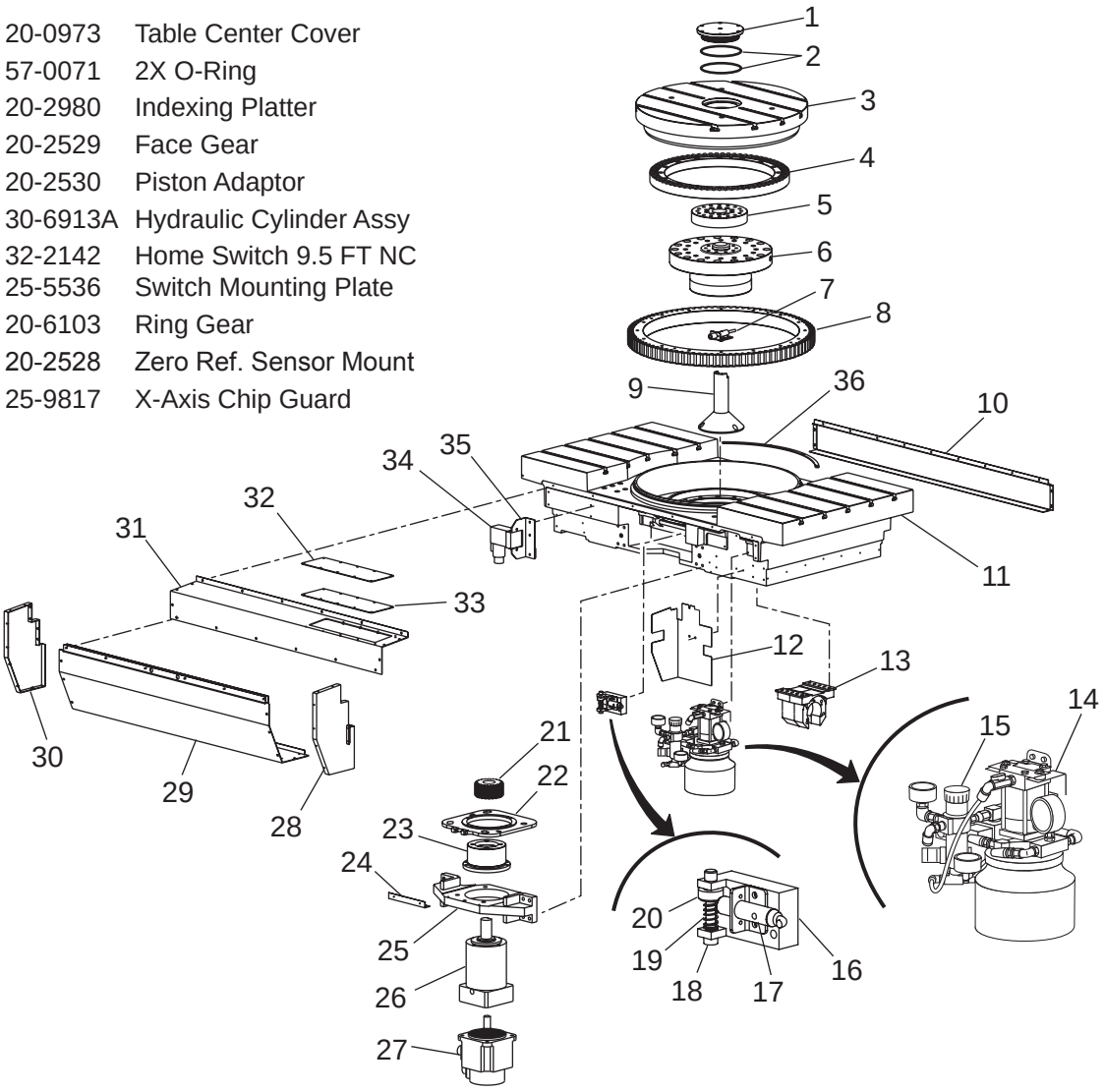
EC-1600 SMTC50/30 Pocket



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

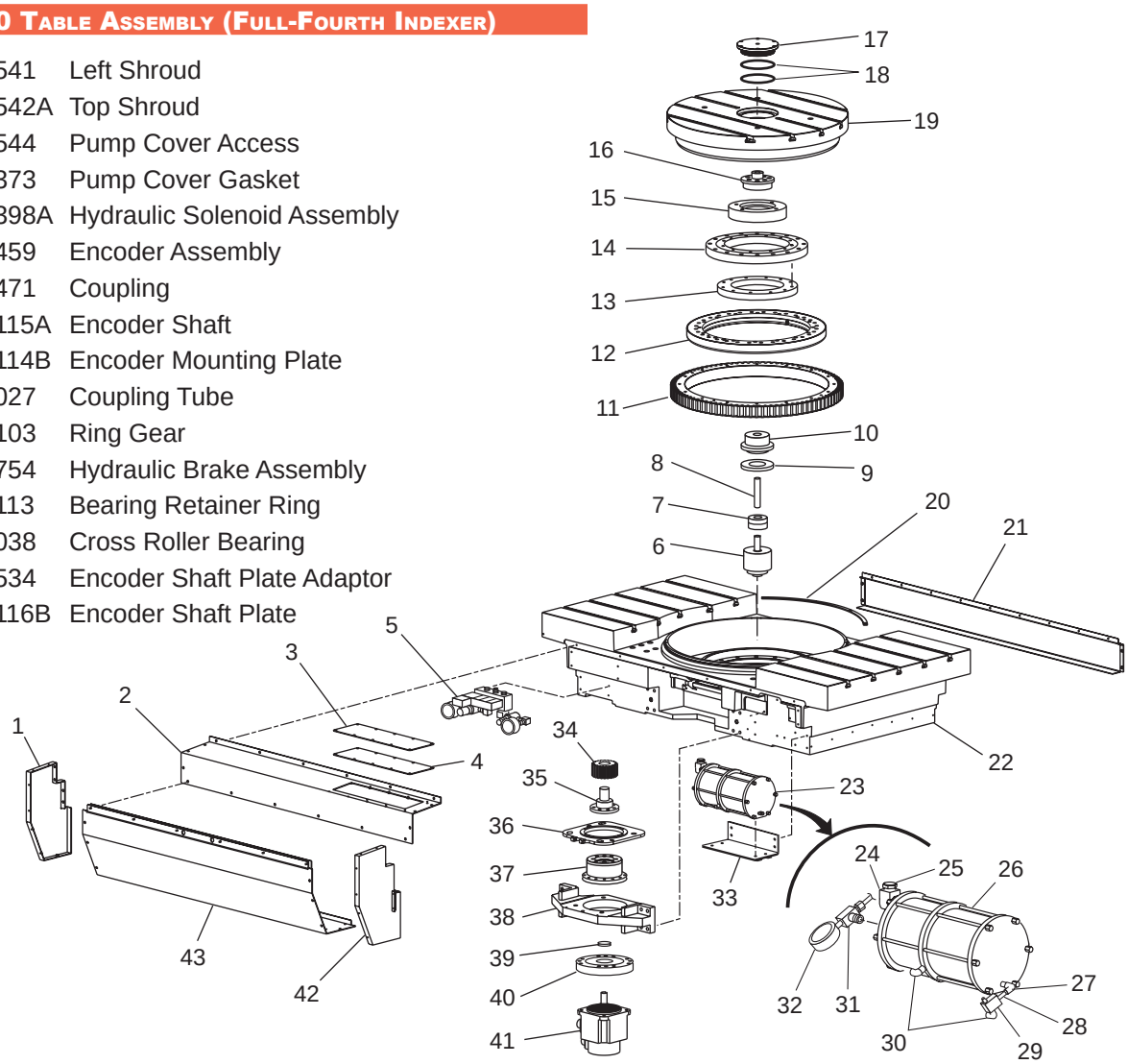
EC-1600 5-Degree Table Assembly

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



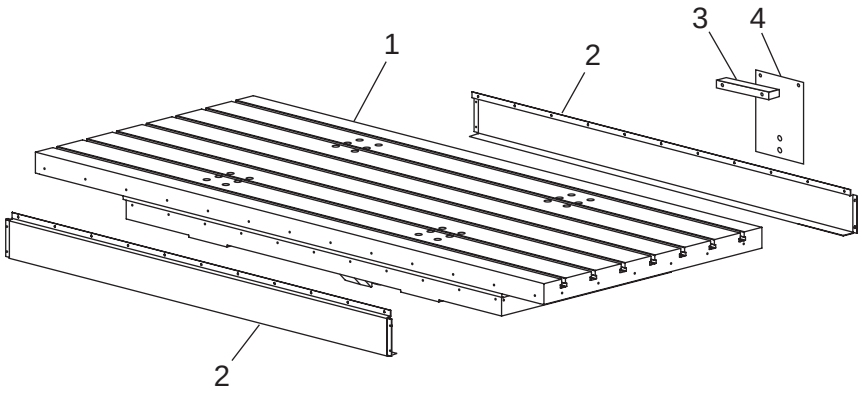
11. 20-2508B Indexing Table
12. 25-5545 Pump Sound Wall
13. 20-0150 Ballnut Housing
    20-2979 2X Shim .220
14. 30-7510 Haskel Pump Assy
15. 30-7511 Air regulator Assy
16. 20-2532 Switch Bracket
17. 32-2130 Home Switch 1.5 FT NC
18. 49-1019 Shoulder Screw
19. 59-0763 Spring Compression
20. 20-2533B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

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

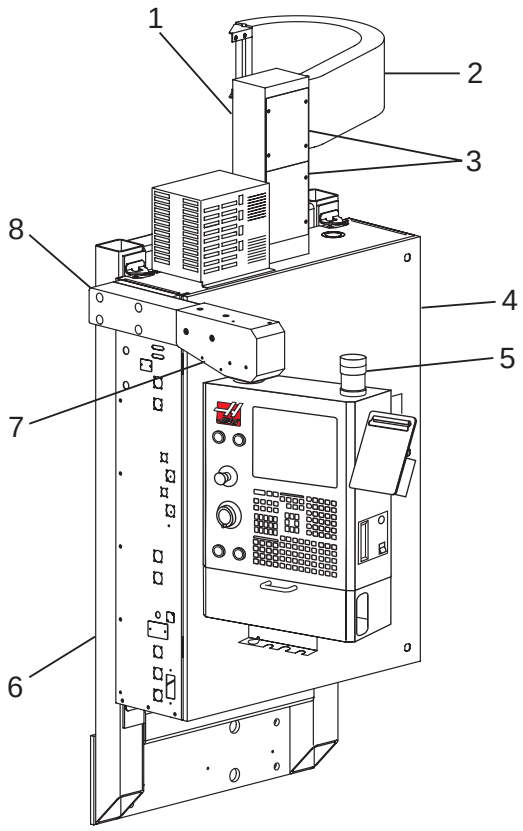
EC-1600 3-Axis Table



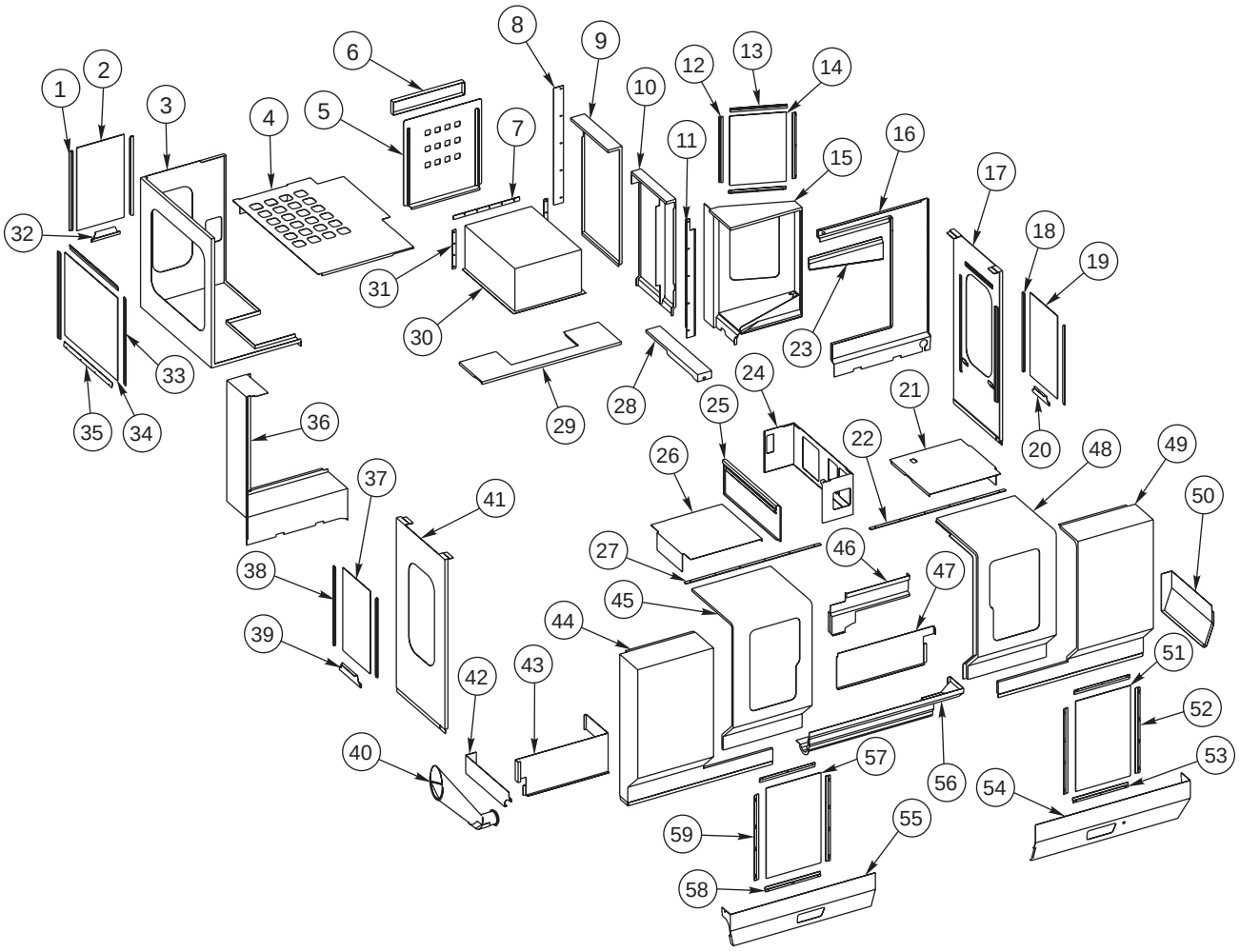
1. 20-2414 Table Machined (EC-1600)
   20-3175 Table Machined (EC-2000)
   20-3369A Table Machined (EC-3000)
2. 25-9817 2X X-Axis Chip Guard (EC-1600)
   25-9980 2X X-Axis Chip Guard (EC-2000)
   25-0032 2X X-Axis Chip Guard (EC-2000)
3. 20-2985A Ship Bracket Stand-Off Block
4. 20-2575 X-Axis Ship Bracket

EC-1600 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
   25-6659A Mounting Plate Swivel
8. 20-2556 Pendant Arm



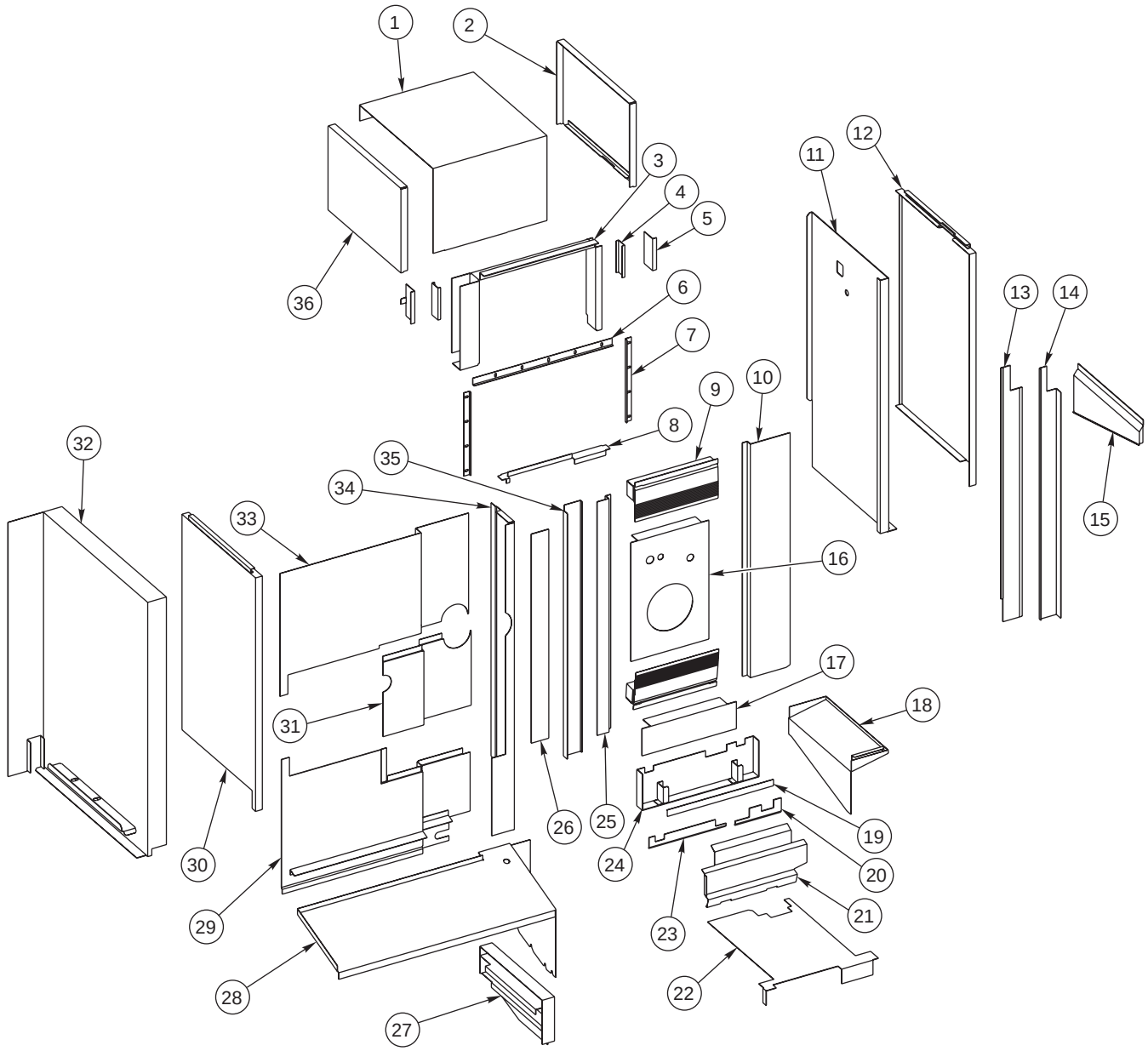
ES-5 External Sheet Metal



ES-5 External Sheet Metal Parts List

1.	28-0036	Side Window Extrusion (x2)
2.	28-0014	Window Door
3.	25-9633A	T/C Rear Panel
4.	25-9637A	T/C Panel Top
5.	25-9711	Access Cover Rear Panels
6.	25-9684	Rear Top Panel Center
7.	26-0259	Felt Column Top
8.	26-10000	Felt T/C Column Side
9.	25-9685	Intermediate Panel Operator Side
10.	25-9636A	Operator Door Rear
11.	26-0257	Felt Column Operator Side
12.	25-0668	Window Retainer Side (x2)
13.	25-0669	Window Reatiner Top/Bottom (x2)
14.	28-0046	Window Top Cover
15.	25-9700C	Operator Door Front
16.	25-9672A	Front Panel Rear Operator
17.	25-9657	Side Panel Right Front
18.	28-0036	Side Window Extrusion (x2)
19.	28-0014	Window Door
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
41.	25-9662	Side Panel Left Front
42.	25-0705	Side Apron Left Front
43.	25-9710A	Tray Cover Left Front Panel
44.	25-9656	Front Panel Left
45.	25-9670A	Front Door Left
46.	25-9718A	Chip Shield Front Lower Operator Door
47.	25-9708A	Tray Cover Right Front Panel
48.	25-9669A	Front Door Right
49.	25-9655	Front Panel Right
50.	25-9704A	Side Apron Right Front
51.	28-0015	Window Door
52.	25-0819	Door Frame Sides (x2)
53.	25-0818	Door Frame Top/Bottom (x2)
54.	25-9727	Apron Front Right
55.	25-9608	Apron Front Left
56.	25-0615	Front Trough Right
57.	28-0015	Window Door
58.	25-0818	Door Frame Top/Bottom (x2)
59.	25-0819	Door Frame Sides (x2)

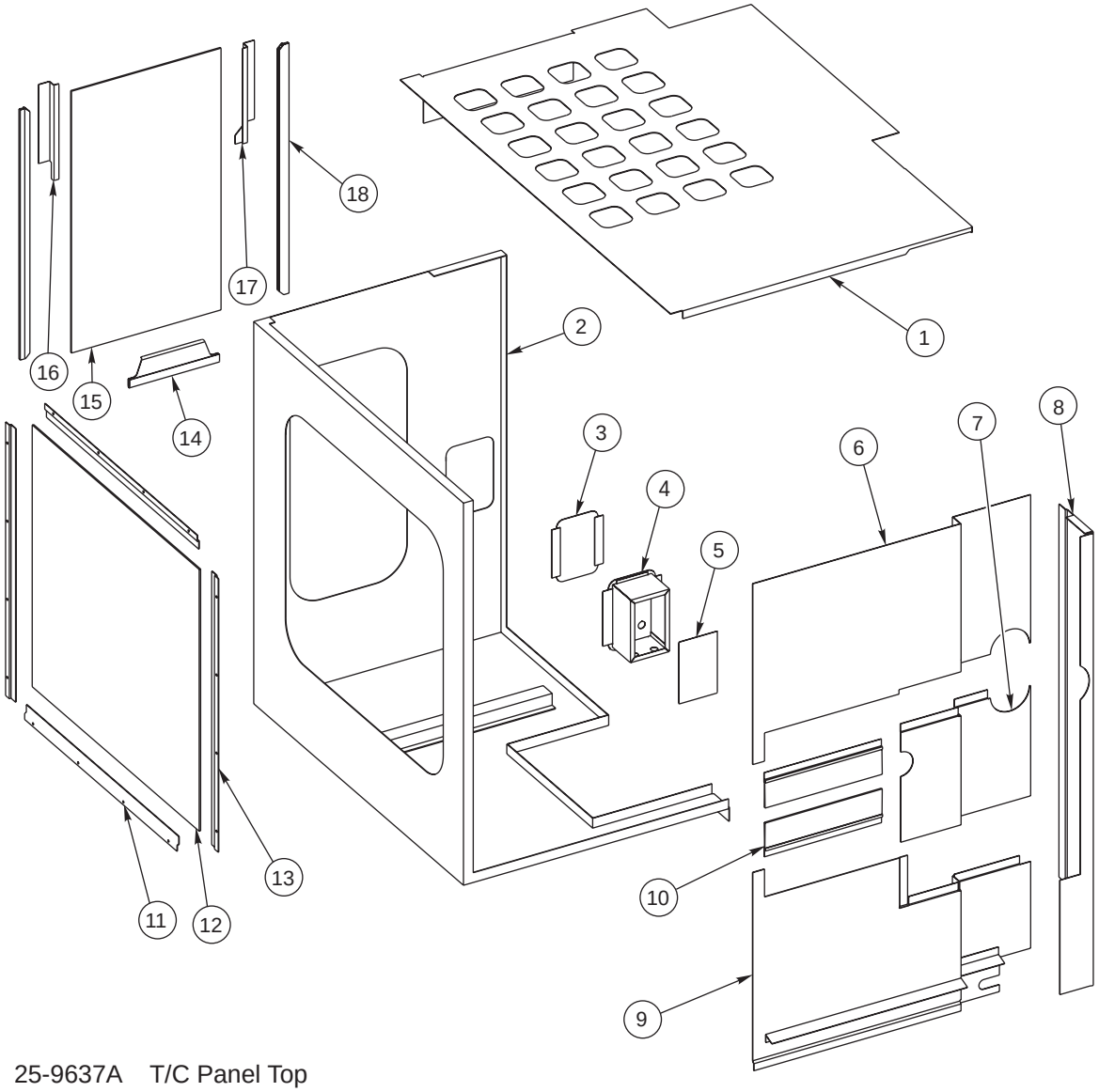
ES-5 Internal Sheet Metal



ES-5 Internal Sheet Metal Parts List

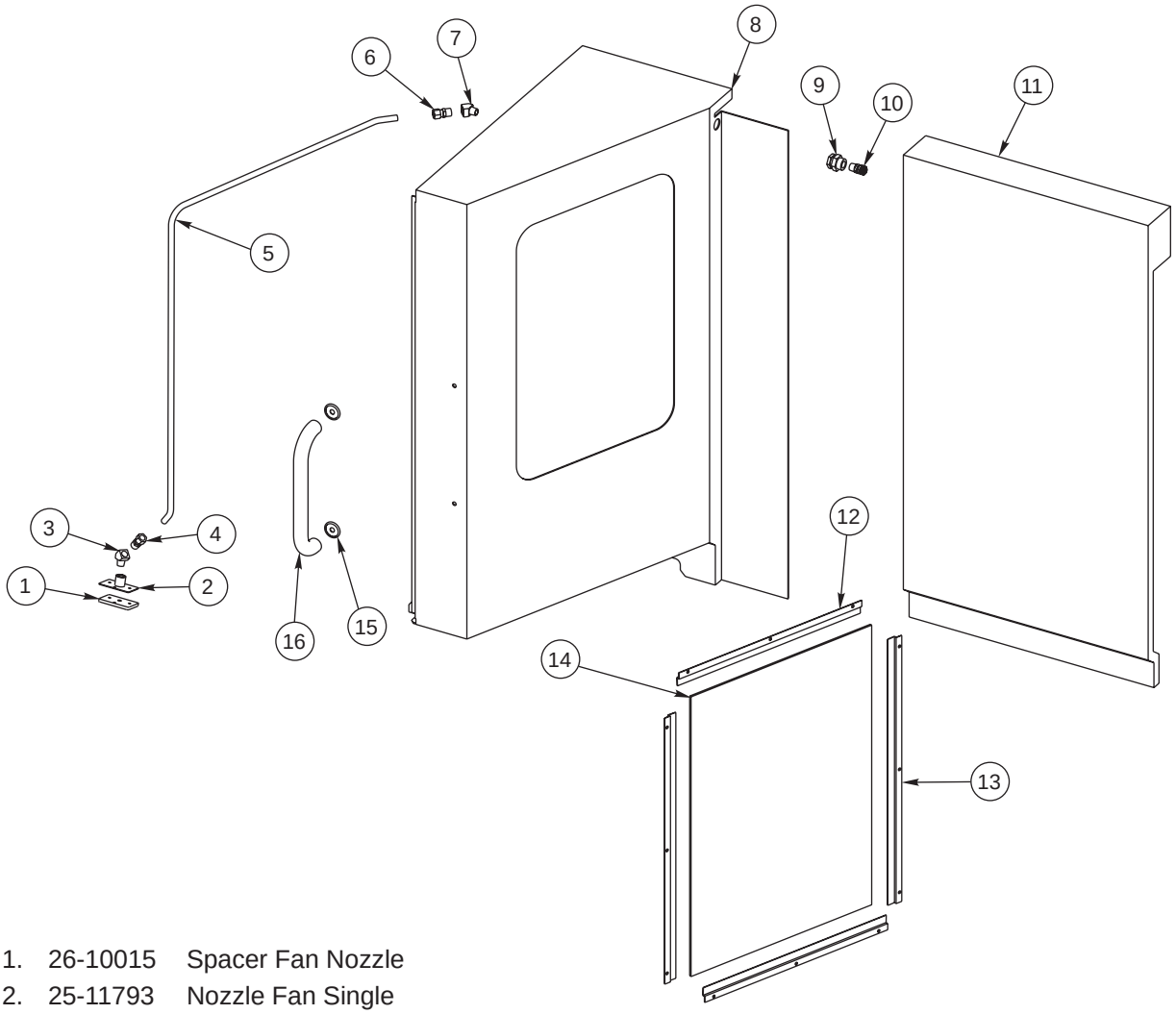
1.	25-5826	Cover Top Column
2.	25-5825	Cover Top Column Side
3.	25-9698	Wiper Support Mounting Bracket Top
4.	25-5733	Nutplate - Column Cover Support (x2)
5.	25-5732	Support Column Cover (x2)
6.	25-9699	Wiper Mounting Bracket Top
7.	25-9638	Wiper Mounting Bracket Side Top (x2)
8.	25-5831A	Top Bracket 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



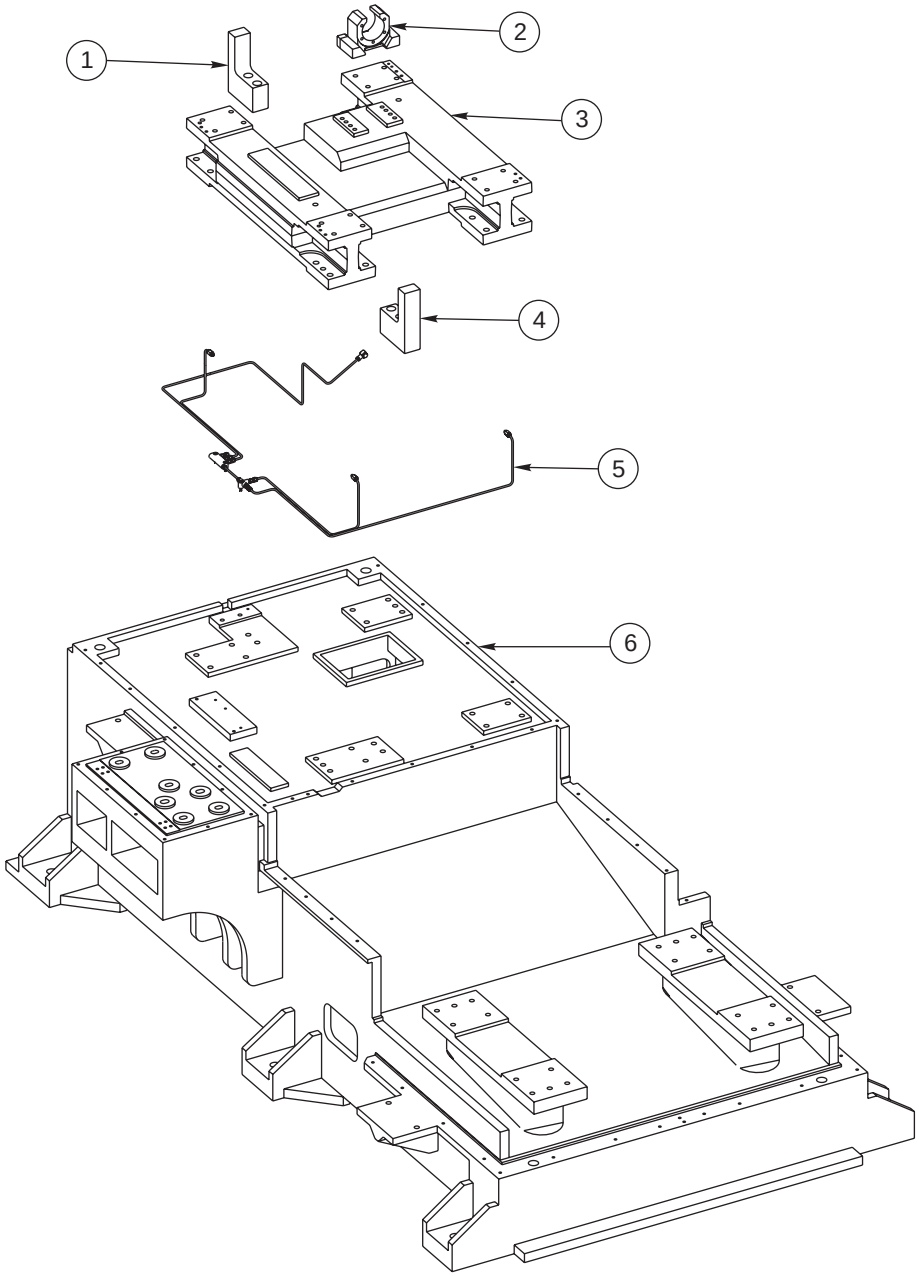
1. 25-9637A T/C Panel Top
2. 25-9633A T/C Rear Panel
3. 25-6362 T/C Panel Switch Box Cover
4. 25-6718A Switch Box SMTC40 (Option)
5. 25-6719 Cover Switch Box SMTC40 (Option)
6. 25-9640A T/C Panel Upper Interior
7. 25-11844 Bulkhead T/C Access Cover
8. 25-9639A T/C Panel Wiper Interior
9. 25-9654A T/C 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)
14. 25-9703 Handle Slide Window
15. 28-0014 Window Door
16. 25-4220C Side Window Rest
17. 25-4221C Side Window Rest Opposite
18. 28-0036 Side Window Extrusion (x2)

ES-5 Operator Door Panels



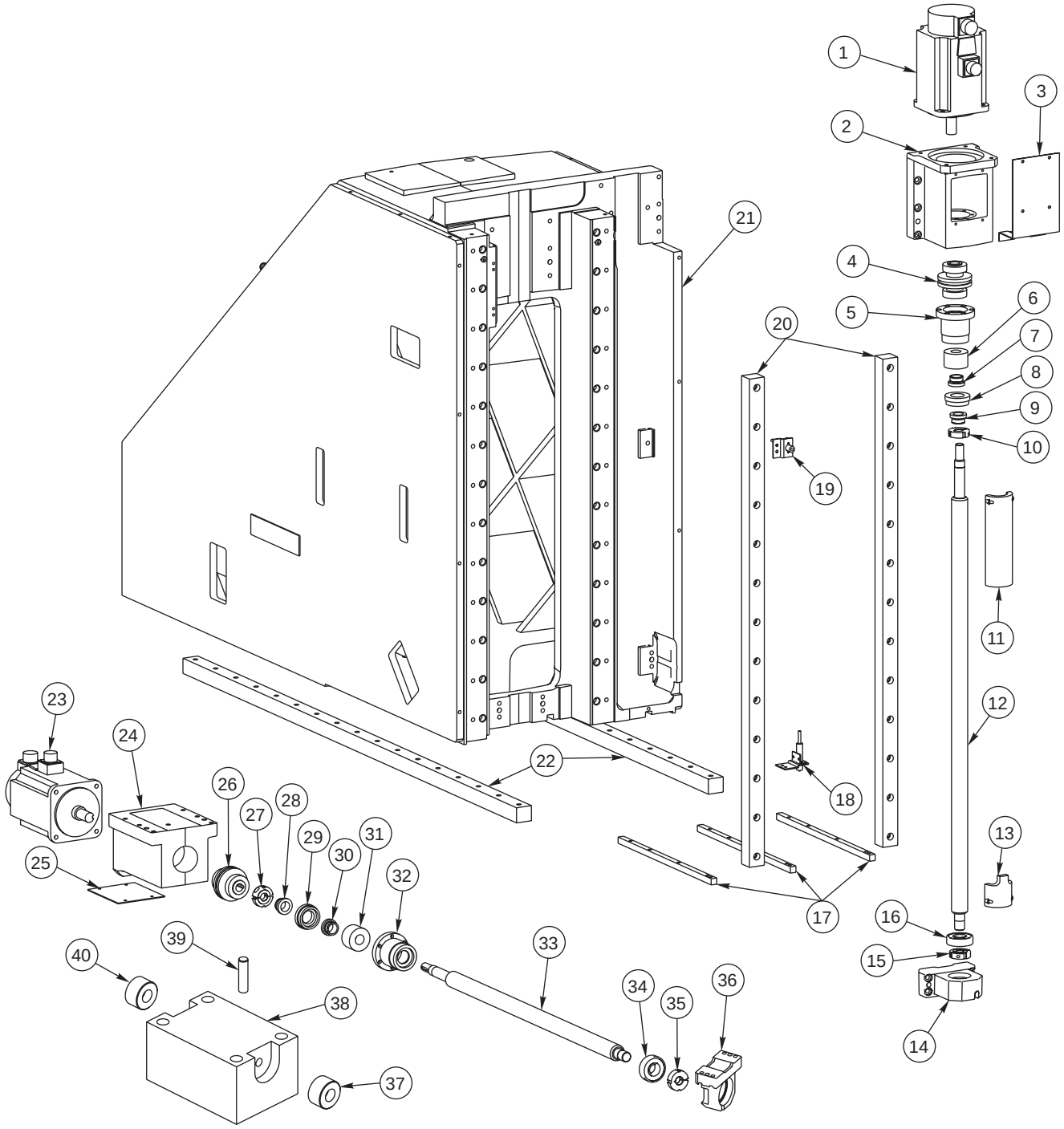
1.	26-10015	Spacer Fan Nozzle
2.	25-11793	Nozzle Fan Single
3.	58-1721	Fitting NPT - 3/8-F x NPT - 3/8-M
4.	58-3087	Fitting Comp - 1/2 x NPT - 3/8-M STR
5.	58-10049A	Washdown Tube Op Door
6.	58-3087	Fitting Comp - 1/2 x NPT - 3/8-M STR
7.	58-1721	Fitting NPT - 3/8-F x NPT - 3/8-M
8.	25-9700C	Operator 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

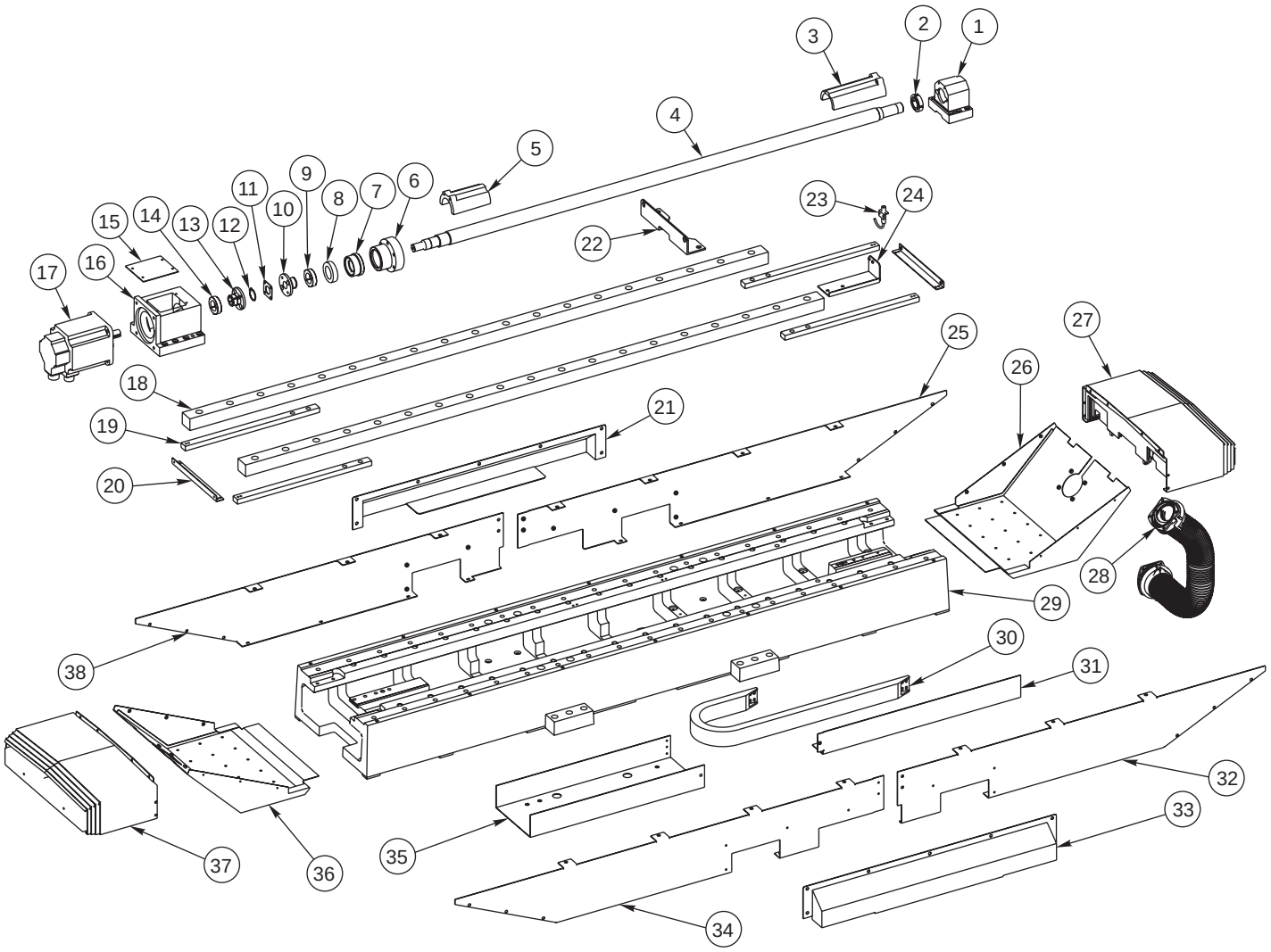
ES-5 Column Assembly



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

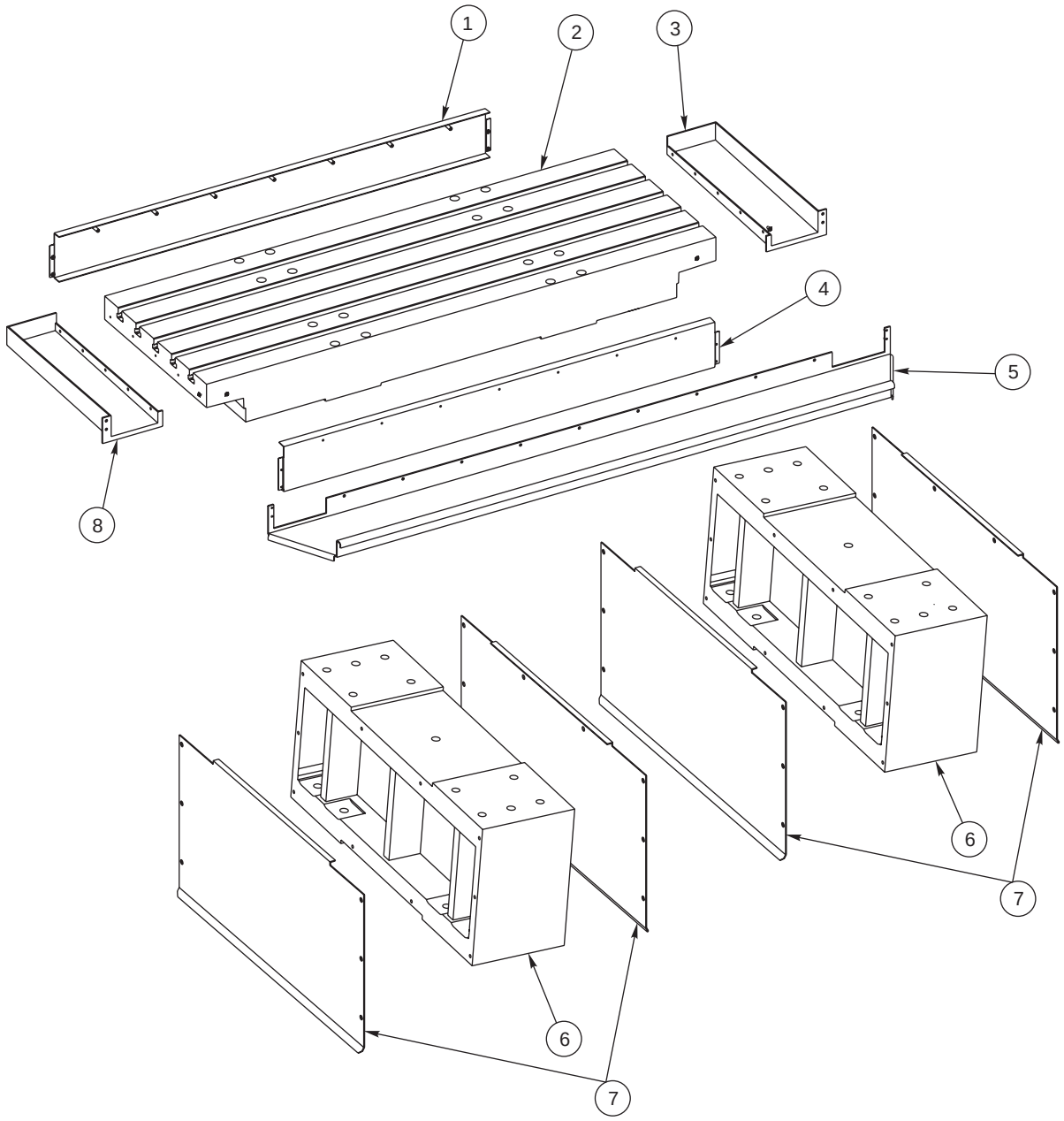
ES-5 Saddle Assembly



ES-5 Saddle Assembly Parts List

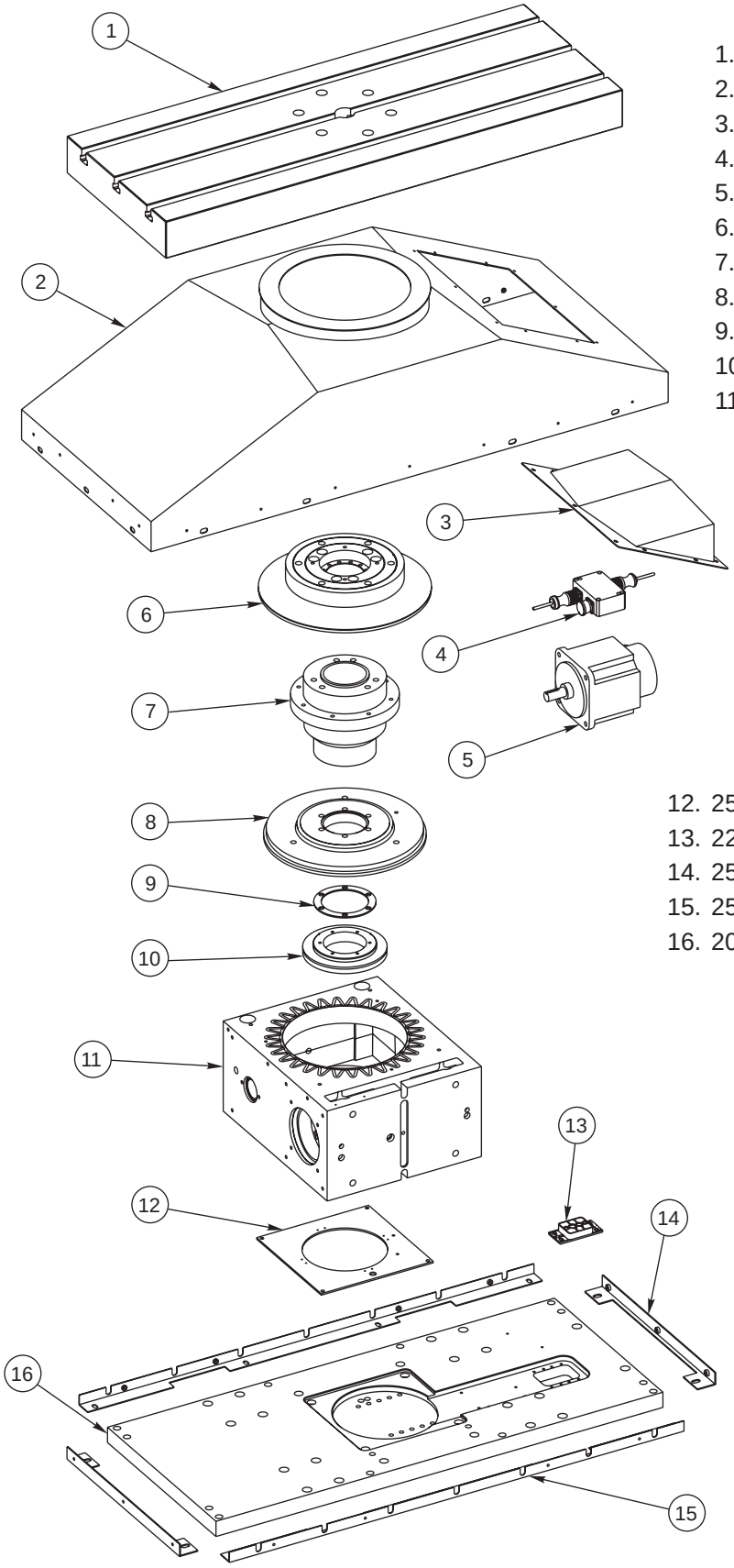
1.	20-0152	Bearing Housing 40/50mm Ballscrew
2.	51-0008	Bearing Lock Nut
3.	28-0209	Bumper X-Axis Motor End
4.	24-0003B	Ballscrew 40-6-1671 Z-Axis
5.	28-0184	Bumper X-Axis Motor End
6.	20-9212	Bearing Housing 40mm Ballscrew
7.	20-9211	Nut Housing 40mm Ballscrew
8.	51-0093	Bearing Angular Contact
9.	51-2019	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 Spash 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



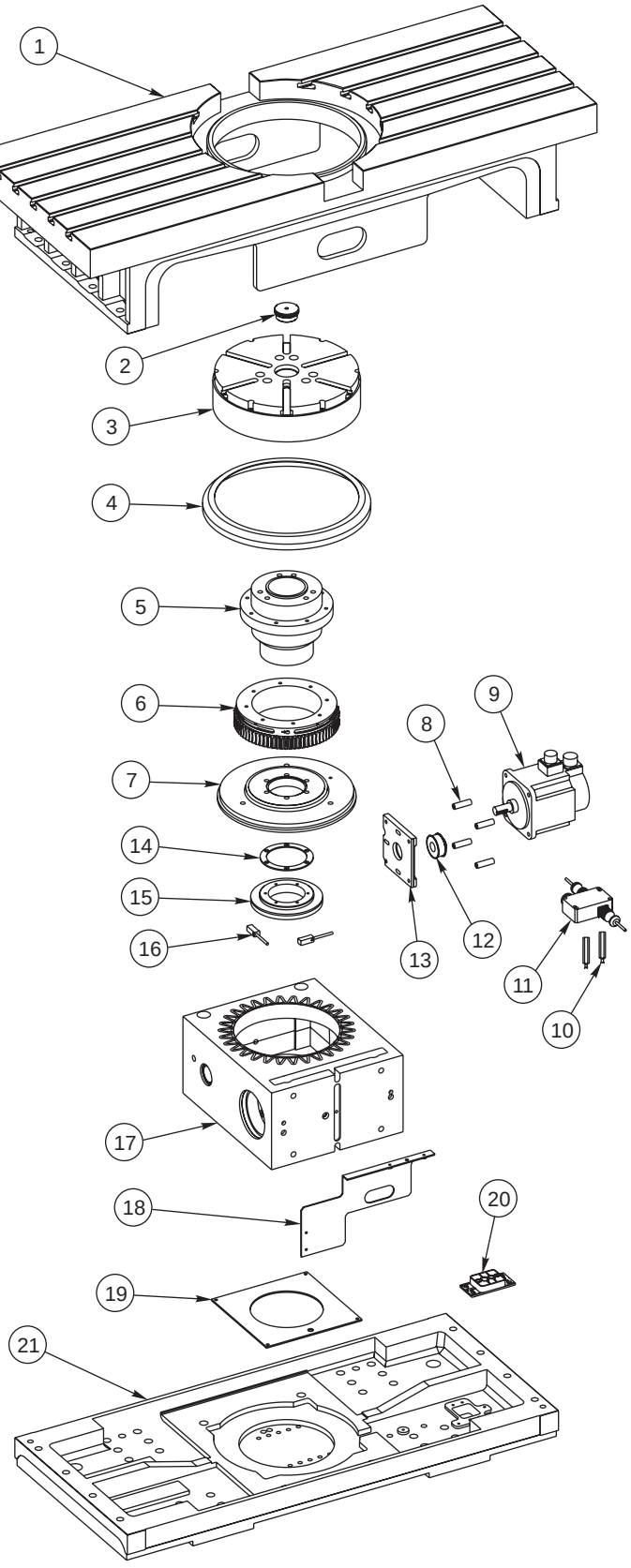
1. 25-9310 Table Cover
2. 20-9308D Table Machined
3. 25-6587 Table Gutter Right
4. 25-6720 Table Gutter Front
5. 25-9310 Table Cover
6. 20-10051 Saddle Spacer Machining 3-Axis Table
7. 25-10602A Saddle Spacer Cover 3-Axis Table
8. 25-6586 Table Gutter Left

ES-5-4T Table



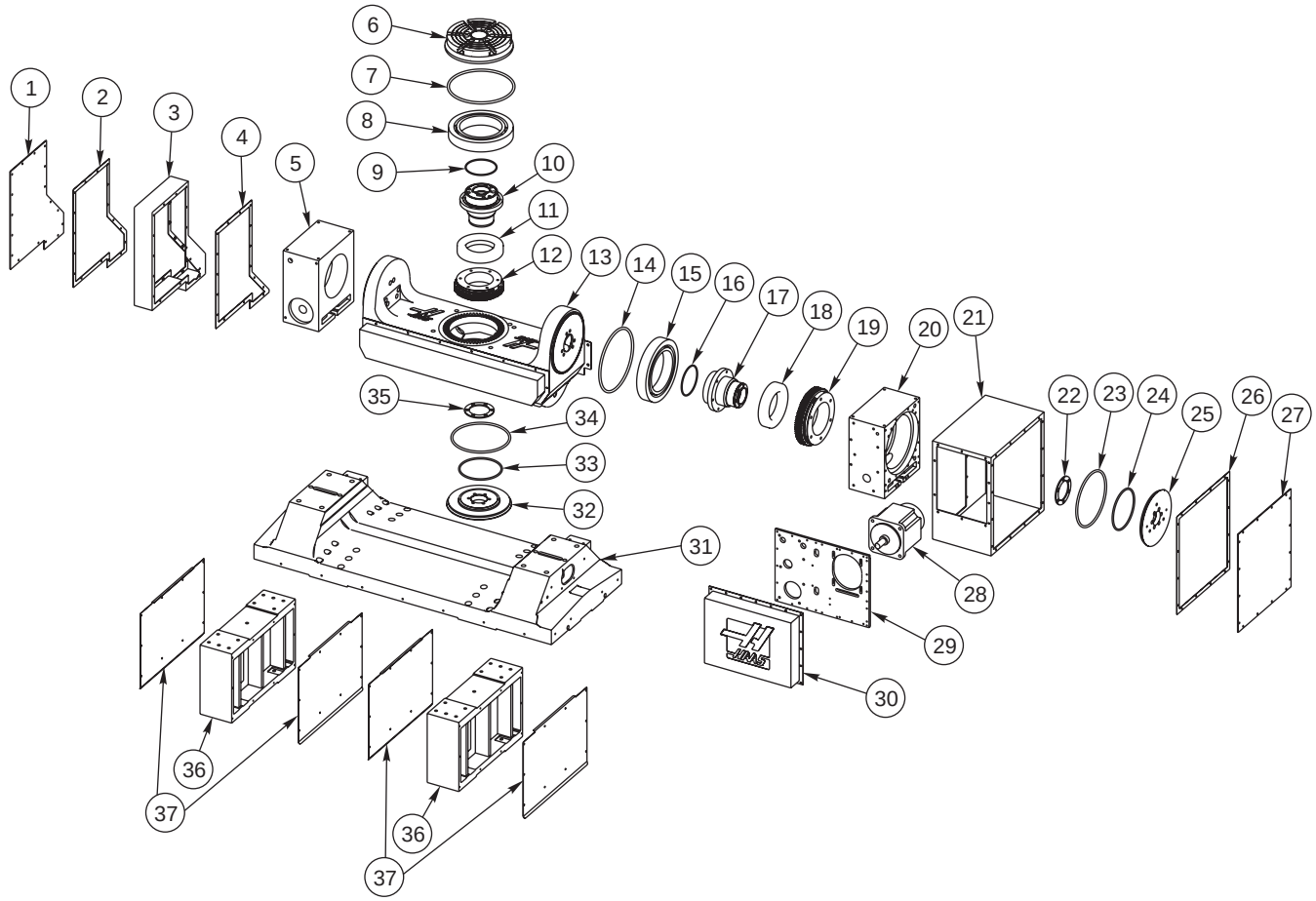
1. 20-4350 Table T-Slot
2. 25-9606 Rotary Table Cover
3. 25-9720 Access Cover Table Motor
4. 32-8888 Interpolation Box Assembly
5. 62-0014 Servomotor Yaskawa 09
6. 20-4349 Platter
7. 20-4212 Spindle
8. 20-4213 Brake Disc
9. 20-4236 Spindle Spacer
10. 20-4463 Scale Mount Adaptor
11. 20-4210 Body Machined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



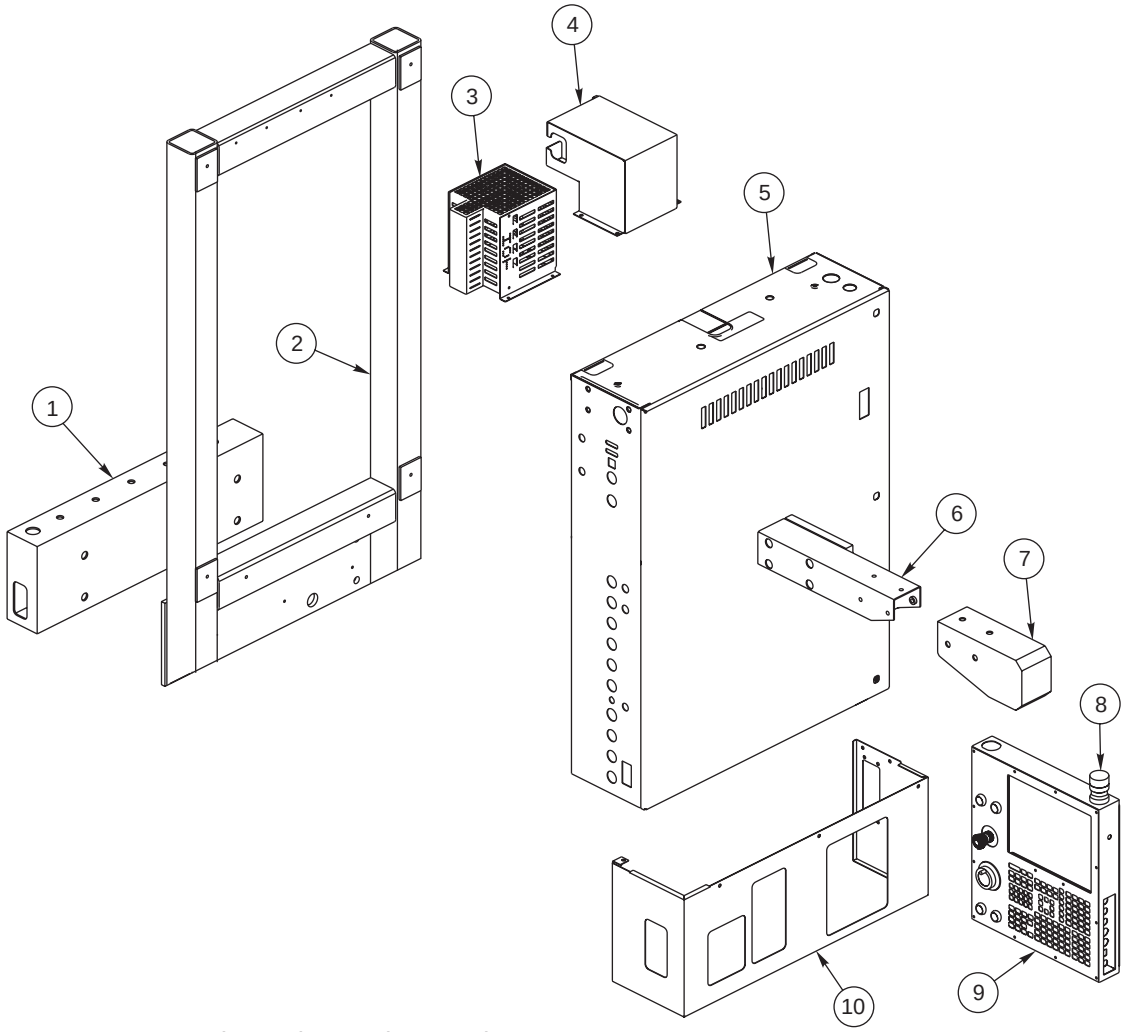
1.	20-10052	Machining Integrated Table
2.	20-1123B	Plug Pallet
3.	20-10054	Platter
4.	20-10060	Platter Shield
5.	20-4212	Spindle
6.	20-4214	Worm Gear 310mm RT
7.	20-4213	Brake Disc
8.	20-4207	Standoff (x4)
9.	62-0014	Servomotor Yaskawa 09 No Brake
10.	63-0201	Standoff 3/8 x 1.812
11.	32-8888	AMO Interpolation 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 Groovfe 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 Groovfe 6016	37.	25-9748A	Saddle Spacer Cover Side
19.	20-4104	Worm Gear HRT210			

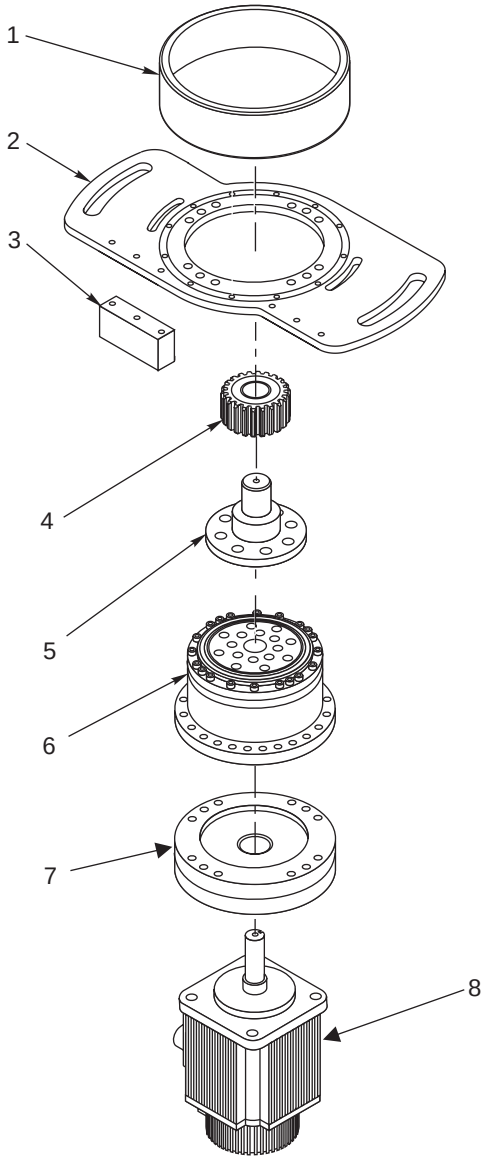
ES-5 Control Assembly



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

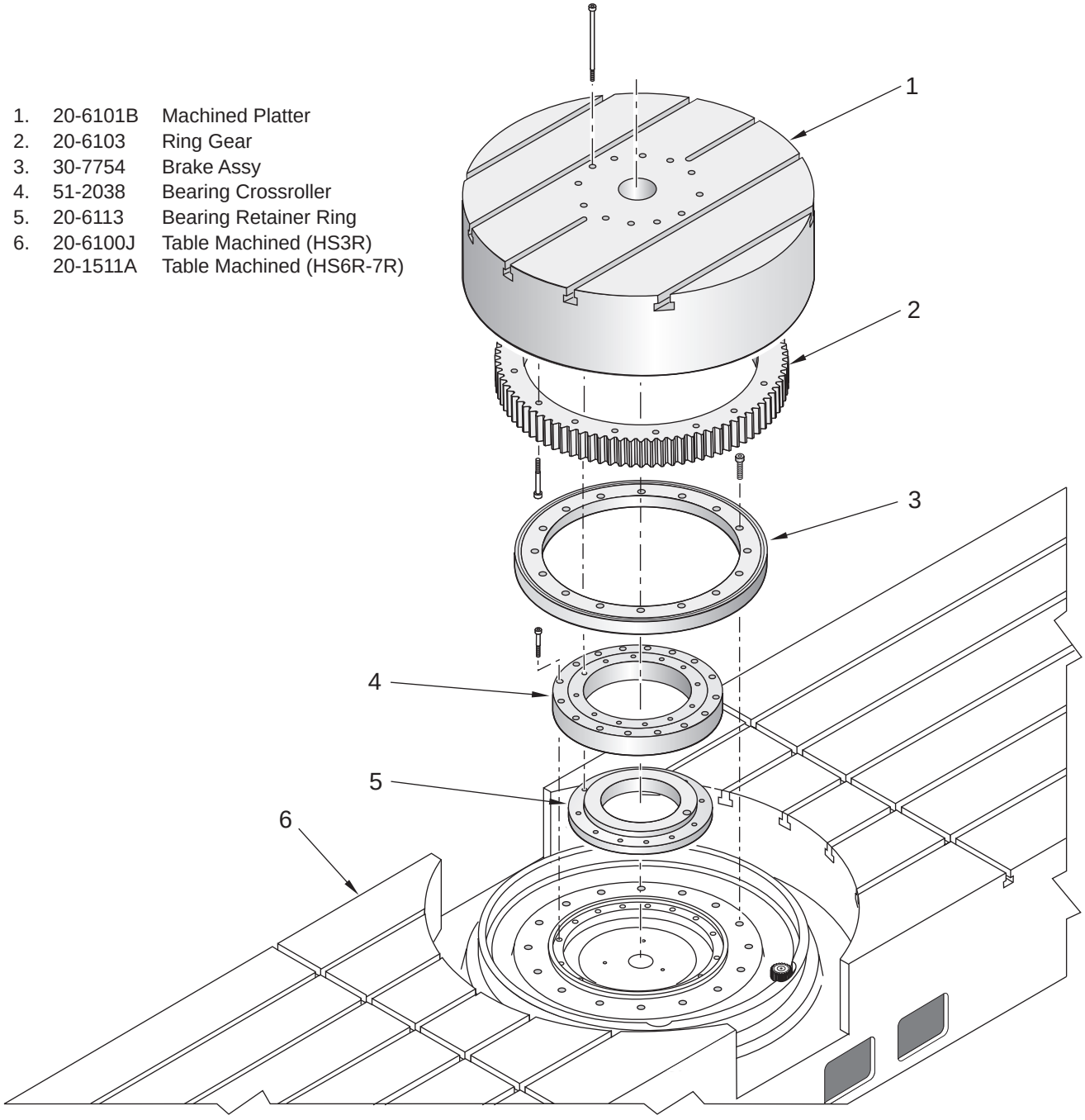
HS3-7R Harmonic Drive Assembly

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

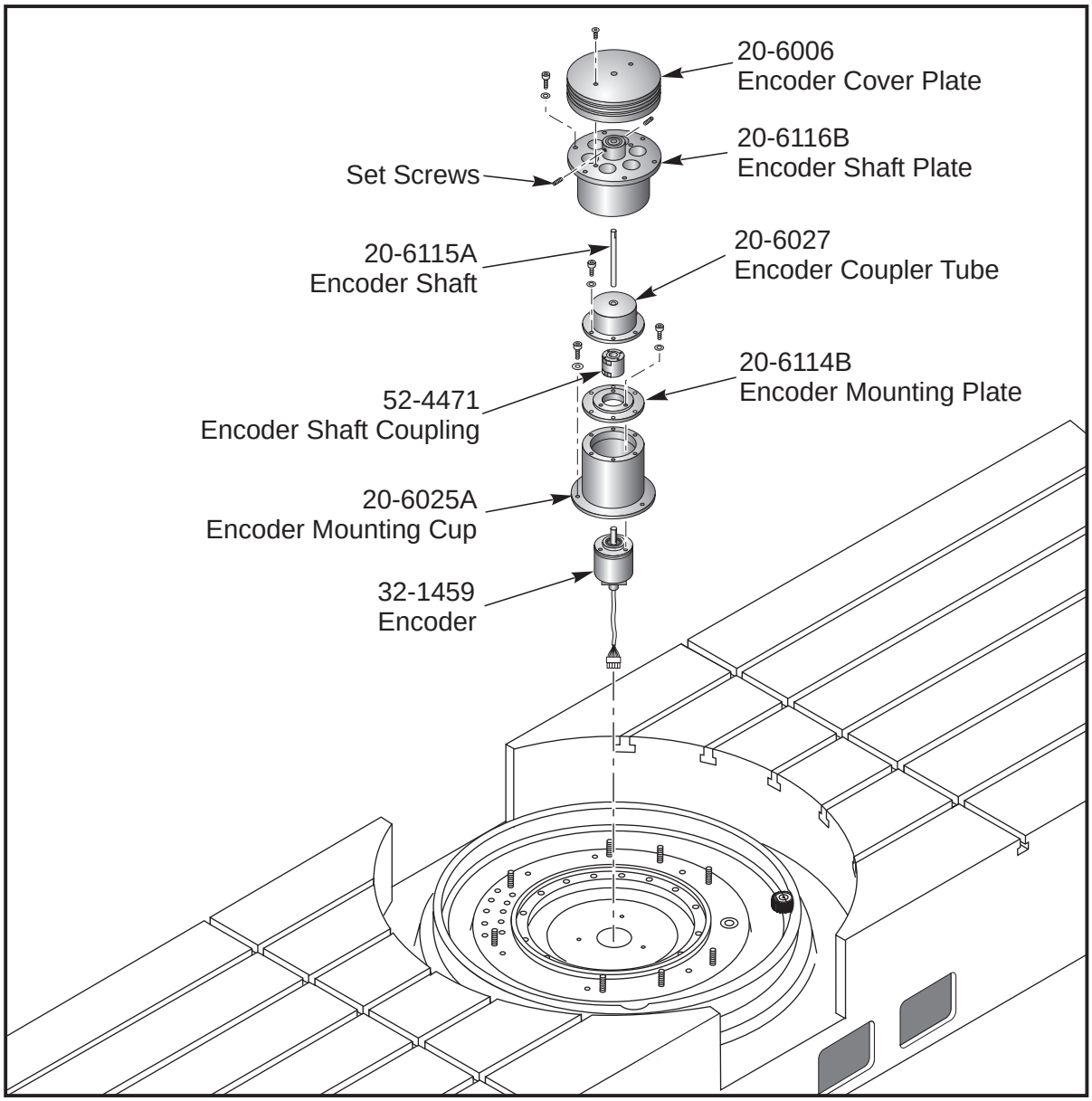


HS3-7R Table Assembly

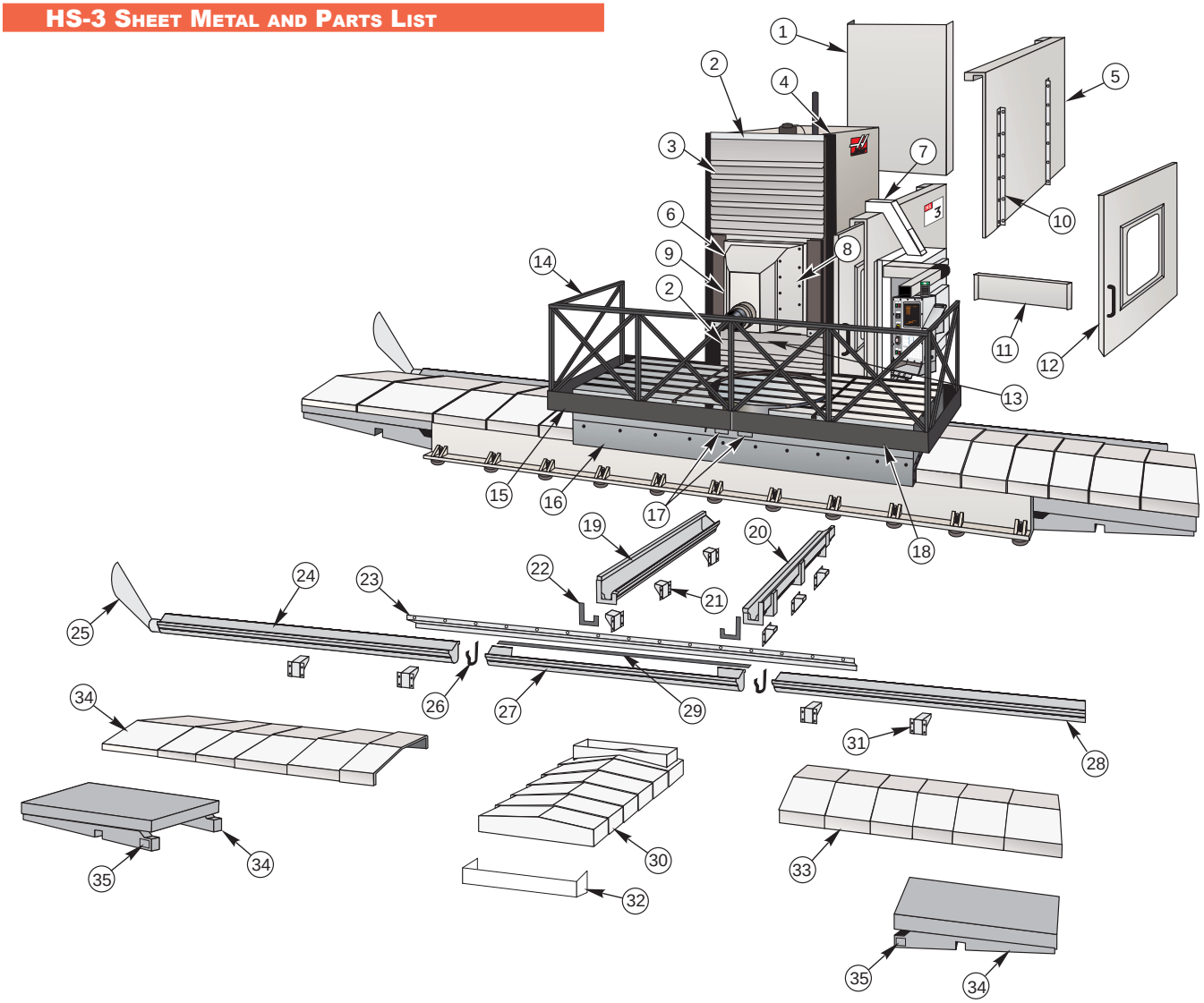
1. 20-6101B Machined Platter
2. 20-6103 Ring Gear
3. 30-7754 Brake Assy
4. 51-2038 Bearing Crossroller
5. 20-6113 Bearing Retainer Ring
6. 20-6100J Table Machined (HS3R)
   20-1511A Table Machined (HS6R-7R)



HS3-7R Encoder Assembly

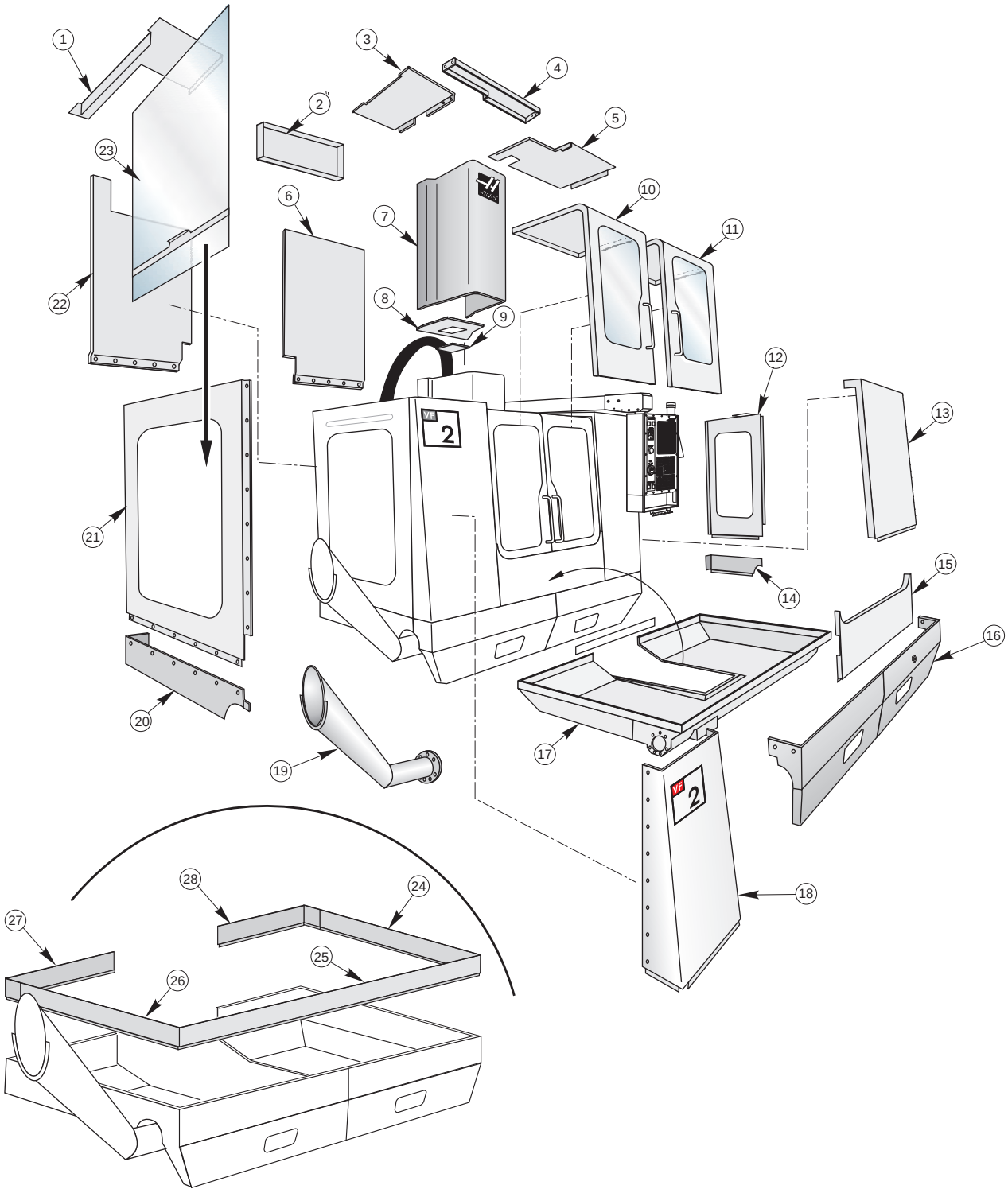


HS-3 Sheet Metal and Parts List



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

VF Exterior Sheet Metal

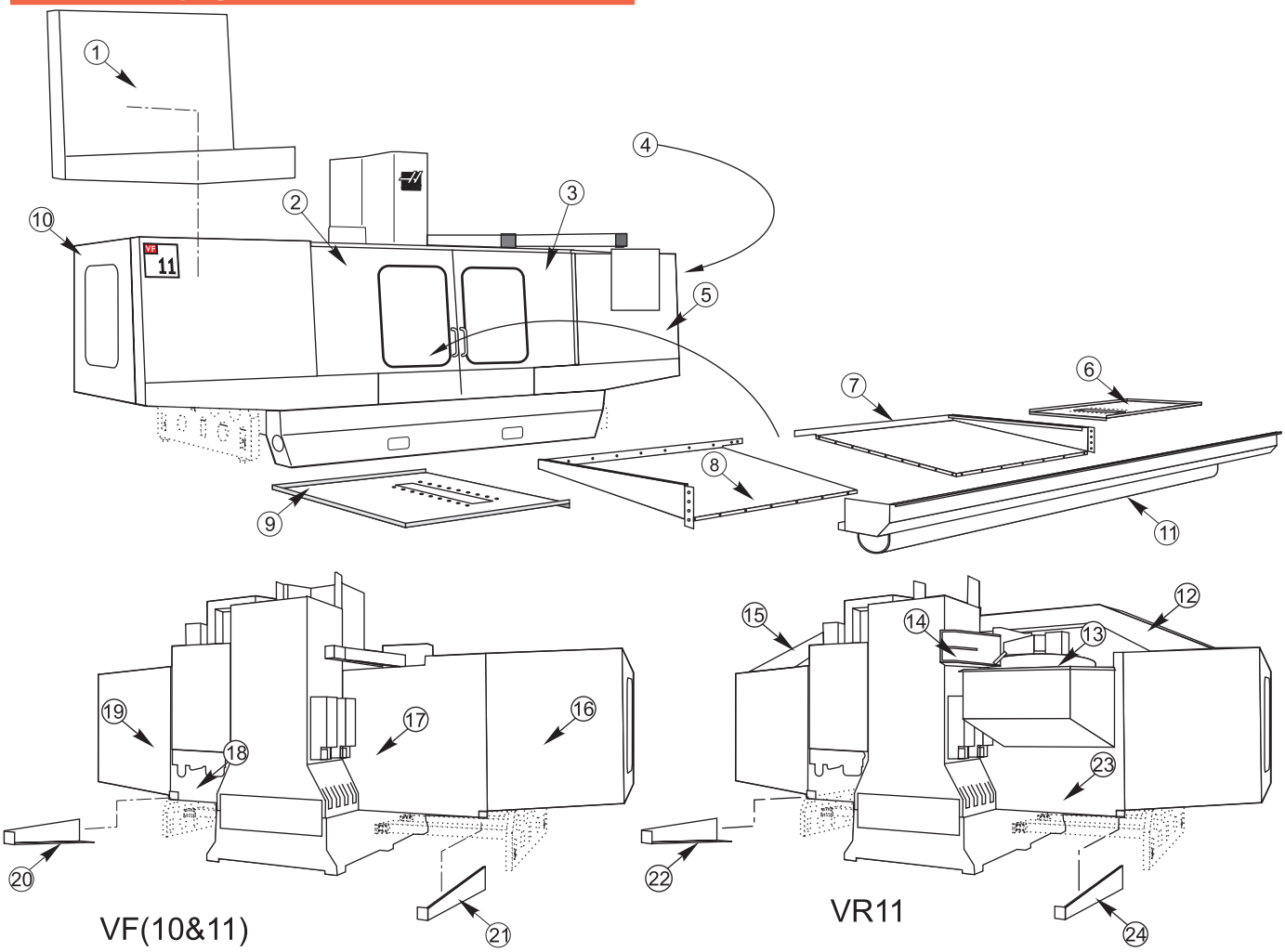


VF6 - 8 Extended Column - Riser Sheet Metal (Optional)

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 Center Panel
16.	25-9236C	Apron, Left
	25-9237B	Apron, Right
17.	25-9230E	Pan, Chip Enclosure
18.	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

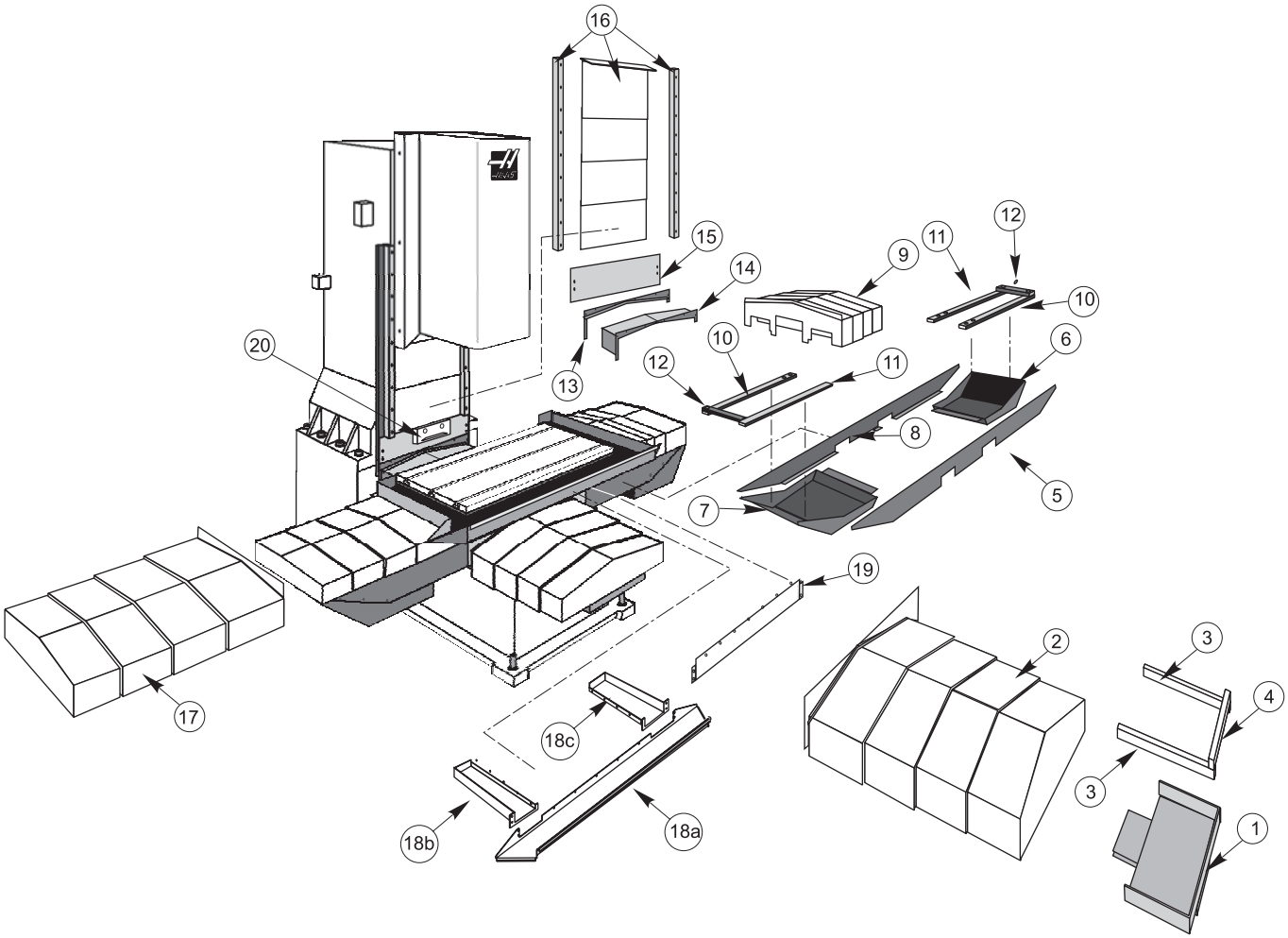


VF(10&11)

VR11

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 panel (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)

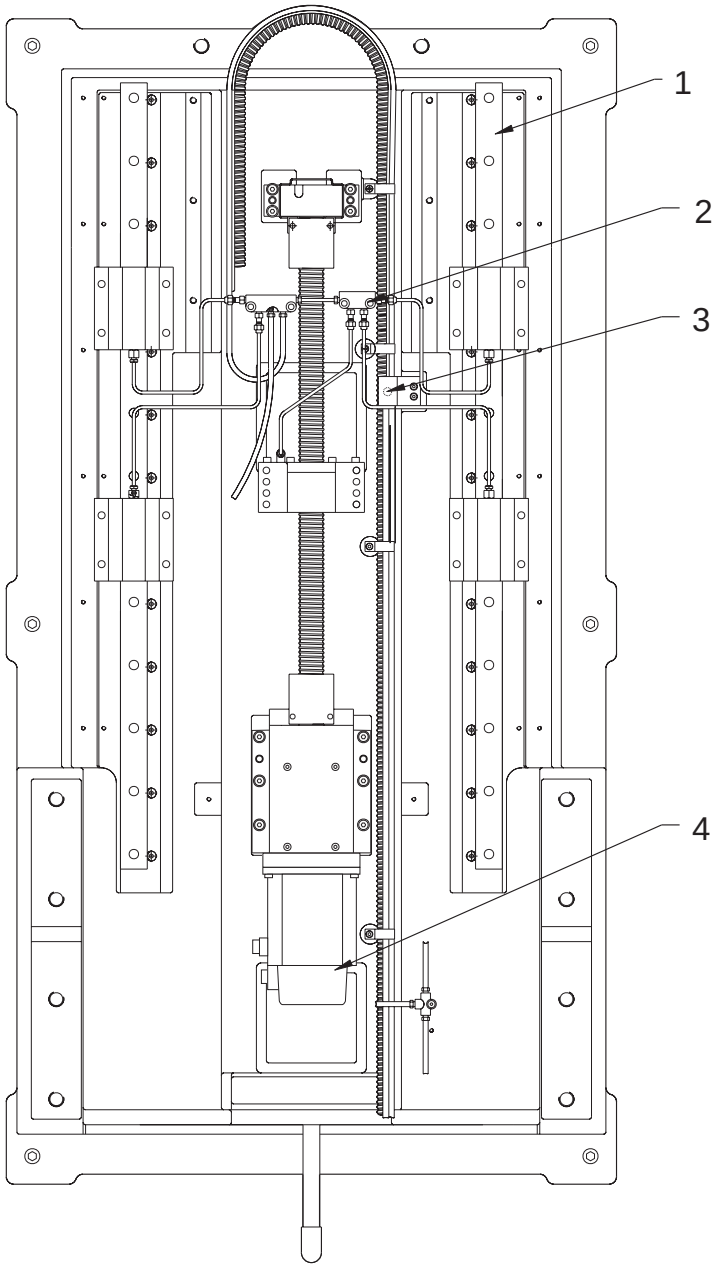
VF Interior Replaceable Parts



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

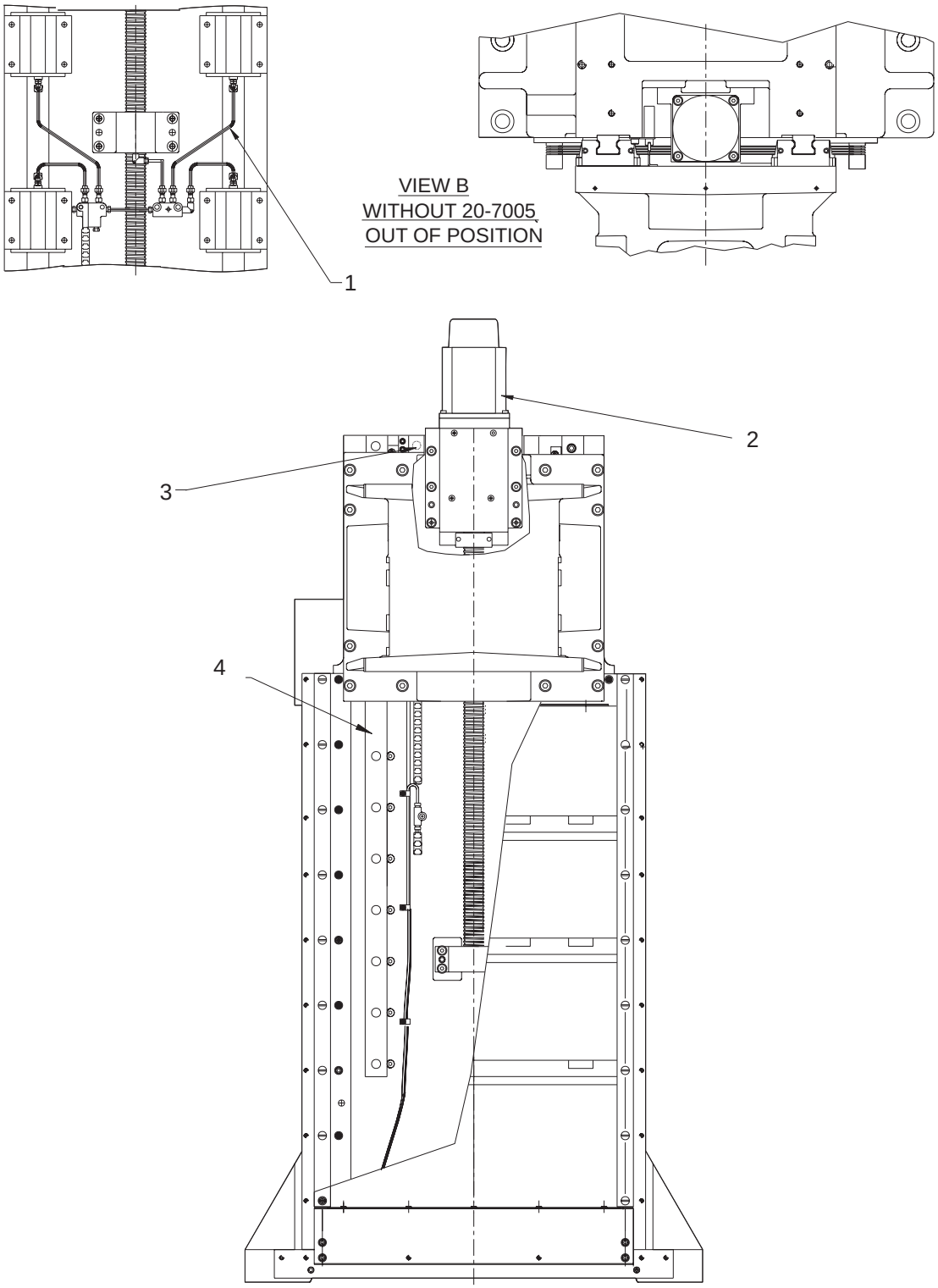
18a. Table Gutter Front
18b. Table Gutter Left
18c. Table Gutter Right

19. X-axis Chip Guard
20. Nozzle Fan Single (25-11793)
    Spacer Fan Nozzle (26-10015)



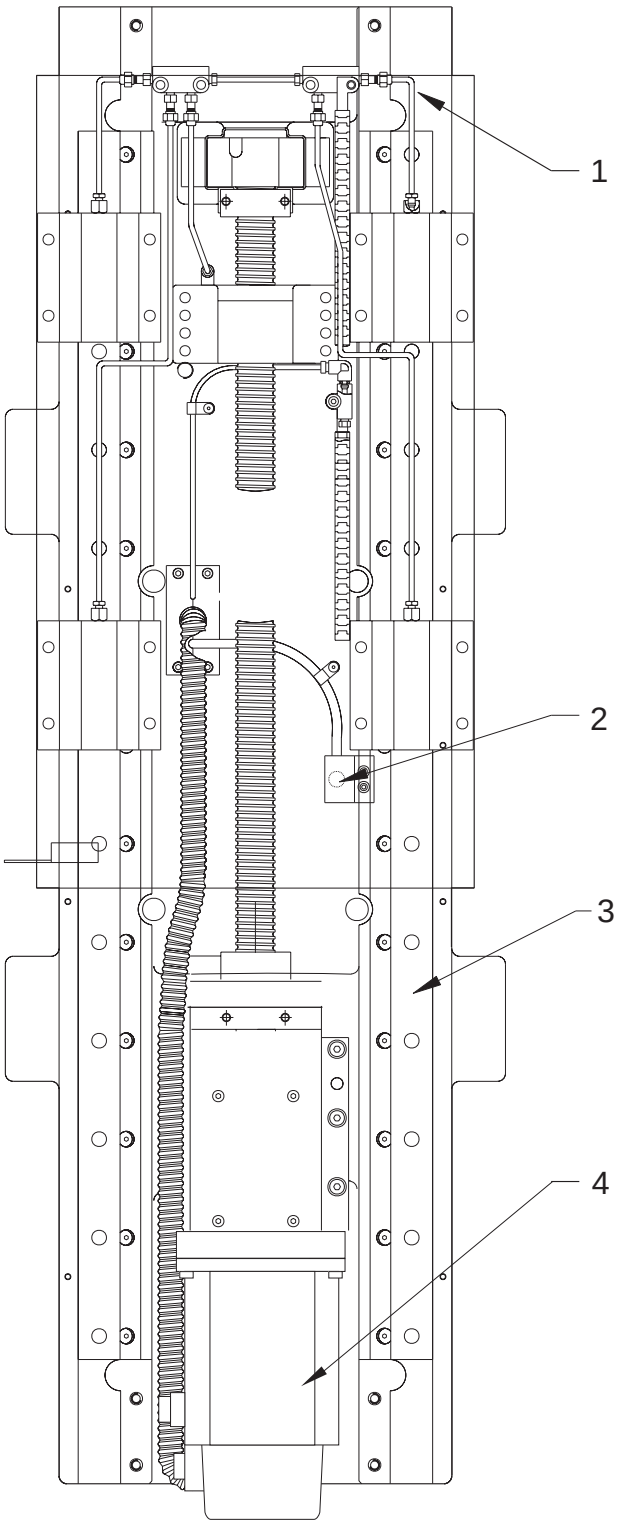
1. 50-3300 Linear guide
2. 30-30535 Oil line assembly
3. 32-2132 Switch assembly
4. 62-0035B Motor (except XRT)

