HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

VF-Series Service Manual 96-8100 English January 15 1996

- 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.

TROUBLESHOOTING

This section is intended for use in determining the solution to a known problem. Solutions given are intended to give the individual servicing the CNC a pattern to follow in, first, determining the problem's source and, second, solving the problem.

The troubleshooting tips are organized in this section according to the area of the CNC that may be giving sign of a problem. (Ex.: Out-of round circles in drilling will be found under the heading General Machine Operation - Accuracy).

If the problem you are experiencing cannot be found under the heading you expect, please try several other possible headings. If the problem is still not found, contact Haas Automation for further details.

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. You must look at all three before blaming one as the fault area. If a bored hole is chattering because of an overextended boring bar, don't expect the machine to correct the fault. Don't suspect machine accuracy if the vise bends the part. Don't claim hole mis-positioning if you don't first center-drill the hole.

FIND THE PROBLEM FIRST

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

DON'T TINKER WITH THE MACHINE

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

1. GENERAL MACHINE OPERATION

1.1 MACHINE NOT RUNNING

Machine cannot be powered on.

- Check input voltage to machine (see "Electrical Service").
- Check main circuit breaker at top right of electrical cabinet; switch must be at the on position.
- Check overvoltage fuses (see "Electrical Service").
- Check wiring to POWER OFF button on front control panel.
- Check wiring to AUTO OFF relay to IOPCB.
- Replace IOPCB (see "Electrical Service").
- Replace POWER PCB (see "Electrical Service").

Machine can be powered on, but turns off by itself.

- Check settings #1 and #2 for Auto Off Timer or Off at M30.
- Check alarm history for OVERVOLTAGE or OVERHEAT shutdown.
- Check AC power supply lines for intermittent supply.
- Check wiring to POWER OFF button on front control panel.
- Replace IOPCB (see "Electrical Service").
- Check Parameter 57 for Power Off at E-STOP.
- Replace MOTIF PCB (see "Electrical Service").

Machine turns on, keyboard beeps, but no CRT display.

- Check for green POWER LED at front of CRT.
- Check for power connections to CRT from IOPCB.
- Check video cable (760) from VIDEO PCB to CRT.
- Replace CRT (see "Electrical Service").

Any LED on Microprocessor PCB goes out (except HALT).

- Replace Microprocessor PCB (Section 4.1, Electrical Service).
- Replace VIDEO PCB (see "Electrical Service").
- Replace MOTIF PCB (see "Electrical Service").

Machine turns on, CRT works, but no keyboard keys work.

- Check keyboard cable (700) from VIDEO to KBIF PCB.
- Replace keypad (see "Electrical Service").
- Replace KBIF PCB (see "Electrical Service").

1.2 VIBRATION

Vibration is a subjective evaluation with perceptions varying among individuals, making it difficult to determine in mild cases if there is an actual problem. Because the VF Series uses a gear head, it will be noisier than a direct drive or belt system. In obvious cases, it is a matter of determining the source _ which is not easy, since all parts rotate together and sound can be transferred readily. Vibrations also need to be distinguished from noise such as a bad bearing. We will assume that vibrations would be something that could be felt by putting your hand on the spindle covers. One crude method of measurement would be to take an 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 being observed. 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 jogging the axis with the hand wheel.

- The HAAS control uses very high gain accelerations curves. This vibration as you jog is simply the servos quickly trying to follow the 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.

⍰ The machine vibrates excessively in a cut.

- This is a tough one to call because machining practices come into play. Generally speaking, the least rigid element of a cut is the tool because 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, you need to 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 in both operation and “cutting air.” Move the axes (individually) without the spindle turning and then turn the spindle without moving the axes. Isolate whether the vibration comes from the spindle head or from an axis. Isolate the source of vibration per "Spindle", "Servo Motors/Leadscrews", and "Gearbox and Spindle Motor" sections.

1.3 ACCURACY

Before you complain of an accuracy problem, please make sure you follow these simple do's and don'ts.

- Don't ever use a wiggler test indicator for linear dimensions. They measure in an arc and have sine/cosine errors over larger distances.
- Don't use magnetic bases as accurate test stops. The high accel/decel of the axis can cause them to move.
- Don't attach test points to the sheet metal of the spindle head or table.
- Don't check for thermal growth with an indicator on a long extension magnetic base.
- Do insure that test indicators and stops are absolutely rigid and mounted to machined casting surfaces.
- Do check a suspected error with another indicator or method for verification.
- Do ensure that the indicator is parallel to the axis being checked to avoid tangential reading errors.
- Do center drill holes before using jobber length 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.

⍰ Machine will not interpolate a round hole.

- Check the levelness of the machine (See the Installation Manual).
- Check for backlash ("Servo Motors/Leadscrews" section).

⍰ Bored holes do not go straight through the workpiece.

- Check the levelness of the machine (See the Installation Manual).
- Check for squareness in the Z axis.

⍰ Machine bores holes out-of-round.

- Check the levelness of the machine (See the Installation Manual).
- Check the sweep of the machine ("Spindle Sweep Adjustment").

⍰ Bored holes are out of round or out of postion.

- The spindle is not parallel to the Z axis. Check the spindle sweep to the table and the squareness of the Z axis with a cylinder square. If available use a spindle master bar and indicate the spindle to the Z axis.

⍰ Machine mis-positions holes.

- Check the levelness of the machine (See the Installation Manual).
- Check for backlash ("Servo Motors/Leadscrews").
- Check the squareness of the X axis to the Y axis.

⍰ Machine leaves large steps when using a shell mill.

- Check the levelness of the machine (See the Installation Manual).
- Check the sweep of the machine ("Spindle Sweep Adjustment").
- Cutter diameter too large for depth of cut.

Boring depth inaccurate (VF-6)

Insufficient counterbalance pressure due to:

- corrupted hose
- bad regulator
- bad check valve
- air cylinder bad
- bound cylinder
- surge tank leak

1.4 FINISH

Machining yields a poor finish.

- Check for gearbox vibration. This is the most common cause of a poor finish.
- Check for backlash ("Accuracy/Backlash" section)
- Check the condition of the tooling and the spindle.
- Check for spindle failure.
- Check the condition of the servo motors.
- Check the machine level.

2. SPINDLE

2.1 NOT TURNING

⍰ Spindle not turning.

- 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 "Belt Assembly" and "Spindle Motor & Transmission" sections.
- Command spindle to turn at 1800 RPM and check spindle drive display. If display blinks “bb”, check spindle orienta tion switch ("Spindle Orientation" section). If spindle drive does not light the RUN LED, check forward/reverse commands from IOPCB ("Electrical Service").
- Check the wiring of analog speed command from MOTIF PCB to spindle drive (cable 720).
- If spindle is still not turning, replace MOTIF PCB ("Electrical Service").
- If spindle is still not turning, replace spindle drive ("Electrical Service").
- Check for rotation of the gearbox (VF-1, VF-2, VF-3) or the motor (VF-0). If the motor or gearbox operates, check the drive belt ("Belt Assembly" section).

- Disconnect the drive belt. If the spindle will not turn, it is seized and must be replaced ("Spindle Assembly" section). NOTE: Before using the replacement spindle, the cause of the previous failure must be determined.

2.2 NOISE

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

⍰ Excessive noise coming from the spindle head area.

On VF-1 through 6 models, first 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, listen for a similar noise at 500 RPM in low gear. If the same noise persists, the problem lies with the gearbox. If the noise disappears, the problem could be either the gearbox or the spindle, and further testing is necessary.

- Remove the head covers and check the machine’s drive belt tension ("Tension Adjustment" section).
  - ➢ If the noise persists, turn the drive belt over on the pulleys. If the noise is significantly different, the belt is at fault. Replace the belt ("Belt Assembly" section).
  - ➢ If the noise does not change, remove the belt and go on to the next step.
- Check the pulleys for excessive runout (more than 0.003" axial or radial).
- Run the motor (VF-0) or the gearbox (VF-1, VF-2, VF-3) 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 (0.5-1.0 cc every two hours) in a 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).

2.3 OVERHEATING

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 in Diagnostics is not relevant. A machine that runs at high RPM continuously 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 broken in. In order to run a valid test on a new spindle, ensure that it is properly broken in.

To break in a spindle, run the following program (it will take approximately 6 hours):

```
N100 S300 M03
G04 P900.
M05
G04 P900.
N200 S1000 M03
G04 P900.
M05
G04 P900.
N300 S2000 M03
G04 P900.
M05
G04 P900.
G04 P900.
N400 S3000 M03
G04 P900.
M05
G04 P900.
G04 P900.
N500 S4000 M03
G04 P900.
M05
G04 P900.
G04 P900.
N600 S5000 M03
G04 P900.
M05
G04 P900.
G04 P900.
N700 S6000 M03
G04 P900.
M05
G04 P900.
G04 P900.
N800 S7500 M03
G04 P900.
M05
G04 P900.
G04 P900.
M99
```

NOTE: This program will step the spindle speed from 300 RPM up to either 5000 or 7500 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.

- If at any time during this procedure the spindle temperature rises above 150 degrees, start the procedure over from the beginning.
  If the spindle fails this test for any reason, check the following:
- Check for correct amount of lubrication.

NOTE: Over lubrication is a common source of overheating. Check the oil flow carefully.

- Check the drive belt tension. Too-tight belts will cause heating of the top bearing in the spindle housing.
- Ensure that the correct oil is being used (refer to "Maintenance Schedule").

2.4 STALLING/LOW TORQUE

Generally, complaints of stalling or low torque relate to incorrect tooling or machining practices. A spindle that is tending to seize 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.

2.5 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.

If the spindle is accelerated and decelerated frequently, the regenerative load resistor inside the control may heat up. If this resistor heats beyond 100°C, a thermostat will generate an "overheat" alarm.

If the regen load resistors are not connected or open, this could then result in an overvoltage alarm. 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.

2.6 ORIENTATION

⍰ Spindle loses correct orientation.

- Check alarm history, looking for spindle overload and axis overcurrent alarms. These alarms the machine is not being properly operated.
- Check the orientation ring for tightness. Ensure the shaft on which the ring mounts is free of grease.
- Check the orientation ring for cracks near the bolt holes or near the balancing holes.
  - ➢ If there are cracks, replace the ring.
- Check the shot pin on the gearbox for binding, damage, and proper operation. Replace it if it is damaged.
- Check the switch on the shot pin against the Diagnostic display. Replace the switch if it is found to be faulty.

2.7 TOOLS STICKING IN TAPER

⍰ Tool sticking in the taper causes ATC to be pulled up; accompanied by a popping noise as the tool holder pops out of the spindle taper.

NOTE: This problem may occur after loading a cold tool into a hot spindle (a result of thermal expansion of the tool holder inside the spindle taper). It may also occur due to heavy milling, milling with long tooling, or cuts with heavy vibration. If sticking only occurs during these situations, no service is necessary.

- Check the condition of the tooling, verifying the taper on the tooling 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 head on the machine.
- Ensure the spindle is not running too hot.

3. SERVO MOTORS/LEADSCREWS

3.1 NOT OPERATING

All problems that are caused by servo motor failures should also register an alarm. Check the alarm history to deter mine the problem's cause 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 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 assem bly ("Axis Motor Removal/Installation").
- Wiring is broken, shorted, or missing shield (Alarms 153-156, 175, 182-185).
- Dust in the motor from brushes has shorted out the motor (Alarms 153-156, 175, 182-185). Replace motor assembly ("Axis Motor Removal/Installation").
- Motor has overheated; no damage to the interior components. OVERHEAT alarm has been triggered. After thorough check of motor (DO NOT DISASSEMBLE!), take necessary steps to eliminate the problem and alarm to resume opera tion. If motor is still inoperable, replace motor assembly ("Axis Motor Removal/Installation").
- Check for broken or loose coupling between the servo motor and the lead screw. Replace or repair the coupling ("Axis Motor Removal/Installation")
- Check for a broken lead screw. If cracked or broken, replace ("Lead Screw Removal and Installation" section).

NOTE: If a lead screw fails, it is most often due to a failed bearing sleeve. When replacing the lead screw in an older machine, always replace the bearing sleeve with the current angular contact bearing sleeve ("Bearing Sleeve Removal and Installation" section).

3.2 NOISE

Lead screw 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 lead screws or bearing sleeves without due consideration; they are extremely durable and reli able. Verify that customer complaints are not due to tooling, programming, or fixturing problems.

◈ Servo motor noise.

- Disconnect the servo motor from the lead screw and rotate by hand. If the noise persists, replace the motor assembly ("Axis Motor Removal/Installation" section).
- Noise is caused by motor brushes. No problems will occur and noise should eventually go away.
- Noise is caused by bearings. Rolling, grinding sound is heard coming from the motor. ENSURE NOISE IS NOT COMING FROM THE BRUSHES. If bearings are making a consistently loud sound, replace the bearing sleeve.

Lead screw noise.

- Ensure oil is getting to the lead screw through the lubrication system (See Air and Oil Diagrams). 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 lead screw. Loosen the clamp nuts at both ends of the lead screw. If the symptom disappears, replace the bearing sleeve. Be certain to check for damage to the lead screw shaft where the bearing sleeve is mounted.
  - ➢ If the noise persists, the lead screw is damaged and must be replaced. When replacing the lead screw in an older machine, always replace the bearing sleeve with the current angular contact design bearing sleeve.

- Check the lead screw for misalignment. If incorrect, perform alignment procedure.
- Misalignment in the lead screw itself will tend to cause the lead screw to tighten up and make excessive noise at both ends of the travel. The ballnut may get hot. Misalignment radially at the yoke where the lead screw ball nut mounts is indicated by heating up of the ball nut on the lead screw, and noise and tightness through out the travel of the lead screw. Misalignment at the yoke where the ball nut mounts is indicated by noise and tightness at both ends of the travel of the lead screw. The ball nut may get hot.

Noise in Z - Motion (VF-6)

Brake won't release (leadscrew won't rotate)

- alarm not cleared
- low pressure switch blown
- brake power fuse blown
- brake power transformer blown
- brake power rectifier blown
- cabling pinched
- brake failed

3.3 ACCURACY/BACKLASH

Accuracy complaints are usually related to tooling, programming, or fixturing problems. Eliminate these possibilities before working on the machine.

Poor mill table-positioning accuracy.

- Check for a loose encoder on the servo motor. Also, ensure the key in the motor or the lead screw is in place and the coupling is tight.
- Check for backlash in the lead screw as outlined below:

INITIAL PREPARATION -

Turn the VMC ON. ZERO RET the machine and move the mill table to the approximate center of its travel in the X and Y directions. Move the spindle head to approximate center of the Z-axis travel, also.

CHECKING X-AXIS:

1. Set up a dial indicator and base on the mill table as shown in Fig. 3-1.

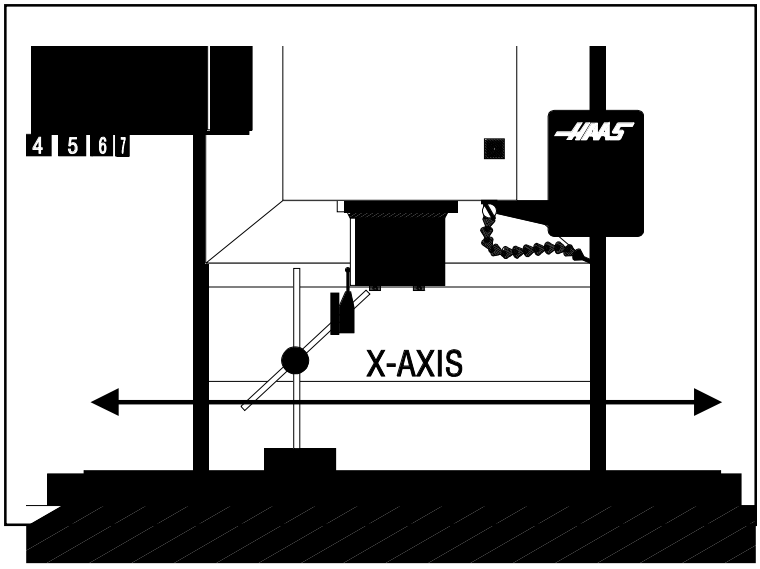


Fig. 3-1 Dial indicator in position to check X-axis.

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 button on the control panel.
   The "Distance to go" display on the lower right hand corner 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 three in the negative (-) direction.

TOTAL DEVIATION BETWEEN THE DIAL INDICATOR AND THE CONTROL PANEL DISPLAY SHOULD NOT EXCEED .0002.

An alternate method for checking backlash is to place the dial indicator as shown in Fig. 3-1 and manually push on the mill table in both directions. The dial indicator should return to zero after releasing the table.
NOTE: The servos must be on to check backlash by this method.

CHECKING Y-AXIS:

1. Set up a dial indicator and base on the mill table as shown in Fig. 3-2.

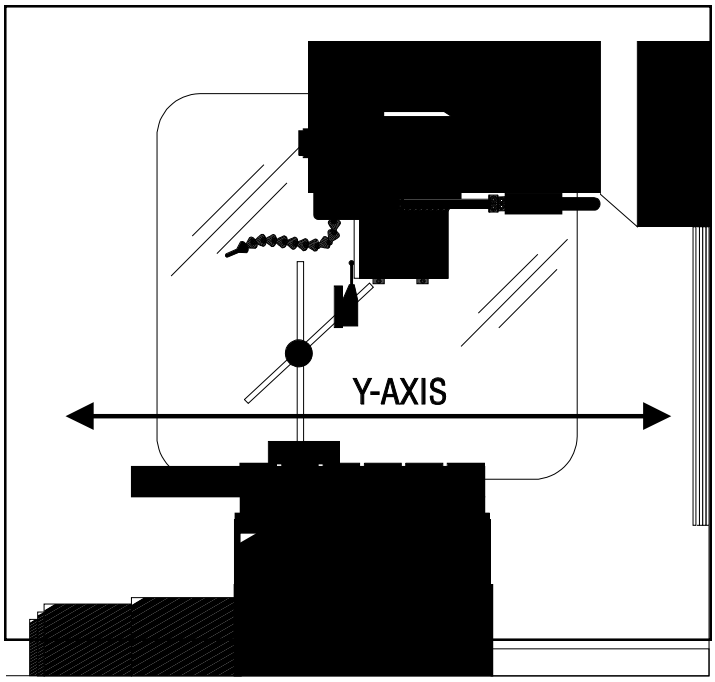


Fig. 3-2 Dial indicator in position to check Y-axis.

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 button on the control panel.

   The "Distance to go" display on the lower right hand corner 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 (+) Y direction. Jog back to zero (0) on the display. The dial indicator should read zero (0) ± .0001.

4. Repeat step three in the negative (-) direction.

TOTAL DEVIATION BETWEEN THE DIAL INDICATOR AND THE CONTROL PANEL DISPLAY SHOULD NOT EXCEED .0002.

An alternate method for checking backlash is to place the dial indicator as shown in Fig. 3-2 and manually push on the mill table in both directions. The dial indicator should return to zero after releasing the table.
NOTE: The servos must be on to check backlash by this method.

CHECKING Z-AXIS:

1. Set up a dial indicator and base on the mill table as shown in Fig. 3-3.
2. Manually push up and down on the spindle head while listening for a 'clunk'. Also, watch for any rapid change in the dial indicator. Either of these indicate possible backlash.

   NOTE: Servos must be on to check for backlash in the Z-axis.

   NOTE: Do not mistake deflection for backlash in the system.

Fig. 3-3 Dial indicator in position to check Z-axis.

If backlash is found in the system, check for the following possible causes:

- Loose SHCS attaching the ball nut to the nut housing. Tighten the SHCS as described in Mechanical Service.
- Loose SHCS attaching the nut housing to the mill table, spindle head, or saddle, depending on the axis. Tighten the SHCS as described in Mechanical Service.
- Loose clamp nut on the bearing sleeve. Tighten the SHCS on the clamp nut.
- Loose motor coupling. Tighten as described in Mechanical Service.
- Broken or loose flex plates on the motor coupling. (NOTE: The coupling cannot be serviced in the field and must be replaced as a unit if it is found to be defective.
- Loosen SHCS attaching the bearing sleeve to the motor housing. Tighten as described in "Lead Screw Removal and Installation".
- Defective thrust bearings in the bearing sleeve. Replace the bearing sleeve as outlined in "Bearing Sleeve Removal and Installation".
- Loose SHCS attaching the axis motor to the motor housing. If the SHCS are found to be loose, inspect the motor fordamage and if none is found, tighten as described in "Axis Motor Removal/Installation". If damage is found, replace the motor.
- Incorrect backlash compensation number in the parameter in the machine. Check Parameters 13, 27, and 41.
- Worn lead screw.

3.4 VIBRATION

⚠ Excessive servo motor vibration.

- If no “A” axis is present, swap the suspected bad servo motor with the “A” driver and check to see if there is a driver problem. If needed, replace the DRIVER PCB ("Electrical Service" section).
- Check all Parameters of the suspected axis against the Parameters as shipped with the machine. If there are any differ ences, correct those and determine how the Parameters were changed. PARAMETER LOCK should normally be on.
- A bad motor can cause vibration if there is an open or short in the motor. A short would normally cause a GROUND FAULT or OVERCURRENT alarm; check the ALARMS. An ohmmeter applied to the motor leads should show between 1 and 3 ohms between leads, and over 1 megohm from leads to chassis. If the motor is open or shorted, replace.

3.5 OVERHEATING

⚠ Servo motor overheating.

- If a motor OVERHEAT alarm occurs (ALARMS 135-138), check the Parameters for an incorrect setting. Axis flags in Parameters 1, 15, or 29 can invert the overheat switch (OVER TEMP NC).
- If the motor is actually getting hot to the touch, there is excessive load on the motor. Check the user’s application for ex cessive load or high duty cycle. Check the lead screw for binding ("Accuracy/Backlash" section). If the motor is binding by itself, replace in accordance with "Axis Motor Removal/Installation".

3.6 FOLLOWING ERROR

⚠ Following error alarms occur on one or more axes sporadically.

- Check DC bus voltage on diagnostics page #2. Verify this voltage on the drive cards in the control panel. If it is at the low side of the recommended voltages, change the transformer tap to the next lower voltage group as explained in the Installation Manual.
- Check motor wiring.
- Replace driver card ("Electrical Service").
- Replace servo motor ("Axis Motor Removal/Installation").

⚠ Z-axis motor overcurrent (VF-6)

- Brake won’t release (leadscrew won’t rotate)
  - ➢ alarm not cleared
  - ➢ low pressure switch blown
  - ➢ brake power fuse blown
  - ➢ brake power transformer blown
  - ➢ brake power rectifier blown
  - ➢ cabling pinched
  - ➢ brake failed

4. AUTOMATIC TOOL CHANGER

4.1 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. Before beginning any troubleshooting, observe the direction of the ATC deflection.

◈ During a tool change, ATC appears to be pushed down.

- Check to see if pull studs on the tool holder are correct and tight.
- Check the adjustment of the “Z” offset ("Setting Parameter 64").

  NOTE: If the offset is incorrect a tool changer crash has occured and a thorough inspection of the ATC is necessary at this time.

- 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 tool holders 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 a ATC will be pushed down about 1/4" before the tool holder is seated in the taper, resulting in damage to the roller bolts on the ATC shuttle. Replace the drawbar.

◈ Tool holder sticking in the spindle taper causes the ATC to be pulled up as the spindle head is traveling up; accompanied by a popping noise as the tool holder pops out of the spindle taper.

NOTE: This problem may occur after loading a cold tool into a hot spindle (a result of thermal expansion of the tool holder inside the spindle taper. It may also occur in cuts with heavy vibration. If sticking occurs only during these circumstances, no service is necessary.

- Check the condition of the customer’s tooling, verifying the taper on the tool holder 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. See "Spindle Assembly" section for spindle cartridge replacement.
- 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 head on the machine. See the "Spindle Assembly" section in Mechanical Service for spindle cartridge replacement.

◈ During a tool change, ATC 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 has occurred, and a thorough inspection of the ATC is necessary at this time.

- 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. See the following section (ATC Crashing) or "Roller Bolt Replacement", for roller bolt replacement. NOTE: Bent roller bolts are a symptom of another problem with the ATC. Repair the bent roller bolt and then 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 tool holder is seated in the taper, resulting in damage to the roller bolts on the ATC shuttle. Replace drawbar.

◈ Tool holders 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).

◈ Tool holders spin at all pockets of the ATC when the ATC shuttle retracts.

- ATC is misaligned in the "Y" axis. Realign ATC ("Automatic Tool Changer Alignment" section). NOTE: Observe the direction the tool holder rotates, as this will be the direction in which the "Y" axis of the ATC needs to be moved.

◈ Tool holders 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. Also, see above. See "Extractor Fork Replacement" section, if necessary.

NOTE: If the ATC shows the problem as described here, each extractor fork must be checked and centered to eliminate the possibility of the ATC being aligned against an incorrectly-centered fork.