VF-1 Column



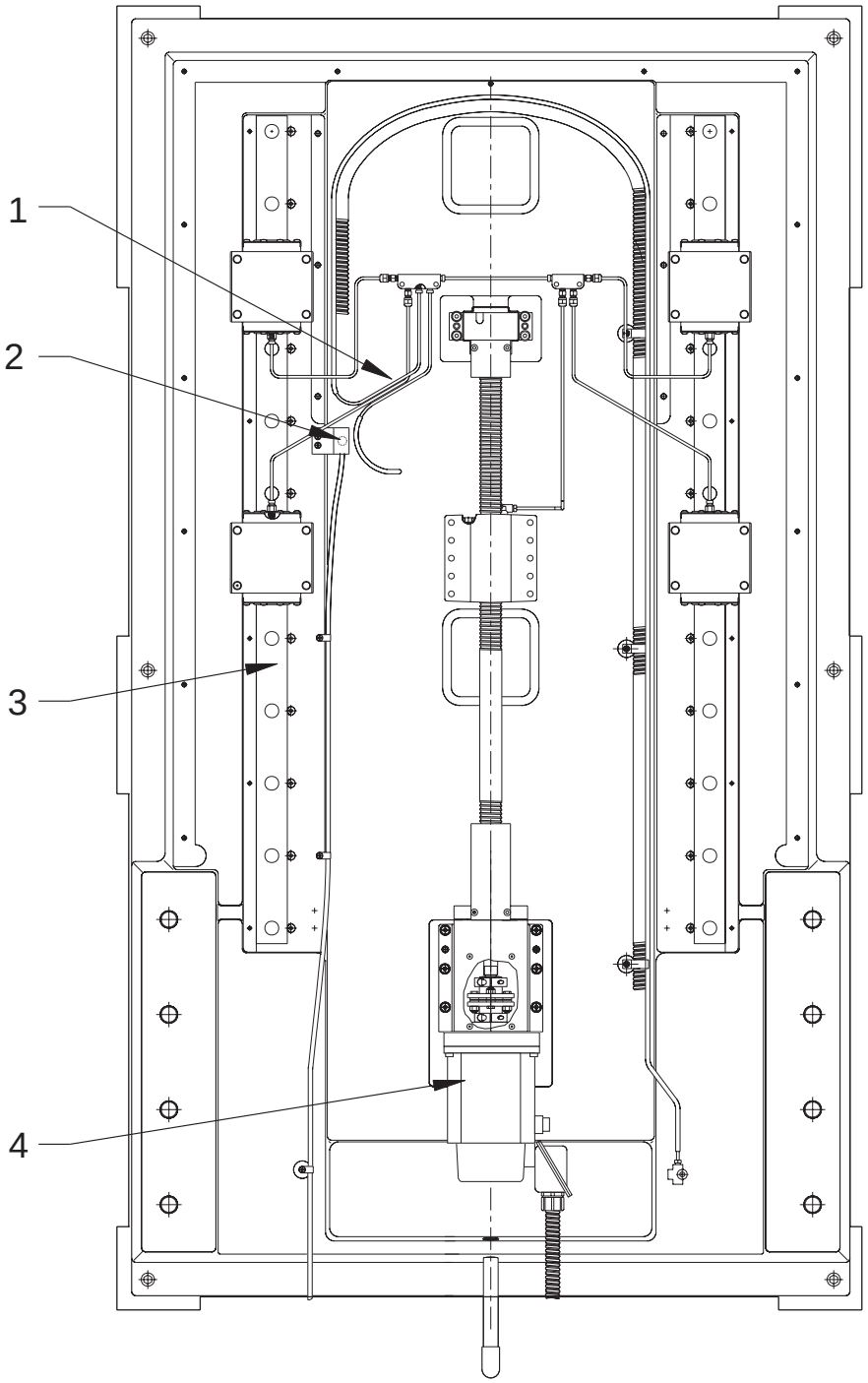
1. 30-0170 Oil line assembly
2. 62-0017 Motor (except XRT)
3. 32-2130 Switch assembly
4. 50-3300 Linear guide

VF-1 Saddle



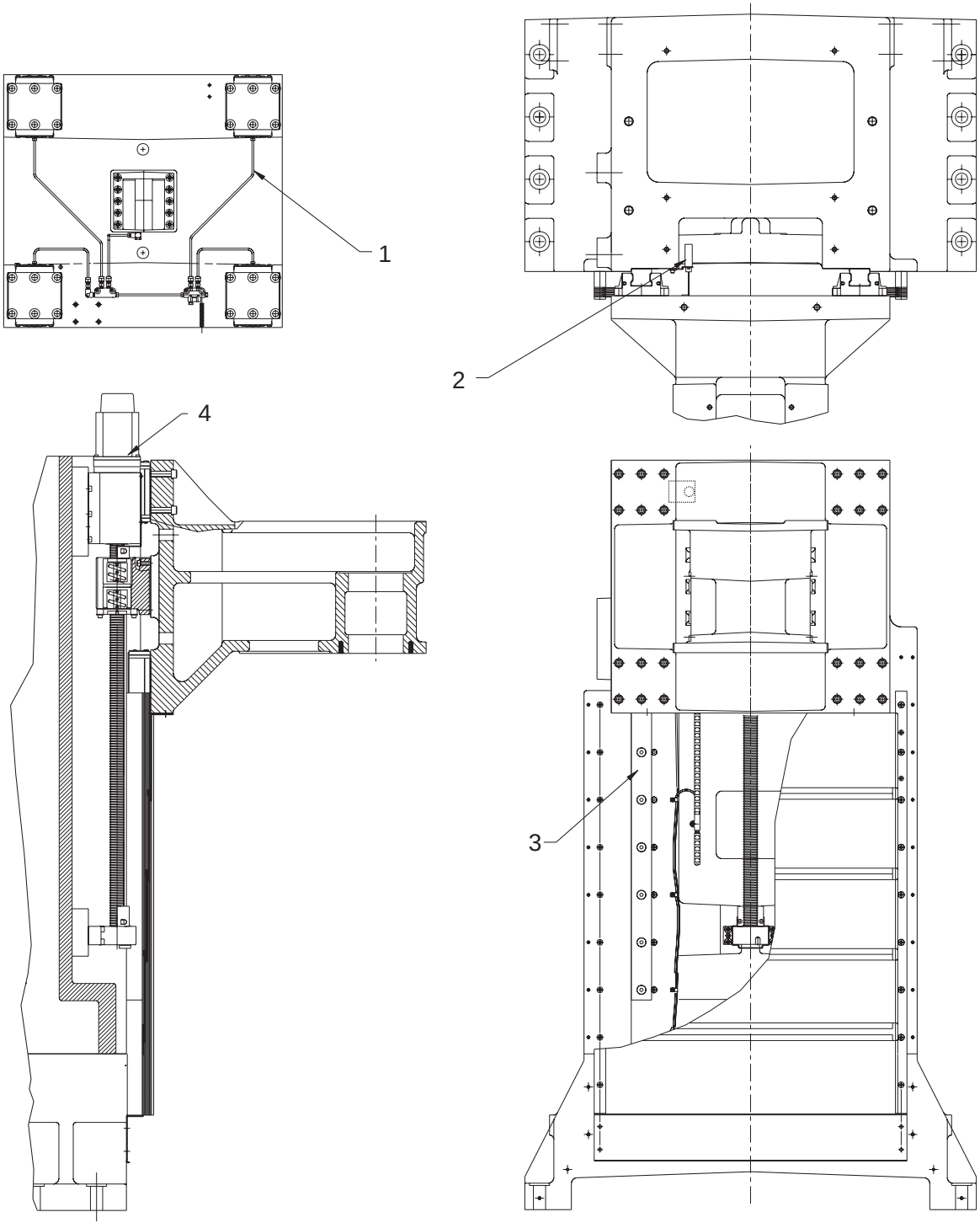
1. 30-0173 Oil line assembly
2. 32-2132 Switch
3. 50-3300 Linear guide
4. 62-0035B Motor (except XRT)

VF-3 Base



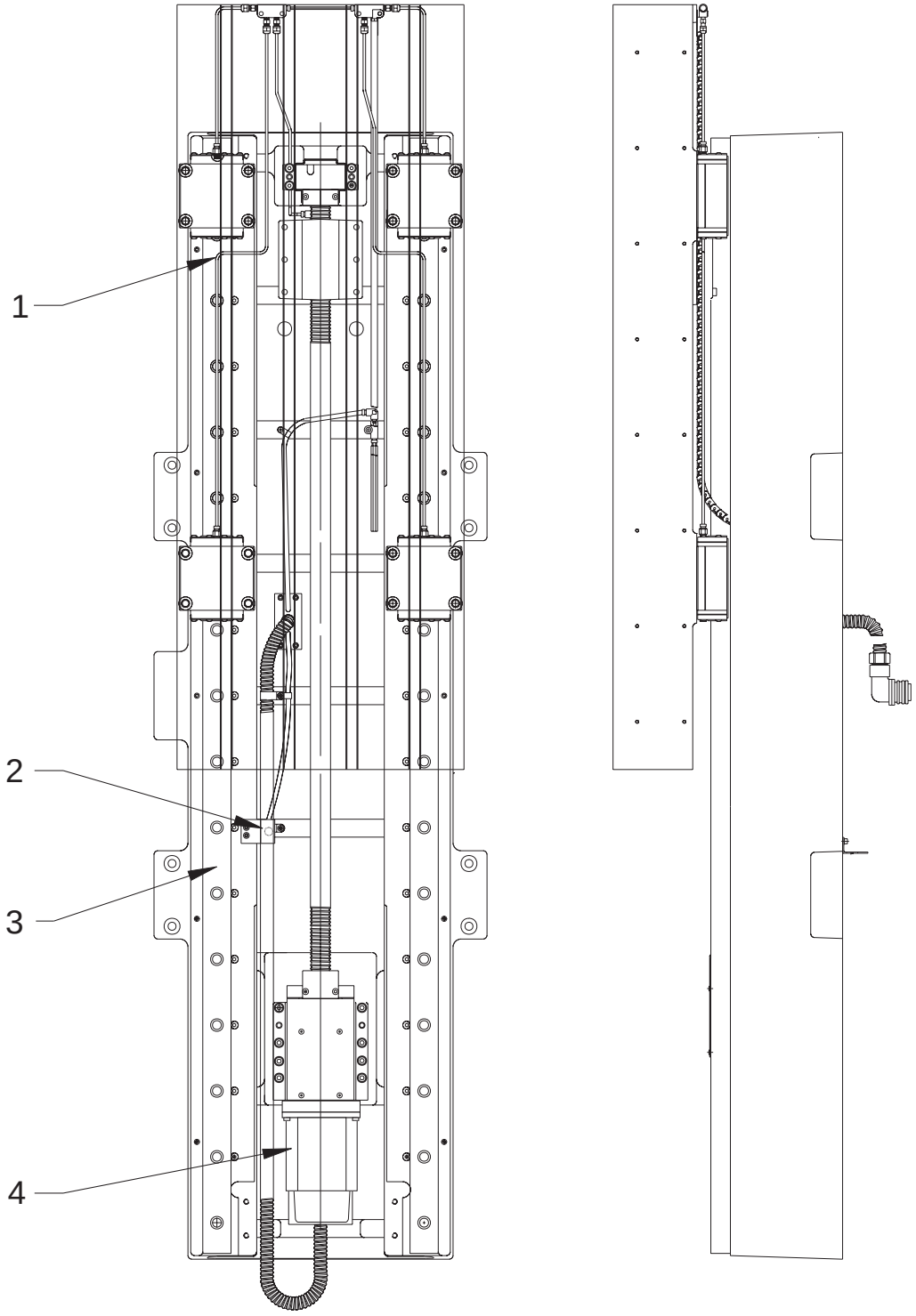
1. 30-0221 Oil line assembly
2. 32-2134 Switch assembly
3. 50-9011 Linear guide
4. 62-0035B Motor assembly (except XRT)

VF-3 Column

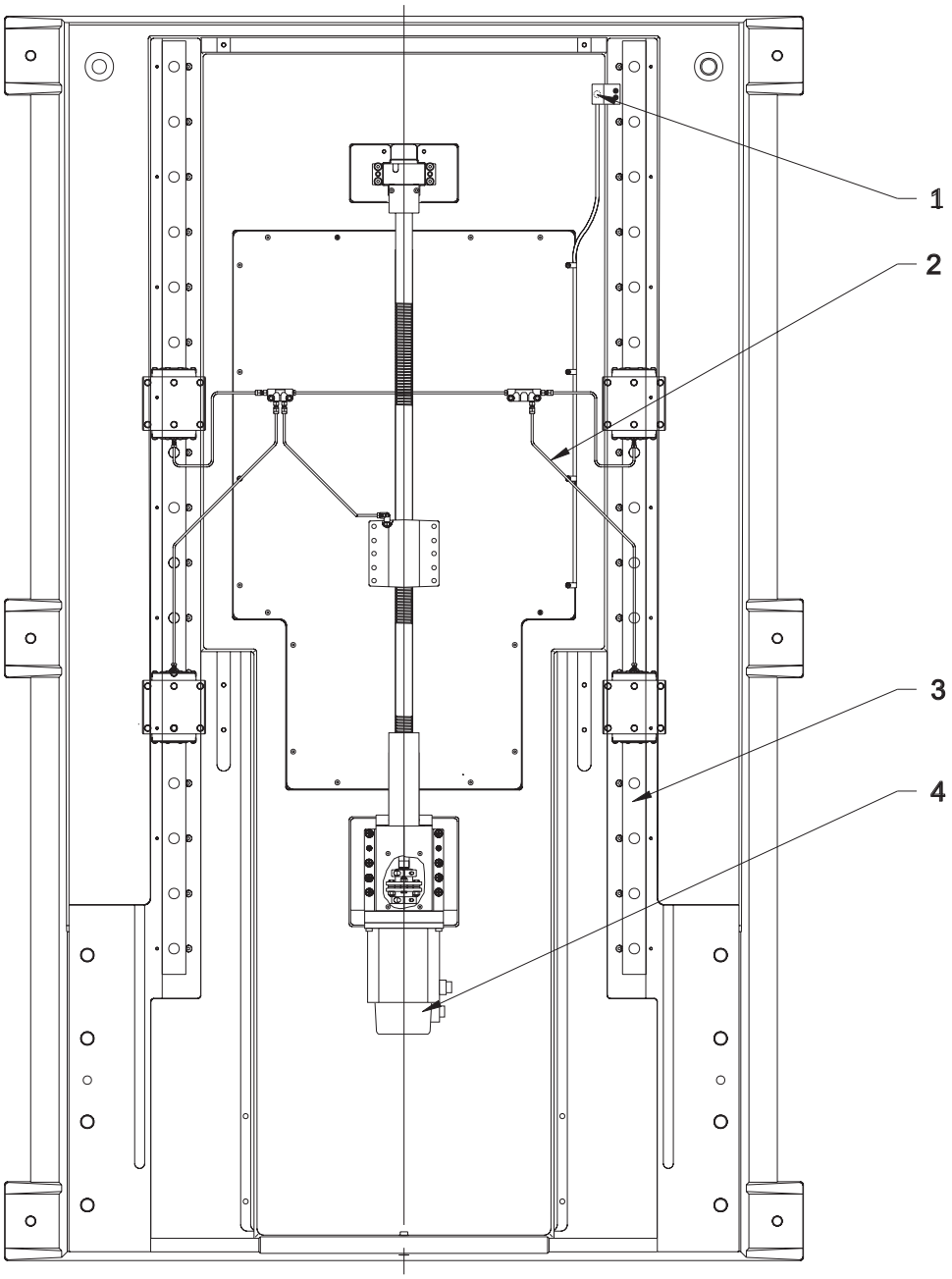


1. 30-0687 Oil line assembly
2. 32-2130 Switch assembly
3. 50-9011 Linear guide
4. 62-0017 Motor (except XRT)

VF-3 Saddle

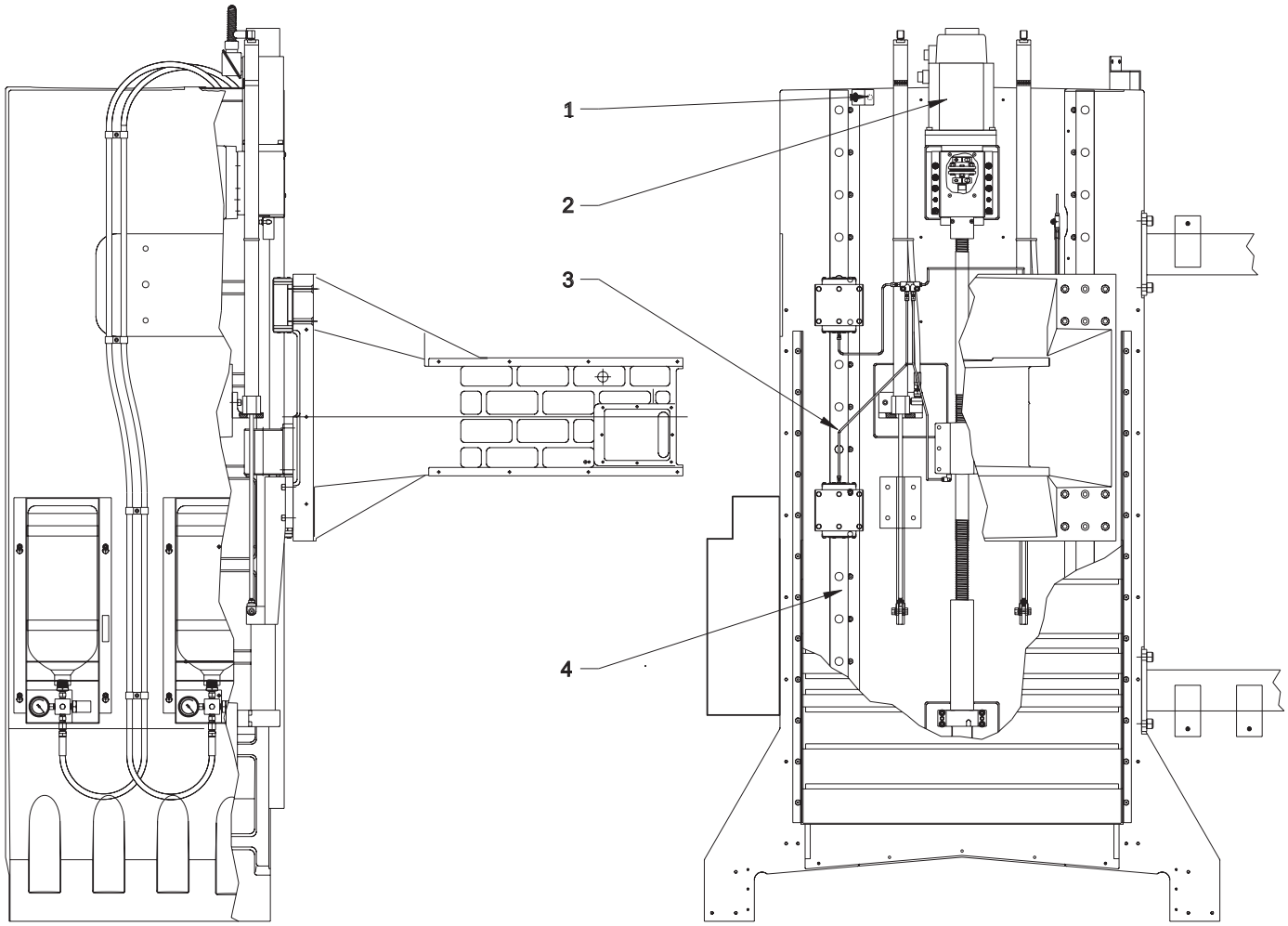


1. 30-0223 Oil line assembly
2. 32-2132 Switch assembly
3. 50-9010 Linear guide
4. 62-0035B Motor (except XRT)



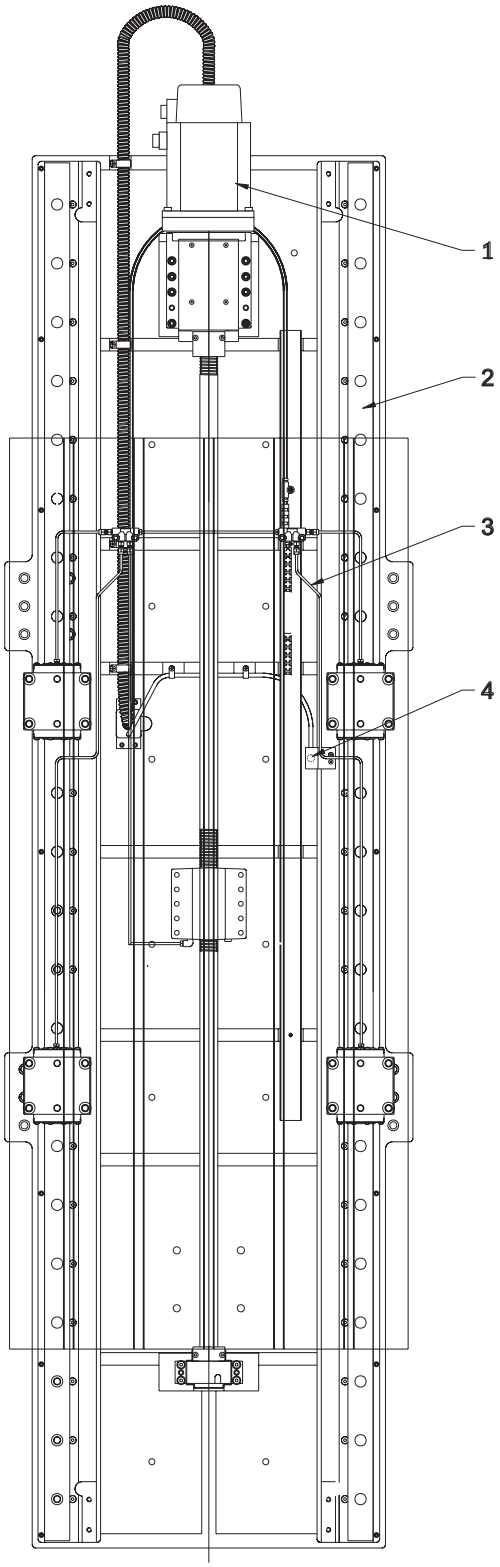
1. 32-2142 Limit switch assembly
2. 30-0461 Oil line assembly
3. 50-9010 Linear guide
4. 62-0035B Motor (except XRT)

VF-6 Column

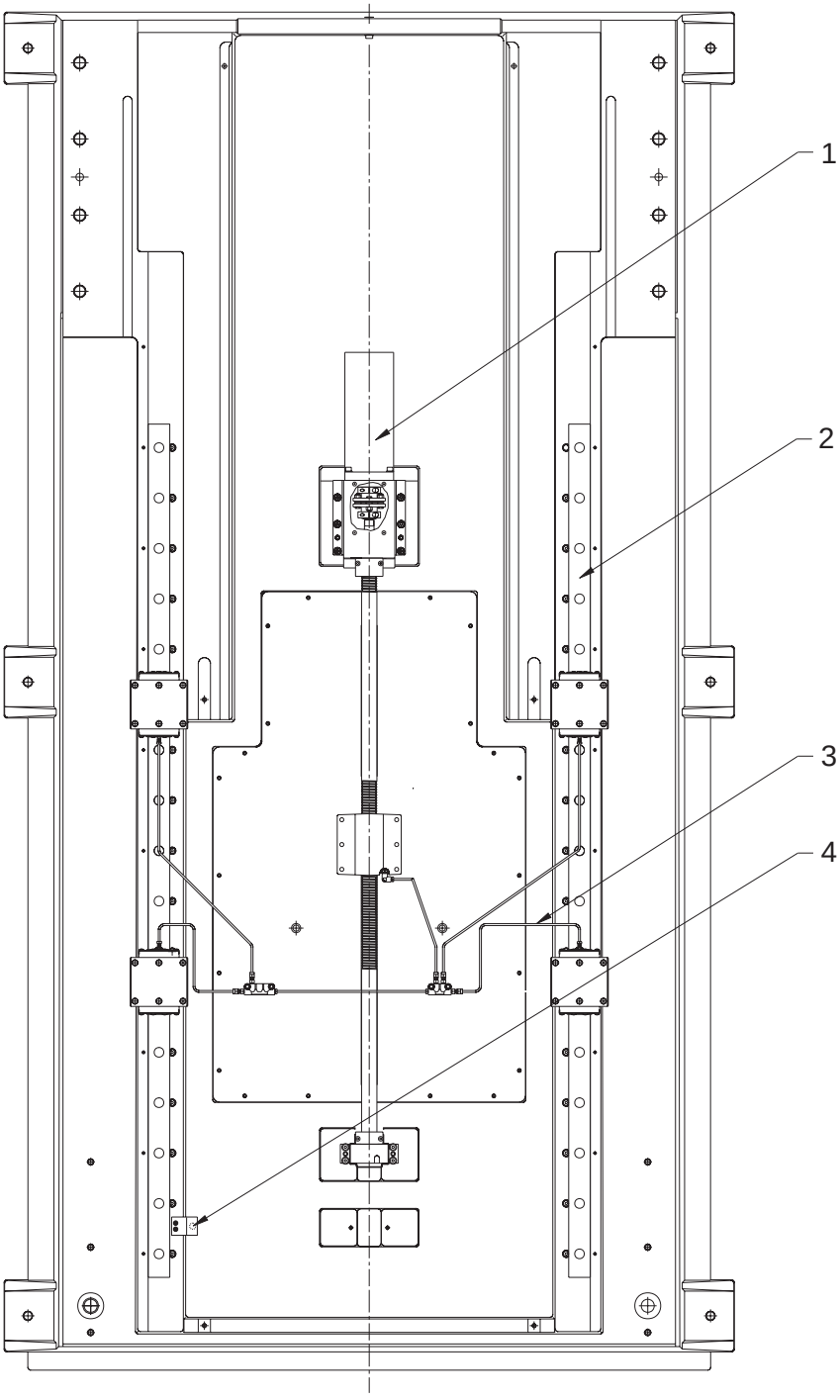


1. 32-2130 Limit switch assembly
2. 62-0037B Motor (except XRT)
3. 30-0464 Oil line assembly
4. 50-9010 Linear guide

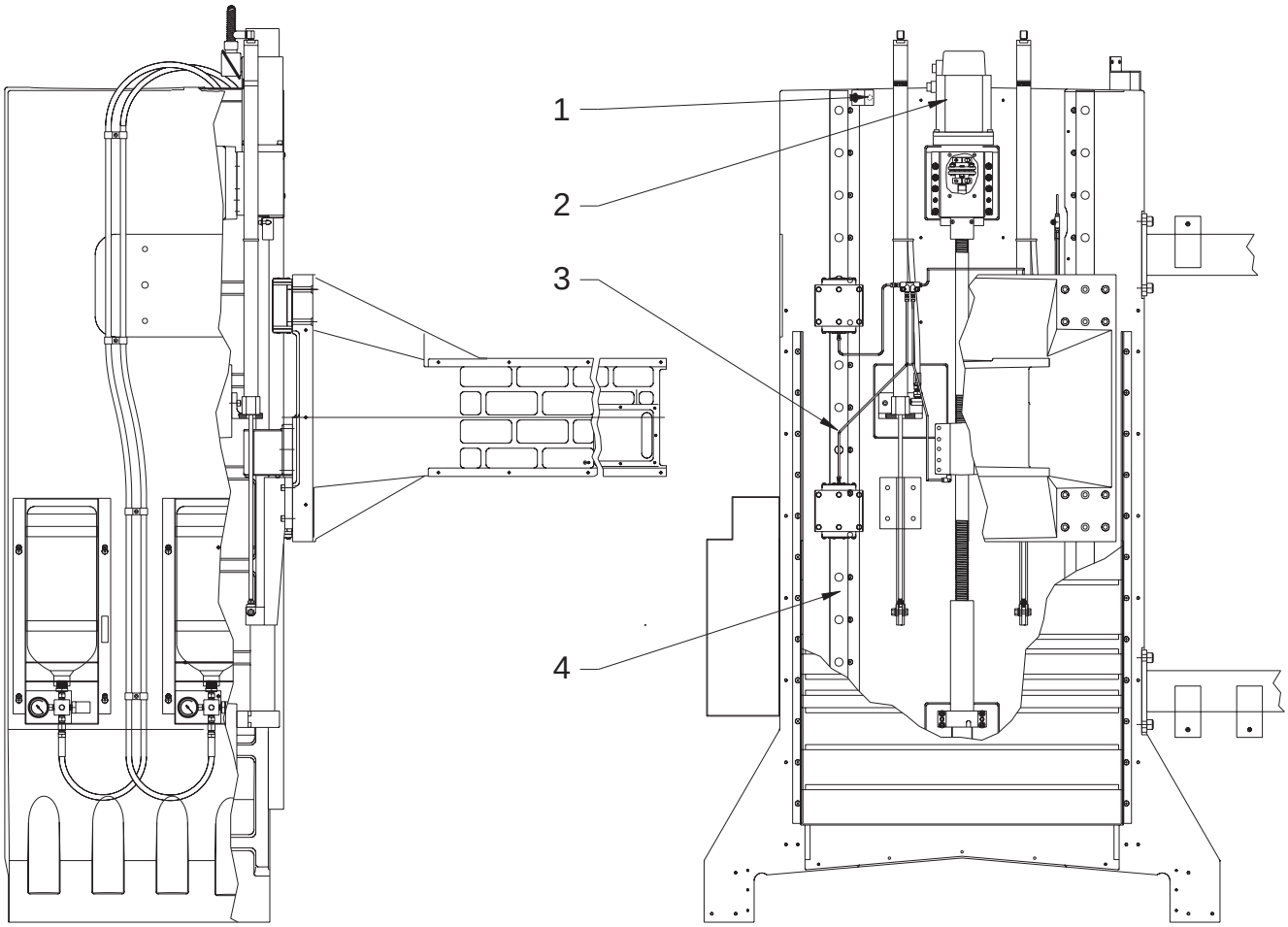
VF-6 Saddle



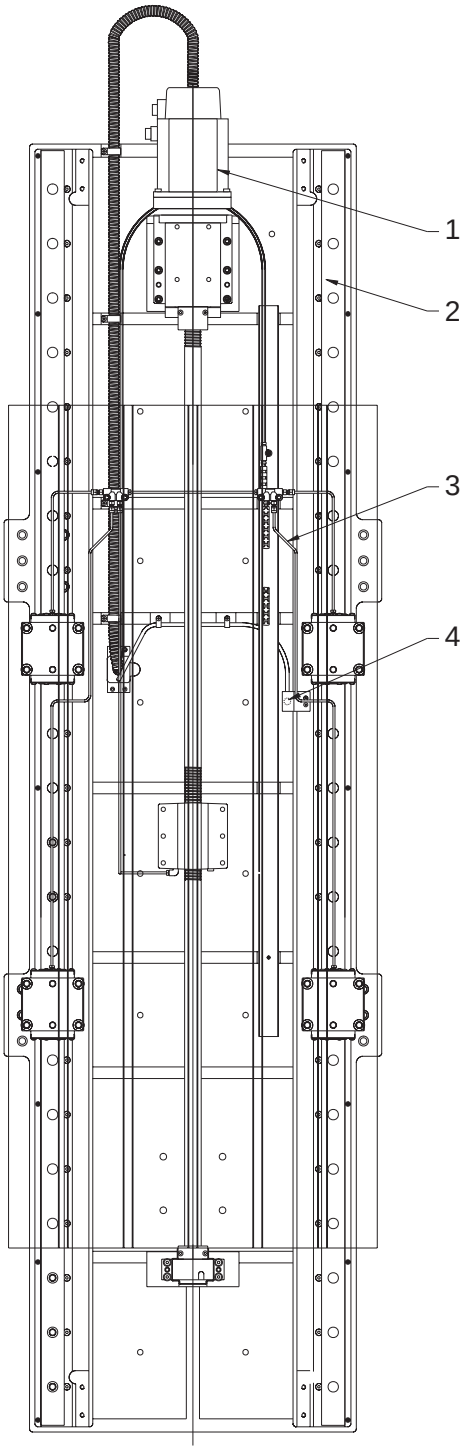
1. 62-0035B Motor (except XRT)
2. 50-9806 Linear guide
3. 30-0463 Oil line assembly
4. 32-2134 Limit switch assembly



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

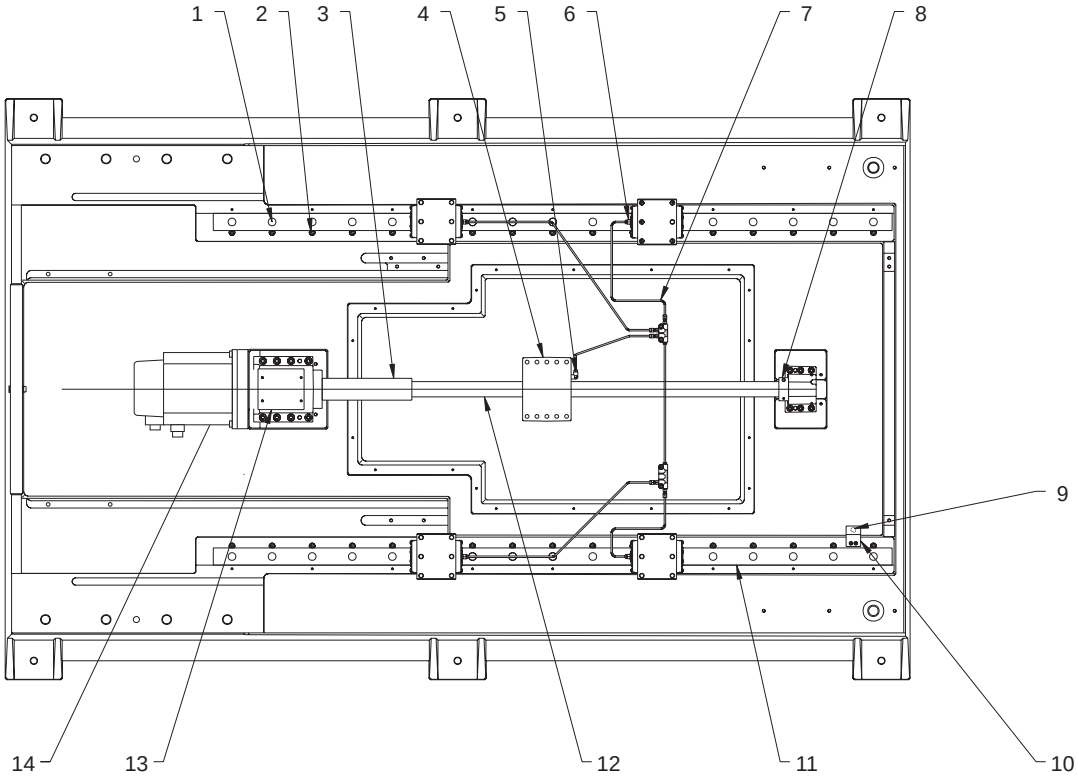


1. 32-2130 Limit switch assembly
2. 62-0037B Motor (except XRT)
3. 30-0464 Oil line assembly
4. 50-9010 Linear guide



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

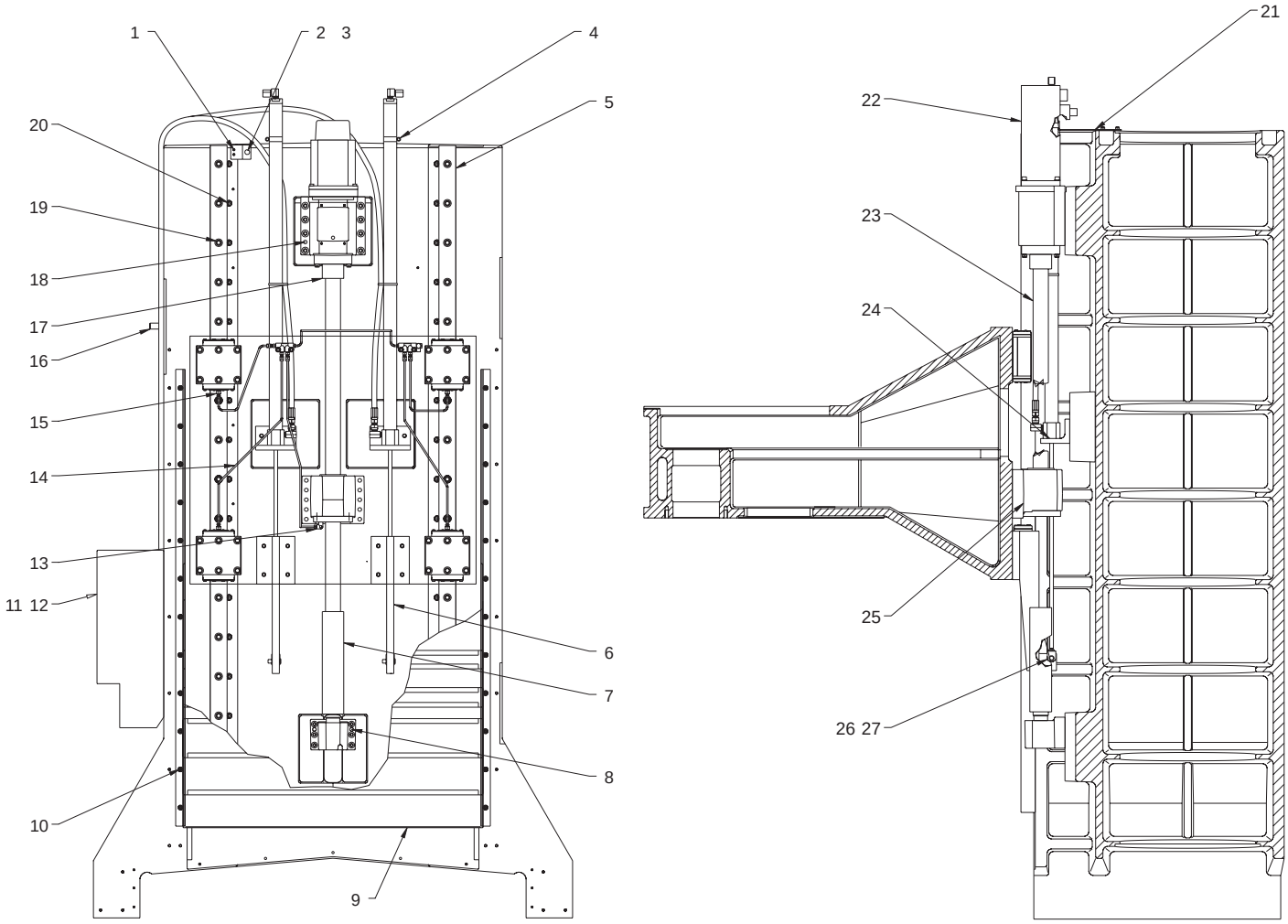
VF-10 Base



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)*

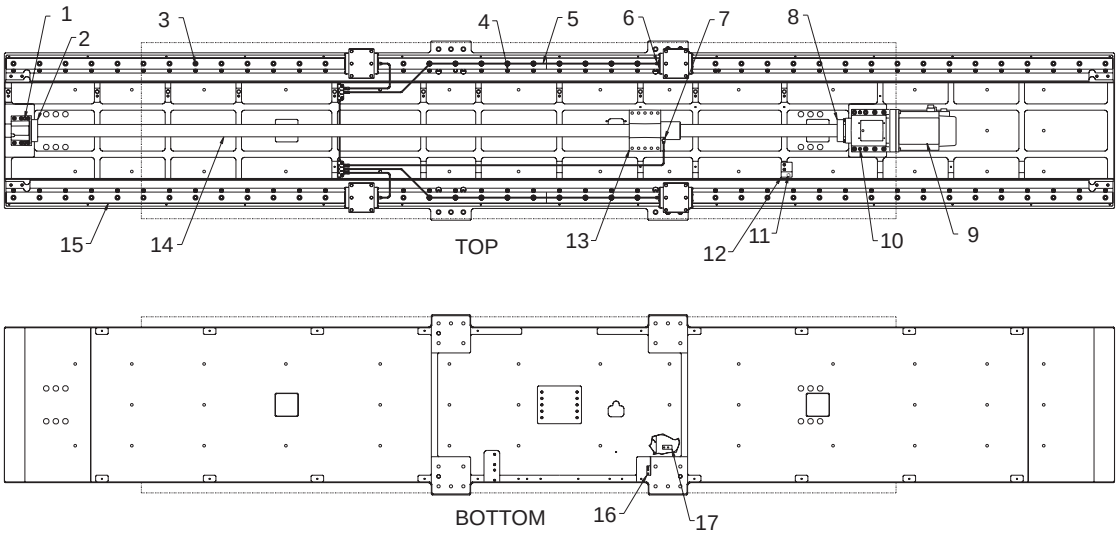
*Except XRT

VF-10 Column



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

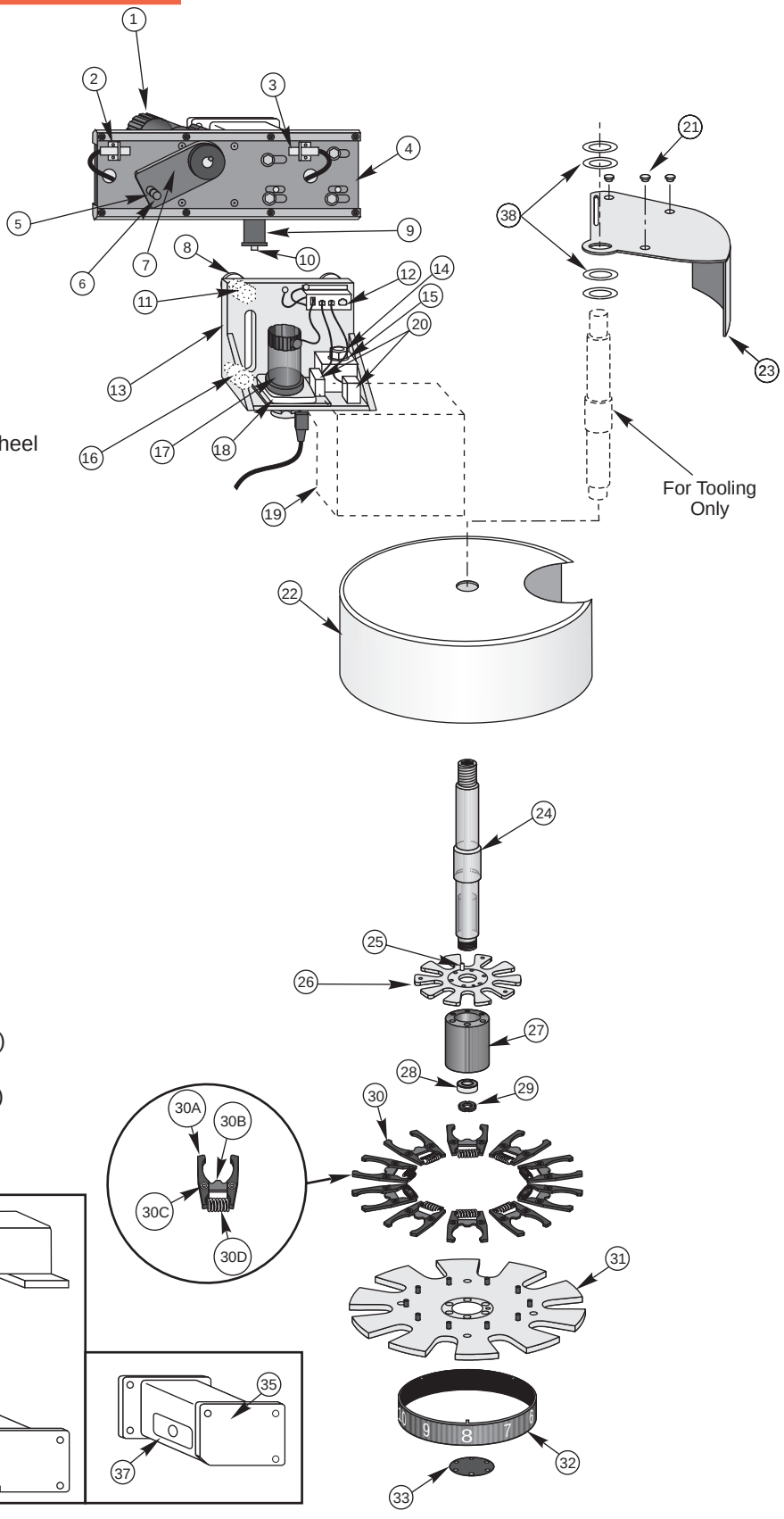
VF-10 Saddle



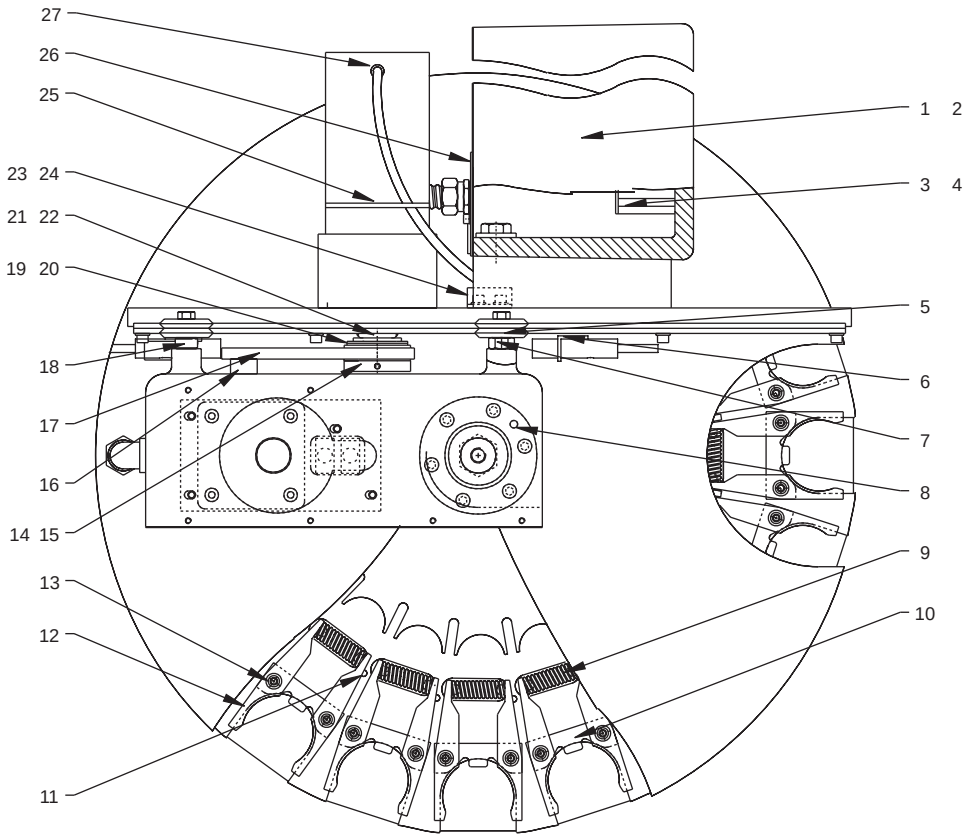
1.	20-0152	Bearing housing 40mm and 50mm ballscrew
2.	20-0194	Bumper
3.	59-6655	Rubber plug
4.	22-7458	Cam, linear guide
5.	30-0534	Oil line assembly
6.	58-1560	Linear guide adapter 1/8m
7.	58-3031	Banjo elbow 5/16 F x M6 M (50T)
8.	20-0194	Bumper 40 and 50mm ballscrews
9.	62-0016	Motor (except XRT)
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

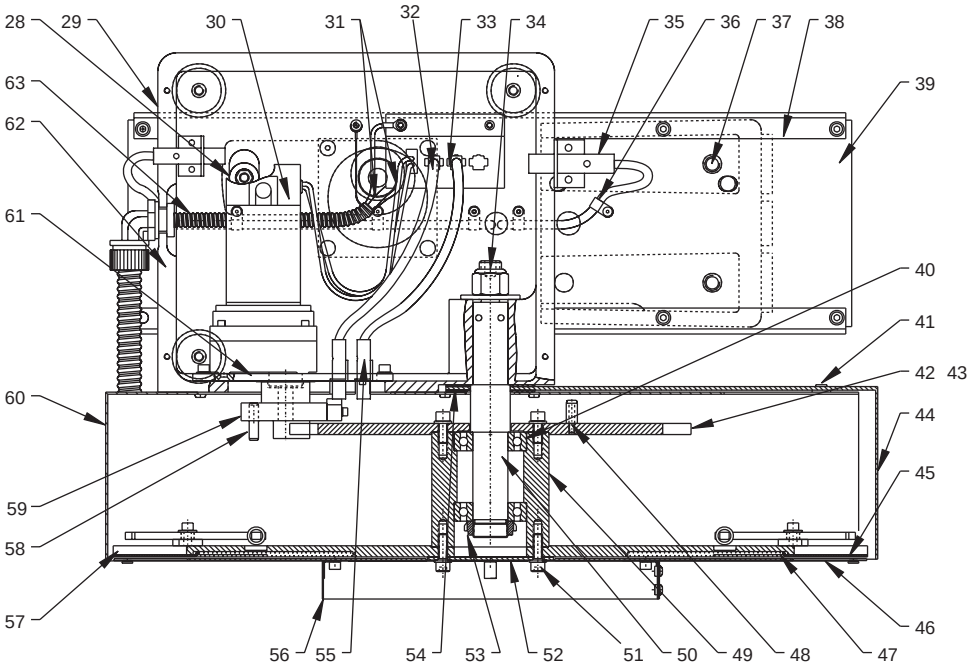
10 Pocket Tool Changer

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
	32-2206	Limit Switch
21.	22-7163	Rider Trap Door
22.	25-0633	T/C Shroud
23.	25-0636A	Trap Door
24.	20-0681	Vertical Axle
25.	22-7255A	Tool #1 Standoff
26.	20-0678	Geneva Star
27.	20-0679	Bearing Housing
28.	51-2022	Bearing Radial
29.	51-2041	Bearing Locknut BH-05
30.	A 22-9574A	CT Extractor
	B 22-7067F	Extractor Key
	C 22-9256	Extractor Bushing
	D 24-9257	Extractor Spring
31.	93-0403	Carousel
32.	25-0638	Number Ring
33.	25-0635	Bearing Cover
34.	20-1118D	Mounting Arm T/C (TRM)
35.	20-1263A	Mounting Arm T/C (MM)
36.	25-9912A	Conduit Mtg Plate (TRM)
37.	25-7906	Conduit Mtg Plate (MM)
38.	45-2020	Washer Nylon



20 Pocket Tool Changer

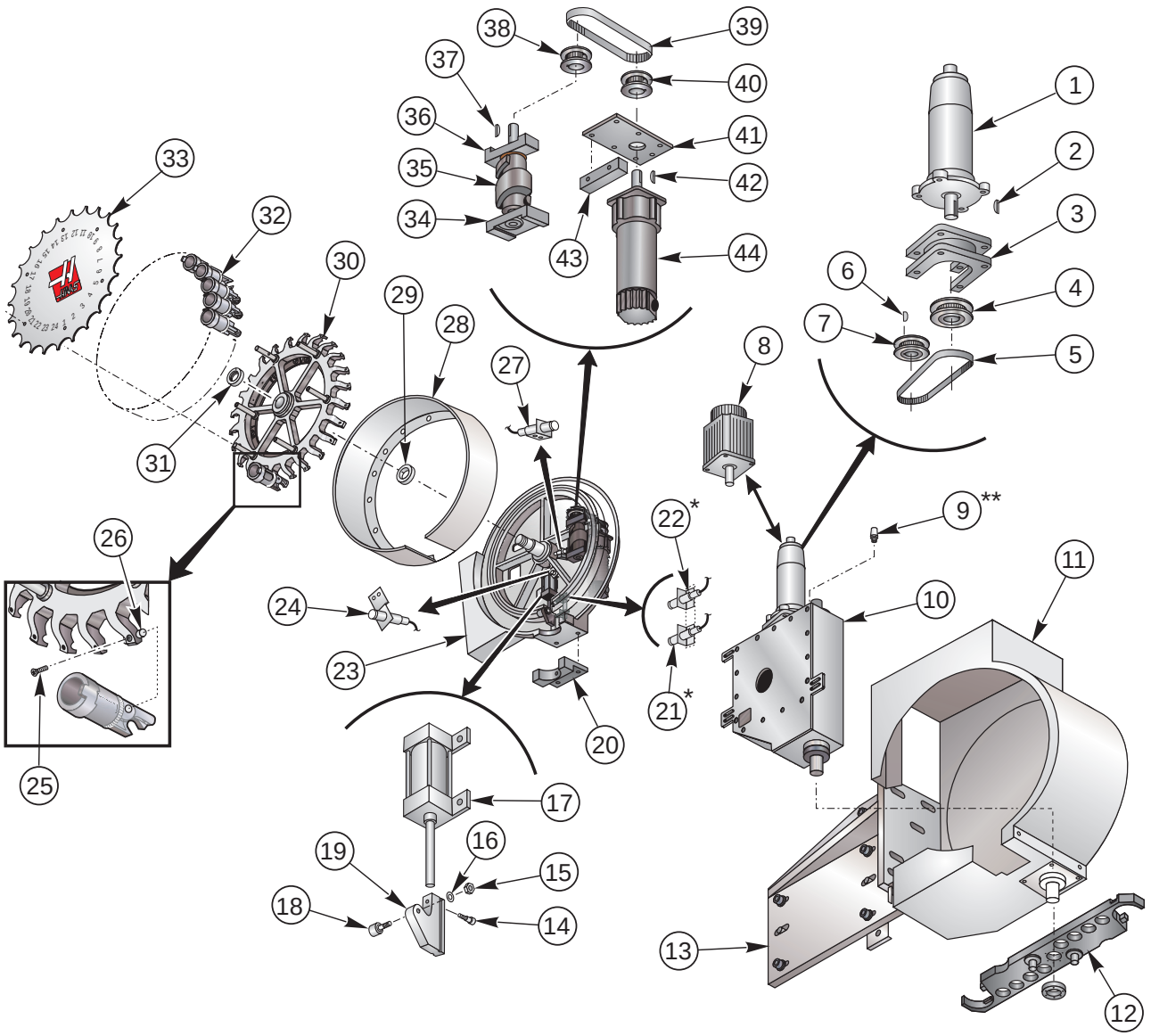




20 Pocket Tool Changer

1.	20-7029C	Holding arm
2.	57-7379	Tool holding arm gasket
3.	79-0014	Wire channel 1in. x 2in.
4.	79-0015	Cover wire channel 1"
5.	54-0030	Guide wheel
6.	22-7263	Block switch mounting
7.	54-0020	Bushing guide wheel
8.	48-0019	Dowel pin 1/4 x 5/8
9.	24-9257	Spring, extractor
10.	22-7067F	Key extractor spring
11.	48-0002	Roll pin 7/32 x 7/8
12.	22-9574A	CT extractor spring load
	22-7166A	BT Extractor
13.	22-9256	Bushing extractor
14.	20-7476	Hub slip clutch
15.	48-0005	Dowel pin 3/16 x 3/8
16.	22-7034	Spacer, cam follower
17.	20-7475	Arm slip clutch
18.	54-0040	Standard bushing guide wheel
19.	22-9256	Bushing extractor
20.	45-2020	Washer 1 1/4 nylon
21.	51-6000	Bearing locknut NT-05
22.	55-0010	Spring washer B2500-080
23.	22-2065	Locating pin
24.	25-0466	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
50.	20-7035G	Vertical axle
51.	54-0040	Standard bushing guide wheel
52.	25-7036	Cap, tool changer
53.	51-0012	Bearing locknut BH-06
54.	26-7239	Spacer ring
55.	32-2205	Prox NC TC mark
56.	25-7570	Number ring
57.	20-7352B	20 tool carousel
	20-1524	20 Tool carousel BT
58.	51-0051	Bearing 3/4 cam follower
59.	20-9332	Driver geneva 2 pin
60.	25-7237C	20 pocket T/C cover
61.	20-7236A	Motor mounting plate
62.	57-7378	Tool Carriage gasket (VF6-10)
63.	78-1996	Split flex tubing 1/2 I.D.

Side Mount Tool Changer Assembly

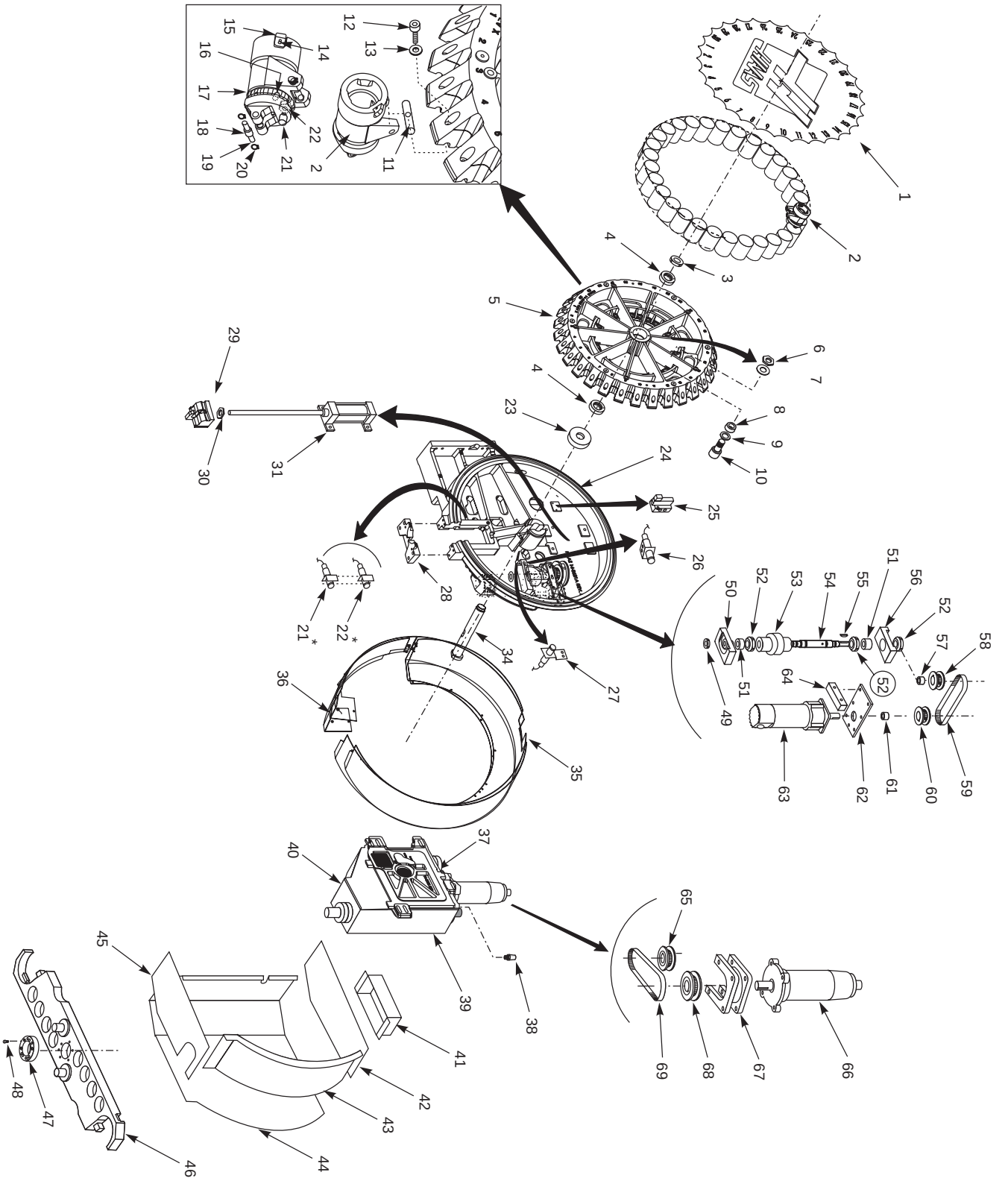


Side Mount Tool Changer Assembly

* 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

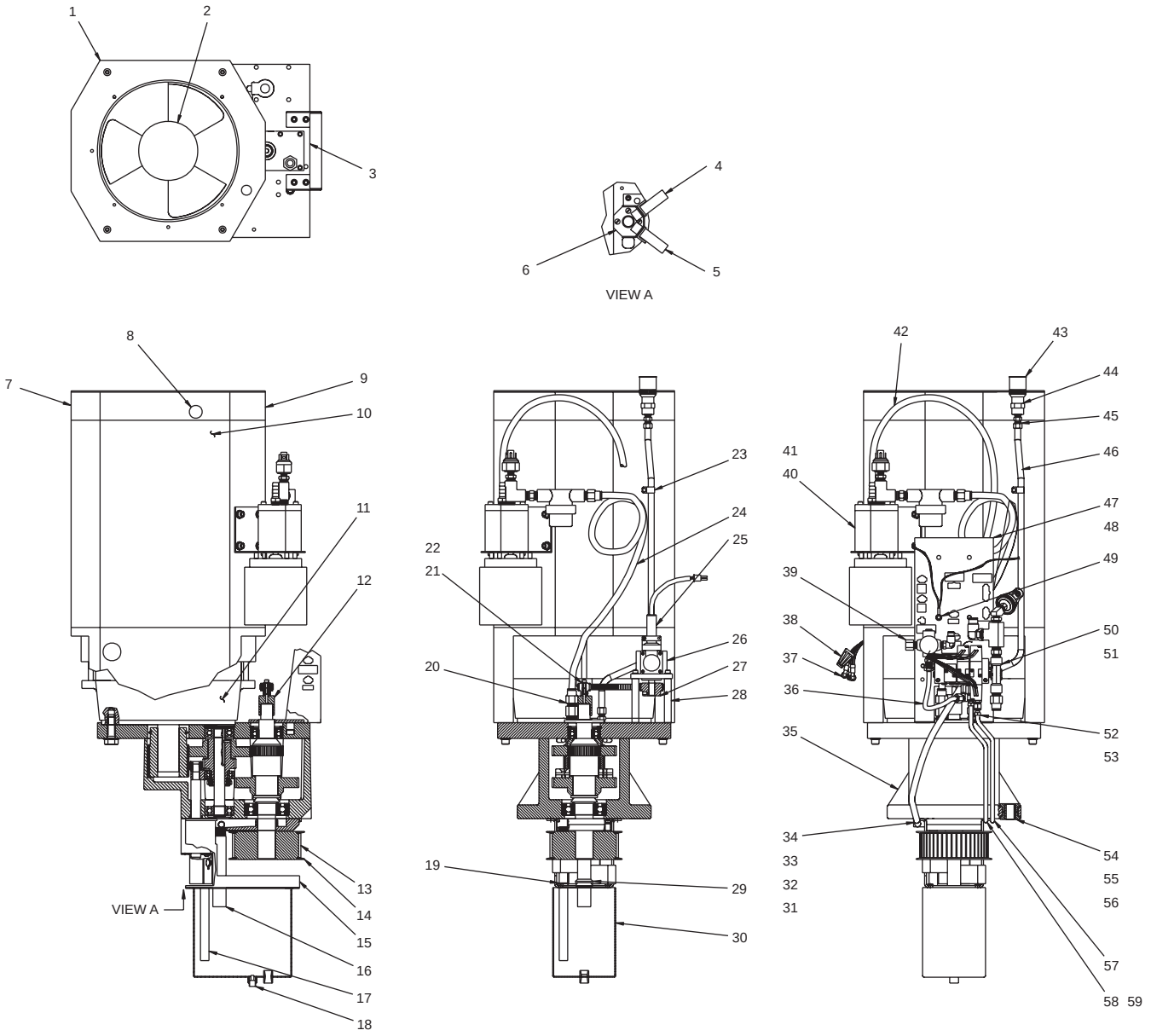
50 Taper Side Mount Tool Changer Assembly



50 Taper Side Mount Tool Changer Assembly

1.	25-0284A	Carousel Cover
2.	20-0490A	Tool Pocket 50T
3.	51-2043	Bearing Lock Nut
4.	51-0020	Bearing
5.	20-0438A	Carousel 50T
6.	46-1663	Jam Nut
7.	45-0068	Flat Washer
8.	20-1239A	Tapered Bushing
9.	45-0070	Washer
10.	51-0045	Cam Follower
11.	20-0386	Pocket Roller Shaft
12.	40-1715	SHCS
12.	45-1739	Washer
14.	40-1919	Screw
15.	20-0384	Arm Key
16.	20-0382	Pocket Plunger
17.	59-0114	Spring
18.	20-0383	Tool Pocket Rollers
19.	56-0020	Retaining Clip
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
54.	20-0231	Carousel Shaft
55.	22-2629	Key Stub
56.	20-7239	Carousel Cam Top Support
57.	54-0017	Bushing
58.	54-0044	Pulley
59.	54-0045	Belt
60.	54-0043	Pulley
61.	54-0017	Bushing
62.	20-0272B	Motor Mount Plate
63.	32-1875	Motor Assy.
64.	20-0273	Motor Mount Block
65.	54-0043	Pulley
66.	32-1880B	Motor Assy.
67.	20-0772	Motor Mounting Base
68.	54-0037	Pulley
69.	54-0036	Belt

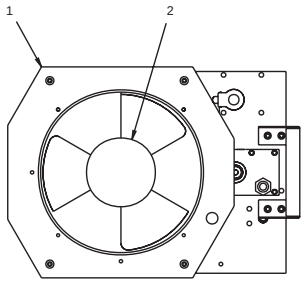
VF 1-11 Gearbox Assembly 15 HP

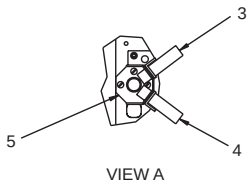


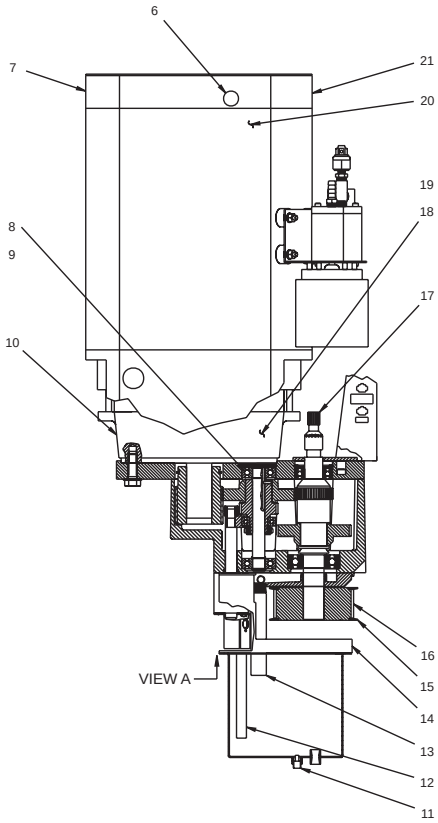
VF 1-11 Gearbox Assembly 15 HP

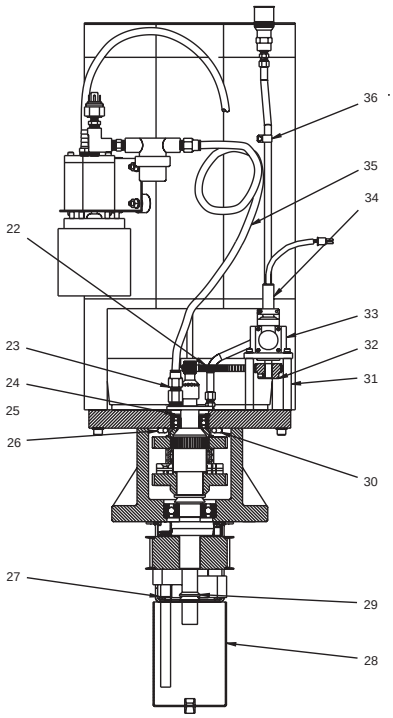
1.	25-0108	Fan bracket motor shroud
2.	36-3035	Spindle fan assembly
3.	59-7130	Protective strip
4.	32-2259A	Prox NO 2WR
5.	32-2214A	Prox NC 2WR
6.	25-7264	Switch mounting bracket
7.	29-0022	Shroud caution decal
8.	59-1482	Nylon finish plug, 13/16
9.	25-01074	Motor shroud
10.	20-0064	Adapter encoder pulley
11.	62-3010	Spindle motor, 10HP
12.	59-0046	Soundcoat shroud RT/LT
13.	N/A	
14.	N/A	
15.	25-7433	Sump bracket
16.	22-7445A	Drain tube dry sump
17.	22-7446	Pick up tube dry sump
18.	58-2745	Magnetic oil plug
19.	57-0001	Oil seal
20.	58-3657	1/4 female 1/8 male adaptor
21.	54-2125	Drive belt HTD 300-3M-09
22.	54-1013	Drive sprocket .250 RTAP
23.	59-2040	Cable clamp 7/16
24.	58-2001	Polyu hose 1/2OD x 3/8ID
25.	32-1455D	RTAP encoder cable
26.	60-1810	Shaft encoder 2000 line
27.	54-7127	Drive sprocket .375 RTAP
28.	22-7260	Encoder standoff
29.	57-0002	Oil seal
30.	25-7434	Sump tank
31.	63-1031	Cable clamp 1/4
32.	59-4006	Hose crimp, 35/64
33.	59-2040	Cable clamp, 7/16
34.	58-3616	3/8 90 deg. elbow 1/4 NPT
35.	N/A	
36.	58-7377	Air reg/solenoid tube
37.	76-2420	Crimp ring, 12-10 10 stud
38.	77-8011	Wire nut, ideal #30-076
39.	30-3270A	Precharge regulator assy
40.	30-3260B	Oil gear pump assy
41.	59-0027	Hose clamp 1/2 hose
42.	58-2020	3/8OD natural tubing
43.	22-7487	Oil fill cap modified
44.	58-2065	Coupling, 1/4NPT
45.	58-2070	1/4NPT male to 3/8 comp
46.	58-9114B	Trans fill tube
47.	25-7336	Solenoid mounting bracket
48.	33-3200	Solenoid bracket cable assembly
49.	33-5088	Ground strap spindle motor shroud
50.	30-3146	Air solenoid assy mac TP
51.	N/A	
52.	58-2100	Sleeve lube assembly
53.	58-2110	Sleeve nuts lube assembly
54.	22-7520A	Isolater trans
55.	22-7521A	Spacer trans
56.	N/A	
57.	58-7636	High gear tube VF-3
58.	58-7635	Low gear tube VF-3
59.	63-0001	Nylon cable clamp 1/2

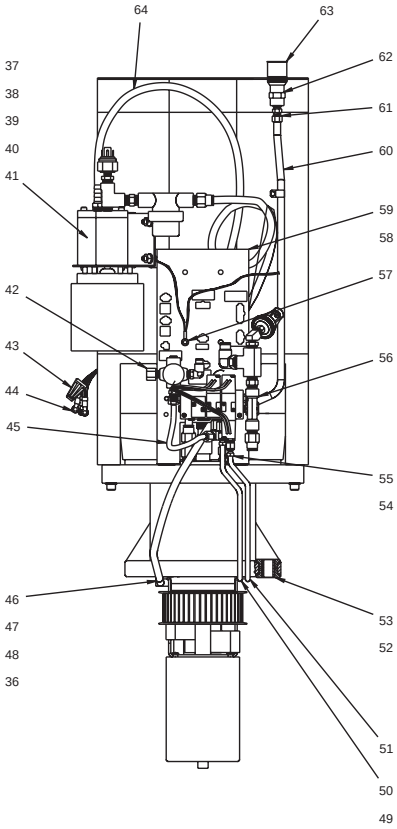
VF 1-11 Gearbox Assembly HT10K







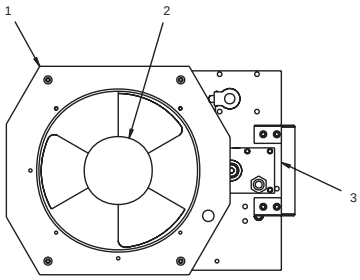


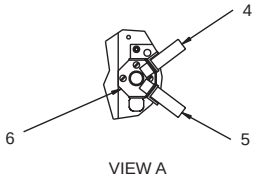


VF 1-11 Gearbox Assembly HT10K

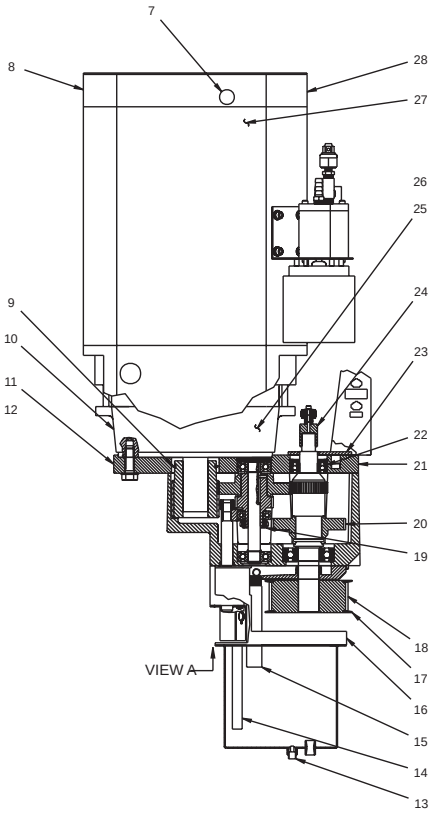
1.	25-0108	Fan bracket motor shroud
2.	36-3035	Spindle fan assembly
3.	32-2011	Switch assembly (30" cable length)
4.	32-2010	24" limit switch
5.	25-7264	Switch mounting bracket
6.	59-1482	Nylon finish plug, 13/16
7.	29-0022	Shroud caution decal
8.	55-0035	Spring washer, BS-204
9.	56-2087	Snap ring, N5000-206
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

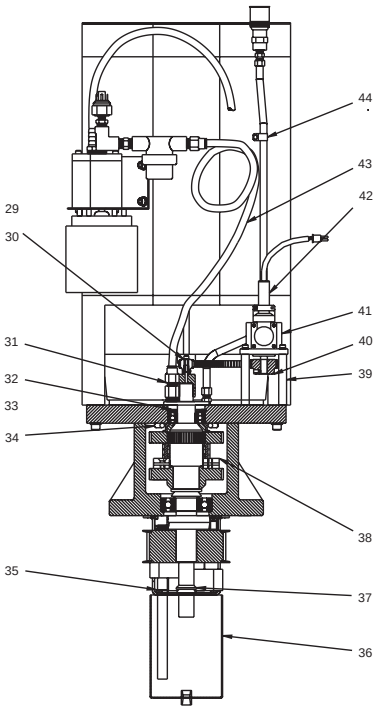
VF 1-11 Gearbox Assembly HT10K TSC

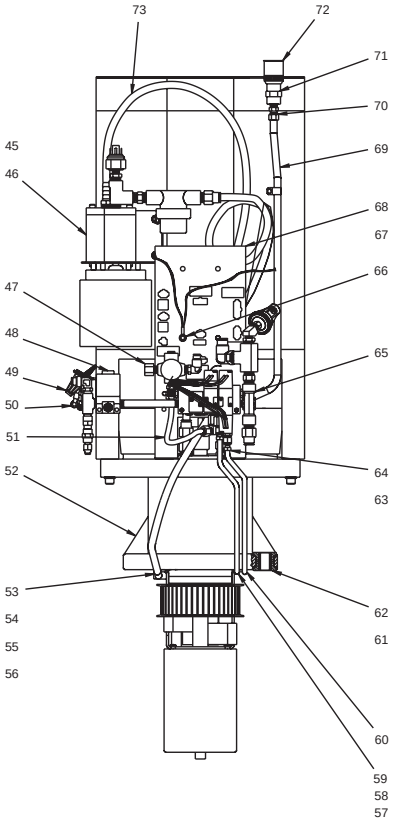




VIEW A



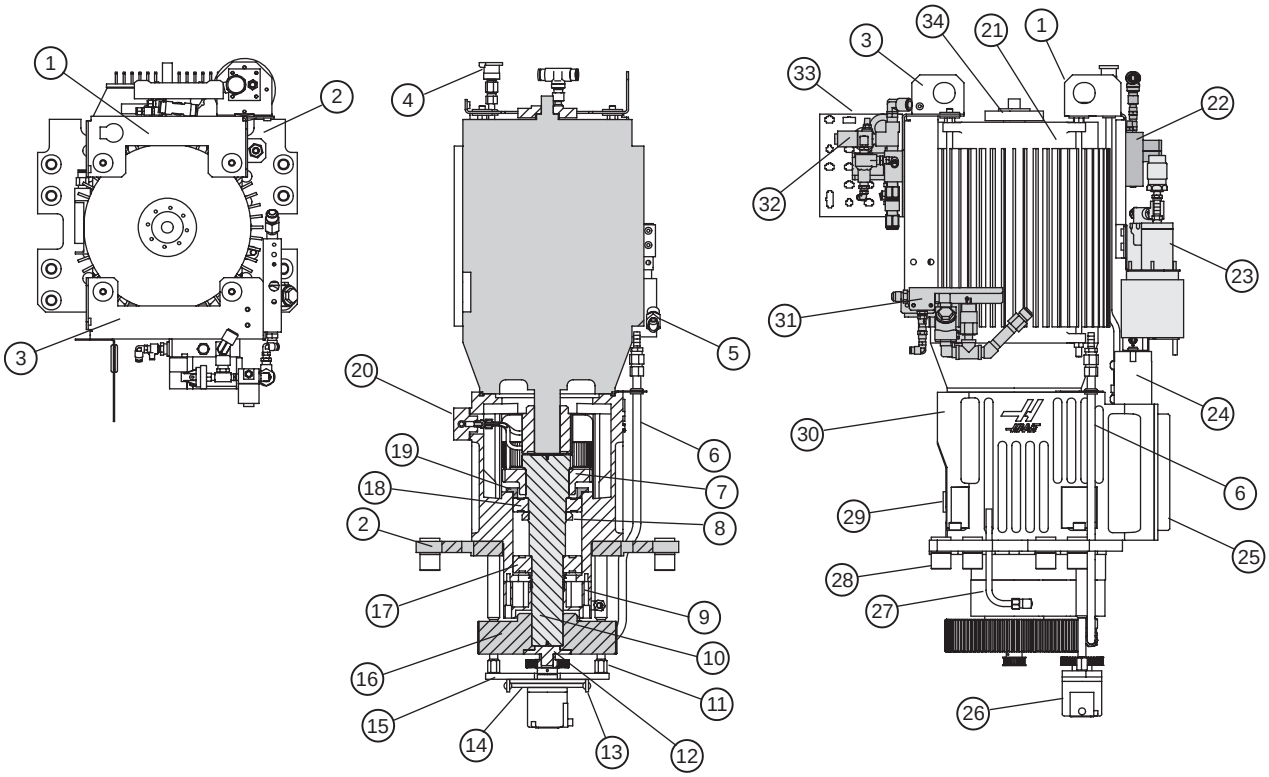




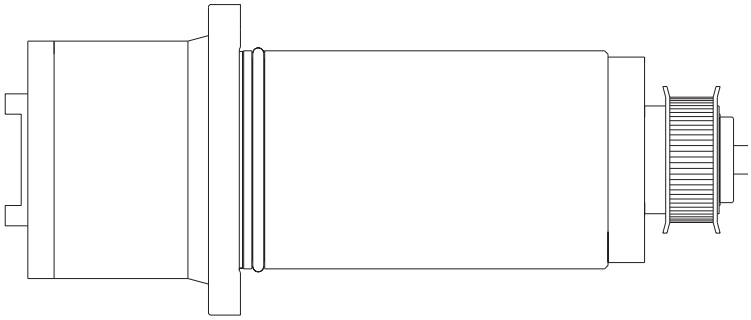
VF 1-11 Gearbox Assembly HT10K TSC

1.	25-0108	Fan bracket motor shroud
2.	36-3035	Spindle fan assembly
3.	59-7130	Protective strip
4.	32-2011	Switch (30" cable lenght)
5.	32-2010	24" limit switch
6.	25-7264	Switch mounting bracket
7.	59-1482	Nylon finish plug 13/16
8.	29-0022	Shroud caution decal
9.	57-0006	O-ring 2-328 buna
10.	29-7399	Transmission motor label
11.	29-9128	Label, transmission
12.	48-0020	Pin, dowel 1/4 x 1
13.	58-2745	Magnetic oil plug
14.	22-7446	Pick up tube dry sump
15.	22-7445A	Drain tube dry sump
16.	25-7433	Sump bracket
17.	22-7376	Sprocket flange
18.	20-7374	1 1/8 Sprocket
19.	N/A	
20.	N/A	
21.	N/A	
22.	N/A	
23.	20-7435	Oil plate
24.	20-0064	Adapter encoder pulley
25.	57-7573A	Trans motor gasket
26.	36-3078	10K 10HP motor kit
27.	59-0046	Soundcoat shroud RT/LT
28.	25-0107	Motor shroud
29.	54-1013	Drive sprocket .250 RTAP
30.	54-2125	Drive belt HTD 300-3M-09
31.	58-3657	1/4 female 1/8 male adapter
32.	55-0036	Spring washer, BS-205
33.	56-0070	Snap ring N5000-187
34.	58-7357	Top plate tube-A
35.	57-0001	Oil seal
36.	25-7434	Sump tank
37.	57-0002	Oil seal
38.	N/A	
39.	22-7260	Encoder standoff
40.	54-7127	Drive sprocket .375 RTAP
41.	60-1810	Shaft encoder 2000 line
42.	32-1455D	RTAP encoder cable
43.	58-2001	Polyu hose 1/2OD x 3/8 ID
44.	59-2040	Cable clamp 7/16
45.	59-0027	Hose clamp 1/2 hose
46.	30-3260B	Oil gear pump asssembly
47.	30-3270A	Precharge regulator assembly
48.	30-3276	Purge solenoid valve assembly
49.	77-8001	Wire nut, ideal #30-076
50.	76-2420	Crimp ring, 12-10 10 stud
51.	58-7377	Air reg solenoid tube
52.	N/A	
53.	58-3616	3/8 90 deg. elbow 1/4NPT
54.	59-4006	Hose crimp, 35/64
55.	59-2040	Cable clamp 7/16
56.	63-1031	Cable clamp 1/4
57.	63-0001	Nylon cable clamp 1/2
58.	58-7635	Low gear tube VF-3
59.	N/A	
60.	58-7636	High gear tube vf-3
61.	22-7521A	Spacer trans
62.	22-7520A	Isolater trans
63.	58-2110	Sleeve nuts lube assembly
64.	58-2100	Sleeve lube assembly
65.	30-3146	Air solenoid assy mac tp
66.	33-5008	Ground strap spindle motor shroud
67.	33-3200	Solenoid bracket cable assembly
68.	25-7336	Solenoid mounting bracket
69.	58-9114B	Trans fill tube
70.	58-2070	1/4NPT male to 3/8 comp
71.	58-2065	Coupling, 1/4NPT
72.	22-7487	Oil fill cap modified
73.	58-2020	3/8OD natural tubing

50 Taper Gearbox Assembly



1.	25-4420	Oil Pump Bracket
2.	20-1452	Transmission Plate
3.	25-4419	Solenoid Bracket
4.	22-7487	Oil Fill Cap
5.	30-3275	TSC Check Valve
6.	58-0609	Oil Pickup Tube
7.	20-1440	Out put Gear
8.	51-0089	Bearing Locknut
9.	20-1459	Oil Pan
10.	35-0017	Output Shaft
11.	20-2965	Encoder Stand Off
12.	20-1454	Encoder Pulley
13.	25-6298	Encoder Spring Clamp
14.	25-6299	Encoder Spring Plate
15.	20-2964	Encoder Spring Mounting Plate
16.	20-1455	Pulley
17.	51-0088	Deep groove Bearing
18.	51-0087	Bearing
19.	20-2393	Bearing Ring
20.	20-1458	Oil Manifold
21.	62-4010	Spindle Motor
22.	30-3644	Shift Valve
23.	30-3260	Oil Pump Assembly
24.	20-1448	Cylinder Shifter
25.	20-1782	Housing Cover Plate
26.	32-1457	Rtap Encoder
27.		Dipstick
28.	20-1396	Transmission Spacer Plug
29.		Oil Sight Level
30.	20-1526	Housing Gearbox
31.	30-3275	Check Valve Assembly
32.	30-3642	TRP TSC Solenoid Assembly
33.	25-4421	Spindle Connector Bracket
34.	20-1147	X-Axis Support Bumper



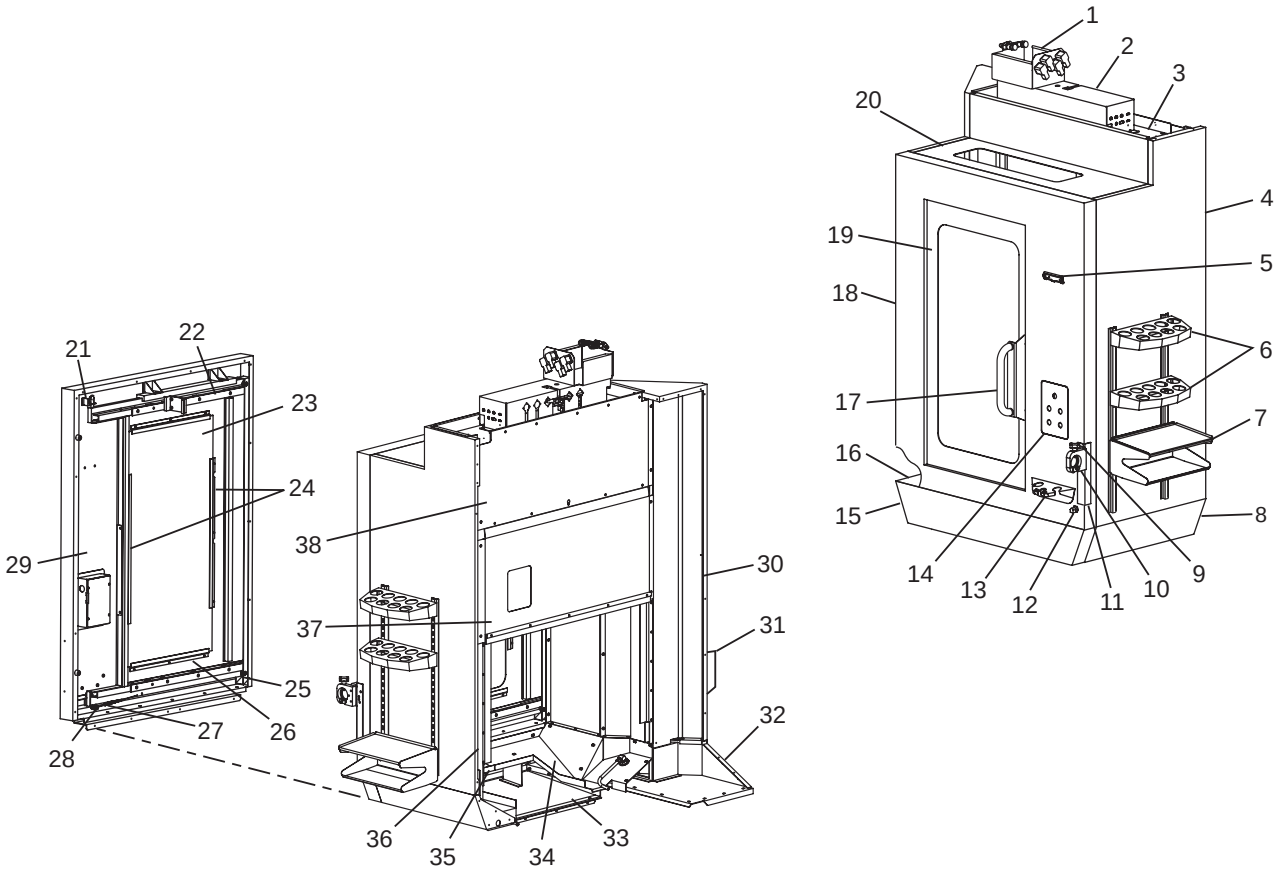
SPINDLES

30-0319A	7.5 Spindle Assembly
93-30-0319A	7.5 Spindle Assembly Service Kit
30-2132	10K Spindle Assembly
93-30-2132	10K Spindle Assembly Service Kit
30-1360A	15K Spindle Assembly
93-30-1360A	15K Spindle Assembly Service Kit
30-30723	15K spindle Assembly VF5-11
30-2014	50 Taper Spindle Assembly
93-30-2014	50 Taper Spindle Assembly Service Kit

DRAWBAR

30-3415G	7.5k spindle with or without TSC
30-2015	50 Taper

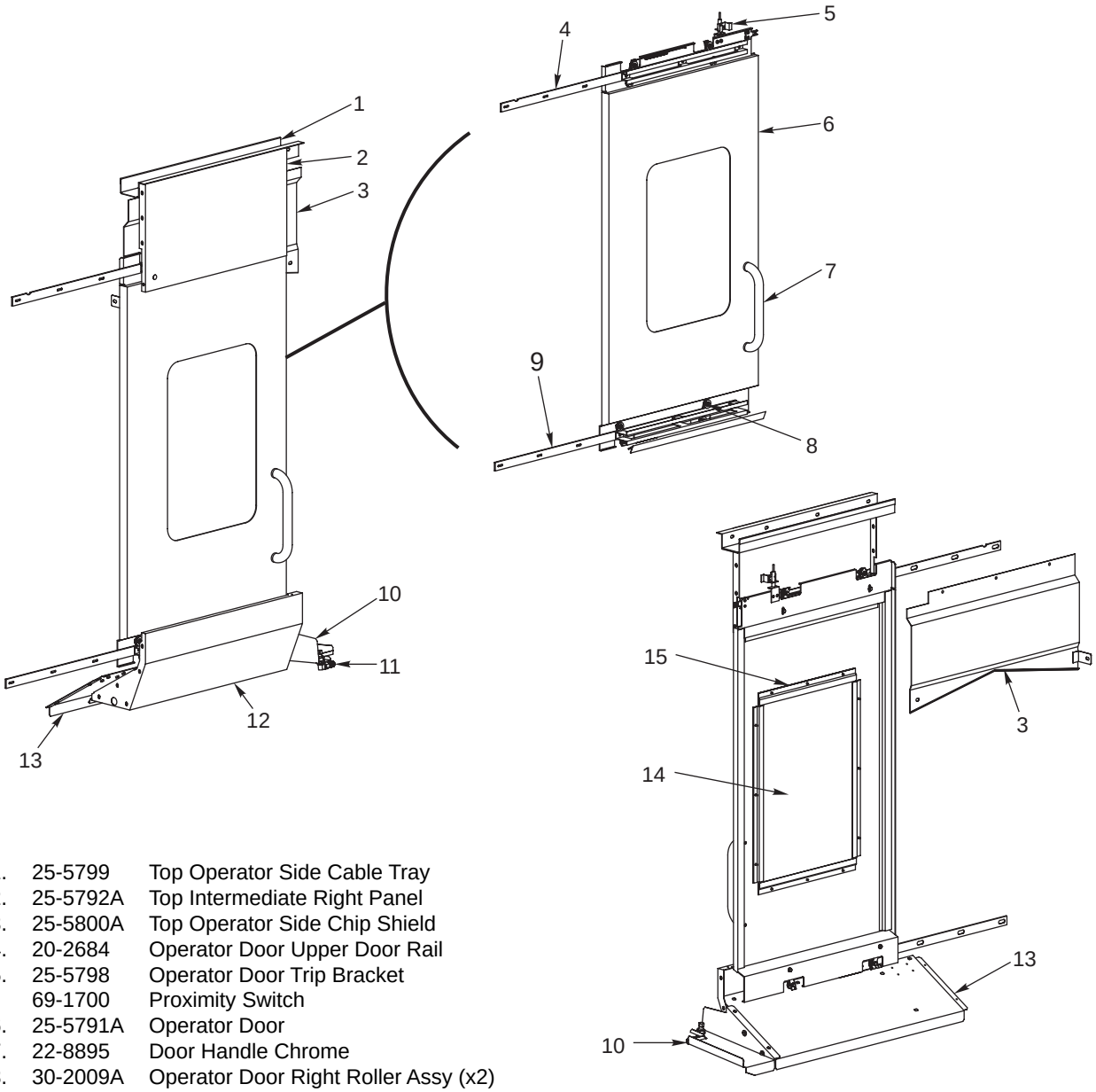
MDC-500 Front Panels Assembly



View Rotated 90° CW for Clarity

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

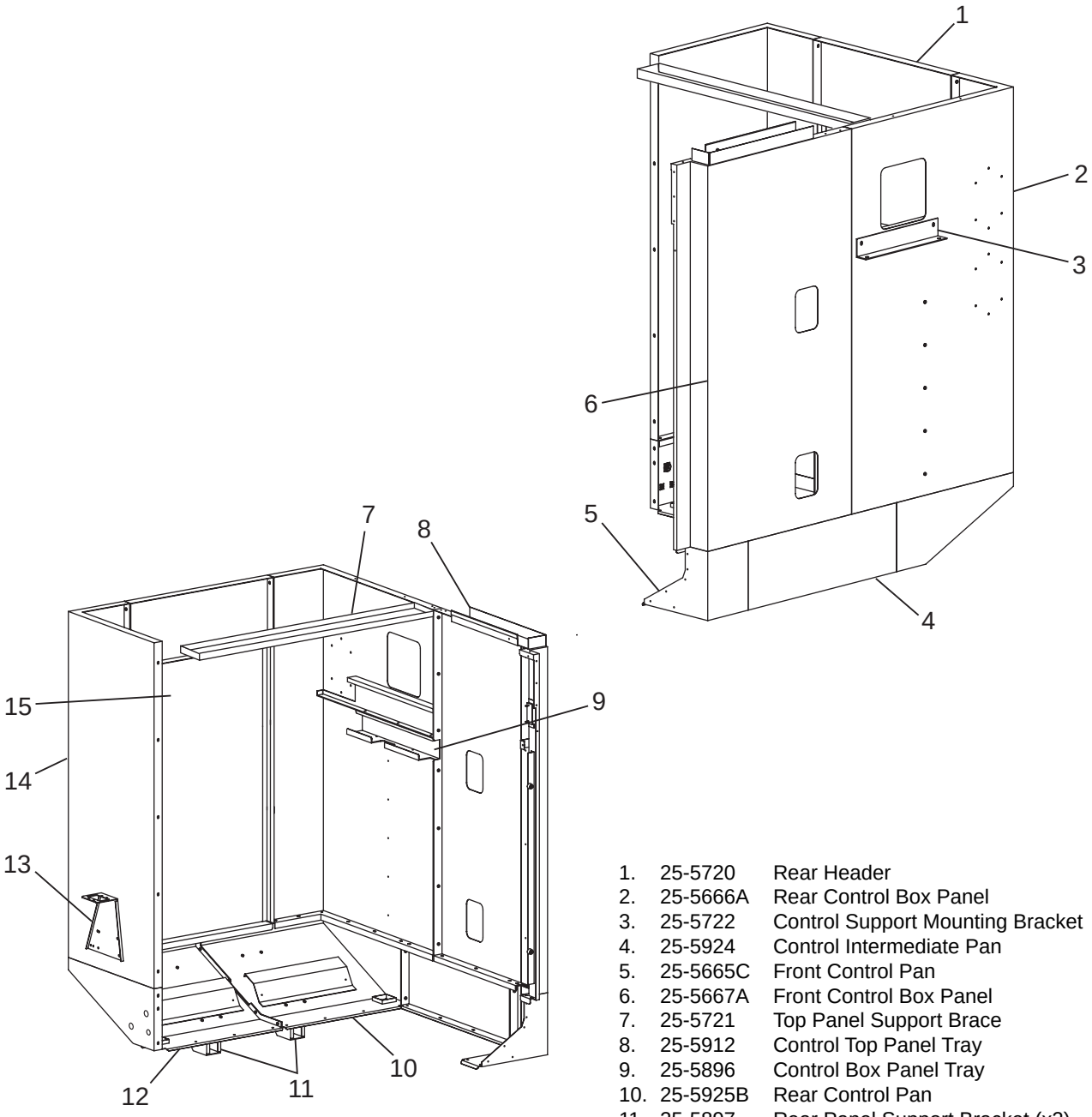
MDC-500 Operator Door Assembly



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
	69-1700	Proximity Switch
6.	25-5791A	Operator Door
7.	22-8895	Door Handle Chrome
8.	30-2009A	Operator Door Right Roller Assy (x2)
	59-9743	Door Spring
9.	20-2685	Operator Door Lower Door Rail
10.	25-5790B	Right Bottom Rollup Chip Shield
11.	30-8526	Rear Washdown Nozzle
12.	25-5788C	Right Intermediat Pan
13.	25-5789B	Operator Side Lower Chip Shield
14.	28-0151	Window
15.	25-5228	Window Z Frame (x2)