4.2 CRASHING

Crashing of the ATC is usually a result of operator error. The most common ATC crashes are outlined as follows:

◈ Shuttle crashes into spindle when a tool change is commanded (tool holder is in the pocket facing the spindle head).

- Rotate the carousel to an empty pocket. Refer to the Programming and Operation manual for correct operation.

NOTE: This crash is fairly common and is a result of operator error. If the ATC is stopped in the middle of 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, the slip clutch, and the shuttle motor in the ATC.

◈ During a tool change spindle crashes into top of the tool holder after a turret rotation.

When the spindle head moves down over the top of the tool holder during a tool change, the pull stud will bind inside the drawbar bore of the spindle, forcing the ATC down, bending the upper right roller bolt on the ATC shuttle or completely breaking it off. Tool holder 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 tool holder after a turret rotation.

The balls in the drawbar do not move freely, causing the ATC to be forced down far enough to bend the upper right roller bolt or completely break it off.

- Ensure the balls on the drawbar move freely in the holes in the drawbar 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.

ATC properly deposits a tool holder in the spindle, but the tools are dropped onto the machine table when the shuttle retracts.

- Inspect the balls and the Belleville springs in the drawbar. See appropriate section and replace drawbar.

The part or fixture on the mill table crashes into long tooling or into the ATC itself during a tool change.

- Program the machine to move the part out of the way of the ATC. Inspect the pocket involved in the crash for damage and replace parts as necessary.

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

- Either reposition the tools to remove the interference, or program the carousel to rotate long tooling out of the way of the part (USE THIS ONLY AS A LAST RESORT). CAUTION! If the carousel has to be programmed to rotate long tools clear of the part, the correct carousel position must be programmed back in before a tool change can be executed. NOTE: If these crashes occur, thoroughly inspect the ATC for damage. Pay close attention to the extractor forks, the sliding covers on the ATC carousel, and the roller bolts on the ATC shuttle. See appropriate section for extractor fork replacement.

4.3 BREAKAGE

Breakage of the ATC is caused by either very hard or repeated crashes.

ATC shuttle is broken off of the holding plate.

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

4.4 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 ("Roller Bolt Replacement" section). 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 labor excessively, 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 the ATC shutter. See "ATC Trap Door Replacement" for shutter replacement.

- Ensure the guide pin mounted to the holding plate is not bent and does not scrape the ATC cover during movement. See "ATC Trap Door Replacement" for guide pin replacement.

- Listen for damage to the gear train in the shuttle motor. If the motor is found to be the source of the noise, replace the motor ("Shuttle Motor Removal" section). DO NOT try to repair the motor or to further isolate the noise in the motor. ATC makes noise during carousel rotation.

- Check to ensure the Geneva driver on the turret motor is tight and properly adjusted ("Shuttle Motor Removal" section). 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 ("Geneva Star Replacement" section).

- Check the adjustment of the Geneva driver in relation to the Geneva star ("Geneva Star Replacement" section). 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 the turret motor adjustment is tight for extended periods, the turret motor, Geneva star, and the I/O board may be damaged. If the adjustment of the Geneva star appears tight at some pockets and loose at others, the problem lies with the Geneva star. Check the concentricity of the star relative to the bearing housing on the carousel assembly. If the concentricity of the star is proven to within specification and the problem still persists, the Geneva star must be replaced ("Geneva Star Replacement" section).

- Ensure the screws holding the turret motor to the mounting plate are tight ("Turret Motor Removal" section).

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

- Check for excessive noise in the gear train of the turret motor. See appropriate section for turret motor 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.

4.5 SPINDLE ORIENTATION

A switch is used to sense when the pin drops in to lock the spindle. When the pin drops the switch opens, indicating orientation is complete. The normally-closed side of this switch is wired to the spindle drive and commands it into the COAST STOP condition. This is done to make sure that the spindle motor is not powered when the pin is locking the spindle. If, during a tool change, the dogs on the spindle shaft do not align with the keys on the ATC carousel, the spindle orientation may be at fault.

The orientation of the spindle is as follows:
1) If the spindle is turning, it is commanded to stop,
2) Pause until spindle is stopped,
3) Spindle orientation speed is commanded forward,
4) Pause until spindle is at orientation speed,
5) Command spindle lock air solenoid active,
6) Pause until spindle locked status is active and stable,
7) If not locked after time-out time, alarm and stop.

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 machine.

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 problem or a turret rotation problem. These alarms will occur either on an attempt to change tools (ATC FWD) or ZERO RETURN the machine (AUTO ALL AXES). Use the appropriate alarm to select one of the problems following:

ATC shuttle will not move; shuttle is getting power (Command a tool change and feel 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, appropriate section for shuttle adjustment.
- Command a tool change with the shuttle disconnected.

  ➢ If the shuttle cycles, check the slip clutch on the ATC. See "Shuttle Installation" 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 the shuttle does not cycle, the motor has failed and must be replaced. Turn the motor by hand and feel for binding in the gear train in the motor.

NOTE: The motor uses a large amount of gear reduction and should be hard to turn by hand.

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

- Command a tool change feel 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 the LED lights, check the fuse FU5 on the POWER PCB or FU1 on the I/O PCB. Otherwise, replace the I/O PCB ("Electrical Service").
    - If the LED does not light, check cables I/O-P1-510 and I/O-P2-520.

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

- Command a tool change feel for power being applied to the turret motor.
- If power is applied but the output shaft on the motor does not turn, check for binding between the turret motor assembly and the Geneva star ("Automatic Tool Changer" section). Check for damage to the Geneva star or the Geneva driver. Check for a broken turret motor ("Turret Motor Removal" section). 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 feel 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 the LED lights, check the fuse FU5 on the POWER PCB or FU1 on the I/O PCB. Otherwise, replace the I/O PCB (Electrical Service).
    - If the LED does not light, check cables I/o-P1-510 and I/O-P2-520.

5. GEARBOX AND SPINDLE MOTOR

The gearbox cannot be serviced in the field and must be replaced as a unit. NEVER remove a motor from a VF-Series mill that has a gearbox as this will damage the gearbox and void the warranty.

5.1 NOISE

When investigating complaints of gearbox noise, also refer to "Spindle" troubleshooting section. Gearboxes can be damaged by failed air solenoids, gearshift cylinders, or bearings, resulting in noisy operation. It is not likely that poor finish on a workpiece can be attributed to a bad gearbox.

◈ Excessive or unusual noise coming from the gearbox and/or spindle motor.

Operate the machine in both high and lowgears. Monitor the gearbox for noise in both gear positions and if the pitch of the noise varies with the motor or the output shaft speed.

- If the noise only occurs in one gear throughout the entire RPM range of that gear position, the problem lies with the gearbox, and it must be replaced ("Spindle Motor & Transmission" section).
- If the noise occurs in both gear positions, disconnect the drive belt and repeat the previous step. If the noise persists, the gearbox is damaged and must be replaced, ("Spindle Motor & Transmission" sec tion).
- With the drive belt disconnected, run the machine at 1000 RPM in high gear. Command a change of direction and listen for a banging noise in the gearbox as the machine slows to zero RPM and speeds back up to 1000 RPM in reverse. If the noise occurs, the motor has failed and the gearbox must be replaced.

5.2 GEARS WILL NOT CHANGE

◈ Machine will not execute a gear change.

NOTE: Whenever a gear change problem occurs, an alarm will also occur. Refer ALARMS section to diagnose each problem before working on the machine.

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

1) If the spindle is turning, it is commanded to stop,
2) Pause until spindle is stopped,
3) Gear change spindle speed is commanded forward,
4) Pause until spindle is at speed,
5) Command high or low gear solenoid active,
6) Pause until in new gear or reversal time,
7) Alarm and stop if max gear change time elapsed,
8) If not in new gear, reverse spindle direction,
9) Turn off high and low gear solenoids.

- Check the air solenoid assembly on the solenoid bracket (rear of gearbox). If the solenoid operates properly and the limit switches on the gearbox operate properly, the problem lies with the gear change piston. Replace the gearbox ("Spindle Motor & Transmission" section).
- Check contactor CB4.

5.3 LOW PRESSURE ALARM

Alarm 179 (Low Pressure Transmission Oil) has been triggered.

- Check for low oil supply in reservoir.
- 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.

6. THROUGH THE SPINDLE COOLANT

6.1 COOLANT OVERFLOW

To begin troubleshooting, check the alarm history to determine the problem's cause before any action is taken.

Coolant pouring out of spindle head covers.

- Check for seal failure. If failure is found, replace the seal (seal / housing assy. kit #93-9000). Refer to the appropriate steps in"TSC-Tool Release Piston Replacement" section for procedure.
- Check that the TSC drain line is intact. If necessary, replace with 5/32" O.D. X 32" long nylon tubing (24" long for VF-O/OE)
- Check pre-charge pressure in accordance with TSC "Pressure Regulator Adjustment' section and reset if necessary. Low pre-charge pressure can cause coolant to dump into the spindle head.
- Ensure the coolant pump relief valve has not been tampered with. (yellow paint band is intact). Check the coolant pump pressure (should be 140 psi), with a standard tool holder in spindle. If pump pressure is above 140 psi, reset the pump relief valve in accordance with the "Setting TSC Pump Relief Valve" section.

Excessive coolant flow out of drain line.

Pulsating flow through tool and drain line.

- Check pre-charge pressure in accordance with TSC "Pressure Regulator Adjustment" section. Reset precharge pressure if necessary. Low pre-charge pressure will cause heavy or pulsating flow from the drain line.
- Ensure the coolant pump relief valve has not been tampered with (yellow paint band is intact). Check the coolant pump pressure (should be 140 psi), with a standard tool holder in spindle. If pump pressure is above 140 psi, reset pump relief valve in accordance with "Setting Pump Relief Valve" section.

6.2 LOW COOLANT

Alarm 151, "Low Thru Spindle Coolant"

- Check coolant tank level. Check the filter and intake strainer for any clogging. Check coolant lines for any clogging or kinking. Clean or replace as needed.
- If received at start-up, check that the breaker hasn't tripped and that the pump is turning. Check the electrical continuity of cables.

- Check for pressure switch failure (refer to "Testing the Coolant Pressure Switch" section), and replace if necessary. Check "LO CLNT" bit in the diagnostics display (0 = pressure on, 1= pressure off).
- If the filter has been cleaned or the coolant line has been disconnected from the pump or check valve assembly, prime the system as described in "Priming TSC System" section.

6.3 COOLANT TIP WEAR

⍰ Coolant tip is wearing quickly and needs frequent replacement.

- Check the filtration system and that the coolant is not contaminated.
- Check pre-charge pressure (refer to the TSC Pressure Regulator Adjustment" section). Heavy wear will occur if this pressure is too high.

6.4 PRE-CHARGE FAILURE

⍰ Alarm 198, "Precharge Failure"

NOTE: This alarm can only applies to the TSC system.

- Check for broken or disconnected pre-charge air line, and replace if necessary.
- Check if the "Tool Clamped" limit switch is sticking, and replace if necessary.
- Check the "Tool Clamped" limit switch adjustment (refer to "Tool Clamp/Unclamp Switch Adjustment").
- Check for low pre-charge pressure (refer to "Pressure Regulator Adjustment" section).
- Check pre-charge solenoid for proper operation.

7. ALARMS

Any time an alarm is present, the lower right hand corner will have a blinking "ALARM". Push the ALARM display key to view the current alarm. All alarms are displayed with a reference number and a complete description. If the RESET key is pressed, one alarm will be removed from the list of alarms. If there are more than 18 alarms, only the last 18 are displayed and the RESET must be used to see the rest. The presence of any alarm will prevent the operator from starting a program.

Note that tool changer alarms can be easily corrected by first correcting any mechanical problem, pressing RESET until the alarms are clear, selecting ZERO RET mode, and selecting AUTO ALL AXES. Some messages are displayed while editing to tell the operator what is wrong but these are not alarms. See the editing topic for those errors.

The following alarm list shows the alarm numbers, the text displayed along with the alarm, and a detailed description of the alarm, what can cause it, when it can happen, and how to correct it.