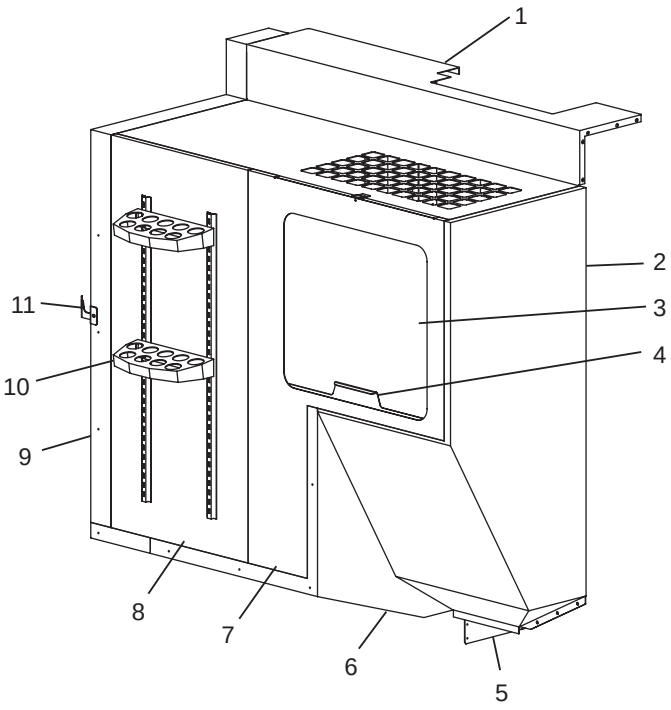
MDC-500 Rear Panels

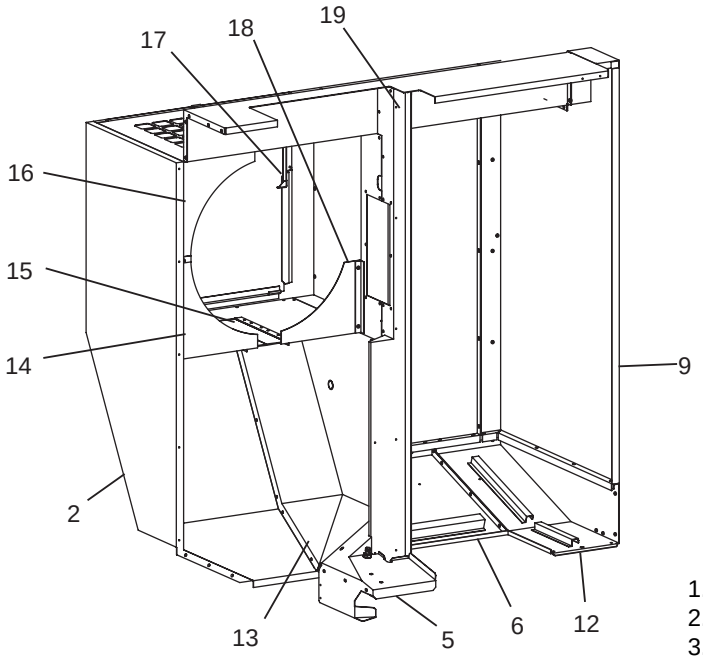


View Rotated 90° CCW for Clarity

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

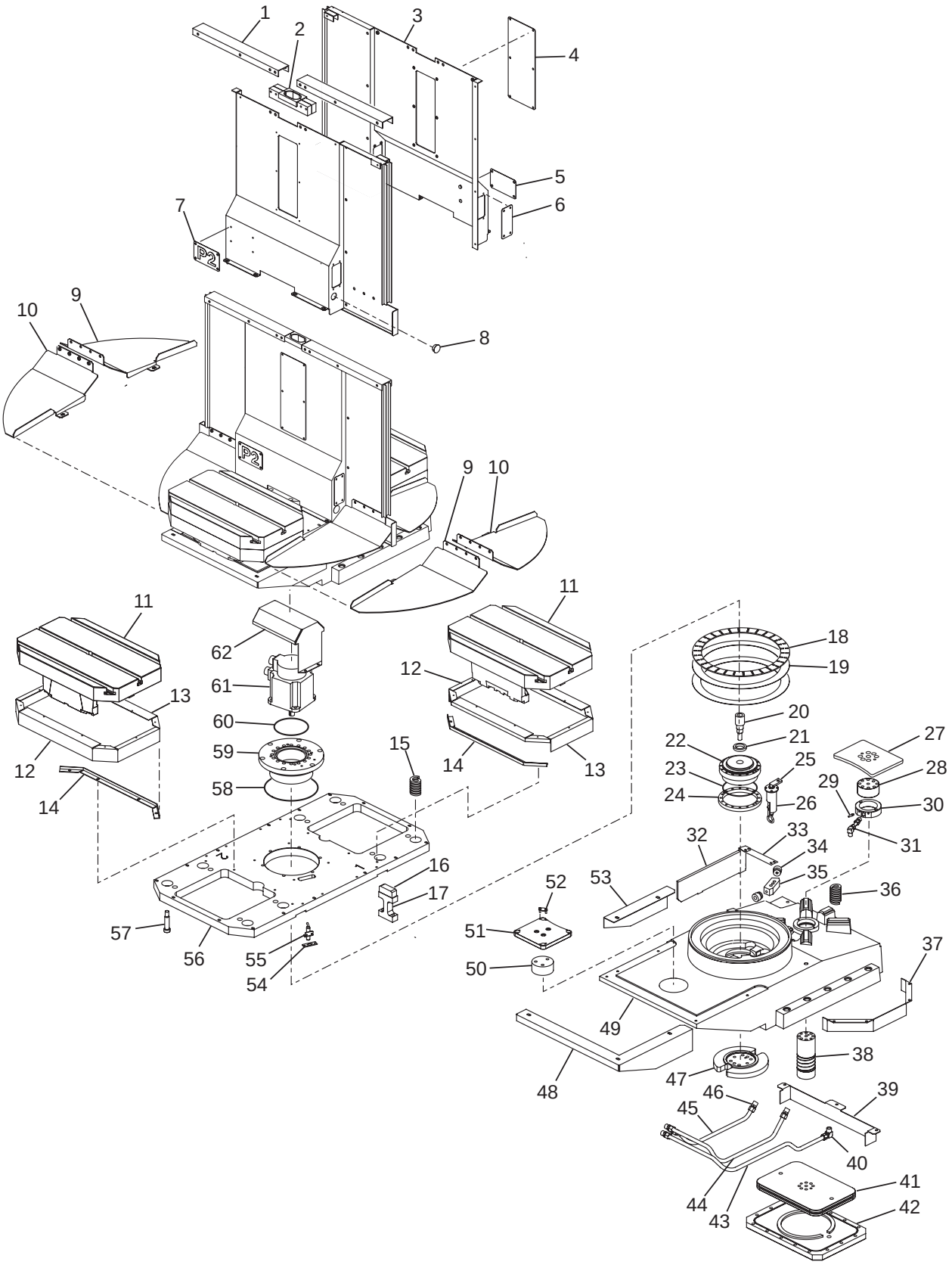




View Rotated 90° CW for Clarity

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

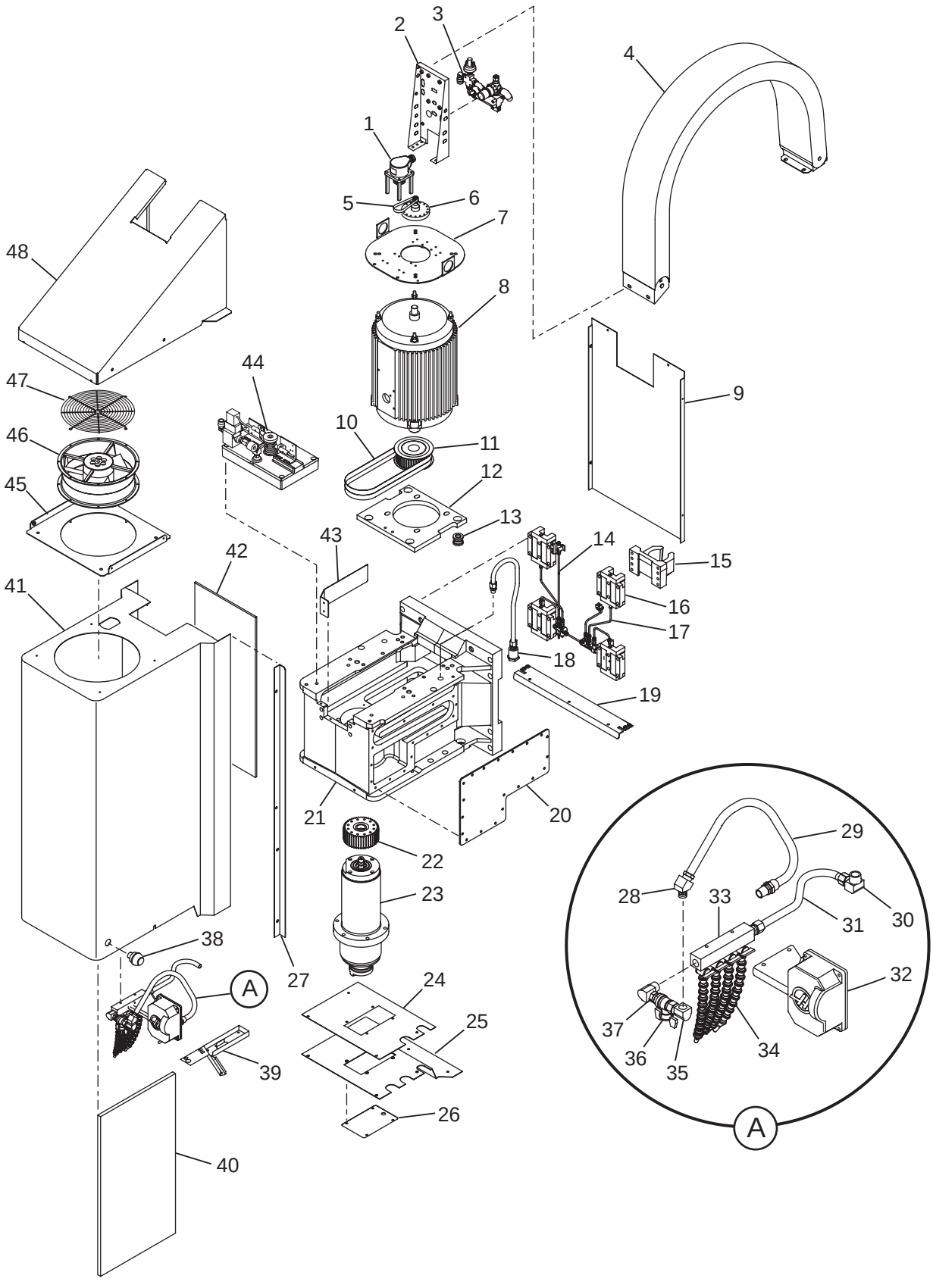
MDC-500 Pallet and Changer Assembly



MDC-500 Pallet and Changer Assembly

1.	25-5813A	Rotating Door Cap
2.	20-2695B	Rotating Door Fairlead (x2)
3.	25-5812B	Rotating Door (x2)
4.	25-6813	Cable Access Cover (x2)
5.	29-0579	(P1) Name Plate
6.	25-5883	Access Cover (x4)
7.	29-0580	(P2) Name Plate
8.	59-0198	Hole Plug 1 in. Dia. (x2)
9.	25-6943A	PC Table Chip Shield
10.	25-6944A	PC Table Chip Shield Opposite Side (x2)
11.	20-2689D	PC Table Cast Machined
12.	25-5906A	Rear Table Skirt (x2)
13.	25-5907A	Front Table Skirt (x2)
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
52.	25-5934	Button Retainer (x4)
	40-1640	SHCS 10-32 x .50 (x8)
	20-2814	Stabilizer Button (x4)
53.	25-6794	Left APC Base Chip Shield
54.	25-5903	Proximity Switch Pallet Home Mount
55.	69-1601	Proximity Switch
56.	20-2729C	Pallet Support Frame
57.	49-0117	Shoulder Bolt .625 x 2 in. LG (x8)
58.	57-0139	O-Ring 2-263
59.	20-2724	Motor Flange RV20E
60.	57-2875	O-Ring 2-157
61.	62-0014	Servo Motor
62.	25-6845	Motor Cover

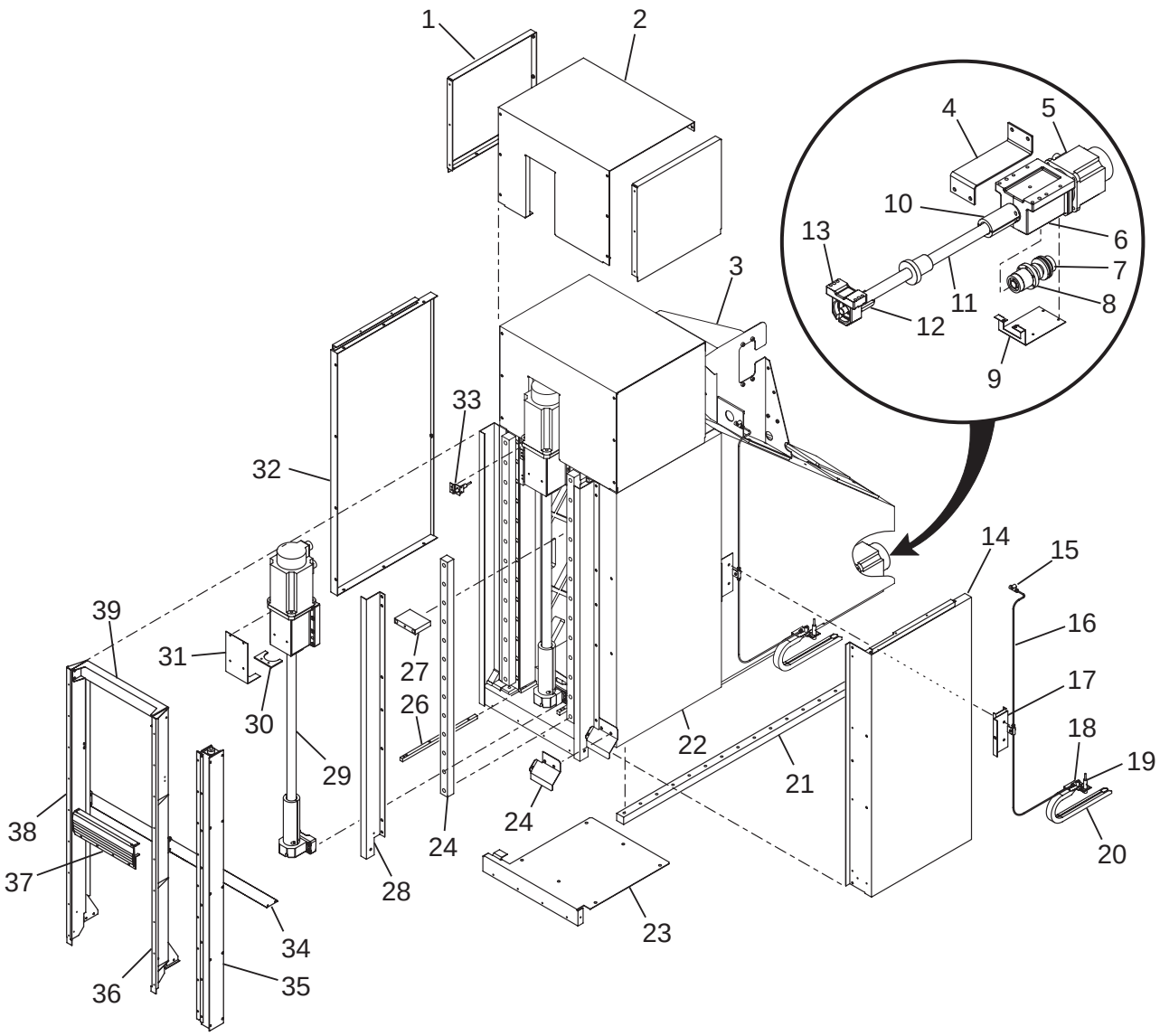
Mill Drill Spindle Head Assembly



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

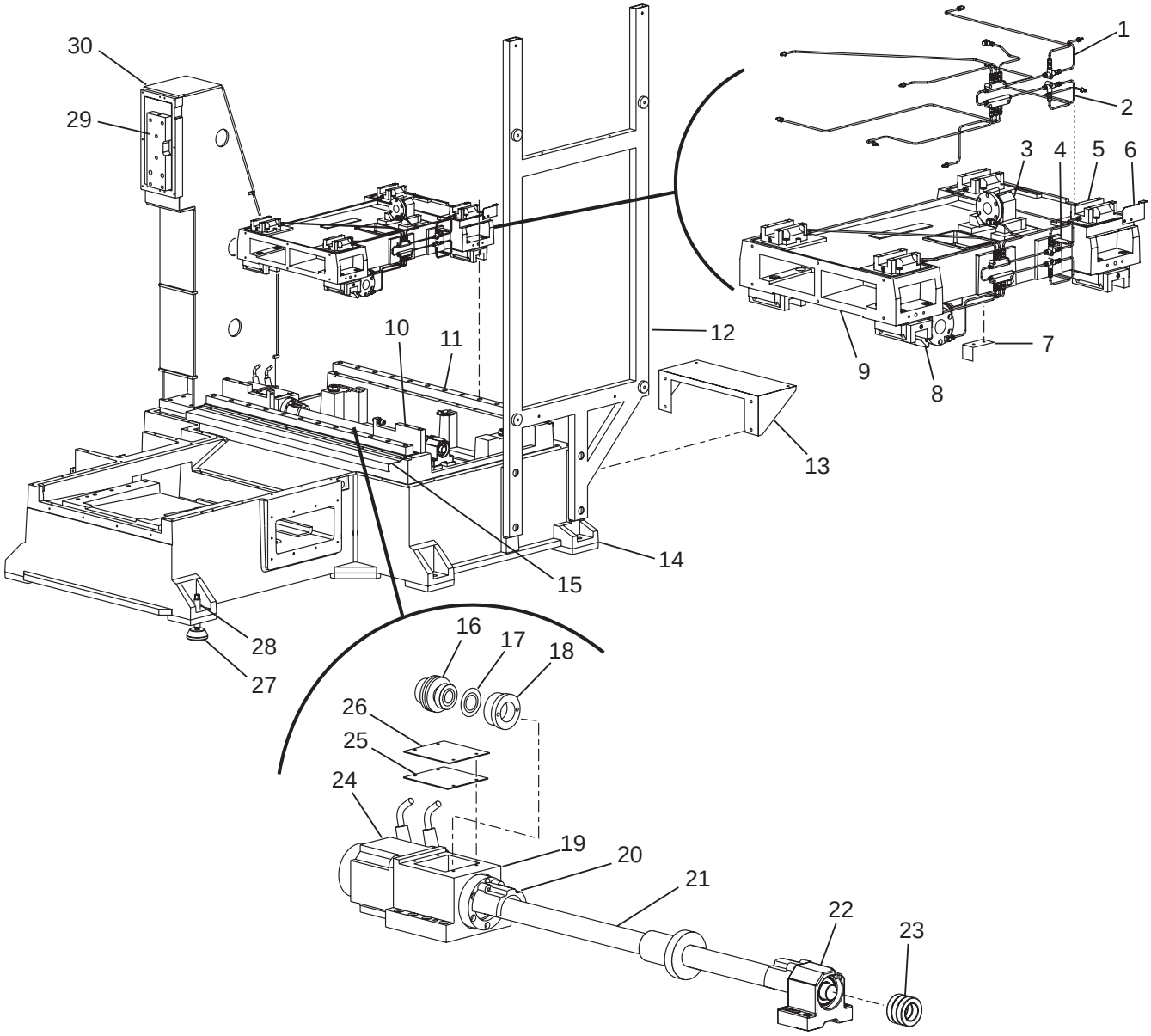
Mill Drill Column and Frame Assembly



Mill Drill Column and Frame Assembly

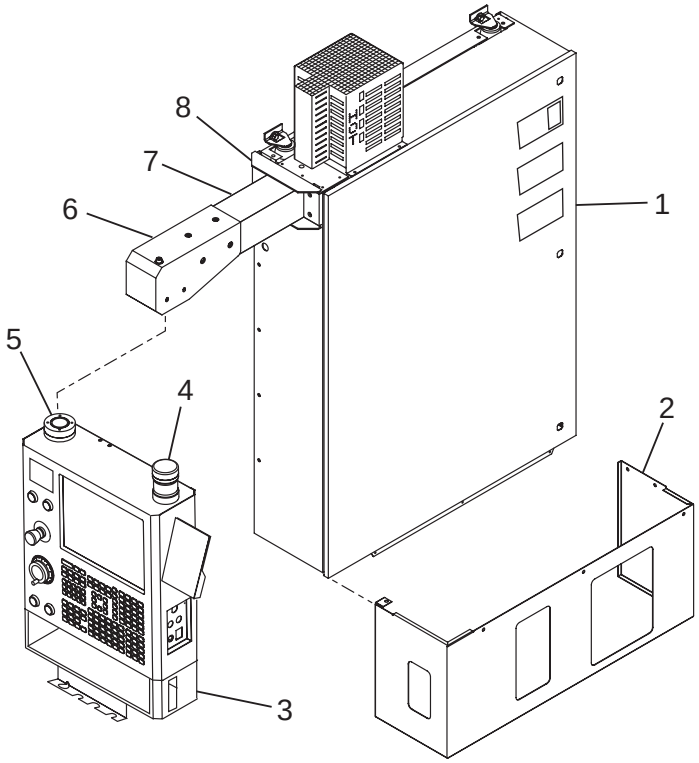
1.	25-5729	Top Column Side Cover (x2)
2.	25-5728	Top Column Top Cover
3.	25-5734C	Cable Carrier Mounting Bracket
4.	25-5736	Column-Saddle Shipping Bracket
5.	62-0014	Servo Motor
6.	20-7010B	Motor Mount Machined
7.	30-1220A	Coupling Assy.
8.	30-0154	Motor Housing Bearing Assy.
9.	25-7042	Motor Mount Cover 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.	24-0041	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

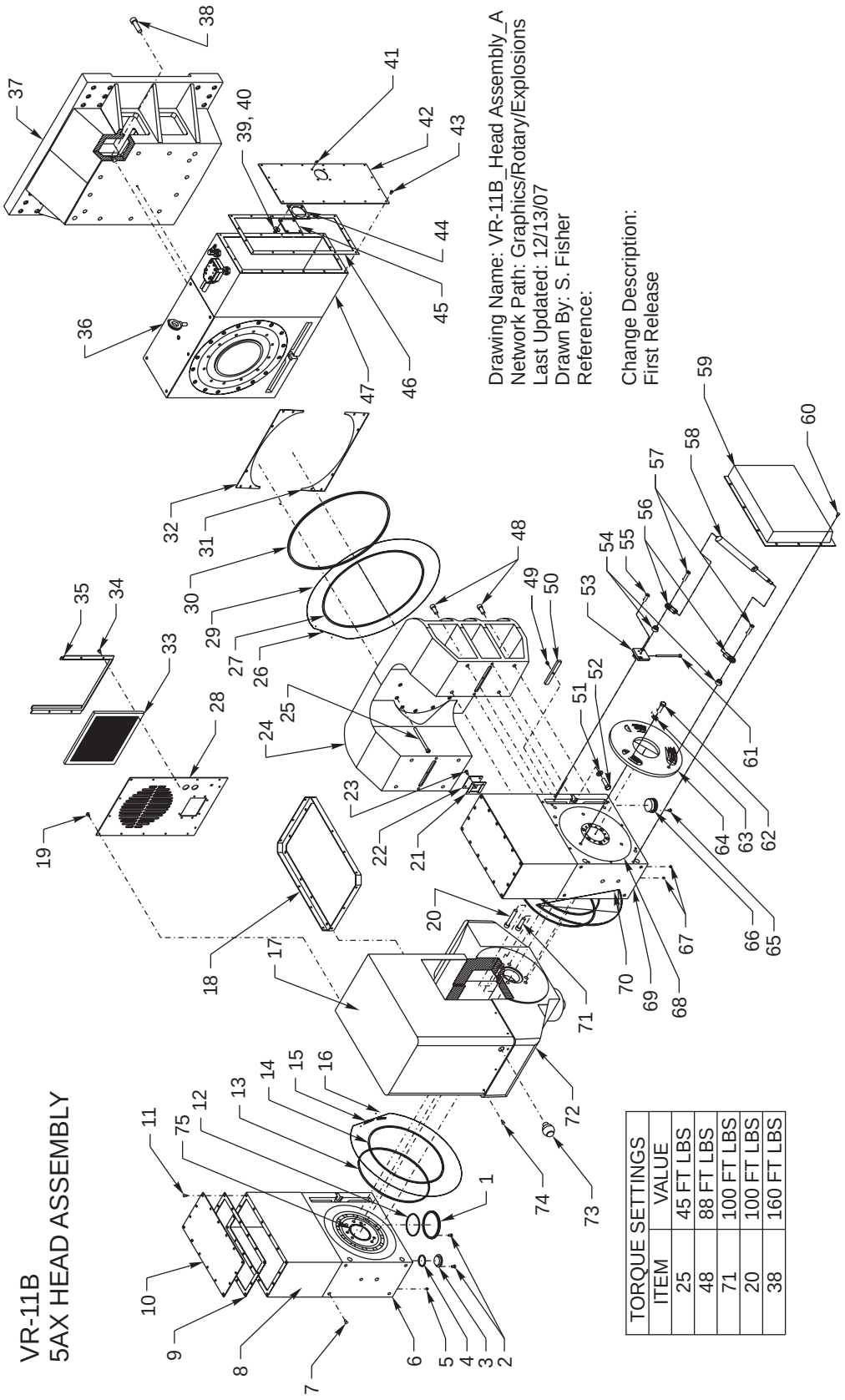


1.	30-7138	Saddle Oil Line Assy.
	58-3031	Banjo Elbow
2.	30-7140	Base Oil Line Assy.
3.	20-2958A	Nut Housing Casting Machined
4.	25-5919	Cable Carrier Mounting Bracket
5.	50-3400	X-Axis Linear Guide 35 x 840 (x2)
6.	25-5187	Z-Axis Trip Bracket
7.	25-5677	X-Axis Trip Bracket
8.	20-0150	Ballscrew Ball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

Mill Drill Control Assembly



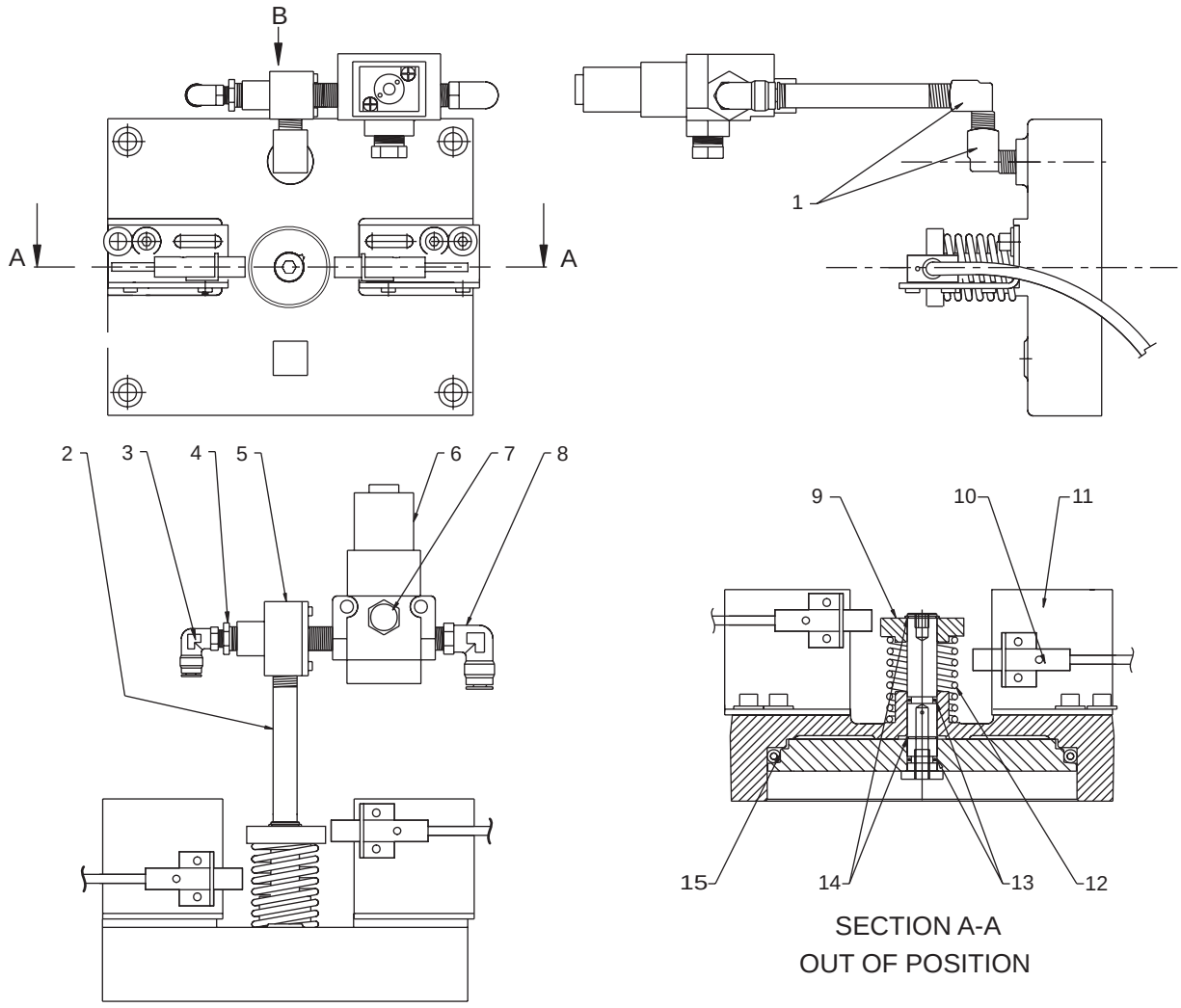
1.	30-30256	CNC Control
2.	25-10649	Control Box Skirt
3.	32-9651B	Pendant Control Assy.
	32-6006A	Front Panel Assy.
4.	28-1071	Top Beacon Light Molded
	28-1075C	Beacon Plastic Base
5.	20-7109C	Swivel Arm Mount
	20-7110C	Swivel Control Mount
6.	25-6659A	Swivel Mounting Plate
	25-6660	Arm End Cap Bottom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



VR-Series Head Assembly

ID	QTY	DWG#	DESCRIPTION
1.	1	20-4382	WORM HOUSING COVER, 5AX
2.	94	49-1750	BHCS 10-32 X 3/8
3.	1	20-4381	SIGHT GLASS PLUG
4.	1	57-2831	O-RING 2-130 BUNA
5.	1	58-3105	1/4 NPT PIPE PLUG
6.	1	30-1071	HRT310 DRIVE ASSY 5AX
7.	19	40-1980	BHCS 1/4-20 X 1/2
8.	2	25-4371	MOTOR ENCLOSURE 310/5AX
9.	4	57-4223	GASKET MOTOR ENCLOSURE
10.	2	25-4375	ENCLOSURE COVER 310/5AX
11.		49-1750	BHCS 10-32 X 3/8
12.	1	57-2250	O-RING 2-156 VITON
13.	2	57-4384	HRT310 TEFLON SEAL
14.	2	57-2980	O-RING 2-278 VITON
15.	2	94-4409	VR11 ORING BANDCLAMP
16.	2	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.	1	94-4409	VR11 ORING BANDCLAMP
27.	1	57-0093	O-RING 2-385 BUNA
28.	1	25-4362	5AX HEAD COVER, BACK PLATE
29.	1	25-9415	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
62.	3	43-0052	HHB 1/2-13 X 3/4
63.	3	45-1740	WASHER BLACK HARD 1/2
64.	1	20-4366	COUNTERBALANCE PLATE
65.		49-1750	BHCS 10-32 X 3/8
66.	1	20-4388	WORM PLUG 310 PULLEY SIDE
67.	3	58-1627	1/8-27 PIPE PLUG
68.	1	20-4365	BRAKE DISC COUNTERBALANCE
69.	1	30-1072	HRT310 DRIVEN ASSY 5AX
70.	2	25-4373	TOP COVER 310/5AX
71.	8	40-1661	SHCS 1/2-13 X 2
		57-2121	O-Ring
72.	1	20-4360	5AX SPINDLE HEAD (MACHINED)
73.	1	61-1040	SWITCH PSHBTN GRAY CABLE
74.		49-1750	BHCS 10-32 X 3/8
75.	1	57-2121	O-ring

Tool Release Piston Assembly



VIEW B
OUT OF POSITION

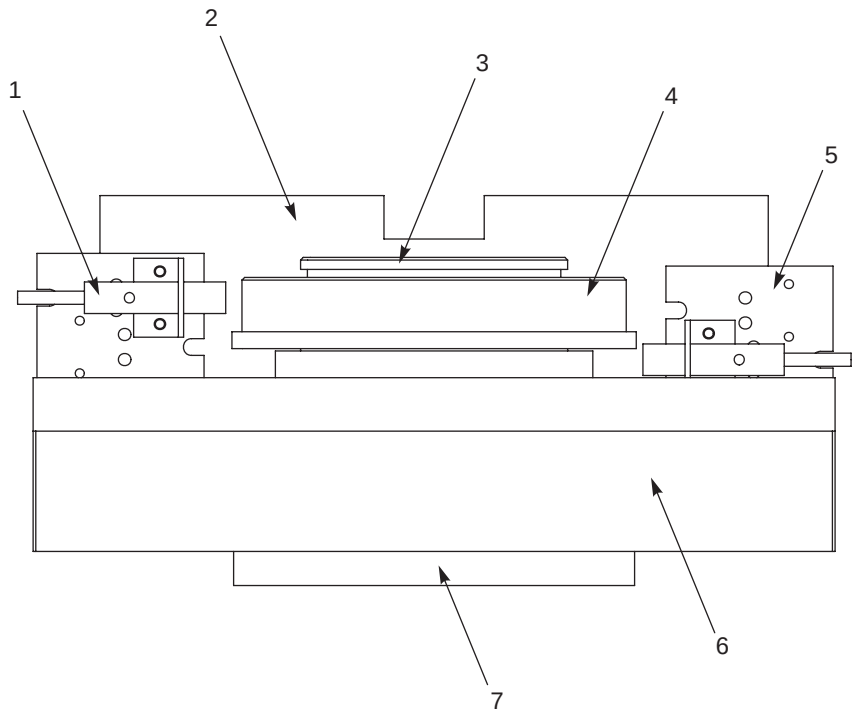
SECTION A-A
OUT OF POSITION

1.	58-3613	1/4 Street elbow
2.	58-3050	Elbow 1/4 bylon tubing
3.	58-3670	1/4NPT M 1/8F reducer
4.	58-3691	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

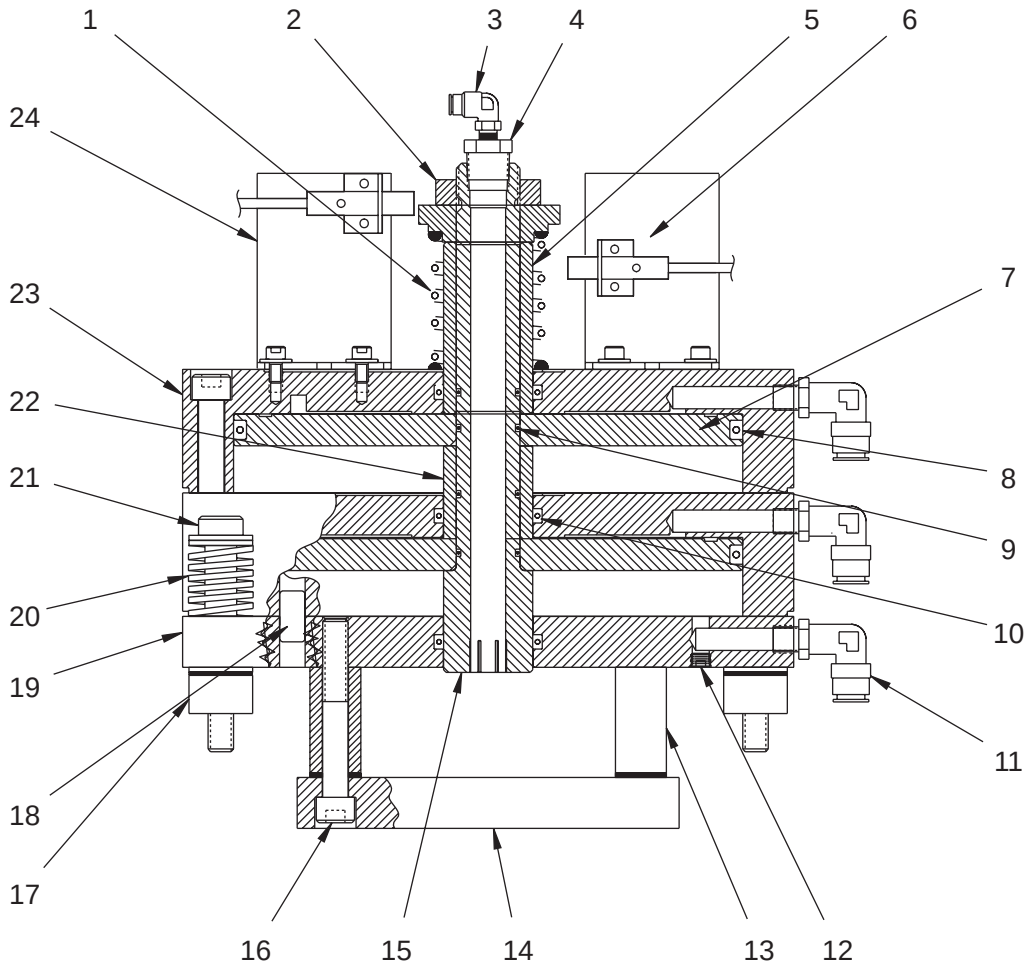
TRP base XHC 30-3207

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

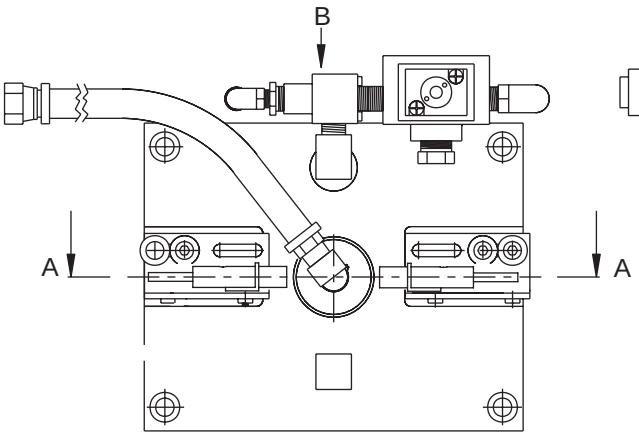
50 Taper Tool Release Piston

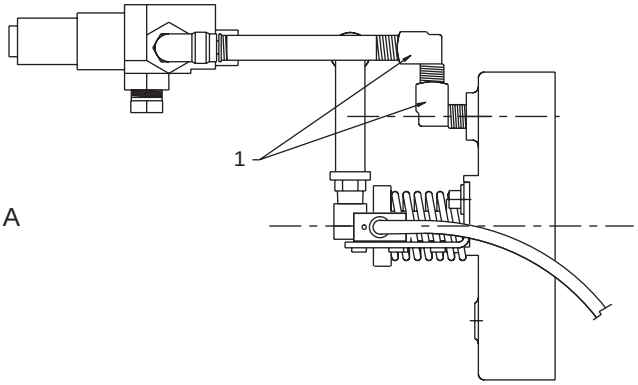


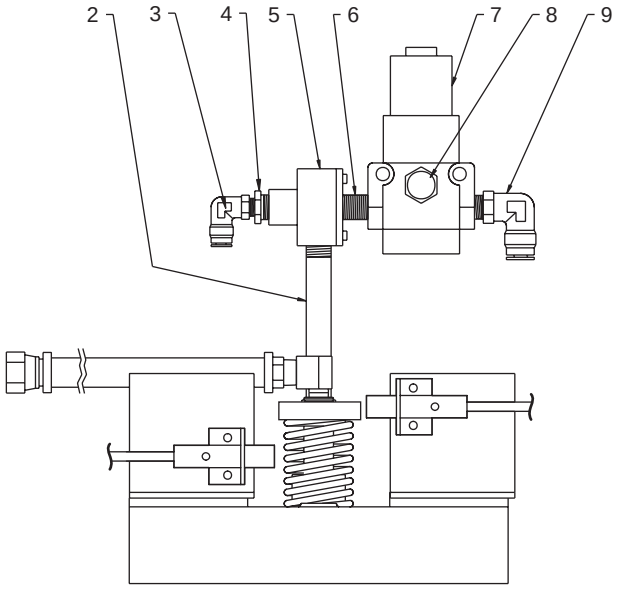
1.	59-0049	Spring compression
2.	52-0003	Shaft clamp
3.	58-3050	Elbow 1/4 nylon tubing
4.	58-3631	Reducer bushing 1/2M-1.8F
5.	20-0021B	Spacer upper TRP 50T
6.	32-2203	Limit switch unclamped
	32-2204	Limit switch clamped
7.	20-0019A	Piston TRP 50T
8.	57-0082	O-ring 2-448 Viton
9.	57-0027	O-ring 2-121 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
18.	48-1662	Dowel pin 1/2 x 1
19.	20-2988	Sub plate TRP 50T
20.	59-0016	Spring compression
21.	49-0003	Shoulder bolt 5/8 x 3 1/2
22.	20-0020A	Spacer lower TRP 50T
23.	20-0022A	Housing air cylinder
24.	25-0009A	Switch mounting bracket

50 Taper complete assembly 30-0013B

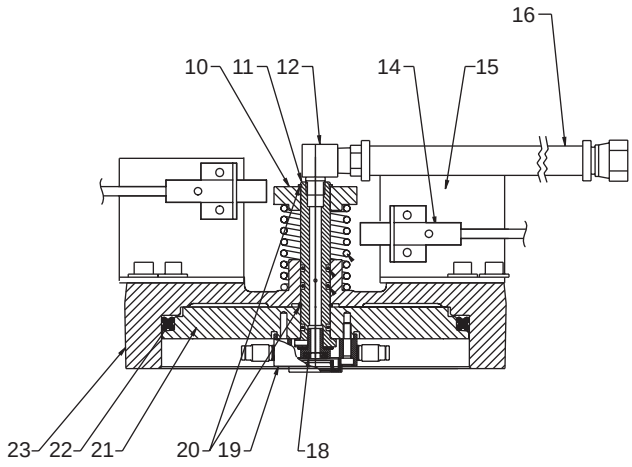
TSCHP Tool Release Piston Assembly







VIEW B
OUT OF POSITION

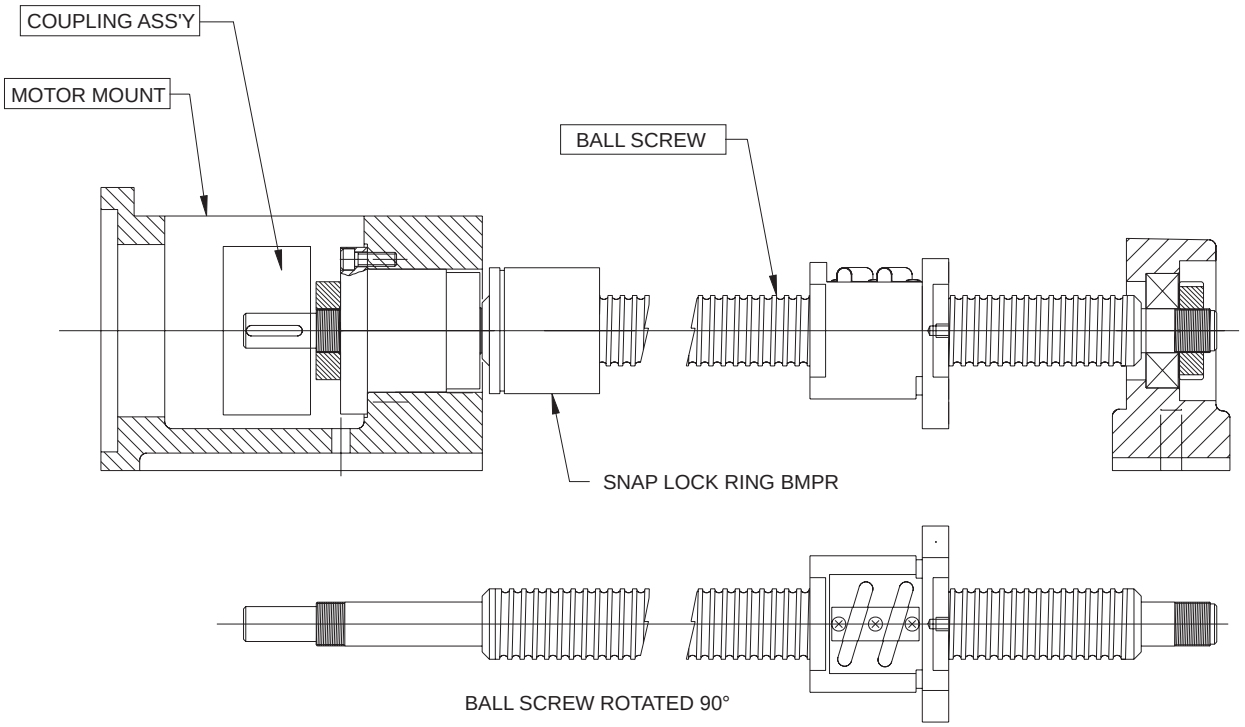


SECTION A-A
OUT OF POSITION

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

Ball Screw Assembly



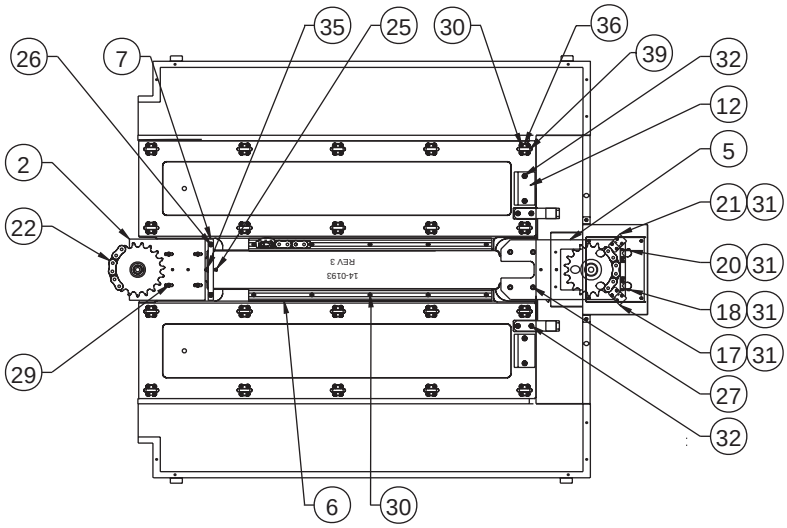
	Mini-mill	VF 0-1	VF 2	VF 3	VF 4	VF-5
Base	24-3006	30-3103	30-3103	30-3107	30-3107	30-2273
Saddle	24-3006	30-3103	30-3104	30-3106	30-3108	30-2720
Column	24-3006	30-4053	30-4053	30-3135	30-3135	30-6524

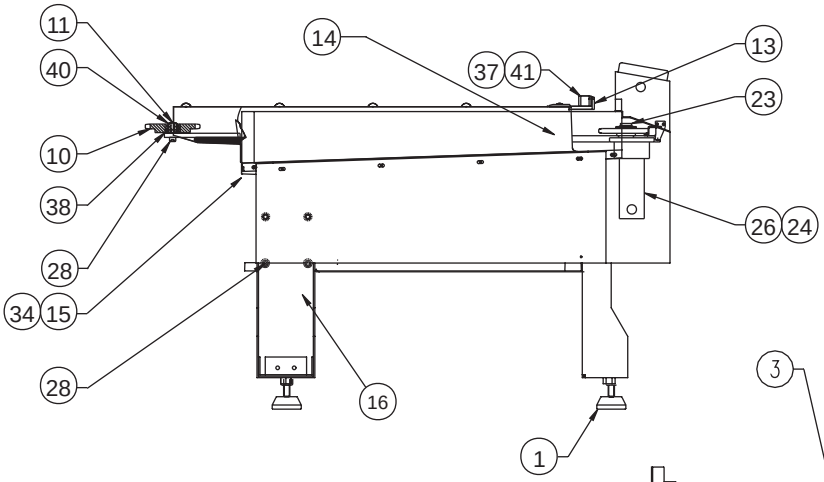
	VF-5XT	VF-6/8	VF-7/9	VF-10/11
Base	30-2538	30-0474	30-0474	30-0474
Saddle	30-2536	30-0470	30-0473	30-0516
Column	30-2536	30-7624	30-7624	30-7624

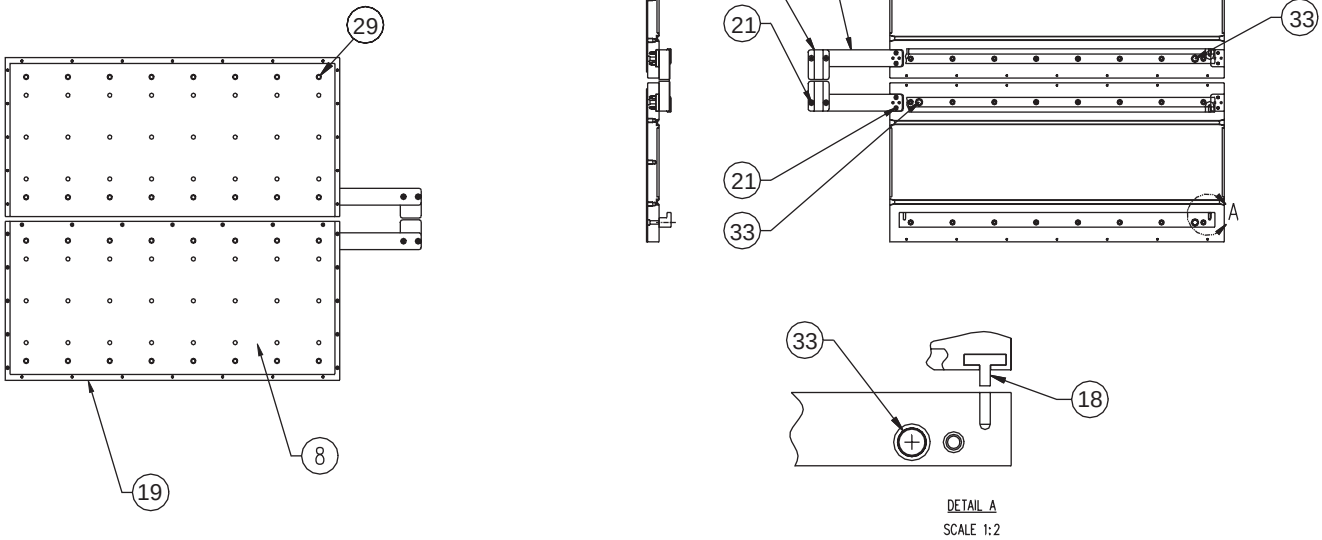
50 Taper

	VF5	VF-5XT	VF-6/8	VF-7/9	VF-10/11
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





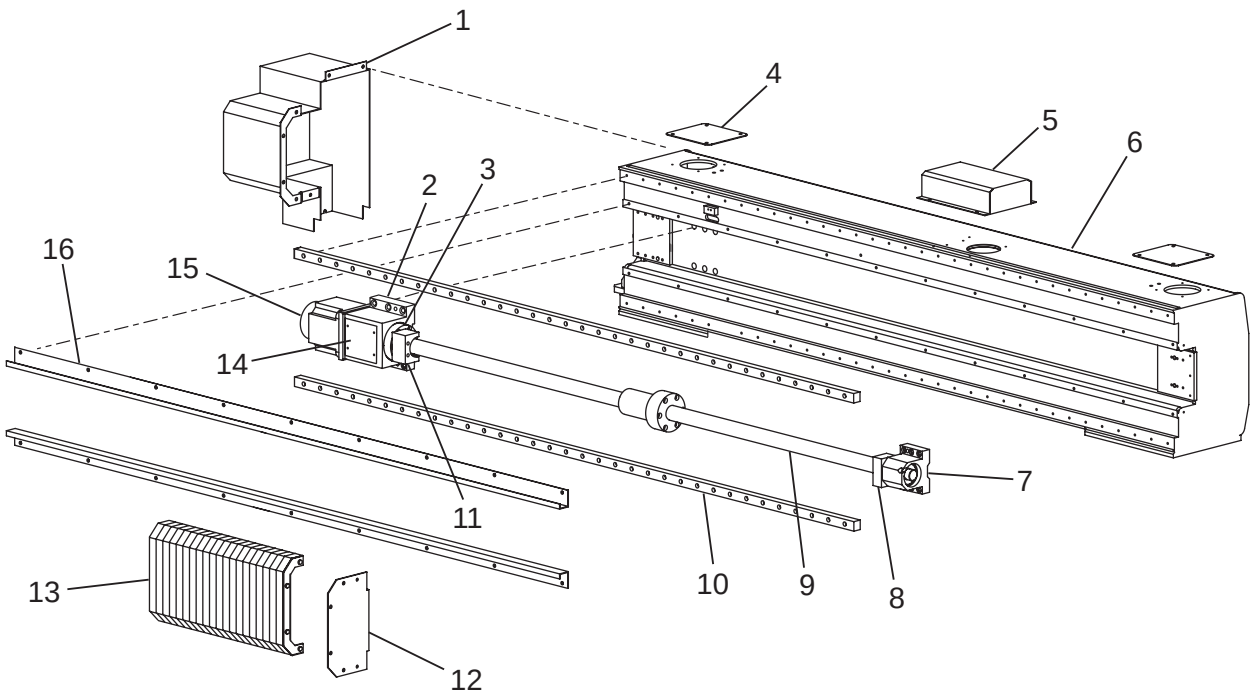


DETAIL A
SCALE 1:2

APC Assembly

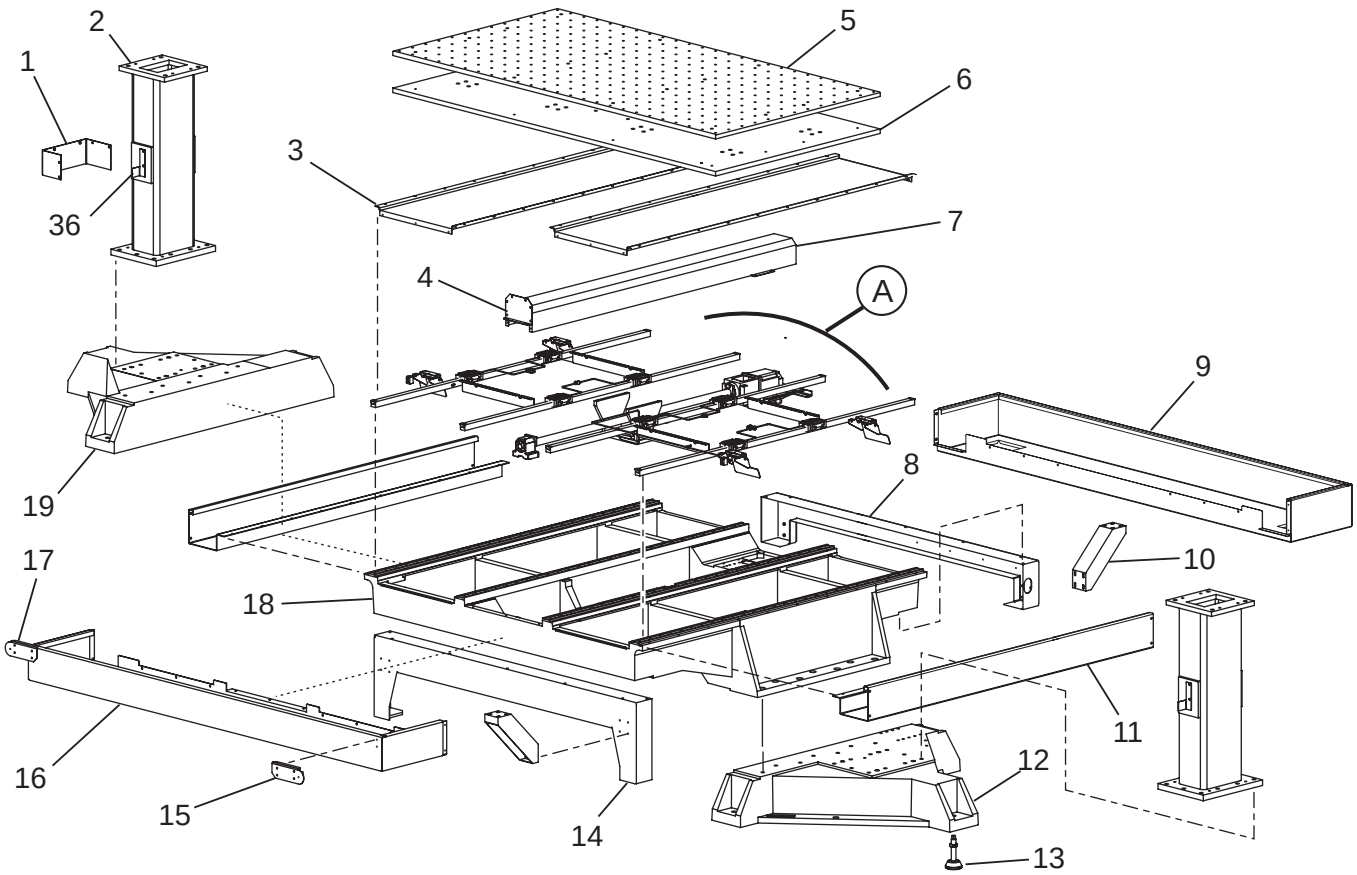
ITEM	QTY.	PART NO.	TITLE
1.	3	14-7068	CASTING, LEVEL PAD
2.	1	20-0046	SUPPORT, IDLER SPROCKET
3.	2	20-0048	DRIVE LEG, APC
4.	2	20-0049	DETENT, APC
5.	1	20-0050A	SUPPORT, MOTOR, APC
6.	2	20-0051	GUIDE, CHAIN, APC
7.	1	20-0052	TENSIONER BLOCK
8.	2	20-1671	PALLET
9.	4	20-0054	CLAMPING RAIL
10.	1	20-0057	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

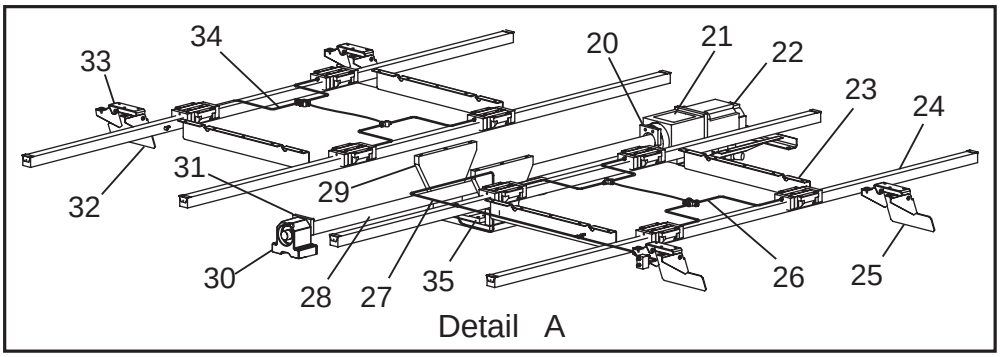
Gantry Router Bridge Assembly Parts List



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

GR-408 Base & Table Assembly Parts List

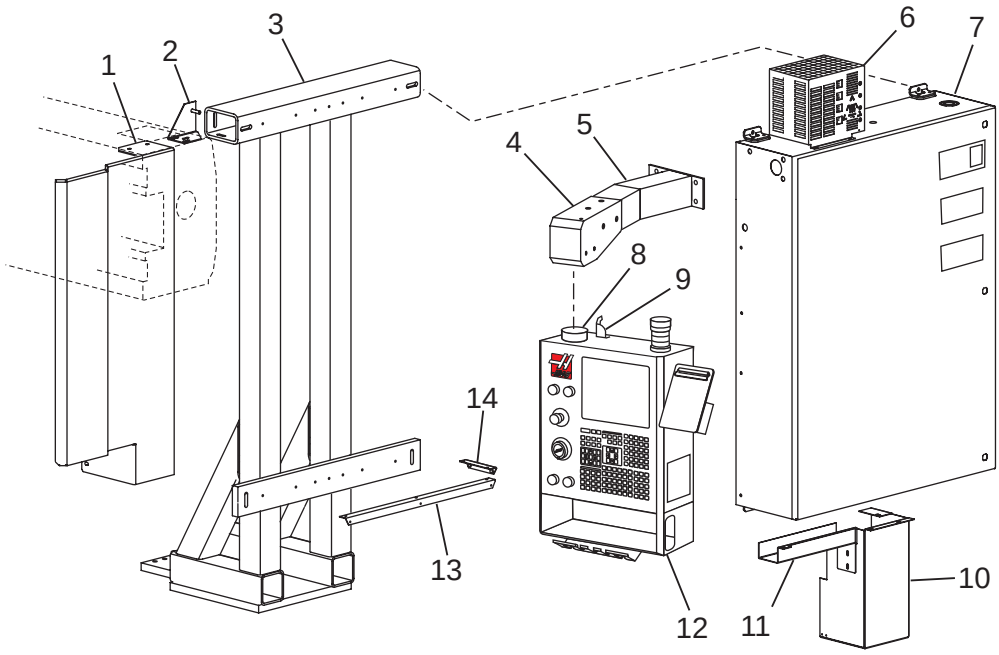




GR-408 Base & Table Assembly Parts List

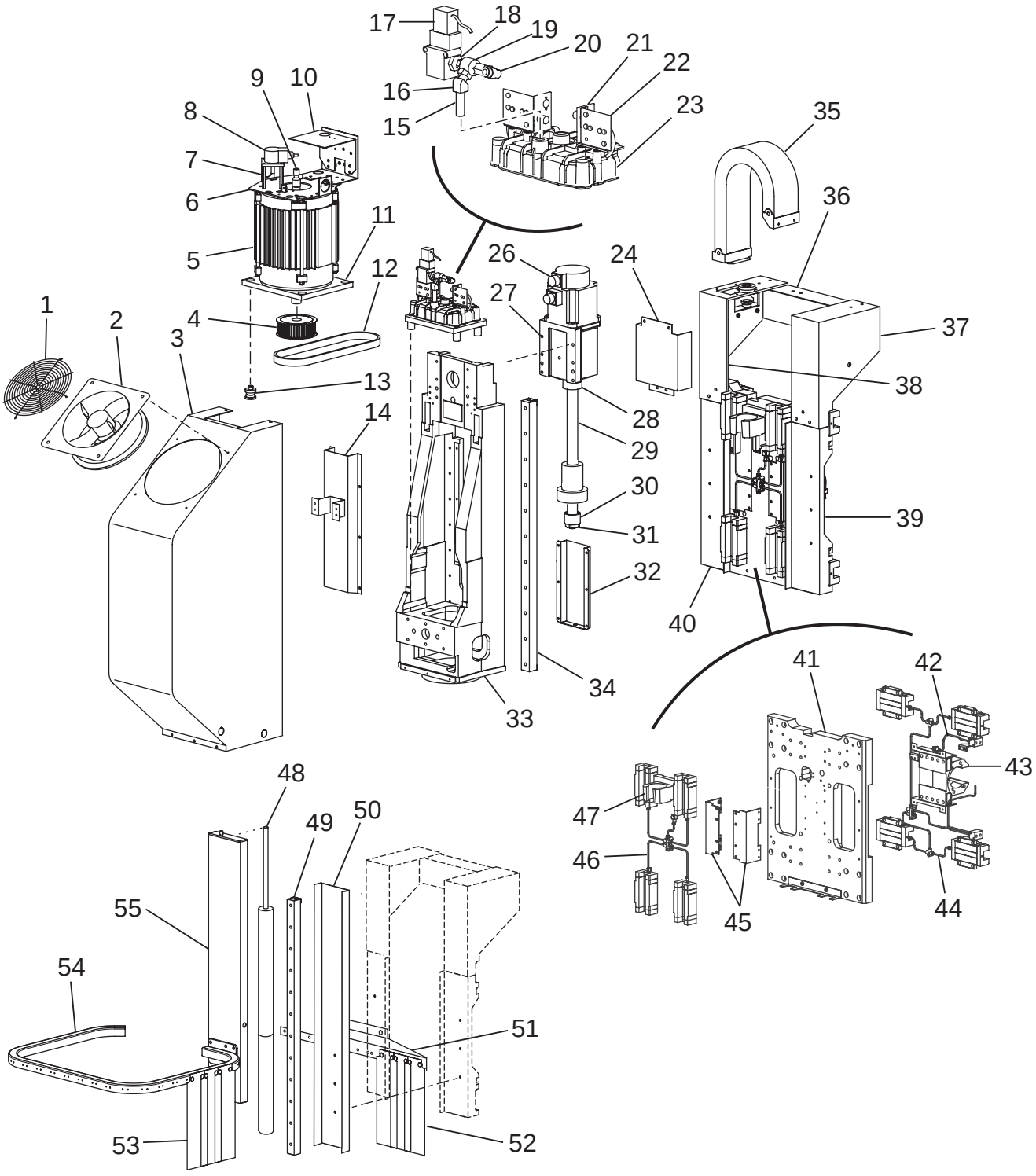
1. 25-7720A MOM-408 Bracket
2. 20-3254 2X Bridge Support
3. 25-7427A 2X Chip Tray
4. 25-7429 X-Axis Ballscrew End Cover
5. 20-3268 Table
6. 20-3267A Sub-Table
   25-7552 Proximity Switch Trip Bracket
7. 25-7428 X-Axis Ballscrew Cover
   25-7801 Cable Cover
8. 25-7417 Rear Chip Pan Support
9. 25-7416A 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

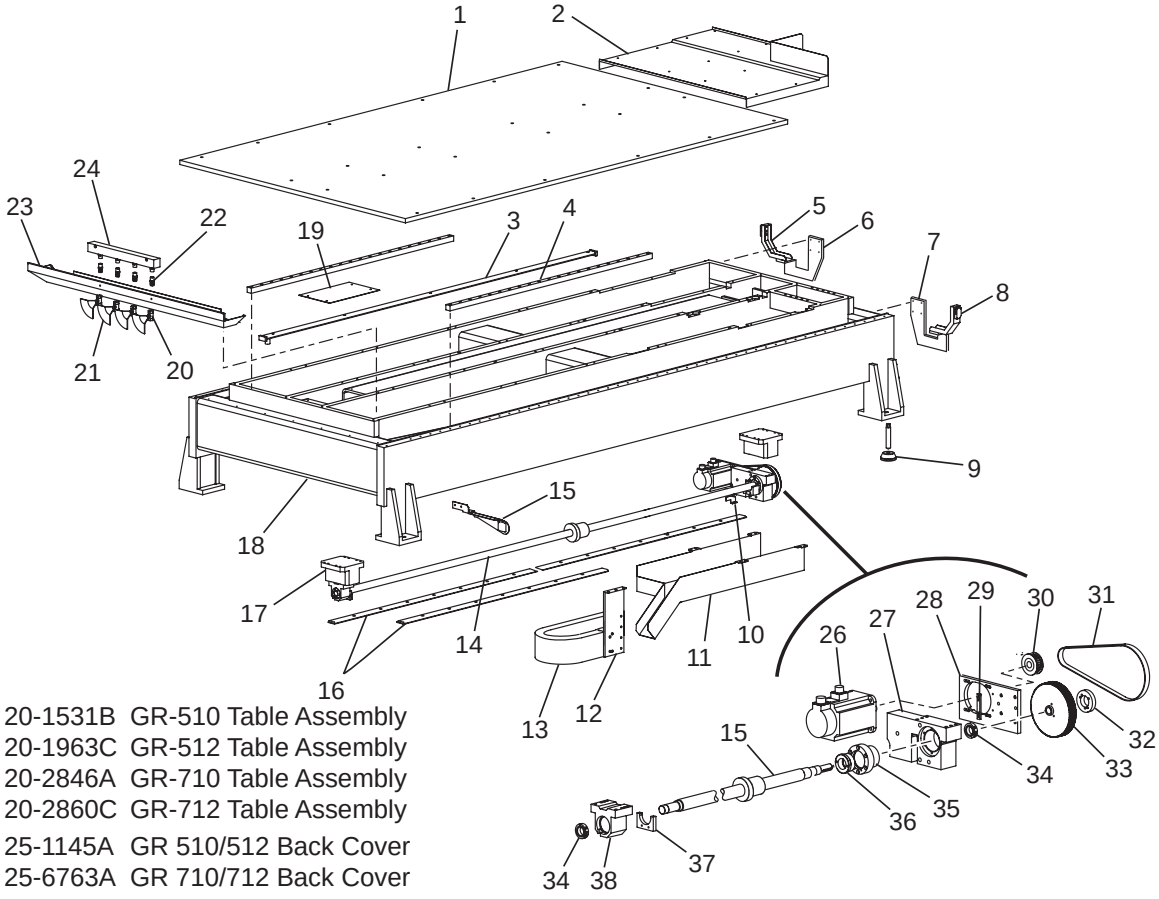


Runner Block Assembly (Optional)

GR-408 Ram Assembly Parts List

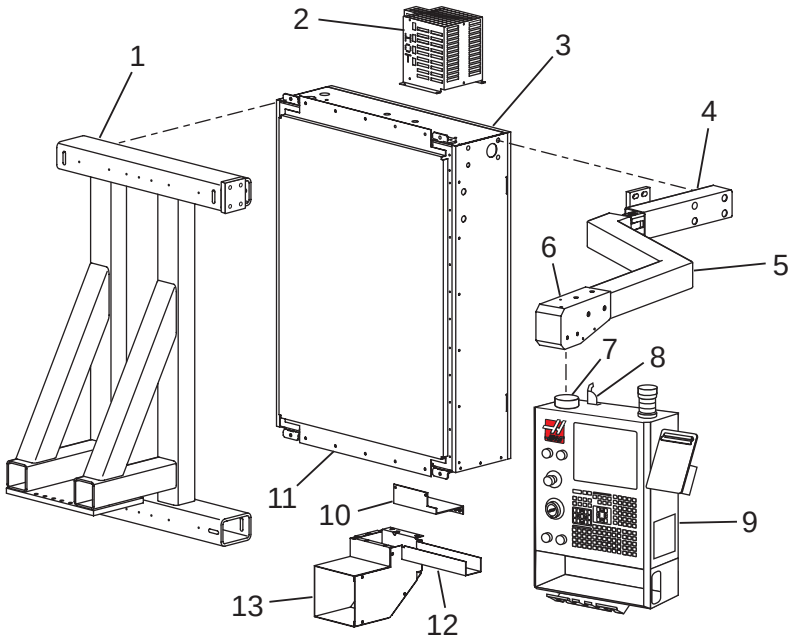
1.	59-0144	Fan Guard
2.	25-1157	Spindle Fan Cover
3.	25-1162	Head Cover
4.	20-3076	2x Sprocket Flange
	20-0997	Pulley
5.	62-1015	Spindle Motor
6.	25-6181	Encoder Mounting Plate
7.	N/A	
8.	30-9569A	Encoder Assembly
9.	54-7127	Encoder Drive Sprocket
10.	25-6180C	Solenoid Motor Plate
11.	20-2415	Spindle Motor Plate
12.	54-2121	Belt
13.	22-7520A	8x Isolator
14.	25-6777	Z-Axis Ballscrew Cover
15.	58-0004	Nipple ¼ NPT x2
16.	58-3613	Street Elbow 1/4F x NPT 1/4M
17.	32-5620	TRP Solenoid Valve Assembly
18.	58-3691	Nipple ¼ NPT Hex
19.	59-2832B	Quick Exhaust
20.	58-3685	90° Elbow 3/8 x NPT ¼-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
42.	30-3778	Y-Axis Lube Line Assembly
43.	20-0150	Ballnut Housing (40-50mm)
44.	30-3786B	Y-Axis Lube Line Assembly
45.	25-1165A	Y-Axis Bellows Moving Mount
46.	30-3788	Z-Axis Lube Line Assembly
47.	20-1532	Ballnut Housing (32mm)
48.	59-0058	Air Cylinder (1.25x26)
49.	50-3007	Linear Guide
50.	25-7659	Curtain Lift Inside Mount
51.	25-7662	Rear Curtain Lift Mount
52.	59-0845	Rear Curtains
53.	59-0844	Front Curtains
54.	20-3463A	Curtain Lift Rod
55.	25-7660	Curtain Lift Cover

GR-510/512/710/712 Base & Table Assembly Parts List

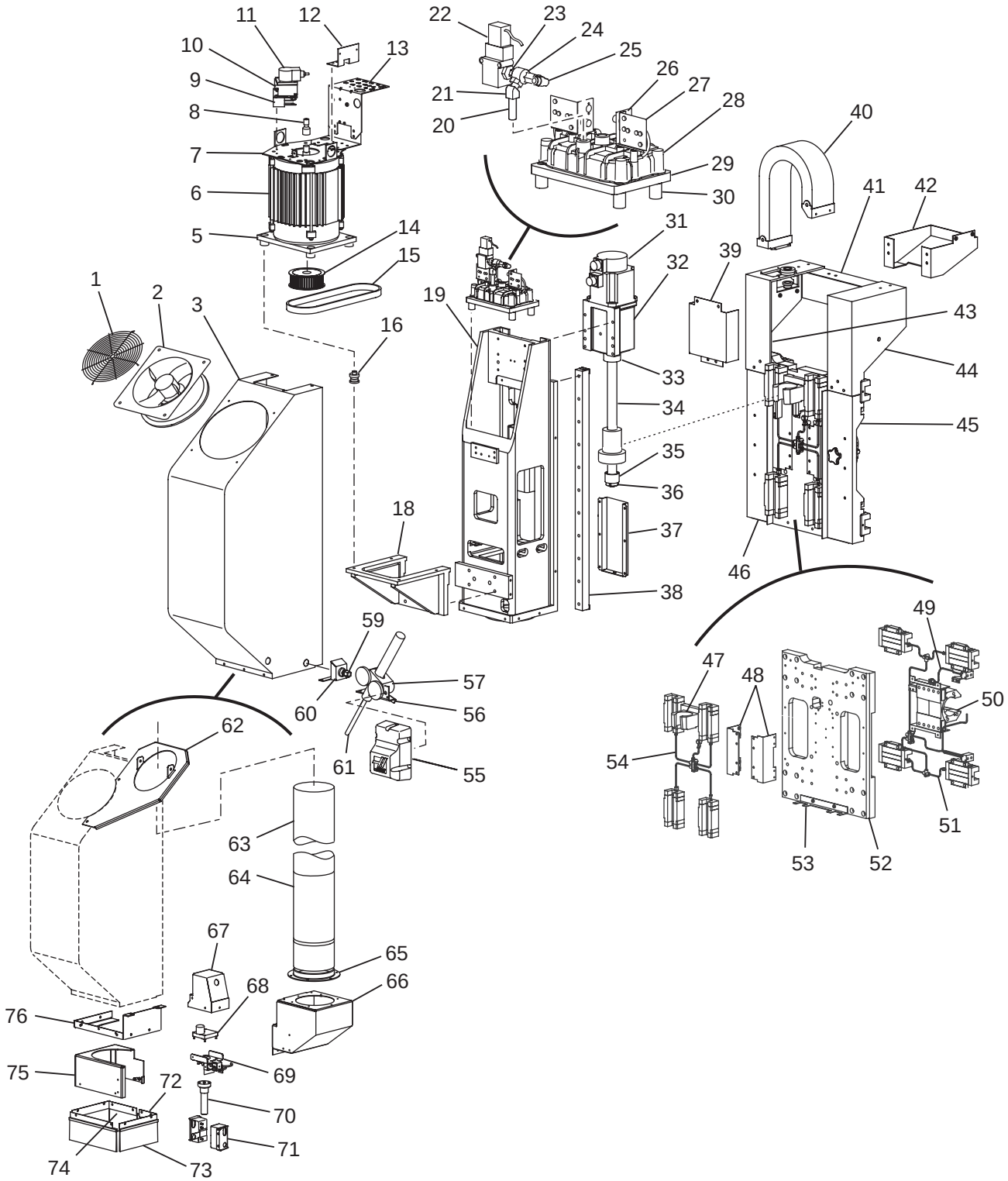


1. 20-1531B GR-510 Table Assembly
   20-1963C GR-512 Table Assembly
   20-2846A GR-710 Table Assembly
   20-2860C GR-712 Table Assembly
2. 25-1145A GR 510/512 Back Cover
   25-6763A GR 710/712 Back Cover
3. 20-1828A Vacuum Table Pipe
4. 50-0023C 2x GR 510, 710 Linear Guide
   50-0029C 2x GR 512, 712 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

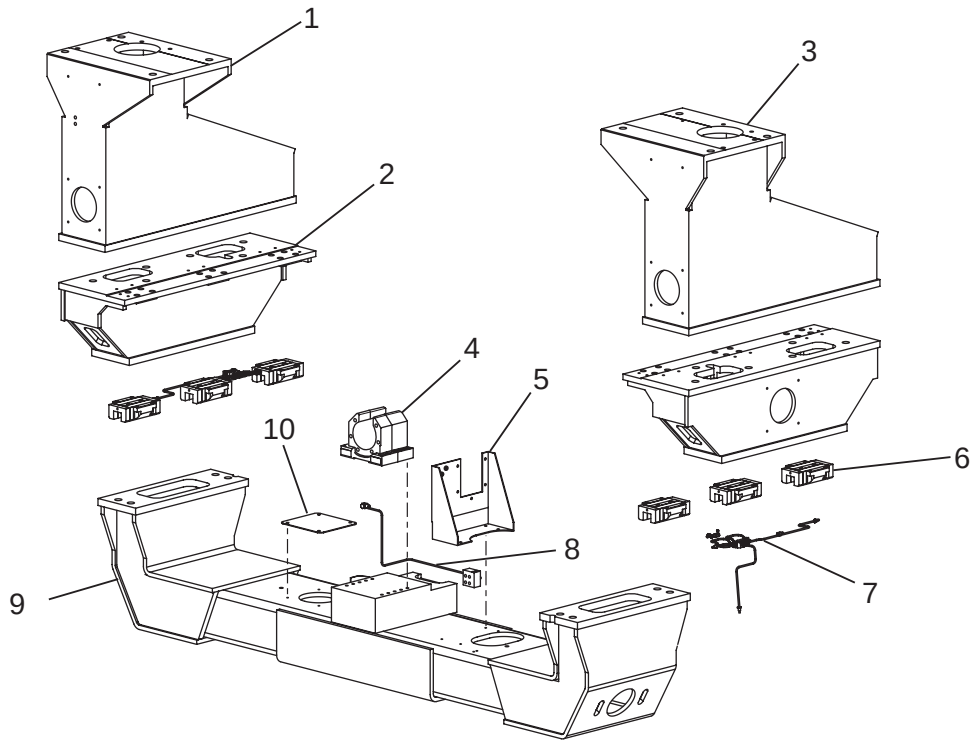


Dust Shroud Assembly (Optional)

GR-510/512/710/712 Ram Assembly Parts List

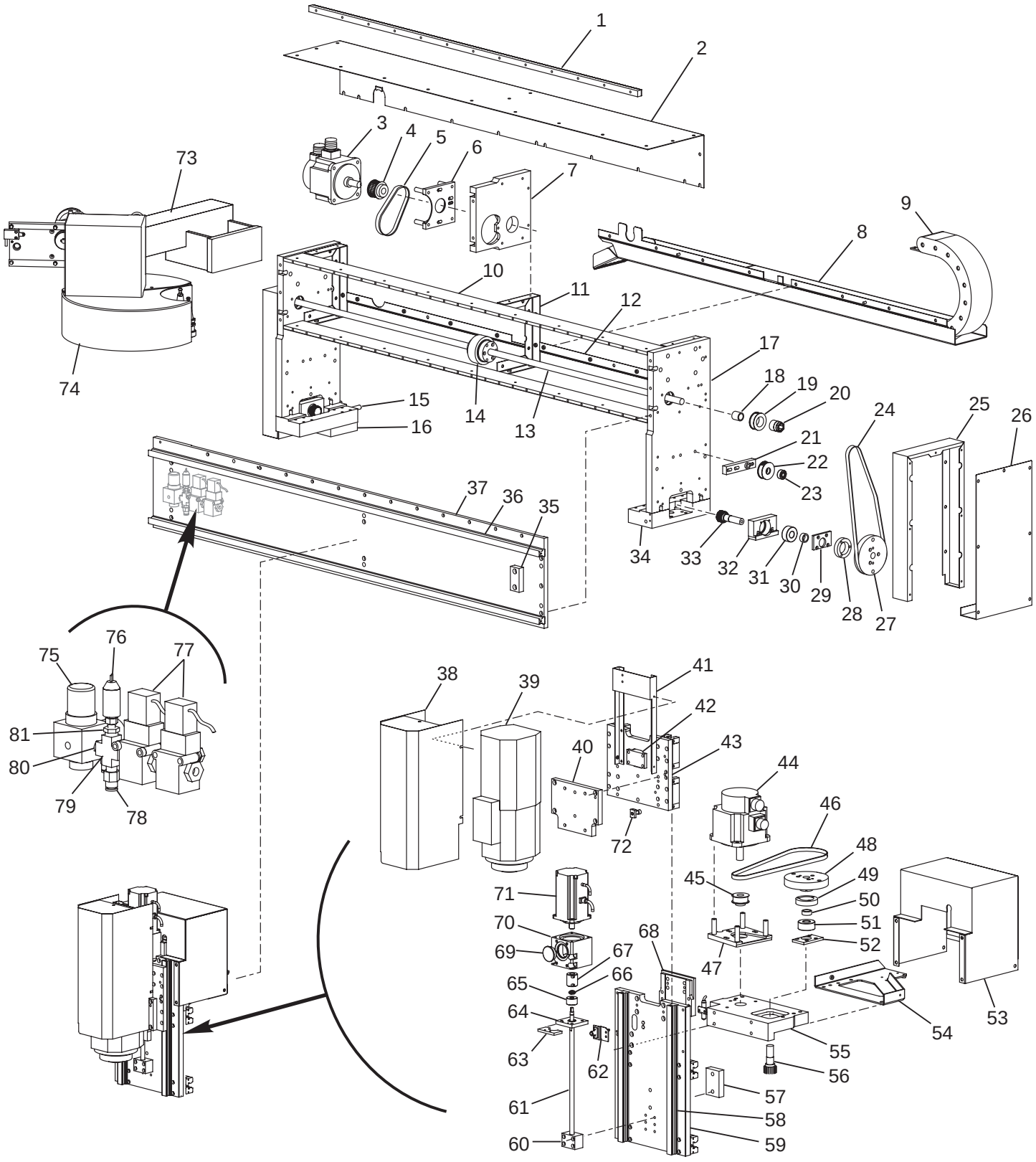
1.	59-0144	Fan Guard
2.	25-1157	Spindle Fan Cover
3.	25-7910	Head Cover
4.	Not Used	
5.	20-2415	Spindle Motor Plate
6.	62-1015	Spindle Motor 5HP
7.	25-6181	Encoder Mounting Plate
8.	20-0276A	Encoder Drive Sprocket
9.	25-6297	Encoder Spring Spacer
10.	25-6293A	Encoder Spring Mounting Box
11.	30-9569A	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 ¼ NPT x 2
21.	58-3613	Street Elbow 1/4F x NPT 1/4M
22.	32-5620	TRP Solenoid Valve Assembly
23.	58-3691	Nipple ¼ NPT HEX x 1
24.	59-2832B	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 ½ 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

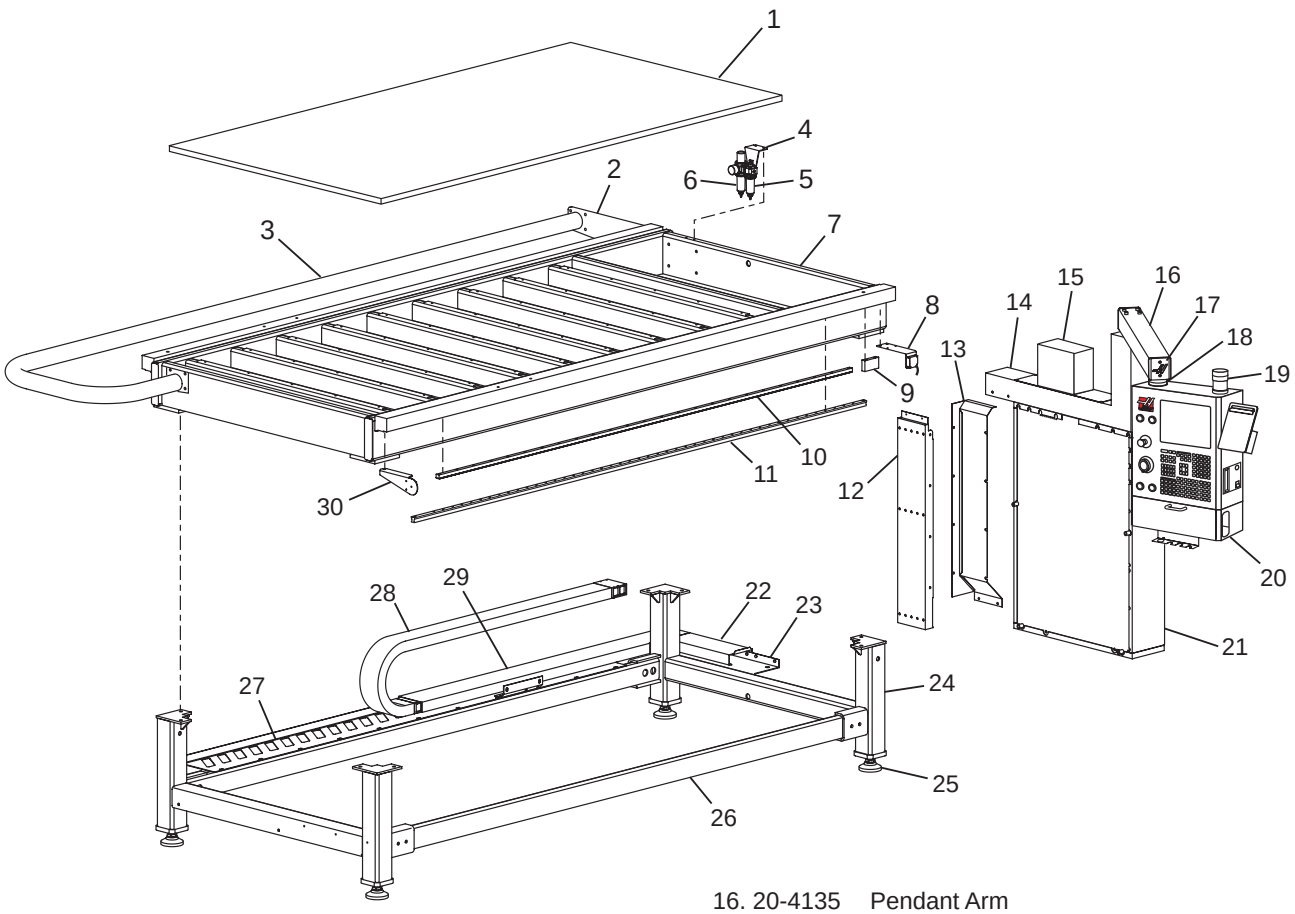
SR-100/200 Bridge-Spindle Head Assembly



SR-100/200 Bridge-Spindle Head Assembly

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

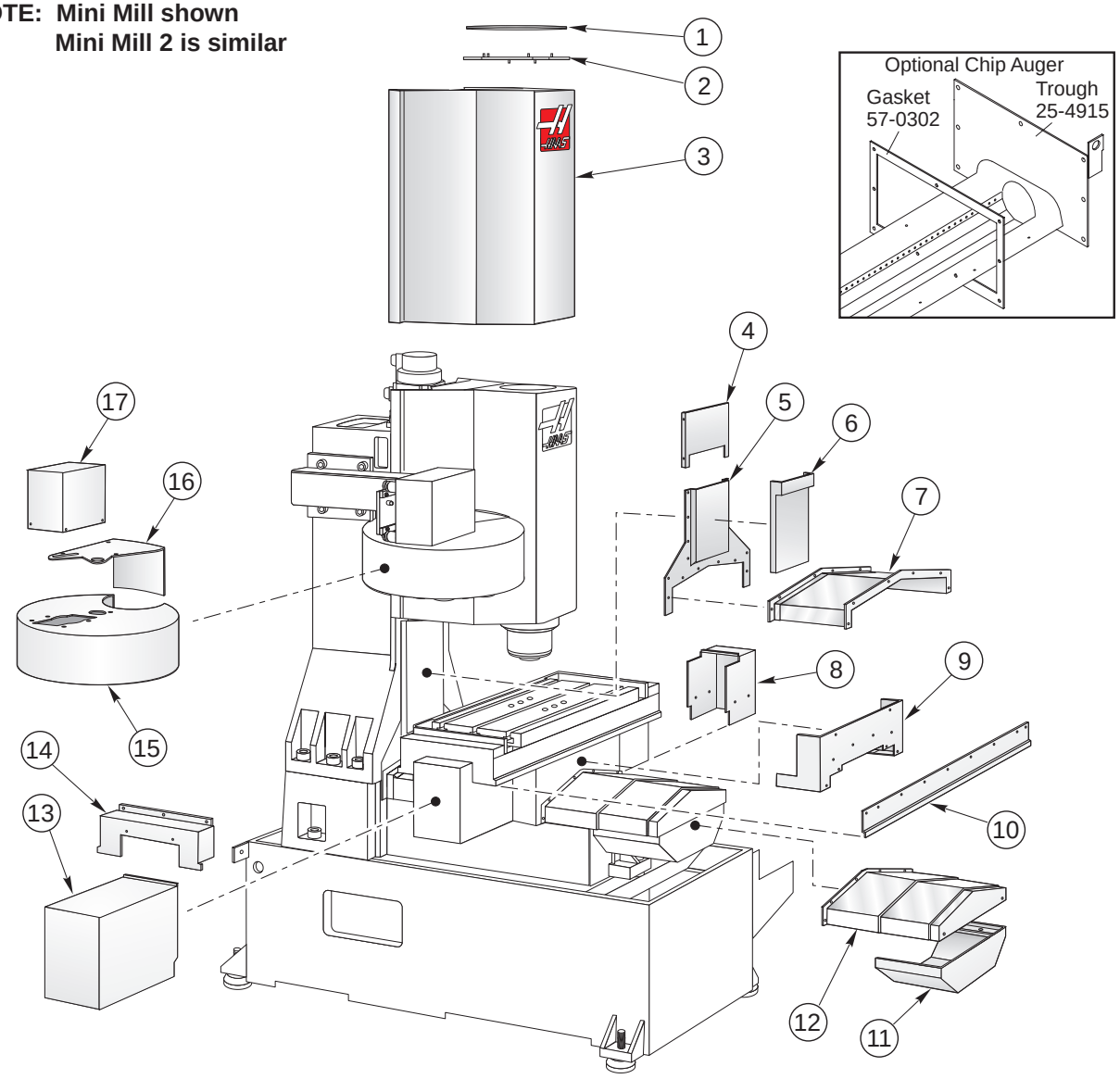
SR-100/200 Bed-Control Assembly



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

Mini Mill Interior Sheet Metal

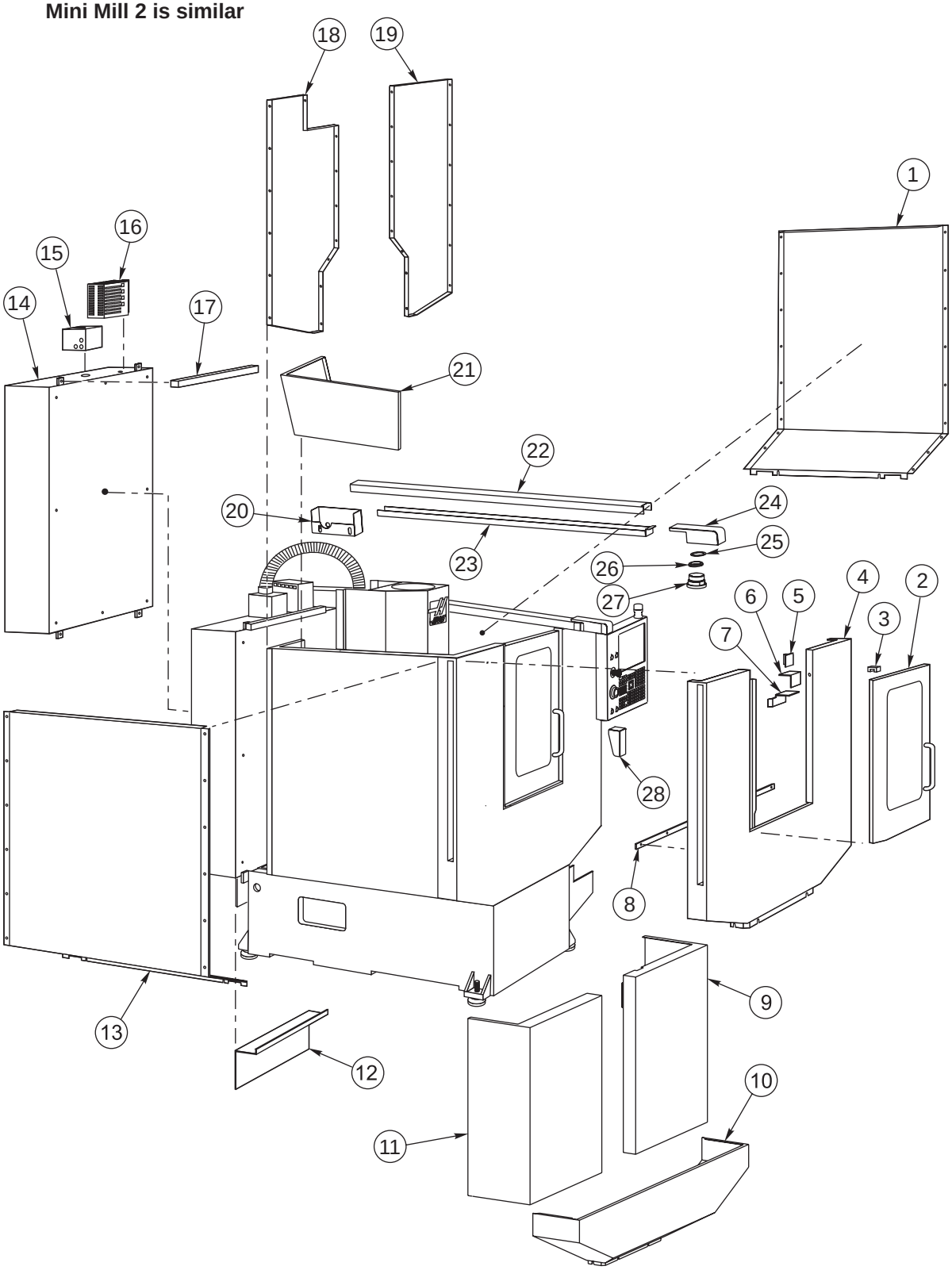
NOTE: Mini Mill shown
Mini Mill 2 is similar



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

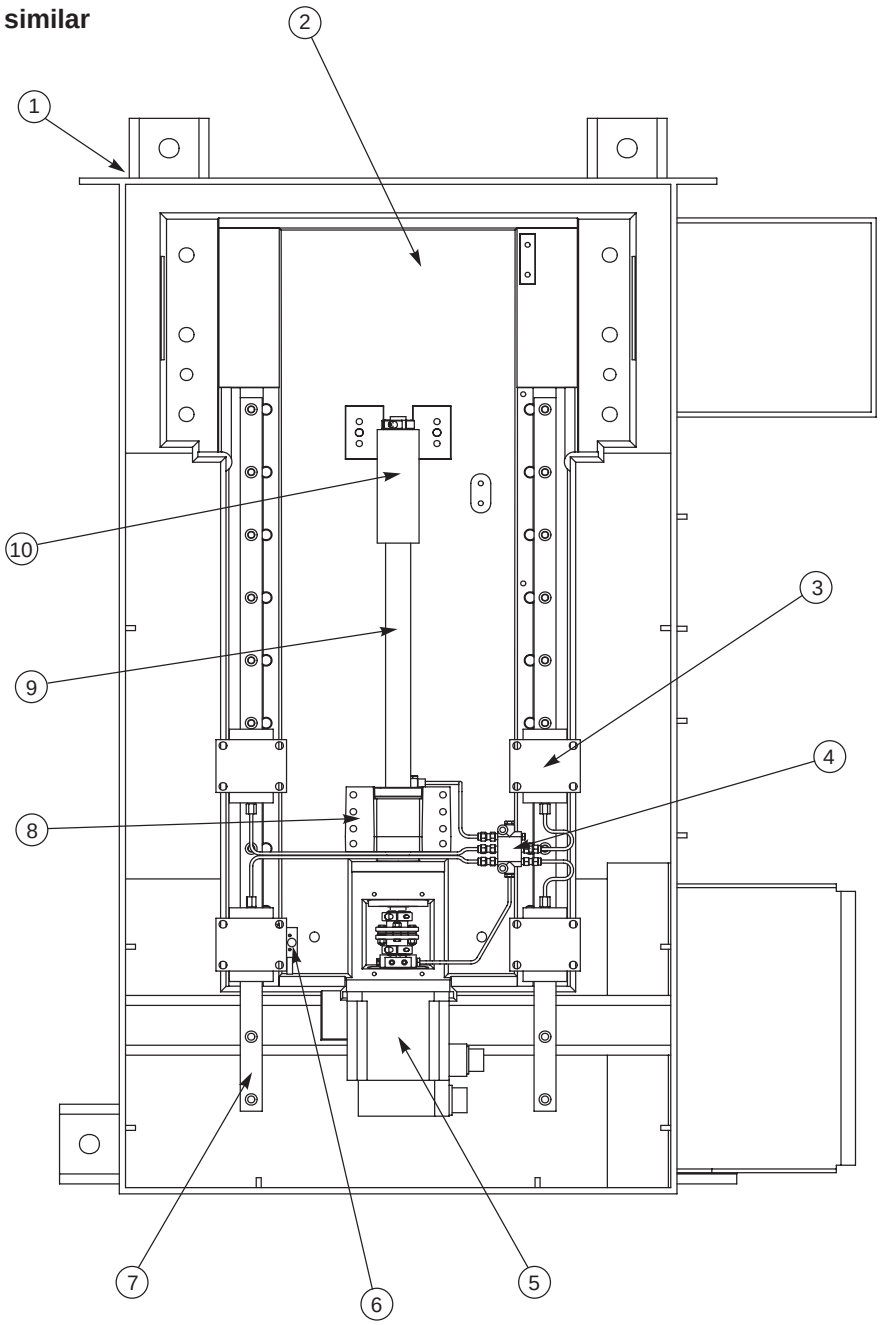


Mini Mill Exterior Sheet Metal Parts List

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

Mini-Mill Base

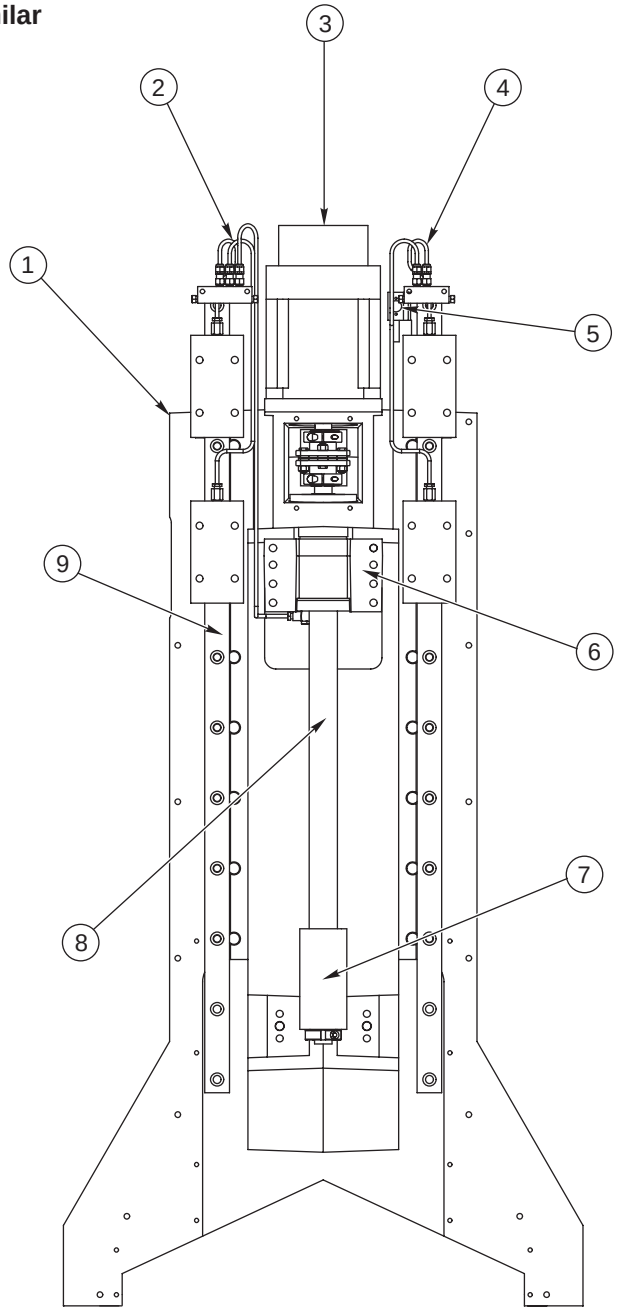
NOTE: Mini Mill shown
Mini Mill 2 is similar



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

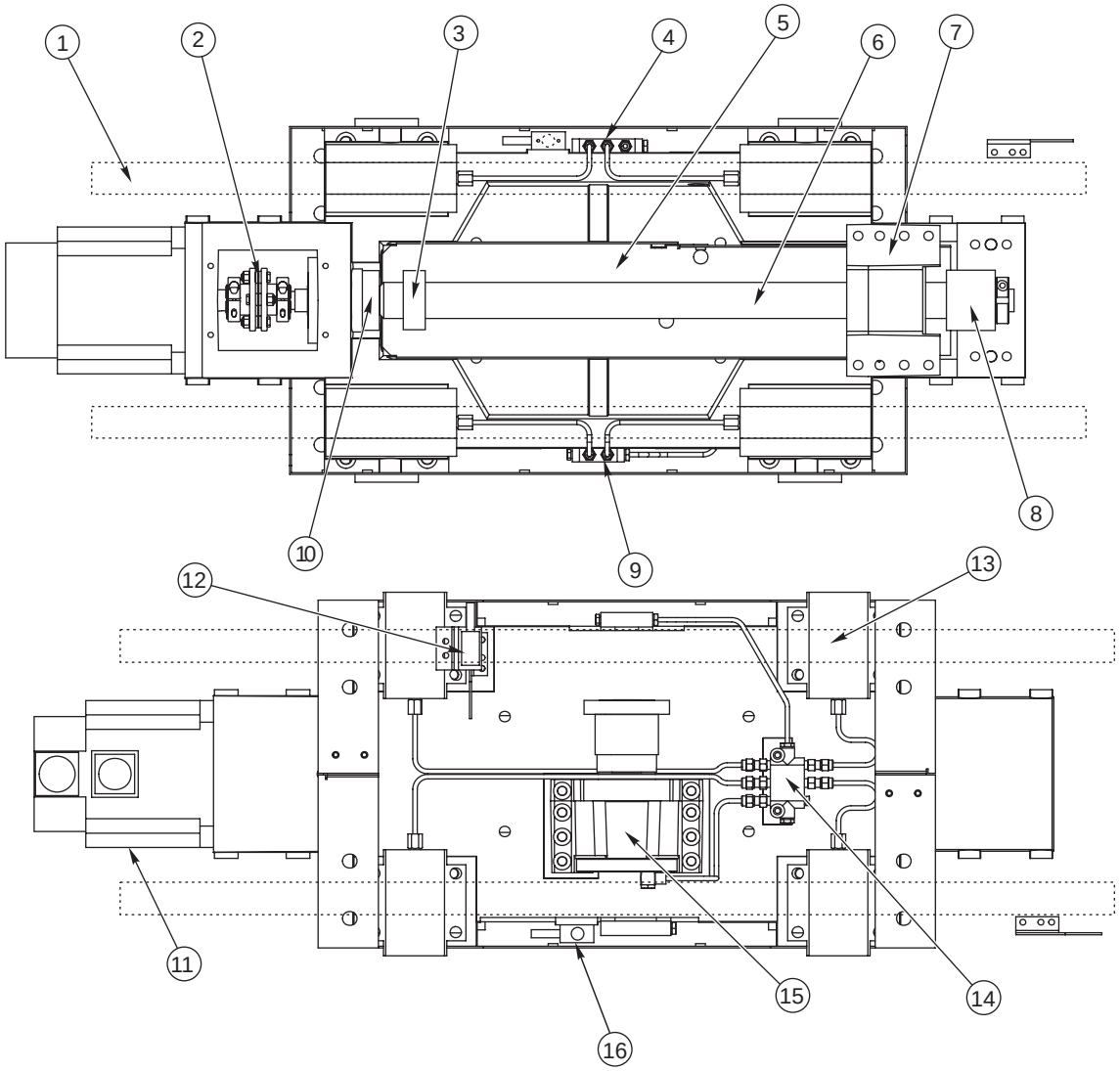
NOTE: Mini Mill shown
Mini Mill 2 is similar



1.	20-1357A	Column Machining (MM/SMM)
2.	30-3048	Lube Line Assembly Z-Axis Left
3.	62-0036C	Servomotor SEM C8 w/Brake
4.	30-3049	Lube Line Assembly Z-Axis Right
5.	32-2130	Home Switch 1.5 ft. NC
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)
8.	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)
9.	50-10000	Linear Guide 30 x 930

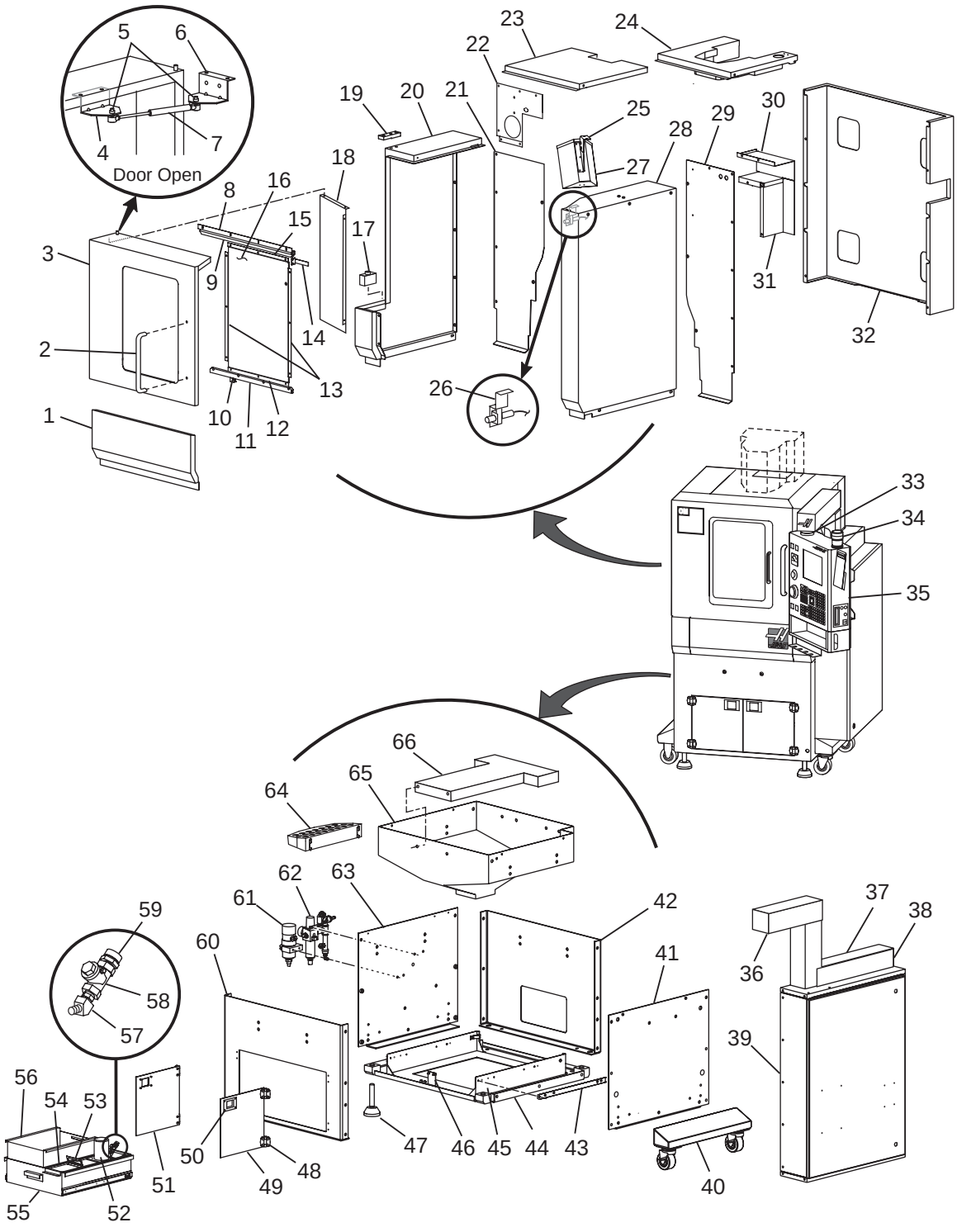
Mini-Mill Saddle

NOTE: Mini Mill shown
Mini Mill 2 is similar



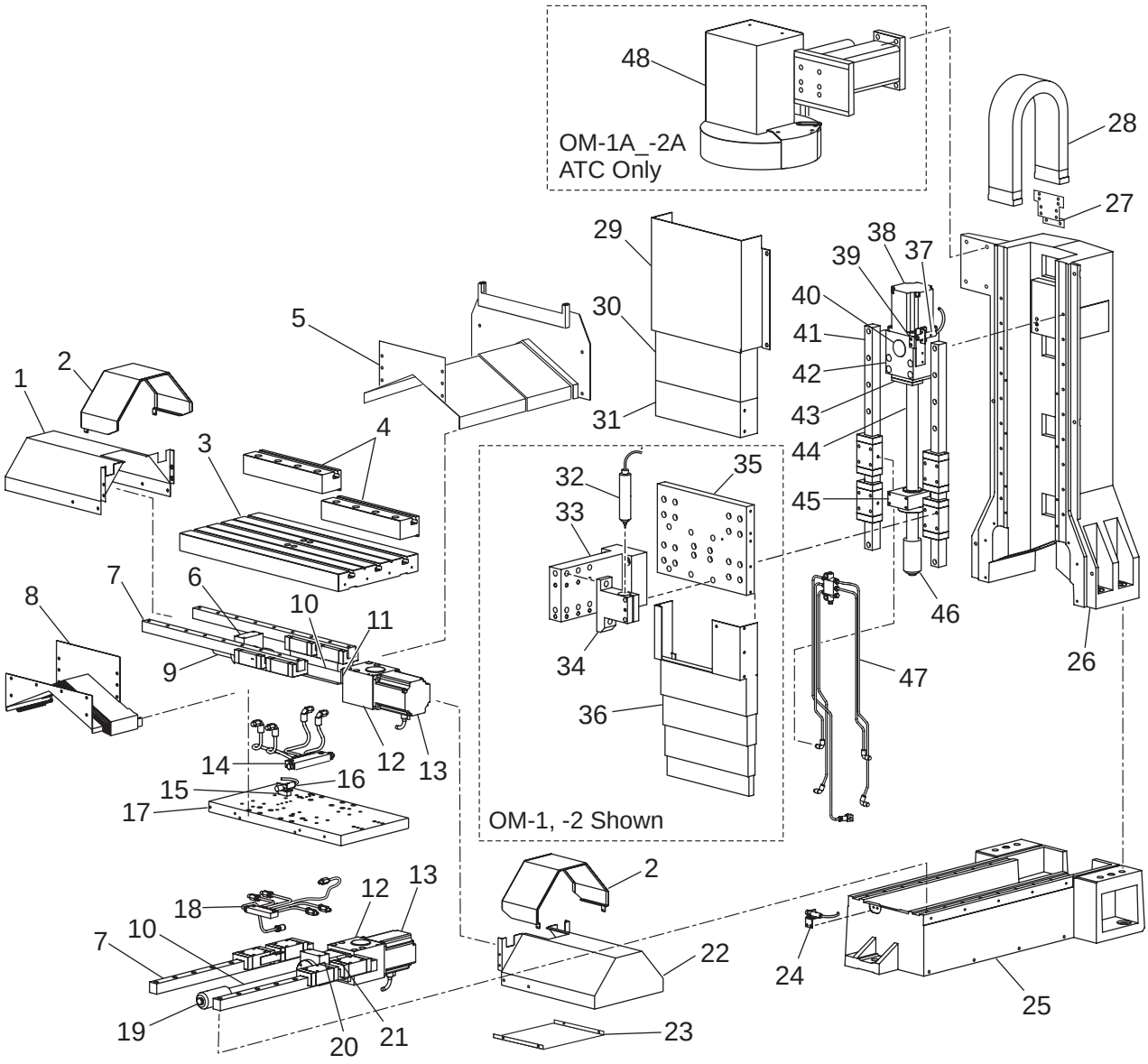
1.	50-10000	Linear Guide 30 x 930 (MM/SMM)
	50-10001	Linear Guide 30 x 1040 (MM2/SMM2)
2.	30-1220A	Coupling assembly
3.	20-0505	Bumper Ballscrew (MM/MM2)
4.	30-1751	Lube Assembly X-Axis Back
5.	25-0659	Carrier Tray X-Axis (MM/SMM)
	25-11364	Carrier Tray X-Axis (MM2/SMM2)
6.	24-3006	Ballscrew 32-6-669.2 (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)
12.	32-2132	Home Switch 3.5 ft. NC
13.	50-0011	Runner Block Linear Guide Y-Axis
14.	30-1752	Lube Line Assembly Y-Axis
15.	20-7008F	Nut Housing Machined
16.	32-2130	Home Switch 1.5 ft. NC

OM-1/OM-2 Exterior Sheet Metal



OM-1/OM-2 Exterior Sheet Metal

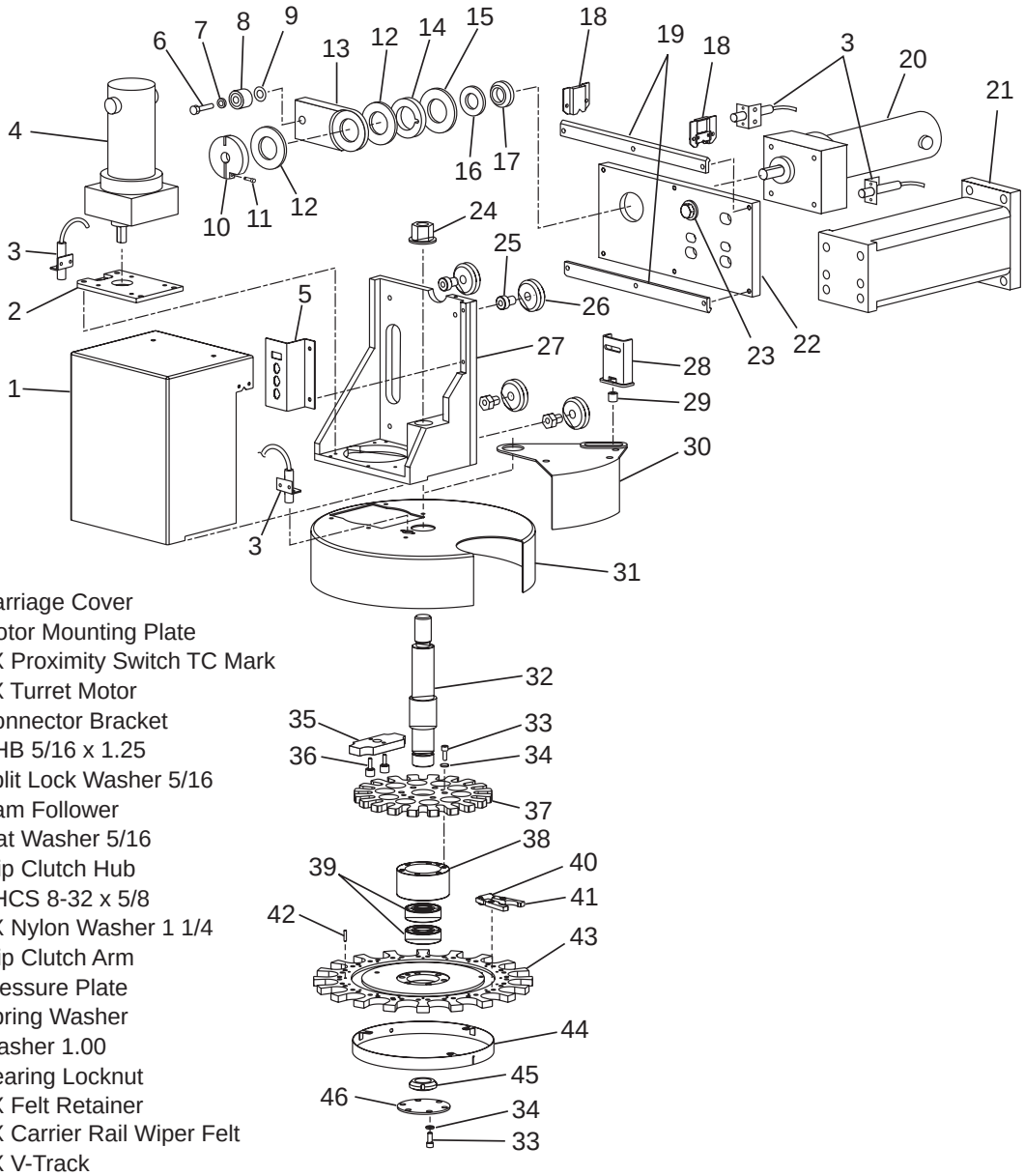
1.	25-7321	Bottom Front Panel
2.	22-8895	Door Handle
3.	25-7317	Enclosure Door
4.	25-7393	Gas Spring Door Bracket
5.	59-0008	2X Gas Spring Ball Stud
6.	25-7394	Gas Spring Enclosure Bracket
7.	59-0839	Gas Spring Assy
8.	25-7331	Op Door Guide Bracket
9.	28-0174	Window Top Guide
10.	25-7673	Shield Support Bracket
11.	20-3241	Op Door Bottom Guide
12.	25-7341	Bottom Window Frame
13.	25-7337	2X Window Frame Sides
14.	25-7333	Door Switch Trip Flag Bracket
15.	25-7338	Top Window Frame
16.	28-0182	Window
17.	20-3239	Door Hinge Stud
	20-3240	Door Hinge Bushing
	20-3242	Hinge Bottom
18.	25-7392	Operator Door Shield
19.	20-3244	Top Hinge
	20-3243	Top Hinge Bracket
20.	25-7319	Left Panel
21.	25-7325A	Left Back Panel
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
44.	25-7350	Base Bottom
45.	25-7072	Coolant Tank Support
46.	25-7672	Tank Shipping Bracket
47.	14-7068	4X Casting Level Pad
48.	59-0023	4X Door Hinge
49.	25-5856A	Right Front Lower Door
50.	58-0227	2X Door Latch Assy
51.	25-5855A	Left Front Lower Door
52.	32-0189A	Coolant Pump Assy
53.	25-6838	Coolant Tank Filter
54.	25-7070	Pump Assy Bracket
55.	25-7069	Coolant Tank
56.	25-7071	Chip Tray
57.	58-1721	45 Degree Elbow 3-8npt
	58-3600	Nipple 3-8 Hex
58.	59-2228	Swing Check Valve
59.	58-3662	Garden Hose Conn. .372" to .75"
60.	25-7346A	Base Front
61.	59-0814	Auto Lube Pump
62.	30-8572	Air Regulator Assy
63.	25-7347	Base Left
64.	25-7390	Tool Tray
65.	25-7490A	Base Basin
66.	25-7354A	Short Machine Support



OM-1/OM-2 Internal Sheet Metal

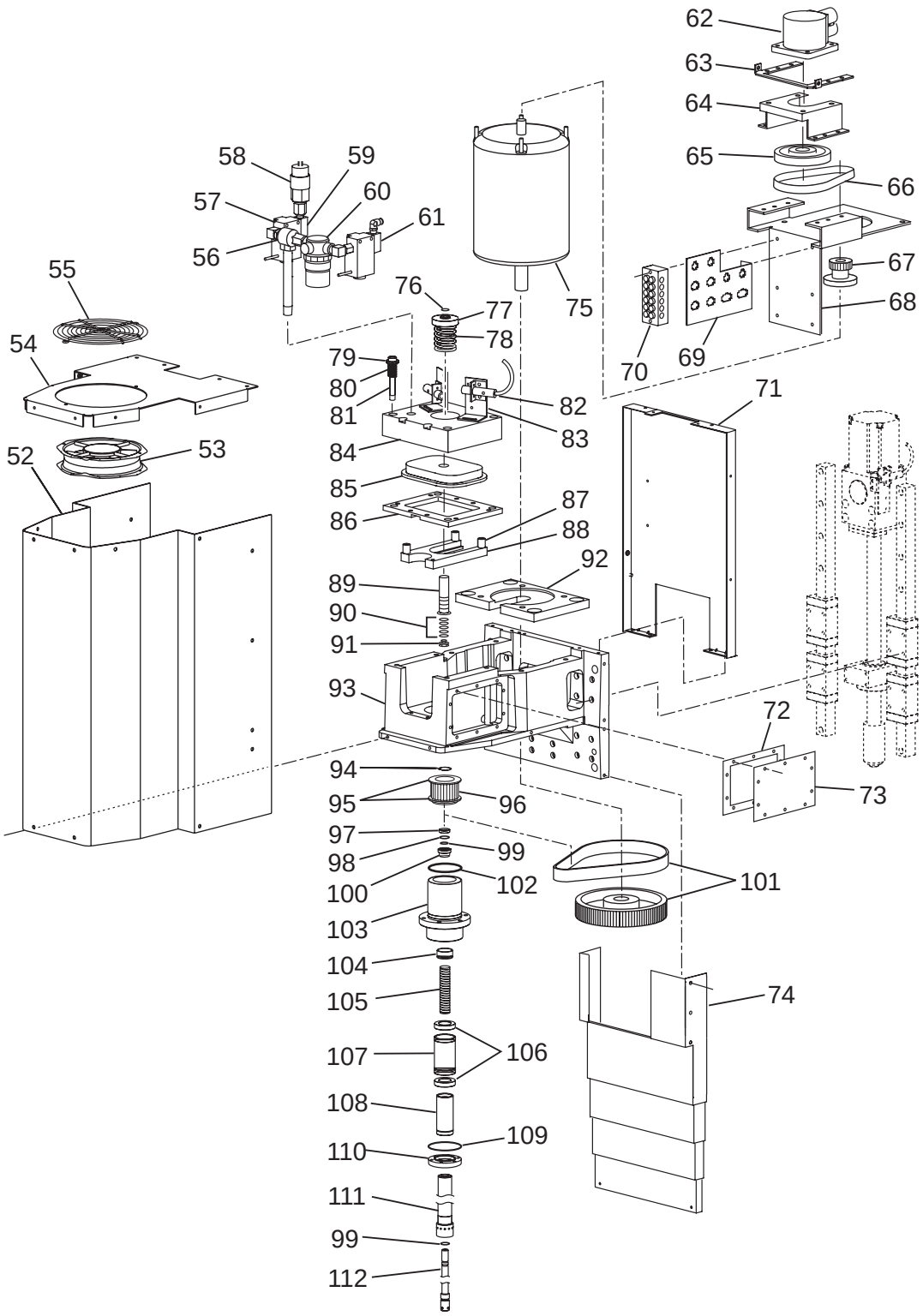
1.	25-6831	X-Axis Short Waycover
2.	25-6848	X-Axis Floater Waycover
3.	20-2743A	Table
4.	20-2775	2X Riser Rail (OL-1)
5.	25-5841A	Y-Axis Rear Waycover
6.	20-3082	Nut Housing
7.	50-0106	2X Linear Guide
8.	25-5840A	Y-Axis Front Waycover
9.	20-2749A	Ball Screw Bumper
10.	24-0110	Ball Screw
11.	20-2748	Bumper (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

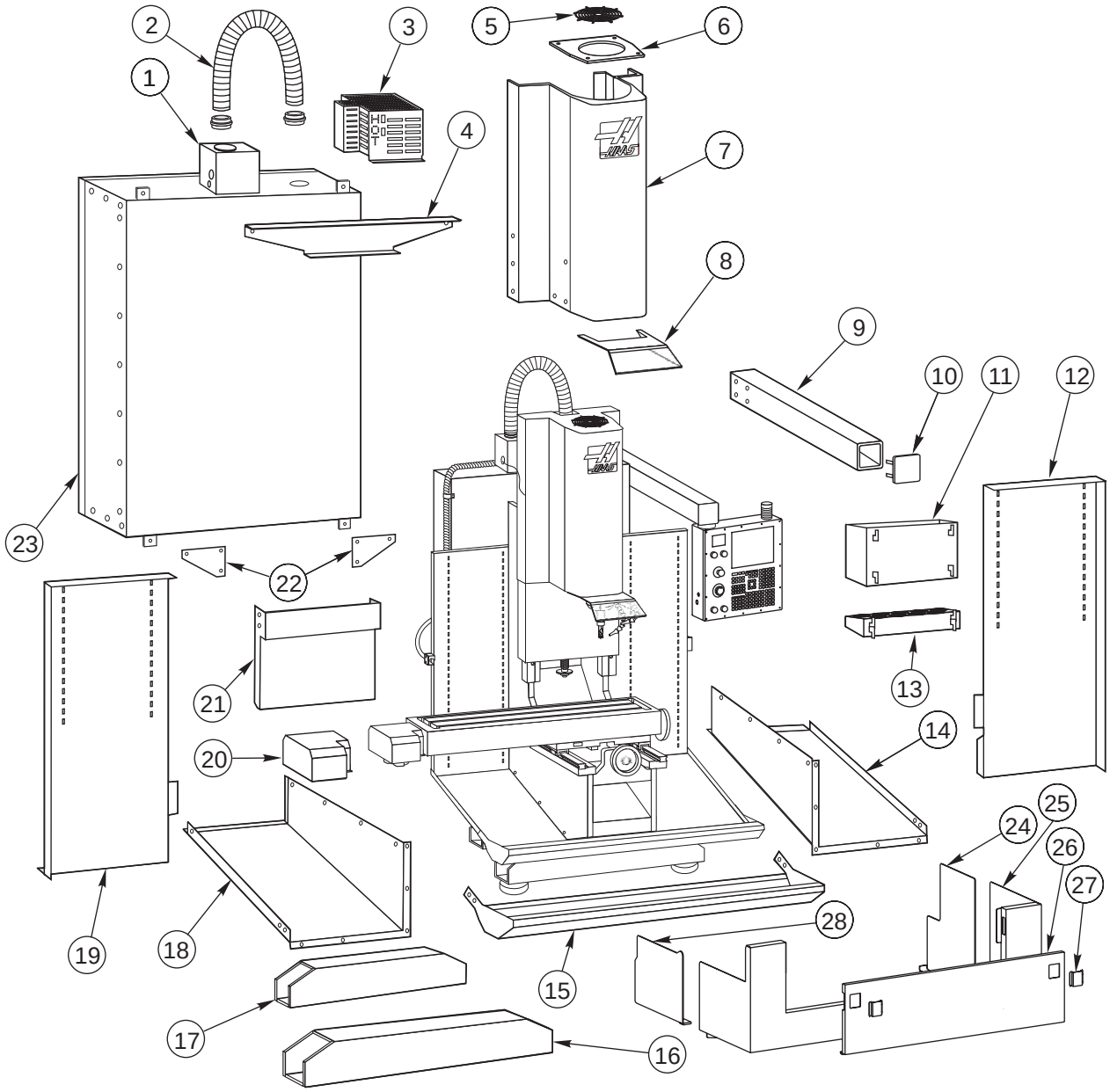
OM-1, -2 Spindle Head Assembly



OM-1, -2 Spindle Head Assembly

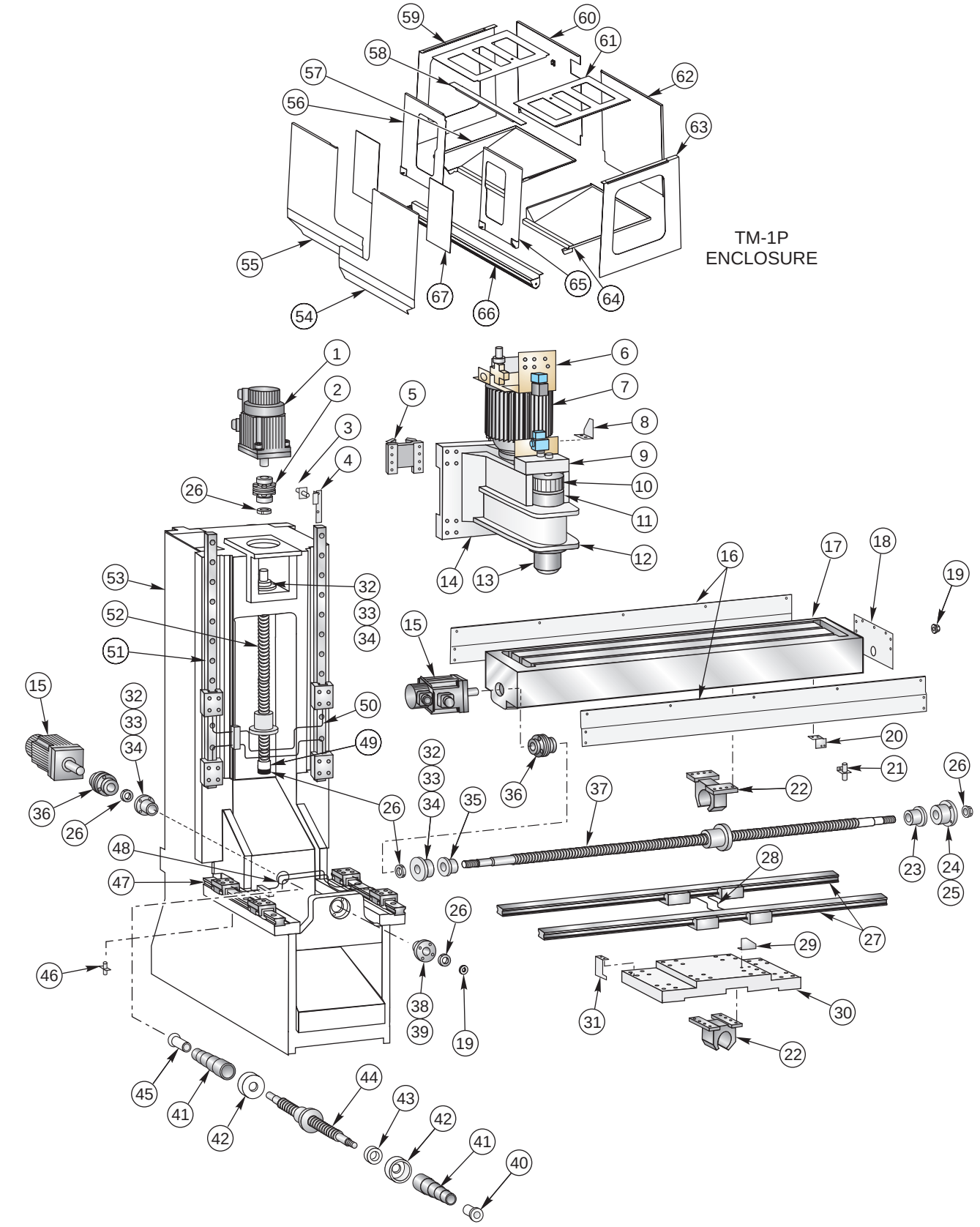
52.	25-7461A	Spindle Head Cover
53.	66-1480	Fan
54.	25-7462A	Top Head Cover
55.	59-0144	Fan Guard
56.	59-2832B	Quick Exhaust
	58-3729	Nipple
57.	36-30675	Solenoid
58.	53-3012	Pressure Switch
59.	58-2743	Branch Tee
60.	58-2736	Air Regulator 0-10 B-1
61.	36-30670	Solenoid
62.	60-1813	Encoder
63.	25-6298	Encoder Spring Clamp
64.	25-6293	Encoder Spring Box
65.	20-3323	Encoder Drive Sprocket
66.	HDT_Wb1	Encoder Drive Belt
67.	20-0276A	Drive Sprocket
68.	25-7463	Terminal Block Mount
69.	25-7469	Spindle Connector Bracket
70.	73-3054	Terminal Block
71.	25-7460A	Head Back Cover
72.	57-0401	2X Coolant Gasket Jacket
73.	25-7432	2X Coolant Gasket Cover
74.	25-6874	Z-Axis Lower Waycover
75.	62-0300	Spindle Motor 1.5 HP
76.	Not Used	
77.	20-1656	TRP Spring Retainer
78.	59-2760	TRP Spring
79.	45-1730	Hard Washer 3_8
80.		Spring C0850_092_0880_M
81.	49-0130	Shoulder Screw 3/8 x 2 3/4
82.	69-1700	2X Proximity Switch
83.	25-7227	2X Switch Mounting Bracket
84.	20-3204	TRP Cylinder
85.	20-3205	TRP Piston
86.	20-3216	TRP Sub-Plate
87.	20-3207	4X TRP Support Spacer
88.	20-3206	TRP Support Finger
89.	20-7626C	TRP TSC Shaft
90.	45-0063	5X
91.	20-7640	Tool Release Bolt
92.	20-3260	Washer 3/8 Steel
93.	20-3121	Head Machined
94.	WHM75	Spiral Retaining Ring
95.	20-3199	2X Sprocket Flange
96.	20-3198	Sprocket GT2 5M-30S-15
97.	54-0101A	Shaft Collar 5/16
98.	57-0070	O-Ring 2-114
99.		O-Ring 2-012
100.	20-3202	Draw Bar Retainer
101.		3MR-635-15 Polychain GT2 Belt
102.	20-3226	Pulley 90T
103.	57-4120	O-Ring 2-226
104.	20-3192A	Spindle Housing
105.	20-3197	Spindle Lock Ring
106.		Spring 4.51g_Comp. 1_15
107.		2X Bearing 25_42_9mm
108.	20-3196	Spindle Outer Spacer
109.	20-3195	Spindle Inner Spacer
110.		O-Ring 2-033
111.	20-3193A	Spindle Cap
112.	20-3194A	Spindle Shaft
113.	20-3201	Spindle Draw Bar

TM-1/TM-2 Exterior Sheet Metal



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

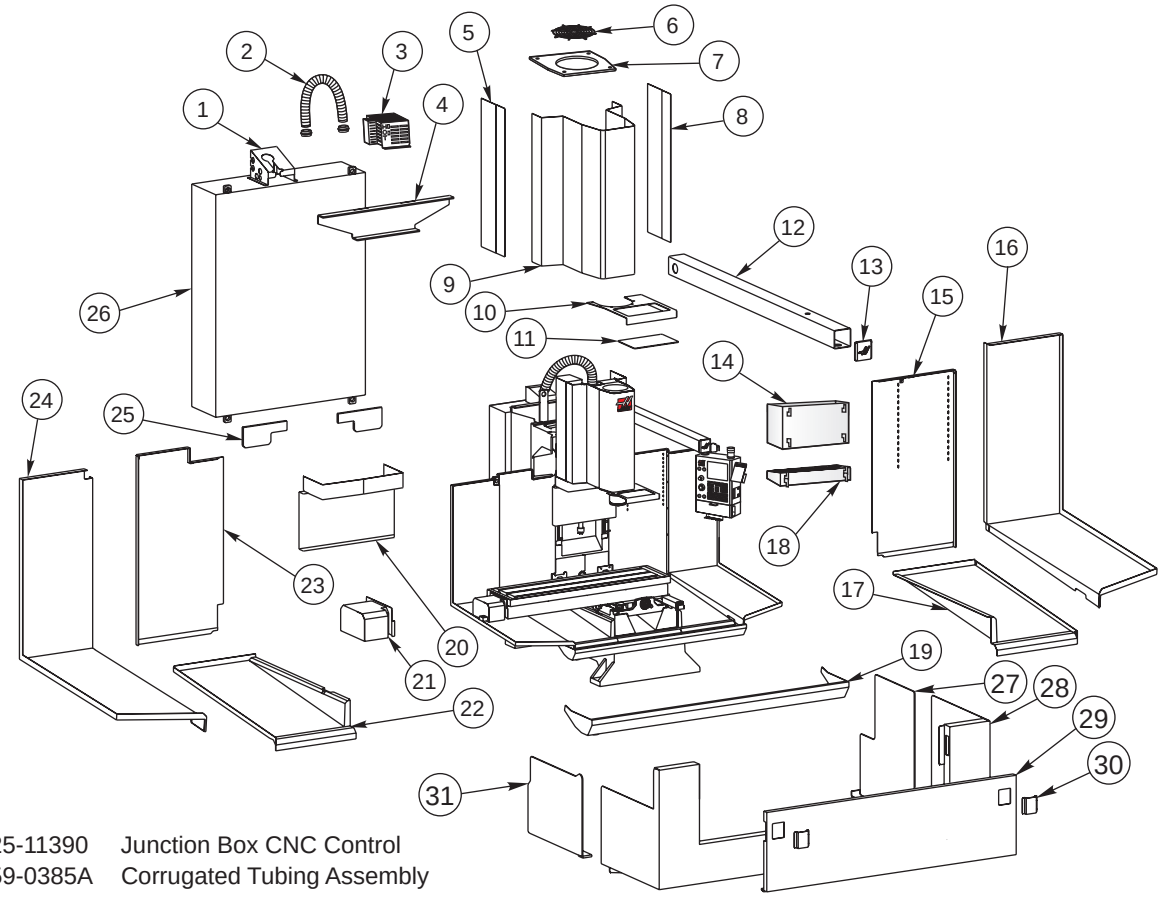
TM-1/TM-2 Enclosure & Interior Parts



TM-1/TM-2 Enclosure & Interior Parts List

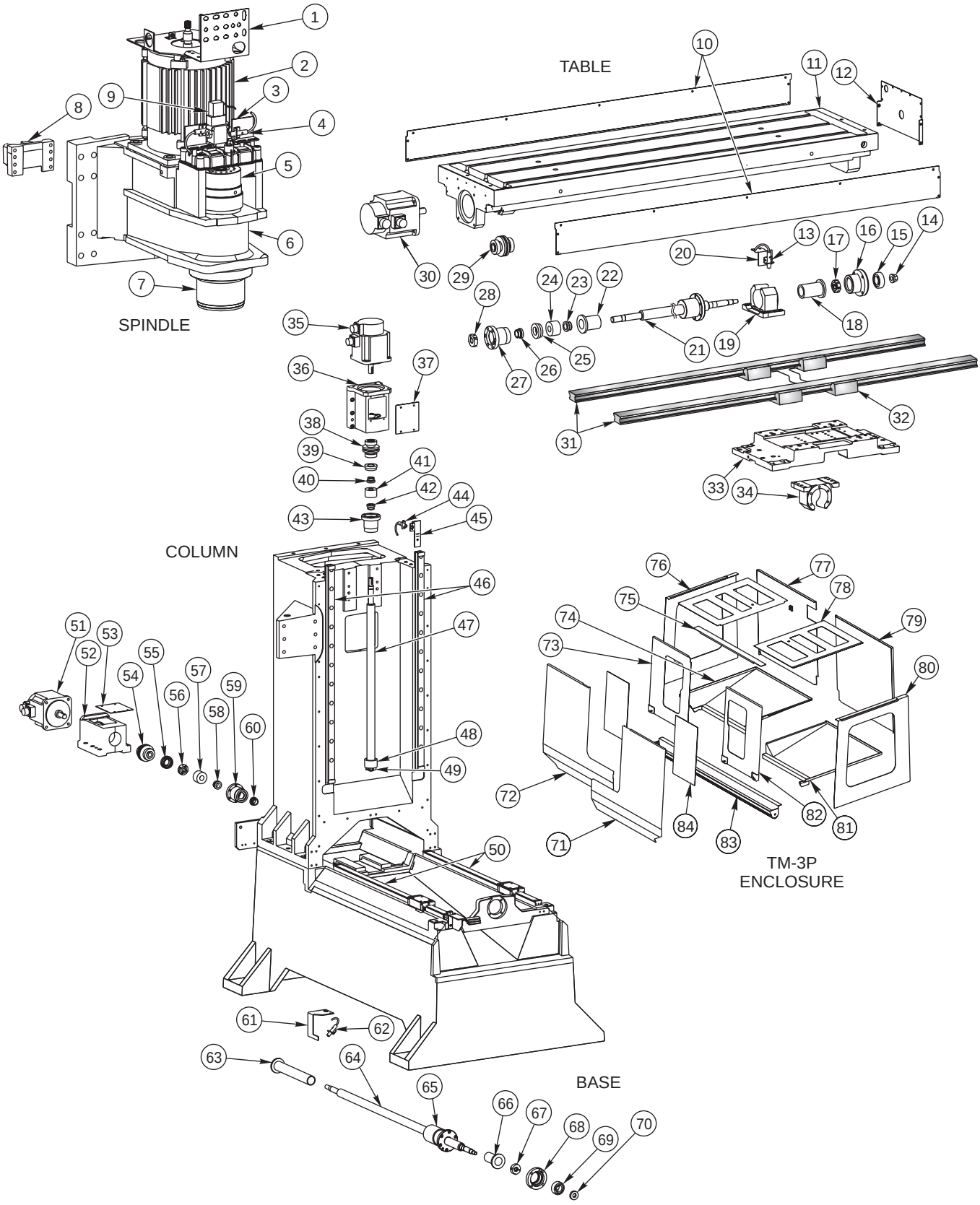
1.	62-0024	Servomotor Yaskawa 05 No Brake
2.	30-1220A	Coupling Assembly BL
3.	69-1601	Proximity Switch
4.	25-4024	Switch Bracket Z-Axis
5.	20-7008F	Nut Housing Machined
6.	30-2465B	Air Solenoid Assembly
7.	30-1674C	Spindle Motor Assembly
8.	25-5190B	Proximity Sensor Trip Flag Z-Axis
9.	30-1668B	TRP Assembly
10.	20-7373	1 7/8 Pulley
11.	20-3823	Oil Injection Cover 40T
12.	20-4196	Spindle Housing 40T
13.	30-1337A	Spindle Assembly 40T
14.	20-3007C	Plate Spindle Motor
15.	62-1015	Spindle Motor 5HP Lincoln
16.	25-4001B	Cover Table Side (2) (TM-1)
	25-5469	Cover Table Side (2) (TM-2)
17.	20-1302C	Table Macining (TM-1)
	20-2488A	Table Machined (TM-2)
18.	25-4002A	Cover Table End
19.	46-0015	Nut 1/4-20 Flange (2)
20.	25-4014	Switch Bracket X-Axis
21.	69-1606	Proximity Switch
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
47.	50-0013A	Linear Guide 30 X 710 (2) (TM-1)
	50-0014A	Linear Guide 30 X 1030 (2) (TM-2)
48.	30-2794A	Lube Line Assembly Y-Axis
49.	28-0221	Bumper X-Axis
50.	30-2042	Lube Line Assembly Z-Axis
51.	50-0014A	Linear Guide 30 X 1030 (2)
52.	24-0021	Ballscrew 32-6-809.37 Z-Axis
53.	20-1303C	Base Machining (TM-1)
	20-2490	Base Machining (TM-2)
54.	25-7879A	Panel Frnt Rt
55.	25-7878A	Panel Frnt Lt
56.	30-8926	Door Assy Lt
57.	25-7874A	Pan Encl Lt
58.	25-8707	Header Brace
59.	25-7882	Panel Side Lt
60.	25-7884B	Panel Back Lt
61.	25-7880A	Cover Top
62.	25-7883A	Panel Back Rt
63.	25-7881	panel Side Rt
64.	25-7875A	Pan Encl Rt
65.	30-8925	Door Assy Rt
66.	25-7905	Trough Encl
67.	28-0240	Window Door

TM-3 Exterior Sheet Metal



1. 25-11390 Junction Box CNC Control
2. 59-0385A Corrugated Tubing Assembly
3. 32-0041B Regen Assembly
4. 25-4044A Support Upper Control Box
5. 25-8402 Side Spindle Head Cover
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
27. 25-8517B Splash Guard Right
28. 25-5579B Table Chip Guard
29. 25-5578 Door
30. 58-0227 Latch Push Close (2)
31. 25-8516B Splash Guard Left

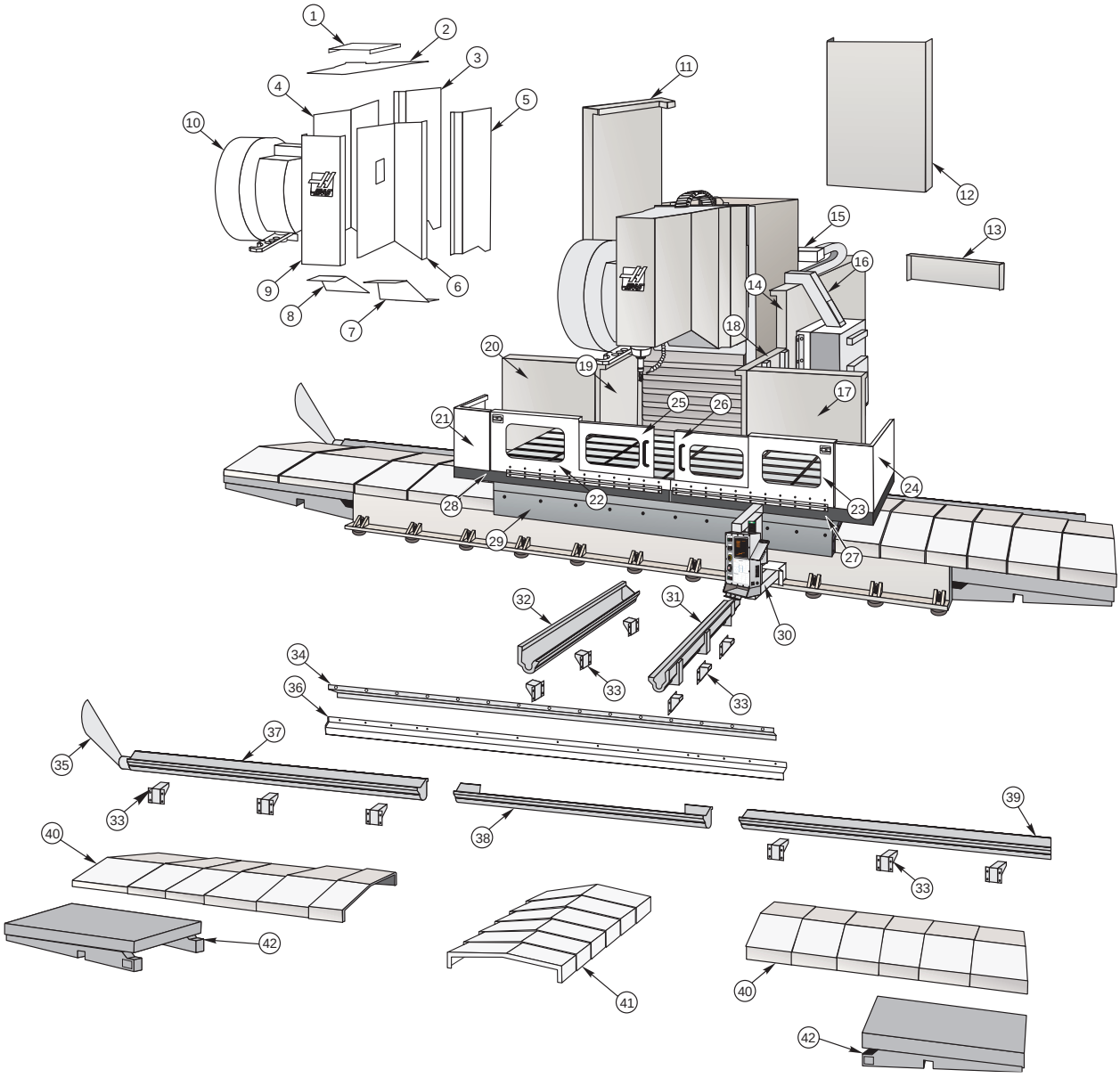
TM-3 Enclosure & Interior Parts



TM-3 Enclosure & Interior Parts List

1.	25-6180C	Solenoid Mounting Bracket
2.	62-1015	Spindle Motor 5HP Lincoln
3.	25-7050C	Switch Mounting Bracket (x2)
4.	69-1700	Proximity Switch (x2)
5.	20-7373	1 7/8 Pulley
6.	20-10217	Spindle Head Machined
7.	20-4196	Spindle Housing 40T
8.	20-7008F	Nut Housing Machined
9.	32-5620	TRP Solenoid Valve Assembly
10.	25-8401	Table Cover Side (x2)
11.	20-3676A	Table Machined
12.	25-4335A	Cover Table End
13.	69-1606	Proximity Switch
14.	46-0015	Nut 1/4-20 Flange
15.	51-2025	Bearing Radial 304PP
16.	20-1094	Bearing Housing
17.	51-2012	Bearing Locknut TCN-04-F
18.	28-0225	Bumper X-Axis Support End
19.	20-1093	Nut Housing X/Y-Axis
20.	25-4014	Switch Bracket X-Axis
21.	24-0106	Ballscrew 32-6-1463.802 X-Axis
22.	28-0224	Bumper X-Axis Motor End
23.	22-7417	Spacer Bearing Cartridge
24.	51-1011U	Bearing Angular Contact
25.	20-7418	Lock Bearing Cartridge
26.	22-7417	Spacer Bearing Cartridge
27.	20-7416	Housing Bearing Cartridge
28.	51-2012	Bearing Locknut TCN-04-F
29.	30-1220A	Coupling Assembly BL
30.	62-0024	Servomotor Yaskawa 05 No Brake
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
55.	20-7418	Lock Bearing Cartridge
56.	51-2012	Bearing Locknut TCN-04-F
57.	51-1011U	Bearing Angular Contact
58.	22-7417	Spacer Bearing Cartridge
59.	20-7416	Housing Bearing Cartridge
60.	22-7417	Spacer Bearing Cartridge
61.	25-8399	Proximity Sensor Trip Y-Axis
62.	69-1606	Proximity Switch
63.	28-0265	Bumper Y-Axis Motor End
64.	24-0019	Ballscrew 32-6-1209.802 X-Axis
65.	20-1113A	Retainer Y-Axis Ballscrew Cover
66.	28-0226	Bumper Y-Axis Support End
67.	51-2012	Bearing Locknut TCN-04-F
68.	20-1094	Bearing Housing
69.	51-2025	Bearing Radial 304PP
70.	46-0015	Nut 1/4-20 Flange
71.	25-7879A	Right Front Panel
72.	25-7878A	Left Front Panel
73.	30-8926	Door Left
74.	25-7874A	Left Pan
75.	25-8707	Header Brace
76.	25-7882	Left Side Panel
77.	25-7884B	Left Back Panel
78.	25-7880A	Roof Panel
79.	25-7883A	Right Back Panel
80.	25-7881	Right Side Panel
81.	25-7875A	Right Pan
82.	30-8925	Right Door
83.	25-7905	Auger Trough
84.	28-0240	Window Door

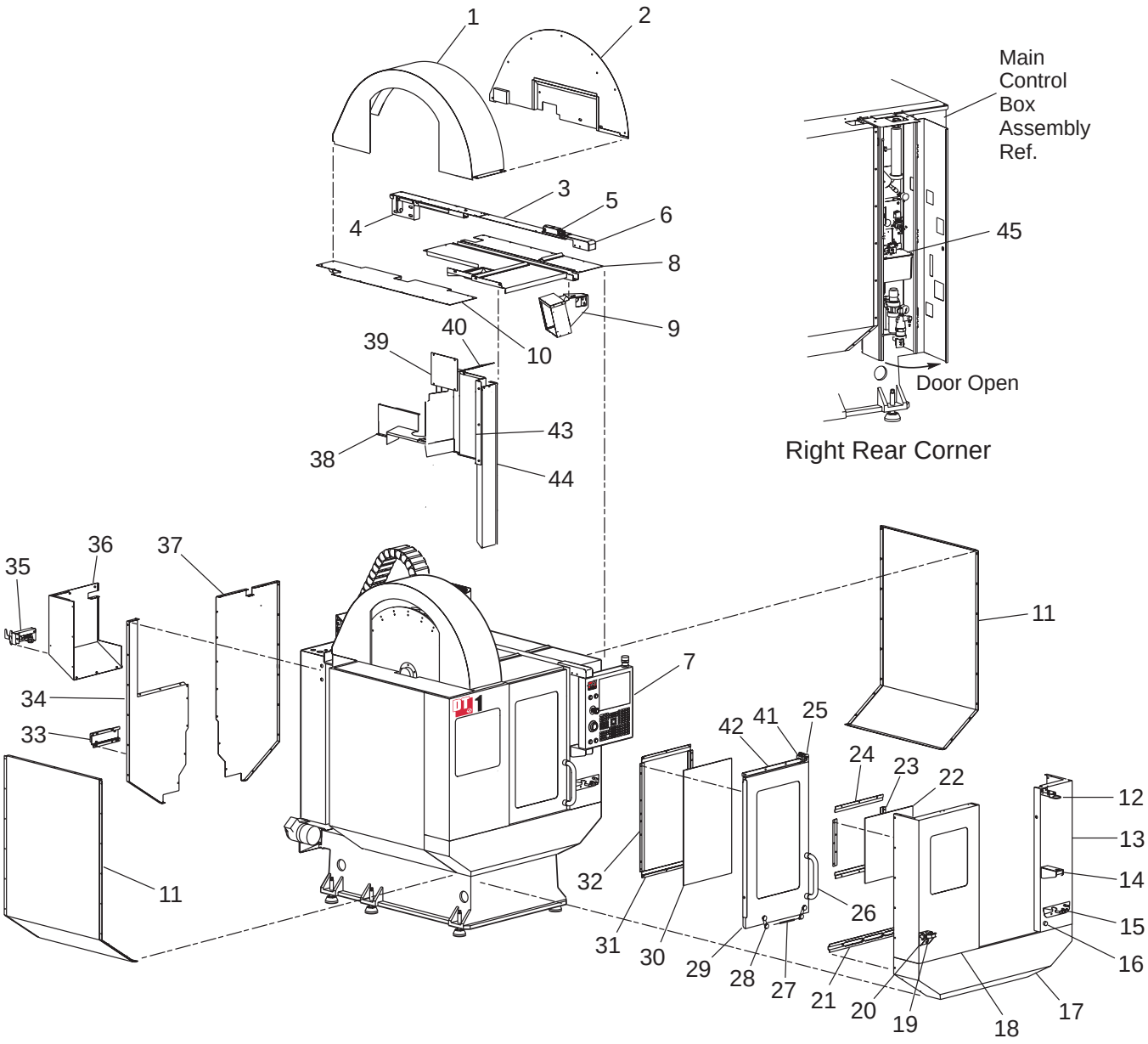
VS-1/3 Sheet Metal Assembly



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)

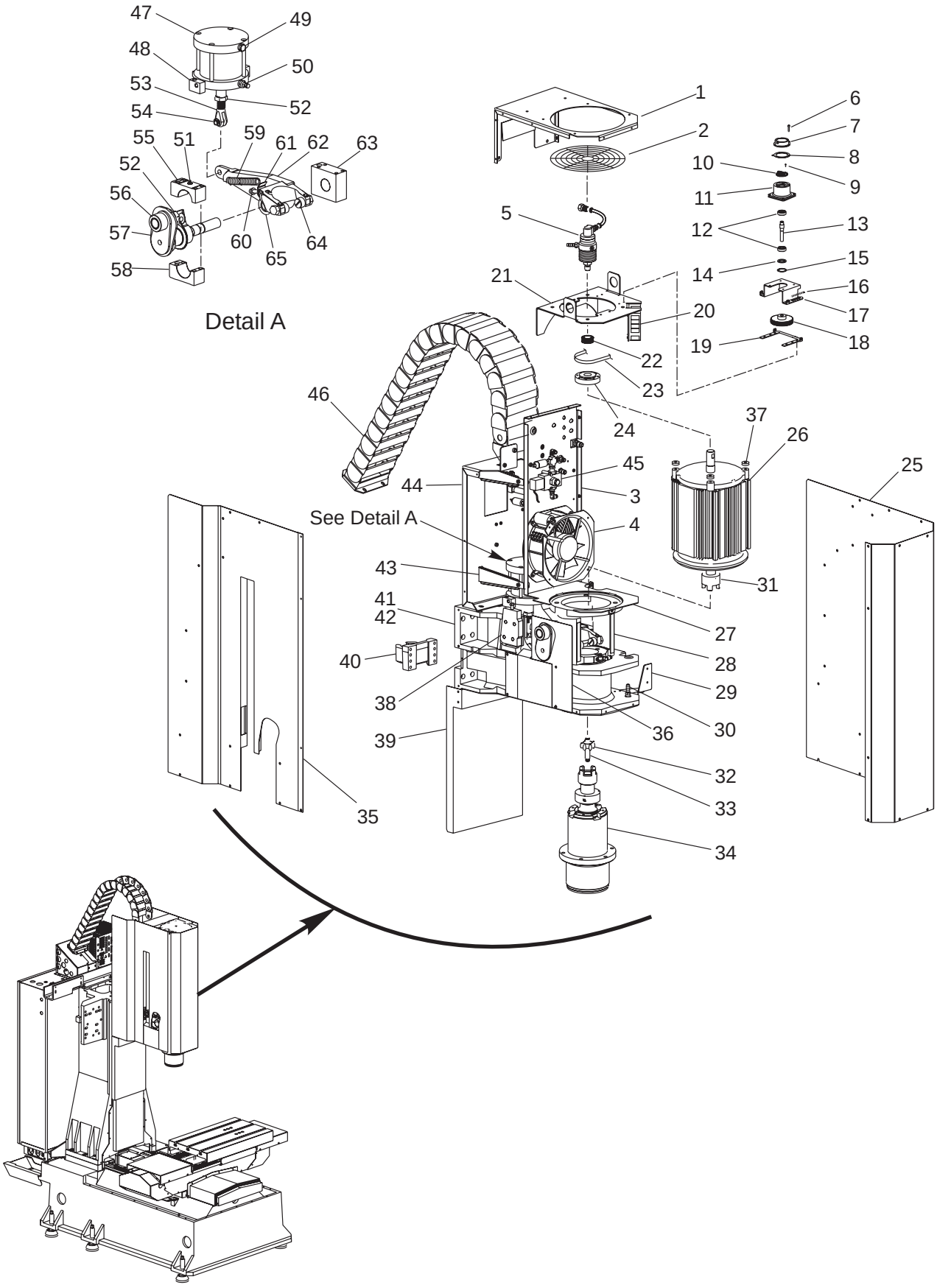
DT-1 Exterior Sheet Metal



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 fron 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

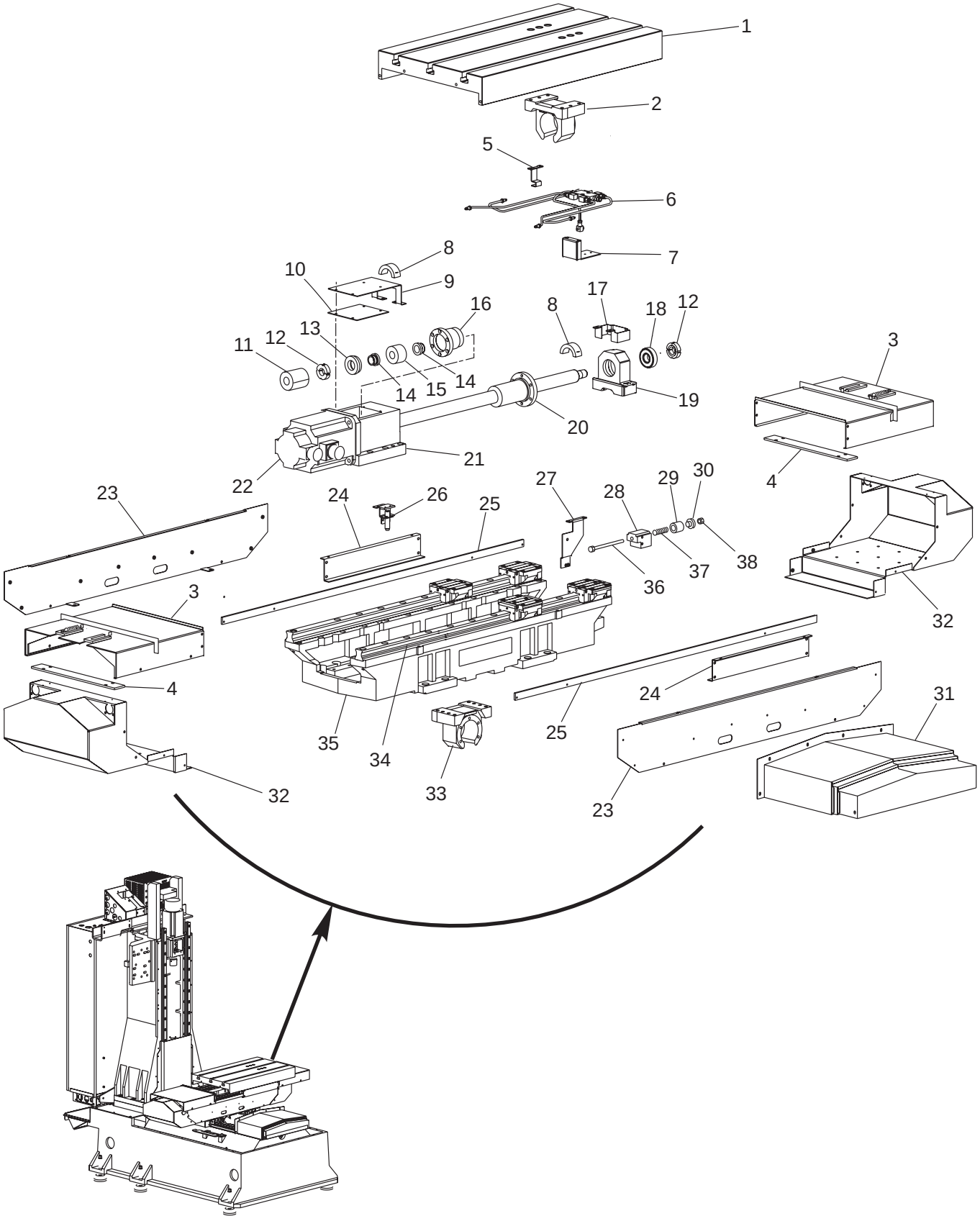
DT-1 Spindle Head



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 cy7linder 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

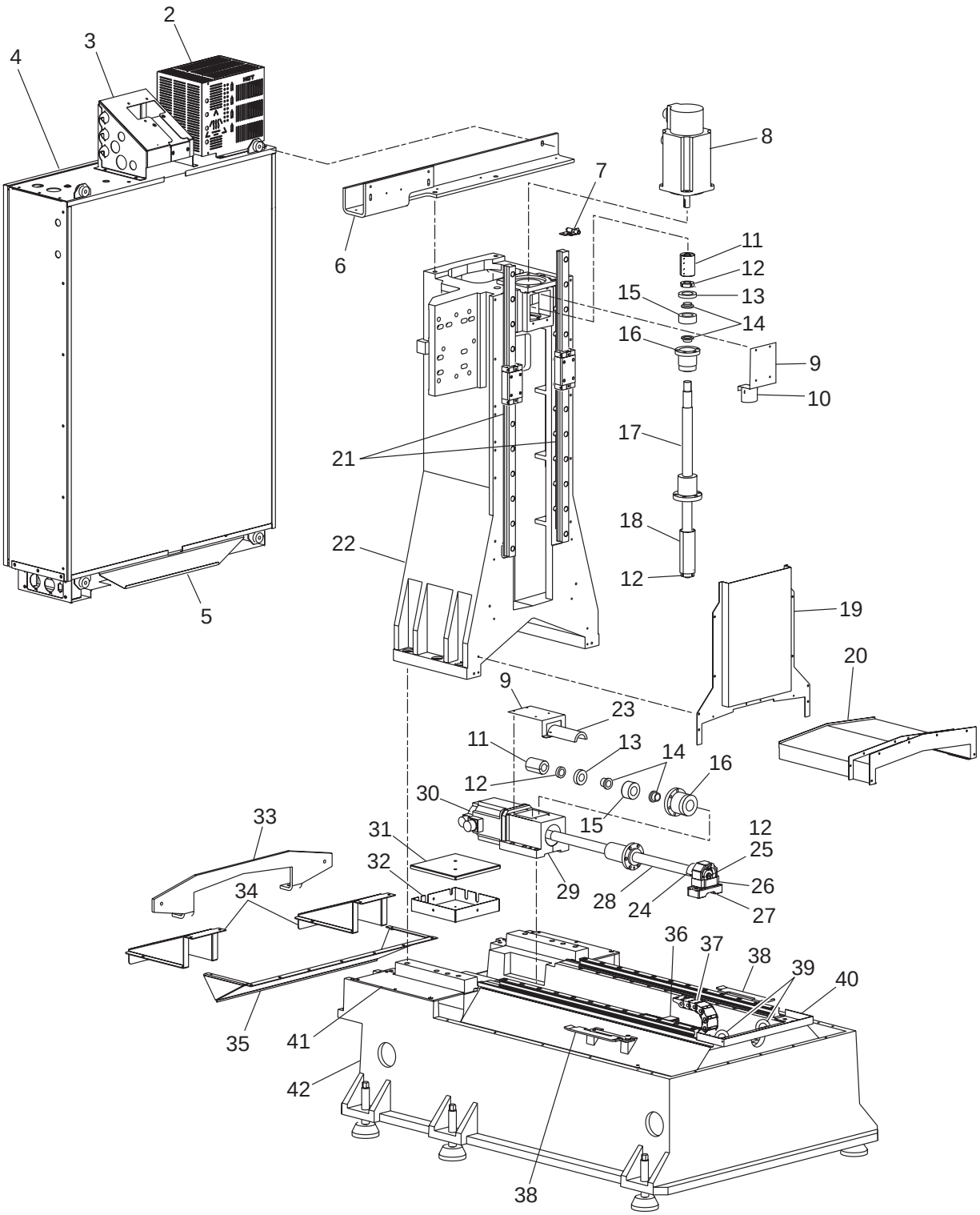
DT-1 Table and Saddle Assembly



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

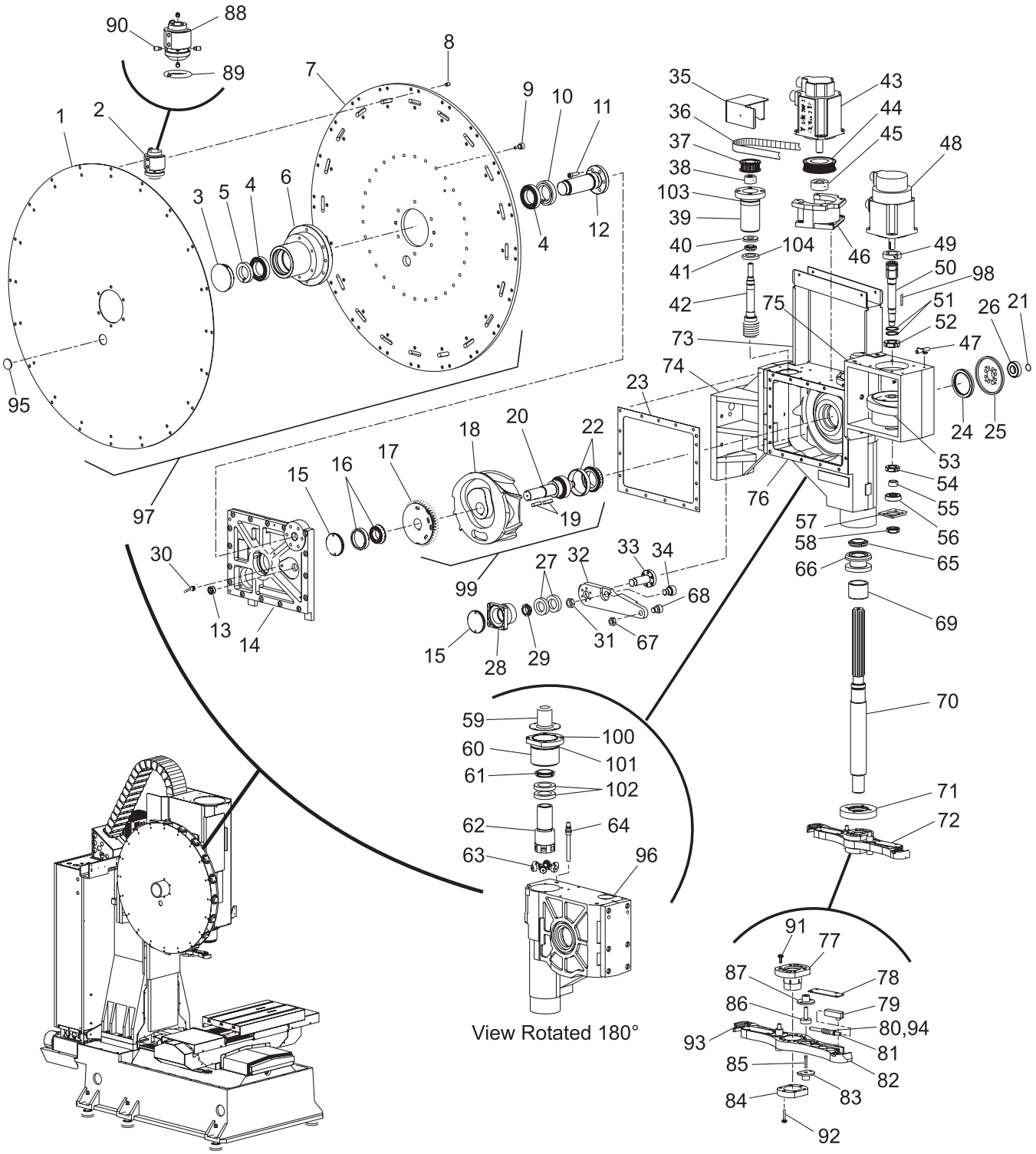
DT-1 Control Column and Base



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

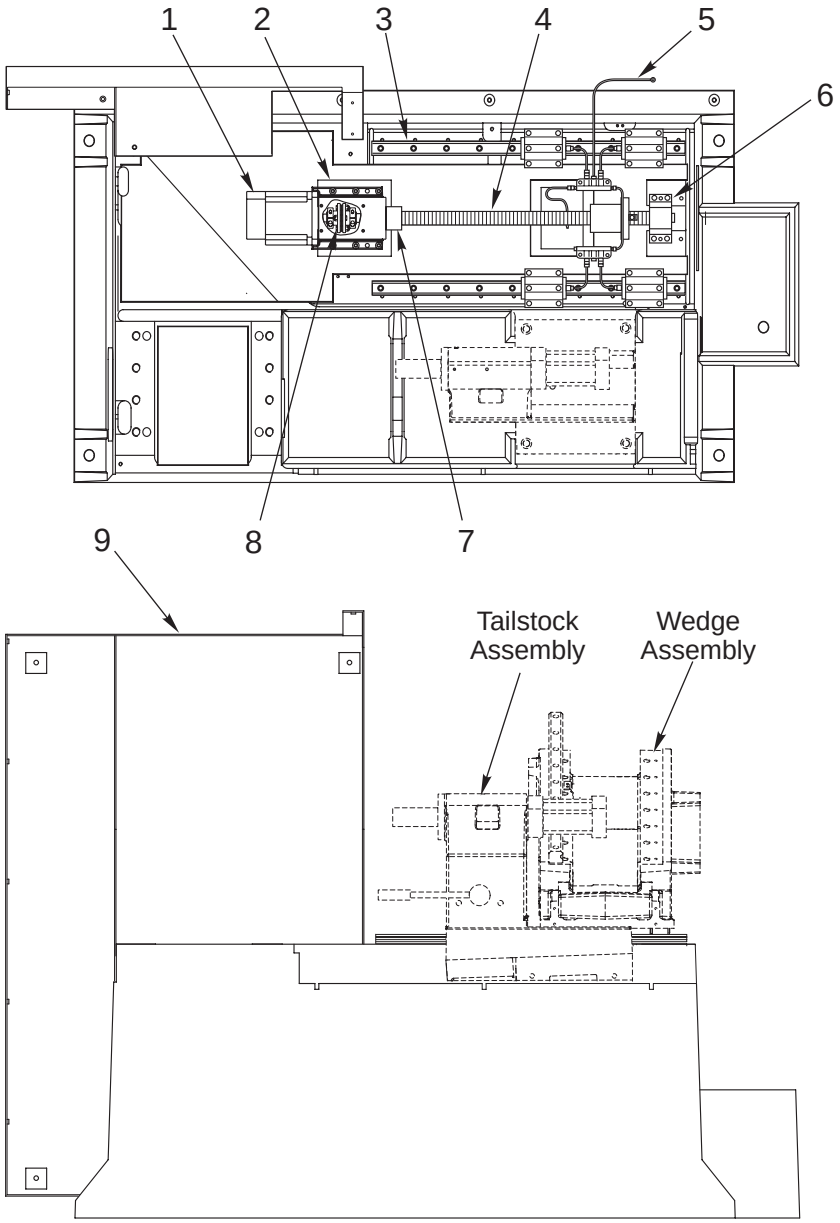
DT-1 Tool Changer



DT-1 Tool Changer Parts List

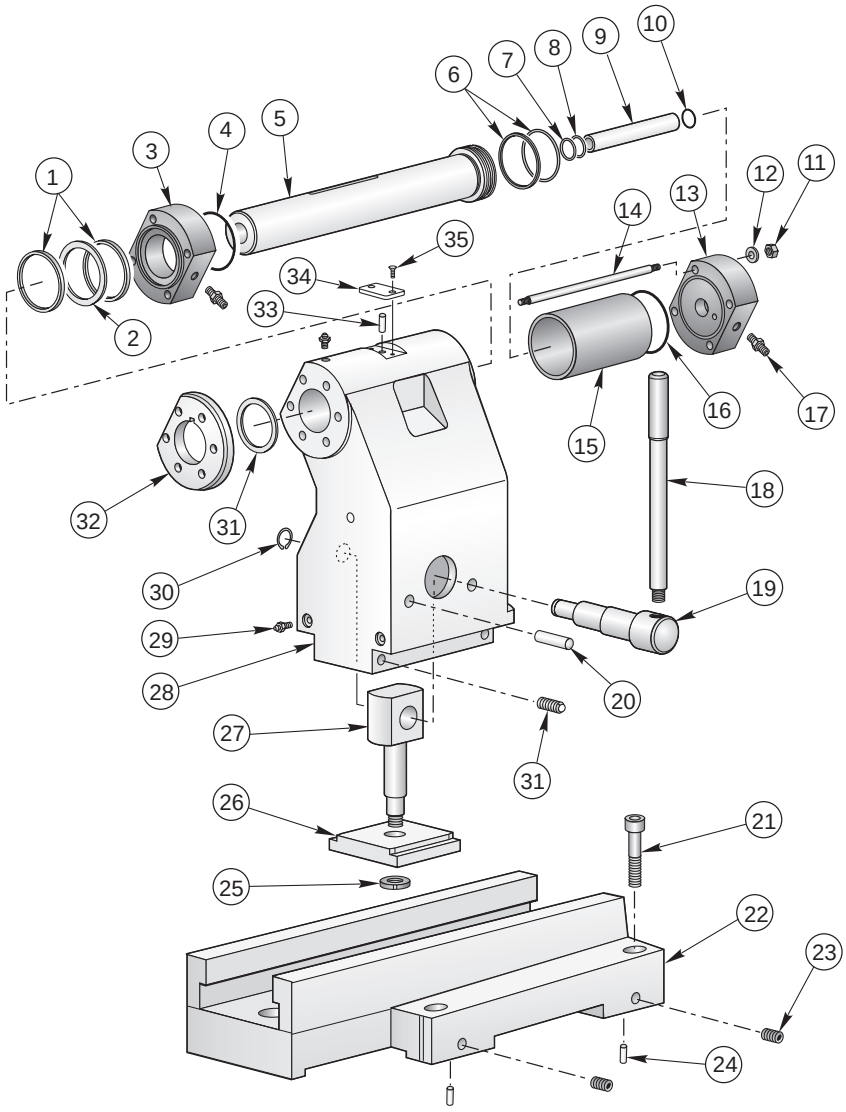
1. 25-1868 SMTYC number plate – 20 Pocket
2. 30- 4453 20x Tool pocket assembly
3. 59-0737 Hole plug 3.375 in. black
4. 51-0020 2x Deep groove bearing 6010ZZW-non metallic
5. 51-0113 Bearing locknut TCN-09-F
6. 20-46992 SMTC Carousel hub
7. 20-4690 Carousel disk 20 pocket
8. 48-0034 60x dowel ring .391 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 SMTC Carousel shaft
13. 59-4110 Sight glass LSP501-08RG
14. 20-4681 SMTC Cambox cover
15. 20-0236 2x SMTC cam bearing adjuster
16. 51-0042 Roller bearing M35-72-18.25
17. 35-1001B Worm gear assembly
18. 20-4662 SMTC cam globoidal 30T
19. 20-6406 2x Cam gear key
20. 20-4679 SMTC Cam box main shaft
21. 56-9058 Retaining ring .781 in. SH5100-78
22. 51-0043 Roller bearing M55-90-23
23. 57-0242 SMTC Cam box gasket
24. 57-0243 Seal 2.875 in. CR28669 3.750 O.D. x.375 in.
25. 20-4680A SMTC 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 SMTC 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 SMTC 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 SMTC 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 SMTC 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 SMTC Double arm assembly BT-30.8 in.
73. 25-2472 SMTC Cable bridge
74. 20-4881 SMTC Mount machined
75. 20-4880 SMTC Carousel drive support
76. 20-4646 SMTC Cambox machined
77. 20-4659 SMTC 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 SMTC 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

SL-10 Casting Assembly and Parts List



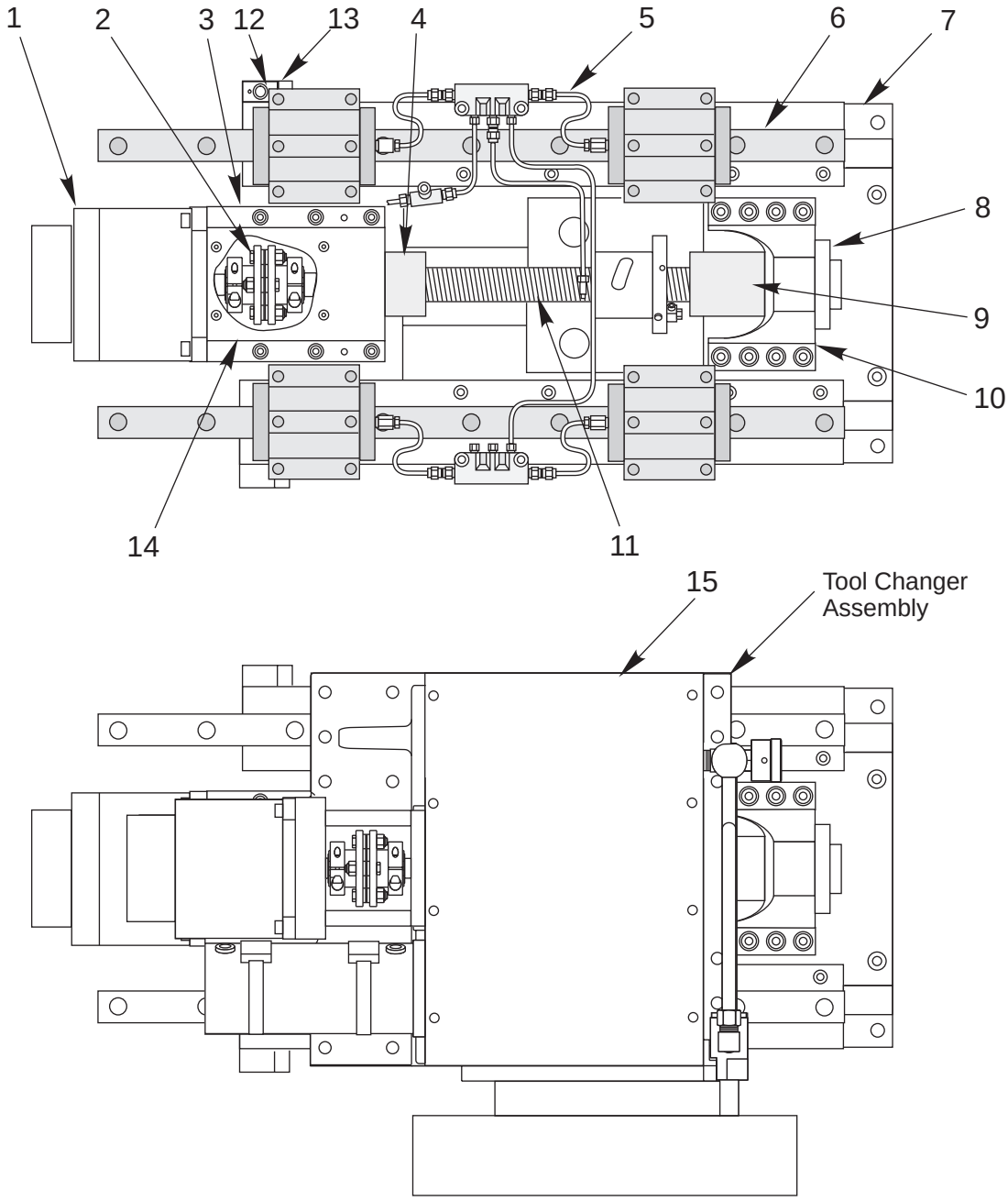
1.	62-0014	Motor
2.	20-7010B	Motor Mount Machined
3.	50-8766	X-axis Linear Guide Assembly
4.	30-2290A	Ball Screw Assembly
5.	30-2388A	Oil Line Assembly
6.	30-0153	Support Bearing Assembly
7.	28-0231	Bumper Z-Axis Motor End
8.	30-1220A	Coupling Assembly
9.	25-0857E	Control Box Bracket

SL-10 Tailstock Assembly and Parts List



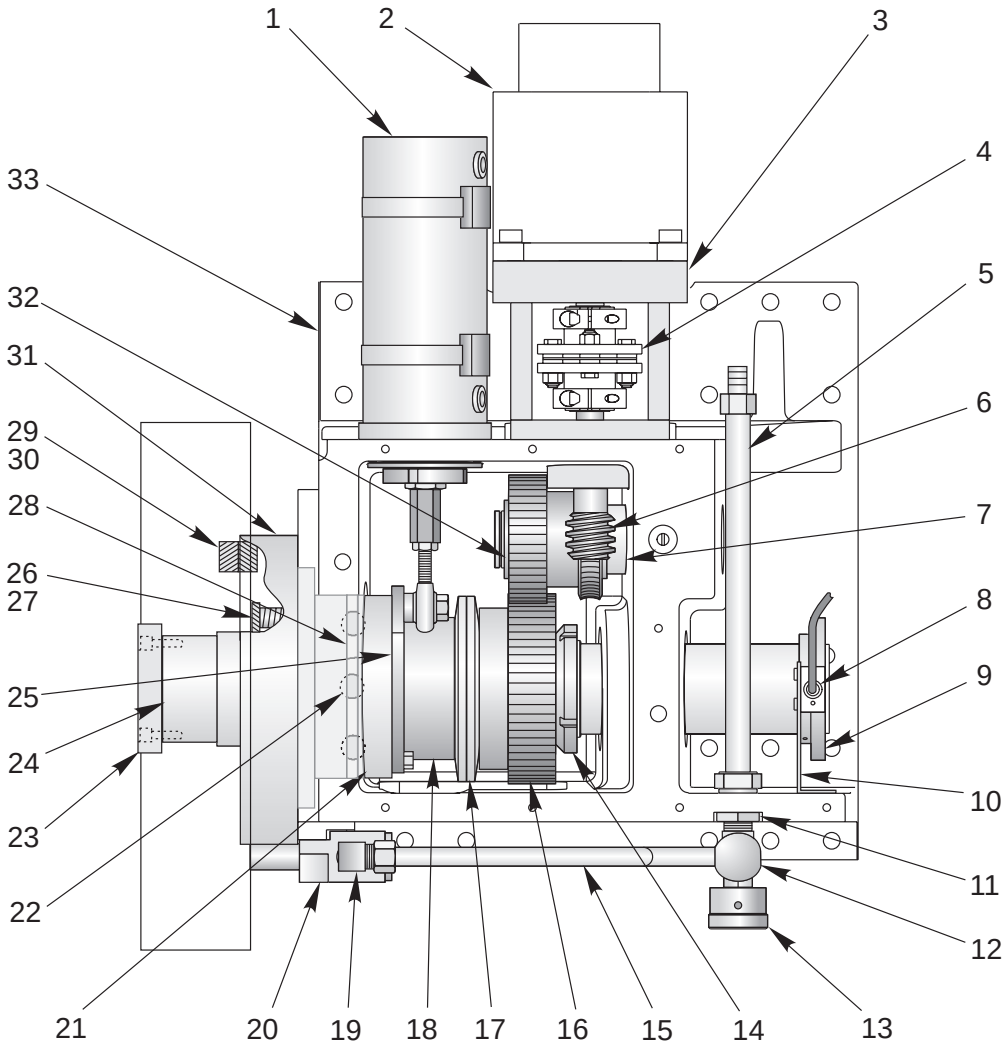
1.	57-0142	Seal Kit
2.	20-1070	Gland Retainer
3.	20-1017	Cylinder Head
4.	57-0140	O-Ring
5.	20-1012A	Shaft
6.	57-0136	Hydraulic Piston Seal
7.	57-0141	Quad Ring
8.	57-0143	Rod Seal
9.	20-1020	Knock-Out Tube
10.	57-0020	O-Ring
11.	46-1653	Hex Nut 5/16-18 (4)
12.	45-1600	Split Lock Washer (4)
13.	20-1014	End Cap
14.	20-1016	Tie Rod (4)
15.	20-1013	Cylinder Tube
16.	57-0140	O-Ring
17.	58-0045	Str Adapter (2)
18.	20-0858	Handle
19.	20-0859	Eccentric Clamp
20.	48-1755	Dowel Pin 1/2 x 2 (2)
21.	40-16643	SHCS 5/8-11 x 2-1/4 (4)
22.	20-1052A	TS Base Machining
23.	44-1699	SSS 1/2-13 Flat PT (2)
24.	48-1755	Dowel Pin 1/2 x 2 (2)
25.	51-2012	Bearing Locknut
26.	20-0861	Clamp Plate
27.	20-0860	Clamp Rod
28.	20-0988A	TS Head Machining
29.	59-2016	Grease Fitting (6)
30.	56-2086	Retaining Ring
31.	57-0135	Wiper
32.	20-0857	Shaft Cap
33.	48-0060	Anti Rotation Pin
34.	20-1959	Key Retainer
	57-0392	Key Retainer Gasket
35.	40-1703	2X FHCS

SL-10 Wedge Assembly and Parts List



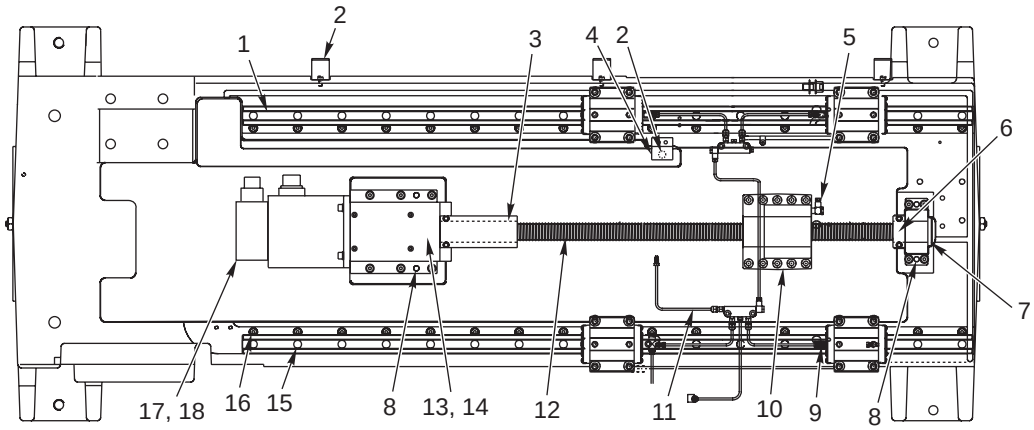
1.	62-0009	Motor
2.	30-1219	Coupling Assembly
3.	20-7010B	Motor Mount Machined
4.	28-0228	Ring Bumper 1.68
5.	30-2387	Lube Line Assembly
6.	50-8766	X-axis Linear Guide Assembly
7.	20-0986D	Wedge Machined
8.	30-0154	Bearing Motor Housing
9.	20-0928	Ring Bumper 2.56
10.	20-0773	Bearing Support Housing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

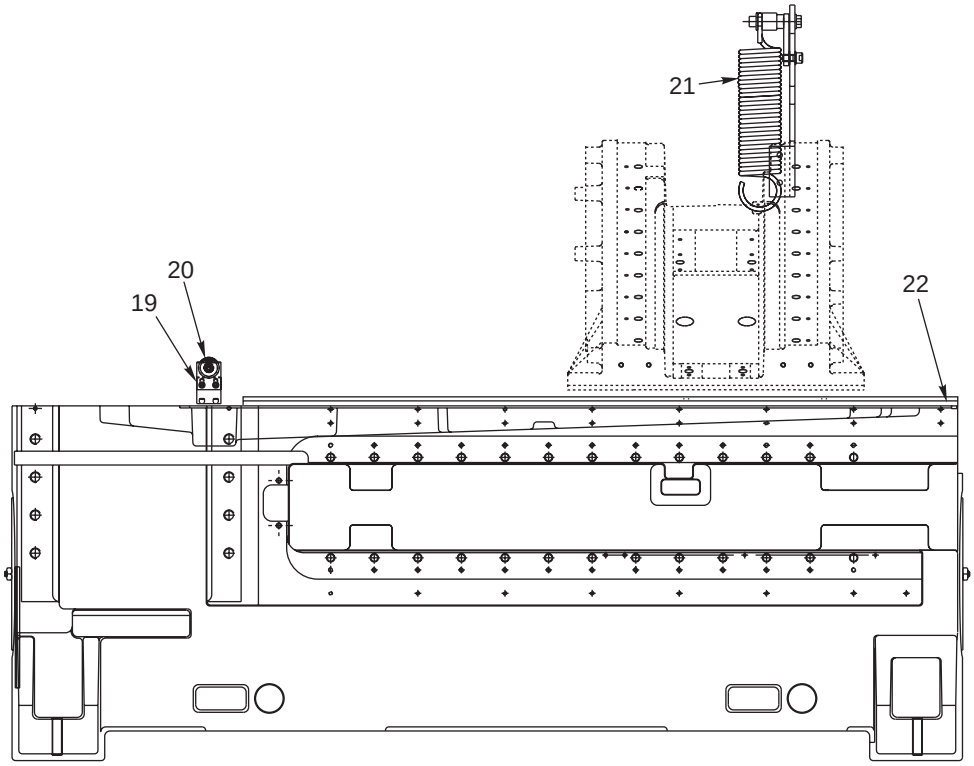
SL-10 Tool Changer Assembly and Parts List



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
	22-8544	Spur Gear Key	33.	20-0985D	TC Turret Housing

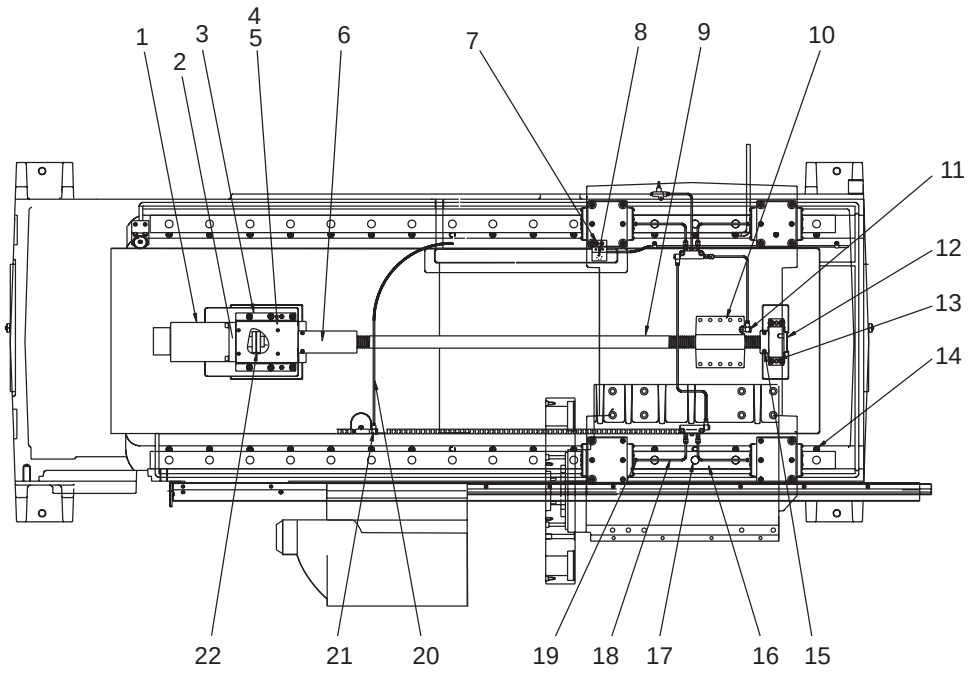
SL-20/20L Casting Assembly and Parts List

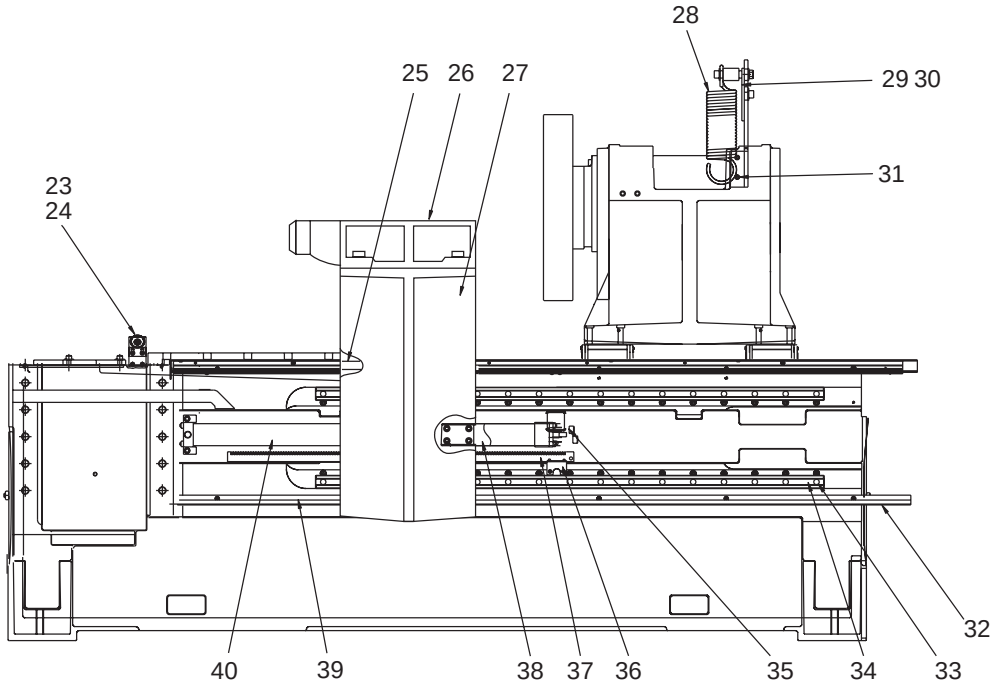




1.	50-3400	Linear Guide X-Axis (SL-20)	11.	30-8717A	Oil Line Assembly
	50-8549	Linear Guide X-Axis (SL-20L)	12.	24-9013	Ballscrew (SL-20)
2.	25-9746	Cable Clamp Base (SL-20)		24-0103	Ballscrew (SL-20L)
	63-1030	Cable Clamp Base (SL-20L)	13.	20-7010B	Motor Mount
3.	20-9058	Ballscrew Bumper (SL-20)	14.	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