Alarm number and text:		Possible causes:
102	Servos Off	Indicates that the servo motors are off, the tool changer is disabled, the coolant pump is off, and the spindle motor is stopped. Caused by EMERGENCY STOP, motor faults, tool changer problems, or power fail.
103	X Servo Error Too Large	Too much load or speed on X-axis motor. The difference between the motor position and the commanded position has exceeded a parameter. The motor may also be stalled, disconnected, or the driver failed. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor, or the slide being run into the mechanical stops.
104	Y Servo Error Too Large	same as 103.
105	Z Servo Error Too Large	same as 103.
106	A Servo Error Too Large	same as 103.
107	Emergency Off	EMERGENCY STOP button was pressed. Servos are also turned off. After the E-STOP is released, the RESET button must be pressed at least twice to correct this; once to clear the E-STOP alarm and once to clear the Servo Off alarm.
108	X Servo Overload	Excessive load on X-axis motor. This can occur if the load on the motor over a period of several seconds or even minutes is large enough to exceed the continuous rating of the motor. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops but not much past them. It can also be caused by anything that causes a very high load on the motors.
109	Y Servo Overload	same as 108.
110	Z Servo Overload	same as 108.
111	A Servo Overload	same as 108.
112	No Interrupt	Electronics fault. Call your dealer.

113	Shuttle In Fault	Tool changer not completely to right. During a tool changer operation the tool in/out shuttle failed to get to the in position. Parameters 62 and 63 can adjust the time-out times. This alarm can be caused by anything that jams the motion of the slide or by the presence of a tool in the pocket facing the spindle. A loss of power to the tool changer can also cause this, so check CB5 and relays 1-8, 2-1, and 2-2.
114	Shuttle Out Fault	Tool changer not completely to left. During a tool change operation the tool in/out shuttle failed to get to the out position. Parameters 62 and 63 can adjust the time-out times. This alarm can be caused by anything that jams the motion of the slide or by the presence of a tool in the pocket facing the spindle. A loss of power to the tool changer can also cause this, so check CB5 and relays 1-8, 2-1, and 2-2.
115	Turret Rotate Fault	Tool carousel motor not in position. During a tool changer operation the tool turret failed to start moving or failed to stop at the right position. Parameters 60 and 61 can adjust the time-out times. This alarm can be caused by anything that jams the rotation of the turret. A loss of power to the tool changer can also cause this, so check CB5 and relays 1-8, 2-3, and 2-4.
116	Spindle Orientation Fault	Spindle did not orient correctly. During a spindle orientation function, the spindle is rotated until the lock pin drops in; but the lock pin never dropped. Parameters 66, 70, 73, and 74 can adjust the time-out times. This can be caused by a trip of circuit breaker CB4, a lack of air pressure, or too much friction with the orientation pin.
117	Spindle High Gear Fault	For Vertical Mills only. Gearbox did not shift into high gear. During a change to high gear, the spindle is rotated slowly while air pressure is used to move the gears but the high gear sensor was not detected in time. Parameters 67, 70 and 75 can adjust the time-out times. Check the air pressure, the solenoids circuit breaker CB4, and the spindle drive.
118	Spindle Low Gear Fault	For Vertical Mills only. Gearbox did not shift into low gear. During a change to low gear, the spindle is rotated slowly while air pressure is used to move the gears but the high gear sensor was not detected in time. Parameters 67, 70 and 75 can adjust the time-out times. Check the air pressure, the solenoids circuit breaker CB4, and the spindle drive.
119	Over Voltage	Incoming line voltage is above maximum (about 255 volts when wired for 240 or 235 when wired for 208). The servos will be turned off and the spindle, tool changer, and coolant pump will stop. If this condition remains for 4.5 minutes, an automatic shutdown will begin.
120	Low Air Pressure	Air pressure dropped below 80 PSI for a period defined by parameter 76. Check your incom ing air pressure for at least 100 PSI and ensure that the regulator is set at 85 PSI.
121	Low Lub or Low Pressure	Way lube is low or empty or there is no lube pressure or too high a pressure. Check tank at rear of mill and below control cabinet. Also check connector P5 on the side of the control cabinet. Check that the lube lines are not blocked.
122	Control Overheat	The control internal temperature is above 150 degrees F. This can be caused by almost anything in the control overheating. But is usually caused by overheat of the two regen resis tors for servos and spindle drive. This alarm will also turn off the servos, spindle drive, coolant pump, and tool changer. One common cause of this overheat condition is an input line voltage too high. If this condition remains for 4.5 minutes, an automatic shutdown will begin.

123	Spindle Drive Fault	Overheat or failure of spindle drive or motor. The exact cause is indicated in the LED window of the spindle drive inside the control cabinet. This can be caused by a stalled motor, shorted motor, overvoltage, undervoltage, overcurrent, overheat of motor, or drive failure.
124	Low Battery	Memory batteries need replacing within 30 days. This alarm is only generated at power on and indicates that the 3.3 volt Lithium battery is below 2.5 volts. If this is not corrected within about 30 days, you may lose your stored programs, parameters, offsets, and settings.
125	Shuttle fault	Tool shuttle not initialized at power on, CYCLE START or spindle motion command. This means that the tool shuttle was not fully retracted to the Out position.
126	Gear Fault	Gearshifter is out of position when a command is given to rotate the spindle. This means that the two speed gear box is not in either high or low gear but is somewhere in between. Check the air pressure, the solenoids circuit breaker CB4, and the spindle drive.
127	No Turret Mark	Tool carousel motor not in position. The turret motor only stops in one position indicated by a switch and cam on the Geneva mechanism. This alarm is only generated at power-on. The AUTO ALL AXES button will correct this but be sure that the pocket facing the spindle after wards does not contain a tool.
128	Tool In Turret	Pocket opposite spindle has tool in it. Future option not yet implemented.
129	M Fin Fault	M-Fin was active at power on. Check the wiring to your M code interfaces. This test is only performed at power-on.
130	Tool Unclamped	Tool release piston is energized at power up. This is a possible fault in the air solenoids, relays on the IO Assembly, the draw bar assembly, or wiring.
131	Tool Not Clamped	Tool Release Piston is not Home. This is a possible fault in the air solenoids, relays on the IO Assembly, the draw bar assembly, or wiring.
132	Power Down Failure	Machine did not turn off when an automatic power-down was commanded. Check wiring to POWIF card on power supply assembly, relays on the IO assembly, and the main contactor K1.
133	Spindle Locked	Shot pin did not release. This is detected when spindle motion is commanded. Check the solenoid that controls the air to the lock, relay 2-8, the wiring to the sense switch, and the switch.
134	Tool Clamp Fault	Tool did not release from spindle when commanded. Check air pressure and solenoid circuit breaker CB4. Can also be caused by misadjustment of drawbar assembly.
135	X Motor Over Heat	Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F. This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.
136	Y Motor Over Heat	same as 135.
137	Z Motor Over Heat	same as 135.

138	A Motor Over Heat	same as 135.
139	X Motor Z Fault	Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connec tors at P1-P4.
140	Y Motor Z Fault	same as 139.
141	Z Motor Z Fault	same as 139.
142	A Motor Z Fault	same as 139.
143	Spindle Not Locked	Shot pin not fully engaged when a tool change operation is being performed. Check air pressure and solenoid circuit breaker CB4. This can also be caused by a fault in the sense switch that detects the position of the lock pin.
144	Time-out- Call Your Dealer	Time allocated for use prior to payment exceeded. Call your dealer.
145	X Limit Switch	Axis hit limit switch or switch disconnected. This is not normally possible as the stored stroke limits will stop the slides before they hit the limit switches. Check the wiring to the limit switches and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.
146	Y Limit Switch	same as 145
147	Z Limit Switch	same as 145
148	A Limit Switch	Normally disabled for rotary axis.
149	Spindle Turning	Spindle not at zero speed for tool change. A signal from the spindle drive indicating that the spindle drive is stopped is not present while a tool change operation is going on.
150	Z and Tool Interlocked	Tool changer not at home and Z is not either at machine home or above. If RESET, E-STOP, or POWER OFF occurs during tool change, Z-axis motion and tool changer motion may not be safe. Check the position of the tool changer and remove the tool if possible. Re-initialize with the AUTO ALL AXES button but be sure that the pocket facing the spindle afterwards does not contain a tool.
151	Low Thru Spindle Coolant	For machines with Through the Spindle Coolant only. This alarm will shut off the spindle, feed, and pump all at once. Check for low coolant tank level, any filter or intake strainer clogging, or for any kinked or clogged coolant lines.
152	Self Test Fail	Control has detected an electronics fault. All motors and solenoids are shut down. This is most likely caused by a fault of the processor board stack at the top left of the control. Call your dealer.
153	X-axis Z Ch Missing	Broken wires or encoder contamination. All servos are turned off. This can also be caused by loose connectors at P1-P4.
154	Y-axis Z Ch Missing	same as 153.

155	Z-axis Z Ch Missing	same as 153.
156	A-axis Z Ch Missing	same as 153.
157	Motor Interface PCB Failure	Internal circuit board problem. The MOTIF PCB in the processor stack is tested at power-on. Call your dealer.
158	Video/Keyboard PCB Failure	Internal circuit board problem. The VIDEO PCB in the processor stack is tested at power-on. This could also be caused by a short in the front panel membrane keypad. Call your dealer.
159	Keyboard Failure	Keyboard shorted or button pressed at power on. A power-on test of the membrane keypad has found a shorted button. It can also be caused by a short in the cable from the main cabinet or by holding a switch down during power-on.
160	Low Voltage	The line voltage to control is too low. This alarm occurs when the AC line voltage drops below 190 when wired for 230 volts or drops below 165 when wired for 208 volts.
161	X-axis Over Current or Drive Fault	Current in X servo motor beyond limit. Possibly caused by a stalled or overloaded motor. The servos are turned off. This can be caused by running a short distance into a mechanical stop. It can also be caused by a short in the motor or a short of one motor lead to ground.
162	Y-axis Over Current or Drive Fault	same as 161.
163	Z-axis Over Current or Drive Fault	same as 161.
164	A-axis Over Current or Drive Fault	same as 161.
165	X Zero Ret Margin Too Small	This alarm will occur if the home/limit switches move or are misadjusted. This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder Z channel signal must occur between 1/8 and 7/8 revolution of where the home switch releases. This will not turn the servos off but will stop the zero return opera tion.
166	Y Zero Ret Margin Too Small	Same as 165.
167	Z Zero Ret Margin Too Small	Same as 165.
168	A Zero Ret Margin Too Small	Not normally enabled for A-axis.
169	Spindle Direction Fault	Problem with rigid tapping hardware. The spindle started turning in the wrong direction.

170	Phase Loss L1-L2	Problem with incoming line voltage between legs L1 and L2. This usually indicates that there was a transient loss of input power to the machine.
171	Phase Loss L2-L3	Problem with incoming line voltage between legs L2 and L3.
172	Phase Loss L3-L1	Problem with incoming line voltage between legs L3 and L1.
173	Spindle Ref Signal Missing	The Z channel pulse from the spindle encoder is missing for hard tapping synchronization.
174	Tool Load Exceeded	The tool load monitor option is selected and the maximum load for a tool was exceeded in a feed. This alarm can only occur if the tool load monitor function is installed in your machine.
175	Ground Fault Detected	A ground fault condition was detected in the 115V AC supply. This can be caused by a short to ground in any of the servo motors, the tool change motors, the fans, or the oil pump.
176	Over heat Shutdown	An overheat condition persisted for 4.5 minutes and caused an automatic shutdown.
177	Over voltage Shutdown	An overvoltage condition persisted for 4.5 minutes and caused an automatic shutdown.
178	Divide by Zero	Software Error; Call your dealer.
179	Low Pressure Transmission Oil	Spindle coolant oil is low or low pressure condition in lines.
180	Tool Arm Rotation Fault	For Side Mount Tool Changer, the tool exchange operation did not sense the 180 degree rotation switch.
181	Tool Pot Position Fault	For Side Mount Tool Changer, the tool pot positioning mechanism is not working.
182	X Cable Fault	Cable from X-axis encoder does not have valid differential signals.
183	Y Cable Fault	Same as 182.
184	Z Cable Fault	Same as 182.
185	A Cable Fault	Same as 182.
186	Spindle Not Turning	Status from spindle drive indicates error.
187	B Servo Error Too Large	Same as 103.
188	B Servo Overload	Same as 108.
189	B Motor Overheat	Same as 135.
190	B Motor Z Fault	Same as 139.
191	B Limit Switch	Same as 148.

192	B Axis Z Ch Missing	Same as 153.
193	B Axis Drive Fault	Same as 161.
194	B Zero Ret Margin Too Small	Same as 168.
195	B Cable Fault	Same as 182.
196	Coolant Spigot Failure	Spigot failed to achieve commanded location after two (2) attempts.
197	100 Hours Unpaid Bill	Call your dealer.
198	Precharge Failure	During TSC operation, the precharge failed for greater than 0.1 seconds. It will shut off the feed, spindle and pump all at once. If received, check all air lines and the air supply pressure.
201	Parameter CRC Error	Parameters lost maybe by low battery. Check for a low battery and low battery alarm.
202	Setting CRC Error	Settings lost maybe by low battery. Check for a low battery and low battery alarm.
203	Lead Screw CRC Error	Lead screw compensation tables lost maybe by low battery. Check for CRC Error low battery and low battery alarm.
204	Offset CRC Error	Offsets lost maybe by low battery. Check for a low battery and low battery alarm.
205	Programs CRC Error	Users program lost maybe by low battery. Check for a low battery and low battery alarm.
206	Internal Program Error	Software Error; Call your dealer.
207	Queue Advance Error	Software Error; Call your dealer.
208	Queue Allocation Error	Software Error; Call your dealer.
209	Queue Cutter Comp Error	Software Error; Call your dealer.
210	Insufficient Memory	Not enough memory to store users program. Check the space available in the LIST PROG mode and possibly delete some programs.
211	Odd Prog Block	Software Error; Call your dealer.
212	Program Integrity Error	Software Error; Call your dealer.
213	EPROM CRC Error	Electronics fault; Call your dealer.
214	No. of Programs Changed	Indicates that the number of programs disagrees with the internal variable that keeps count of the loaded programs. Call your dealer.
215	Free Memory PTR Changed	Indicates the amount of memory used by the programs counted in the system disagrees with the variable that points to free memory. Call your dealer.

216	EPROM Speed Failure	Indicates that an EPROM internal driver has weakened so that data read from that EPROM may be unreliable. Call your dealer.
217	X Axis Phasing Error	Error occured in phasing initialization of brushless motor. This can be caused by a bad encoder, or a cabling error.
218	Y Axis Phasing Error	Same as above.
219	Z Axis Phasing Error	Same as above.
220	A Axis Phasing Error	Same as above.
221	B Axis Phasing Error	Same as above.
222	C Axis Phasing Error	Same as above.
223	X Transition Fault	Illegal transition of count pulses in X axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON PCB.
224	Y Transition Fault	Same as above.
225	Z Transition Fault	Same as above.
226	A Transition Fault	Same as above.
227	B Transition Fault	Same as above.
228	C Transition Fault	Same as above.
231	Jog Handle Transition Fault	Same as 223.
232	Spindle Transition Fault	Same as above.
233	Jog Handle Cable Fault	Cable from jog handle encoder does not have valid differential signals.
234	Spindle Enc. Cable Fault	Cable from spindle encoder does not have valid differential signals.
235	Spindle Z Fault	Same as 139.
240	Empty Prog or No EOB	Software Error; Call your dealer.
241	Invalid Code	RS-232 load bad. Data was stored as comment. Check the program being received.
242	No End	Check input file for a number that has too many digits
243	Bad Number	Data entered is not a number.
244	Missing)	Comment must end with a ") ".
245	Unknown Code	Check input line or data from RS-232. This alarm can occur while editing data into a program or loading from RS-232.
246	String Too Long	Input line is too long. The data entry line must be shortened.
247	Cursor Data Base Error	Software Error; Call your dealer.

248	Number Range Error	Number entry is out of range.
249	Prog Data Begins Odd	Software Error; Call your dealer.
250	Program Data Error	Same as 249.
251	Prog Data Struct Error	Same as 249.
252	Memory Overflow	Same as 249.
257	Program Data Error	Same as 249.
258	Invalid DPRNT Format	Macro DPRNT statement not structured properly.
259	Bad Language Version	Call your dealer.
260	Bad Language CRC	Indicates FLASH memory has been changed. Call your dealer.
261	Rotary CRC Error	Rotary table saved parameters (used by Settings 30, 78) have a CRC error. Indicates a loss of save memory - call your dealer.
262	Parameter CRC Missing	RS-232 or floppy read of parameter had no CRC when loading from floppy or RS-232.
263	Lead Screw CRC Missing	Lead screw compensation tables have no CRC when loading from floppy or RS-232.
264	Rotary CRC Missing	Rotary table parameters have no CRC when loading from floppy or RS-232.
302	Invalid R In G02 or G03	Check your geometry with the HELP page. R must be less than or equal to half the distance from start to end within an accuracy of 0.0010 inches.
303	Invalid X, Y, or Z In G02 or G03	Check your geometry with the HELP page.
304	Invalid I, J, or K In G02 or G03	Check your geometry with the HELP page. Radius at start must match radius at end of arc within 0.0010 inches.
305	Invalid Q In Canned Cycle	Q in a canned cycle must be greater than zero.
306	Invalid I, J, K, or Q In Canned Cycle	I, J, K, and Q in a canned cycle must be greater than zero.
307	Subroutine Nesting Too Deep	Subprogram nesting is limited to nine levels. Simplify your program.
309	Exceeded Max Feed Rate	Use a lower feed rate.
310	Invalid G Code	G code not defined and is not a macro call.
311	Unknown Code	Possible corruption of memory by low battery. Call your dealer.

312	Program End	End of subroutine reached before M99. Need an M99 to return from subroutine.
313	No P Code In M97, M98, or G65	Must put subprogram number in P code.
314	Subprogram or Macro Not In Memory	Check that a subroutine is in memory or that a macro is defined.
315	Invalid P Code In M97, M98 or M99	The P code must be the name of a program stored in memory without a decimal point for M98 and must be a valid N number for M99.
316	X Over Travel Range	X-axis will exceed stored stroke limits. This is a parameter in negative direction and is machine zero in the positive direction. This will only occur during the operation of a user's program.
317	Y Over Travel Range	same as 316.
318	Z Over Travel Range	same as 316.
319	A Over Travel Range	Not normally possible with A-axis.
320	No Feed Rate Specified	Must have a valid F code for interpolation functions.
321	Auto Off Alarm	A fault turned off the servos automatically; occurs in debug mode only.
322	Sub Prog Without M99	Add an M99 code to the end of program called as a subroutine.
324	Delay time Range Error	P code in G04 is over 1000.0 or over 9999.
325	Queue Full	Control problem; call your dealer.
326	G04 Without P Code	Put a Pn.n for seconds or a Pn for milliseconds.
327	No Loop For M Code Except M97, M98	L code not used here. Remove L Code.
328	Invalid Tool Number	Tool number must be between 1 and 16.
329	Undefined M Code	That M code is not defined and is not a macro call.
330	Undefined Macro Call	Macro name O90nn not in memory. A macro call definition is in parameters and was accessed by user program but that macro was not loaded into memory.
331	Range Error	Number too large.
332	H and T Not Matched	This alarm is generated when Setting 15 is turned ON and an H code number in a running program does not match the tool number in the spindle. Correct the Hn codes, select the right tool, or turn off Setting 15.
333	X-axis Disabled	Parameters have disabled this axis. Not normally possible in VF Series CNC Mill.
334	Y-axis Disabled	same as 333.

335	Z-axis Disabled	same as 333.
336	A-axis Disabled	Parameters have disabled this axis. Must enable A-axis to program it or remove programming of A-axis. The A-axis can be disabled permanently by Parameter 43 or temporarily by Setting 30.
337	Line Referenced By P, Not Found	Subprogram is not in memory, or P code is incorrect.
338	Invalid IJK and XYZ in G02 or G03	There is a problem with circle definition; check your geometry.
339	Multiple Codes	Only one M, X, Y, Z, A, Q, etc. allowed in any block or two G codes in the same group.
340	Cutter Comp Begin With G02 or G03	Select cutter comp earlier.
341	Cutter Comp End With G02 or G03	Disable cutter comp later.
342	Cutter Comp Path Too Small	Geometry not possible. Check your geometry with the HELP page.
343	Display Queue Record Full	A block exists that is too long for displaying queue. Shorten title block.
344	Cutter Comp With G18 and G19	Cutter Comp only allowed in XY plane (G17).
345	Diff Step Ratio On G17 Plane	Parameters 5 and 19 must be same value.
346	Diff Step Ratio On G18 Plane	Parameters 5 and 33 must be same value.
347	Diff Step Ratio On G19 Plane	Parameters 19 and 33 must be same value.
348	Illegal Spiral Motion	Linear axis path is too long. For helical motions, the linear path must not be more than the length of the circular component.
349	Prog Stop W/O Cancel Cutter Comp	Information message only. Fix or Ignore.
350	Cutter Comp Look Ahead Error	There are too many non-movement blocks between motions when cutter comp is being used. Remove some intervening blocks.
351	Invalid P Code	Software error. Call your dealer.

352	Aux Axis Power Off	Aux B, C, U, V, or W axis indicate servo off. Check auxiliary axes. Status from control was OFF.
353	Aux Axis No Home	A ZERO RET has not been done yet on the aux axes. Check auxiliary axes. Status from control was LOSS.
354	Aux Axis Disconnected	Aux axes not responding. Check auxiliary axes and RS-232 connections.
355	Aux Axis Mismatch	Position Mismatch between machine and aux axes position. Check aux axes and interfaces. Make sure no manual inputs occur to aux axes.
356	Aux Axis Travel Limit	Aux axes are attempting to travel past their limits.
357	Aux Axis Disabled	Aux axes are disabled.
358	Multiple Aux Axis	Can only move one auxiliary axis at a time.
359	Invalid I, J, or K In G12 or G13	Check your geometry with the HELP page.
360	Tool Changer Disabled	Check Parameter 57. Not a normal condition for VF Series CNC Mill.
361	Gear Change Disabled	Check Parameter 57. Not a normal condition for VF Series CNC Mill.
362	Tool Usage Alarm	Tool life limit was reached. To continue, reset the usage count in the Current Commands display and press RESET.
363	Coolant Locked Off	Override is off and program tried to turn on coolant.
364	No Circ Interp Aux Axis	Only rapid or feed is allowed with aux axes.
367	Cutter Comp Interference	G01 cannot be done with tool size.
368	Groove Too Small	Tool too big to enter cut.
369	Tool Too Big	Use a smaller tool for cut.
370	Pocket Definition Error	Check geometry for G150.
371	Invalid I, J, K, OR Q	Check G150.
372	Tool Change In Canned Cycle	Tool change not allowed while canned cycle is active.
373	Invalid Code in DNC	A code found in a DNC program could not be interpreted because of restrictions to DNC.

374	Missing XYZA in G31 or G36	G31 skip function requires an X, Y, Z, or A move.
375	Missing Z or H in G37	G37 auto offset skip function requires H code, Z value, and tool offset enabled. X, Y, and A values not allowed.
376	No Cutter Comp In Skip	Skip G31 and G37 functions cannot be used with cutter compensation.
377	No Skip in Graph/Sim	Graphics mode cannot simulate skip function.
378	Skip Signal Found	Skip signal check code was included but skip was found when it was not expected.
379	Skip Signal Not Found	Skip signal check code was included but skip was not found when it was expected.
380	X, Y, A, or G49 Not Allowed in G37	G37 may only specify Z-axis and must have tool offset defined.
381	G43 or G44 Not Allowed in G36 or G136	Auto work offset probing must be done without tool offset.
382	D Code Required in G35	A Dnn code is required in G35 in order to store the measured tool diameter.
383	Inch Is Not Selected	G20 was specified but settings have selected metric input.
384	Metric Is Not Selected	G21 was specified but settings have selected inches.
385	Invalid L, P, or R Code In G10	G10 was used to changes offsets but L, P, or R code is missing or invalid.
386	Invalid Address Format	An address A¼Z was used improperly.
387	Cutter Comp Not Allowed With G103	If block buffering has been limited, Cutter comp cannot be used.
388	Cutter Comp Not Allowed With G10	Coordinates cannot be altered while cutter comp is active. Move G10 outside of cutter comp. enablement.
389	G17, G18, G19 Illegal in G68	Planes of rotation cannot be changed while rotation is enabled.
390	No Spindle Speed	S code has not been encountered. Add an S code.
391	Feature Disabled	An attempt was made to use a control feature not enabled by a parameter bit. Set the parameter bit to 1.
392	B Axis Disabled	Same as 336.
393	Invalid Motion In G74 or G84	Rigid Tapping can only be in the Z minus G74 or G84 direction. Make sure that the distance from the initial position to the commanded Z depth is in the minus direction.