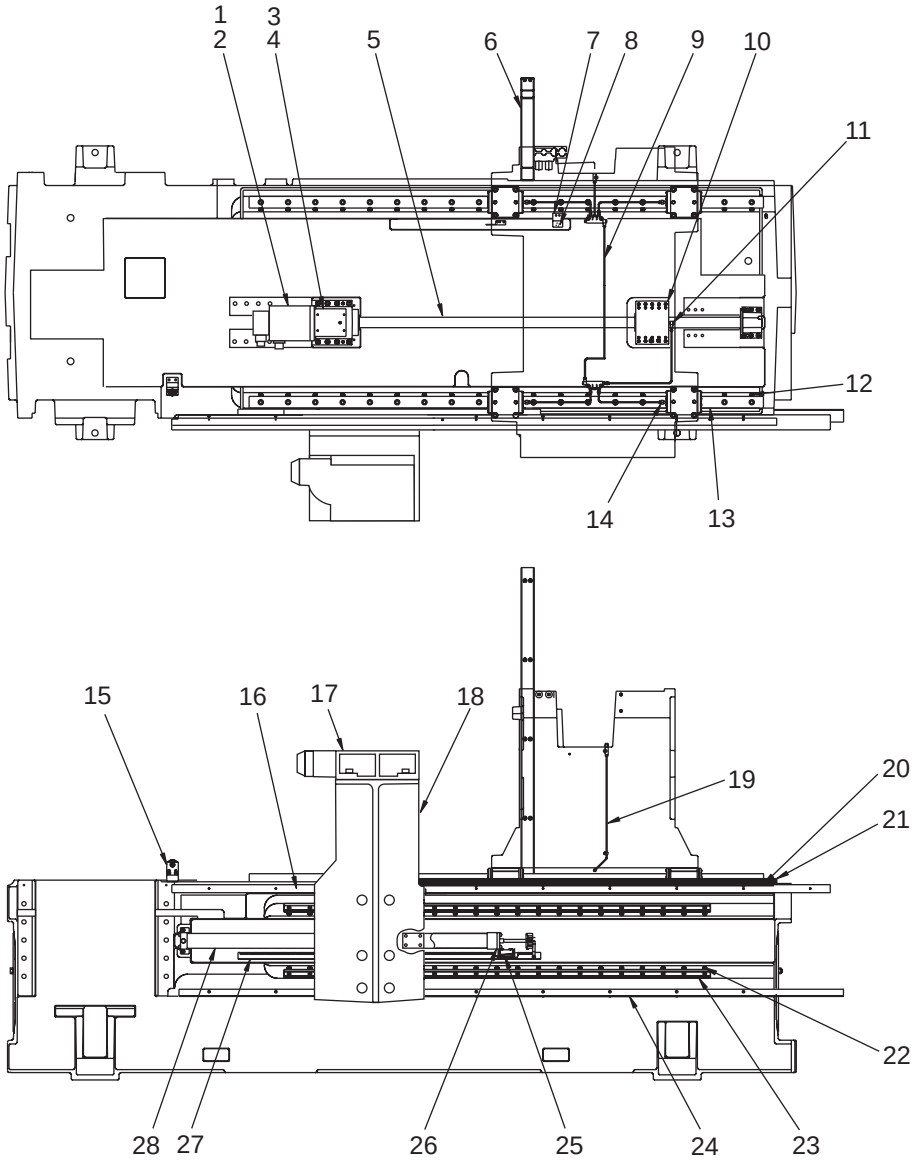




SL-30/30L Casting Assembly w/Tailstock Parts List

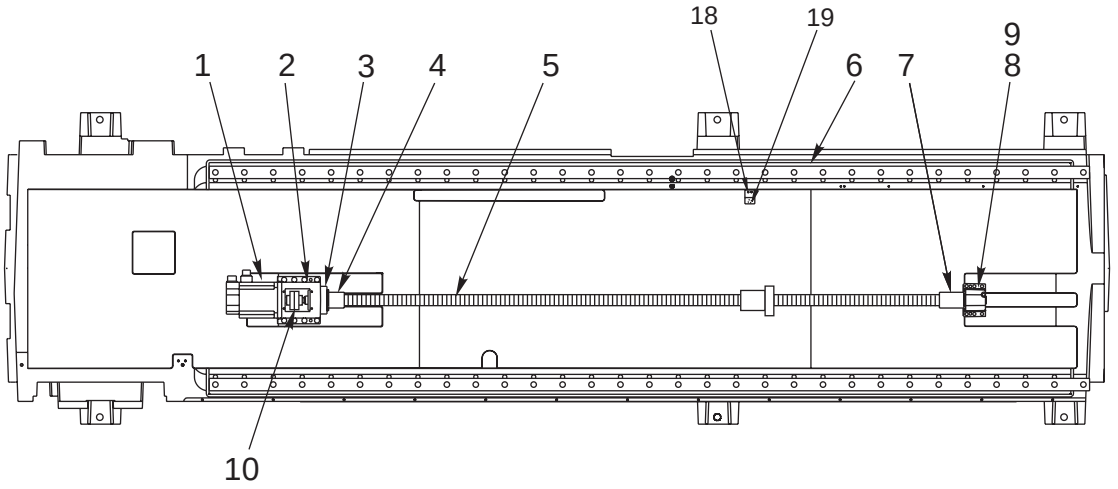
1.	22-2629	Key Stub Shaft/Worm Shaft
2.	62-0016	Servomotor Yaskawa 13 No Brake
3.	20-0151A	Machining Motor Mount 40 & 50mm Ballscrew
4.	25-9203	Cover Plate Motor Mount
5.	26-7233A	Gasket, Deflector Shield
6.	28-0235	Snap Lock Ring Bumper (SL-30)
7.	25-5184	Proximity Sensor Mounting Bracket
8.	32-2134	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

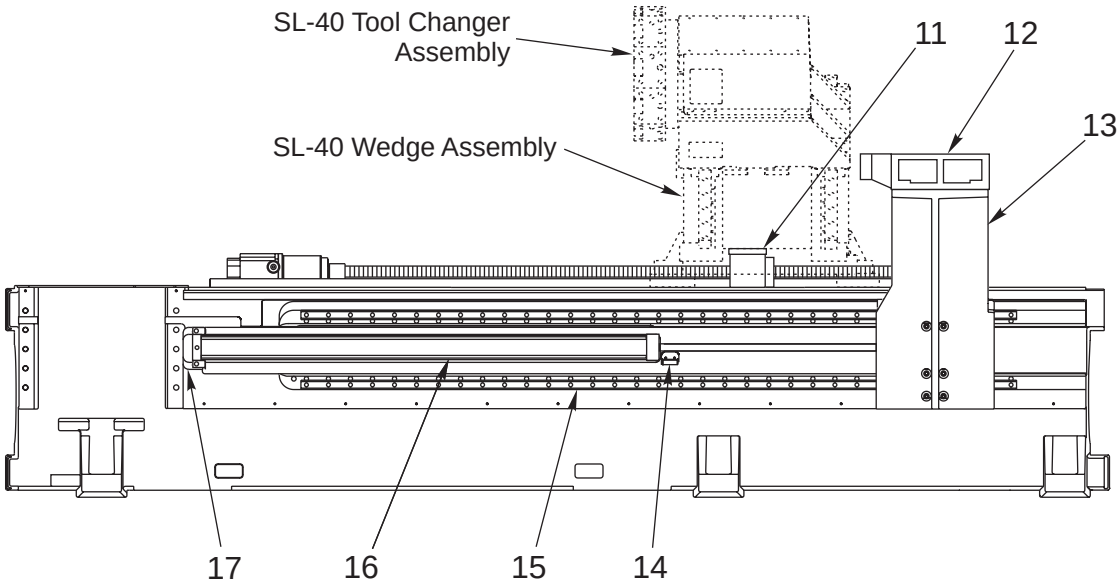
SL-40 Casting Assembly w/Tailstock and Parts List



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

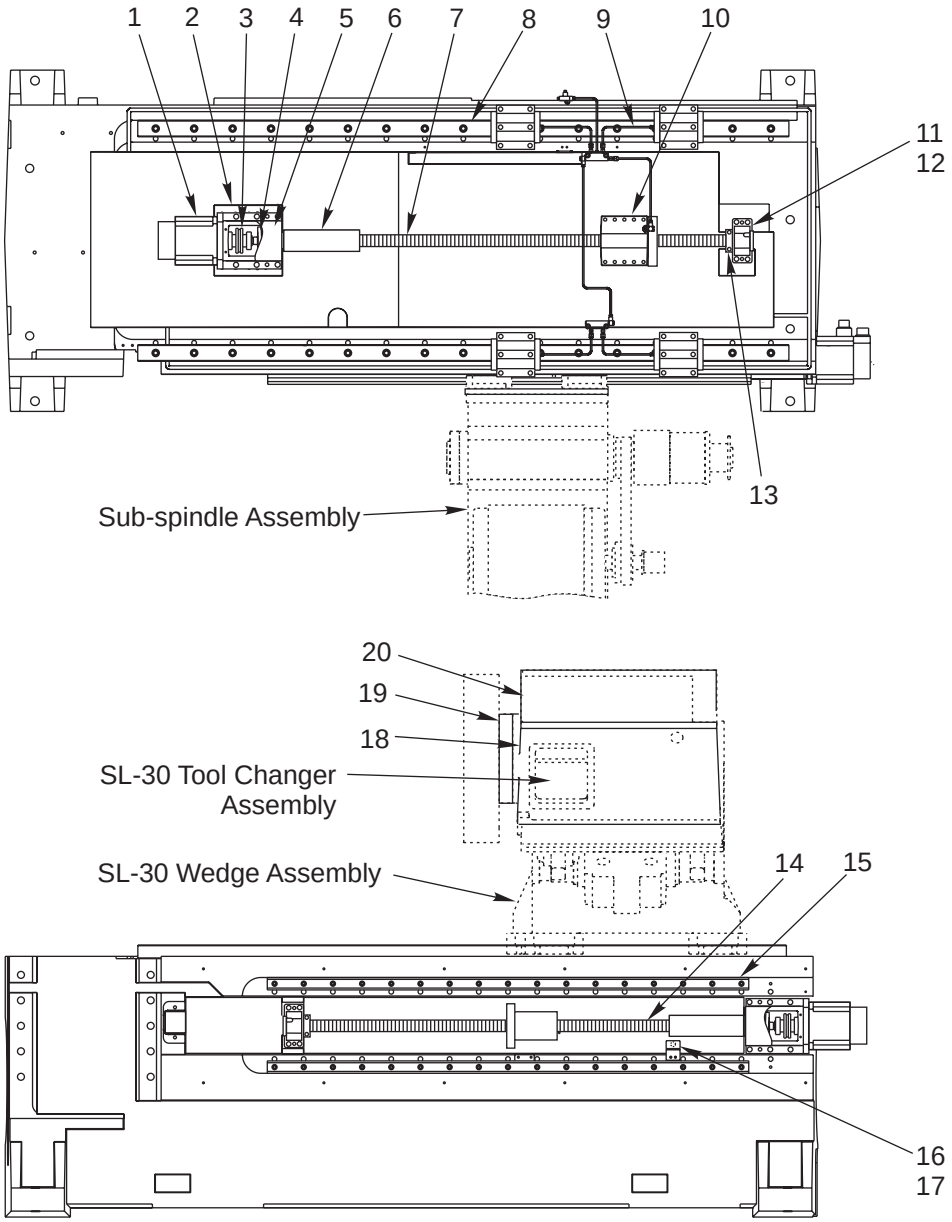
SL-40L Casting Assembly and Parts List





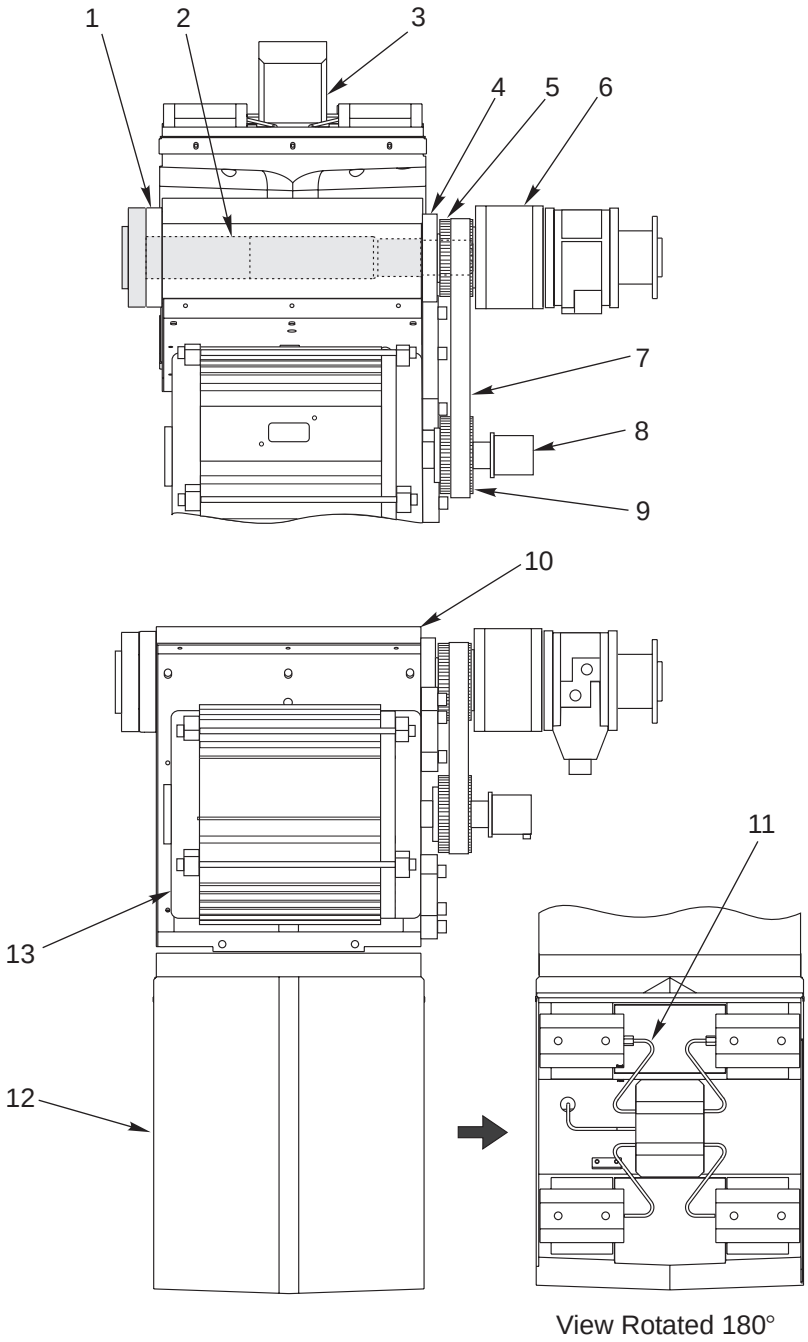
1.	62-0016	Motor
2.	20-0151A	Motor Mount
3.	20-9212	Bearing Cartridge Housing
4.	28-0229	Snap Lock Ring Bumper
5.	24-9970D	Z-Axis Ball Screw
6.	50-0132	Z-Axis Linear Guides (2)
7.	28-0214	Z-Axis Bumper (Support End)
8.	20-0152	Z-Axis Support Bearing Housing
9.	30-0472	Support Bearing Assembly
10.	30-1225A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

TL-25 Casting Assembly and Parts List



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

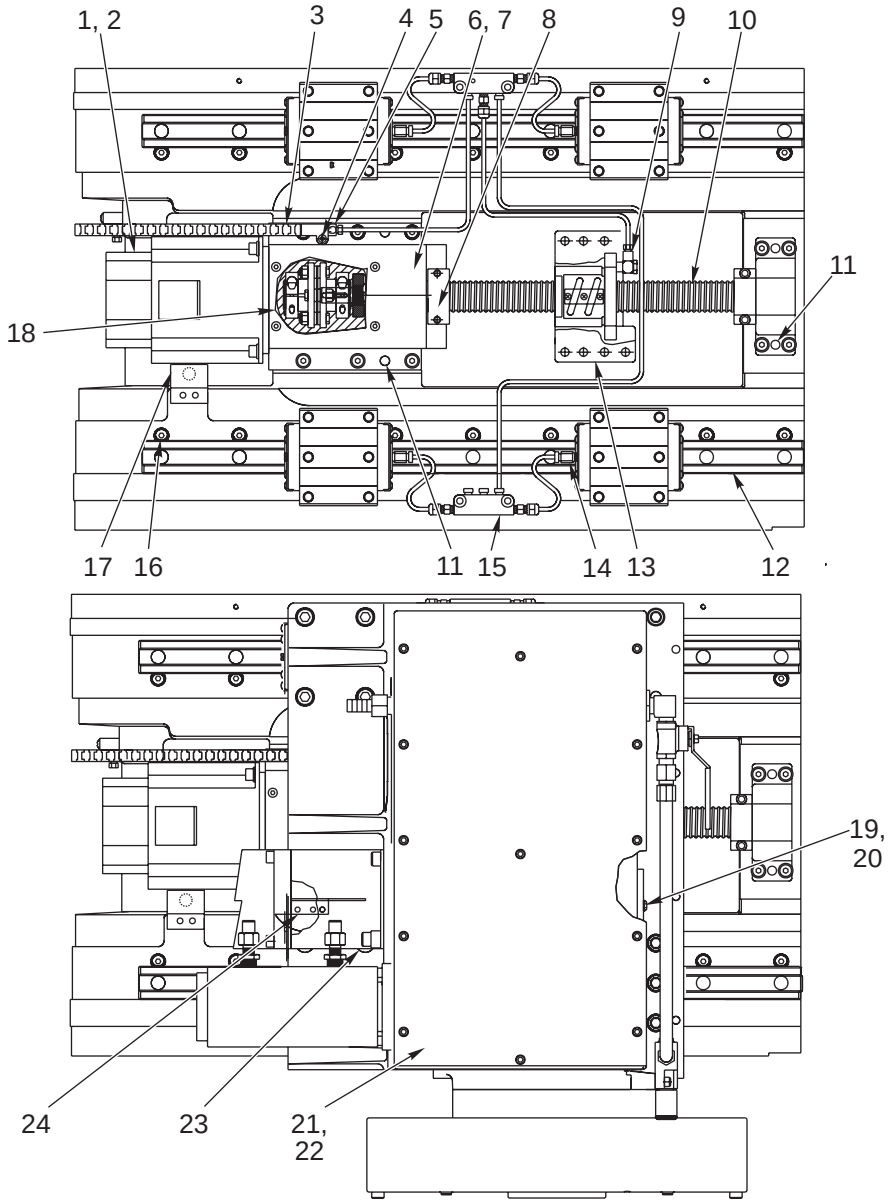
TL-25 Sub-Spindle Assembly and Parts List



View Rotated 180°

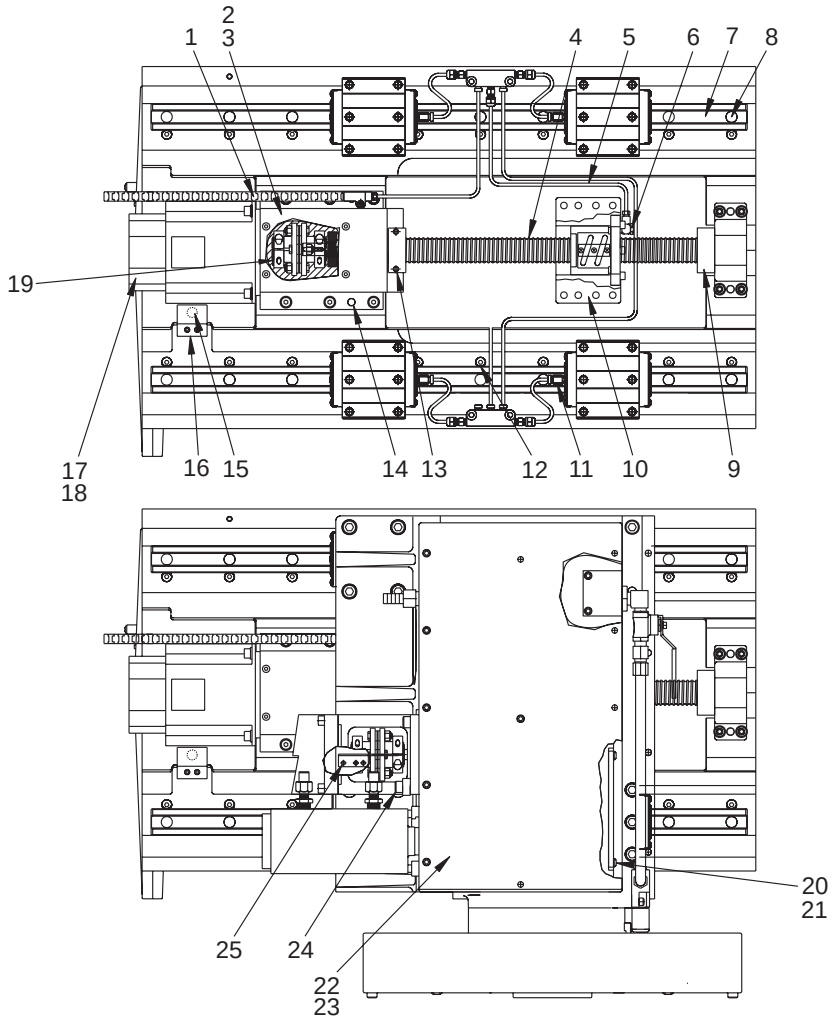
1.	20-0609	Front Cap	8.	30-30390	Encoder
2.	20-0608A	Spindle Shaft	9.	20-0611	Sub-spindle Motor Pulley
3.	20-0627	Nut Housing Machined	10.	20-1852	Spindle Head Machined
4.	20-3823	Oil Injector Cover	11.	30-1616A	Oil Line Assembly
5.	20-0610	Spindle Pulley	12.	20-1414	Sub-spindle Base Machined
6.	90-0008A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

SL-20/20L Wedge Assembly and Parts List



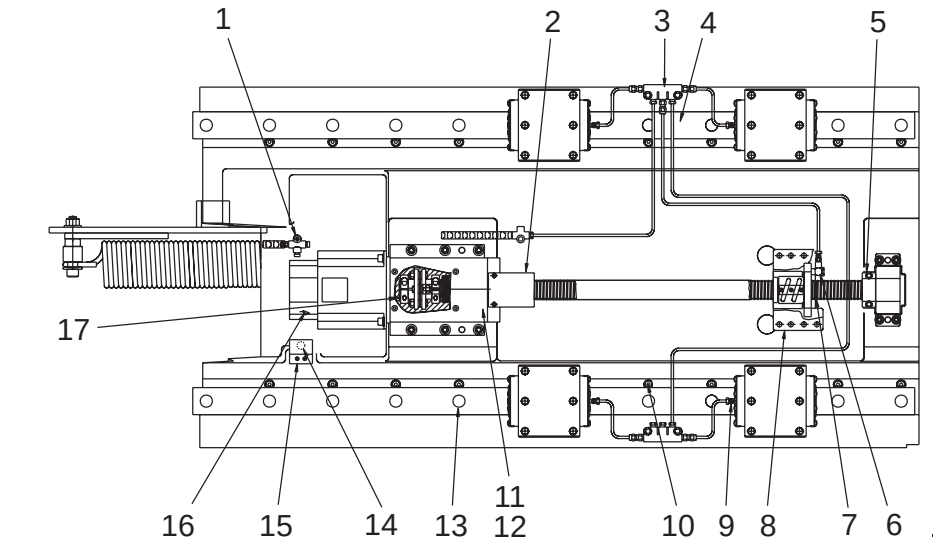
1.	62-0009	Motor w/Brake
2.	22-2629	Stub Shaft Key
3.	30-0592	Oil Line Carrier
4.	41-1717	Long Stud/Set Screw
5.	58-2110	Sleeve Nuts Lube Assembly
6.	25-7042	Snap Lock Motor Mount Cover Plate
7.	26-7233A	Deflector Shield Gasket
8.	28-0196	Z-Axis Motor End Bumper
9.	58-3031	Banjo Elbow 5/16 F x M6 M
10.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

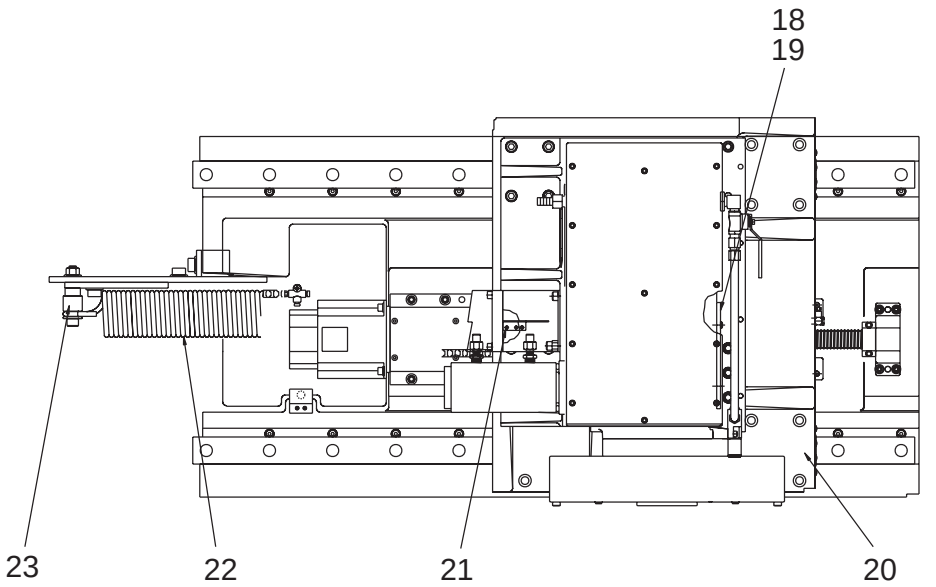
SL-30/30L Wedge Assembly and Parts List



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

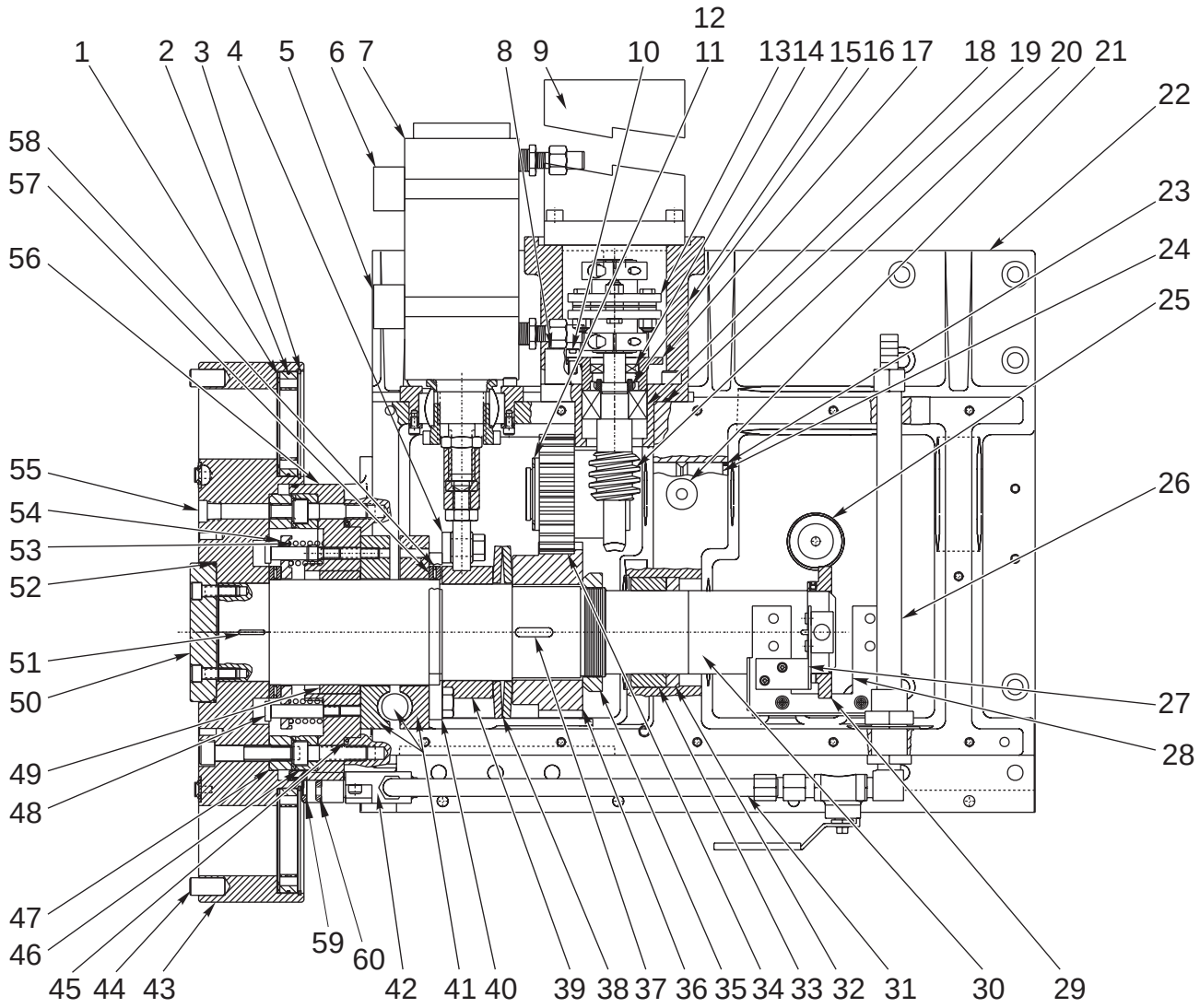
SL-40 Wedge Assembly and Parts List





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

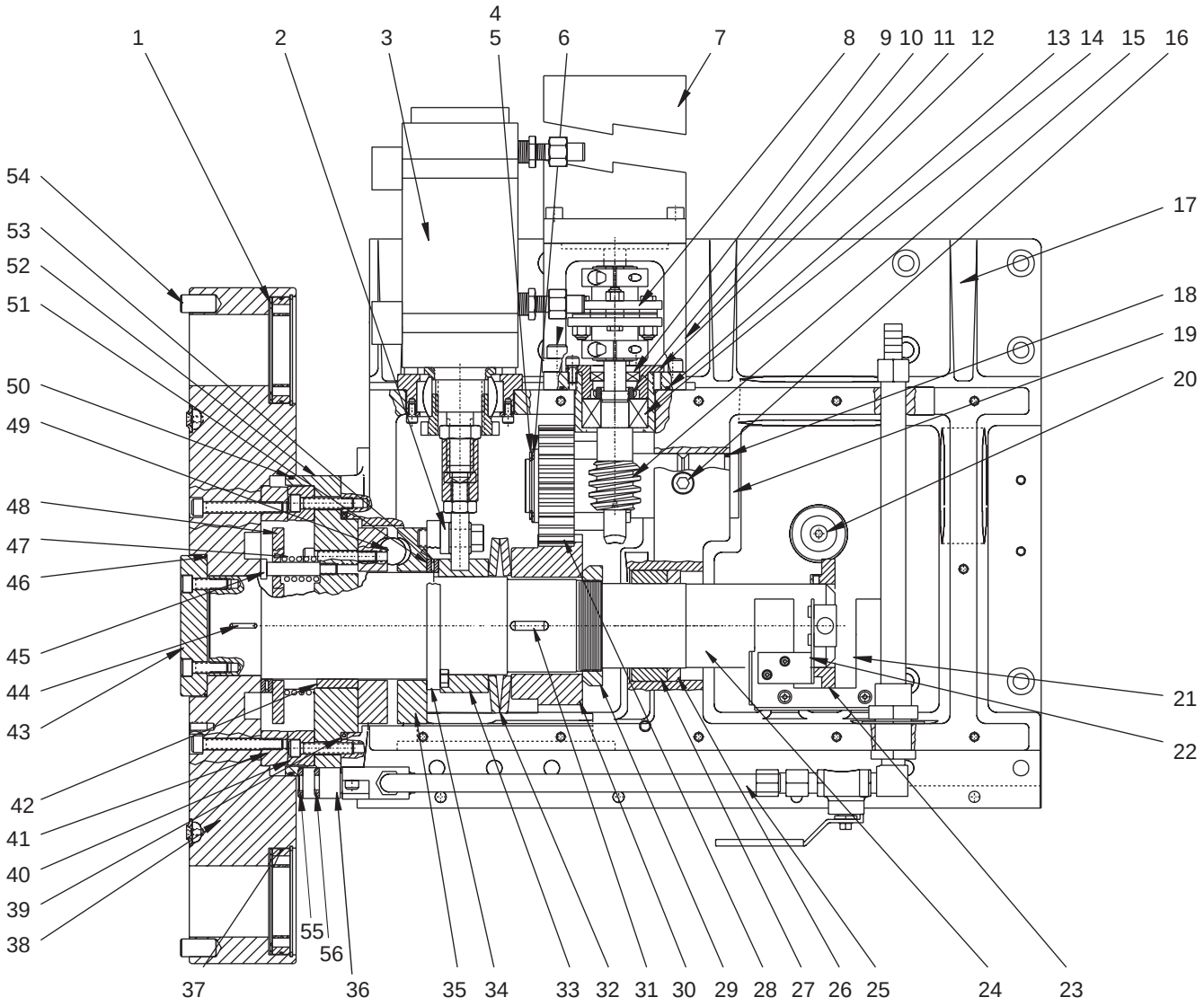
SL-20/20L Tool Changer Assembly



SL-20/20L Tool Changer Assembly Parts List

1.	51-2983	Thrust washer TRB-3446
2.	57-2994	O-ring
3.	56-2090	Retaining Ring RR-300 (SL-20)
	56-9057	Retaining Ring (SL-20L)
4.	22-8538	Rod end spacer
5.	32-2153	Unclamp switch (SL-20)
	25-8536	Clamp/Unclamp Switch (SL-20L)
6.	32-2154	Clamp switch (SL-20)
7.	30-3650	Air Cylinder assembly
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
50.	20-8532	Retainer turret T/C
51.	22-8543	Key
52.	57-2154	O-ring
53.	59-0035	Spring, Turret Coupling
54.	20-8518	Retainer springs T/C
55.	58-3105	Pipe plug 1/4 NPT
56.	20-0675A	Turret mounting coupling
57.	51-3001	Bearing thrust needle
58.	51-2983	Thrust washer TRD-4860
59.	57-0084	O-Ring 2-204 Buna
60.	57-0083	O-Ring 2-112 Buna

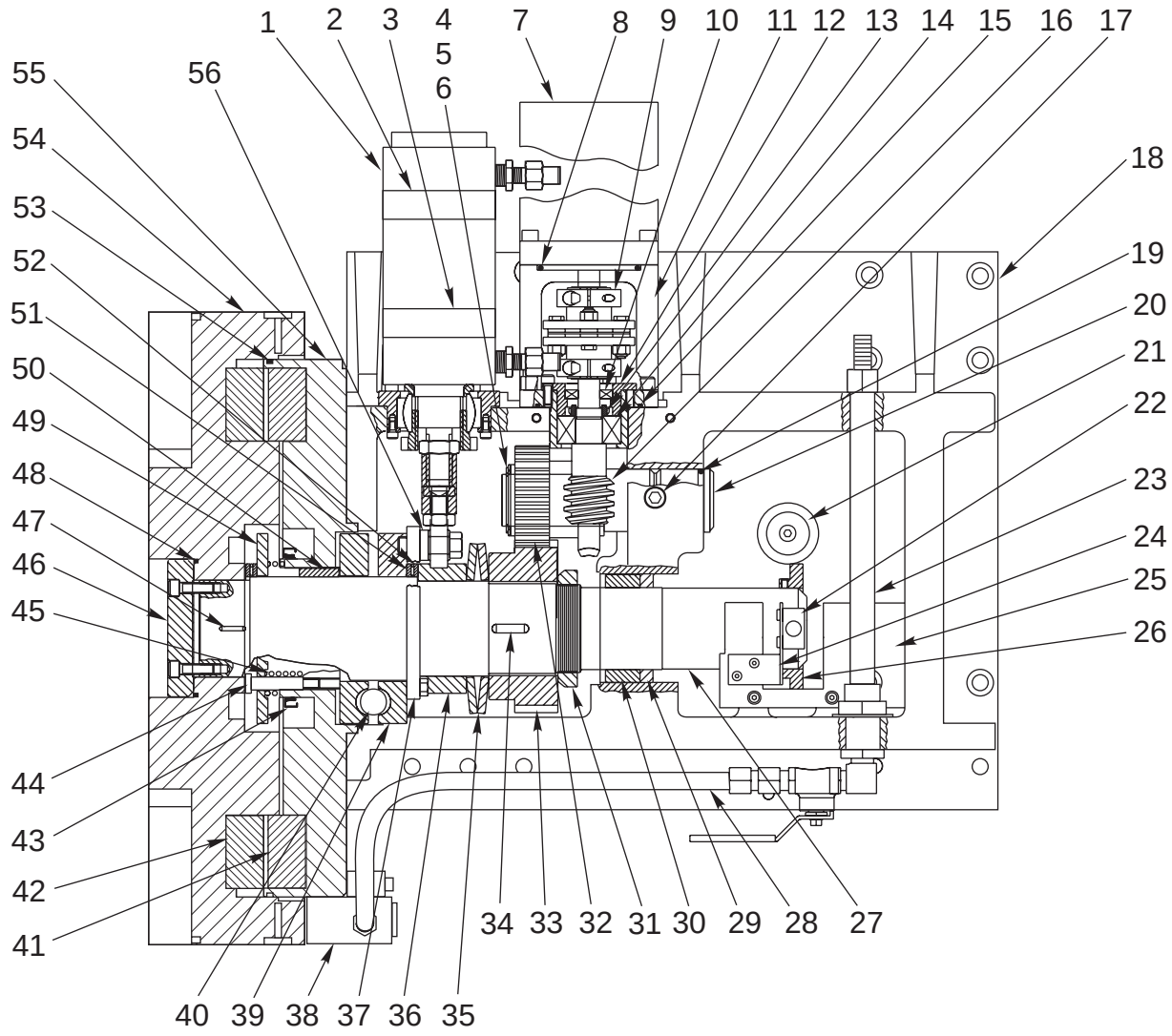
SL-30/30L Tool Changer Assembly



SL-30/30L Tool Changer Assembly Parts List

1.	51-2984	Thrust washer TRB-3446
2.	22-8538	Spacer Rod End T/C
3.	30-3650	Air Cylinder Assembly
4.	56-9057	Retaining Ring 1.500 SH
5.	49-4115	Washer 1 1/2 Steel .075 thick
6.	45-2001	Washer 1 1/2 Steel .002 thick
7.	62-0035B	Servomotor C8 w/o Brake
8.	30-1220A	Coupling Assembly
9.	57-2129	Seal .625 CR6372
10.	51-2042	Bearing Locknut BH-04
11.	20-8512A	Housing Worm
12.	20-8515	Clamp Bearing Worm T/C
13.	57-2022	O-Ring 2-150 V-1164-75
14.	51-7001	R Bearing Angular M20-47-20.6
15.	20-8509	Worm Shaft
16.	59-2057	Ball 5/16 Steel
17.	20-0674A	Tool Changer Machined
18.	57-2831	O-Ring 2-130 Buna
19.	20-8510	Shaft Transfer T/C
20.	20-8537	Retainer Spring T/C
21.	25-8536	Bracket Limit Switch T/C Clamp/Unclamp
22.	25-8534	Bracket Home Switch
23.	20-8533	Ring Switch T/C
24.	20-8530	Shaft Turret T/C
25.	30-3655	Transfer Coolant Line Assembly
26.	57-1045	Seal 2.375 CR23646
27.	20-8539	Bearing Rear T/C
28.	20-8511A	Gear Cluster T/C
29.	46-7016	Lock Nut N-13
30.	20-8522A	Gear Spur T/C
31.	22-8544	Key Gear Spur T/C
32.	24-4010	Bellville Washer
33.	22-8550A	Spacer Belleville T/C
34.	20-8516	Lever Cam T/C
35.	93-8138	Lathe Turret Cam Upgrade Kit
36.	30-1957	Coolant Transfer Tip Assembly
37.	57-2994	O-Ring 2-039 Buna
38.	20-0671	Turret T/C
39.	57-0030	O-Ring 2-258 Buna
40.	20-8768A	Coupling Turret Male
41.	20-8769A	Coupling Turret Female
42.	20-8557	Bushing Front Turret
43.	20-8532	Retainer Turret T/C
44.	22-8543	Key Turret T/C
45.	49-1010	Shoulder Bolt 3/8 x 1 1/2
46.	57-2154	O-Ring 2-240 Buna
47.	59-0035	Die Spring
48.	20-8518	Retainer Spring T/C
49.	59-2059	Ball 15/16 Steel
50.	57-2975	O-Ring 2-274 Buna
51.	51-2983	Thrust Washer TRD-4860
52.	20-0676A	Mount Coupling Turret
53.	51-3001	Bearing Thrust Needle
54.	48-0049	Dowel Pin 1/2 x 1 Pull
55.	57-0084	O-Ring 2-204 Buna
56.	57-0083	O-Ring 2-112 Buna

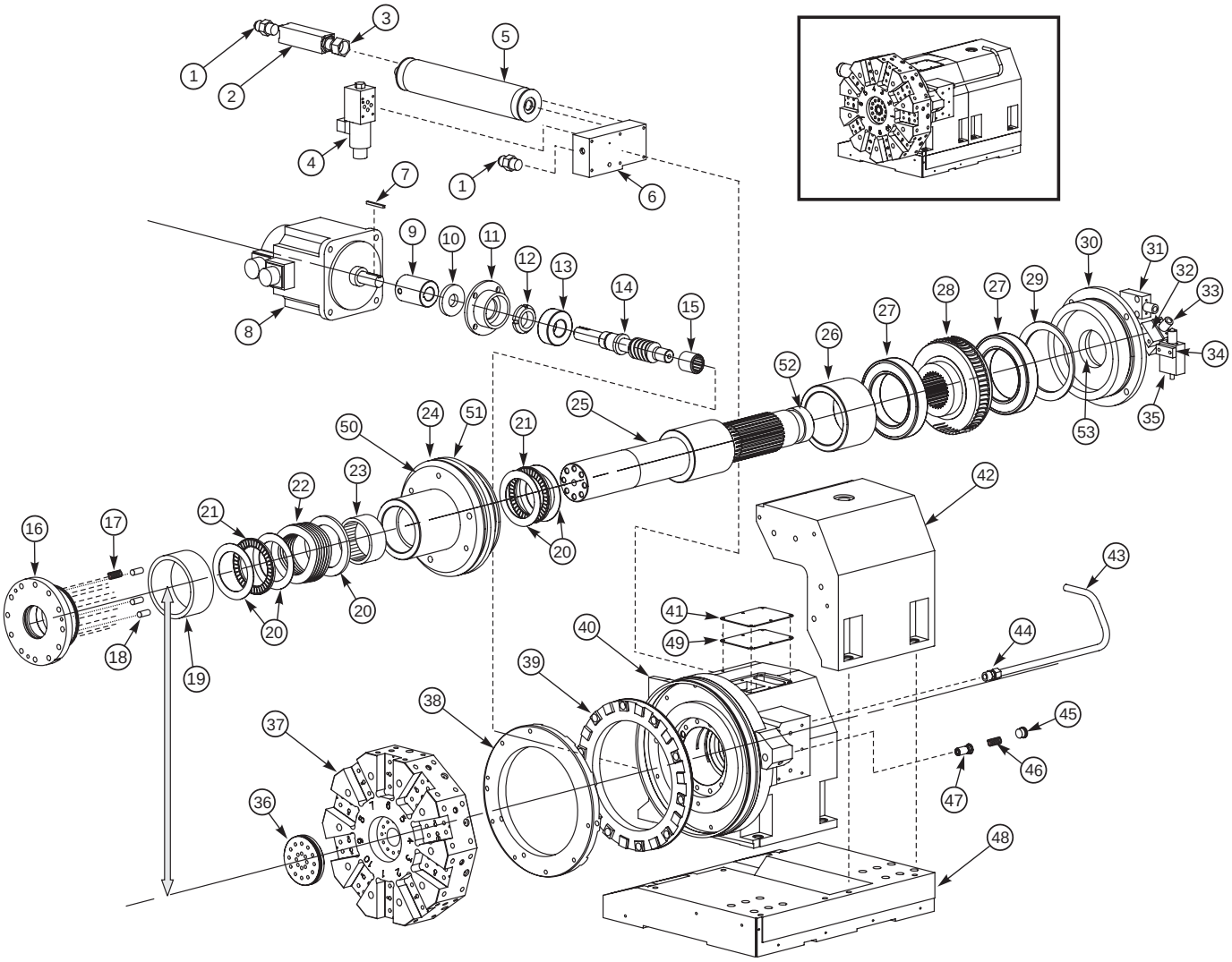
SL-40 Tool Changer Assembly



SL-40 Tool Changer Assembly Parts List

1. 30-3650 Air Cylinder Assembly
2. 32-2162 Clamp Switch
3. 32-2161 Unclamp Switch
4. 49-4115 1-1/2 Steel Washer
5. 56-9057 Retaining Ring 5100-150
6. 45-2001 Shim .002 Thick
7. 62-0014 Motor
8. 57-0075 O-Ring 2-02 Buna
9. 30-1220A Coupling Assembly
10. 57-2129 Worm Seal
11. 20-8512A Worm Housing
12. 20-8515 Worm Bearing Clamp
13. 51-2042 Bearing Locknut BH-04
14. 51-7001 Ball Bearing 5204-1SB-Kff
15. 57-2022 O-Ring
16. 20-8509 Worm Shaft
17. 59-2057 5/16 Steel Balls
18. 20-0249 TC Housing Machined
19. 57-2831 O-Ring 2-130 Buna
20. 20-8510 TC Transfer Shaft
21. 20-8537 TC Spring Retainer
22. 32-2011 Switch (30" Cable)
23. 30-3655 Coolant Line Assembly
24. 25-8534 Home Bracket
25. 25-8536 Clamp Bracket
26. 20-8533 TC Switch Ring
27. 20-8530 TC Turret Shaft
28. 58-7242 Coolant Tubing
29. 57-1045 Seal CR6372
30. 20-8539 TC Rear Bearing
31. 46-7016 Locknut
32. 20-8511A TC Gear Cluster
33. 20-8522A TC Spur Gear
34. 22-8544 TC Spur Gear Key
35. 24-4010 Belleville Washer (2)
36. 22-8550A Belleville Spacer
37. 20-8516 TC Cam Lever
38. 30-3660A Transfer Coolant Nozzle Haas Turret, (30-1159 BOT Turret, 30-6065 VDI Turret)
39. 93-8138 TC Turret Cam (2)
40. 59-2059 15/16 Steel Balls
41. 20-0247 Female Turret Coupling
42. 20-0248 Male Turret Coupling
43. 57-0029 Seal CR29841
44. 49-1010 Shoulder Bolt 3/8 x 1-1/2
45. 59-0035 Die Springs
46. 20-8532 TC Turret Retainer
47. 22-8543 TC Turret Key
48. 57-2154 O-Ring 2-240 Buna
49. 20-8518 Spring Retainer
50. 20-8557 Bushing and 57-0029 Seal
51. 51-3001 Needle Thrust Bearing
52. 51-2983 Thrust Washer TRD-4860
53. 57-0047 O-Ring
54. 20-0397 Turret Block
55. 20-0250 Coupling Mount
56. 22-8538 TC End Rod Spacer

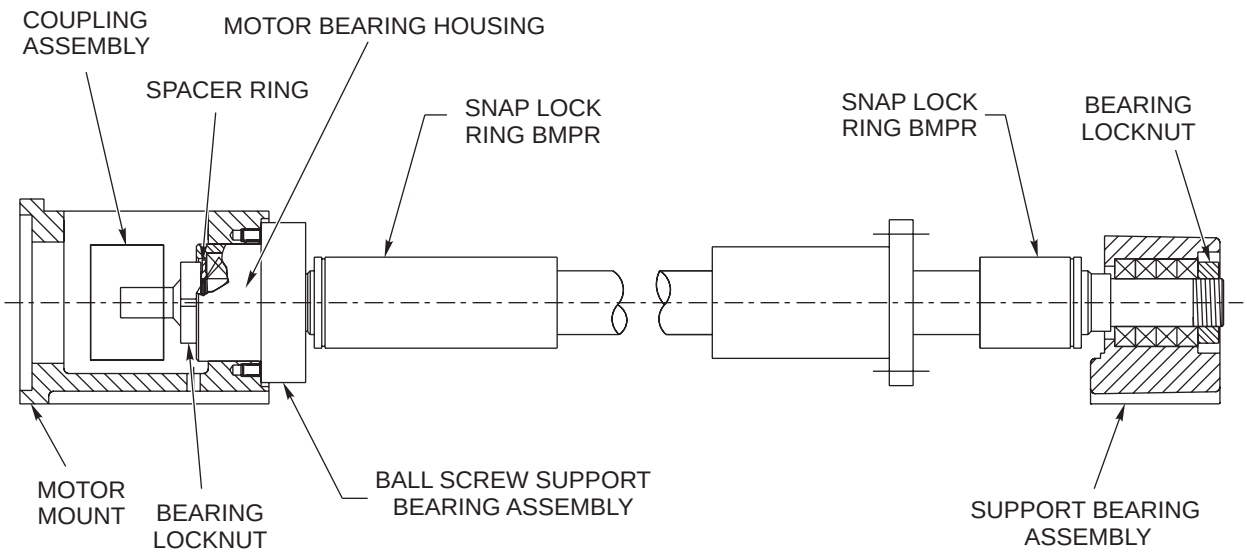
SL-40 Hydraulic Tool Changer

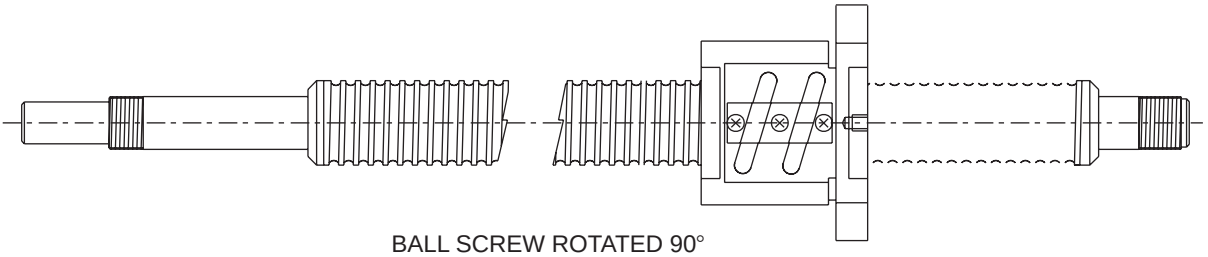


SL-40 Hydraulic Tool Changer Parts List

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
50.	57-0349	O-RING 2-431 BUNA
51.	57-0350	O-RING 2-349 BUNA
52.	57-0353	SEAL 2.688 CR26761
53.	57-0352	SEAL 1.813 CR18025

Ball Screw Assembly

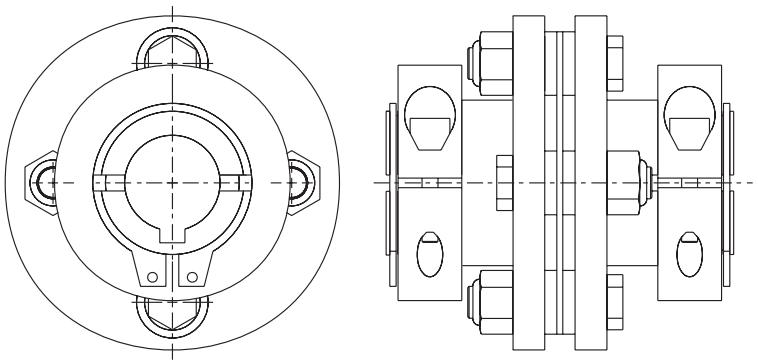




BALL SCREW ROTATED 90°

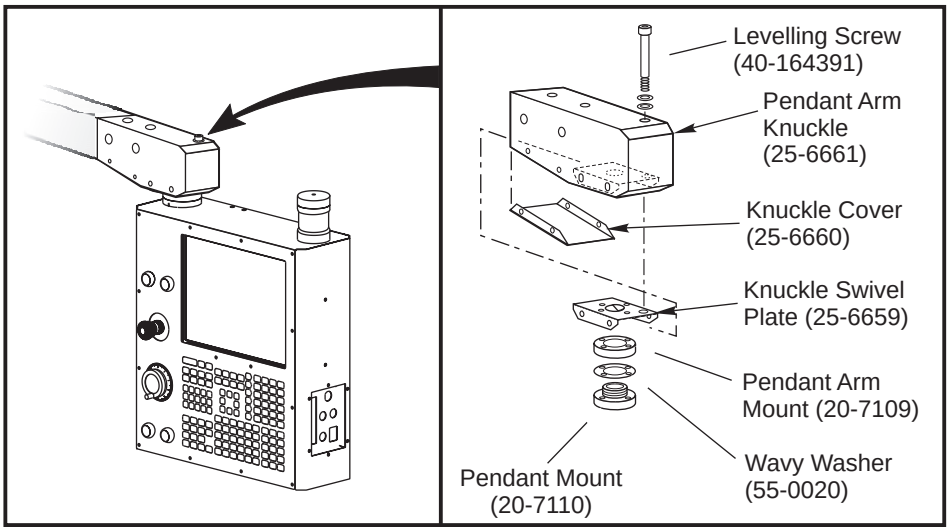
BALL SCREW ASSY "A"	BALL SCREW	SNAP LOCK RING BMPR	MOTOR MOUNT	COUPLING ASSY	APPLICATION
30-2977 BS ASSY 32mm	24-8765 BALLSCR 32mm	NONE	20-7010A	30-1220A	MINI LATHE (Z)
30-2972 BS ASSY 32mm	24-8765 BALLSCR 32mm	NONE	20-7010A	30-1220A	MINI LATHE (X)
30-2290 BS ASSY 32mm	24-7146 BALLSCR 32mm	20-0735 SNAP 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

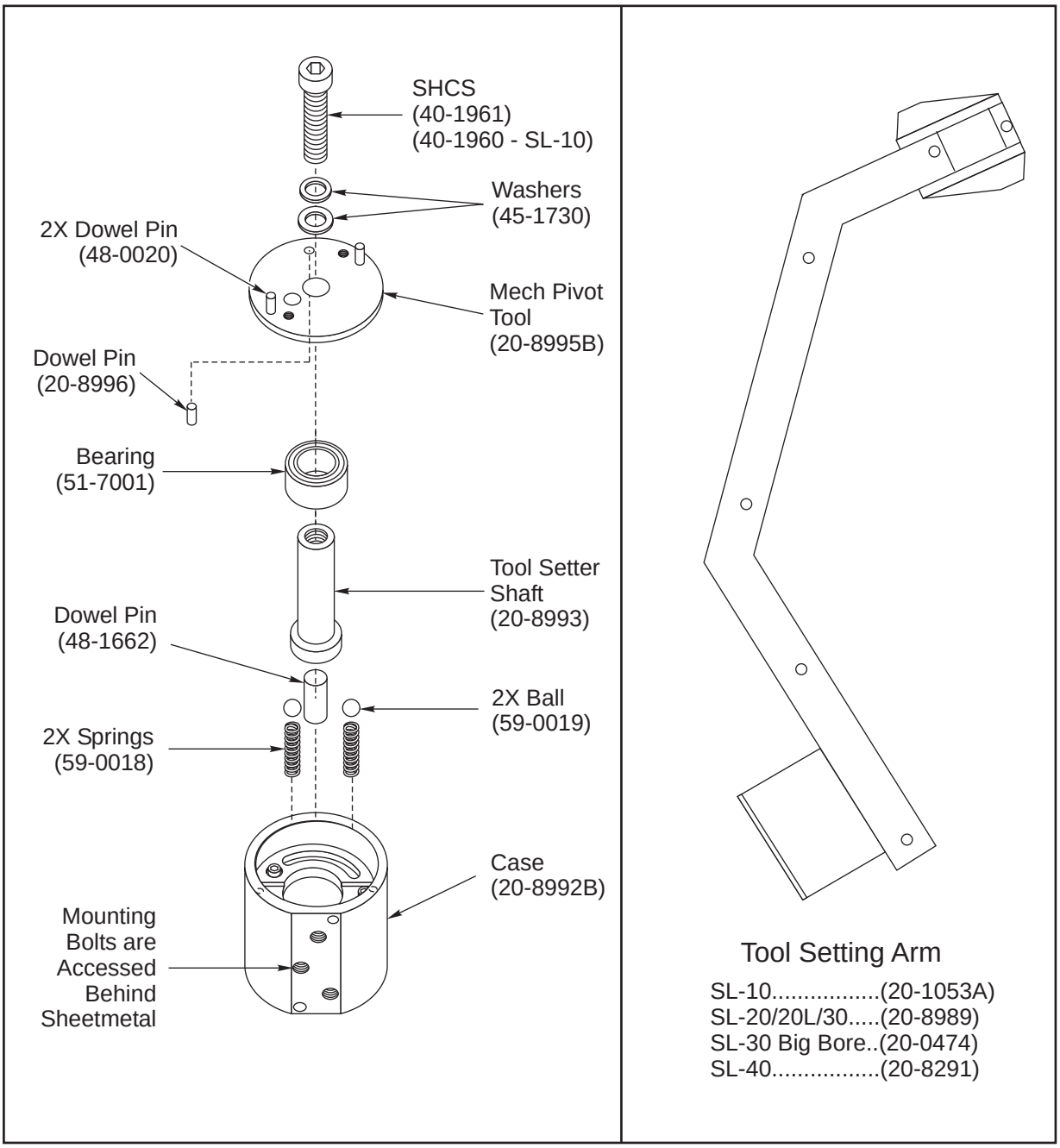


WHERE USED		APPLICATION
30-2290A	BSCREW ASSY 32mm	SL-10 (Z)
30-2244A	BSCREW ASSY 32mm	SL-10 (X)
30-0615A	BSCREW ASSY 32mm (1.26) X 33.27	SL-20 (Z)
30-1962	BSCREW ASSY 32mm (1.26) X 48.23	SL-30 (Z)
30-1397A	BSCREW ASSY 32mm (1.26) X 25.65	SL-40 (X)
30-0616C	BSCREW ASSY 32mm (1.26) X 13.53	SL-20 (X)
30-0618B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

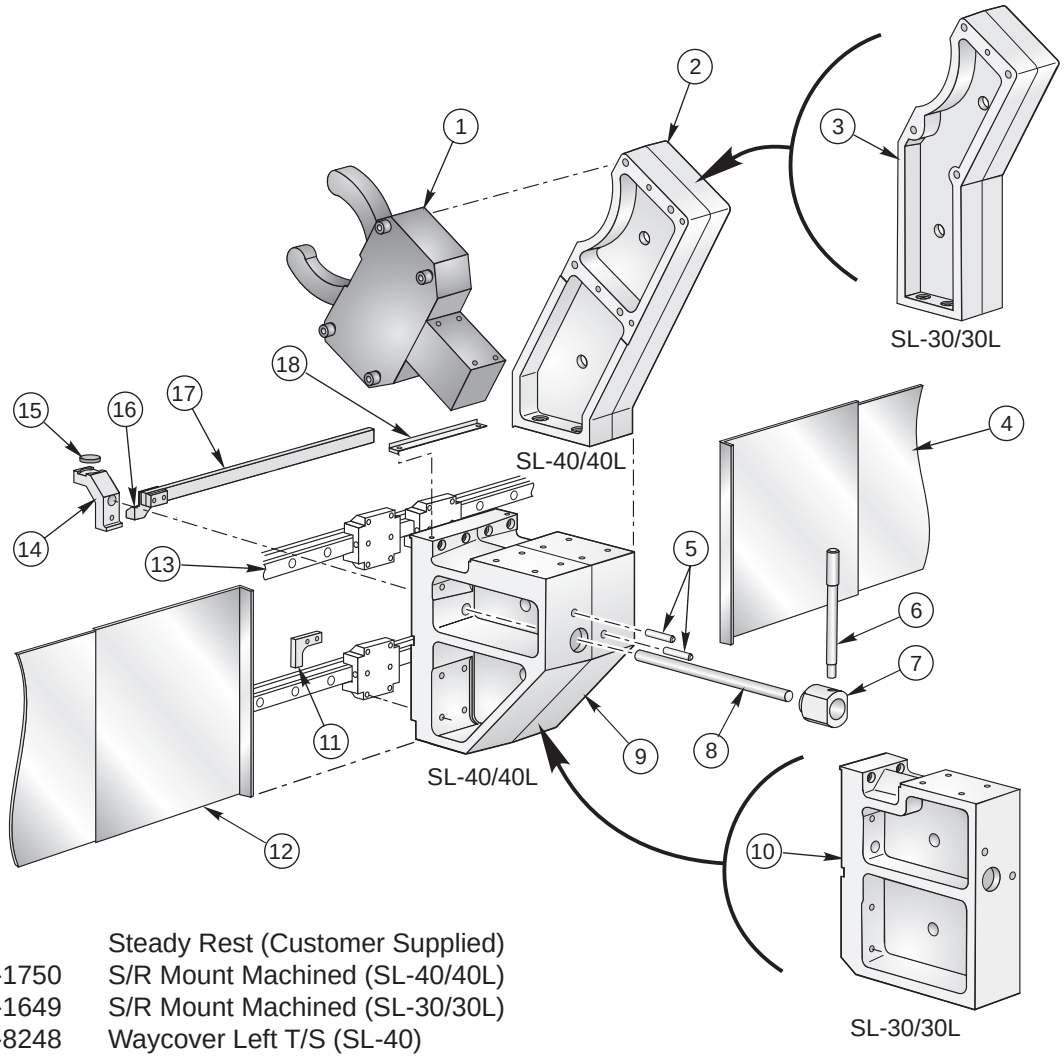
Pendant Leveling Assembly



Lathe Tool Setting Arm

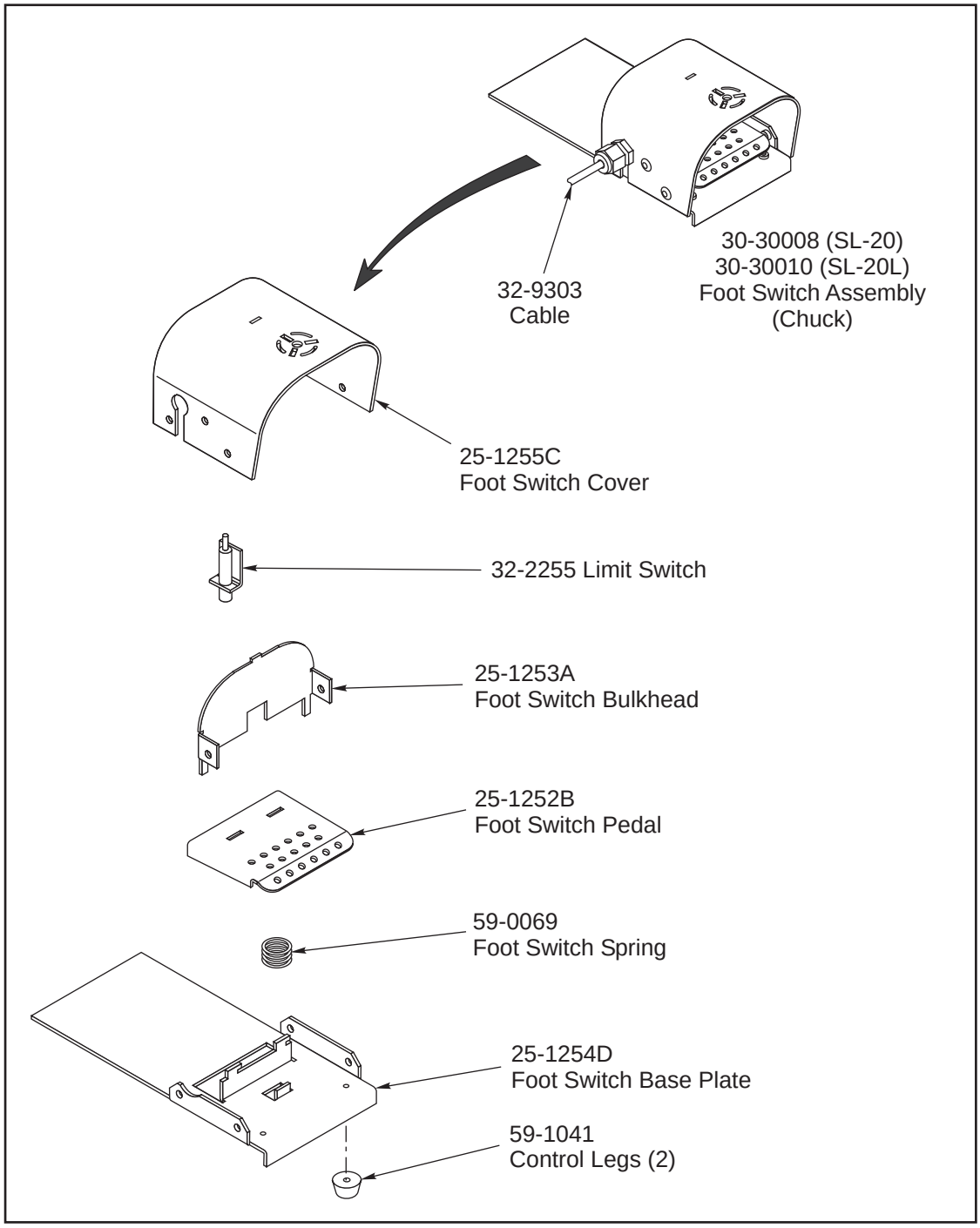


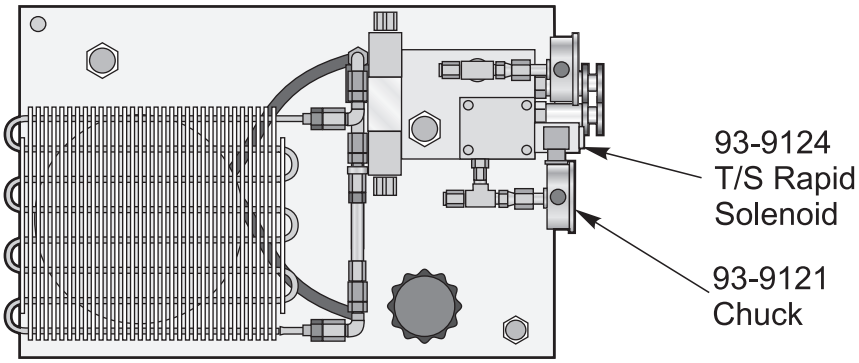
SL-30/30L and SL-40/40L Steady Rest

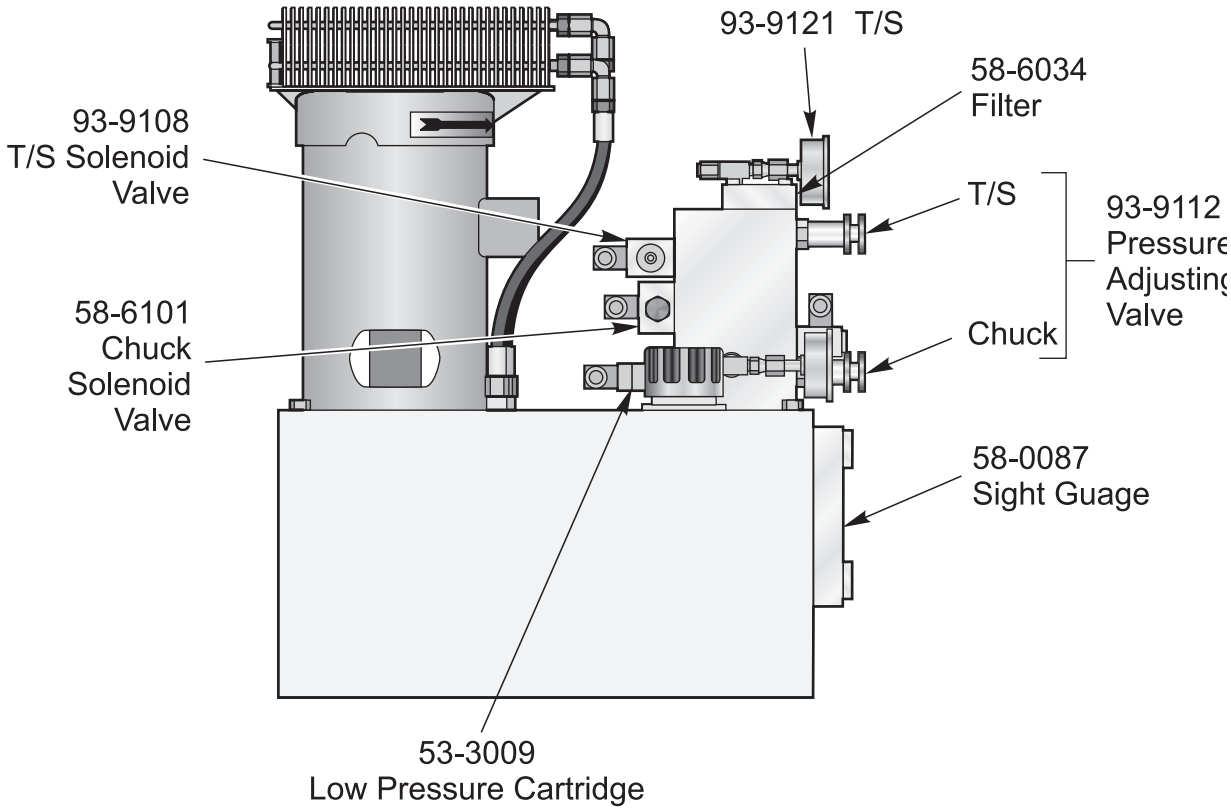


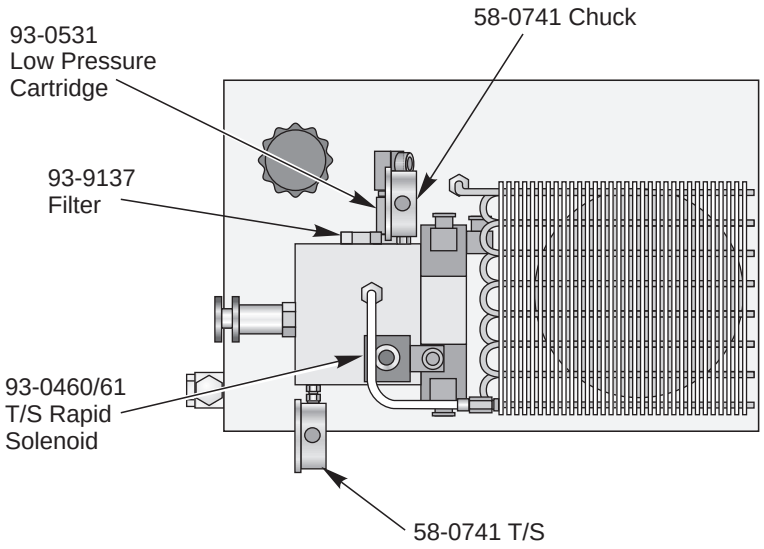
1.		Steady Rest (Customer Supplied)
2.	20-1750	S/R Mount Machined (SL-40/40L)
3.	20-1649	S/R Mount Machined (SL-30/30L)
4.	25-8248	Waycover Left T/S (SL-40)
	25-4737	Waycover Left T/S (SL-40L)
	25-8756C	Waycover Left T/S (SL-30)
	25-8564A	T/S Left Base Cover (SL-30L)
5.	48-0009	Dowel Pin 1/2 x 3 1/4 (SL-30/40/40L)
6.	20-0858	Handle T/S (SL-40/40L)
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)
14.	20-1625B	S/R Brake (SL-30/40)
	20-3720	S/R Brake (SL-30L)
	20-2406	S/R Brake (SL-40L)
15.	57-0045	Brake Pad
16.	20-1620	Right Travel Stop (SL-30)
17.	20-1628A	S/R Push Bar (SL-40/40L)
	20-1622	S/R Push Bar (SL-30)
18.	25-1320A	Strip Shield (SL-40/40L)
	25-1314	Strip Shield (SL-30)

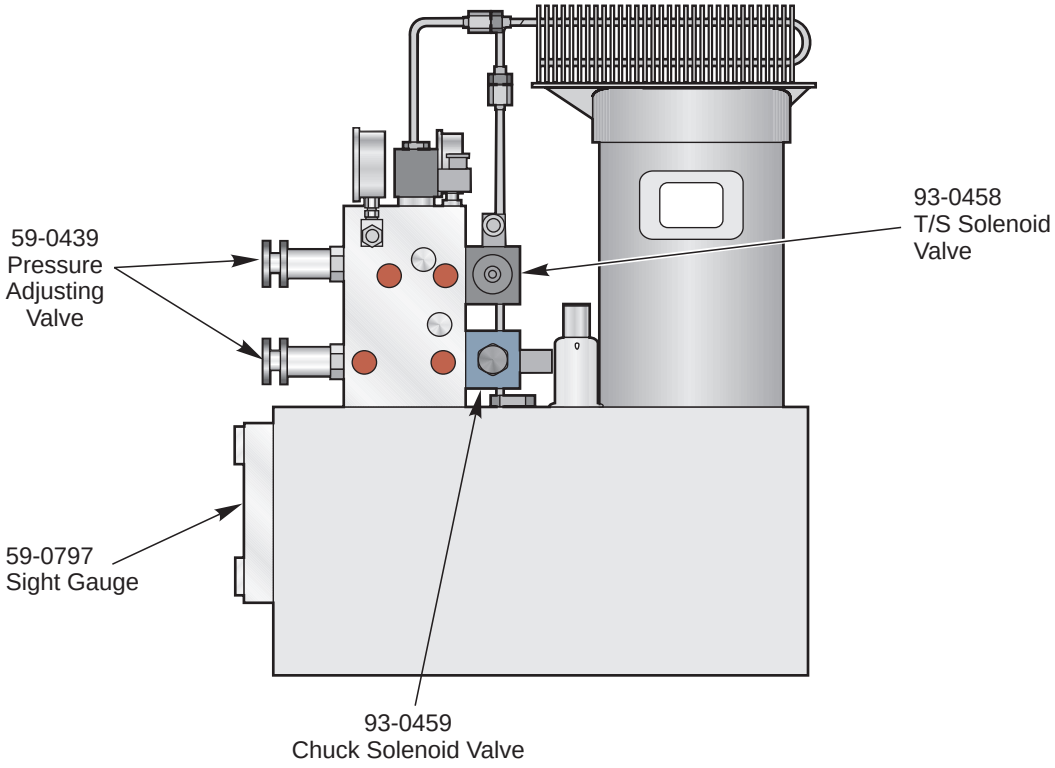
Foot Switch Assembly



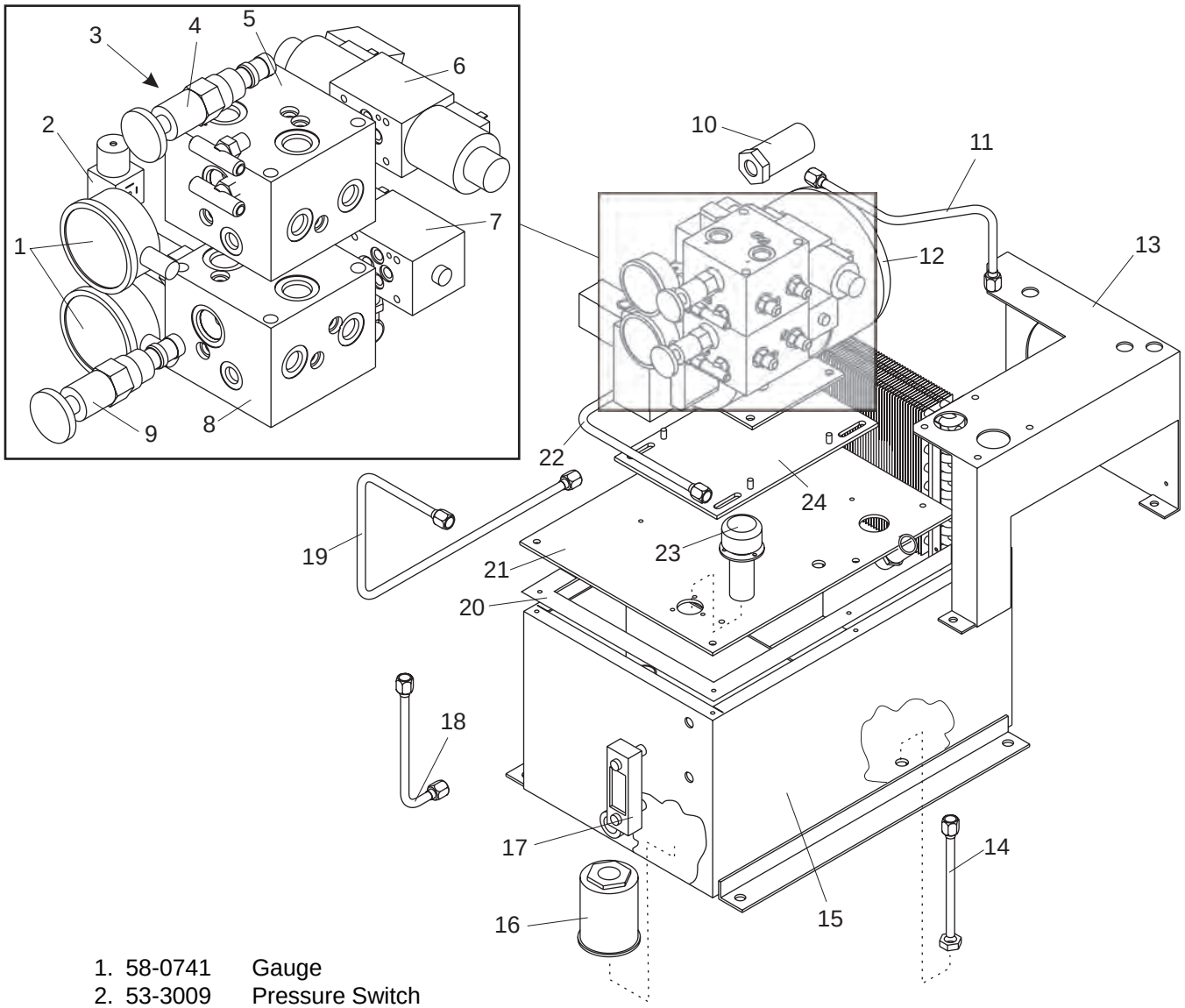








Haas Hydraulic Power Unit

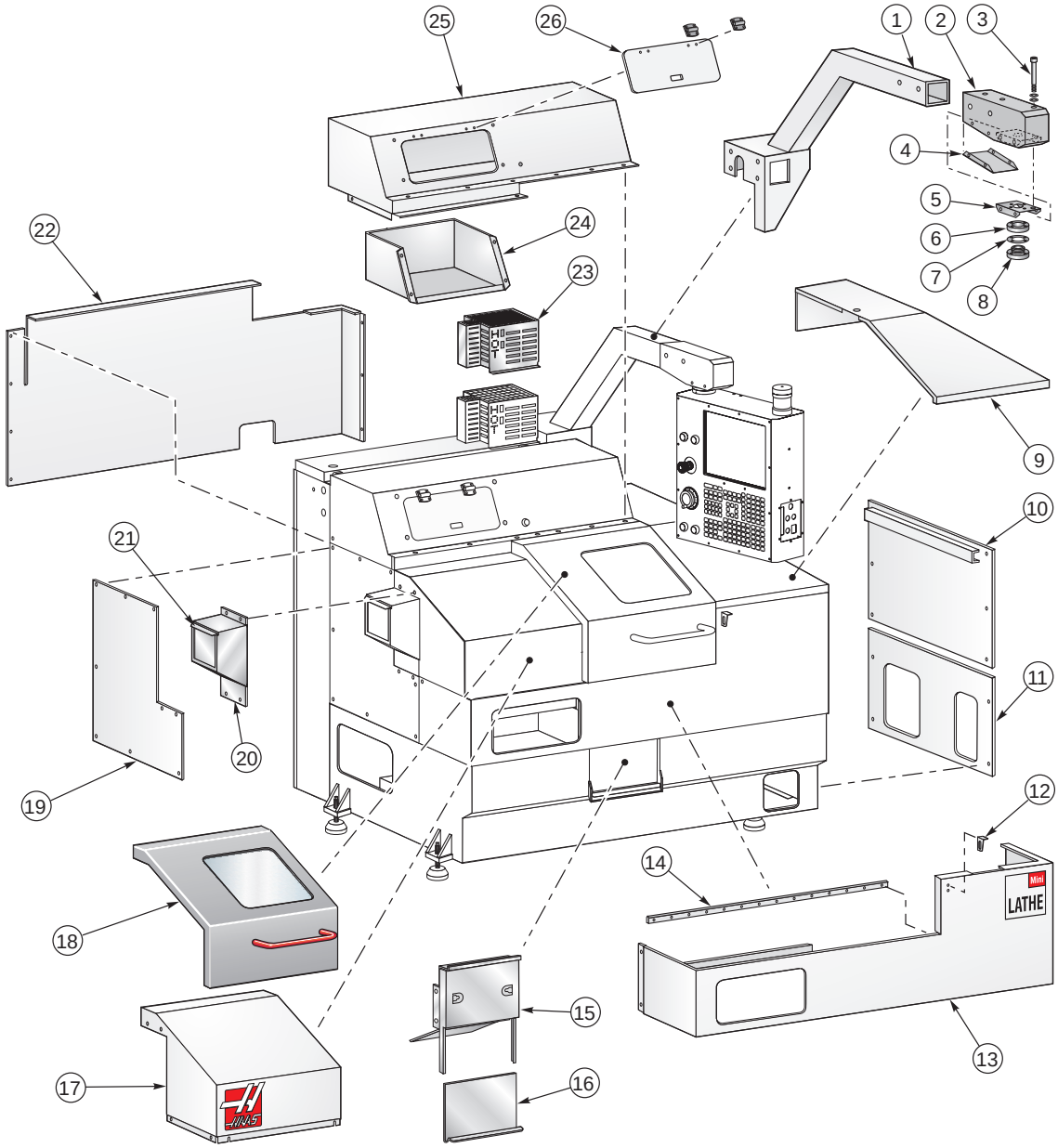


1. 58-0741 Gauge
2. 53-3009 Pressure Switch
3. 90-0114 Hydraulic Valve
4. 59-0439 Pressure Adjusting Valve
5. 20-3109 Valve Block (Tailstock)
6. 90-0105 Hydraulic Valve (Tailstock)
7. 90-0104 Hydrulic Valve (Chuck)
8. 20-3108 Valve Block (Chuck)
9. 59-0439 Pressure Adjusting Valve
10. 58-0875 In-Line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

Filter Replacement

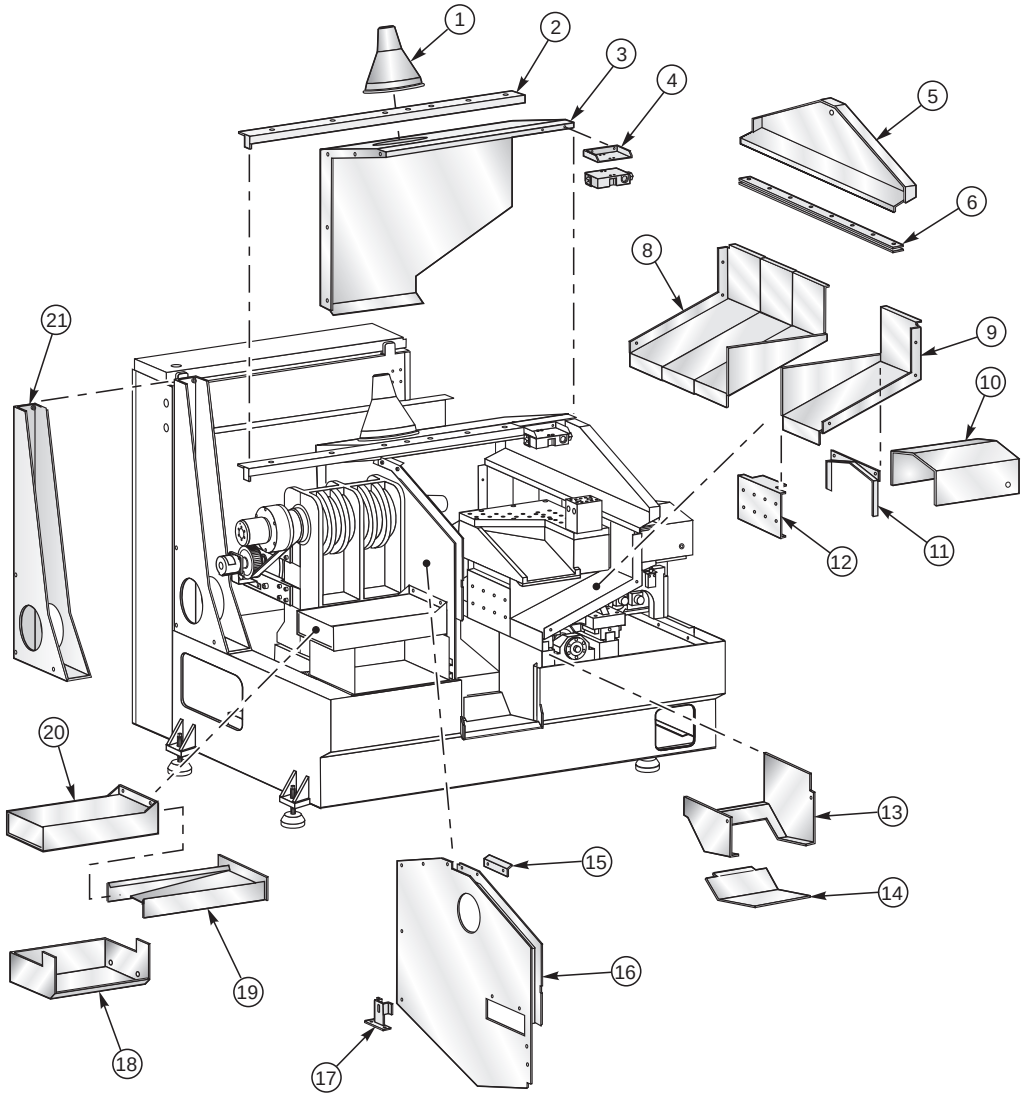
Filter Manufacturer	Oil Filter Part Number	Replacement Element Part Number
Pall	58-1064	58-1065
Hydac	58-1064	58-1066
Flow Ezy	58-1064	58-1067

Mini Lathe External Sheetmetal and Parts List



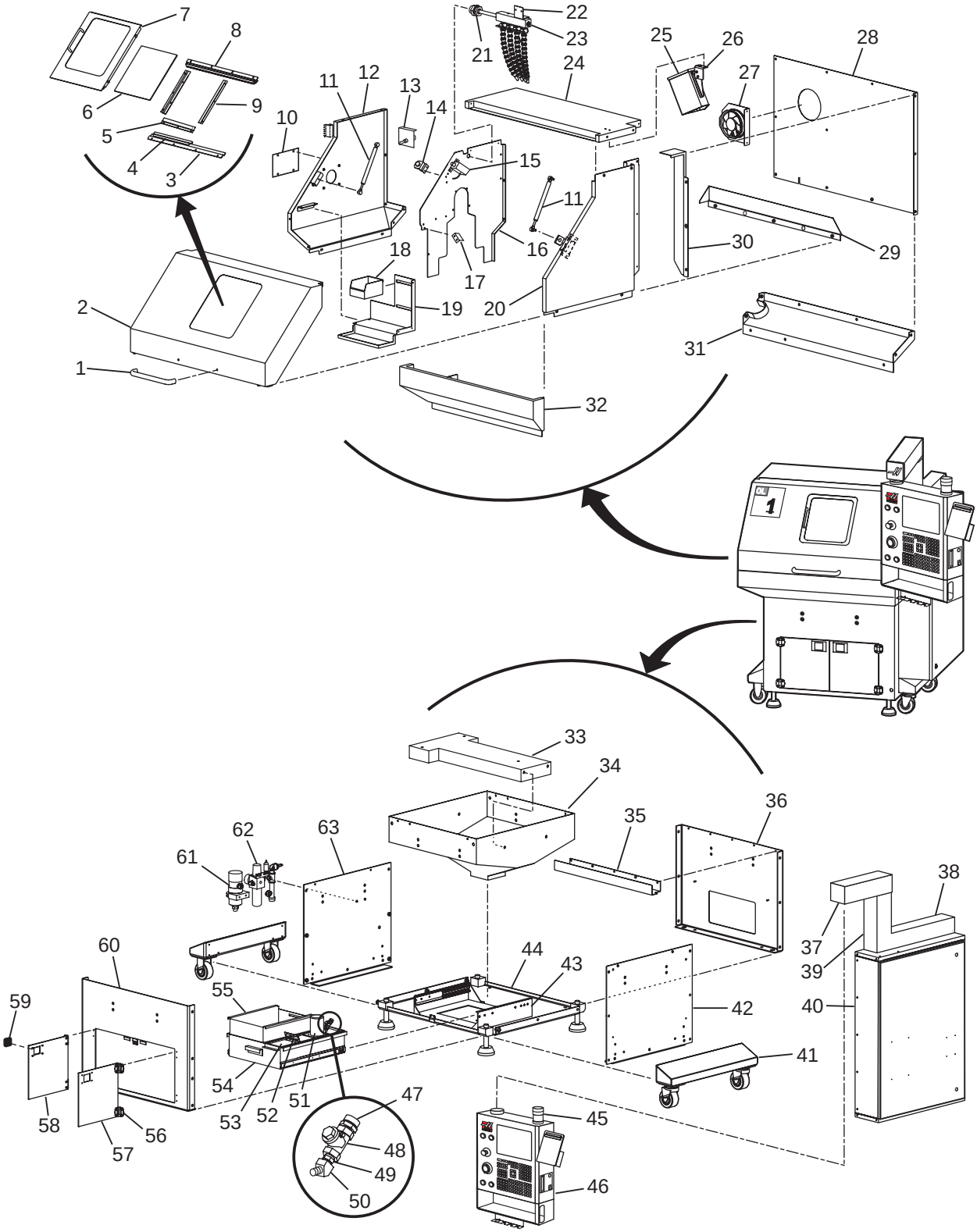
1.	20-1292	Pendant Arm	14.	20-1224	Door V-Track
2.	25-6661	Pendant Arm Knuckle	15.	25-4148	Chip Tray Door Bracket
3.	40-164391	Leveling SHCS	16.	25-4128	Chip Tray Door
4.	25-6660	Knuckle Cover	17.	25-4121	Spindle Cover
5.	25-6659	Knuckle Swivel Plate	18.	30-2961	Door Assembly
6.	20-7109A	Pendant Arm Mount	19.	25-4122	Left End Panel
7.	55-0020	Wavy Washer	20.	25-4124	Coolant Collector
8.	20-7110A	Pendant Mount	21.	25-4125	Coolant Collector Door
9.	25-4110	Top Right Cover	22.	25-4112	Back Panel
10.	25-4111	Right End Panel	23.	32-0042	Regen Cover
11.	25-4106A	Lube Cover	24.	25-4144	Toolbox
12.	25-6152A	Air Hose Bracket	25.	25-4108	Top Hat
13.	25-4109	Front Skirt	26.	25-4145	Toolbox Door

Mini Lathe Internal Sheetmetal and Parts List



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

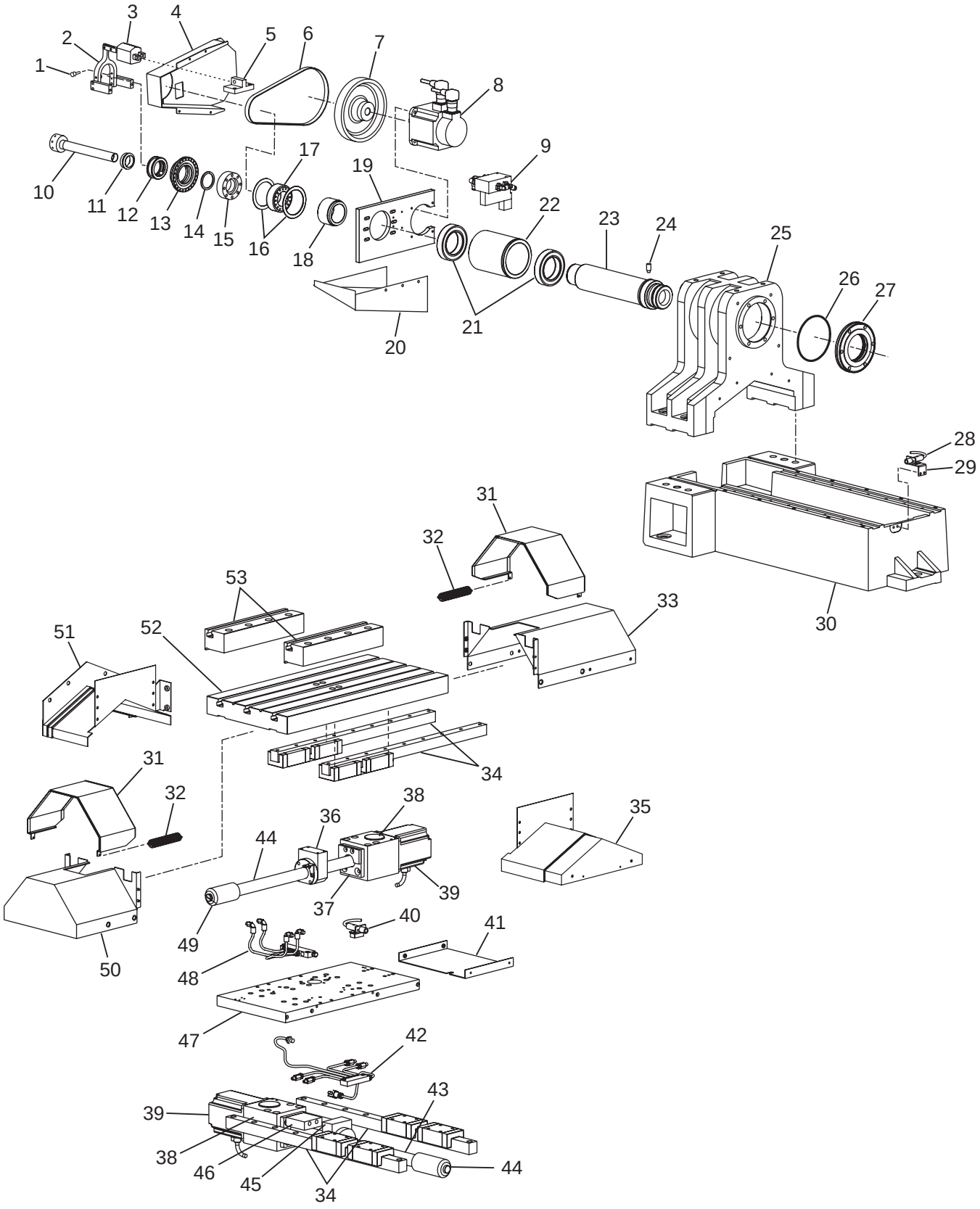
Office Lathe External Sheetmetal and Parts List



Office Lathe External Sheetmetal and Parts List

1. 22-8895 Chrome Handle
2. 25-6905 Set-Up Door Panel
3. 25-6070A Window Rail
4. 28-0175 Bottom Window Guide
5. 25-6247A Bottom Window Frame
6. 28-0173A Window
7. 25-7549 Operator Door Panel
   59-0901 Small Handle
8. 25-6081 Window Guide Bracket
   28-0174 Top Window Guide
9. 25-6084A Left Window Side Frame
   25-6108 Right Window Side Frame
10. 25-7198B Junction Box Cover
11. 59-0101 2X Gas Spring
12. 25-6907 Left Panel
13. 59-2746 Reverse Acting TV-4DMP Model CS-1781
    25-7579 Drawbar Relief Bracket
14. 32-1210C Chuck Release Button
    25-6924 Chuck Release Bracket
15. 25-7553 Door Switch Bracket
    32-2305 Proximity Switch
16. 25-6912 Spindle Partition
17. 25-7573 Coolant Splash Shield
18. 59-0712 3X AKROBIN AKRO-Mils 30-210 Red
19. 25-6933 Tool Tray
20. 25-6908 Right Panel
21. 58-1679 Bulkhead Fitting NPT-3/8 x 1.000 Dia.
22. 25-6796A Coolant Manifold Bracket
23. 30-8487 Spindle Head Manifold Assy
24. 25-6909 Top Panel
25. 32-0229 Work Light Housing
26. 25-4789A Work Light Adjust Bracket
27. 66-1480 Fan 5.91 x 6.78 in. 200 cfm
    25-6923 Fan Bracket
    66-1485 Fan Guard
28. 25-6910 Back Panel
29. 25-7500 Horizontal Cables Back Cover
30. 25-7501 Vertical Cables Back Cover
31. 25-6911 Bottom Back Panel
32. 25-6906 Bottom Front Panel
33. 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
39. 25-6946A Pendant Arm Support
40. 32-9841A Electrical Control Box Assy
41. 30-7741 Right Swiveling Caster
    30-7742 Left Swiveling Caster
42. 25-7348A Base Right Panel
43. 25-7072 Coolant Tank Support
44. 25-7350 Base Bottom
45. 28-1071 Top Beacon Light Assy
46. 25-8354C Front Pendant Enclosure
47. 58-3662 .375 Garden Hose Fitting
48. 59-2228 .375 Swing Valve Brass
49. 58-3600 .375 Hex Nipple
50. 58-1721 45 Degree Elbow
51. 32-5005 Coolant Pump Kit
52. 25-6838 Coolant Tank Filter
53. 25-7070 Pump Assy Bracket
54. 25-7069 Coolant Tank
55. 25-7071 Chip Tray
56. 59-0023 4X Door Hinge
57. 25-5856A Right Base Door
58. 25-5855A Left Base Door
59. 58-0227 2X Push Close Latch
60. 25-7346A Base Front Panel
61. 59-0814 Auto Lube Pump
62. 30-8257 Air Regulator Assy
63. 25-7347A Base Left Panel

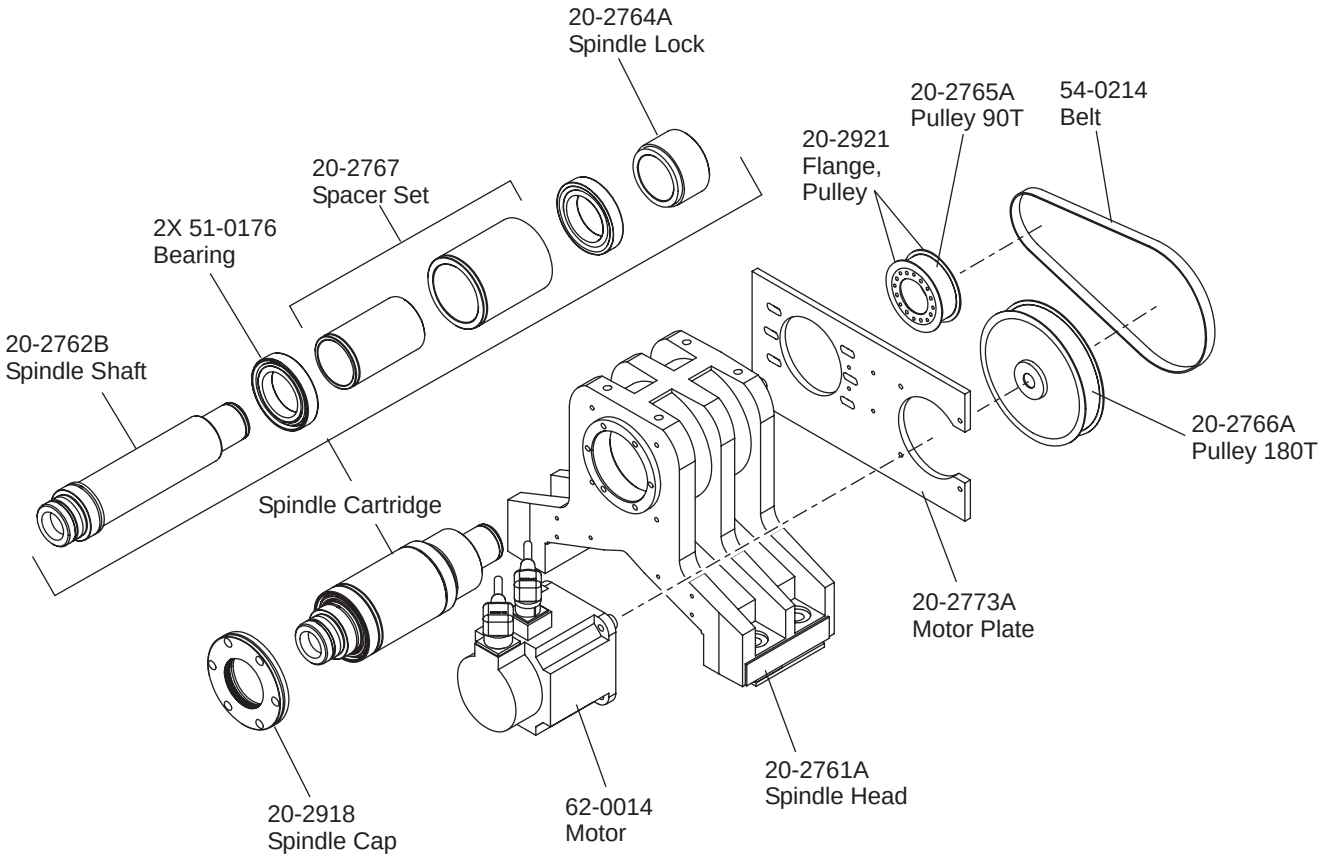
Office Lathe Internal Sheetmetal and Parts List



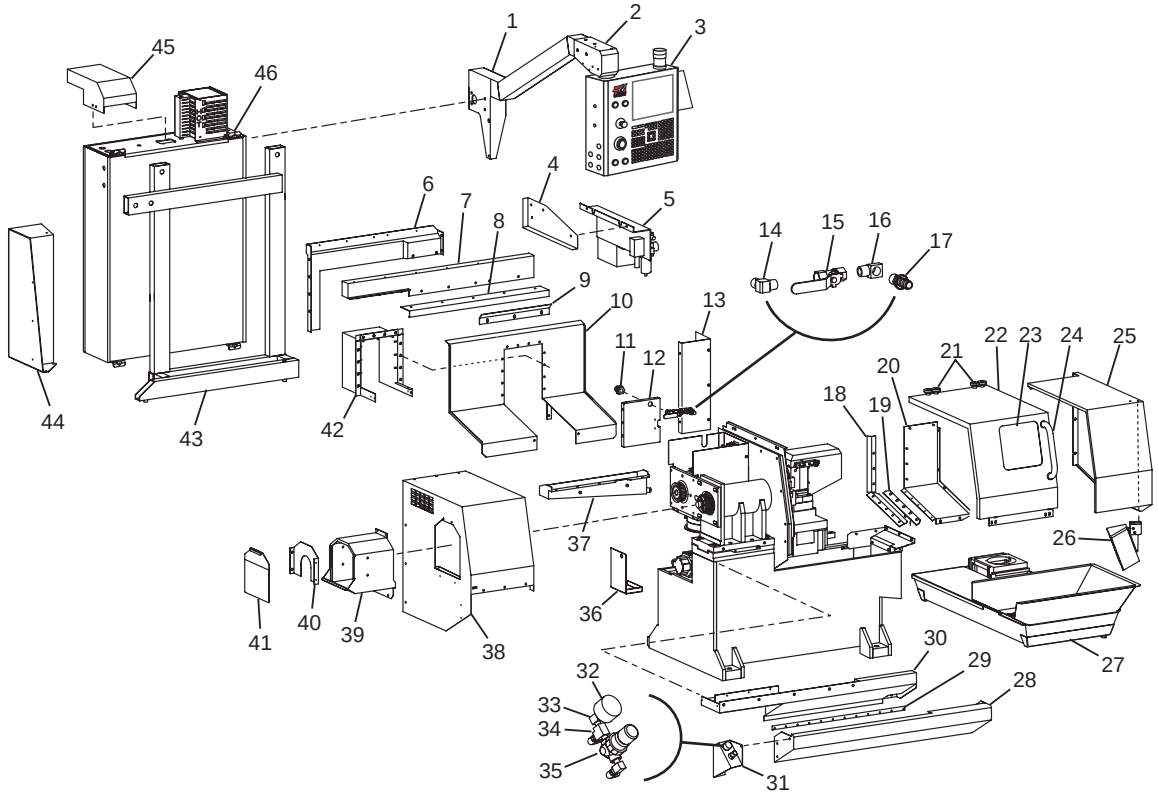
Office Lathe Internal Sheetmetal and Parts List

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. 62-0016 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

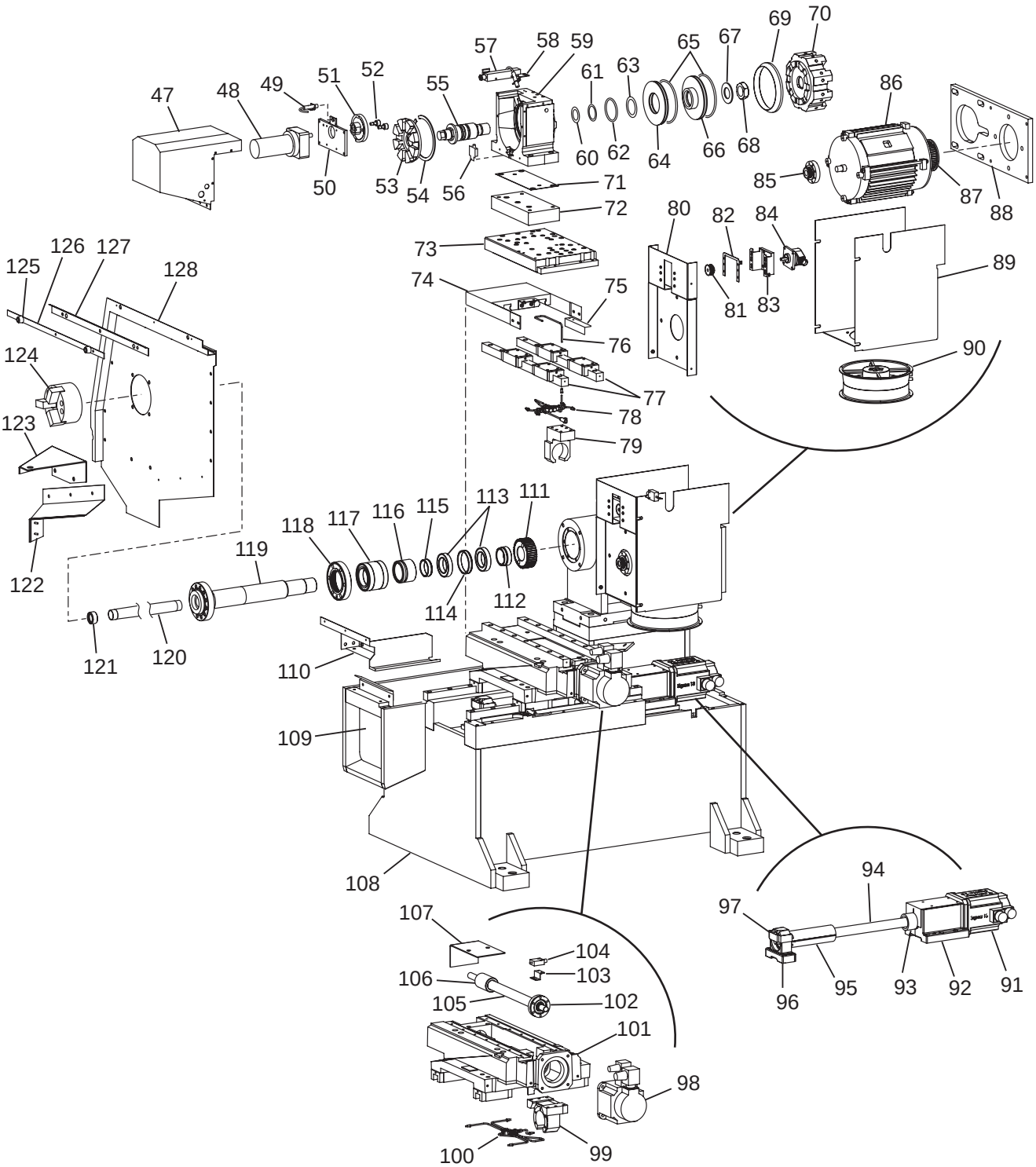


GT-10 External Sheetmetal and Parts List



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

GT-10 Internal Sheetmetal

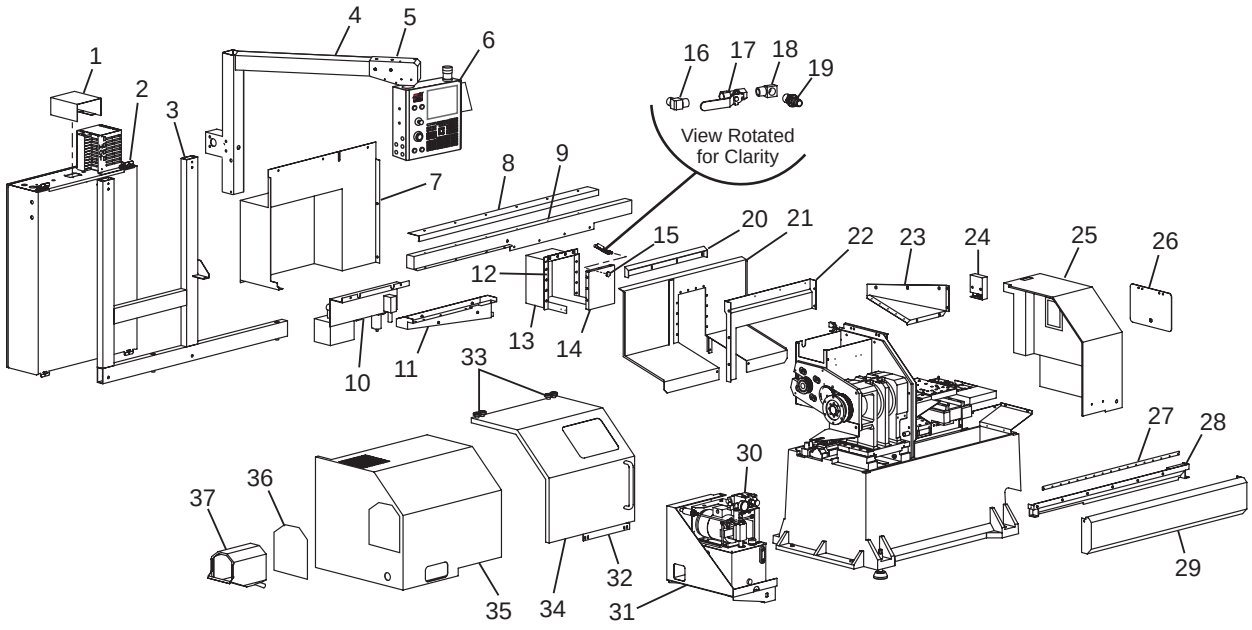


(View Rotated 180°)

GT-10 Internal Sheetmetal Parts List

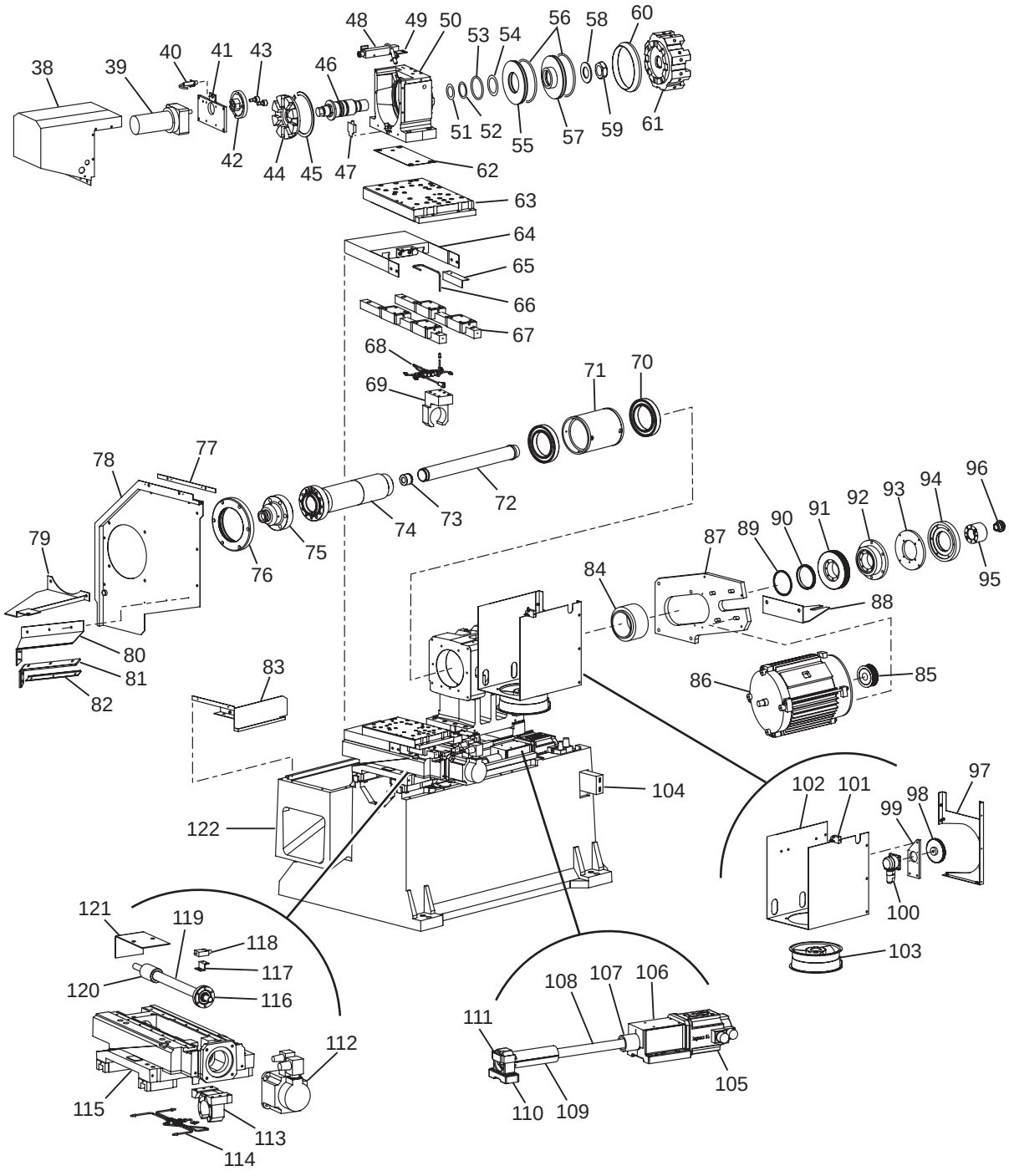
47.	25-7907	TT-20-3 TC Housing Cover
48.	62-0025	Geneva Drive Motor
49.	32-2267	Tool Position Sensor Switch
50.	20-3412	Motor Bracket
51.	20-9332	Geneva Driver 2 Pin
52.	51-0051	2X Cam Follower .75 in. Hex,
53.	20-3411A	Geneva Flower
54.	56-0030	Retaining Ring 6.000 in. HO
55.	20-3406A	Piston Shaft
56.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

GT-20 External Sheetmetal and Parts List



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

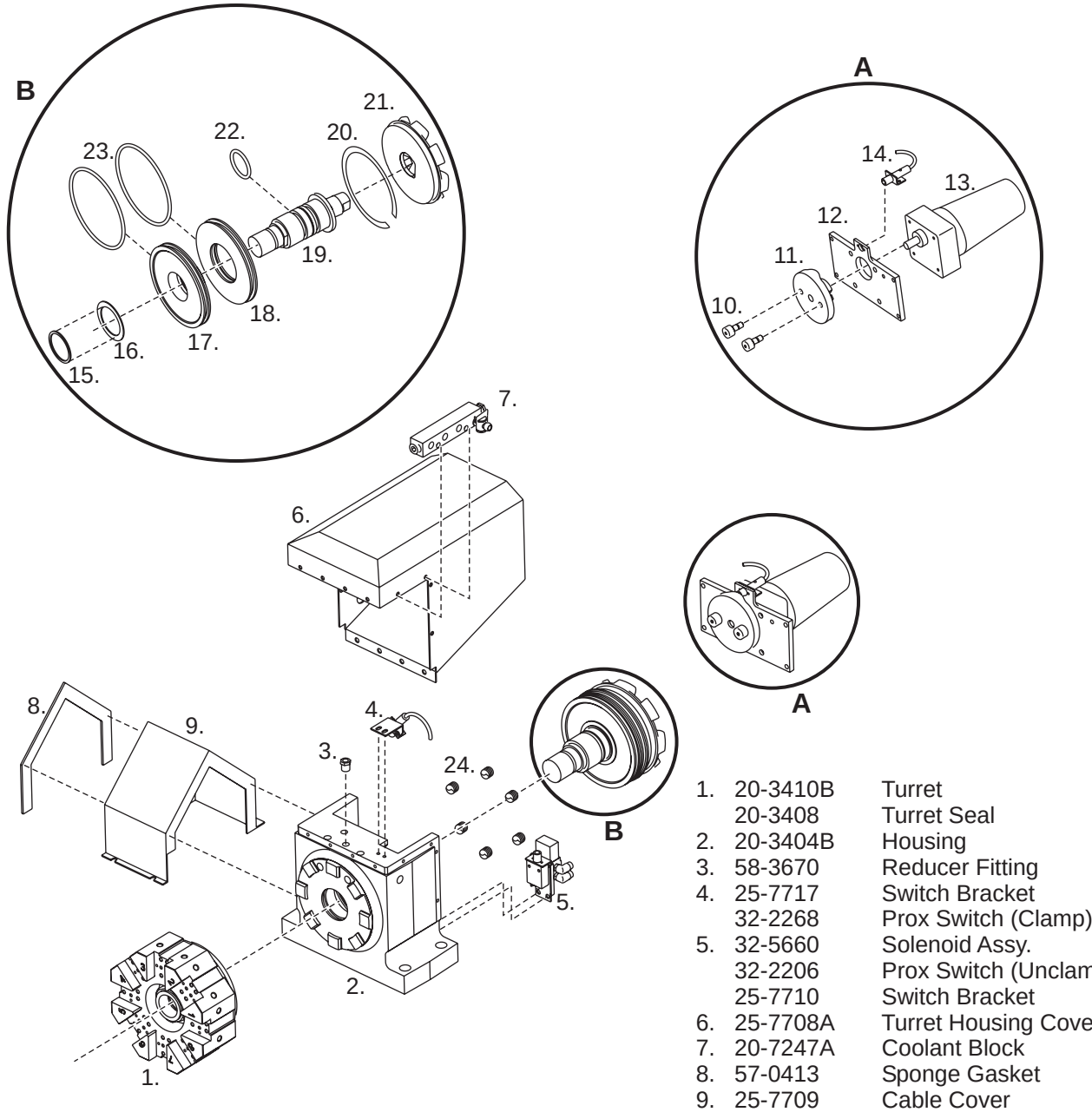
GT-20 Internal Sheetmetal



GT-20 Internal Sheetmetal Parts List

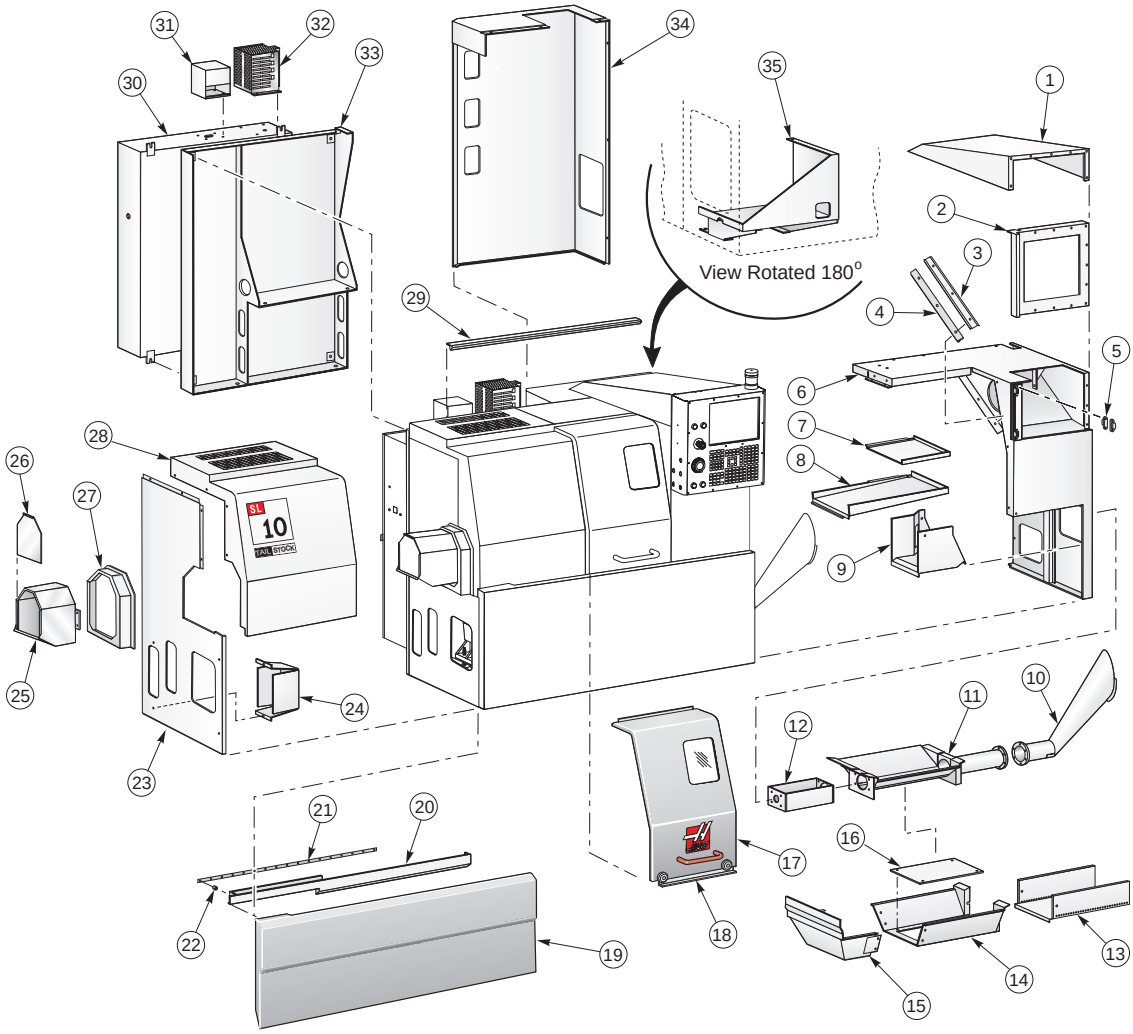
38. 25-7907 TT-20-3 TC Housing Cover
39. 62-0025 Geneva Drive Motor
40. 69-1700 Proximity Switch
41. 20-3412 Motor Bracket
42. 20-9332 Geneva Driver 2 Pin
43. 51-0051 2X Cam Follower .75 in. Hex,
44. 20-3411A Geneva Flower
45. 56-0030 Retaining Ring 6.000 in. HO
46. 20-3406A Piston Shaft
47. 25-7710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

TT-20 Tool Turret



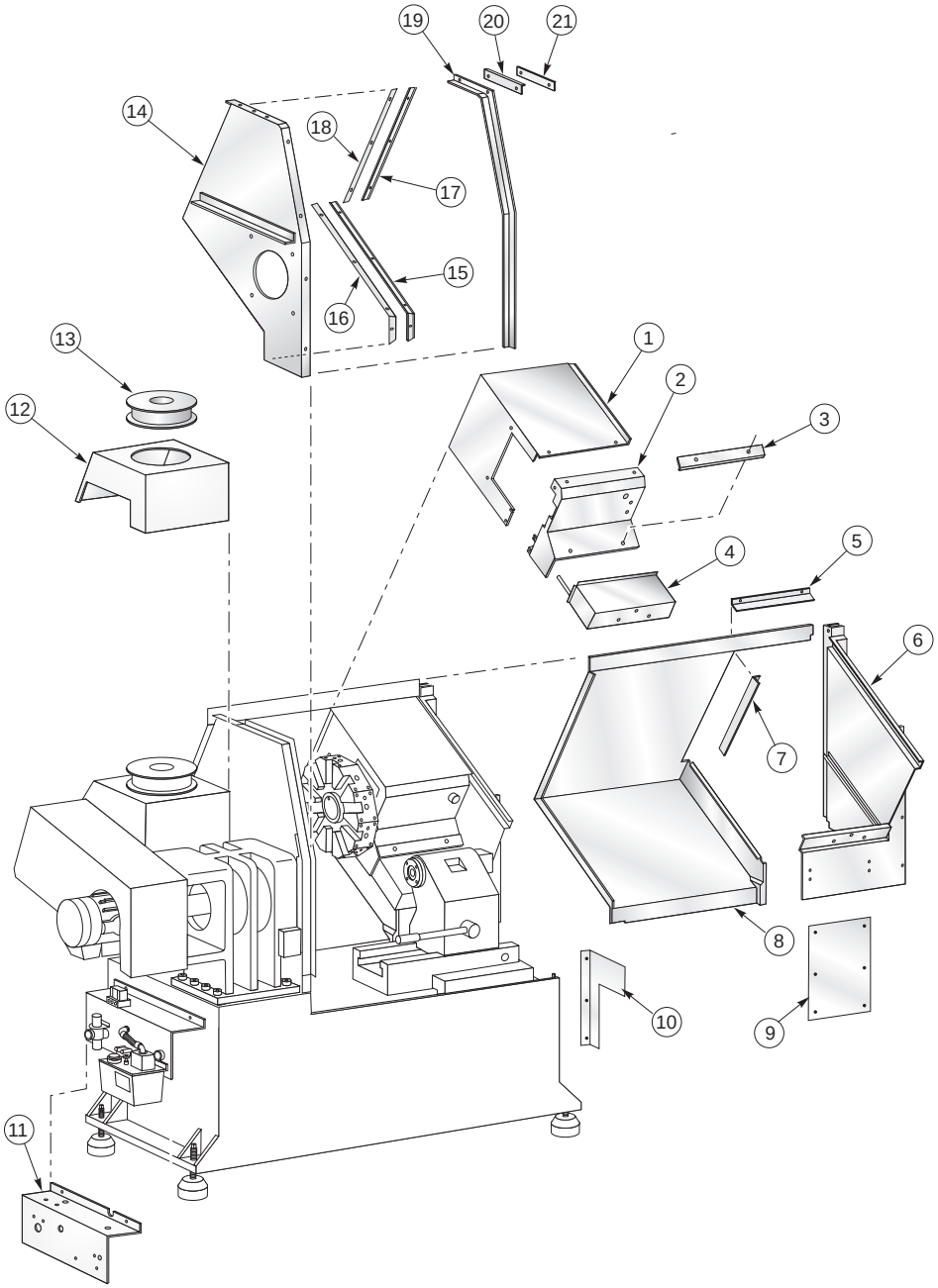
1.	20-3410B	Turret
	20-3408	Turret Seal
2.	20-3404B	Housing
3.	58-3670	Reducer Fitting
4.	25-7717	Switch Bracket
	32-2268	Prox Switch (Clamp)
5.	32-5660	Solenoid Assy.
	32-2206	Prox Switch (Unclamp)
	25-7710	Switch Bracket
6.	25-7708A	Turret Housing Cover
7.	20-7247A	Coolant Block
8.	57-0413	Sponge Gasket
9.	25-7709	Cable Cover
10.	51-0051	Cam Follower (x2)
11.	20-9332	Geneva Driver, 2 pin
12.	20-3412	Motor Bracket
13.	62-0025	Motor
14.	32-2267	Prox Switch (Cam Home)
15.	56-0055	Retaining Ring
16.	51-2984	Washer
17.	20-3405	Upper Piston
18.	20-3409	Lower Piston
19.	20-3406A	Piston Shaft
20.	56-0030	Snap Ring
21.	20-3411A	Geneva Star
22.	57-0095	O-Ring
23.	57-2146	O-Ring (x2)
24.	59-3014	Die Springs (x6)

SL-10 External Sheetmetal and Parts List



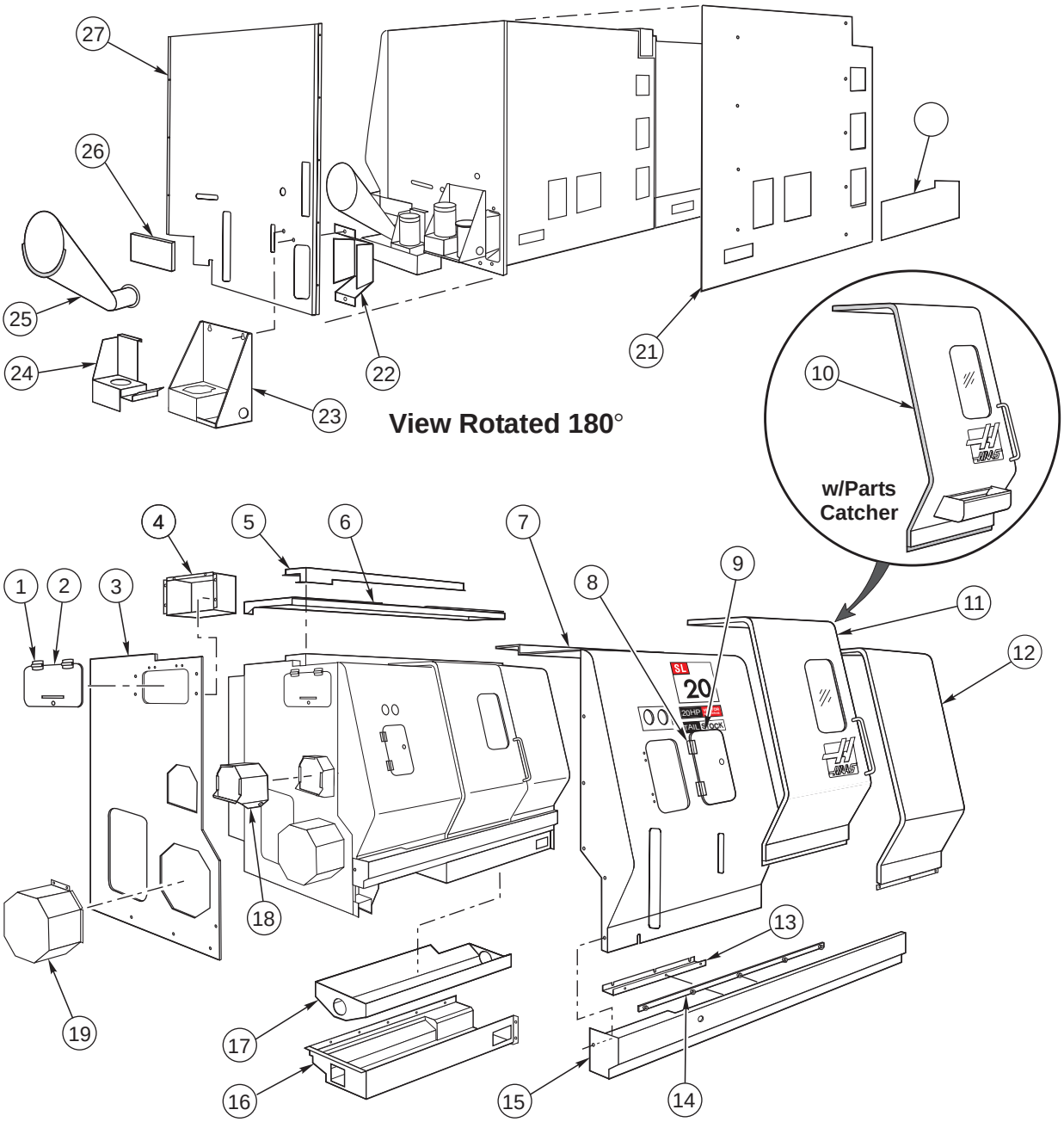
1. 25-0875D Monitor Cover
2. 25-0876B Pendant Back Cover
3. 25-0879A Z-Axis Right Bottom Wiper Retainer
4. 26-0030 Z-Axis Right Bottom Wiper Felt
5. 59-0252B R-Type Hinge Half
6. 25-4074B Right Panel
7. 25-1002A Tailstock Pan
8. 25-0890A NOTS Tray
9. 25-1023A Motor Pump Coolant Tray
10. 25-0548 Discharge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

SL-10 Internal Sheetmetal and Parts List



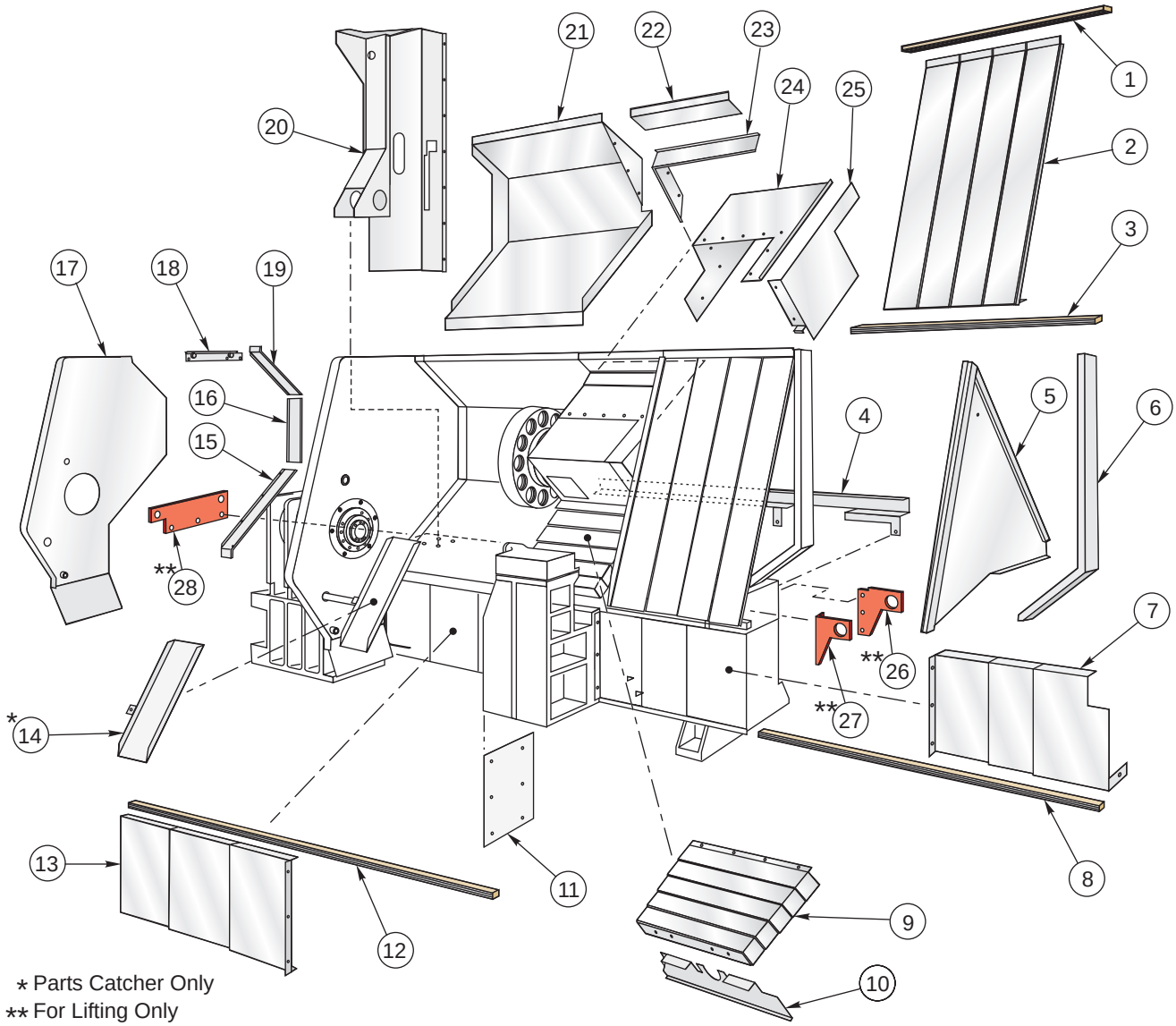
1. 25-0870B X-Axis Top Cover
2. 25-0871B X-Axis Front Cover
3. 25-0884 X-Axis Wiper Retainer
4. 25-0872B X-Axis Way Cover
5. 26-0034 X-Axis Top Wiper Felt
6. 25-0866C Moving Bulkhead
7. 26-0035 X-Axis Side Wiper Felt
8. 25-0873D Z-Axis Sliding Cover
9 26-0036 Cover, Z-axis Right
10. 25-6138A Chip Shield 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



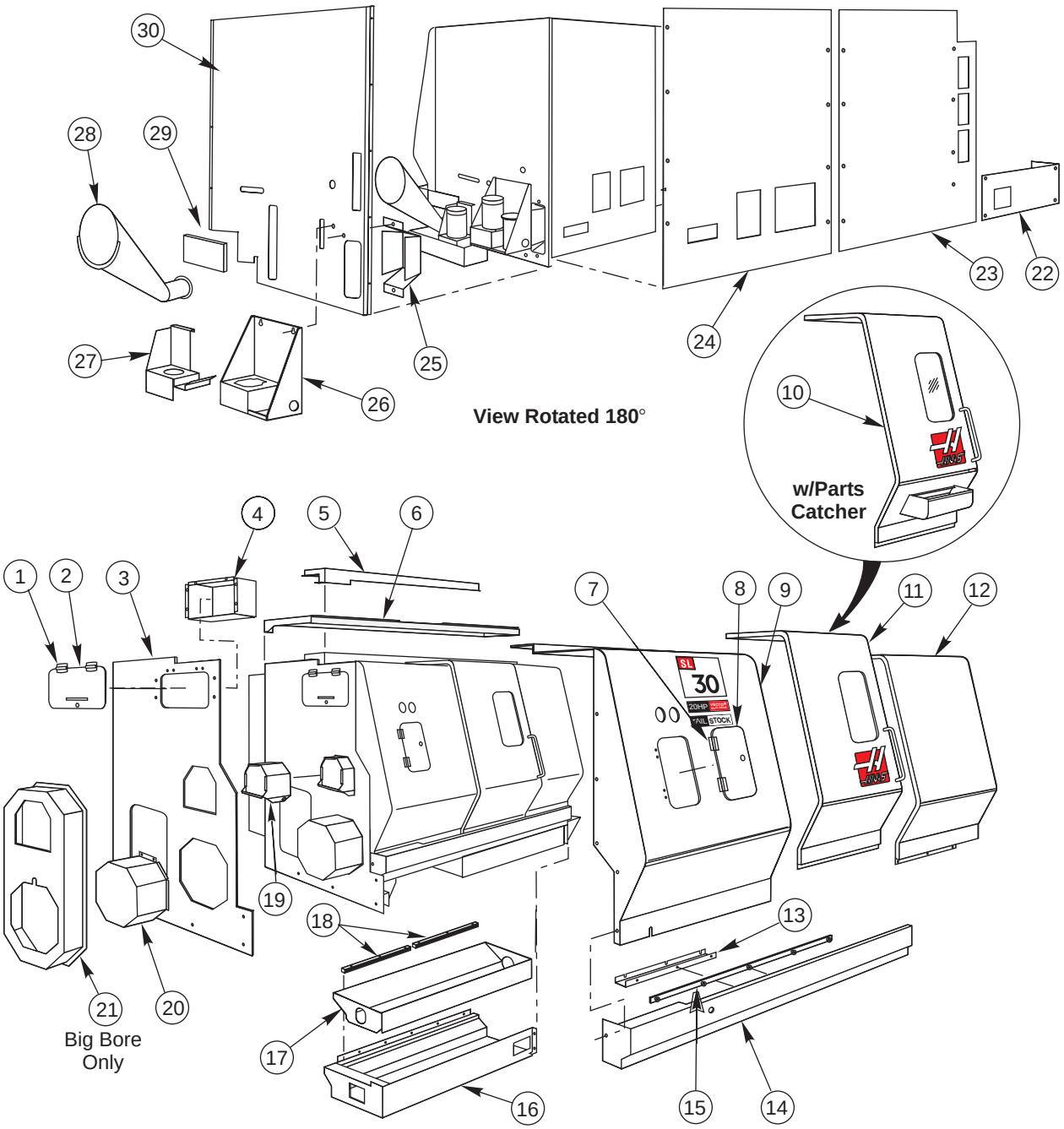
1.	59-0023	Door Hinges
2.	25-1350A	Toolbox Door
3.	25-8909H	Left Side Panel
4.	25-1349	Toolbox
5.	25-8935D	Top Door Roller Mount (SL-20)
	25-8036B	Top Door Roller Mount (SL-20L)
6.	25-8916D	Top Panel (SL-20)
	25-8096	Top Panel (SL-20L)
	25-8104	Roof Extension (SL-20L)
	25-8037A	Left Roof Panel (SL-20L)
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



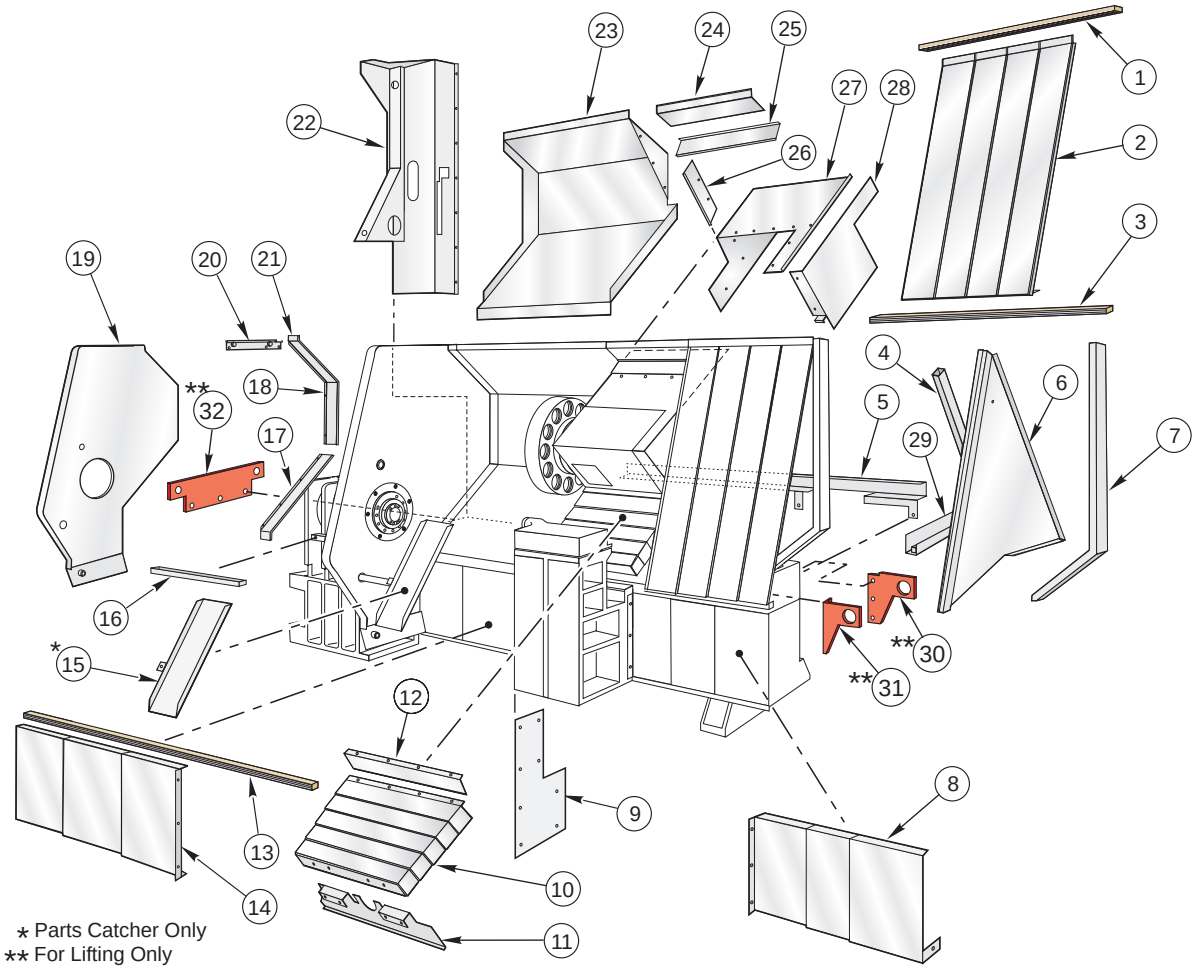
1.	22-8053	Upper Waycover Guide (SL-20)
	25-7994	Upper Waycover Guide (SL-20L)
2.	25-8051	Z-Axis Waycovers (SL-20)
	25-7990	Z-Axis Waycovers (SL-20L)
3.	20-1466	Lower Waycover Guide (SL-20)
	25-7984	Lower Waycover Guide (SL-20L)
4.	25-4423A	Cable Rail
5.	25-8933E	Moving Bulkhead (SL-20)
	25-7989	Moving 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

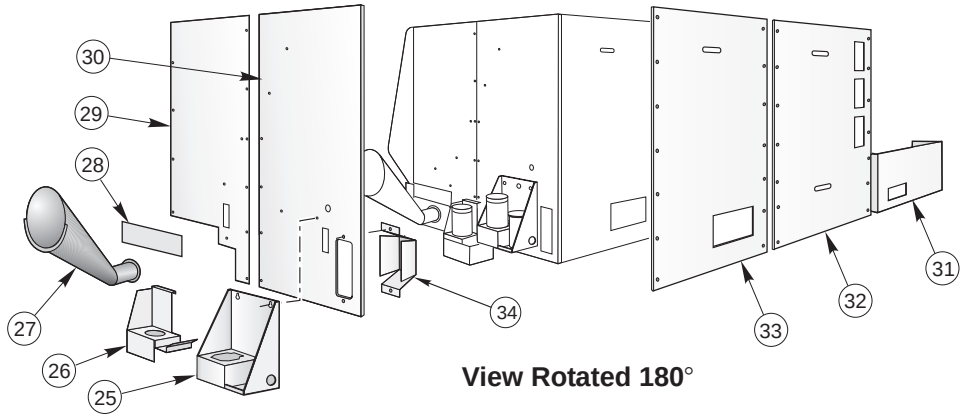
1.	59-0023	Door Hinges (2)
2.	25-1350A	Toolbox Door
3.	25-6345D	Left Side Panel (SL-30)
	25-8567	Left Side Panel (SL-30L)
4.	25-1349	Toolbox
5.	25-8819D	Top Door Roller Mount (SL-30)
	25-8634B	Right Roof Beam (SL-30L)
	25-8636A	Left Roof Beam (SL-30L)
6.	25-8818F	Top Right Panel (SL-30)
	25-8618A	Top 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)



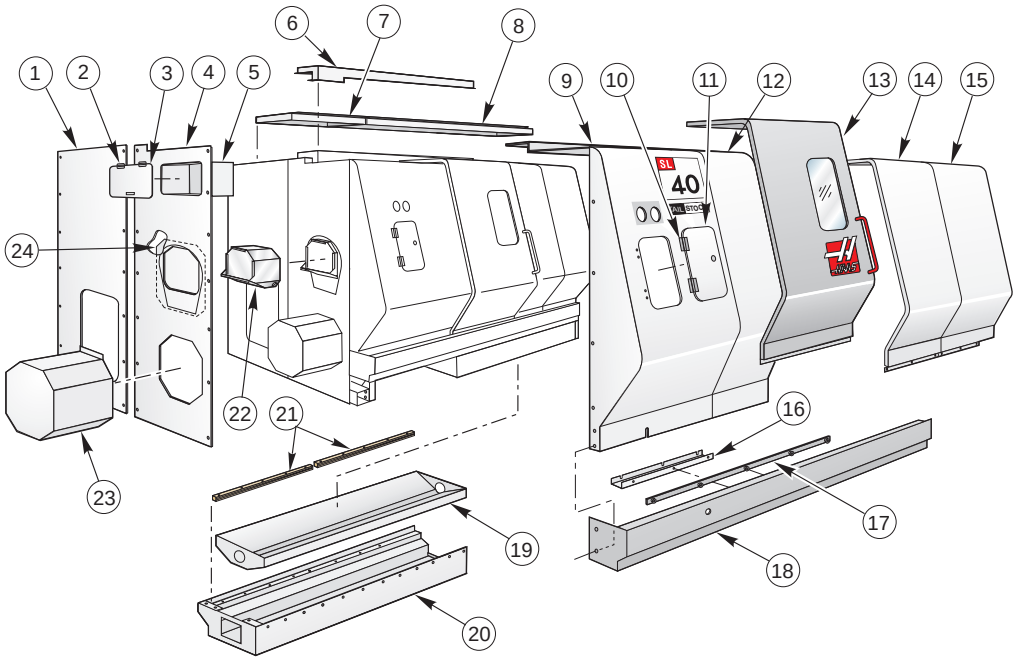
SL-30/30L Internal Sheetmetal and Parts List

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

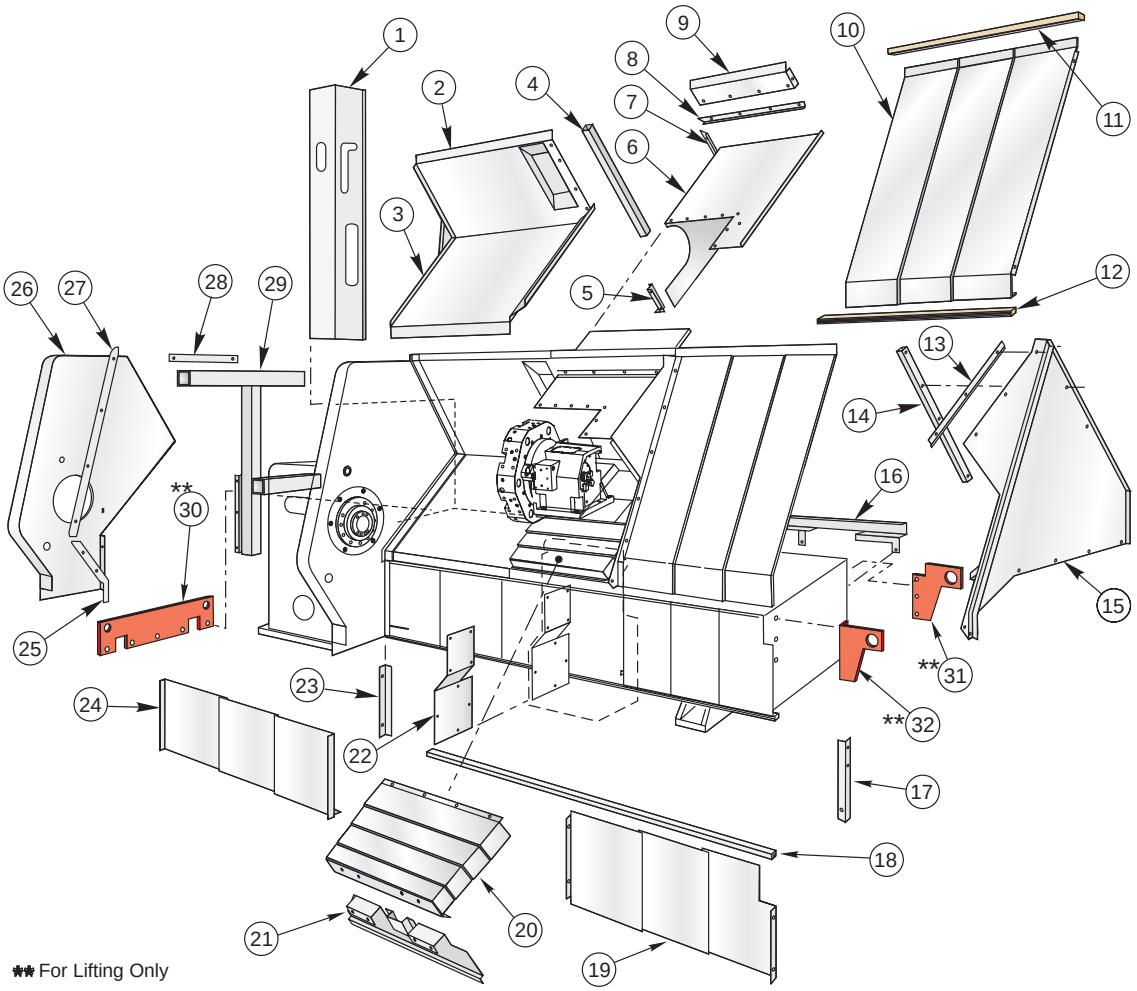


View Rotated 180°



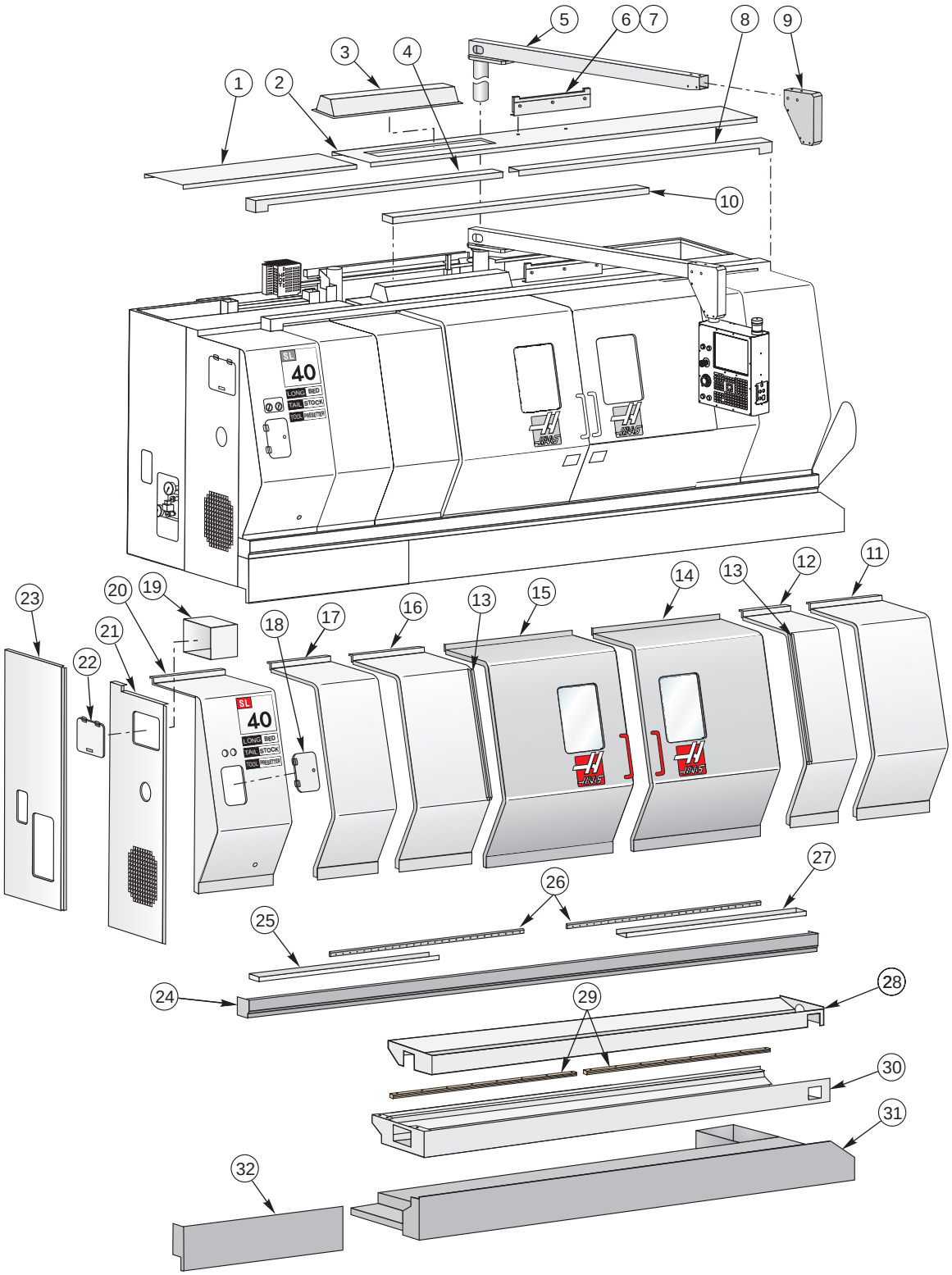
1. 25-0780D Left End Rear Panel
2. 59-0023 Toolbox Door Hinge
3. 25-1350A Toolbox Door
4. 25-8211F Left End Front Panel
5. 25-4729A Toolbox
6. 25-8285D Door Rail Mount
7. 25-8218B Left Top Panel
8. 25-8219C Right Top Panel
9. 25-8206A Front Left Panel
10. 59-0023 Access Door Hinge
11. 25-8021 Access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

SL-40 Internal Sheetmetal and Parts List

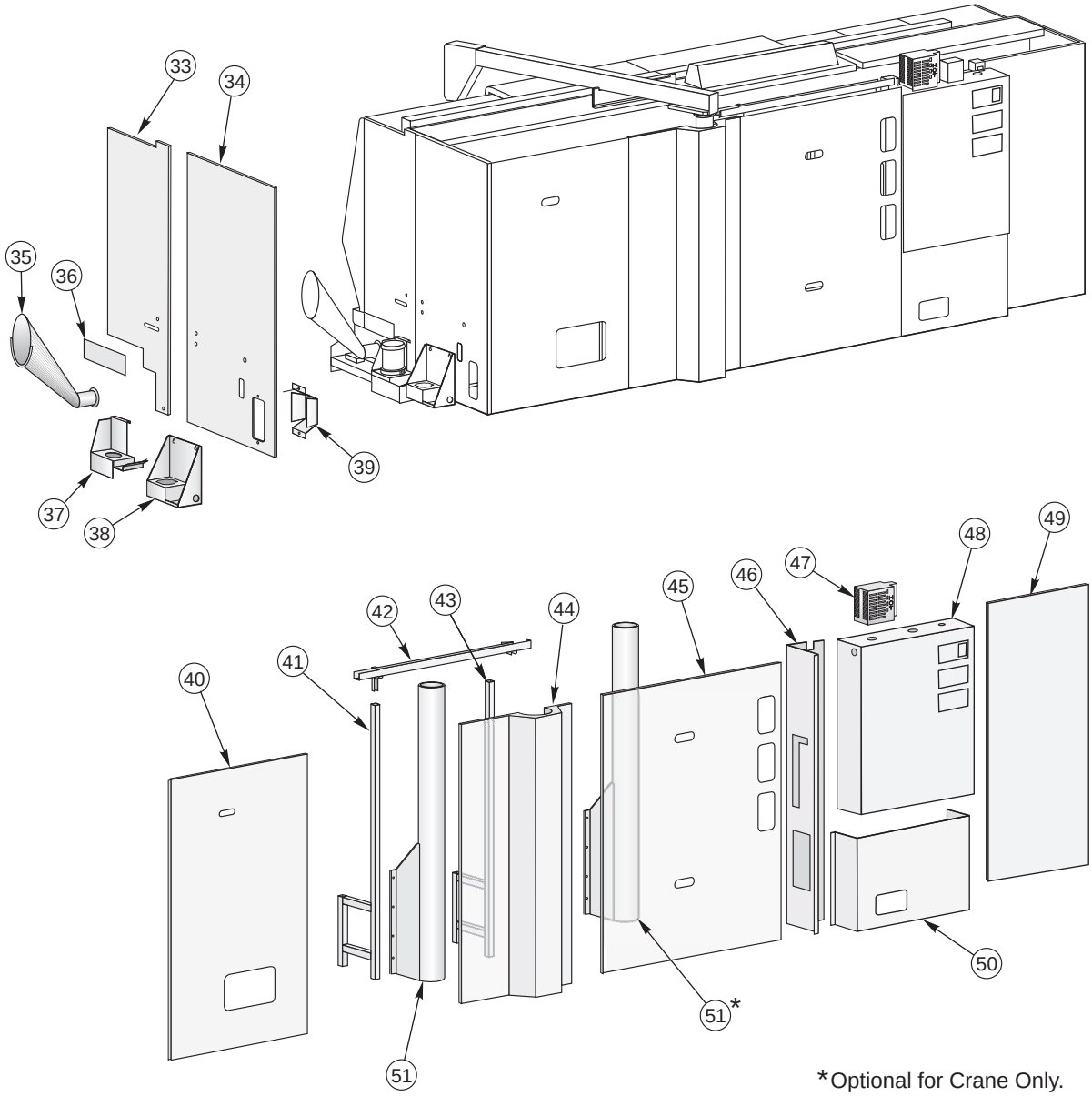


1. 22-8233A Control Box Mounting Bracket
2. 25-0145C Z-Axis Top Rear Sliding Cover
3. 25-8246C Z-Axis Bottom Rear Sliding Cover
4. 25-8653A Z-Axis Waycover Support Bracket
5. 25-5443 Tool Changer Cover Spacer
6. 25-5442A Tool Changer Cover
7. 25-8253A X-Axis Vertical Wiper
8. 25-8254A X-Axis Horizontal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

SL-40L External Sheetmetal (Sheet 1 of 2)



SL-40L External Sheetmetal (Sheet 2 of 2)



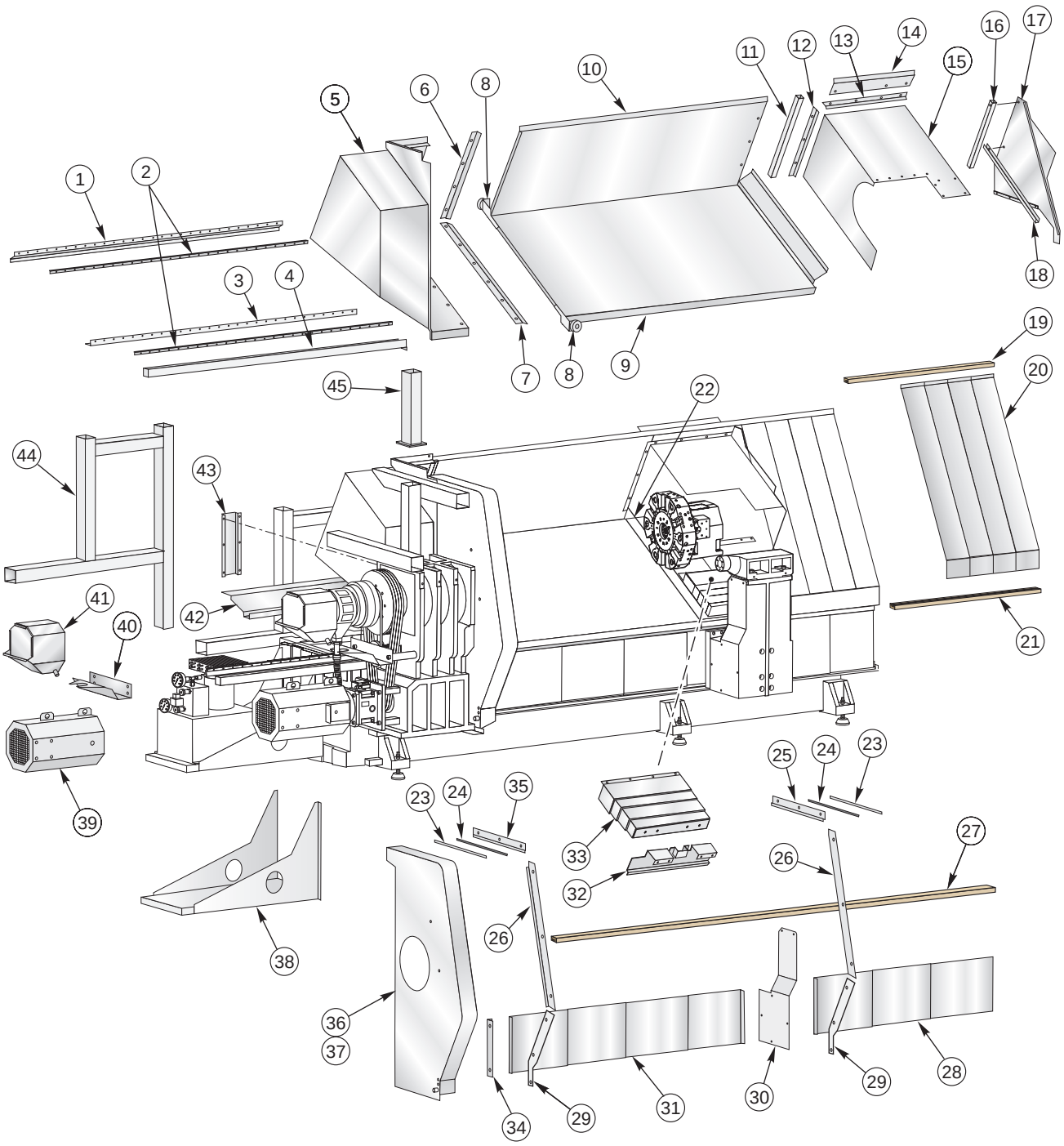
*Optional for Crane Only.

BACK VIEW

SL-40L External Sheetmetal Parts List

1. 25-4541A Left Top Front Panel
2. 25-4542B Right Top Front Panel
3. 25-4723 Light Fixture Body
4. 25-4563A Left Top Door Mount
5. 20-1775 Pendant Boom Arm
6. 20-1773 Boom Arm Detent
7. 25-4578 Boom Arm Detent Support
8. 25-4562 Right Top Door Mount
9. 25-4633A 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
    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
    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
47. 32-0042A Regen Assembly
48. 25-11310A Main Electrical Control Box Assembly
49. 25-4553 Left Back Panel
50. 25-0783A Left Back Lower Panel
51. 20-1254 Boom Support (2)

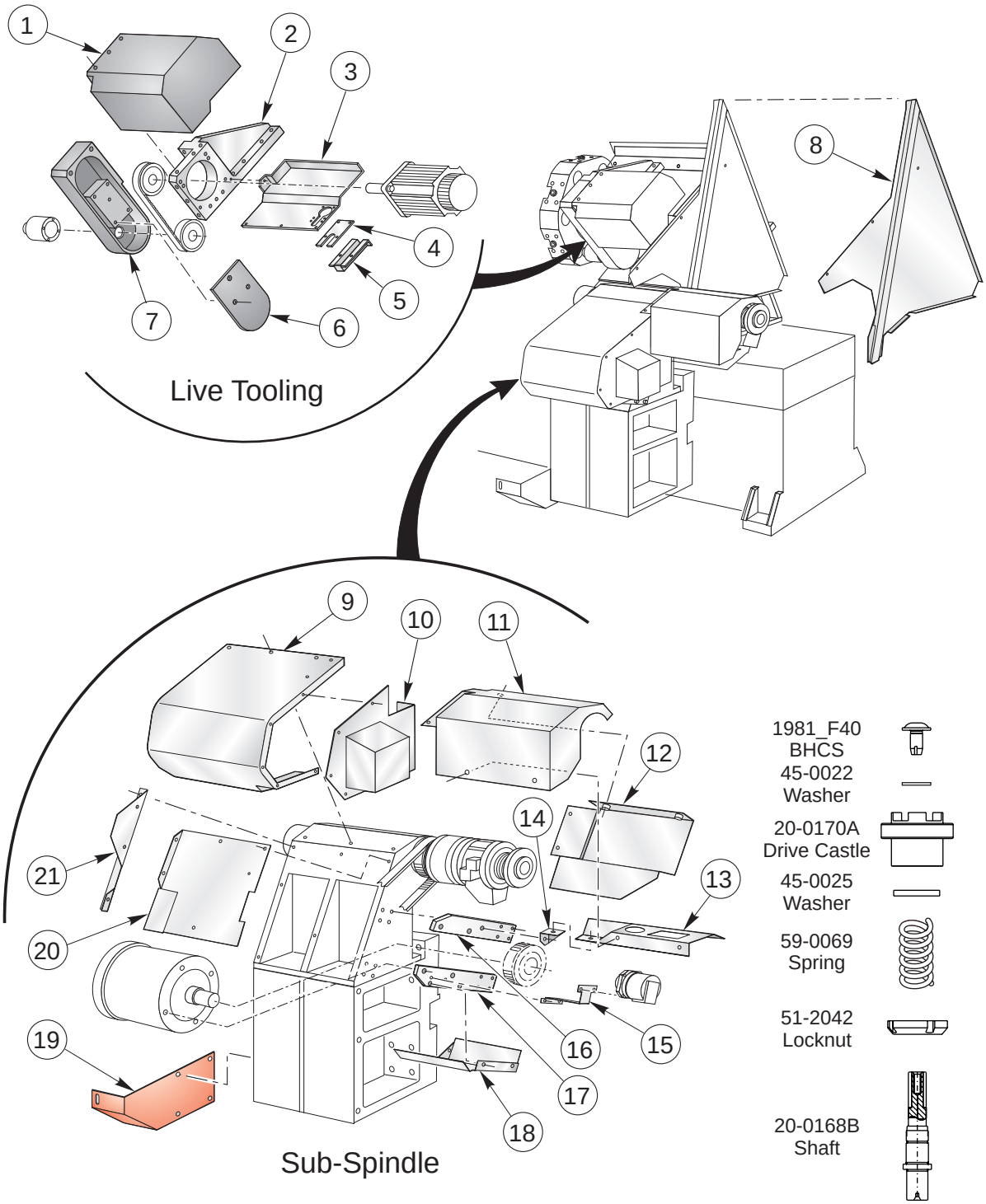
SL-40L Internal Sheetmetal

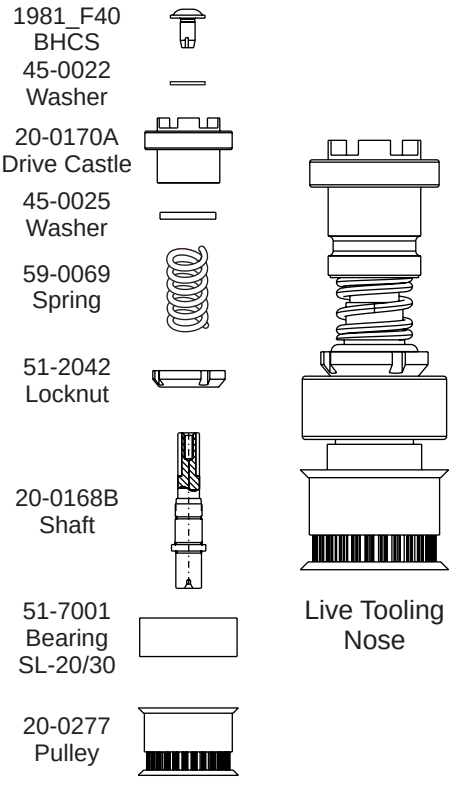


SL-40L Internal Sheetmetal Parts List

1.	25-4572	Rear V-Track Mount
2.	20-1772	Z-Axis V-Track (2)
3.	25-4573A	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





Live Tooling Nose

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

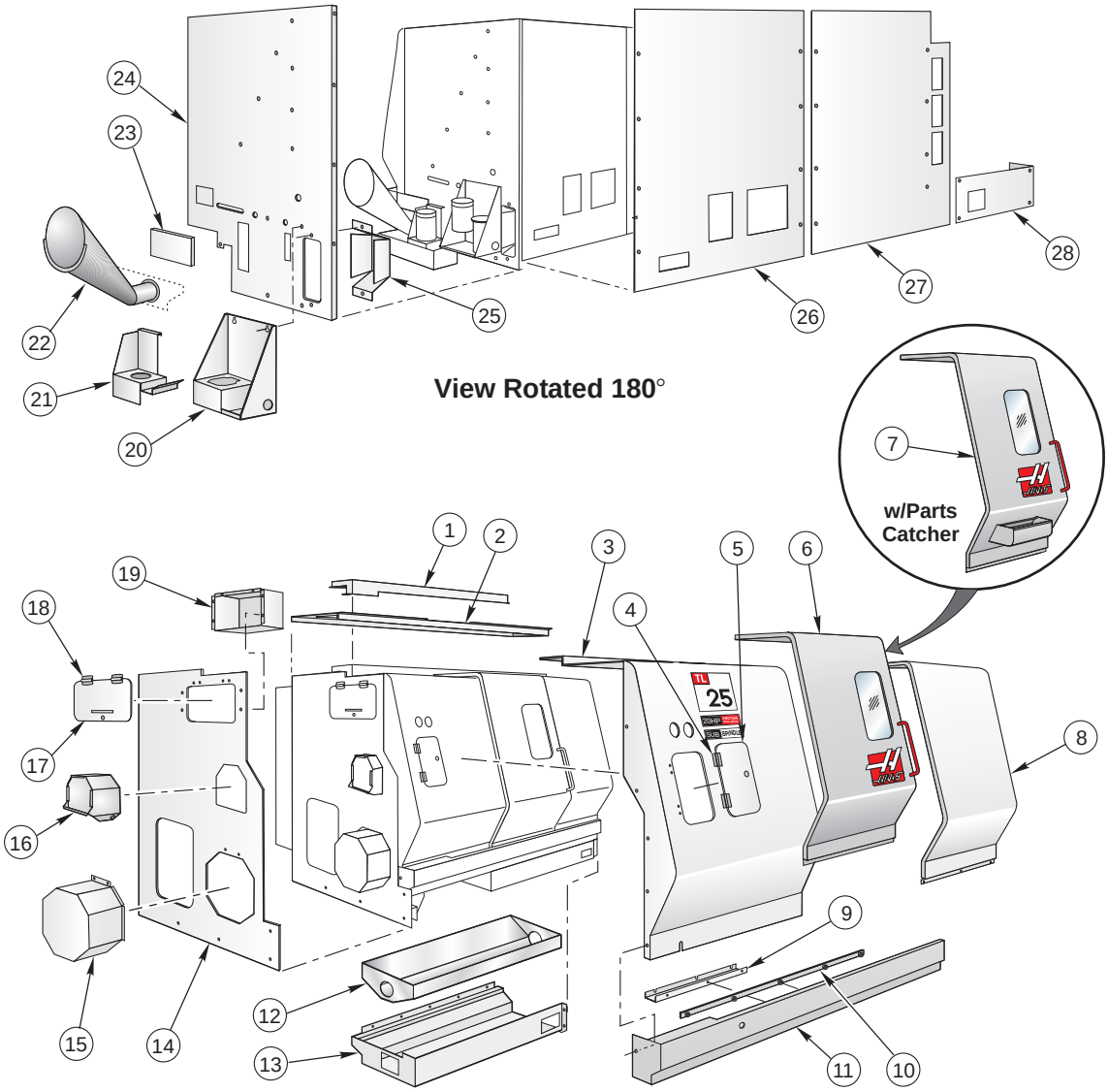
5a. 25-6553 Channel (Larger Turret)

6. 20-0161 Belt Arm Cover
7. 20-0162A Belt Arm

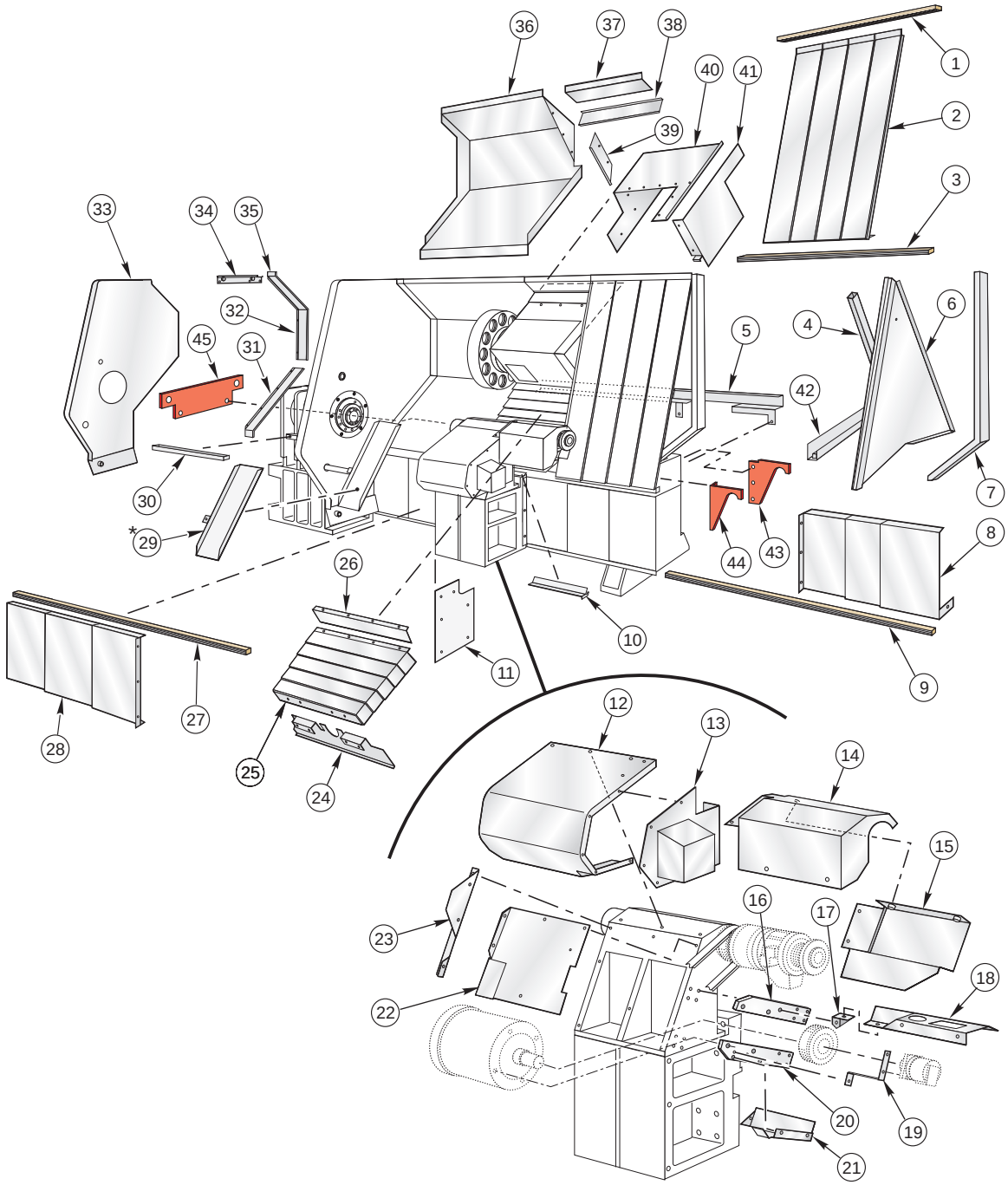
Sub-Spindle

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



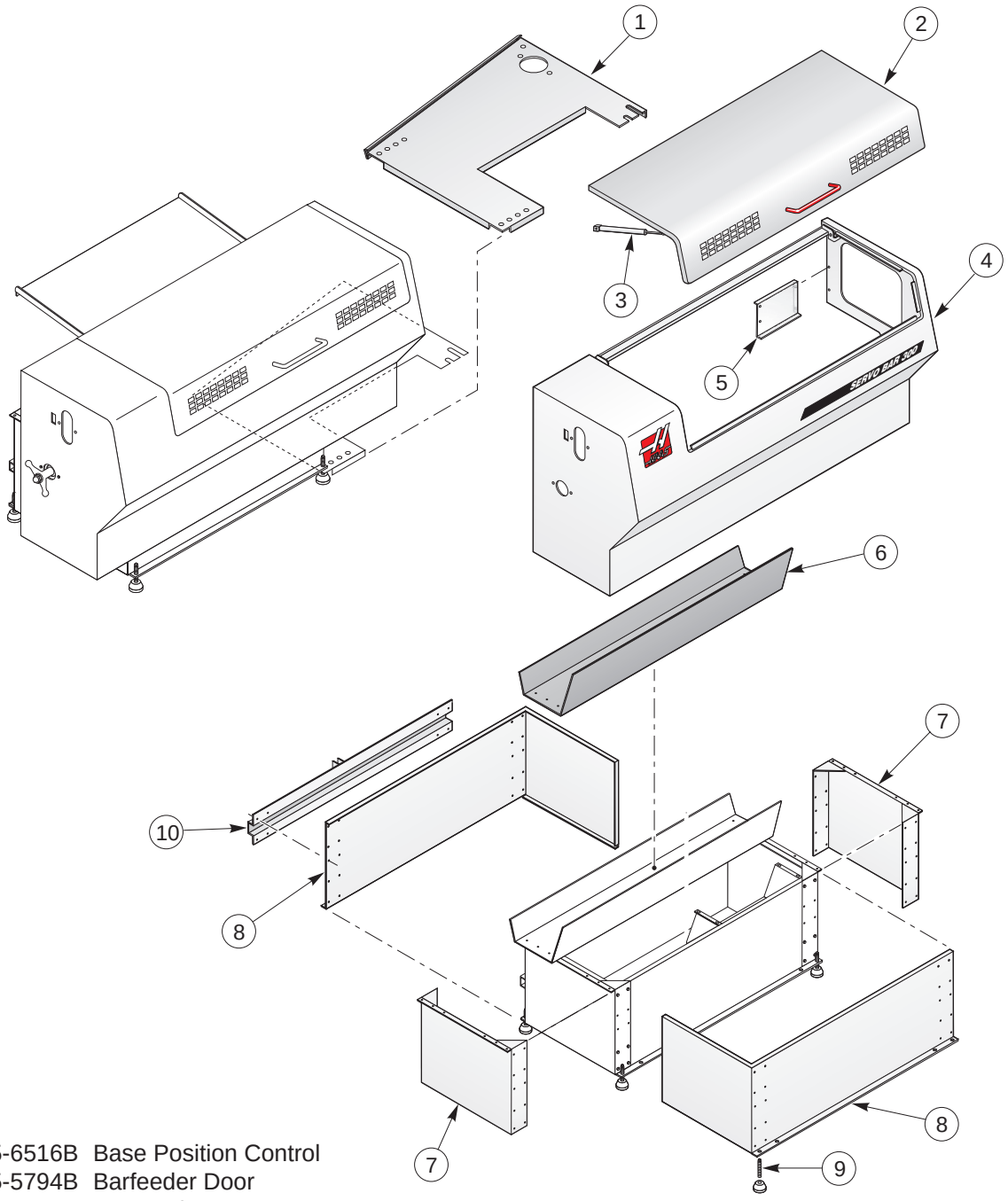
*Parts Catcher Only

SUB-SPINDLE ASSEMBLY

TL-25 Internal Sheetmetal Parts List

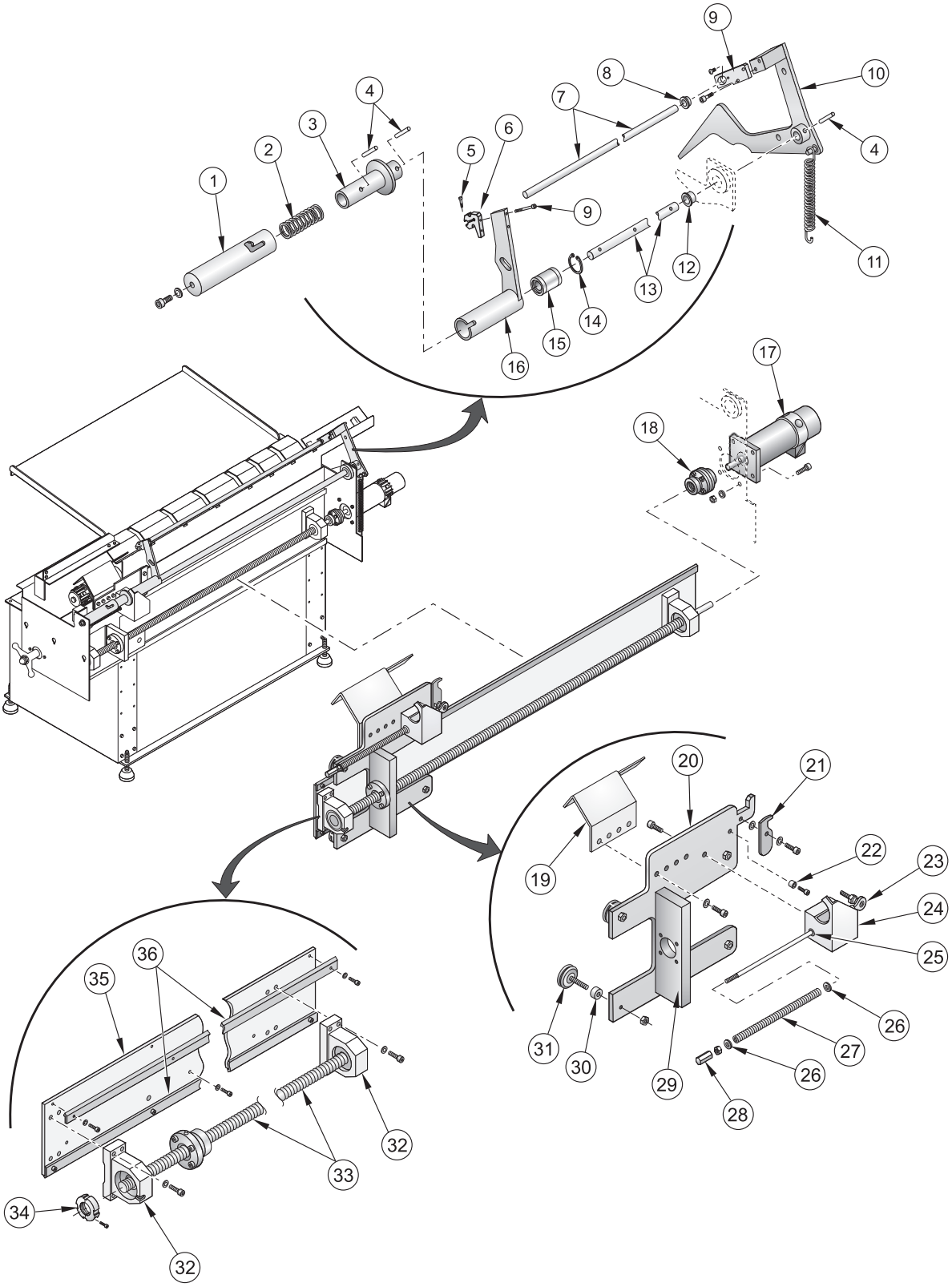
1. 22-8049 Z-Axis Top Waycover Guide
2. 25-8047 Z-Axis Waycover
3. 22-8048 Z-Axis Bottom Waycover Guide
4. 22-8783 Moving Bulkhead Support
5. 22-0830A Cable Channel Cover
6. 25-8843B Moving Bulkhead
7. 25-6543A Right End Support Bracket
8. 25-4348 Right Sub-spindle Waycover (4)
9. 20-1521 Lower Tailstock 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

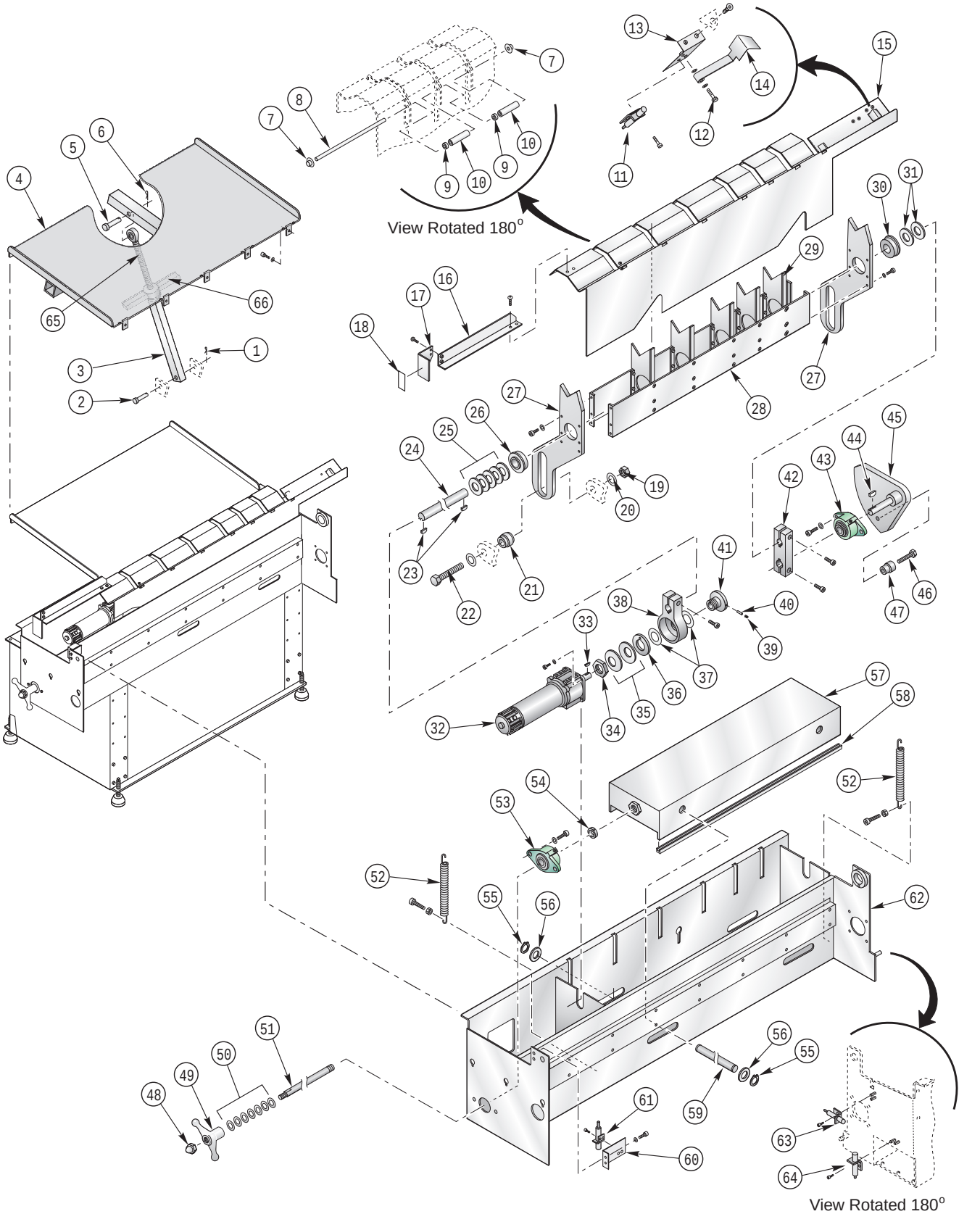
Barfeeder External Parts



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

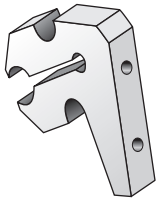
1.	49-1203	1/8 x 1 Cotter pin
2.	49-1201	3/4 x 3 Clevis pin
3.	20-3886	Support stand
4.	25-6541	Charging table
5.	49-1202	1 x 6 Clevis pin
6.	49-1203	1/8 x 1 Cotter pin
7.	46-0011	1/4 Push cap nut
8.	20-0341	Transfer table
9.	22-9256	Bushing extractor
10.	58-1982	Hose urethane 3/8 OD x 1/4 ID (APL)
11.	32-2213	Limit switch (end of bar)
12.	49-1019	Shoulder bolt 1/4 x 1
13.	25-6528B	Bar end mounting
14.	25-6529C	Bar end switch paddle
15.	25-6527E	Bar transfer table
16.	25-6546A	Height indicator support bracket
17.	25-6547	Height indicator flag
18.	29-0051	Height gauge decal
19.	46-1702	Nut
20.	45-1739	Washer
21.	54-0010	Cam follower
22.	43-7000	Bolt
23.	49-0101	Key
24.	20-6487	Lifting arm shaft
25.	45-0013	Washer
26.	51-1017	Bearing
27.	25-6530A	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
48.	46-0010	3/4-10 Cap nut
49.	59-0102	Clamp handle 3/4-10
50.	45-0004	3/4 Flat washer
51.	20-6026C	Height adjusting
52.	59-0110	Spring 6 x 27/32 x .106
53.	51-1015	Flange bearing 3/4
54.	54-0057	Shaft collar 3/4
55.	56-0085	Snap ring
56.	45-0013	Washer
57.	25-6549A	Height adjusting box
58.	59-7200	Grommet material .125
59.	20-6490A	Box cross rollers
60.	25-0338	Home switch bracket
61.	32-2142	Home Switch
62.	30-0802A	Main frame
63.	32-2212	Load Q limit switch
64.	32-2211	Load bar limit switch
65.	22-6025	1" Acme adjusting screw
66.	49-1020	Acme wing nut 1-5

Detailed Bar 300 Parts

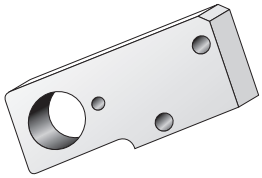
30-1389 – 3/8" Pushrod

30-0804 – 3/4" Pushrod

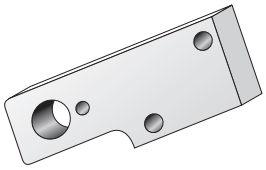
CURRENT



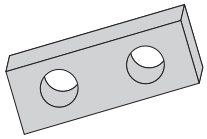
20-1033 Push Rod End Clamp



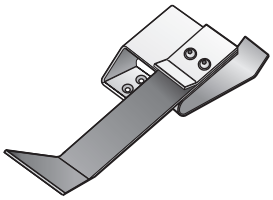
20-1034 Push Rod Control Bushing Holder 3/4”



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

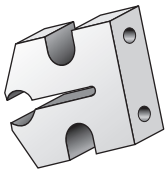


20-1923 Spacer

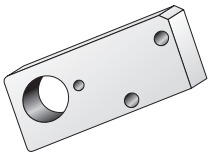


30-1336 Switch Hold Down Assembly

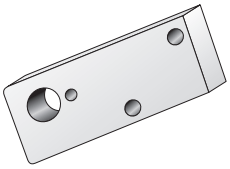
PREVIOUS



20-6483 Push Rod Connector Adapter

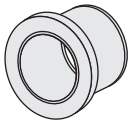


20-6032 Push Rod Control Bushing Holder 3/4”