394	B Over Travel Range	Same as 316.
398	Aux Axis Servo Off	Aux. axis servo shut off due to a fault.
403	RS-232 Too Many Progs	Cannot have more than 100 programs in memory.
404	RS-232 No Program Name	Need name in programs when receiving ALL; otherwise has no way to store them.
405	RS-232 Illegal Prog Name	Check files being loaded. Program name must be Onnnn and must be at beginning of a block.
406	RS-232 Missing Code	A receive found bad data. Check your program. The program will be stored but the bad data is turned into a comment.
407	RS-232 Invalid Code	Check your program. The program will be stored but the bad data is turned into a comment.
408	RS-232 Number Range Error	Check your program. The program will be stored but the bad data is turned into a comment.
409	RS-232 Invalid N Code	Bad Parameter or Setting data. User was loading settings or parameters and something was wrong with the data.
410	RS-232 Invalid V Code	Bad parameter or setting data. User was loading settings or parameters and something was wrong with the data.
411	RS-232 Empty Program	Check your program. Between % and % there was no program found.
412	RS-232 Unexpected End of Input	Check Your Program. An ASCII EOF code was found in the input data before program receive was complete. This is a decimal code 26.
413	RS-232 Insufficient Memory	Program received doesn't fit. Check the space available in the LIST PROG mode and possibly delete some programs.
414	RS-232 Buffer Overflow	Data sent too fast to CNC. This alarm is not normally possible as this control can keep up with even 38400 bits per second.
415	RS-232 Overrun	Data sent too fast to CNC. This alarm is not normally possible as this control can keep up with as much as 38400 bits per second.
416	RS-232 Parity Error	Data received by CNC has bad parity. Check parity settings, number of data bits and speed. Also check your wiring.
417	RS-232 Framing Error	Data received was garbled and proper framing bits were not found. One or more characters of the data will be lost. Check parity settings, number of data bits and speed.
418	RS-232 Break	Break condition while receiving. The sending device set the line to a break condition. This might also be caused by a simple break in the cable.

419	Invalid Function For DNC	A code found on input of a DNC program could not be interpreted.
420	Program Number Mismatch	The O code in the program being loaded did not match the O code entered at the keyboard. Warning only.
430	Floppy Unexpected End of Input	Check your program. An ASCII EOF code was found in the input data before program receive was complete. This is a decimal code 26.
431	Floppy No Prog Name	Need name in programs when receiving ALL; otherwise has no way to store them.
432	Floppy Illegal Prog Name `	Check files being loaded. Program must be Onnnn and must be at the beginning of a block.
433	Floppy Empty Prog Name	Check your program. Between % and % there was no program found.
434	Floppy Insufficient Memory	Program received doesn't fit. Check the space available in the LIST PROG mode and possibly delete some programs.
435	Floppy Abort	Could not read disk.
436	Floppy File Not Found	Could not find floppy file.
501	Too Many Assignments In One Block	Only one assignment "=" is allowed per block. Divide block in error into multiple blocks.
502	[Or = Not First Term In Expressn	An expression element was found where it was not preceded by "[" or "=", that start expressions.
503	Illegal Macro Variable Reference	A macro variable number was used that is not supported by this control, use another variable.
504	Unbalanced Paren. In Expression	Unbalanced brackets, "[" or "]", were found in an expression. Add or delete a bracket.
505	Value Stack Error	The macro expression value stack pointer is in error. Call your dealer.
506	Operand Stack Error	The macro expression operand stack pointer is in error. Call your dealer.
507	Too Few Operands On Stack	An expression operand found too few operands on the expression stack. Call your dealer.
508	Division By Zero	A division in a macro expression attempted to divide by zero. Re-configure expression.
509	Illegal Macro Variable Use	See "Macros" section for valid variables.

510	Illegal Operator or Function Use	See "Macros" section for valid operators.
511	Unbalanced Brackets	Right Number of right brackets not equal to the number of left brackets.
512	Illegal Assignment Use	Attempted to write to a read-only macro variable.
513	Var. Ref. Not Allowed With N Or O	Alphabetic addresses N and O cannot be combined with macro variables. Do not declare N#1, etc.
514	Illegal Macro Address Reference	A macro variable was used incorrectly with an alpha address. Same as 513.
515	Too Many Conditionals In a Block	Only one conditional expression is allowed in any WHILE or IF-THEN block.
516	Illegal Conditional Or No Then	A conditional expression was found outside of an IF-THEN, WHILE, or M99 block.
517	Exprsn. Not Allowed With N Or O	A macro expression cannot be concatenated to N or O. Do not declare O[#1], etc.
518	Illegal Macro Exprsn Reference	An alpha address with expression, such as A[#1+#2], evaluated incorrectly. Same as 517.
519	Term Expected	In the evaluation of a macro expression an operand was expected and not found.
520	Operator Expected	In the evaluation of a macro expression an operator was expected and not found.
521	Illegal Functional Parameter	An illegal value was passed to a function, such as SQRT[or ASIN[.
522	Illegal Assignment Var Or Value	A variable was referenced for writing. The variable referenced is read only.
523	Conditional Reqd Prior To THEN	THEN was encountered and a conditional statement was not processed in the same block.
524	END Found With No Matching DO	An END was encountered without encountering a previous matching DO. DO-END numbers must agree.
525	Var. Ref. Illegal During Movement	Variable cannot be read during axis movement.
526	Command Found On DO/END Line	A G-code command was found on a WHILE-DO or END macro block. Move the G-code to a separate block.
527	= Not Expected Or THEN Required	Only one Assignment is allowed per block, or a THEN statement is missing.

528	Parameter Precedes G65	On G65 lines all parameters must follow the G65 G-code. Place parameters after G65.
529	Illegal G65 Parameter	The addresses G, L, N, O, and P cannot be used to pass parameters.
530	Too Many I, J, or K's In G65	Only 10 occurrences of I, J, or K can occur in a G65 subroutine call. Reduce the I, J, or K count.
531	Macro Nesting Too Deep	Only four levels of macro nesting can occur. Reduce the amount of nested G65 calls.
532	Unknown Code Pocket Pattern	In Macro syntax is not allowed in a pocket pattern subroutine.
533	Macro Variable Undefined	A conditional expression evaluated to an UNDEFINED value, i.e. #0. Return True or False.
534	DO Or END Already In Use	Multiple use of a DO that has not been closed by and END in the same subroutine. Use another DO number.
535	Illegal DPRNT Statement	A DPRNT statement has been formatted improperly, or DPRNT does not begin block.
536	Command Found On DPRNT Line	A G-code was included on a DPRNT block. Make two separate blocks.
537	RS-232 Abort On DPRNT	While a DPRNT statement was executing, the RS-232 communications failed.
538	Matching END Not Found	A WHILE-DO statement does not contain a matching END statement. Add the proper END statement.
539	Illegal Goto	Expression after "GOTO" not valid.
613	Command Not Allowed In Cutter Comp.	A command (M96, for example) in the highlighted block cannot be executed while cutter comp. is invoked.

MECHANICAL SERVICE

1. HEAD COVERS REMOVAL / INSTALLATION

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REMOVE OR REPLACE COVERS.

REMOVAL -

1. Power on the Vertical Machining Center (VMC).

2. Zero return (ZERO RET) all axes, then HANDLE JOG to center X- and Y-axes under spindle.

3. Protect table surface with a piece of cardboard.

4. Loosen the four SHCS that attach top cover to side covers, and remove.

5. Loosen the six SHCS that attach rear cover to side covers, and remove.

6. Loosen the eight SHCS that attach front cover to side covers, then carefully remove front cover from the bottom until you can disconnect the tool release cable (quick disconnect).

7. Loosen the seven SHCS that attach each side cover, and remove from the top side. Jog Z-axis as necessary to make screw removal easier.

CAUTION! Be careful not to run head covers into the enclosure.

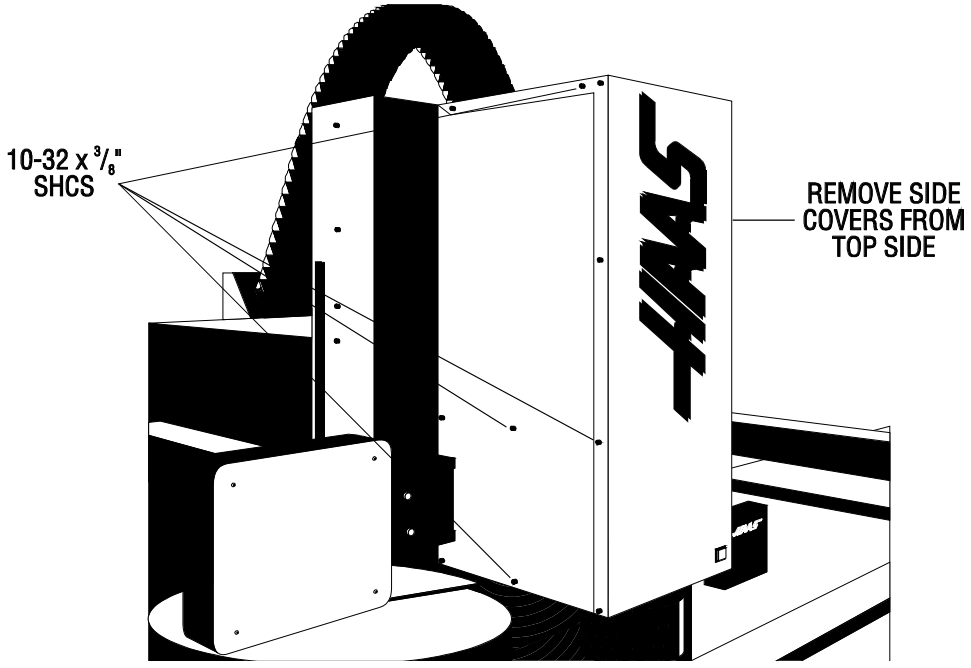


Fig. 1-1 View of VMC head covers.

INSTALLATION -

1. Protect table surface with a piece of cardboard.

2. Replace each side cover from the top side with seven SHCS. Jog Z-axis as necessary to make access to screws easier.

CAUTION! Be careful not to run the head covers into the enclosure.

3. Reconnect tool release cable, if equipped, then replace front cover from the bottom and attach with eight SHCS.

4. Replace rear cover, and attach to side covers with six SHCS.

5. Replace top cover, and attach to side covers with four SHCS.

2 . TOOL RELEASE PISTON ASSEMBLY

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REPLACE TOOL RELEASE PISTON ASSEMBLY.

NOTE: If machine is equipped with the TSC option, refer to the "Through the Spindle Coolant" section for TRP Assembly procedures.

2.1 REMOVAL

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

2. Remove the four 3/8-16 x 1¾" SHCS holding the tool release piston assembly to the head casting.

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

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

5. Remove the tool release air hose at the fitting shown in Fig. 2-2.

6. Remove entire tool release piston assembly.

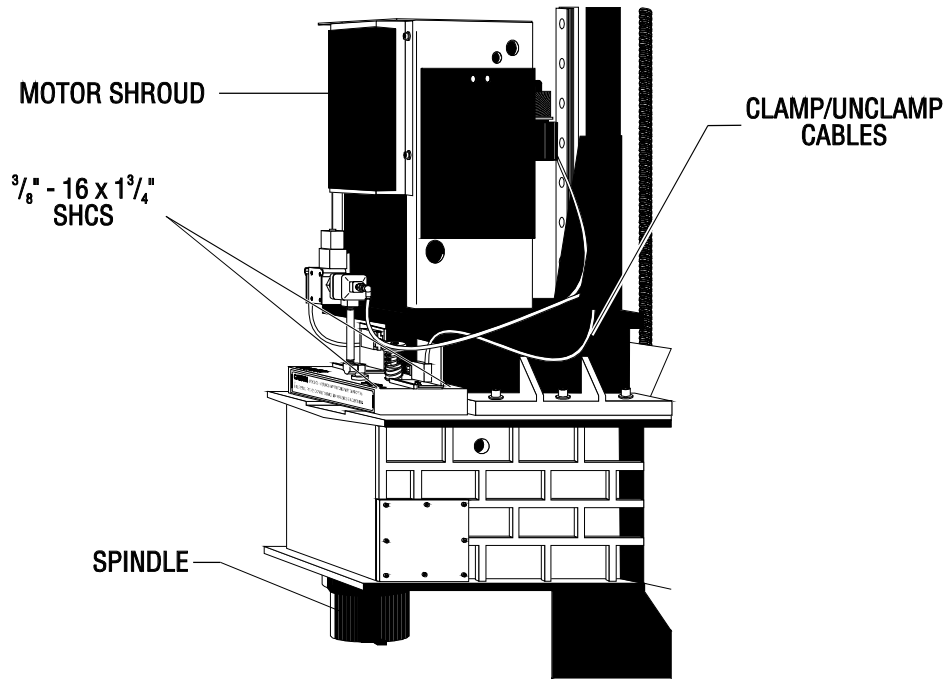


Fig. 2-1 Spindle and headstock area shown with covers removed. VF-0 will have no transmission.