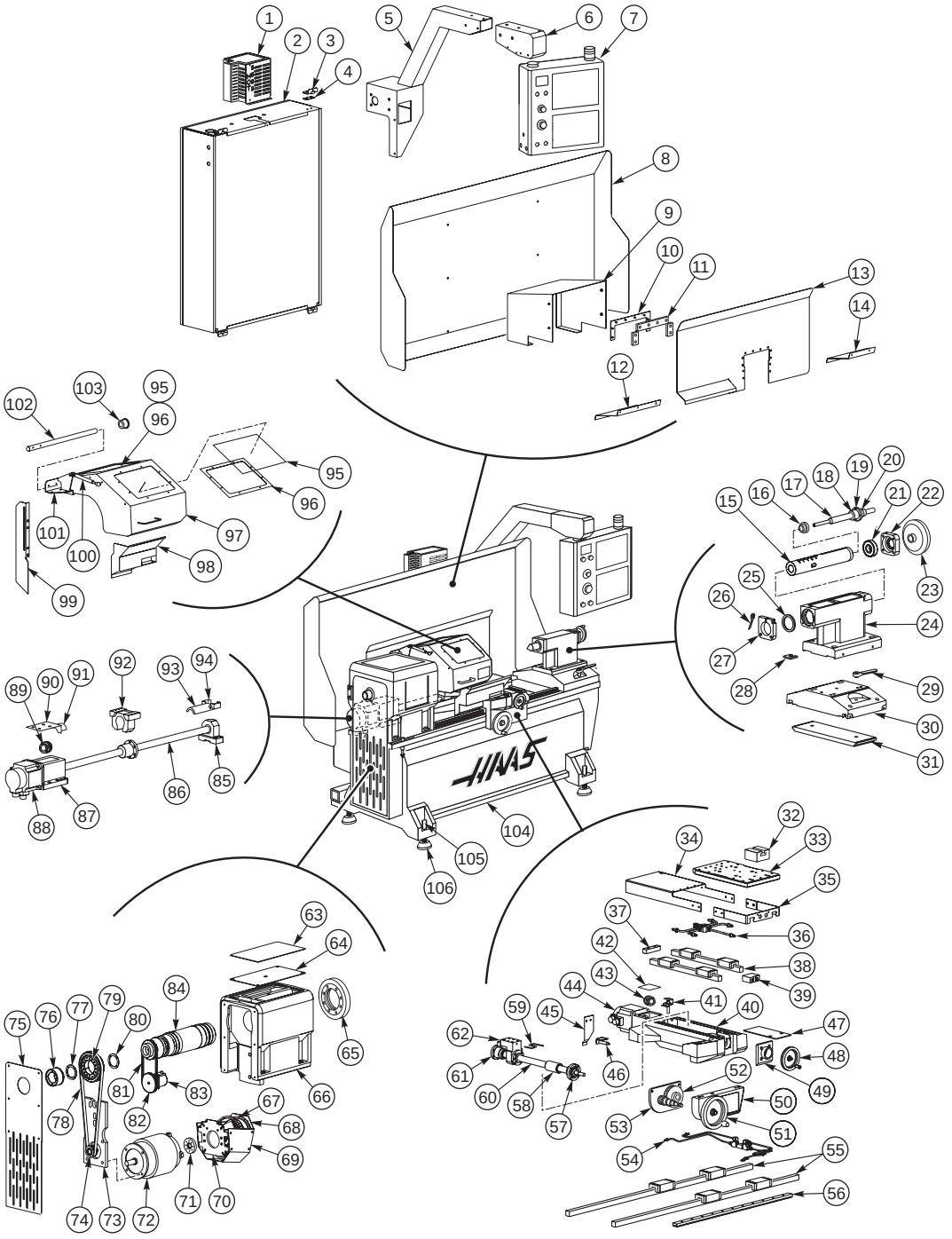
20-6044 Push Rod Control Bushing Holder 3/8”

51-0055 Nylon Flange Bearing 3/8"



20-1046 Push Shaft Bushing 3/4"

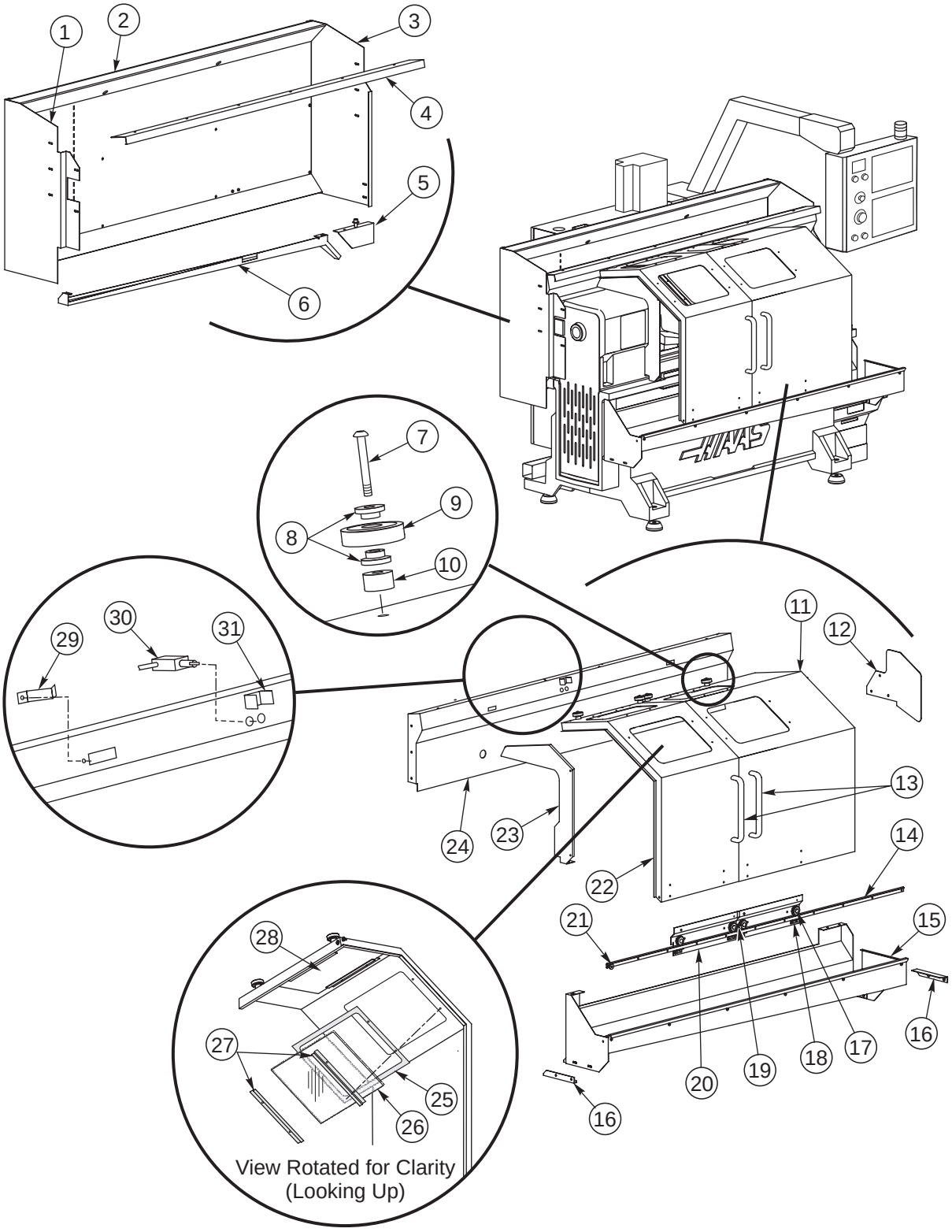
Toolroom Lathe (TL-1/2)



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

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

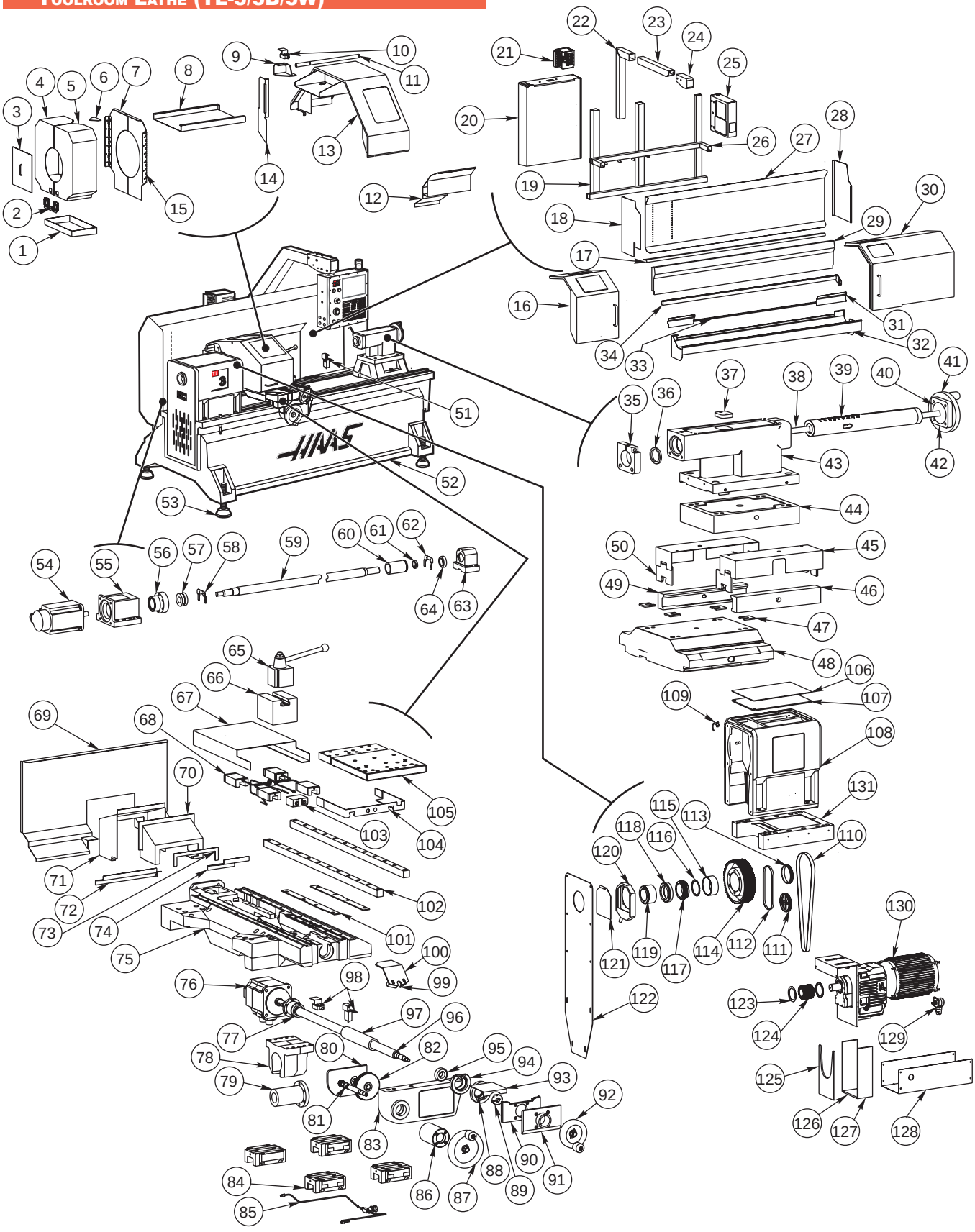
TL 1-2CE



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 ¼-20 x 1-¾
8. 20-0260 Top Door Spacer (2x)
9. 51-2020 Bearing Radial FAFNIR 303
10. 22-7034 Spacer Cam Follower
11. 25-6408F (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 (Tl-2-CE) Front Gutter
16. 25-5949 Push Bar
17. 54-0030 Guide Wheel (4x)
18. 25-6019 Door Guide Retainer (4x)
19. 26-0163 Lathe Doors Felt Wiper (2x)
    25-5746 Outer Felt Retainer (4x)
    25-5745 Inner Felt Retainer (2x)
20. 25-5944B Lower Rear Mount (2x)
21. 20-6016A Rail Spacer
    40-0126 BHCS ¼-20 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)



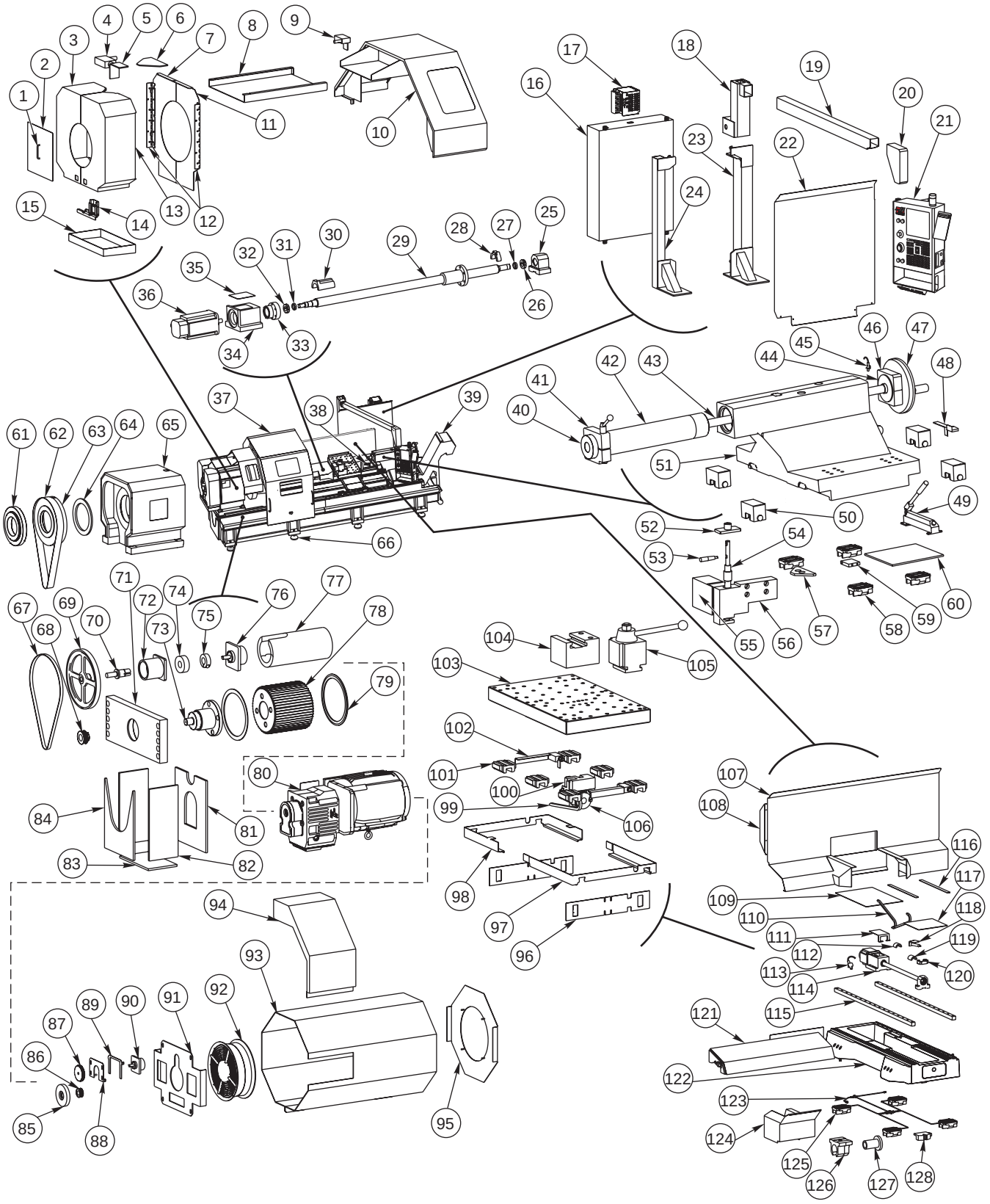
TL 3/3B/3W Parts List

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 Hnge 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
85.	30-4910A	Air/Reg Lube Assy
86.	20-3247	TL-3B/3W Z Handle Retainer, Extended
87.	20-1930A	TL-3 Hand Wheel
	20-1932A	TL-3B/3W Hand Wheel
88.	20-4442	TL-3/3B Bearing Housing
89.	51-2012	TL-3/3B Bearing Locknut
90.	20-3257A	TL-3B/3W Cover X Ball Screw Front
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
125.	59-0870A	TL-3B/3W Sound Foam Mtr Mount Front
126.	59-0869A	TL-3B/3W Sound Foam Mtr Mount Bottom
127.	59-0868A	TL-3B/3W Sound Foam Mtr Mount L/R
128.	25-7310C	TL-3B/3W Motor Shroud
129.	60-1813	TL-3B/3W Encoder 2K M23 Short
130.	30-9211A	TL-3B Gear Box Assembly
	30-8334A	TL-3W Gear Box Assembly
131.	20-3391A	TL-3W Sub Plate Spindle Machining

Toolroom Lathe (TL-4)

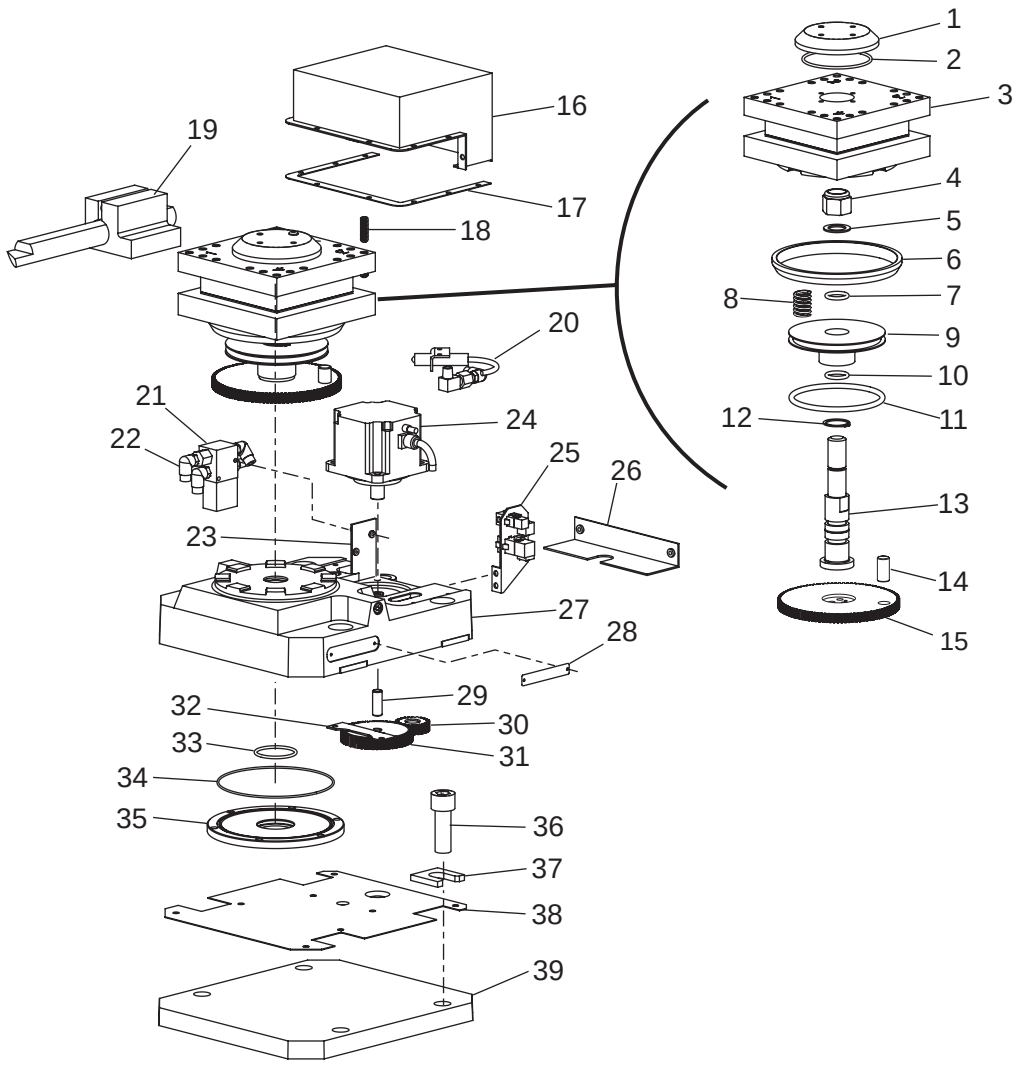


Toolroom Lathe (TL-4) Parts List

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 Lrge
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 Sprkdrv 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

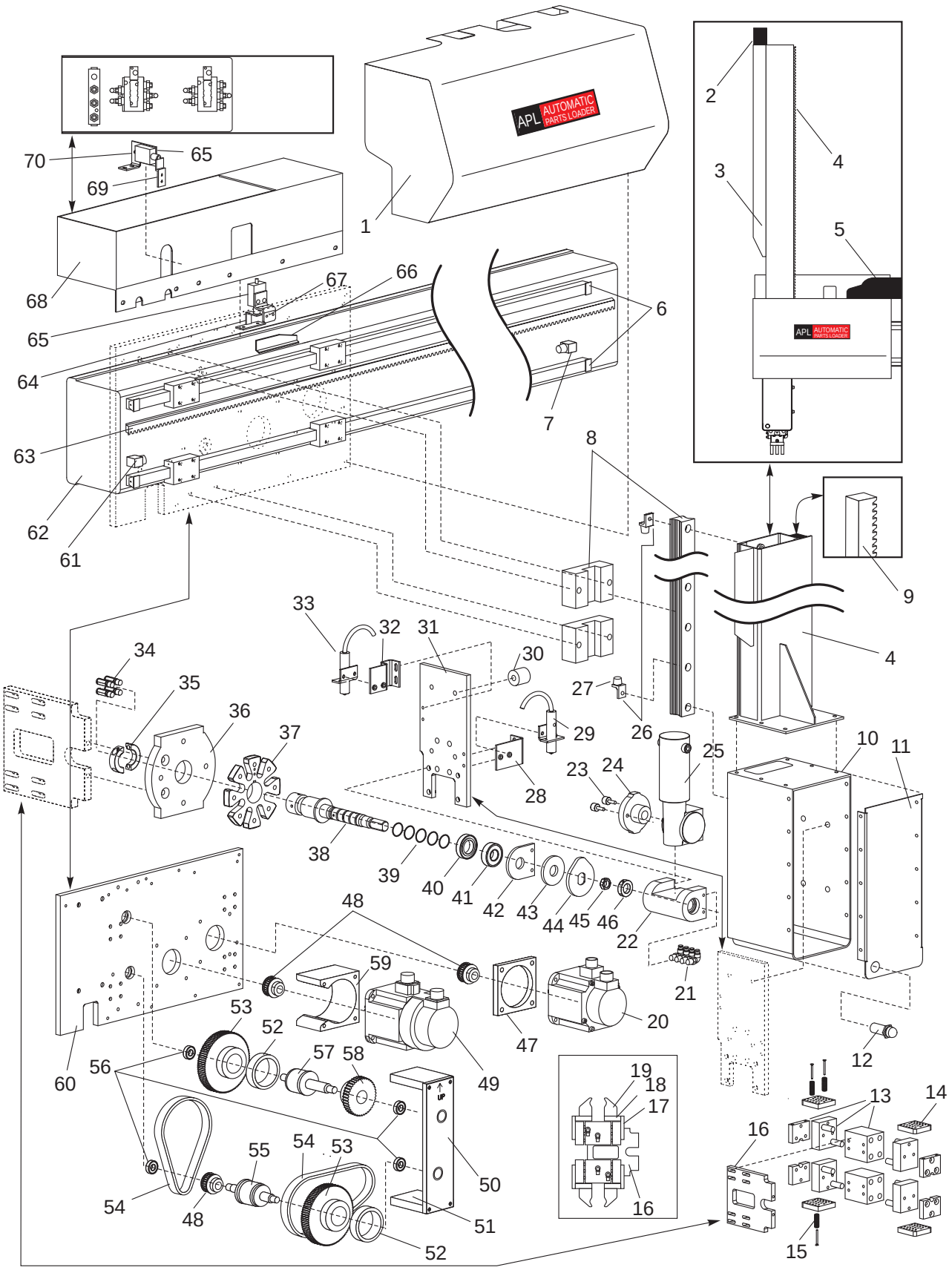
107. 25-8737B Saddle Chip Guard TL-4
108. 25-8738 Cover, X Motor TL-4
109. 25-8716 X BScrew Back Cover TL-4
110. 59-0757 Cbl Carrier KSchlepp Microtrac KSA#0
111. 25-7042 Cover Plate Motor Mnt
112. 28-0198 Bumper Blscrw X-Axis Motor End
113. 32-2240A Sw. Prox. N. C. Mold 19 FT.
114. 30-9698 BScrew Assy 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
2. 57-2747 O-Ring 2-148 Buna
3. 20-4527 Tool Post (TL-1)
   20-10028 Tool Metric (TL-2)
4. 46-1705 Nut 3/4-10 Nylon Lock
5. 45-0031 Washer 3/4 in.
6. 20-4528 Cover Ring
7. 57-0020 O-Ring 2-210 Viton
8. 59-3014 Spring Century D1122
9. 20-4495 Piston Machined
10. 57-0020 O-Ring 2-210 Viton
11. 57-0478 O-Ring 2-342 Buna N
12. 56-0085 Retaining Ring
13. 20-4496 Piston Shaft Machined
14. 48-1662 Dowel Pin 1/2 x 1 in.
15. 20-4525 Piston Gear 100T
16. 25-9761 Motor Cover
17. 57-0477 Motor Cover Gasket
18. 44-0117 (20) SSS 5/16-18 x 1 in. Flat Pt.
19. 20-3032 Tool Changer Holder 1 in. Dia. Bore
20. 69-1600 Proximity Switch NC 3WR 9.5 ft. w/Brkt
21. 32-5671 Turret Up Solenoid Assy
    58-4080 Orifice 1/8 NPT x .040 in.
22. 58-3050 (3) Elbow Fitting 1/4 x NPT 1/8 in. M 90
23. 25-9762 Solenoid Bracket
24. 62-2492 Motor Yaskawa 02 w/o Brake
25. 25-10004 Connectors Bracket
26. 25-9763 Box Cover
27. 20-4493 Tool Turret Housing Machined
28. 29-0606 Name Plate
29. 48-0040 Dowel Pin 3/8 x 1 in.
30. 20-4498 Motor Gear 25T
31. 20-4526 Idler Gear 55T
32. 25-9758 Air Hose Shield
33. 57-0119 O-Ring 2-128 Buna
34. 57-0479 O-Ring 2-047 Buna N
35. 20-4497 Piston Seal Cover
36. 40-0277 (4) SHCS 5/8-11 x 1-3/4 in. (TL-1)
    40-16644 (4) SHCS 5/8-11 x 2-1/2 in. (TL-2)
37. 20-10002 (4) Shim .230 x 5/8 I.D. x 1.50 in.
38. 25-9757 Bottom Cover
39. 20-10001 Riser Plate (TL-2 Only)

Lathe APL



Lathe APL Parts List

1.	25-0704	Carriage Cover
2.	59-0197	Cable Carrier
3.	25-0705	Cable Carrier Mount
4.	25-0703	B-Axis Ram
5.	59-0245	Cable Carrier
6.	50-0008	Linear Guide
7.	20-0739	Hard Stop
8.	50-0009	Linear Guide
9.	20-0749	B-Axis Rack
10.	25-0768A	Rotator Housing
11.	25-0769A	Rotator Cover
12.	87-6535	Light Bulb
	87-6700	Panel Light Fixture
	87-6710	Amber Lens
13.	30-6466	Gripper Assy
14.	20-2299A	Jaw
15.	20-2297	Gripper Finger
16.	20-0747A	Gripper Plate
17.	20-1176	Gripper Flange
18.	20-0747A	Gripper Plate
19.	20-1177	Gripper Jaw
20.	62-0014	Servo Motor
21.	58-16700	Fittings
22.	20-0790	Spindle Bearing Housing
23.	51-0000	Cam Follower
24.	20-0792	Geneva Plate Pin
25.	62-0007	Motor
26.	20-0759	Z-Axis Hard Stop, Lower
27.	59-1056	Bumper Support
28.	25-0716	Bracket, Switch
29.	32-2257	Prox Switch
30.	20-0795	Motor Mounting Spacer
31.	20-0789	Motor Mounting Plate
32.	25-0770	Switch Counter Bracket
33.	32-2256	Prox Switch
34.	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
46.	51-0081	Collar Clamp
47.	20-0743	A-Axis Motor Spacer
48.	20-4519	Drive Pulley
49.	62-0009	Servo Motor
50.	20-0744	Bearing Support
51.	20-0745	Bearing Spacer
52.	20-4264	Lock Ring
53.	20-4509	Driven Pullet
54.	54-0218	Belt
55.	20-0758	Idler Shaft
56.	51-4000	Radial Bearing
57.	20-0741	Drive Shaft
58.	20-5164	Pinion
59.	20-0742	W-Axis Spacer
60.	20-0740	Carriage Plate
61.	20-0739	Hard Stop
62.	25-0693	Beam
63.	20-0738	Horizontal Rack
64.	25-0082	Switch Bracket
65.	32-2130	Home Switch 1.5FT NC
66.	25-7459	Trip Bracket
67.	25-6826	Home Bracket
68.	25-0696	Cable Junction
69.	20-0467	Trip Block
70.	25-0714	Limit Switch Bracket

VF BRUSHLESS SYSTEM
CABLE INTERCONNECT DIAGRAM

3 PHASE INCOMING POWER TO HAAS CNC 195–260 VAC/(354–488 VAC)

TOOL CHANGER
T.C. STATUS
CAROUSEL MTR
TURRET MTR
ATC STATUS
PKT U/D SOL
820
470
810A
220
810

OPERATOR PENDANT
INV OUT IN
ON/OFF
E–STOP
AUTO DOOR
FEED/HLD
700A
JOG
WRK LIGHT SW
2ND HOME BUTTON (OPTION)
MEMORY LOCK (OPTION)
USB CABLE
BEACON
BEEP
SKBIF
J13 J10 J16
J23
J21
P9
P10
850
J18/P1
J5 J6 J20
C–RJH

CB1
K1
74, 75, 76
AUX/COIL
TO MCDI (P2)
71,72,73
T5
XFORMR
860
LOW PSUP
POWER FAIL J3 J1 J2
SERVO FAN
P26 P1 P2 P8 P35 P25 P24
SKBIF PROC FAN 115V
MCD1 TO K1 TO T5
P5/SW DOOR FAN
P6/SRVO FAN
P36
P27/IOPCB
P28/MOTIF
90B
90B
860
860
POWER SUPPLY PCB VER "L"
P23 AUTO OFF CONTACTOR 170
P22 ON/OFF 740
P1 115V IN 94,95,96
P33
3PH TO IOPCB 115V P19 P17 P16 P7
COOLANT TSC P20
CHIP C 230V P21
P10 230V IN
90 90C 93C 160 77,78,79

520
510
530
550
540
TC CW/CCW
TC IN/OUT
GFCI
AIR BLAST SOL
PROBE (OPTION)
M FUNC (USER)
Z–AXIS BRAKE

IOPCB VER."AC"
M21 M22 M23 M24 M25
P66 P60 P59
860A +5/+12V DGND
810 TC MTRS
P69
P78/P79
P77
P83
P82
P62
P57
P56/90
P55/880A
P54/880B
P53/880C
P50/130
P46/390
P45/940A
P44/930
P43/940
P42/170
P41/300A
P40/300
P39/160
P36A
230 250 270 260 200 280 140
P31 P32 P33 P34 P35 P36 P37 P38
540A 540 P62 P61
520 P64
550 P63
530 P70
510 P65

N/A 140B/P1
N/A 820B/P2
T.C STAT 820/P3
LOW TSC 900/P4
E–STOP 770/P5
C BAL 770A/P6
2ND E–STOP 770B/P7
DOOR 1050/P8
M–FIN 100/P10
OVERVOLT 970/P11
LO AIR/OIL 950/P12
LO LUBE 960/P13
OVERH 830/P14
SP HD STAT 890/P15
N/A 780/P16
N/A 410/P17
N/A 790/P18
REM UNCLMP–A 190/P19
N/A 240/P21
SKIP 1070/P22
ATC STATUS 470/P27
N/A 480/P28
CE DOOR LOCK–B 1040/P30

LOW TSC
C BAL
DOOR
LOW AIR LOW OIL
LOW LUBE OIL
LOW LUBE PRESS
REMOTE UNCLAMP SP
CE DOOR LOCK (OPTION)

SMTC RESISTOR 115V 3PH
SMTC RES
SP HD SOLENOIDS
GB I/F
DELTA WYE
4TH BRAKE
TSC PUMP OPTION
4TH AXIS BRAKE
TSC COOL
COOLANT/TSC 230 VIN
COOLANT
AUTO OFF
SP FAN
LUBE OIL PUMP
230V AC 3PH
CLNT PUMP
LUBE OIL PUMP
SOL PWR
140 CHIP
HIL
WORK LIGHT
PURGE TSC
CHIP CONV MTR
AIR TOOL SOL
5TH AXIS BRAKE
SPIGOT
SPIGOT MTR
270
200
890 SP HD
880A SP SOLENOID

COOLANT LEVEL GUAGE

MAINCON BOARD
550 P10 510 P11 530 P13
520 P12 540 P14
P22 P17 P26
1000 SP ENC
X ENC 660
Y ENC 670
Z ENC 680
A ENC 690
B ENC 690B
1000 SP ENC P20
X 660 P6
Y 670 P7
Z 680 P8
A 690 P9
B 690B P30
C 640C P33
B 640B P32
A 640 P5
Z 630 P4
Y 620 P3
X 610 P2
J8
J4/J7 J10
J6
J19
ADDRESS DATA
P19 P1
550 640C 520 510 540 530
C 640C
B 640B
A 640A
Z 630
Y 620
X 610
ENET CBL
RS-232 IN/OUT

MOCON BOARD II
550 P10 510 P11 530 P13
520 P12 540 P14
750 JOG P18
P17 720 P16
1000 SP ENC P20 E–STOP P34
X 660 P6 C 640C P33
Y 670 P7 B 640B P32
Z 680 P8 A 640 P5
A 690 P9 Z 630 P4
B 690B P30 Y 620 P3
X 610 P2
ADDRESS DATA
C 690C P31 P19 P1 860 J6
AD
AD 640B

CHIP CONV MTR
QUAD CHIP CCA
P7 P6
P8/P9 P2/P3
P1 P5/P9 P4/P9

HAAS VECTOR DRIVE
J1 970
J3 C 640C
640C
REGEN RES 325DC
INPUT 230V3ø GRND
OUTPUT TO MOTOR
R + – øA øB øC
BRWN BLK RED 79L 78L2 77L3 GND 651U 652V 653W
REG. RES. P PR
1030 REGEN SP DRIVE
PRE CHARGE
LO–HI GEAR
CLMP UNCL
HIG/LOG STATUS
SPINDLE TRANSMISSION
650 SP MTR
SPDL MTR
SP FAN
150° OVERHEAT
ENCODER

TRANS/HYD PCB
TB2
TB3
P2 90
P1 880B
P6 350
P4 350
P3 410
P5 350A
BLOWR PWR
300A SP OIL/FAN

K4 CONTACTOR
K5 CONTACTOR
880C
650B
325 VDC
650A

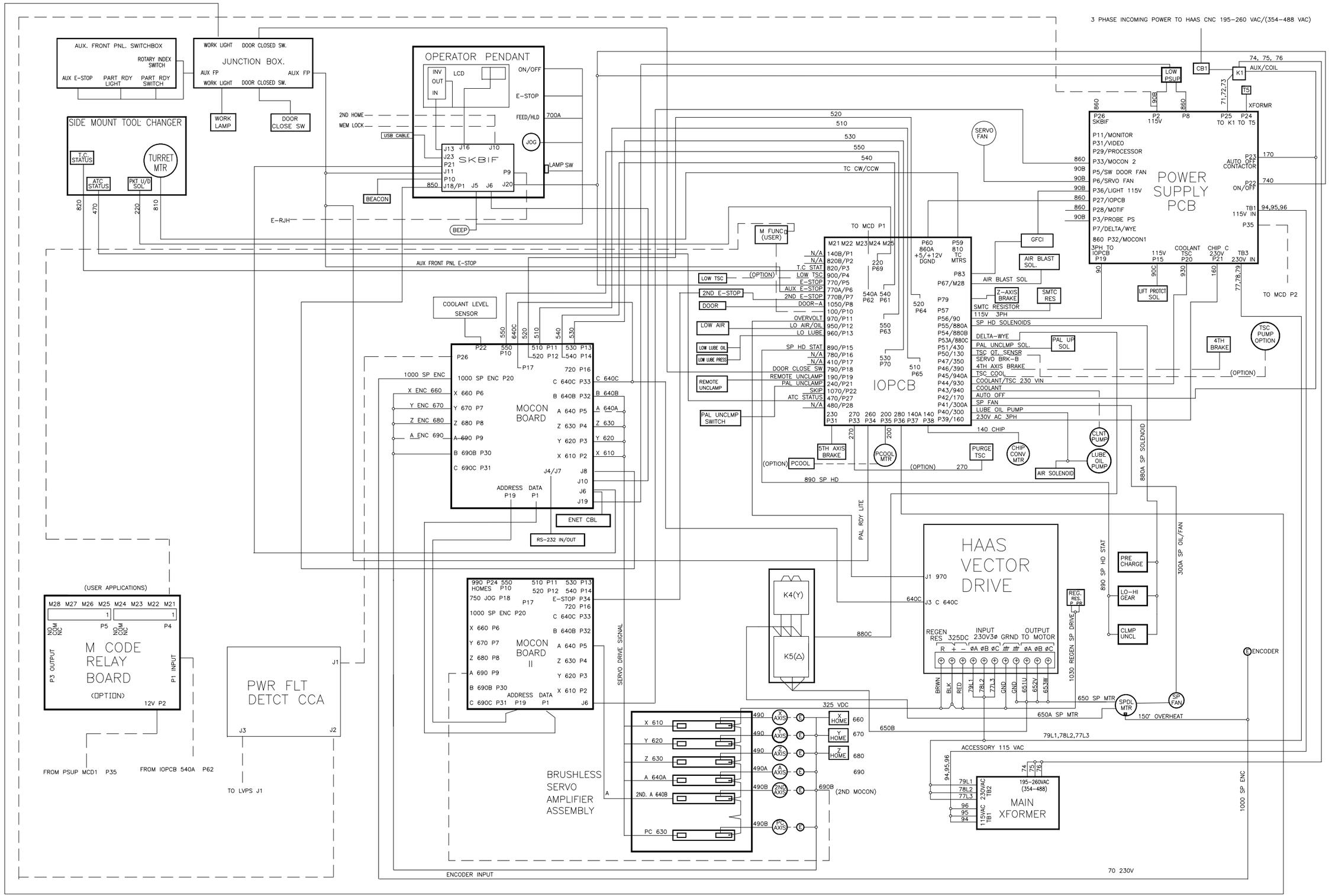
DELTA/WYE
BRUSHLESS SERVO AMPLIFIER ASSEMBLY
SERVO DRIVE SIGNAL
X 610
Y 620
Z 630
A 640A
B 640B
AD
490 X AXIS E
490 Y AXIS E
490 Z AXIS E
490A A AXIS E
490B B AXIS E
490 P AXIS E
X HOME
Y HOME
Z HOME
A HOME (OPTIONAL)
B HOME (OPTIONAL)

(OPTION)
MOTOR INTERFACE BOARD
X P6
Y P7
Z P8
A P9
P15 TO PSUP (P28) 860
ADDRESS BUS
DATA BUS
TO LINEAR XYZ GLASS SCALE ASSEMBLIES
ENCODER INPUT

(USER APPLICATIONS)
M CODE RELAY BOARD
(OPTION)
M28 M27 M26 M25 M24 M23 M22 M21
NO COM NO2 COM P5 COM NO2 P4
P3 OUTPUT
P1 INPUT
12V P2
FROM PSUP MCD1 P35
FROM IOPCB 540A P62

ACCESSORY 115 VAC
94,95,96
74 75 76
79L1 78L2 77L3 230VAC TB2
96 95 94 115VAC TB1
195–260VAC (354–488)
MAIN XFORMER
70 230V
79L1,78L2,77L3
1000 SP ENC
77,78

VF BRUSH SYSTEM CABLE
CABLE INTERCONNECT DIAGRAM



MDC-500 BRUSHLESS SYSTEM
CABLE INTERCONNECT DIAGRAM

THREE/SINGLE PHASE INCOMING POWER TO HAAS CNC

CB1 — K1 — 74, 75, 76 AUX/COIL — 71,72,73 — T5 XFORMR

OPERATOR PENDANT
INV OUT IN — LCD — ON/OFF — E-STOP — FEED/HLD — JOG
SKBIF: J13 J10 J16 J23 J21 P9 P10 P6 J18/P1 AUX J5 J20 J6
USB CABLE
2ND HOME BUTTON (OPTION)
MEMORY LOCK (OPTION)
BEACON
BEEP
RGH-C

TOOL CHANGER
T.C. STATUS — SHTL MTR — TURRET MTR
820 — 810A — 810

520 — 510 — 530 — 550 — 540 — TC CW/CCW — TC IN/OUT

POWER FAIL J3 J1 J2 — SERVO FAN — LOW PSUP — GFCI

POWER SUPPLY PCB
P26 SKBIF — P1 PROC FAN — P29 PROC VIDEO — P31 VIDEO — P32 MOCN1 — P25 TO K1 TO T5 — P24 TO T5
P8 LOW VOLT — P2/115V — P5/SW DOOR FAN — P6/SRVO FAN — P36/LIGHT 115V — P27/IOPCB — P28/MOTIF — P3/PROBE PS — P34/MCD2 — P33/MOCON2
P35 MCD1 — P23 AUTO OFF CONTACTOR — P22 ON/OFF — P1 115V IN — P13 115V
3PH TO IOPCB P19 — 115V P11 — DELTA WYE P7 — 115V P12 — 115V P14 — COOLANT TSC P20 — CHIP C 230V P21 — P10 230V IN

1070 SKIP (OPTION) — (COMMON) M22 — M FUNC (USER) — PROBE PWR SUP (OPTION) — 24VDC

IOPCB
M21 M22 M23 M24 M25
140B/P1 N/A
820B/P2
820/P3 T.C STAT
900/P4 N/A
770/P5 E-STOP-A
770A/P6 E-STOP-B
770B/P7 E-STOP-C
1050/P8 DOOR-A
100/P10 M-FIN
970/P11 OVERVOLT
950/P12 LO AIR/OIL
960/P13 LO LUBE
830/P14 N/A
890/P15 SP HD STAT
780/P16 N/A
410/P17 N/A
790/P18 N/A
190/P19 REM UNCLMP-A
240/P21 N/A
1070/P22 SKIP
480/P28 N/A
1040/P30 CE DOOR LOCK-B
230 250 270 260 200 280 140A 140 P31 P32 P33 P34 P35 P36 P37 P38
540A P62 — 540 P61 — 550 P63 — 530 P70 — 510 P65 — 520 P64
P60 860A +5/+12V DGND — P59 810 TC MTRS — P77 — P76 — P71 — P68 — P79
P56/90 — P55/880A — P54/880B — P53/880C — P52/710 — P47/350 — P46/390 — P45/940A — P44/930 — P43/940 — P42/170 — P41/300A — P40/300 — P39/160
115V 3PH — SP HD SOLENOIDS — N/A — N/A — N/A — 4TH AXIS BRAKE — TSC COOL — COOLANT/TSC 230 VIN — COOLANT — AUTO OFF — SP FAN — SP AIR SOL — N/A

DOOR — LOW AIR — LOW SPNDL OIL
CE DOOR LOCK (OPTION)
WIPS PROBE IF — GREASE SOL PWR — LOW GREASE — OIL INJCTR SOL — Z-AXIS BRAKE — 4TH BRAKE — SPNDL AIR SOL — (OPTION) CLNT PUMP
SPIGOT — (OPTION) — SPIGOT MTR — CHIP CONV MOTOR
890 SP HD

MAINCON BOARD
550 P10 — 640C — 520 — 510 P11 — 520 P12 — 540 — 530 P13 — 540 P14 — P17 — P26
1000 SP ENC — 1000 SP ENC P20
X ENC 660 — X 660 P6
Y ENC 670 — Y 670 P7
Z ENC 680 — Z 680 P8
A ENC 690 — A 690 P9
B 690B P30
C 690C P31
C 640C P33 — B 640B P32 — A 640 P5 — Z 630 P4 — Y 620 P3 — X 610 P2
A 640A — Z 630 — Y 620 — X 610
J8 — J10 — J4/J7 — J6 — J19
ADDRESS P19 — DATA P1
860
ENET CBL
RS-232 IN/OUT

REG. RES. P PR — J6 J8 J7 J5 J4 J3
HAAS 320V POWER SUPPLY — J2 J1

890 SP HD STAT — LO-HI GEAR — CLMP UNCL — SPIN LOCK — 880A SP SOLENOID — 300A SP OIL/FAN

OIL PUMP — 650 SP MTR — SPDL MTR — SP FAN — 150° OVERHEAT — ENCODER

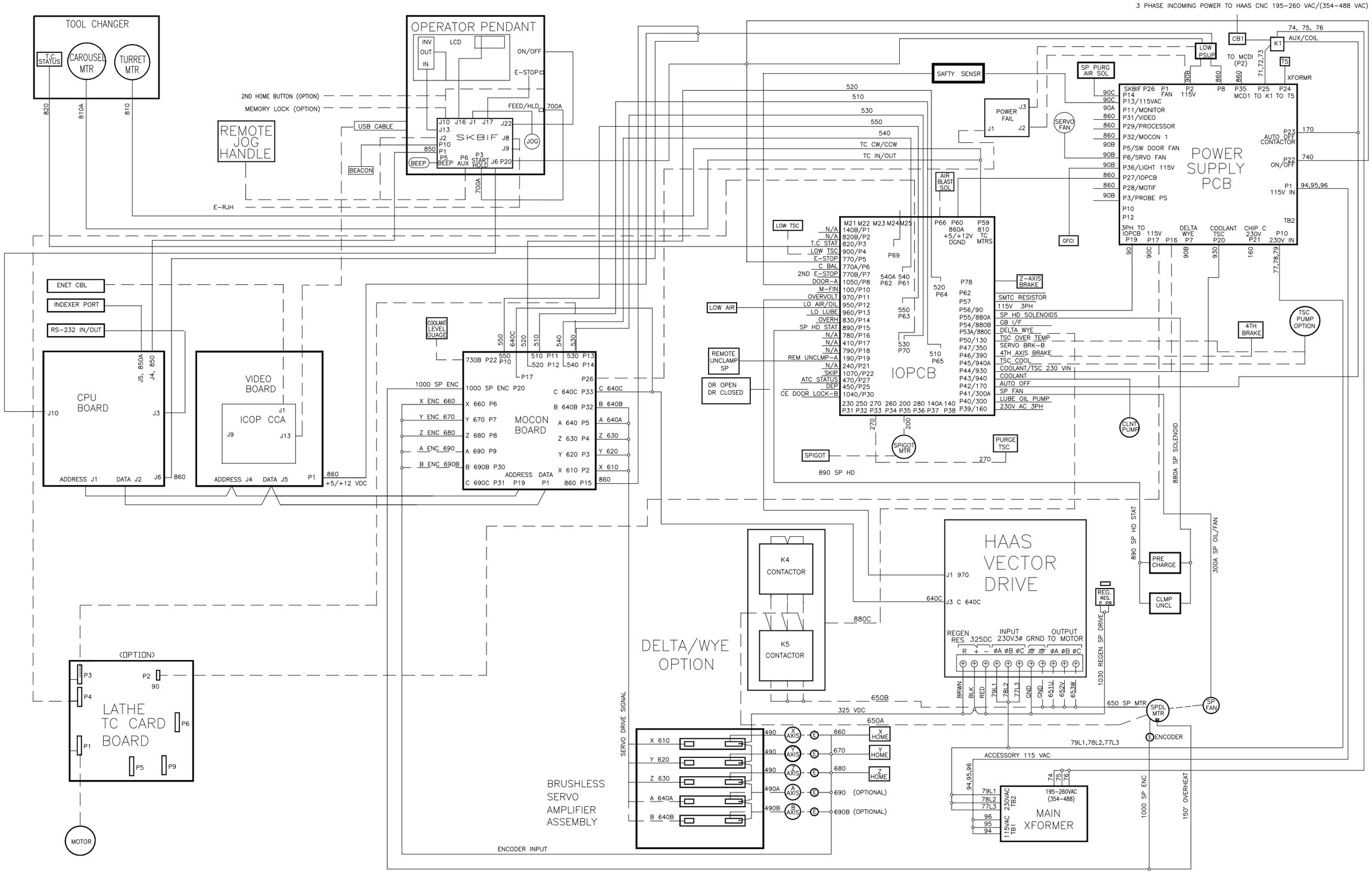
(USER APPLICATIONS)
M CODE RELAY BOARD (OPTION)
M28 M27 M26 M25 M24 M23 M22 M21
P5 — P4
NO NOM NC
P3 OUTPUT — P1 INPUT
12V P2
FROM IOPCB 540A P62
FROM PSUP MCD1 P35

SERVO DRIVE SIGNAL
BRUSHLESS SERVO AMPLIFIER ASSEMBLY
X 610 — Y 620 — Z 630 — C 640C — A 640A
490 — X AXIS — E — 660 X HOME
490 — Y AXIS — E — 670 Y HOME
490 — Z AXIS — E — 680 Z HOME
SPINDLE DRIVE
490A — A AXIS — E — 690 A HOME (OPTIONAL)
ENCODER INPUT

74/75/76 — 94,95 — 74 — 76 — 210-240VAC (366-425VAC) — 115VAC — 95 — 94 — MAIN XFORMER
1000 SP ENC

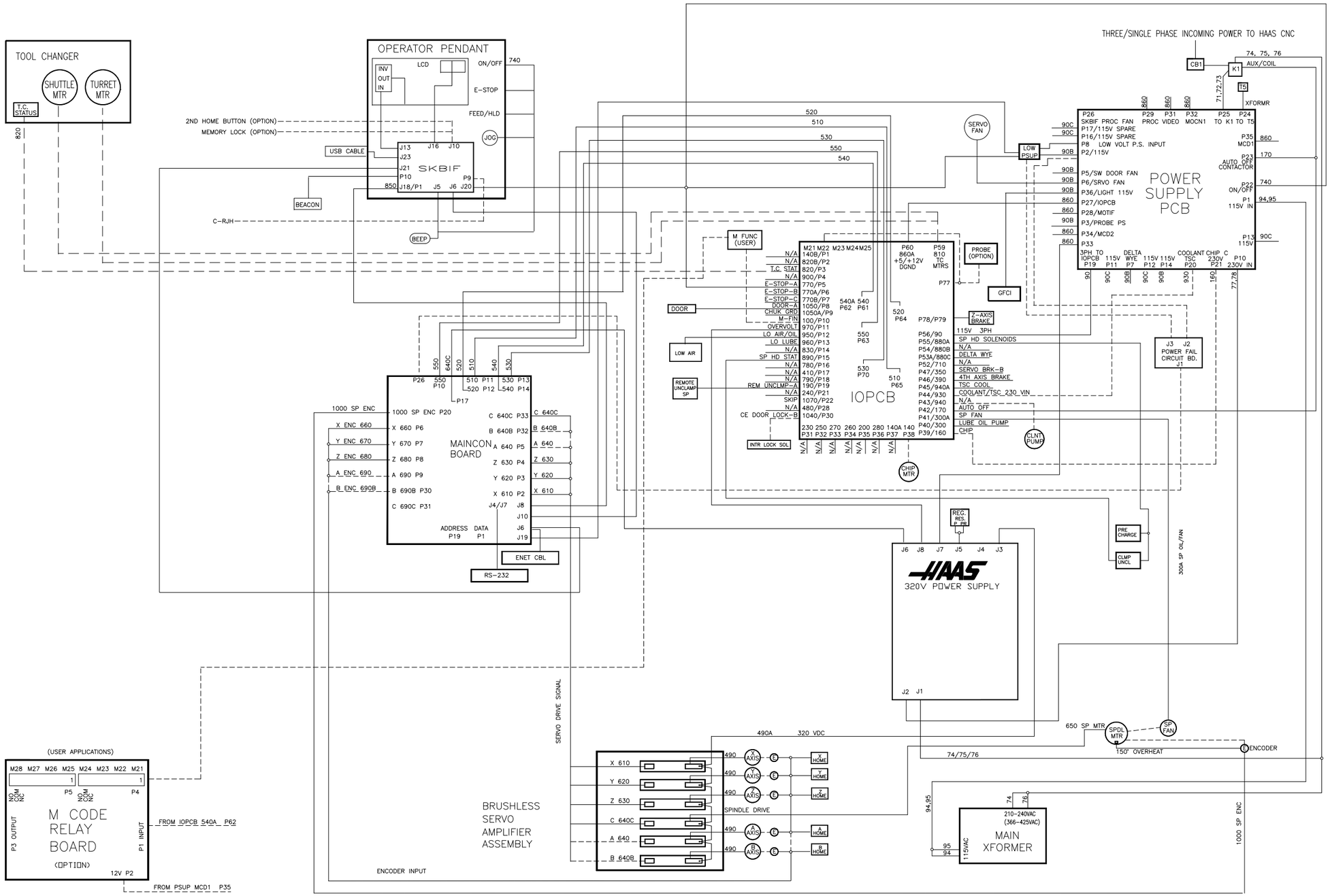
⚠ P9, P20, P23, P24, P25, P26, P27, P29, P48, P49, P50, P51, P57, P58, P66, P67,, P69 NOT SHOWN.

MINI-MILL BRUSHLESS SYSTEM CABLE INTERCONNECT DIAGRAM

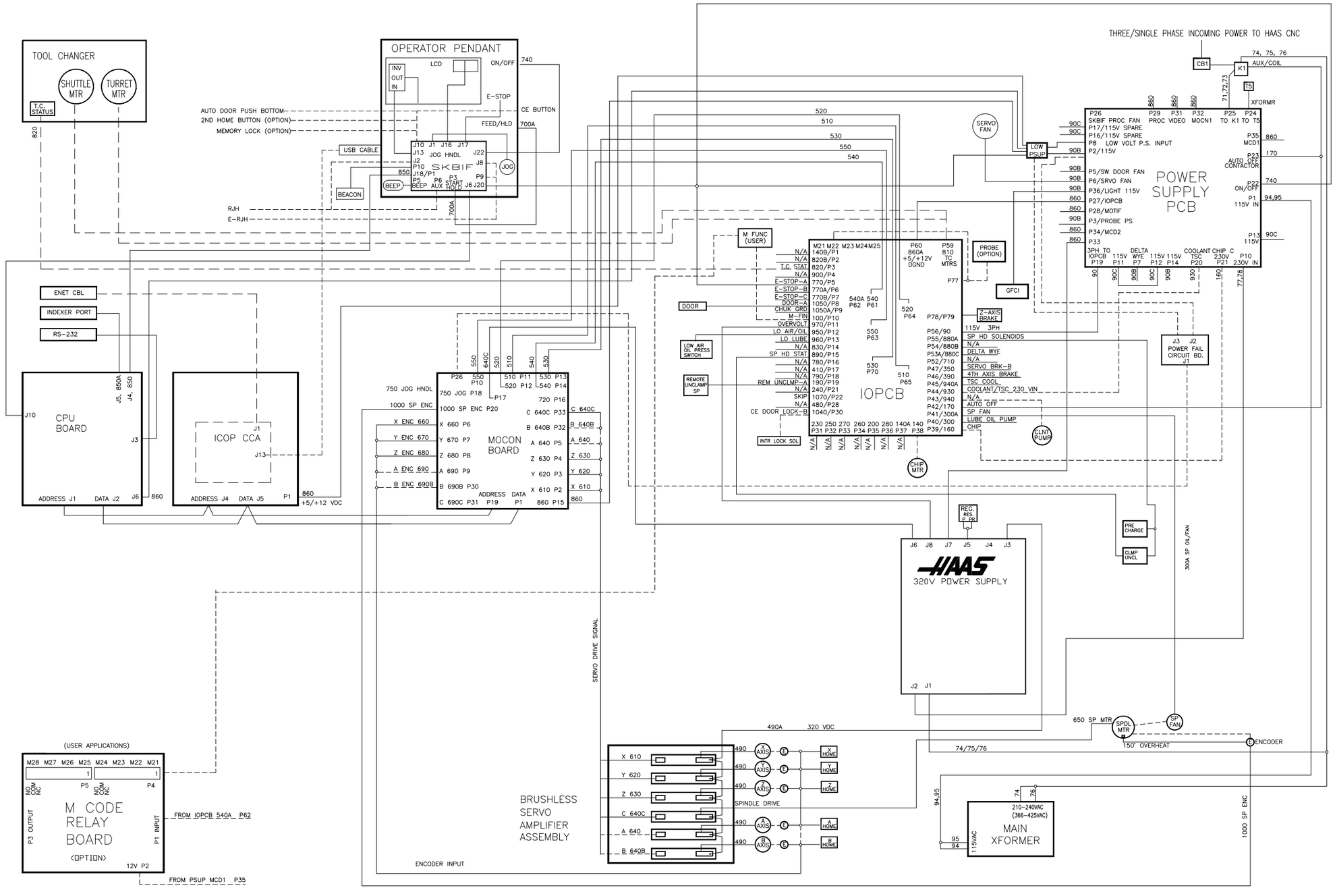


GR BRUSHLESS SYSTEM

CABLE INTERCONNECT DIAGRAM



TM-1/2/3,CABLE INTERCONNECT DIAGRAM



TM–3, AND TM–3P CABLE INTERCONNECT DIAGRAM

OM–1, AND OM–2 CABLE INTERCONNECT DIAGRAM

THREE/SINGLE PHASE INCOMING POWER TO HAAS CNC

TERM BLOCK · CB1 · K1 AUX/COIL · T5 XFORMR · 71,72,73

OPERATOR PENDANT
INV · OUT · IN · LCD · ON/OFF · E–STOP · FEED/HLD · JOG · WRK LIGHT
2ND HOME BUTTON · MEMORY LOCK · USB CABLE · BEACON · BEEP · RJH–C
SKBIF P9: J13 J16 J10 · J23 · J21 · P10 · J18/P1 J5 J6 J20

520 · 510 · 530 · 550 · 540 · TC CW/CCW · TC IN/OUT

SERVO FAN · LOW PSUP · 860

POWER SUPPLY PCB VER "K"
P18/115V P30 · P17/115V SPARE · P16/115V SPARE · P15/115V SPARE · P2/115V · P8 LOW VOLT P.S. INPUT · P5/SW SERVO FAN · P6/SRVO FAN · P4/LIGHT 115V · P27/IOPCB · P28/MOTIF · P3/PROBE PS · P36 · P33/MOCON2
P25 P24 TO K1 TO T5 · P35 860A · P23 AUTO OFF CONTACTOR 170 · P22 ON/OFF 740 · P1 115V INPUT 115 V · P10 230V IN · P13 115V 90C
3PH TO IOPCB P19 · 115V P11 · DELTA WYE P7 · 115V P12 · 115V P14 · COOLANT TSC P20 · CHIP C 230V P21
90 · 90A · 90A · 90C · 90C · 930 · 160

GFCI

IOPCB VER."U"
M21 M22 M23 M24 M25 · P60 860A +5/+12V DGND · P59 810 TC MTRS · P83 · P78/P79 · P64 · P63 · P65 · P70
N/A · 140B/P1 · 820B/P2 · T.C STAT 820/P3 · N/A 900/P4 · E–STOP–A 770/P5 · E–STOP–B 770A/P6 · E–STOP–C 770B/P7 · DOOR–A 1050/P8 · CHUK GRD 1050A/P9 · M–FIN 100/P10 · OVERVOLT 970/P11 · LO AIR/OIL 950/P12 · LO LUBE 960/P13 · N/A 830/P14 · SP HD STAT 890/P15 · SPINDLE DR. STAT 780/P16 · N/A 410/P17 · N/A 790/P18 · REM UNCLMP–A 190/P19 · N/A 240/P21 · SKIP 1070/P22 · N/A 480/P28 · CE DOOR LOCK–B 1040/P30
540A 540 P62 P61 · 520 P64 · 550 P63 · 530 P70 · 510 P65
230 250 270 260 200 280 140A 140 P31 P32 P33 P34 P35 P36 P37 P38
P56/90 · P55/880A · P54/880B · P53/880C · P52/710 · P51/710 · P49/350 · P45/940A · P44/930 · P43/940 · P42/170 · P41/300A · P40/300 · P39/160
115V 3PH · SP HD SOLENOIDS · N/A · DELTA WYE · REV · FWD · SERVO BRK–B · 4TH AXIS BRAKE · TSC COOL · COOLANT/TSC 230 VIN · COOLANT · AUTO OFF · SP FAN · LUBE OIL PUMP · N/A
DOOR · LOW AIR OIL PRESS SWITCH · Z–AXIS BRAKE · WORK LIGHT · CLNT PUMP

MAINCON BOARD
550 640C 520 510 540 530 · 550 P10 · 510 P11 · 520 P12 · 530 P13 · 540 P14 · P17
1000 SP ENC · X ENC 660 · Y ENC 670 · Z ENC 680 · A ENC 690 · B ENC 690B
1000 SP ENC P20 · X 660 P6 · Y 670 P7 · Z 680 P8 · A 690 P9 · B 690B P30 · C 690C P31
720 P16 · C 640C P33 · B 640B P32 · A 640 P5 · Z 630 P4 · Y 620 P3 · X 610 P2 · J8 · J10 · J6 · J19 · J4/J7
B 640B · A 640 · Z 630 · Y 620 · X 610
ADDRESS DATA P19 P1
ENET CBL · RS–232 IN/OUT

REG. RES.

320V POWER SUPPLY
MADE IN USA
P2 · P8 · P5 · P6 · P4 · P3 · P1 · P7

POWER SPLY · K2 · K3 · CN2
ASTRO SPINDLE MOTOR CONTROLER

(USER APPLICATIONS)
M28 M27 M26 M25 M24 M23 M22 M21 · P5 · P4
NO COM NC · NO COM NC
M CODE RELAY BOARD (OPTION)
P3 OUTPUT · P1 INPUT · 12V P2
FROM IOPCB 540A P62 · FROM PSUP MCD1 P35

SERVO DRIVE SIGNAL

BRUSHLESS SERVO AMPLIFIER ASSEMBLY
860 · X HOME 991 · Y HOME 992 · Z HOME 993
X 610 · Y 620 · Z 630 · A 640C · B 640C
490 · X AXIS · Y AXIS · Z AXIS · A AXIS · B AXIS · E
660 · 680

ENCODER INPUT

SPDL MTR

240 VAC · 210–240VAC (366–425VAC) · 74 · 76 · 115VAC
MAIN XFORMER

THREE/SINGLE PHASE INCOMING POWER TO HAAS CNC

TOOL CHANGER
SHUTTLE MTR
TURRET MTR
T.C. STATUS
820

OPERATOR PENDANT
INV
OUT
IN
ON/OFF
E-STOP
FEED/HLD
JOG
WRK LIGHT
USB CABLE
J13
J16
J23
J21
SKBIF P9
P10
J18/P1
J5
J6
J20
BEACON
BEEP
C-RJH

520
510
530
550
540
TC CW/CCW
TC IN/OUT

TERM BLOCK
CB1
K1
AUX/COIL
71,72,73
T5
XFORMR
860
92A
860
860
P26 P1 P31 P32 P25 P24
SKBIF PROC FAN
P17/115V SPARE
P16/115V SPARE
P2/115V
P8 LOW VOLT P.S. INPUT
P5/SW SERVO FAN
P6/SRVO FAN
P4/LIGHT 115V
P27/IOPCB
P28/MOTIF
P3/PROBE PS
P36
P33/MOCON2
P35 MCD1
P23 AUTO OFF CONTACTOR
P22 ON/OFF
P1 115V IN
P13 115V
3PH TO IOPCB P19
115V P11
DELTA WYE P7
115V P12
115V P14
COOLANT CHIP C TSC P20
230V P21
P10 230V IN
90
90A
90B
90C
90B
930
N/A 160
77,78
90C
860
860
860
860
90B
90B
90B
90B
92A
860
SERVO FAN
LOW PSUP
GFCI
POWER SUPPLY PCB

M21 M22 M23 M24 M25
N/A 140B/P1
N/A 820B/P2
T.C STAT 820/P3
N/A 900/P4
E-STOP-A 770/P5
E-STOP-B 770A/P6
E-STOP-C 770B/P7
DOOR-A 1050/P8
CHUK GRD 1050A/P9
M-FIN 100/P10
OVERVOLT 970/P11
LO AIR/OIL 950/P12
LO LUBE 960/P13
N/A 830/P14
SP HD STAT 890/P15
SPINDLE DR. STAT 780/P16
N/A 410/P17
N/A 790/P18
REM UNCLMP-A 190/P19
N/A 240/P21
SKIP 1070/P22
N/A 480/P28
CE DOOR LOCK-B 1040/P30
230 250 270 260 200 280 140A 140
P31 P32 P33 P34 P35 P36 P37 P38
540A P62
540 P61
550 P63
530 P70
510 P65
520 P64
P60 860A +5/+12V DGND
P59 810 TC MTRS
P83
P78/P79
P76/1160
P71/500
P56/90
P55/880A
P54/880B
P53A/880C
P52/710
P51/710
P49/350
P46/390
P45/940A
P44/930
P43/940
P42/170
P41/300A
P40/300
P39/160
DOOR
LOW AIR OIL PRESS SWITCH
Z-AXIS BRAKE
GREASE GUN SOL
LOW GREASE SENSOR
115V 3PH
SP HD SOLENOIDS
N/A
DELTA WYE
SERVO BRK-B
4TH AXIS BRAKE
TSC COOL
COOLANT/TSC 230 VIN
COOLANT
AUTO OFF
SP FAN
LUBE OIL PUMP
N/A
IOPCB
WORK LIGHT
CLNT PUMP

N/A 550 640C 520 510 540 530
990 P24 550 510 P11 530 P13
HOMES P10 520 P12 540 P14
750 JOG P18 P17 720 P16
1000 SP ENC
X ENC 660
Y ENC 670
Z ENC 680
A ENC 690
B ENC 690B
1000 SP ENC P20
X 660 P6
Y 670 P7
Z 680 P8
A 690 P9
B 690B P30
C 690C P31
MOCON BOARD
C 640C P33
B 640B P32
A 640 P5
Z 630 P4
Y 620 P3
X 610 P2
J4/J7
J8
J10
J6
J19
ADDRESS P19
DATA P1
C 640C
B 640B
A 640
Z 630
Y 620
X 610
ENET CBL
RS-232 IN/OUT

K4 CONTACTOR
K5 CONTACTOR
REG. RES.
P2
P8
P5
P6
P4
HAAS 320V POWER SUPPLY
MADE IN USA
P3
P1
P7
PRE CHARGE
CLMP UNCL
300A SP OIL/FAN

(USER APPLICATIONS)
M28 M27 M26 M25 M24 M23 M22 M21
1
1
P5
P4
NO COM NC
NO COM NC
M CODE RELAY BOARD
(OPTION)
P3 OUTPUT
P1 INPUT
12V P2
FROM IOPCB 540A P62
FROM PSUP MCD1 P35

860
SERVO DRIVE SIGNAL
X 610
Y 620
Z 630
A 640C
B 640C
C 640C
490
X AXIS
Y AXIS
Z AXIS
A AXIS
B AXIS
E
680
X HOME
Y HOME
Z HOME
A HOME
B HOME
SPINDLE DRIVE
BRUSHLESS SERVO AMPLIFIER ASSEMBLY
ENCODER INPUT

SPDL MTR
SP FAN
150° OVERHEAT
ENCODER
240 VAC
210-240VAC (366-425VAC)
74
76
115VAC
MAIN XFORMER
1000 SP ENC

OM-1, AND OM-2 CABLE INTERCONNECT DIAGRAM

SR–100/200 SYSTEM CABLE INTERCONNECT DIAGRAM

THREE/SINGLE PHASE INCOMING POWER TO HAAS CNC

CB1 — K1 — 74, 75, 76 AUX/COIL — 71,72,73 — T5 XFORMR

OPERATOR PENDANT
INV OUT IN — LCD — ON/OFF — E–STOP — CE BUTTON — FEED/HLD — 700A
2ND HOME BUTTON (OPTION)
MEMORY LOCK (OPTION)
USB CABLE
J10 J1 J16 J17 J13 J22 J2 SKBIF J8 J18/P1 P9 P10 P5 P6 P3 J20
BEEP AUX START HOLD J6 — JOG
850

TOOL CHANGER
T.C STATUS — SHTL MTR — TURRET MTR
820 — 810A — 810

(OPTION) REMOTE JOG HANDLE

BEACON — 700A

E–RJH

520
510
530
550
540
TC CW/CCW
TC IN/OUT

POWER FAIL J1 J2 J3
SERVO FAN
LOW PSUP
GFCI

860 P8 LOW VOLT
90B P2/115V
N/A 90B P5/SW DOOR FAN
90B P6/SRVO FAN
90B P36/LIGHT 115V
860 P27/IOPCB
860 P28/MOTIF
90B P3/PROBE PS
860 P34/MCD2
860 P33/MOCON2

POWER SUPPLY PCB
P29 PROC 860 — P31 VIDEO 860 — P32 MOCN1 860 — P25 TO K1 TO T5 — P24
P35 MCD1 860
P23 AUTO OFF CONTACTOR 170
P22 ON/OFF 740
P1 115V IN 94,95
P10 DOOR FAN 90B
P13 115V 90C
3PH TO IOPCB P19 — 115V WYE P11 — DELTA P7 — 115V P12 — 115V P14 — COOLANT CHIP C P20 — TSC 230V P21 — P10 230V IN
90 — 90C — 90B — 90C — 90B — 930 — N/A 160 — 77,78

M FUNC (USER)

IOPCB
M21 M22 M23 M24 M25
140B/P1 N/A
820B/P2
820/P3 T.C STAT
900/P4 N/A
770/P5 E–STOP–A
770A/P6 E–STOP–B
770B/P7 E–STOP–C
1050/P9 DOOR–A
100/P10 M–FIN
970/P11 OVERVOLT
950/P12 LO AIR/OIL
960/P13 LO LUBE
830/P14 N/A
890/P15 SP HD STAT
780/P16 SP DR. STAT
410/P17 N/A
790/P18 N/A
190/P19
240/P21 N/A
1070/P22 SKIP
480/P28 N/A
1040/P30
230 250 270 260 200 280 140A 140
P31 P32 P33 P34 P35 P36 P37 P38
P60 860A +5/+12V DGND
P59 810 TC MTRS
540A 540 P62 P61
520 P64
550 P63
530 P70
510 P65
P65 — AIR BLAST
P79
P56/90 115V 3PH
P55/880A SP HD SOLENOIDS
P54/880B N/A
P53/880C N/A
P52/710 N/A
P47/350 N/A
P46/390 4TH AXIS BRAKE
P45/940A N/A
P44/930 N/A
P43/940 N/A
P42/170 AUTO OFF
P41/300A N/A
P40/300 N/A
P39/160 N/A

SAFETY SENSOR
LOW AIR
LOW LUBE OIL
TOOL RELEASE SW

4TH BRAKE
5TH BRAKE

ENET CBL
INDEXER PORT
RS–232 IN/OUT

CPU BOARD
J5, 850A — J4, 850
J10 — J3
ADDRESS J1 — DATA J2 — J6 — 860

VIDEO BOARD
ICOP CCA
J1 — J13
ADDRESS J4 — DATA J5 — P1 — +5/+12 VDC

MOCON BOARD
550 P10 — 510 P11 — 520 P12 — 530 P13 — 540 P14
P22 — P16 — P26
X ENC 660 — X 660 P6
Y ENC 670 — Y 670 P7
Z ENC 680 — Z 680 P8
A ENC 690 — A 690 P9
B ENC 690B — B 690B P30
C 640C P33 — B 640B P32 — B 640A
A 640 P5 — A 640
Z 630 P4 — Z 630
Y 620 P3 — Y 620
X 610 P2 — X 610
ADDRESS — DATA P1 — 860 P15 — 860
C 690C P31 — P19

SERVO DRIVE SIGNAL

890 SP HD

I/O INTERFACE
J2 J9 J5 J6 J7 J4 J1 J3 J8

SPINDLE DRIVE.
784 "12"
783 "11"
782 "AL1"
781"CM2"
785"AL0"
1
2
4
731"AM"
721 "0" 722 "L"
RB + T1 T2 T3 GND 5 732 "L"
(OUTPUT) +1 N
(INPUT/OUTPUT) L1 L2 L3
REG. RES. P PR

880A SP SOLENOID

CLMP UNCL

320 VDC

THERMAL SW. — SP FAN — SPDL MTR

BRUSHLESS SERVO AMPLIFIER ASSEMBLY
X 610 — Y 620 — Z 630 — A 630 — B 630
490 — X AXIS — E — 660 — X HOME
490 — Y AXIS — E — 670 — Y HOME
490 — Z AXIS — E — 680 — Z HOME
490 — A AXIS — E — 680 — A HOME
490 — B AXIS — E — B HOME

ENCODER INPUT

94,95
95
94
208 V. 210–240VAC (366–425VAC) (INPUT)
115VAC 240 V. (OUTPUTS)
MAIN XFORMER

3 PHASE INCOMING POWER TO HAAS CNC 195–260 VAC/(354–488 VAC)

TOOL CHANGER
T.C. STATUS
CAROUSEL MTR
TURRET MTR
ATC STATUS
PKT U/D SOL
820
470
810A
220
810

OPERATOR PENDANT
INV
OUT
IN
ON/OFF
E–STOP
FEED/HLD
700A
JOG
WRK LIGHT SW
2ND HOME BUTTON (OPTION)
MEMORY LOCK (OPTION)
USB CABLE
BEACON
BEEP
E–RJH
SKBIF
J13 J10 J16
J23
J21
P9
P10
850
J18/P1 J5 J6 J20

CB1
K1
74, 75, 76
AUX/COIL
TO MCDI (P2)
T5
XFORMR
LOW PSUP
POWER FAIL
J3
J2
J1
860
71,72,73
P26 P1 P2 P8 P35 P25 P24
SKBIF PROC FAN 115V
MCD1 TO K1 TO T5
P23
AUTO OFF CONTACTOR
170
P22
ON/OFF
740
P1
115V IN
94,95,96
TB2
P5/SW DOOR FAN
P6/SRVO FAN
P36
P27/IOPCB
P28/MOTIF
P10
P12
90B
90B
860
860
POWER SUPPLY PCB VER "L"
3PH TO IOPCB 115V
P19 P17 P16 P7
COOLANT TSC
P20
CHIP C 230V
P21 P10 230V IN
90
90C
930
160
77,78,79

SERVO FAN
AIR BLAST SOL
PROBE (OPTION)
SMTC DRIVER
P1 P4
P6 P3
AUTO DOOR MTR
CLUTCH
Z–AXIS BRAKE
SMTC RESISTOR
115V 3PH
SMTC RES
SP HD SOLENOIDS
GB I/F
DELTA WYE
TSC OVER TEMP
4TH AXIS BRAKE
TSC COOL
COOLANT/TSC 230 VIN
COOLANT
AUTO OFF
SP FAN
LUBE OIL PUMP
230V AC 3PH
4TH BRAKE
TSC PUMP OPTION

520
510
530
550
540
TC CW/CCW
TC IN/OUT
GFCI
M FUNC (USER)
LOW TSC
C BAL
DOOR
LOW AIR
LOW GEAR OIL
LOW LUBE OIL
REMOTE UNCLAMP SP

M21 M22 M23 M24 M25
N/A 140B/P1
N/A 820B/P2
T.C STAT 820/P3
LOW TSC 900/P4
E–STOP 770/P5
C BAL 770A/P6
2ND E–STOP 770B/P7
DOOR–A 1050/P8
M–FIN 100/P10
OVERVOLT 970/P11
LO AIR/OIL 950/P12
LO LUBE 960/P13
OVERH 830/P14
SP HD STAT 890/P15
N/A 780/P16
N/A 410/P17
N/A 790/P18
REM UNCLAMP–A 190/P19
N/A 240/P21
SKIP 1070/P22
ATC STATUS 470/P27
N/A 480/P28
CE DOOR LOCK–B 1040/P30
230 250 270 260 200 280 140A 140
P31 P32 P33 P34 P35 P36 P37 P38
P69
540A 540
P62 P61
550
P63
530
P70
510
P65
IOPCB VER."AC"
P66 P60 P59
860A 810
+5/+12V TC
DGND MTRS
520
P64
P82
P78/P79
P77
P83
P82
P62
P57
P56/90
P55/880A
P54/880B
P53/880C
P50/130
P46/390
P45/940A
P44/930
P43/940
P42/170
P41/300A
P40/300
P39/160
140 CHIP
270
200
CE DOOR LOCK (OPTION)
5TH AXIS BRAKE
SPIGOT
SPIGOT MTR
PURGE TSC
CHIP CONV MTR
CLNT PUMP
LUBE OIL PUMP
SOL PWR
AIR TOOL SOL
890 SP HD
880A SP SOLENOID
LOW OIL MOM SOL
BLOWR PWR

550 640C 520 510 540 530
550 510 P11 530 P13
P10 520 P12 540 P14
P26
P22 P17
1000 SP ENC
1000 SP ENC P20
X ENC 660
X 660 P6
Y ENC 670
Y 670 P7
Z ENC 680
Z 680 P8
A ENC 690
A 690 P9
B ENC 690B
B 690B P30
C 640C P33
B 640B P32
A 640 P5
Z 630 P4
Y 620 P3
X 610 P2
C 640C
B 640B
A 640A
Z 630
Y 620
X 610
J8
J4/J7 J10
J6
ADDRESS DATA
P19 P1
J19
MainCon BOARD
ENET CBL
RS–232 IN/OUT
COOLANT LEVEL GUAGE

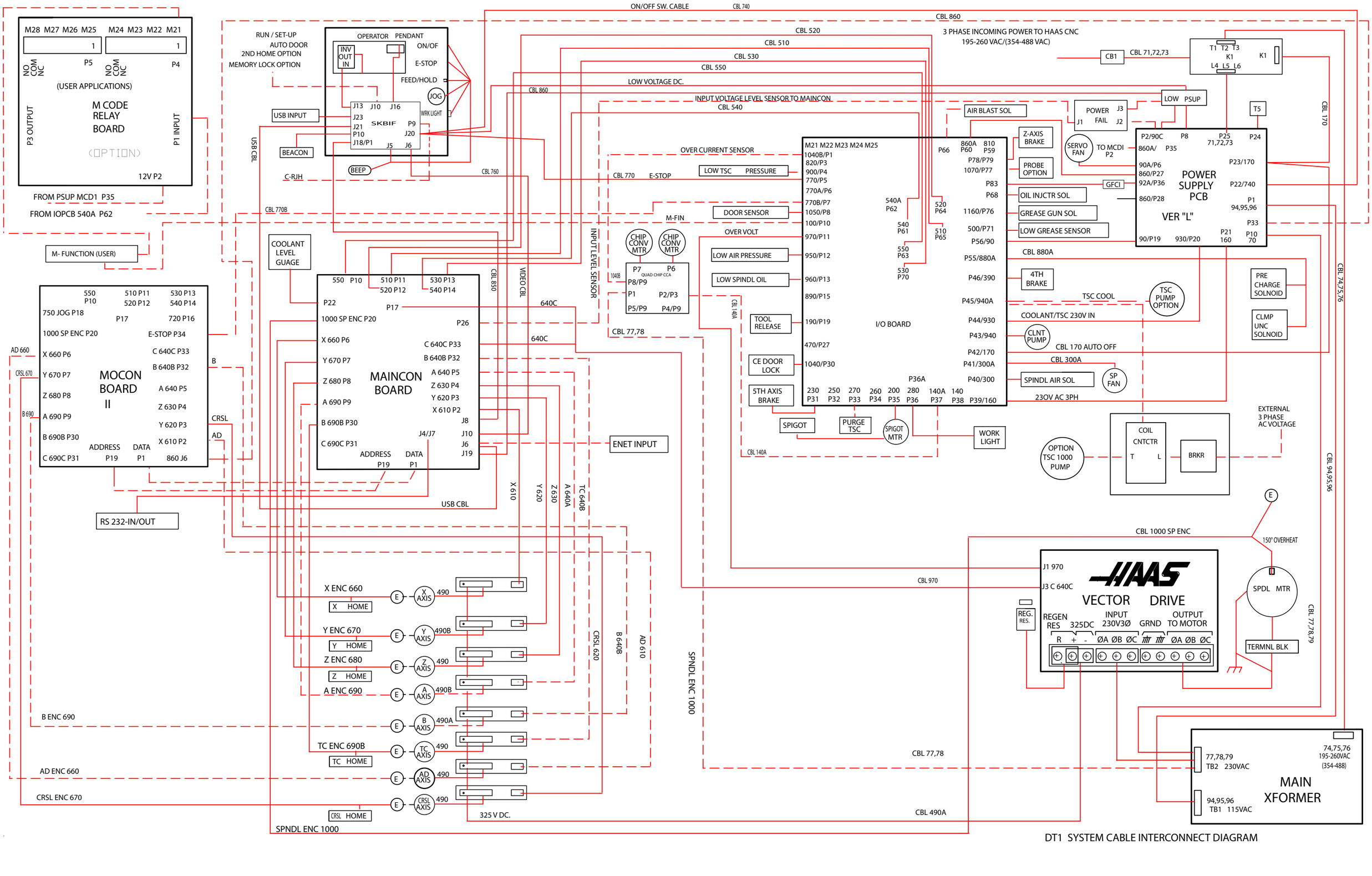
K4 CONTACTOR
K5 CONTACTOR
880C
DELTA/WYE OPTION
HAAS VECTOR DRIVE
J1 970
640C J3 C 640C
REGEN RES 325DC
INPUT 230V3Ø GRND
OUTPUT TO MOTOR
R + – ØA ØB ØC
ØA ØB ØC
BRWN BLK RED 79L1 78L2 77L3 GND GND 651U 652V 653W
REG. RES. P, PR
1030 REGEN SP DRIVE
890 SP HD STAT
PRE CHARGE
LO–HI GEAR
CLMP UNCL
300A SP OIL/FAN
TRANS/HYD PCB
TB2 TB3
P2 90
P1 880B
P6 350
P4 350
P3 410
P5 350A
HIG/LOG STATUS
SPINDLE TRANSMISSION
ENCODER
650B
325 VDC
650A
650 SP MTR
SPDL MTR
SP FAN
150° OVERHEAT
79L1,78L2,77L3
ACCESSORY 115 VAC
74
75
76
94,95,96
79L1
78L2
77L3
96
95
94
230VAC TB2
115VAC TB1
195–260VAC (354–488)
MAIN XFORMER
1000 SP ENC

(USER APPLICATIONS)
M28 M27 M26 M25 M24 M23 M22 M21
1 1
P5 P4
NO COM NC NO COM NC
M CODE RELAY BOARD
(OPTION)
P3 OUTPUT
P1 INPUT
12V P2
FROM IOPCB 540A P62
FROM PSUP MCD1 P35

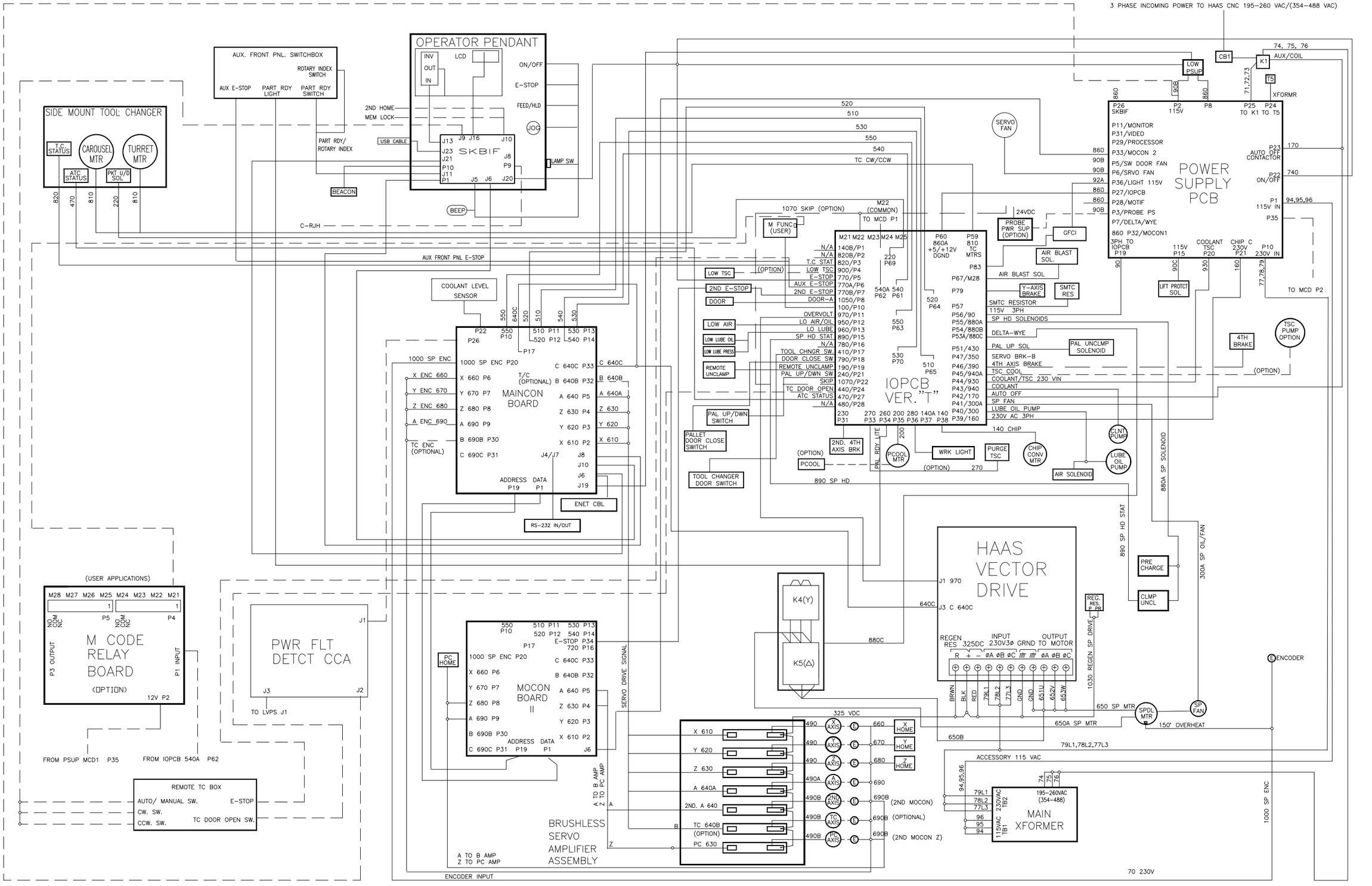
(OPTION)
X P6
Y P7
Z P8
A P9
MOTOR INTERFACE BOARD
P15 860
TO PSUP (P28)
ADDRESS BUS
DATA BUS
SERVO DRIVE SIGNAL

TO LINEAR XYZ GLASS SCALE ASSEMBLIES
BRUSHLESS SERVO AMPLIFIER ASSEMBLY
X 610
Y 620
Z 630
A 640A
B 640B
490 X AXIS E X HOME
490 Y AXIS E Y HOME
490 Z AXIS E Z HOME
490A A AXIS E A HOME (OPTIONAL)
490B B AXIS E B HOME (OPTIONAL)
ENCODER INPUT

VS BRUSHLESS SYSTEM
CABLE INTERCONNECT DIAGRAM



DT1 SYSTEM CABLE INTERCONNECT DIAGRAM



EC–300 BRUSHLESS SYSTEM

CABLE INTERCONNECT DIAGRAM

EC-400 BRUSHLESS SYSTEM CABLE INTERCONNECT DIAGRAM

3 PHASE INCOMING POWER TO HAAS CNC 195-260 VAC/(354-488 VAC)

REMOTE TC BOX
AUTO/ MANUAL SW.
CW. SW.
CCW. SW.
E-STOP
TC DOOR OPEN SW.

OPERATOR PENDANT
INV
OUT
IN
LCD
ON/OFF
E-STOP
FEED/HLD
2ND HOME
MEM LOCK
USB CABLE
J13 J9 J16 J10
P23 SKBIF J8
J21
P10 P9
J11
J18/P1 J5 J6 J20
JOG
SW LAMP
BEACON
BEEP

SIDE MOUNT TOOL CHANGER
T.C. STATUS
CAROUSEL MTR
TURRET MTR
ATC STATUS
PKT U/D SOL
820 470 810A 220 810
E-RJH

860
LOW PSUP
CB1
74, 75, 76
AUX/COIL
K1
T5
XFORMR
TO MCD1 (P2)
71,72,73
90B 860 860
P26 P1 SKBIF PROC FAN
P2 115V P8 P35 P25 P24
MCD1 TO K1 TO T5
P11/MONITOR
P31/VIDEO
P29/PROCESSOR
P33/MOCON 2
P5/SW DOOR FAN
P6/SRVO FAN
P36/LIGHT 115V
P27/IOPCB
P28/MOTIF
P3/PROBE PS
P7/DELTA-WYE
P23 AUTO OFF CONTACTOR 170
P22 ON/OFF 740
TB1 115V IN 94,95,96
P18 115V N/A
3PH TO IOPCB P19
115V P14
115V P13
115V P16
COOLANT TSC P20
CHIP C 230V P21
TB3 230V IN
90 90C 90C TSC COIL 930 160 77,78,79
POWER SUPPLY PCB

PC PALLET CLMP/PC AIR BLST 520
510
530
PALLET BEEPER 550
540
TC CW/CCW
TC IN/OUT
POWER FAIL J3 J1 J2
SERVO FAN
860
90B 92A 860 860 90B
24VDC
PROBE PWR SUP (OPTION)
GFCI
Y-AXIS BRAKE
INTRLK SOL.PWR
SMTC RESISTOR 115V 3PH
SMTC RES
TSC COIL
4TH PLATTER
TSC PUMP OPTION

1070 SKIP (OPTION)
(COMMON) M22
TO MDC BOARD
M FUNCT (USER)
M21 M22 M23,M24 M25
140B/P1
820B/P2
820/P3
900/P4
770/P5
770A/P6
770B/P7
1050/P8
100/P10
970/P11
950/P12
960/P13
830/P14
890/P15
780/P16
410/P17
790/P18
190/P19
240/P21
1070/P22
470/P27
420/P23
440/P24
230 250 270 260 200 280 140A 140
P31 P32 P33 P34 P35 P36 P37 P38
N/A
N/A
T.C STAT
LOW TSC
E-STOP
2ND E-STOP
2ND E-STOP
DOOR-A
OVERVOLT
LO AIR/OIL
LO LUBE
OVERH
SP HD STAT
N/A
TC DOOR
FRNT DR SW
PAL UP/DWN SW
SKIP
ATC STATUS
PAL FNCT SWS
LOW TSC
2ND E STOP
2ND E STOP
DOOR
LOW AIR
LOW LUBE ON
LOW LUBE PRESS
220 P69
540A 540 P62 P61
550 P63
M28 P67
530 P70
510 P65
520 P64
310 P68
IOPCB
P60 860A +5/+12V DGND
P59 810 TC MTRS
P83
P78
P30/1040
P57
P56/90
P55/880A
P54/880B
P53A/880C
P52/710
P51/430
P47/350
P46/390
P45/940A
P44/930
P43/940
P42/170
P41/3000A
P40/300
P39/160
DELTA-WYE
PAL UP/DWN SOL
TC DOOR SOL
SERVO BRK-B
4TH AXIS PLATTER UP
TSC COOL
COOLANT/TSC 230 VIN
COOLANT
AUTO OFF
SP FAN
LUBE OIL PUMP
230V AC 3PH

COOLANT LEVEL SENSOR
640C 520 510 540 530
P22 550 P10 510 P11 520 P12 530 P13 540 P14
P17 P26
1000 SP ENC
1000 SP ENC P20
X ENC 660
Y ENC 670
Z ENC 680
A ENC 690
B ENC 690B
X 660 P6
Y 670 P7
Z 680 P8
A 690 P9
B 690B P30
C 690B P31
MAINCON BOARD
C 640C P33
B 640B P32
A 640 P5
Z 630 P4
Y 620 P3
X 610 P2
J4/J7 J8 J10 J6 J19
ADDRESS P19 DATA P1
ENET CBL
RS-232 IN/OUT
C 640C
B 640B
A 640
Z 630
Y 620
X 610
5TH AXIS BRAKE
PCOOL MTR
PURGE TSC
270 PAL RDY LITE 200
(OPTION) PCOOL
(OPTION) NIAGRA SOL
890 SP HD
P5 HOPT P1
TP1 P2
RT CHP MTR
LT CHP MTR
AIR SOLENOID
CLNT PUMP
LUBE OIL PUMP
880A SP SOLENOID

PC SIGNAL BRACKET
PAL UNCLMP SW
PAL CLMP SW
PAL CLMP ERROR SW
TC DOOR SW
PC CLMP SOL
PAL UNCLMP SOL
AIRBLAST SOL
PC CLMP 2ND SOL
PLATTER LIFT SOL
TC DOOR SOL
PAL CLMP SW
PAL UNCLMP SW
PAL CLMP ERROR SW
TC DOOR SW
PAL CLMP SOL
PAL UNCLMP SOL
AIRBLAST SOL
PC CLMP 2ND SOL
PLATTER LIFT SOL
TC DOOR SOL
PC CLMP SIGNALS
TC DOOR SW
PAL CLMP/AIRBLAST SOL
PC CLMP 2ND SOL
PLATTER LIFT SOL
TC DOOR SOL

(OPTION)
550 P34 510 P11 530 P13
P10 520 P12 540 P14
P17
1000 SP ENC P20
X 660 P6
Y 670 P7
Z 680 P8
A 690 P9
B 690B P30
C 690C P31
MOCON BOARD II
ADDRESS P19 DATA P1
C 640C P33
B 640B P32
A 640 P5
Z 630 P4
Y 620 P3
X 610 P2
J6
SERVO DRIVE SIGNAL

K4(Y)
K5(Δ)
880C
J1 970
J3 C 640C
HAAS VECTOR DRIVE
REGEN RES 325DC
INPUT 230V3ø
GRND
OUTPUT TO MOTOR
R + – øA øB øC
BRWN BLK RED 79L1 78L2 77L3 GND GND 651U 652V 653W
REG. RES. P PR
1030 REGEN SP DRIVE
890 SP HD STAT
PRE CHARGE
CLMP UNCL
300A SP OIL/FAN
ENCODER

FRONT PANEL JUNCTION BOX
PAL DWN SW
PAL UP SW
WORK LAMP
FRONT DOOR SW
PC OPRATOR LOCK SW
AUXILLARY FRONT PANEL
PAL RDY SW
CW ROT
CCW ROT
2ND E-STOP
PAL RDY LITE
PAL ALARM
PAL DWN SW
PAL UP SW
WORK LITE
FRNT DR SW
PC OP LOCK SW
AUX FP
PAL ALARM
PAL DWN SOL
PAL UP/DOWN SW
PAL ALARM
AUX FP
WORK LITE
FRNT DR SW
PC OP LOCK SW
LOAD LITE
PAL UP/DWN SOL
PAL UP SOL
PAL DWN SOL
PAL UP SOL

M28 M27 M26 M25 M24 M23 M22 M21
P5 P4
M CODE RELAY BOARD
(OPTION)
12V P2
P3 OUTPUT
P1 INPUT
X 610
Y 620
Z 630
A 640
TC 640B
PC 640B
490 A AXIS E 660 X-AXIS HOME
490 A AXIS E 670 Y-AXIS HOME
490 A AXIS E 680 Z-AXIS HOME
490A A AXIS E 690 A-AXIS HOME
PLATR LIFT SW
(OPTIONAL)(2ND MOCON)
490B TC AXIS E 690B (OPTIONAL)
490B PC AXIS E 690B (2ND MOCON Z 630 IF TC OPTION)
325 VDC
650B
650 SP MTR
650A SP MTR
SPDL MTR
SP FAN
150° OVERHEAT
79L1,78L2,77L3
ACCESSORY 115 VAC
94,95,96
79L1
78L2
77L3
1 PHASE 230VAC TB1
96
95
94
195-260VAC (354-488)
MAIN XFORMER
74
75
76
1000 SP ENC
70 230V
ENCODER INPUT
FROM PSUP MCD1 P35
FROM IOPCB 540A P62

EC-400PP BRUSHLESS SYSTEM CABLE INTERCONNECT DIAGRAM

3 PHASE INCOMING POWER TO HAAS CNC 195-260 VAC/(354-488 VAC)

PALLET POOL JUNCTION
SAFTY SOL.
PAL LIFT SOL.
PAL LIFT SW.

REMOTE TC BOX
AUTO/ MANUAL SW.
E-STOP
CW. SW.
TC DOOR OPEN SW.
CCW. SW.

OPERATOR PENDANT
INV
OUT
IN
ON/OFF
E-STOP
CE BUTTON
FEED/HLD
700A
KEY LOCK
SECOND HOME
USB CABLE
SKBIF
J10 J9 J16 J17 J1
J13 J22
J2 J8
P10 P9
J18/P1 J11
P5 P6 P3
BEEP AUX START HOLD J6 J20
JOG
LAMP SW
BEEP
700A

SIDE MOUNT TOOL CHANGER
T.C. STATUS
CAROUSEL MTR
TURRET MTR
ATC STATUS
PKT U/D SOL

REMOTE JOG HANDLE
850
BEACON
E-RJH

820 470 810A 220 810

ENET CBL
INDEXER PORT
RS-232 IN/OUT

CPU BOARD
J10
J5, 850A
J4, 850
J3
J6 860
ADDRESS J1 DATA J2

VIDEO BOARD
J1
ICOP CCA
J13
P1 860
+5/+12 VDC
ADDRESS J4 DATA J5

COOLANT LEVEL SENSOR

MOCON BOARD
P22 550 P10
550 640C 520 510 540 530
510 P11 520 P12 530 P13 540 P14
P17 P26
1000 SP ENC P20
X ENC 660 X 660 P6
Y ENC 670 Y 670 P7
Z ENC 680 Z 680 P8
A ENC 690 A 690 P9
TC ENC 690B B 690B P30
C 690C P31
C 640C P33
B 640B P32
A 640 P5
Z 630 P4
Y 620 P3
X 610 P2
ADDRESS P19 DATA P1 860 P15
C 640C
B 640C
A 640
Z 630
Y 620
X 610
860

PC PALLET CLMP/PC AIR BLST 520
510
PALLET BEEPER 550
530
540
TC CW/CCW
TC IN/OUT
GFCI
1070 SKIP (OPTION)
(COMMON) M22
TO MDC BOARD
M FUNC (USER)

IOPCB
M21 M22 M23 M24 M25
N/A 140B/P1
N/A 820B/P2
T.C STAT 820/P3
LOW TSC 900/P4
E-STOP 770/P5
2ND E-STOP 770A/P6
2ND E-STOP 770B/P7
DOOR-A 1050/P8
100/P10
OVERVOLT 970/P11
LO AIR/OIL 950/P12
LO LUBE 960/P13
OVERH 830/P14
SP HD STAT 890/P15
N/A 780/P16
TC DOOR 410/P17
PAL LIFT SW. 790/P18
FRNT DR SW 190/P19
PAL UP/DWN SW 240/P21
SKIP 1070/P22
ATC STATUS 470/P27
PAL FNCT SWS 420/P23
440/P24
P30/1040 230 250 270 260 200 280 140A 140
P31 P32 P33 P34 P35 P36 P37 P38
220 P69
540A 540 P62 P61
550 P63
M28 P67
530 P70
LOW TSC
2ND E STOP
2ND E STOP
DOOR
LOW AIR
LOW LUBE OIL
LOW LUBE PRESS
INTRLK SOL.PWR

P60 860A +5/+12V DGND
P59 810 TC MTRS
P78
P57
P56/90
P55/880A
P54/880B
P53A/880C
P52/710
P51/430
P50/130
P47/350
P46/390
P45/940A
P44/930
P43/940
P42/170
P41/300A
P40/300
P39/160
520 P64
310 P68
510 P65
Y-AXIS BRAKE
SMTC RES
SMTC RESISTOR
115V 3PH
DELTA-WYE
PAL UP/DWN SOL
TC DOOR SOL
TSC OT SENSOR
SERVO BRK-B
4TH AXIS PLATTER UP
TSC COOL
COOLANT/TSC 230 VIN
COOLANT
AUTO OFF
SP FAN
LUBE OIL PUMP
230V AC 3PH
TSC OT
4TH PLATTER
TSC PUMP OPTION

24VDC
PROBE PWR SUP (OPTION)

POWER SUPPLY PCB
POWER J3 FAIL
J1 J2
SERVO FAN
P26 SKBIF PROC FAN
P1 115V
P2 P8 P35 MCD1 TO K1 TO T5
P11/MONITOR
P31/VIDEO
P32/12 VDC
P33/MOCON 2
P5/SW DOOR FAN
P6/SRVO FAN
P36/LIGHT 115V
P27/IOPCB
P28/MOTIF
P3/PROBE PS
P7/DELTA-WYE
P15/115V
3PH TO IOPCB P19
115V P14
115V P13
COOLANT CHIP C TSC P16
230V P20
P10 230V IN P21
P23 AUTO OFF CONTACTOR
P22 ON/OFF
P1 115V IN
P18 115V
860 90B 90B 90B 860 860 90B
90 90C 90C 930 160
170 740 94,95,96 N/A
77,78,79
TSC COIL

LOW PSUP
CB1
K1
74, 75, 76
AUX/COIL
TO MCDI (P2)
T5
XFORMR
71,72,73
860 90B 860 860

PCOOL MTR
PCOOL (OPTION)
PURGE TSC
270 200
HOPT P5 P1 TP1 P2
RT CHP MTR
LT CHP MTR
AIR SOLENOID
CLNT PUMP
LUBE OIL PUMP
AUGER
890 SP HD
880A SP SOLENOID
PAL RDY LITE
890 SP HD STAT
300A SP OIL/FAN

PC SIGNAL BRACKET
PAL CLMP SW
PAL UNCLMP SW
PAL CLMP ERROR SW
TC DOOR SW
PC CLMP SOL
PAL UNCLMP SOL
AIRBLAST SOL
PC CLMP 2ND SOL
PLATTER LIFT SOL
TC DOOR SOL
PAL CLMP SW
PAL UNCLMP SW
PAL CLMP ERROR SW
TC DOOR SW
PAL CLMP SOL
PAL UNCLMP SOL
AIRBLAST SOL
PC CLMP 2ND SOL
PLATTER LIFT SOL
TC DOOR SOL
PC CLMP SIGNALS
TC DOOR SW
PAL CLMP/AIRBLAST SOL
PC CLMP 2ND SOL
PLATTER LIFT SOL
TC DOOR SOL

910C

MOCON BOARD II
550 P34 510 P11 530 P13
P10 520 P12 540 P14
P17
1000 SP ENC P20
X 660 P6
Y 670 P7
Z 680 P8
A 690 P9
B 690B P30
C 690C P31
C 640C P33
B 640B P32
A 640 P5
Z 630 P4
Y 620 P3
X 610 P2
ADDRESS P19 DATA P1 860 P15

K4(Y)
K5(Δ)
880C

HAAS VECTOR DRIVE
J1 970
640C J3 C 640C
REGEN RES 325DC
INPUT 230V3ø GRND
OUTPUT TO MOTOR
R + – øA øB øC
BRWN BLK RED 79L1 78L2 77L3 GND GND 651U 652V 653W
REG. RES. P PR
1030 REGEN SP DRIVE
PRE CHARGE
CLMP UNCL
ENCODER

FRONT PANEL JUNCTION BOX
PAL DWN SW
PAL UP SW
WORK LAMP
FRONT DOOR SW
PC OPRATOR LOCK SW
PAL UP/DOWN SW
PAL ALARM
AUX FP
WORK LITE
FRNT DR SW
PC OP LOCK SW
LOAD LITE
PAL DWN SOL
PAL UP SOL

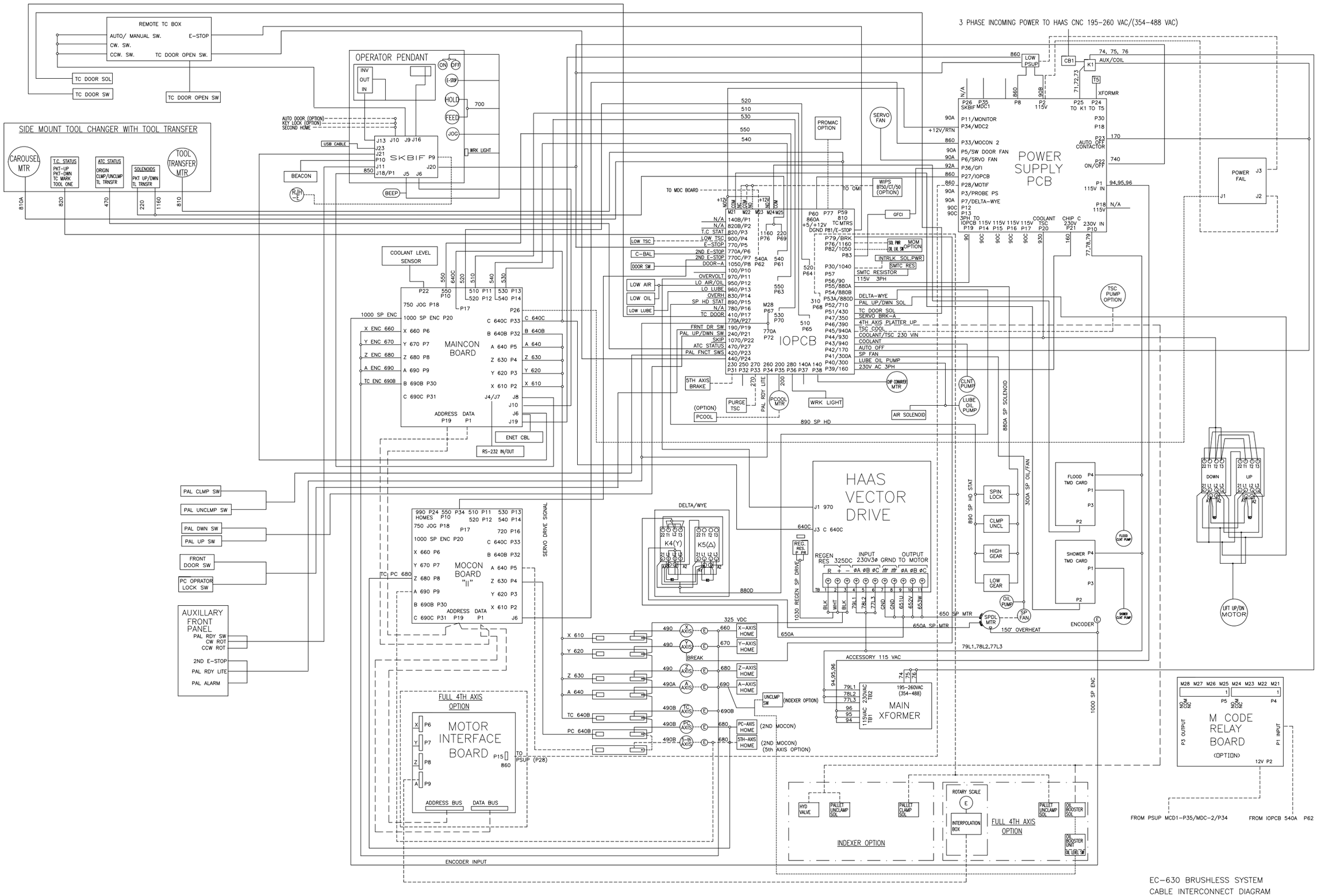
AUXILLARY FRONT PANEL
PAL RDY SW
CW ROT
CCW ROT
2ND E-STOP
PAL RDY LITE
PAL ALARM

M CODE RELAY BOARD
(OPTION)
M28 M27 M26 M25 M24 M23 M22 M21
P5 P4
NOM NC
P3 OUTPUT
P1 INPUT
12V P2

SERVO DRIVE SIGNALS
X 610
Y 620
Z 630
A 640
TC 640C
PC 630
U 610
V 620
490 X AXIS E
490 Y AXIS E
490 Z AXIS E
490A A AXIS E
490A TC AXIS E
490A PC AXIS E
490B U AXIS E
490B V AXIS E
660 X-AXIS HOME
670 Y-AXIS HOME
680 Z-AXIS HOME
690 A-AXIS HOME
PLATR LIFT SW.

325 VDC
650 SP MTR
SPDL MTR
150° OVERHEAT
SP FAN
650A SP MTR
650B
79L1,78L2,77L3
ACCESSORY 115 VAC
94,95,96
79L1
78L2
77L3
74
75
76
115VAC 230VAC TB2
TB1
96
95
94
195-260VAC (354-488)
MAIN XFORMER
1000 SP ENC
70 230V

ENCODER INPUT
FROM PSUP MCD1 P35
FROM IOPCB 540A P62


3 PHASE INCOMING POWER TO HAAS CNC 195-260 VAC/(354-488 VAC)
REMOTE TC BOX
AUTO/ MANUAL SW.
E-STOP
CW. SW.
CCW. SW.
TC DOOR OPEN SW.
TC DOOR SOL
TC DOOR SW
TC DOOR OPEN SW
OPERATOR PENDANT
INV
OUT
IN
ON
OFF
E-STOP
HOLD
FEED
JOG
700
WRK LIGHT
AUTO DOOR (OPTION)
KEY LOCK (OPTION)
SECOND HOME
USB CABLE
SKBIF
BEACON
BEEP
SIDE MOUNT TOOL CHANGER WITH TOOL TRANSFER
CAROUSEL MTR
T.C. STATUS
PKT-UP
PKT-DWN
TC MARK
TOOL ONE
ATC STATUS
ORIGIN
CLMP/UNCLMP
TL TRNSFR
SOLENOIDS
PKT UP/DWN
TL TRNSFR
TOOL TRANSFER MTR
COOLANT LEVEL SENSOR
MAINCON BOARD
ADDRESS DATA
ENET CBL
RS-232 IN/OUT
PROMAC OPTION
SERVO FAN
TO MDC BOARD
TO OMI
WIPS B150/CT/50 (OPTION)
GFCI
IOPCB
LOW TSC
E-STOP
C-BAL
2ND E-STOP
DOOR SW
DOOR-A
OVERVOLT
LO AIR
LO AIR/OIL
LO OIL
LO LUBE
LO LUBE
OVERH
SP HD STAT
TC DOOR
FRNT DR SW
PAL UP/DWN SW
SKIP
ATC STATUS
PAL FNCT SWS
5TH AXIS BRAKE
PURGE TSC
(OPTION) PCOOL
PCOOL MTR
WRK LIGHT
AIR SOLENOID
890 SP HD
DIP CONVEYOR MTR
CLNT PUMP
LUBE OIL PUMP
880A SP SOLENOID
POWER SUPPLY PCB
+12V/RTN
P11/MONITOR
P34/MDC2
P33/MOCON 2
P5/SW DOOR FAN
P6/SRVO FAN
P36/GFI
P27/IOPCB
P28/MOTIF
P3/PROBE PS
P7/DELTA-WYE
P12
P13
3PH TO IOPCB
AUTO OFF CONTACTOR
ON/OFF
115V IN
SMTC RESISTOR
115V 3PH
SOL PWR MOM OPTION
OL LVL SW
LINTRLK SOL-PWR
SMTC RES
DELTA-WYE
PAL UP/DWN SOL
TC DOOR SOL
SERVO BRK-A
4TH AXIS PLATTER UP
TSC COOL
COOLANT/TSC 230 VIN
COOLANT
AUTO OFF
SP FAN
LUBE OIL PUMP
230V AC 3PH
TSC PUMP OPTION
POWER FAIL
XFORMR
T5
CB1
K1
AUX/COIL
LOW PSUP
74, 75, 76
71,72,73
DOWN
UP
LIFT UP/DN MOTOR
HAAS VECTOR DRIVE
REGEN RES 325DC
INPUT 230V3ø
OUTPUT TO MOTOR
REGEN SP DRIVE
880D
640C
SPIN LOCK
CLMP UNCL
HIGH GEAR
LOW GEAR
300A SP OIL/FAN
OIL PUMP
SP FAN
SPDL MTR
150° OVERHEAT
ENCODER
650 SP MTR
650A SP MTR
650A
79L1,78L2,77L3
FLOOD TMD CARD
SHOWER TMD CARD
FLOOD CNT PUMP
SHWER CNT PUMP
DELTA/WYE
K4(Y)
K5(Δ)
SERVO DRIVE SIGNAL
MOCON BOARD "II"
TC PC 680
PAL CLMP SW
PAL UNCLMP SW
PAL DWN SW
PAL UP SW
FRONT DOOR SW
PC OPRATOR LOCK SW
AUXILLARY FRONT PANEL
PAL RDY SW
CW ROT
CCW ROT
2ND E-STOP
PAL RDY LITE
PAL ALARM
325 VDC
X-AXIS HOME
Y-AXIS HOME
Z-AXIS HOME
A-AXIS HOME
PC-AXIS HOME
5TH-AXIS HOME
(2ND MOCON)
(5th AXIS OPTION)
UNCLMP SW
(INDEXER OPTION)
BREAK
ACCESSORY 115 VAC
195-260VAC (354-488)
MAIN XFORMER
FULL 4TH AXIS OPTION
MOTOR INTERFACE BOARD
TO PSUP (P28)
ADDRESS BUS
DATA BUS
ENCODER INPUT
INDEXER OPTION
HYD VALVE
PALLET UNCLAMP SOL
PALLET CLAMP SOL
ROTARY SCALE
INTERPOLATION BOX
OIL BOOSTER SOL
OIL BOOSTER UNIT
OIL LEVEL SW
M CODE RELAY BOARD
(OPTION)
12V P2
FROM PSUP MCD1-P35/MDC-2/P34
FROM IOPCB 540A P62
EC-630 BRUSHLESS SYSTEM
CABLE INTERCONNECT DIAGRAM

3 PHASE INCOMING POWER TO HAAS CNC 195–260 VAC/(354–488 VAC)

OPERATOR PENDANT
INV
OUT
IN
LCD
ON/OFF 740
E–STOP
FEED/HLD
JOG
WRK LIGHT
2ND HOME BUTTON (OPTION)
MEMORY LOCK (OPTION)
USB CABLE
BEACON
BEEP
RJH–C
J13 J16 J10
J23
J21
P10
J18/P1 J5 J6 J20
P9
SKBIF

SIDE MOUNT TOOL CHANGER
T.C STATUS
CAROUSEL MTR
TURRET MTR
ATC STATUS
PKT U/D SOL
820 470 810A 220 810

CB1
K1
74, 75, 76
AUX/COIL
T5
71,72,73
XFORMR
860
N/A
N/A
P26 SKBIF PROC FAN
P1
P35 P25 P24 MCD1 TO K1 TO T5
P8 P.S. INPUT
P2 115V
P5/SW DOOR FAN
P6/SRVO FAN
P36/LIGHT 115V
P27/IOPCB
P28/MOTIF
P3/PROBE PS
P23 AUTO OFF CONTACTOR 170
P22 ON/OFF 740
P1 115V IN 94,95,96
POWER SUPPLY PCB
3PH TO IOPCB P19
115V P17
DELTA WYE P7
COOLANT TSC P20
P16
CHIP C 230V P21
P10 230V IN
90 N/A 90B 930 160 77,78,79

SERVO FAN
LOW PSUP
860
90B
J3
POWER FAIL
J1 J2
PROBE PWR SUP (OPTION)
24VDC
GFCI

520
510
530
550
540
TC CW/CCW
TC IN/OUT

1070 SKIP (OPTION)
M FUNC (USER)
IOPCB
M21 M22 M23 M24 M25
OVER CURRENT 140B/P1
N/A 820B/P2
T.C STAT 820/P3
LOW TSC 900/P4
E–STOP 770/P5
C BAL 770A/P6
2ND E–STOP 770B/P7
DOOR–A 1050/P8
SW. DOOR 1050A/P9
M–FIN 100/P10
OVERVOLT 970/P11
LO AIR/OIL 950/P12
LO LUBE 960/P13
OVERH 830/P14
SP HD STAT 890/P15
N/A 780/P16
N/A 410/P17
N/A 790/P18
REM UNCLMP–A 190/P19
N/A 240/P21
SKIP 1070/P22
ATC STATUS 480/P27
CE DOOR LOCK–B 1040/P30
230 250 270 260 200 280 140A 140
P31 P32 P33 P34 P35 P36 P37 P38
220 P69
540A 540 P62 P61
520 P64
550 P63
530 P70
510 P65
P60 860A +5/+12V DGND
P59 810 TC MTRS
P83
P79
P57
P56/90
P55/880A
P54/880B
P53A/880C
P52/710
P47/350
P46/390
P45/940A
P44/930
P43/940
P42/170
P41/300A
P40/300
P39/160
LOW TSC
C BAL
DOOR
SW.DOOR
LOW AIR
LOW LUBE
REMOTE UNCLAMP SP
CE DOOR LOCK (OPTION)
Y–AXIS BRAKE
SMTC RES
SMTC RESISTOR
115V 3PH
SP HD SOLENOIDS
GB I/F
DELTA WYE
N/A
SERVO BRK–B
4TH AXIS BRAKE
TSC COOL
COOLANT/TSC 230 VIN
COOLANT
AUTO OFF
SP FAN
LUBE OIL PUMP
230V AC 3PH
140 CHIP
UNCLAMP SOL PWR
TSC PUMP OPTION

COOLENT LEVEL GAUGE
MAINCON BOARD
550 640C 520 510 540 530
550 P10
510 P11
520 P12
530 P13
540 P14
P22
P17
P26
1000 SP ENC
1000 SP ENC P20
X ENC 660
X 660 P6
Y ENC 670
Y 670 P7
Z ENC 680
Z 680 P8
A ENC 690
A 690 P9
B ENC 690B
B 690B P30
C 690C P31
C 640C
C 640C P33
B 640B
B 640B P32
A 640A
A 640 P5
Z 630
Z 630 P4
Y 620
Y 620 P3
X 610
X 610 P2
J4/J7 J8 J10 J6 J19
ADDRESS P19
DATA P1
ENET CBL
RS–232 IN/OUT

P3 PCB, CHIP CONVEYOR (OPTION) P9 P8 P4
CHIP CONV MTR LEFT MOTOR
SPIGOT
5TH AXIS BRAKE
270
SPIGOT MTR
200
WORK LAMP
PURGE TSC
270
CHIP CONV MTR RIGHT MOTOR
890 SP HD
CLNT PUMP
AIR SOLENOID
LUBE OIL PUMP
880A SP SOLENOID
890 SP HD STAT
300A SP OIL/FAN

DELTA/WYE
K4 CONTACTOR
K5 CONTACTOR
880C
HAAS VECTOR DRIVE
J1 970
640C
J3 C 640C
NC 100 DEG C
REG. RES. P PB
1030 REGEN SP DRIVE
REGEN RES 325DC
INPUT 230V3ø GRND
OUTPUT TO MOTOR
R + – øA øB øC
BRWN BLK RED 79L1 78L2 77L3 GND GND 651U 652V 653W
650 SP MTR
SPDL MTR
SP FAN
150° OVERHEAT
PRE CHARGE
LO–HI GEAR
CLMP UNCL
(OPTION)
SPINDLE TRANSMISSION
HIG/LOG STATUS
ENCODER

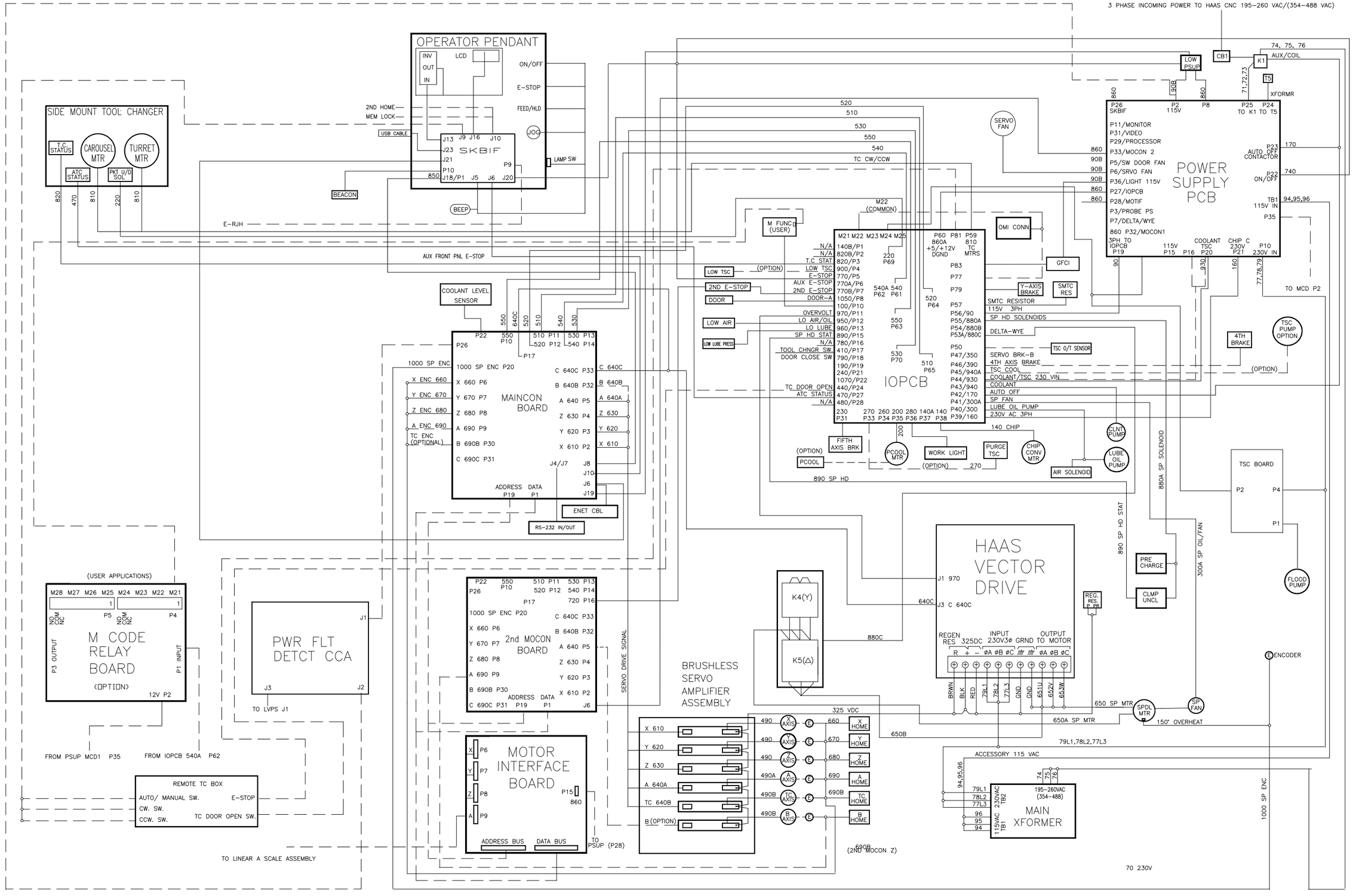
(OPTION)
MOTOR INTERFACE BOARD
X P6
Y P7
Z P8
A P9
P15 860 TO PSUP (P28)
ADDRESS BUS
DATA BUS

BRUSHLESS SERVO AMPLIFIER ASSEMBLY
325 VDC
650B
650A
SERVO DRIVE SIGNAL
X 610
Y 620
Z 630
A 640A
B 640B
490 X AXIS E 660 X HOME
490 Y AXIS E 670 Y HOME
490 Z AXIS E 680 Z HOME
490A A AXIS E 690 (OPTIONAL)
490B B AXIS E 690B (OPTIONAL)
ENCODER INPUT

(USER APPLICATIONS)
M28 M27 M26 M25 M24 M23 M22 M21
P5
P4
NO COM NC
M CODE RELAY BOARD
(OPTION)
P3 OUTPUT
P1 INPUT
12V P2
TO LINEAR XYZ GLASS SCALE ASSEMBLIES

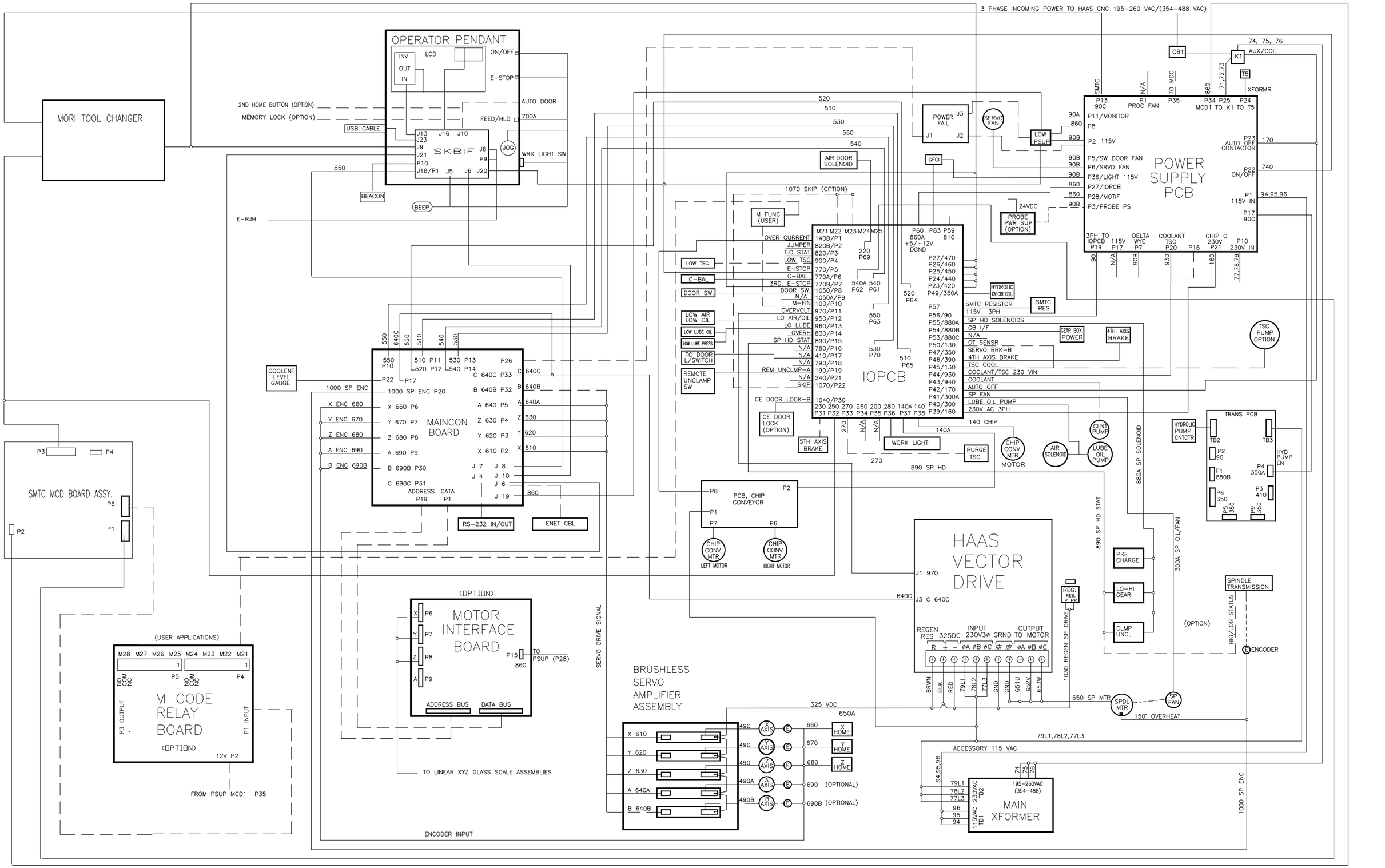
79L1,78L2,77L3
ACCESSORY 115 VAC
94,95,96
79L1
78L2
77L3
96
95
94
115VAC TB1
230VAC TB2
74
75
76
195–260VAC (354–488)
MAIN XFORMER
70 230V
1000 SP ENC

EC–1600 BRUSHLESS SYSTEM
CABLE INTERCONNECT DIAGRAM

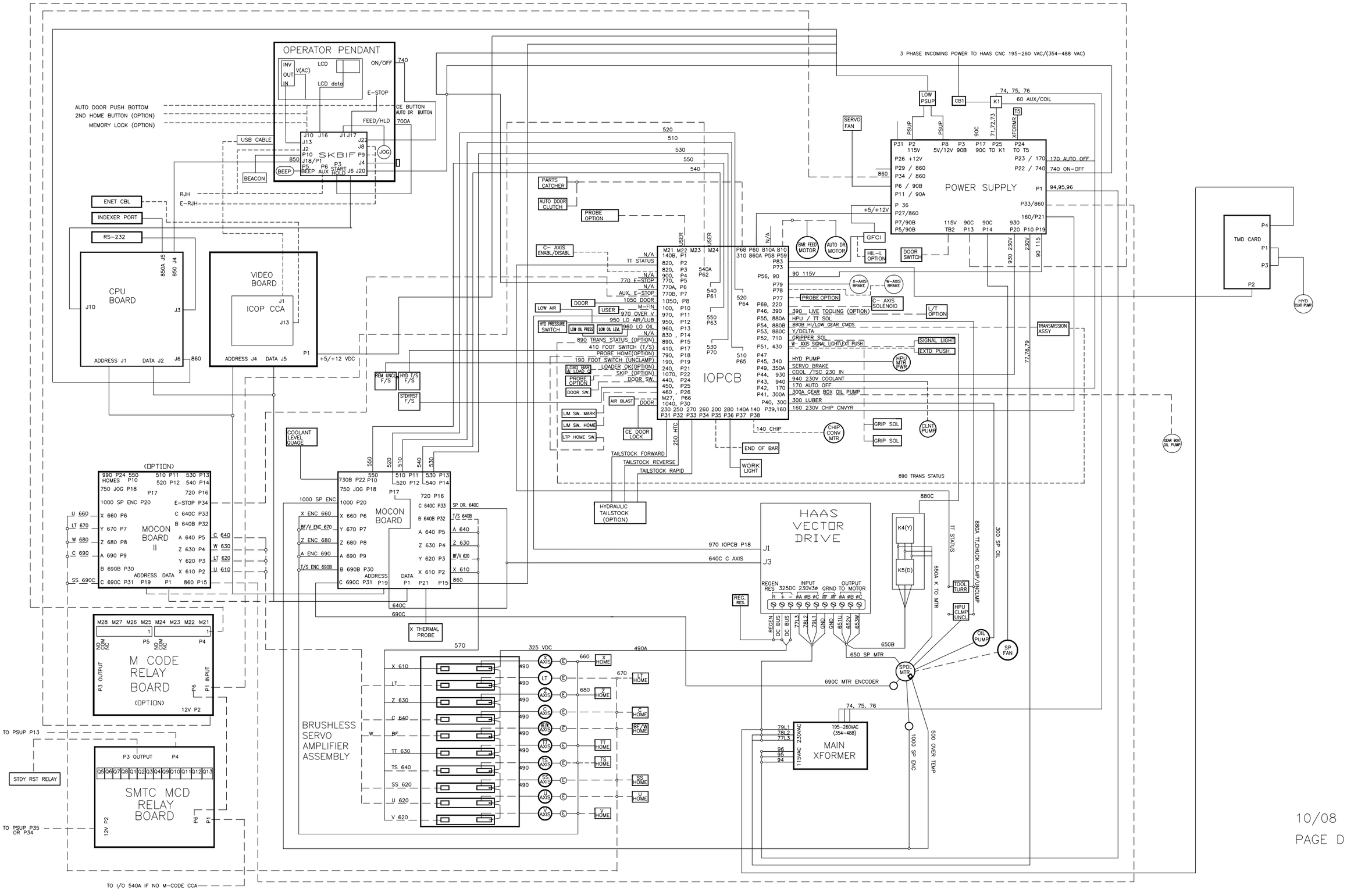


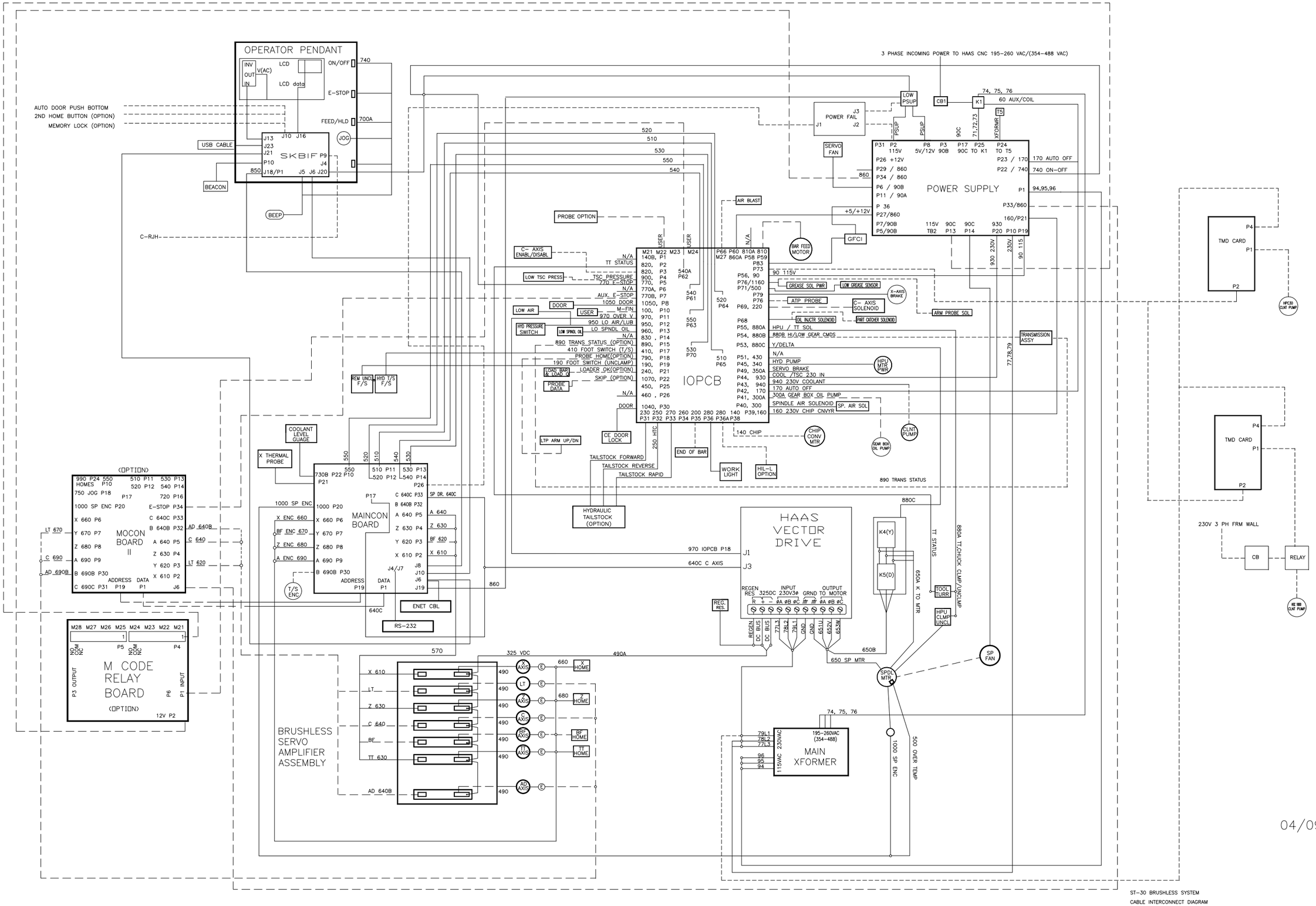
ES-5 BRUSHLESS SYSTEM

CABLE INTERCONNECT DIAGRAM



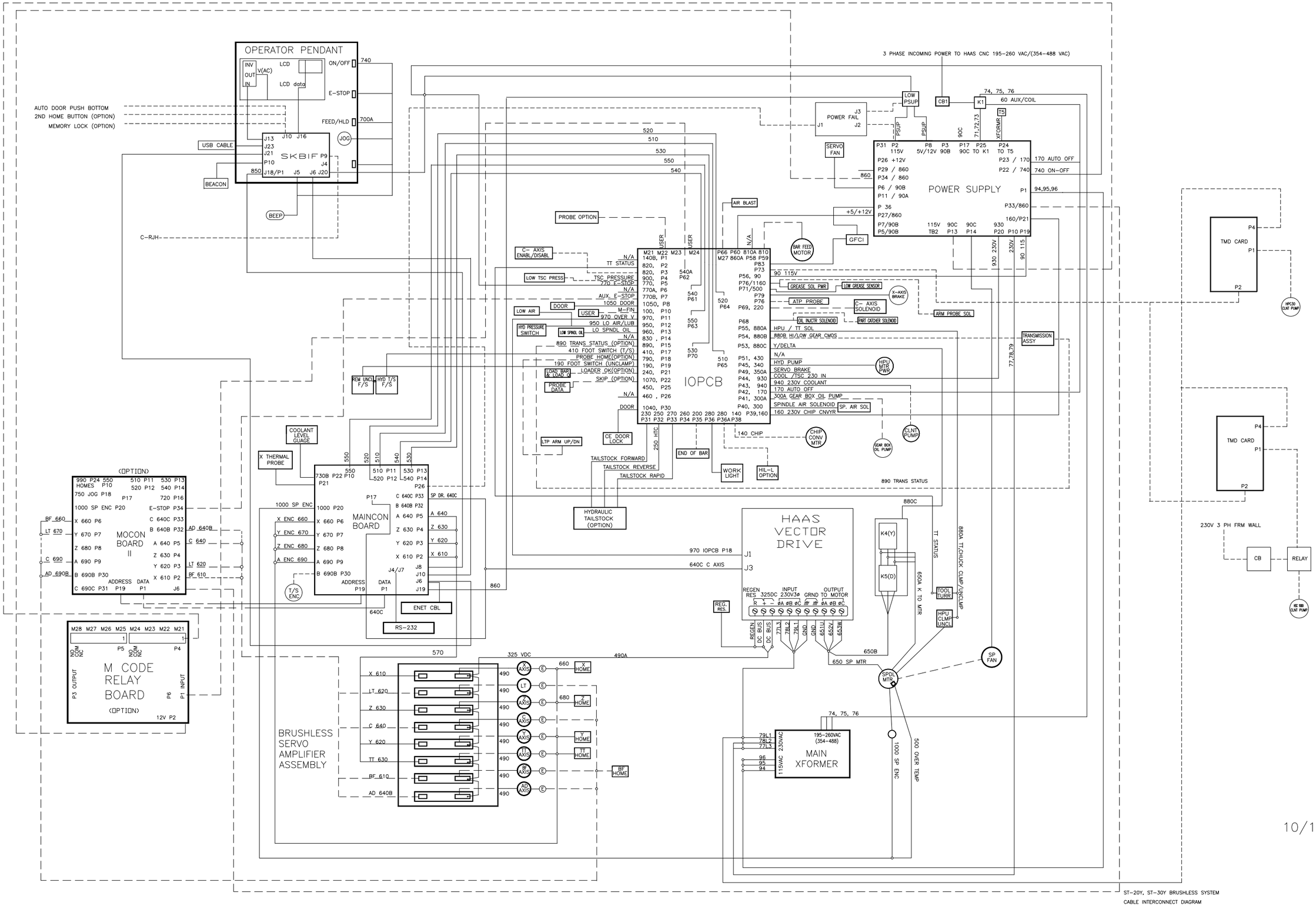
HS BRUSHLESS SYSTEM
CABLE INTERCONNECT DIAGRAM


OPERATOR PENDANT
INV
OUT
IN
V(AC)
LCD
LCD data
ON/OFF
740
E-STOP
CE BUTTON
AUTO DR BUTTON
700A
FEED/HLD
AUTO DOOR PUSH BOTTOM
2ND HOME BUTTON (OPTION)
MEMORY LOCK (OPTION)
USB CABLE
J10 J16 J1 J17
J13
J2
P10 SKBIF P9
J18/P1
P5 P6 P3
BEEP AUX START HOLD
J6 J20
J22
J8
J4
JOG
850
BEEP
BEACON
RJH
E-RJH
ENET CBL
INDEXER PORT
RS-232
CPU BOARD
J10
J3
850A J5
850 J4
ADDRESS J1
DATA J2
J6
860
VIDEO BOARD
J1
ICOP CCA
J13
P1
ADDRESS J4
DATA J5
+5/+12 VDC
REM UNCL F/S
HYD T/S F/S
STDYRST F/S
COOLANT LEVEL GUAGE
(OPTION)
990 P24 550 HOMES P10
750 JOG P18
1000 SP ENC P20
X 660 P6
Y 670 P7
Z 680 P8
A 690 P9
B 690B P30
C 690C P31
MOCON BOARD II
P17
510 P11 530 P13
520 P12 540 P14
720 P16
E-STOP P34
C 640C P33
B 640B P32
A 640 P5
Z 630 P4
Y 620 P3
X 610 P2
860 P15
ADDRESS DATA P19 P1
U 660
LT 670
W 680
C 690
SS 690C
C 640
W 630
LT 620
U 610
730B P22 P10
1000 SP ENC
X ENC 660
BF/V ENC 670
Z ENC 680
A ENC 690
T/S ENC 690B
MOCON BOARD
SP DR. 640C
T/S 640B
BF/V 620
640C
690C
X THERMAL PROBE
M28 M27 M26 M25 M24 M23 M22 M21
M CODE RELAY BOARD
(OPTION)
P3 OUTPUT
P1 INPUT
P5
P4
P6
12V P2
TO PSUP P13
STDY RST RELAY
P3 OUTPUT P4
Q5 Q6 Q7 Q8 Q1 Q2 Q3 Q4 Q9 Q10 Q11 Q12 Q13
SMTC MCD RELAY BOARD
TO PSUP P35 OR P34
TO I/O 540A IF NO M-CODE CCA
520
510
530
550
540
PARTS CATCHER
AUTO DOOR CLUTCH
PROBE OPTION
C- AXIS ENABL/DISABL
TT STATUS
E-STOP
DOOR
LOW AIR
USER
M-FIN
970 OVER V
950 LO AIR/LUB
HYD PRESSURE SWITCH
LOW OIL PRESS
LOW OIL LEVL
960 LO OIL
890 TRANS STATUS (OPTION)
410 FOOT SWITCH (T/S)
PROBE HOME(OPTION)
190 FOOT SWITCH (UNCLAMP)
LOADER OK(OPTION)
LOAD BAR & LOAD Q
SKIP (OPTION)
PROBE OPTION
DOOR SW.
AIR BLAST
DOOR
LIM SW. MARK
LIM SW. HOME
LTP HOME SW.
CE DOOR LOCK
TAILSTOCK FORWARD
TAILSTOCK REVERSE
TAILSTOCK RAPID
HYDRAULIC TAILSTOCK (OPTION)
M21 M22 M23 M24
140B, P1
820, P2
820, P3
900, P4
770, P5
770A, P6
770B, P7
1050, P8
100, P10
970, P11
950, P12
960, P13
830 , P14
890, P15
410, P17
790, P18
190, P19
240, P21
1070, P22
440, P24
450, P25
460 , P26
M27, P66
1040, P30
230 250 270 260 200 280 140A 140 P39,160
P31 P32 P33 P34 P35 P36 P37 P38
540A P62
540 P61
550 P63
530 P70
510 P65
520 P64
IOPCB
250 HTC
140 CHIP
END OF BAR
WORK LIGHT
CHIP CONV MTR
GRIP SOL
GRIP SOL
CLNT PUMP
890 TRANS STATUS
3 PHASE INCOMING POWER TO HAAS CNC 195-260 VAC/(354-488 VAC)
LOW PSUP
CB1
K1
74, 75, 76
60 AUX/COIL
T5
XFORMR
PSUP
PSUP
90C
71,72,73
SERVO FAN
POWER SUPPLY
P31 P2 115V
P8 5V/12V 90B
P3 90B
P17 P25 90C TO K1
P24 TO T5
P26 +12V
P29 / 860
P34 / 860
P6 / 90B
P11 / 90A
P 36
P27/860
P7/90B
P5/90B
P1
94,95,96
P33/860
160/P21
P23 / 170
170 AUTO OFF
P22 / 740
740 ON-OFF
+5/+12V
115V 90C 90C 930
TB2 P13 P14 P20 P10 P19
930 230V
230V
90 115
860
BAR FEED MOTOR
AUTO DR MOTOR
GFCI
HIL-L OPTION
DOOR SWITCH
N/A
90 115V
X-AXIS BRAKE
W-AXIS BRAKE
PROBE OPTION
C- AXIS SOLENOID
L/T OPTION
390 LIVE TOOLING (OPTION)
HPU / TT SOL
880B HI/LOW GEAR CMDS
Y/DELTA
GRIPPER SOL
W- AXIS SIGNAL LIGHT\EXT PUSH
SIGNAL LIGHT
EXTD PUSH
HPU MTR PWR
HYD PUMP
SERVO BRAKE
COOL /TSC 230 IN
940 230V COOLANT
170 AUTO OFF
300A GEAR BOX OIL PUMP
300 LUBER
160 230V CHIP CNVYR
TRANSMISSION ASSY
77,78,79
TMD CARD
P4
P1
P3
P2
HYD CLNT PUMP
GEAR BOX OIL PUMP
HAAS VECTOR DRIVE
970 IOPCB P18
640C C AXIS
J1
J3
REGEN RES 325DC
INPUT 230V3ø
GRND
OUTPUT TO MOTOR
REG. RES.
REGEN DC BUS
DC BUS
77L3
78L2
79L1
GND
651U
652V
653W
880C
K4(Y)
K5(D)
650A K TO MTR
650B
650 SP MTR
TT STATUS
880A TT,CHUCK CLMP/UNCLMP
300 SP OIL
TOOL TURR
HPU CLMP UNCL
OIL PUMP
SP FAN
SPDL MTR
690C MTR ENCODER
74, 75, 76
79L1
78L2
77L3
96
95
94
195-260VAC (354-488)
MAIN XFORMER
230VAC
115VAC
1000 SP ENC
500 OVER TEMP
BRUSHLESS SERVO AMPLIFIER ASSEMBLY
325 VDC
490A
570
X 610
LT
Z 630
C 640
BF
TT 630
TS 640
SS 620
U 620
V 620
490
X AXIS
LT
Z AXIS
C AXIS
BF/W AXIS
TT AXIS
TS AXIS
SS AXIS
U AXIS
V AXIS
E
660 X HOME
670 LT HOME
680 Z HOME
C HOME
BF/W HOME
TT HOME
TS HOME
SS HOME
U HOME
V HOME



04/09

ST-30 BRUSHLESS SYSTEM
CABLE INTERCONNECT DIAGRAM

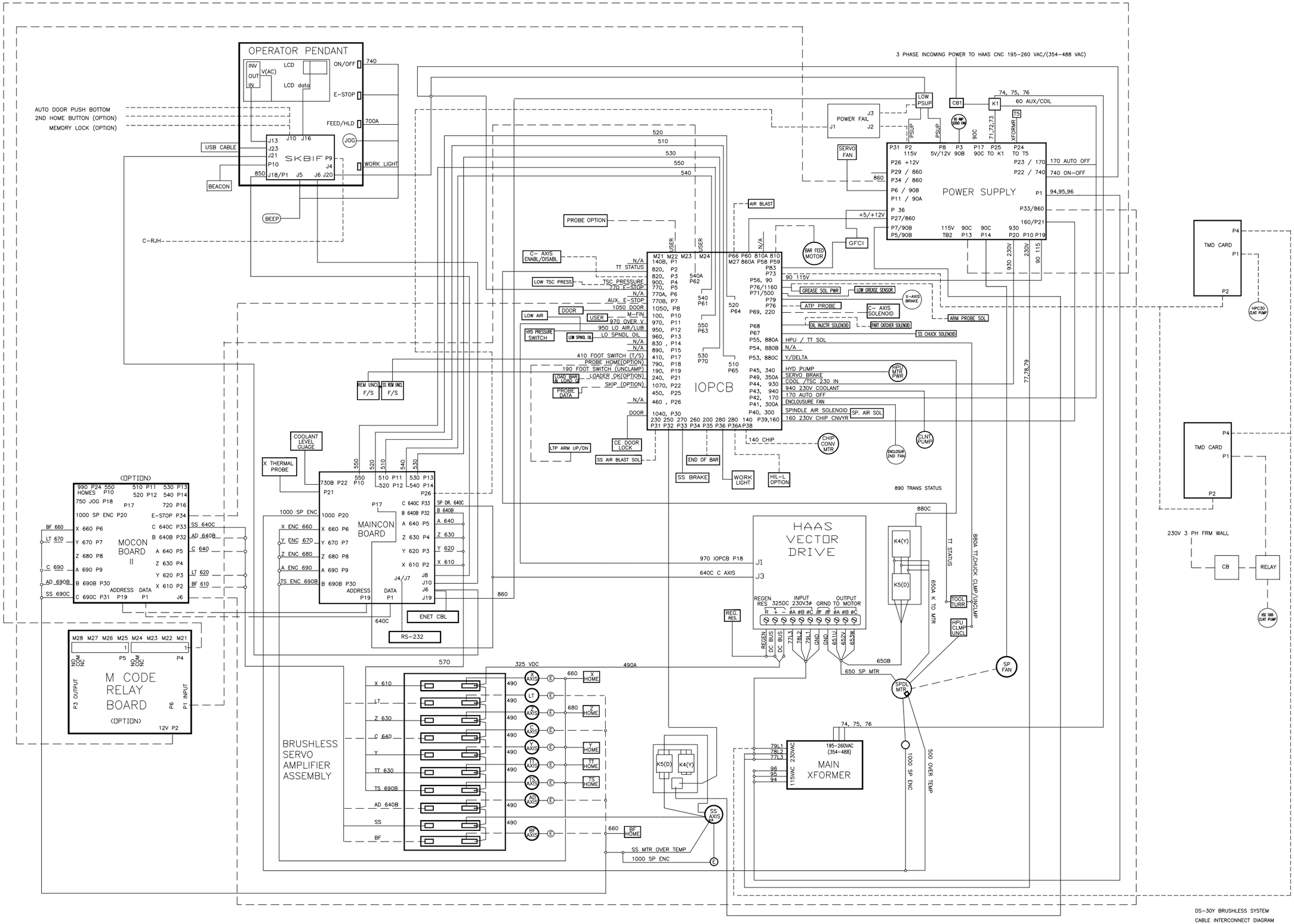


10/10

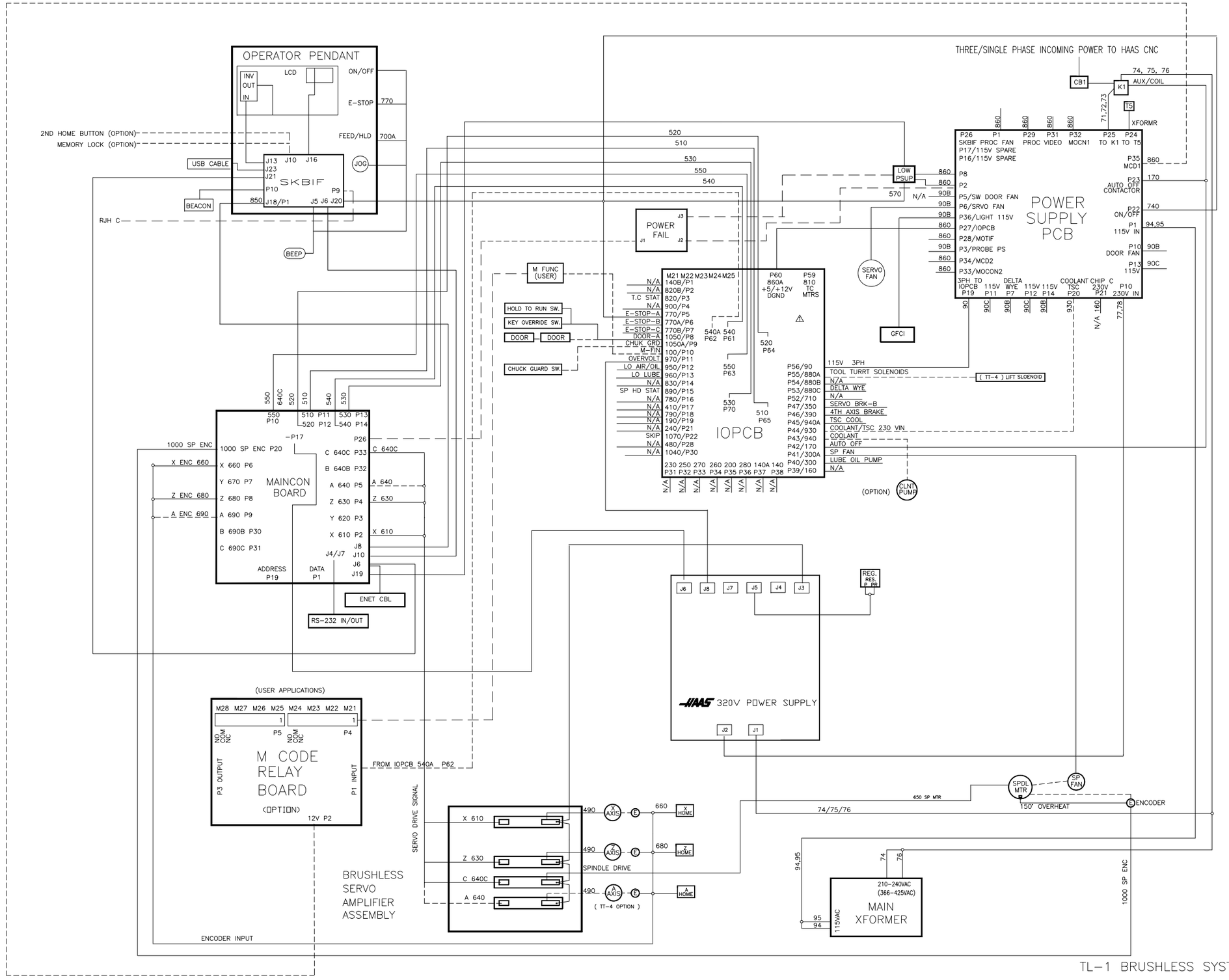
ST-20Y, ST-30Y BRUSHLESS SYSTEM
CABLE INTERCONNECT DIAGRAM

OPERATOR PENDANT
INV
OUT
IN
V(AC)
LCD
LCD data
ON/OFF
E-STOP
FEED/HLD
JOG
740
700A
AUTO DOOR PUSH BOTTOM
2ND HOME BUTTON (OPTION)
MEMORY LOCK (OPTION)
USB CABLE
BEACON
BEEP
C-RJH
J13
J23
J21
P10
J18/P1
J10 J16
SKBIF P9
J4
J5 J6 J20
850
3 PHASE INCOMING POWER TO HAAS CNC 195-260 VAC/(354-488 VAC)
LOW PSUP
CB1
K1
74, 75, 76
60 AUX/COIL
POWER FAIL
J3
J1 J2
PSUP
PSUP
90C
71,72,73
XFORMR
T5
SERVO FAN
860
P31 P2 115V
P8 5V/12V
P3 90B
P17 90C TO K1
P25
P24 TO T5
P26 +12V
P29 / 860
P34 / 860
P6 / 90B
P11 / 90A
P 36
P27/860
P7/90B
P5/90B
POWER SUPPLY
P1
P23 / 170
P22 / 740
170 AUTO OFF
740 ON-OFF
94,95,96
P33/860
160/P21
+5/+12V
115V 90C 90C 930
TB2 P13 P14 P20 P10 P19
930 230V
230V
90 115
520
510
530
550
540
PROBE OPTION
AIR BLAST
BAR FEED MOTOR
GFCI
C- AXIS ENABL/DISABL
LOW TSC PRESS
LOW AIR
DOOR
USER
HYD PRESSURE SWITCH
LOW SPNDL OIL
M21 M22 M23 M24
140B, P1
820, P2
820, P3
900, P4
770, P5
770A, P6
770B, P7
1050, P8
100, P10
970, P11
950, P12
960, P13
830 , P14
890, P15
410, P17
790, P18
190, P19
240, P21
1070, P22
450, P25
460 , P26
1040, P30
230 250 270 260 200 280 280 140 P39,160
P31 P32 P33 P34 P35 P36 P36A P38
N/A
TT STATUS
TSC PRESSURE
770 E-STOP
AUX. E-STOP
1050 DOOR
M-FIN
970 OVER V
950 LO AIR/LUB
LO SPNDL OIL
410 FOOT SWITCH (T/S)
PROBE HOME(OPTION)
190 FOOT SWITCH (UNCLAMP)
LOADER OK(OPTION)
SKIP (OPTION)
LOAD BAR & LOAD OK
PROBE DATA
540A P62
540 P61
550 P63
530 P70
510 P65
520 P64
IOPCB
P66 P60 810A 810
M27 860A P58 P59
P83
P73
P56, 90
P76/1160
P71/500
P79
P76
P69, 220
P68
P67
P55, 880A
P54, 880B
P53, 880C
P45, 340
P49, 350A
P44, 930
P43, 940
P42, 170
P41, 300A
P40, 300
90 115V
GREASE SOL PWR
LOW GREASE SENSOR
X-AXIS BRAKE
ATP PROBE
C- AXIS SOLENOID
OIL INJCTR SOLENOID
PART CATCHER SOLENOID
ARM PROBE SOL
SS CHUCK SOLENOID
HPU / TT SOL
N/A
Y/DELTA
HYD PUMP
SERVO BRAKE
COOL /TSC 230 IN
940 230V COOLANT
170 AUTO OFF
ENCLOSURE FAN
SPINDLE AIR SOLENOID
160 230V CHIP CNVYR
HPU MTR PWR
SP. AIR SOL
77,78,79
140 CHIP
CHIP CONV MTR
CLNT PUMP
ENCLSUR 2ND FAN
LTP ARM UP/DN
CE DOOR LOCK
SS AIR BLAST SOL
END OF BAR
SS BRAKE
WORK LIGHT
HIL-L OPTION
REM UNCL F/S
SS REM UNCL F/S
COOLANT LEVEL GUAGE
X THERMAL PROBE
TMD CARD
P4
P1
P2
HPC30 CLNT PUMP
230V 3 PH FRM WALL
CB
RELAY
HSC 1000 CLNT PUMP
(OPTION)
990 P24 550 HOMES P10
750 JOG P18
P17
1000 SP ENC P20
X 660 P6
Y 670 P7
Z 680 P8
A 690 P9
B 690B P30
C 690C P31
ADDRESS DATA P19 P1
510 P11 520 P12 530 P13 540 P14 720 P16
E-STOP P34
C 640C P33
B 640B P32
A 640 P5
Z 630 P4
Y 620 P3
X 610 P2
J6
MOCON BOARD II
SS 640C
AD 640B
C 640
LT 620
LT 670
C 690
AD 690B
SS 690C
730B P22
P21
550 P10
510 P11 520 P12 530 P13 540 P14
P26
1000 SP ENC
X ENC 660
BF ENC 670
Z ENC 680
A ENC 690
TS ENC 690B
MAINCON BOARD
P17
C 640C P33
B 640B P32
A 640 P5
Z 630 P4
Y 620 P3
X 610 P2
J4/J7
J8
J10
J6
J19
SP DR. 640C
B 640B
A 640
Z 630
BF 620
X 610
860
640C
ENET CBL
RS-232
M CODE RELAY BOARD
(OPTION)
12V P2
M28 M27 M26 M25 M24 M23 M22 M21
P5
P4
P3 OUTPUT
P1 INPUT
P6
HAAS VECTOR DRIVE
970 IOPCB P18
640C C AXIS
J1
J3
REGEN RES
325DC
INPUT 230V3ø
GRND
OUTPUT TO MOTOR
REG. RES.
REGEN
DC BUS
DC BUS
77L3
78L2
79L1
GND
651U
652V
653W
880C
650A K TO MTR
650B
650 SP MTR
TT STATUS
TOOL TURR
HPU CLMP UNCL
880A TT,CHUCK CLMP/UNCLMP
K4(Y)
K5(D)
SP FAN
SPDL MTR
570
325 VDC
490A
660 X HOME
680 Z HOME
BF HOME
TT HOME
TS HOME
X 610
LT
Z 630
C 640
BF
TT 630
TS 690B
AD 640B
SS
490
X AXIS
LT
Z AXIS
C AXIS
BF AXIS
TT AXIS
TS AXIS
AD AXIS
SS AXIS
BRUSHLESS SERVO AMPLIFIER ASSEMBLY
SS MTR OVER TEMP
74, 75, 76
195-260VAC (354-488)
MAIN XFORMER
79L1
78L2
77L3
115VAC 230VAC
96
95
94
1000 SP ENC
500 OVER TEMP
890 TRANS STATUS

DS-30 BRUSHLESS SYSTEM
CABLE INTERCONNECT DIAGRAM

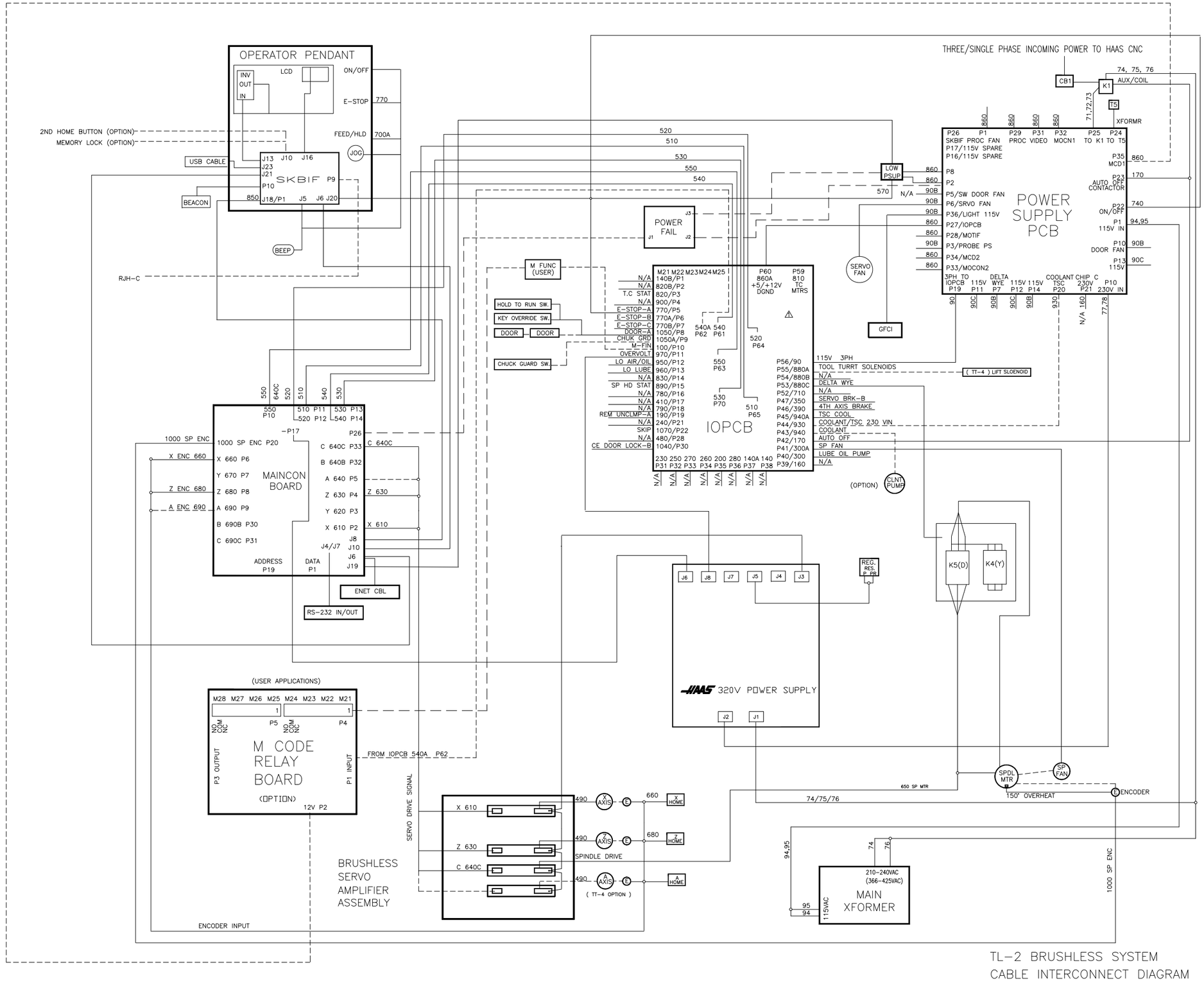


DS-30Y BRUSHLESS SYSTEM
CABLE INTERCONNECT DIAGRAM

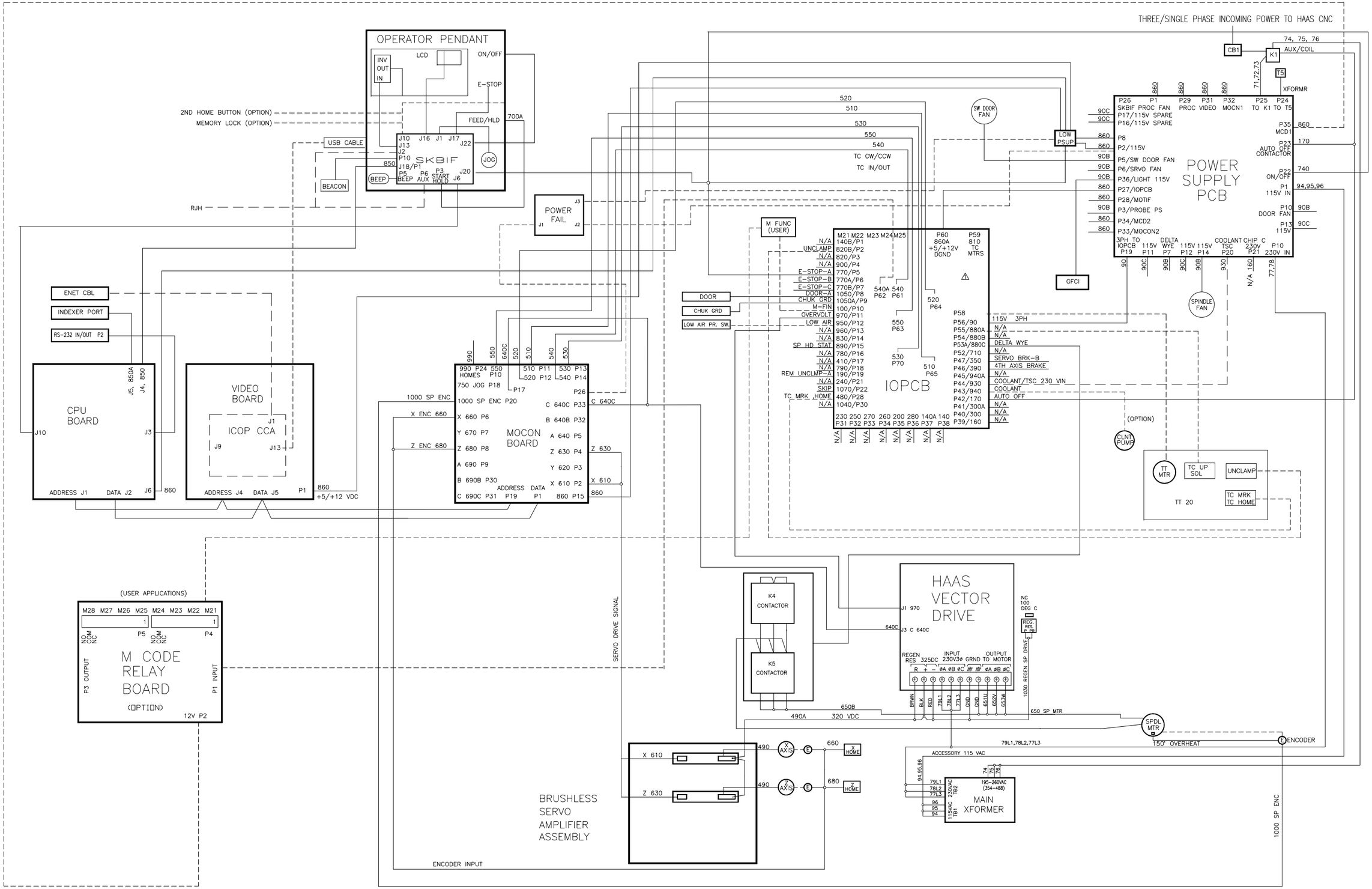


TL-1 BRUSHLESS SYSTEM

CABLE INTERCONNECT DIAGRAM



TL-2 BRUSHLESS SYSTEM
CABLE INTERCONNECT DIAGRAM



TL-3

CABLE INTERCONNECT DIAGRAM

THREE/SINGLE PHASE INCOMING POWER TO HAAS CNC

CB1 — K1 — 74, 75, 76 AUX/COIL — T5 XFORMR — 71,72,73

OPERATOR PENDANT
LCD
INV
OUT
IN
ON/OFF
E-STOP
FEED/HLD
700A
JOG
2ND HOME BUTTON (OPTION)
MEMORY LOCK (OPTION)
USB CABLE
BEACON
BEEP
RJH-C
J13 J10 J16
J23
J21
P10
SKBIF
P9
J20
850
J18/P1 J5 J6

POWER FAIL J3 J2 J1

520
510
530
550
540
TC CW/CCW
TC IN/OUT

LOW PSUP

860 860 860 860
P26 P1 P29 P31 P32 P25 P24
SKBIF PROC FAN
P17/115V SPARE
P16/115V SPARE
P8
P2/115V
P5/SW DOOR FAN
P6/SRVO FAN
P36/LIGHT 115V
P27/IOPCB
P28/MOTIF
P3/PROBE PS
P34/MCD2
P33/MOCON2
PROC VIDEO MOCN1 TO K1 TO T5
90C 90C 860 860 90B 90B 90B 860 860 90B 860 860
P35 MCD1 860
P23 AUTO OFF CONTACTOR 170
P22 ON/OFF 740
P1 115V IN 94,95,96
P10 DOOR FAN 90B
P13 115V 90C
POWER SUPPLY PCB
3PH TO IOPCB P19 | 115V P11 | DELTA WYE P7 | 115V P12 | 115V P14 | COOLANT CHIP C TSC P20 | 230V P21 | P10 230V IN
90 90C 90B 90C 90B 930 N/A 160 77,78

GFCI
SPINDLE FAN

M FUNC (USER)

HOLD TO RUN SW.
KEY OVERRIDE SW.
DOOR SW.
DOOR SW.
CHUCK GUARD SW.
LOW AIR PR. SW.

M21 M22 M23 M24 M25
N/A 140B/P1
UNCLAMP 820B/P2
N/A 820/P3
N/A 900/P4
E-STOP-A 770/P5
E-STOP-B 770A/P6
E-STOP-C 770B/P7
DOOR-A 1050/P8
CHUK GRD 1050A/P9
M-FIN 100/P10
OVERVOLT 970/P11
LOW AIR 950/P12
N/A 960/P13
N/A 830/P14
SP HD STAT 890/P15
N/A 780/P16
N/A 410/P17
N/A 790/P18
REM UNCLMP-A 190/P19
N/A 240/P21
SKIP 1070/P22
TC MRK HOME 480/P28
N/A 1040/P30
230 250 270 260 200 280 140A 140 P31 P32 P33 P34 P35 P36 P37 P38
540A 540 P62 P61
550 P63
530 P70
510 P65
520 P64
P60 860A +5/+12V DGND
P59 810 TC MTRS
P58
115V 3PH
P56/90
P55/880A
P54/880B
P53A/880C
P52/710
P47/350
P46/390
P45/940A
P44/930
P43/940
P42/170
P41/300A
P40/300
P39/160
N/A
HI/LO GEAR SOL
DELTA WYE
N/A
SERVO BRK-B
4TH AXIS BRAKE
N/A
COOLANT/TSC 230 VIN
COOLANT
AUTO OFF
TRANS OIL (TL-3W)
LUBE OIL PUMP
N/A
IOPCB
SOL PWR
LUBE OIL PUMP
TRANS OIL PUMP
TRANSMISSION (TL-3W)
(OPTION)
CLNT PUMP
TT MTR
TC UP SOL
UNCLAMP
TC MRK TC HOME
TT 20

550 640C 520 510 540 530
550 P10
510 P11 520 P12 530 P13 540 P14
P17
P26
1000 SP ENC
X ENC 660
Z ENC 680
1000 SP ENC P20
X 660 P6
Y 670 P7
Z 680 P8
A 690 P9
B 690B P30
C 690C P31
MAINCON BOARD
C 640C P33
B 640B P32
A 640 P5
Z 630 P4
Y 620 P3
X 610 P2
J8
J4/J7 J10
J6 J19
ADDRESS P19 DATA P1
C 640C
Z 630
X 610
ENET CBL
RS-232 IN/OUT P2

(USER APPLICATIONS)
M28 M27 M26 M25 M24 M23 M22 M21
P5 P4
M CODE RELAY BOARD
(OPTION)
P3 OUTPUT
P1 INPUT
12V P2

SERVO DRIVE SIGNAL

K4 CONTACTOR
K5 CONTACTOR
640C
650B
490A
320 VDC

HAAS VECTOR DRIVE
J1 970
J3 C 640C
NC 100 DEG C
REGEN RES
REGEN RES 325DC
INPUT 230V3ø GRND TO MOTOR
R + – øA øB øC
BRWN BLK RED 79L1 78L2 77L3 GND 651U 652V 653W
1030 REGEN SP DRIVE
650 SP MTR
SPDL MTR
150° OVERHEAT
ENCODER
79L1,78L2,77L3
ACCESSORY 115 VAC
94,95,96
79L1 78L2 77L3 230VAC TB2
96 95 94 115VAC TB1
195-260VAC (354-488)
MAIN XFORMER
74 75 76

X 610
Z 630
490
660
680
X AXIS
Z AXIS
X HOME
Z HOME
BRUSHLESS SERVO AMPLIFIER ASSEMBLY
ENCODER INPUT
1000 SP ENC

TL-3/ TL-3W
CABLE INTERCONNECT DIAGRAM

THREE/SINGLE PHASE INCOMING POWER TO HAAS CNC

CB1

K1

74, 75, 76 AUX/COIL

71,72,73

T5 XFORMR

OPERATOR PENDANT

LCD

INV OUT IN

ON/OFF

E-STOP

FEED/HLD

700A

JOG

2ND HOME BUTTON (OPTION)

MEMORY LOCK (OPTION)

USB CABLE

BEACON

BEEP

RJH-C

J13 J10 J16 J23 J21 SKBIF P9 P10 J20 J18/P1 J5 J6

850

520 510 530 550 540 TC CW/CCW TC IN/OUT

POWER FAIL J3 J1 J2

M FUNC (USER)

HOLD TO RUN SW.

KEY OVERRIDE SW.

TRVL DOOR SW.

CHUCK GUARD SW.

LOW AIR PR. SW.

SPINDLE DOOR SW.

M21 M22 M23 M24 M25 P60 P59

N/A 140B/P1
UNCLAMP 820B/P2
N/A 820/P3
N/A 900/P4
E-STOP-A 770/P5
E-STOP-B 770A/P6
E-STOP-C 770B/P7
DOOR-A 1050/P8
CHUK GRD 1050A/P9
M-FIN 100/P10
OVERVOLT 970/P11
LOW AIR 950/P12
N/A 960/P13
N/A 830/P14
SP HD STAT 890/P15
N/A 780/P16
N/A 410/P17
N/A 790/P18
REM UNCLMP-A 190/P19
N/A 240/P21
SKIP 1070/P22
TC MRK HOME 480/P28
N/A 1040/P30

860A +5/+12V DGND 810 TC MTRS

540A P62 540 P61 550 P63 520 P64 530 P70 510 P65

P58
P56/90 115V 3PH
P55/880A N/A
P54/880B HI/LO GEAR SOL
P53A/880C DELTA WYE
P52/710 N/A
P47/350 SERVO BRK-B
P46/390 4TH AXIS BRAKE
P45/940A N/A
P44/930 COOLANT/TSC 230 VIN
P43/940 COOLANT
P42/170 AUTO OFF
P41/300A TRANS OIL
P40/300 LUBE OIL PUMP
P39/160 N/A

230 250 270 260 200 280 140A 140
P31 P32 P33 P34 P35 P36 P37 P38

IOPCB

SOL PWR

LUBE OIL PUMP

TRANS OIL PUMP

TRANSMISSION

(OPTION) CLNT PUMP

LOW PSUP

GFCI

860 860 860 860 860

P26 P1 P29 P31 P32 P25 P24
SKBIF PROC FAN PROC VIDEO MOCN1 TO K1 TO T5
90C P17/115V SPARE
90C P16/115V SPARE
860 P8
860 P2/115V
90B P5/SW DOOR FAN
90B P6/SRVO FAN
90B P36/LIGHT 115V
860 P27/IOPCB
860 P28/MOTIF
90B P3/PROBE PS
860 P34/MCD2
860 P33/MOCON2

POWER SUPPLY PCB

P35 860 MCD1
P23 170 AUTO OFF CONTACTOR
P22 740 ON/OFF
P1 94,95,96 115V IN
P10 90B DOOR FAN
P13 90C 115V

3PH TO IOPCB P19 | 115V P11 | DELTA WYE P7 | 115V P12 | 115V P14 | COOLANT CHIP C TSC P20 | 230V P21 | 230V IN P10

90 90C 90B 90C 90B 930 N/A 160 77,78

SPINDLE FAN

550 640C 520 510 540 530
550 P10 510 P11 530 P13 520 P12 540 P14 P17

MAINCON BOARD

1000 SP ENC 1000 SP ENC P20
X ENC 660 X 660 P6
Z ENC 680 Y 670 P7
Z 680 P8
A 690 P9
B 690B P30
C 690C P31

P26
C 640C P33 C 640C
B 640B P32
A 640 P5
Z 630 P4 Z 630
Y 620 P3
X 610 P2 X 610
J8
J4/J7 J10
J6
J19

ADDRESS P19 DATA P1

ENET CBL

RS-232 IN/OUT P2

(USER APPLICATIONS)

M28 M27 M26 M25 M24 M23 M22 M21
1 1
NO COM NC P5 COM NO NC P4

M CODE RELAY BOARD
(OPTION)

P3 OUTPUT P1 INPUT
12V P2

SERVO DRIVE SIGNAL

HAAS VECTOR DRIVE

J1 970
640C J3 C 640C

NC 100 DEG C

REGEN RES | 325DC | INPUT 230V3ø | GRND | OUTPUT TO MOTOR
R + - | ø A ø B ø C | | ø A ø B ø C

BRWN BLK RED 79L1 78L2 77L3 GND GND 651U 652V 653W

1030 REGEN SP DRIVE

650 SP MTR

490A 320 VDC

SPDL MTR

150° OVERHEAT

ENCODER

79L1,78L2,77L3

ACCESSORY 115 VAC

94,95,96

74 75 76

79L1 78L2 77L3 195-260VAC (354-488) MAIN XFORMER

115VAC TB1 96 95 94 230VAC TB2

X 610 Z 630

490 X AXIS E 660 HOME

490 Z AXIS E 680 HOME

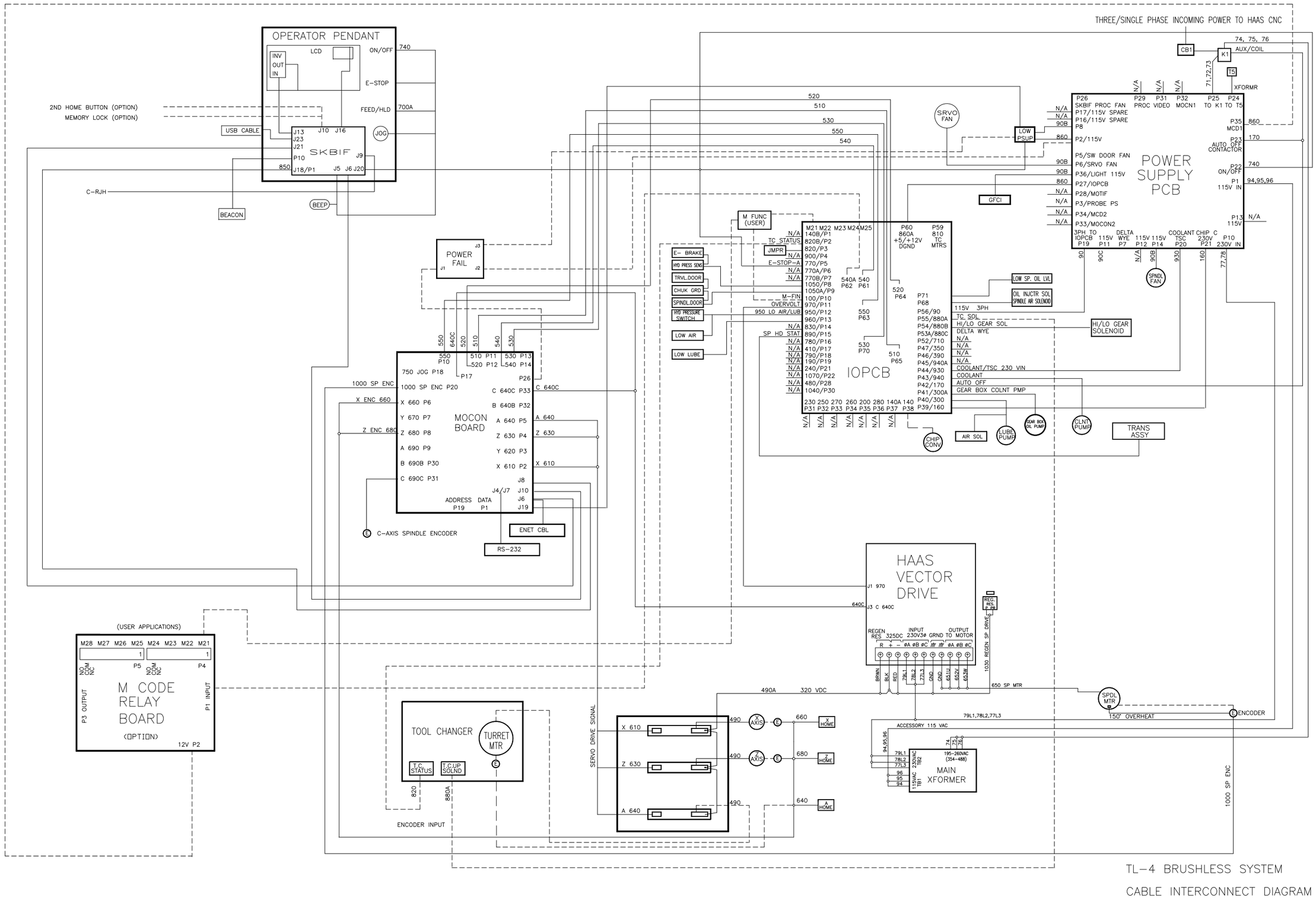
BRUSHLESS SERVO AMPLIFIER ASSEMBLY

ENCODER INPUT

1000 SP ENC

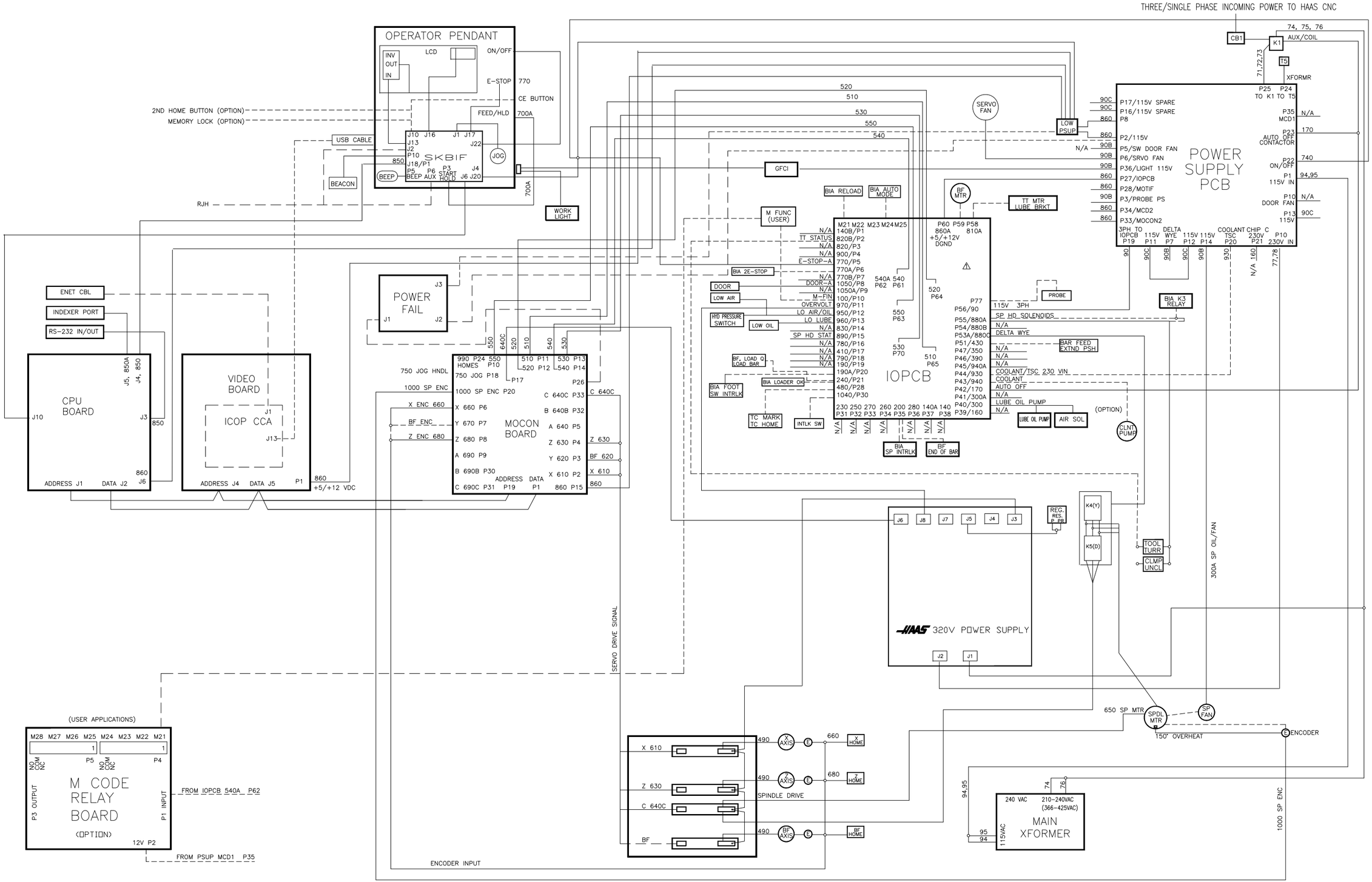
TT MTR TC_UP SOL UNCLAMP TC MRK TC HOME TT 20

TL-3B
CABLE INTERCONNECT DIAGRAM

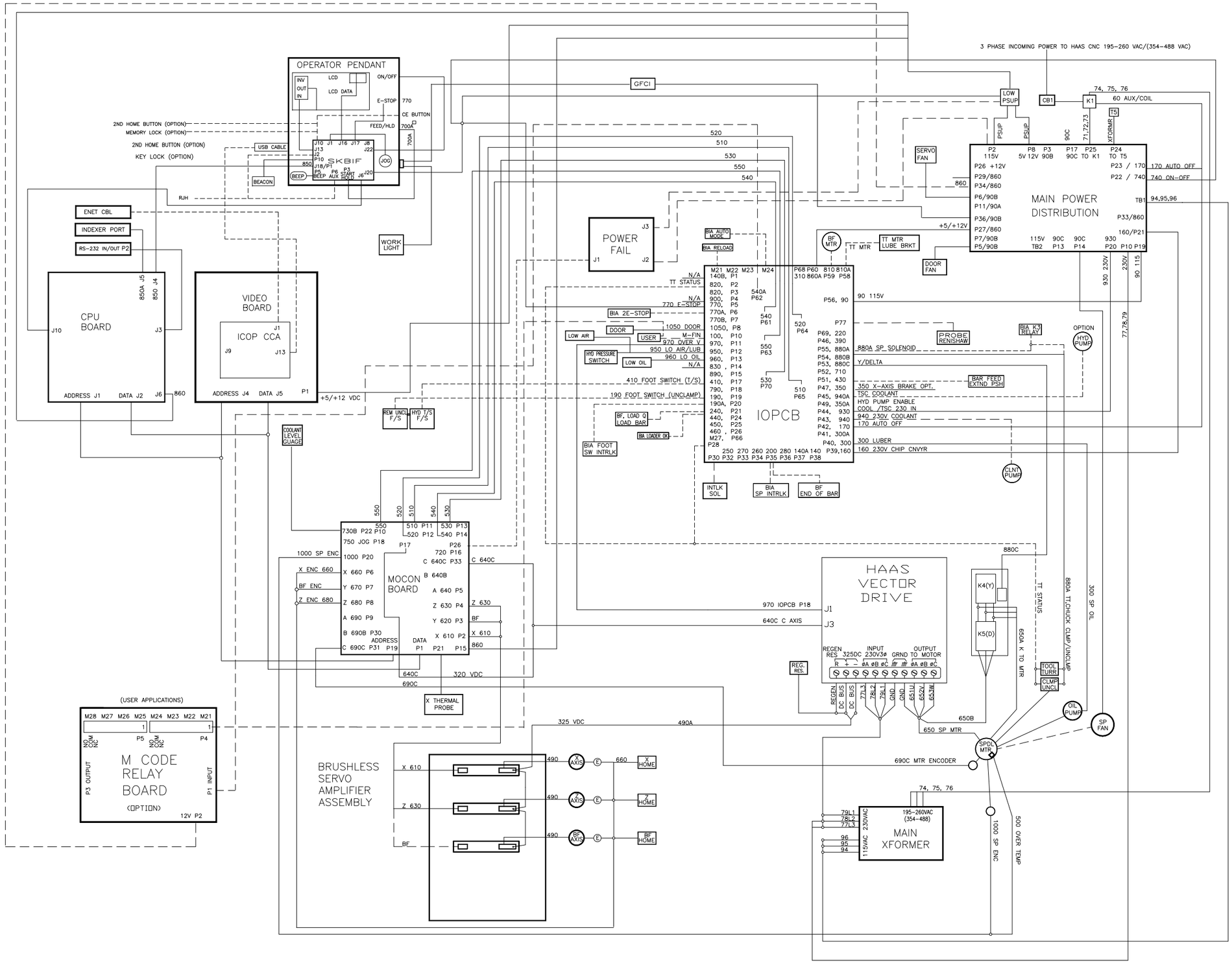


TL-4 BRUSHLESS SYSTEM

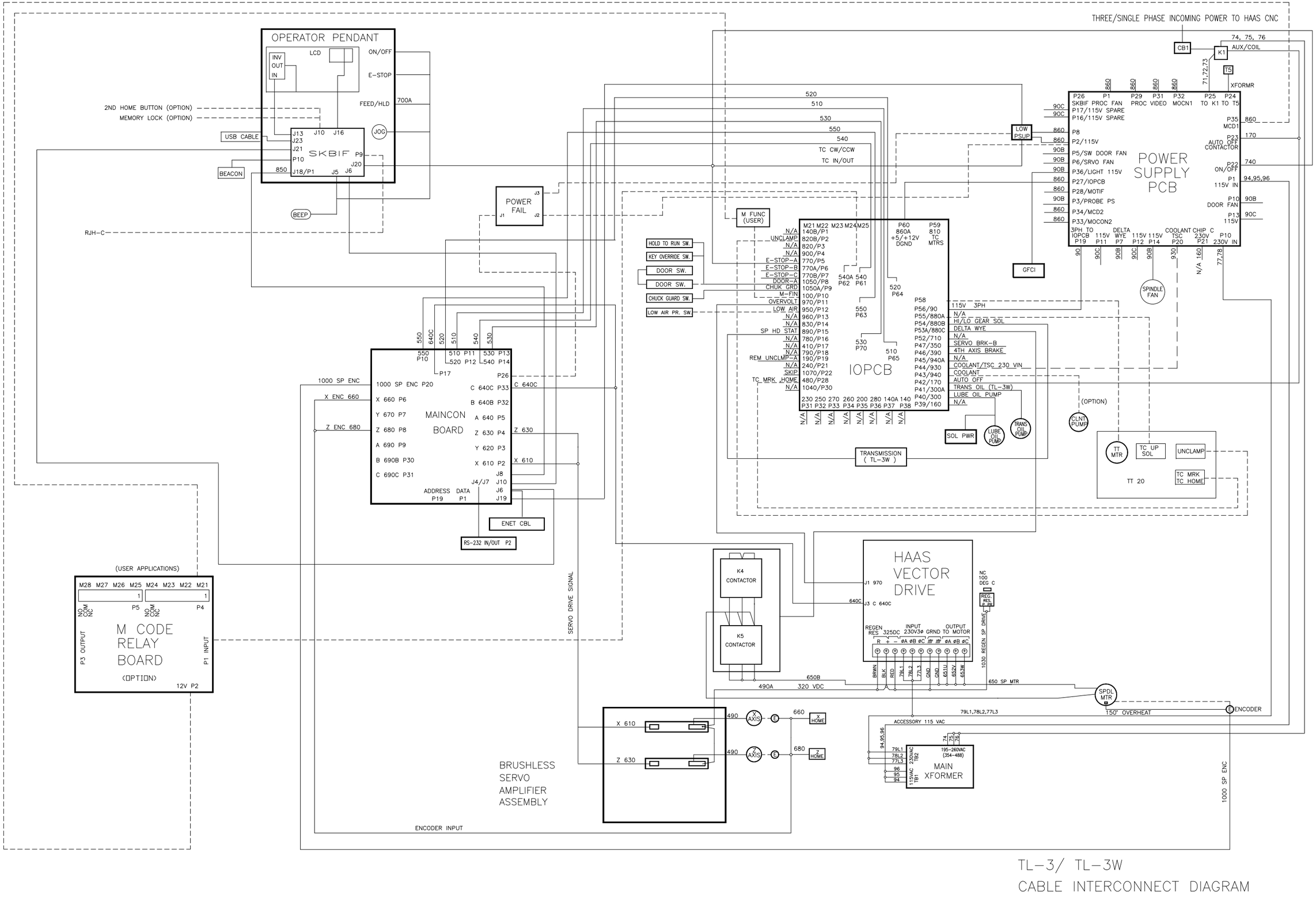
CABLE INTERCONNECT DIAGRAM



GT-10 CABLE INTERCONNECT DIAGRAM



CABLE INTERCONNECT DIAGRAM – GT SERIES (BRUSHLESS)



TL-3/ TL-3W
CABLE INTERCONNECT DIAGRAM