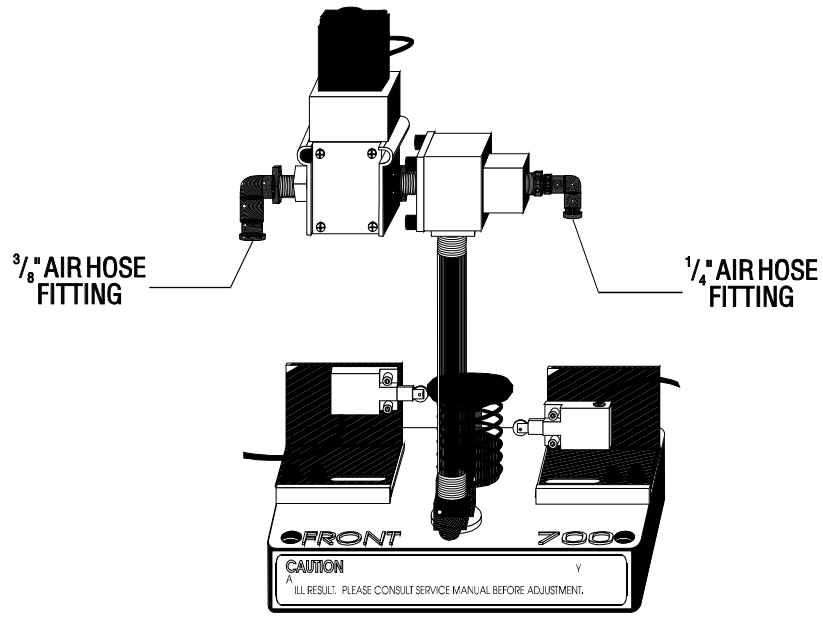


Fig. 2-2 Tool release piston with solenoid valve.

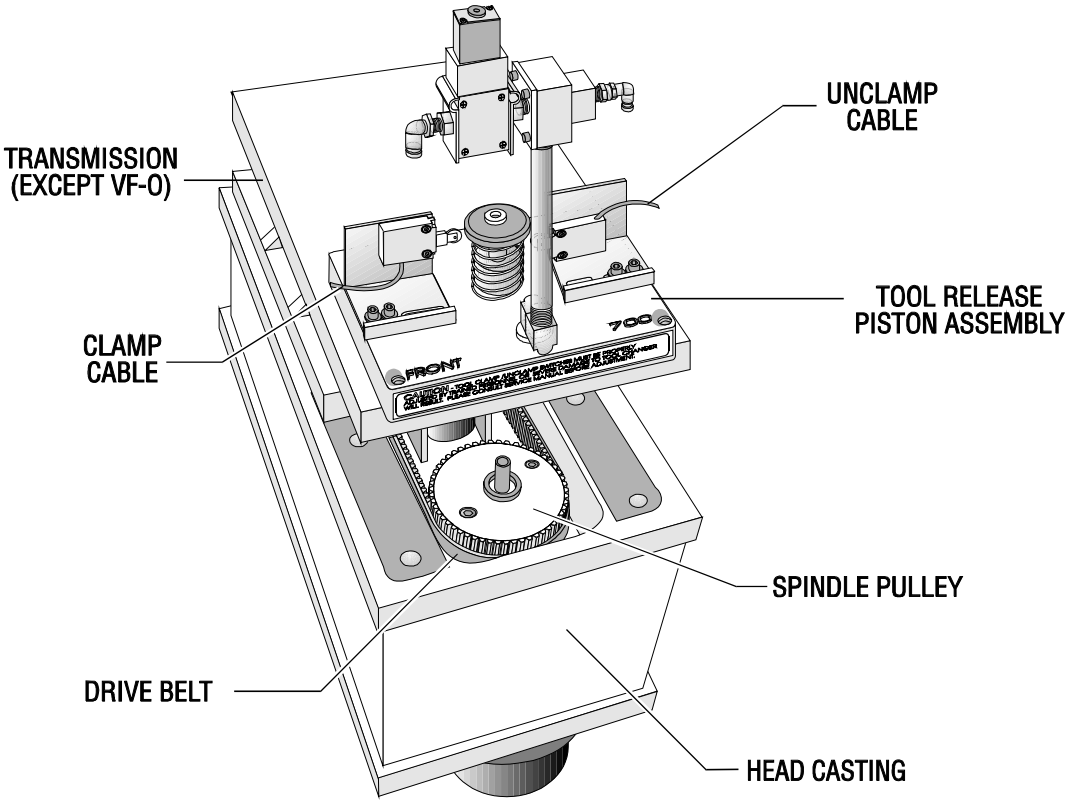


Fig. 2-3 Mounting location for tool release piston assembly

2.2 INSTALLATION

1. Ensure drive belt has been properly replaced as described in "Belt Assembly" section.

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

3. Reinstall tool release piston assembly, tightening down the four SHCS alternately until all are completely tight.

4. Reconnect the air hoses at the applicable fittings on the tool release piston assembly.

5. Reconnect the clamp/unclamp cables to the sides of the solenoid bracket.

6. Continue with the reassembly and adjustments described later in this manual.

2.3 SETTING PRE-CHARGE

1. Remove the cover panels in accordance with "Head Covers Removal and Installation". It will not be necessary to remove the rear or right side panels for this operation.

2. Turn the air pressure regulator down to zero (0). The knob must be pulled out to unlock before adjusting.

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

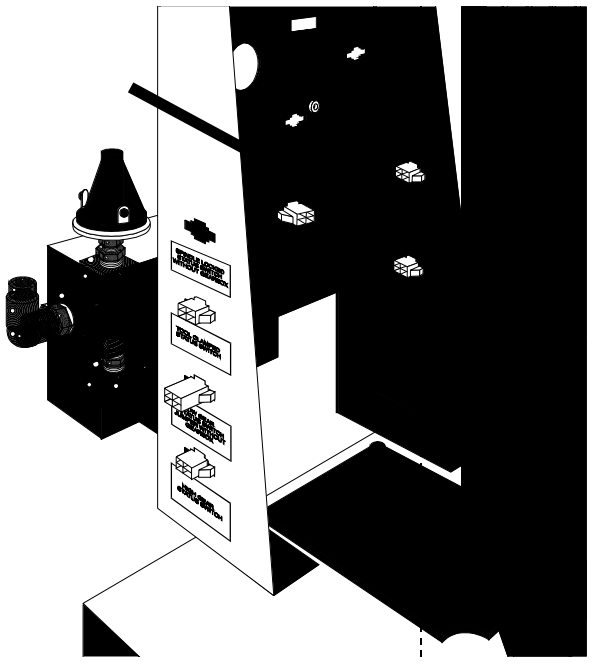


Fig. 2-4 Air pressure regulator adjustment knob.

3. Go to PARAMETERS page of CRT and ensure PRE-CHARGE DELAY is set to 200. If not, do so at this time.

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

5. Turn the air pressure regulator ½ turn in. Execute a tool change and listen for the noise described previously. If it is heard, repeat this step until no noise is heard. There should be no noise with or without a tool in the spindle.

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

3. BELT ASSEMBLY

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REPLACE THE DRIVE BELT.

3.1 BELT 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 and Installation".

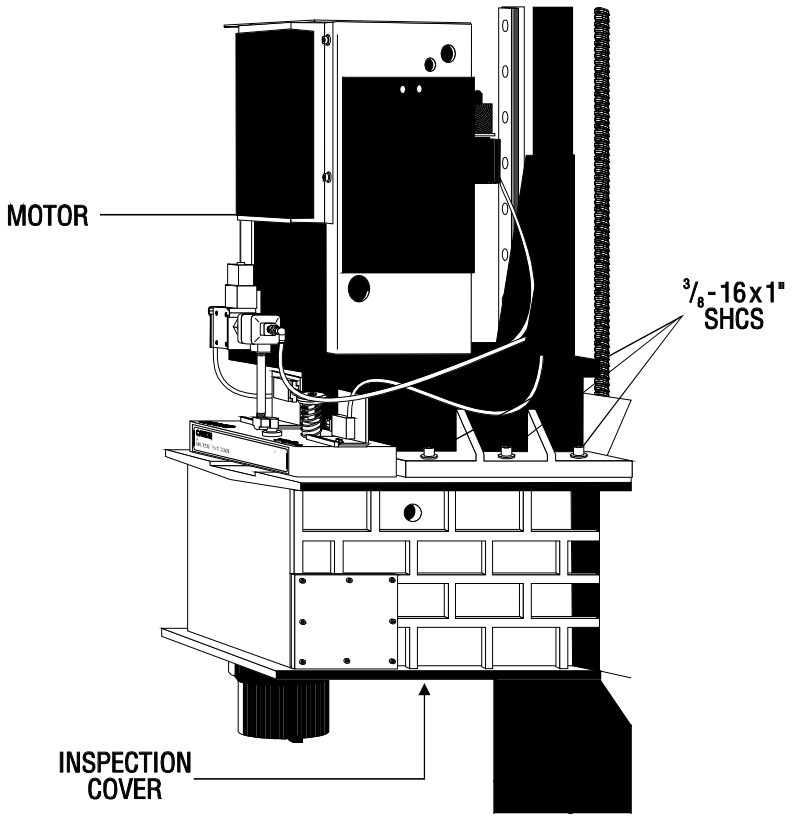


Fig. 3-1 Spindle head casting disconnect points

2. Remove tool release piston assembly in accordance with "Tool Release Piston Assembly Removal".

3. For all VMC's except VF-0, 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.

4. For the VF-0, 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.

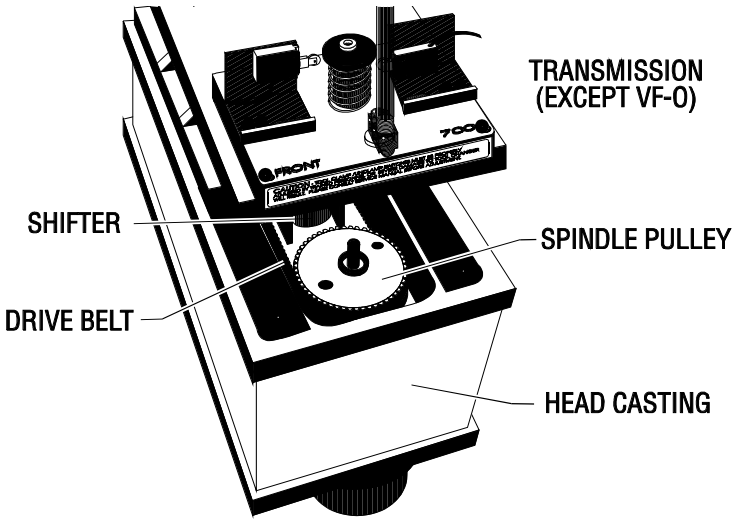


Fig. 3-2 Head casting area showing belt location

5. 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.

6. First, pull the belt up over the spindle pulley, then 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.

3.2 BELT INSTALLATION

1. For all VMC's except VF-0 (only one belt on VF-0's), slide the replacement belt(s) under the sump tank and onto the pulley.

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.

2. 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.

3. Tighten the drive belt in accordance with the following section.

4. Set the spindle orientation in accordance with appropriate 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.

3.3 TENSION ADJUSTMENT

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

1. Turn the machine ON. Position the spindle head casting at a level that will allow you to work on the drive belt comfortably.

2. Remove the cover panels from the head stock area as shown in "Head Covers Removal" section.

3. Remove the tool release piston assembly in accordance with appropriate section.

4. Screw a 3/8-16 x 1¼" bolt into each of the rearmost mounting holes for the tool release piston assembly on the spindle head casting. The bolt should protrude ½"-¾" above the casting.

VF-1, VF-2, VF-3, VF-4:

5. Loosen the six SHCS holding the transmission to the spindle head casting.

6. Place the pry bar between the transmission and the bolt in the spindle head and force the transmission back until the belt tension is set. The belt tension should be set moderately tight. If it is set too tight, the belt will whine when the assembly is at speed; and if it is set too loose, if will vibrate during accelerations and decelerations.

7. Tighten the SHCS holding the transmission to the spindle head casting.

8. Recheck the tension and repeat steps 5-7, if necessary.

VF-0:

9. Loosen the four SHCS holding the motor plate to the spindle head casting.

10. Using the pry bar, force the motor plate back until the belt tension is set. The belt tension should be set moderately tight. If it is set too tight, the belt will whine when the assembly is at speed; and if it is set too loose, it will vibrate during accelerations and decelerations.

11. Retighten the SHCS holding the motor plate to the spindle head casting.

4. SPINDLE ASSEMBLY

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REPLACE SPINDLE.

IMPORTANT!
The current pulley is shrink-fitted onto the spindle and is not field-serviceable. It is identified by two threaded holes on top of the spindle pulley. Should any attempt to remove the pulley damage the spindle or its components, the service warranty will be voided.

If the VMC being serviced has an old style pulley and requires removal, refer to service manual 96-8100, 4/13/93 for further assistance.

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

4.1 SPINDLE CARTRIDGE REMOVAL

1. Ensure the VMC is ON. You will need to raise and lower the head stock to remove the spindle. Place the cardboard on the mill table to protect the surface.

2. Remove cover panels from head stock area as described in "Head Covers Removal" section.

3. Remove the tool release piston assembly in accordance with appropriate section.

4. Remove the spindle drive belt from the spindle pulley as shown in previous section. It is not possible to completely remove the belt at this time.

5. 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 the top.

6. Ensure oil plug is inserted into oil injection port of spindle before removing spindle or oil may spill into the spindle cartridge.

7. With the 5/16" hex wrench, loosen approximately two turns the six SHCS holding the spindle to the underside of the head casting.

8. Place the block of wood (minimum 6" thick) on the table directly under the spindle.

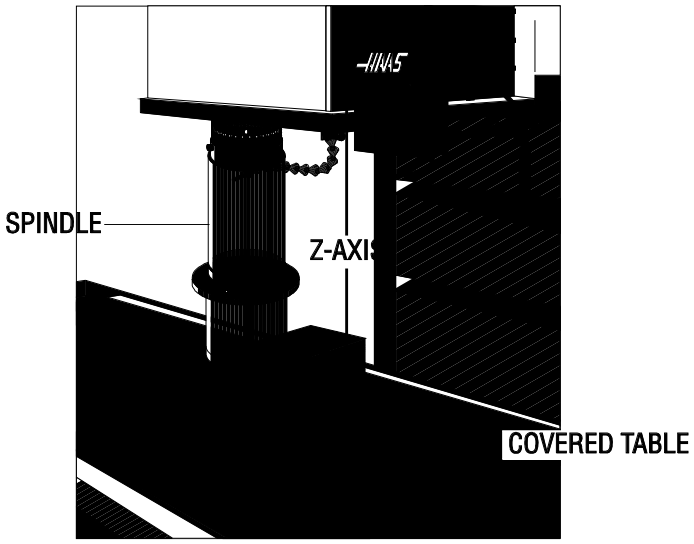


Fig. 4-1 Position wood block under spindle.

9. At the panel, go to the JOG mode and choose Z-axis. Slowly jog in the negative (-) direction until the spindle rests on the block, then remove the screws that were previously loosened (step 7).

10. Jog Z-axis in the positive (+) direction until spindle is half way out of the head casting.

11. Grasp spindle with one hand and continue to jog in Z in the positive (+) direction until it is completely free of the casting.

4.2 SPINDLE CARTRIDGE INSTALLATION

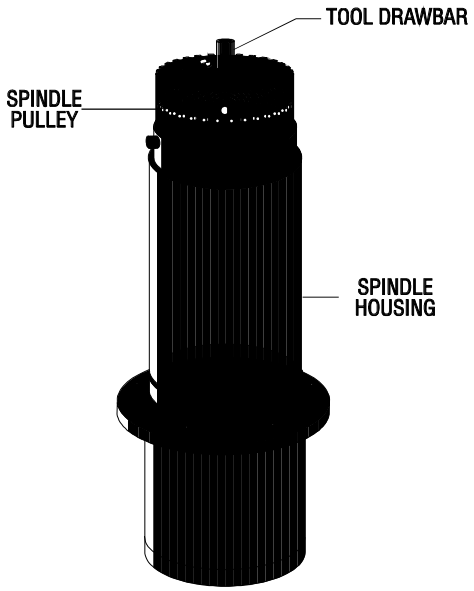


Fig. 4-2 Spindle cartridge.

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

2. Place spindle on wood block making sure both spindle dogs contact the block. Align the two 10-32 holes located on the spindle lock so they are approximately 90 degrees from the front of the spindle on the right side.

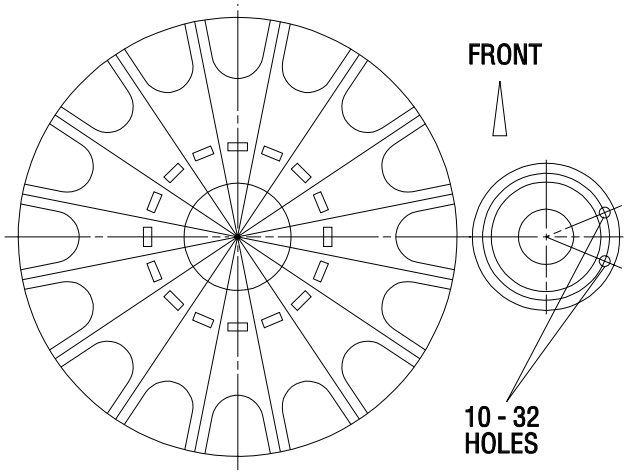


Fig. 4-3 Underside view of spindle cartridge.

3. Slowly jog the Z-axis in the negative (-) direction until threaded portion of spindle is inside of head casting. At this point, align spindle to spindle bore. While performing this operation, you must make sure the spindle cartridge is straight to the spindle bore.

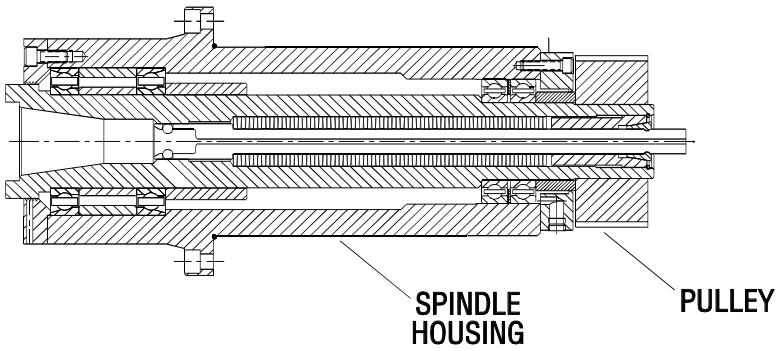


Fig. 4-4 Spindle cartridge alignment.

4. If the spindle moves to one side, use a rubber mallet and/or jog in the X or Y directions to straighten it. The spindle must go in easy. If it does not, check your alignment. **Do not force it!**

5. Install the six SHCS and tighten down completely.

6. Reattach the brass fitting to the oil injection cover and connect the oil line to the fitting. **CAUTION!** Do not overtighten the fittings when replacing on the oil injection cover. Overtightening may result in damage to the spindle cartridge.

7. Fill the cavity between the housing and the spindle cartridge with oil. The oil fill hole is to the left side of the spindle head near the spindle bore, as viewed from the top. **WARNING!** Never pour oil into the spindle housing.

8. Reinstall the drive belt and adjust the tension as needed.

9. Reinstall the tool release piston assembly.

10. Check the spindle sweep, as described later in this section.

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

4.3 DRAWBAR REPLACEMENT

NOTE: If machine is equipped with the TSC option, refer to the "Through the Spindle Coolant" section for the drawbar replacement procedure.

REMOVAL -

1. Place a tool holder with no cutter in the spindle.

2. Remove head cover panels as shown in "Head Covers Removal'.

3. Remove the tool release piston in accordance with appropriate section.

4. Remove the snap ring from the top of the spindle shaft.

5. Reinstall the tool release piston.

6. Remove the tool holder from the spindle.

7. Remove the spindle, as described earlier in this section.

8. Remove the drawbar and distance tube from the spindle assembly.

INSTALLATION -

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

10. If machine is equipped with Through the Spindle Coolant option, grease the O-rings.

11. Insert four new balls 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 the drawbar gently so the O-rings are not damaged. DO NOT use a hammer to 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, the spindle must be replaced.

12. Refer to appropriate section, and install the spindle cartridge. The tool release piston will have to be reinstalled at this time.

13. Install a tool holder with no cutter into the spindle taper.

14. Remove the tool release piston.

15. Install the snap ring on the spindle shaft.

16. Reinstall the tool release piston.

17. Finish installation of the spindle, beginning with "Spindle sweep adjustment".

18. Set the drawbar height, clamp and unclamp switches, as described in the following section.

CAUTION! Step 20 must be followed or damage to the ATC will result.
19. Refer to "Spindle Orientation" and set the spindle orientation.

20. Reinstall the head covers.

21. Test-run the machine and perform the necessary ATC adjustments in the "Automatic Tool Changer" section.

4.4 SPINDLE SWEEP ADJUSTMENT

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

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 axes' travels. Slowly jog Z-axis in the negative (-) direction to zero out indicator.

2. Establish reference zero at rear of the table. Sweep the three remaining points (left, front, and right) and record the reading.

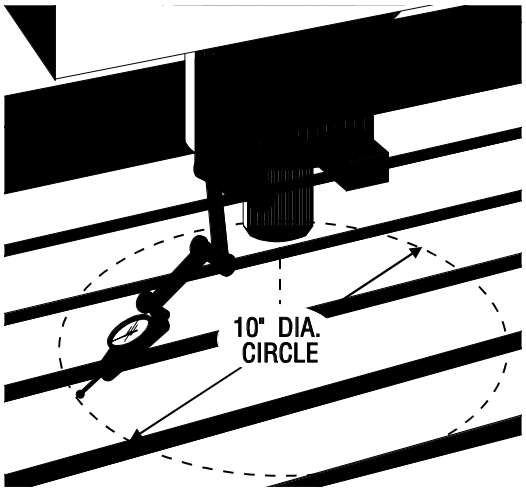


Fig. 4-5 Spindle sweep area.

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 VMC.

5. Replace the Tool Release Piston Assembly in accordance with the "Tool Release Piston Assembly Installation" and "Setting Pre-Charge" sections.

5. TOOL CLAMP/UNCLAMP SWITCH ADJUSTMENT

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ADJUSTING CLAMP/UNCLAMP SWITCHES OR SETTING DRAW-BAR HEIGHT.

TOOLS REQUIRED:
MACHINED ALUMINUM BLOCK (2" x 4" x 4")
6" FLEXIBLE RULER or .020" SHIM
1" DIA. PIPE (APPROX. 1' LONG)

5.1 TOOL CLAMP/UNCLAMP SWITCH ADJUSTMENT - INITIAL PREPARATION

1. Remove cover panels, as described in "Head Covers Removal".

2. Place a sheet of paper under the spindle for table protection, then place a machined block of aluminum (approximately 2" x 4" x 4") on the paper.

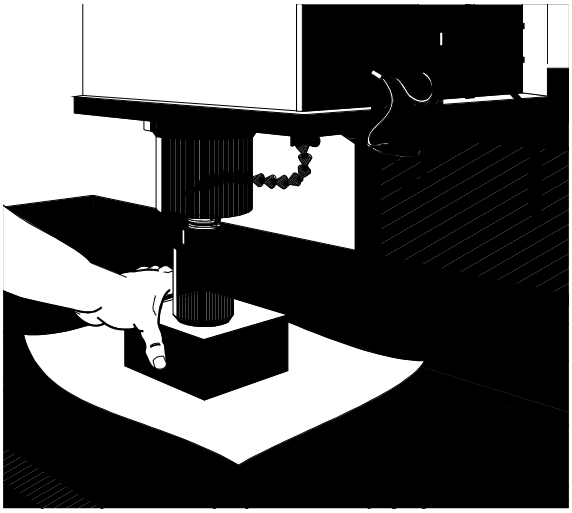


Fig. 5-1 Placement of aluminum block under spindle.

3. Power on the VMC.

4. Insert a tool holder WITHOUT ANY TYPE OF CUTTER into the spindle taper.

5. Go to the HANDLE JOG mode. Choose Z-axis and set jog increments to .01.

6. Jog Z-axis in the negative (-) direction until the tool holder is approximately .03 from the block. At this point, stop jogging the spindle and push the tool release button (top left). You will notice that the tool holder comes out of the taper.

NOTE: The clearance from the tool holder to the block should be zero (0).

7. To accomplish this, set the jog increments to .001 and jog in the negative (-) Z direction a few increments of the hand wheel at a time. Between these moves, push the tool release button and feel for movement by placing your finger between the tool holder and the spindle. Do this until no movement is felt. You are now at zero (0).

CAUTION! Do not jog too far in the negative (-) direction or else it will cause an overcurrent in the Z-axis.

5.2 SETTING DRAWBAR HEIGHT

1. Press MDI and turn hand wheel to zero (0).

2. Press HANDLE JOG button and set increments to .01. Jog Z-axis in the positive (+) direction 0.100".

3. Press and hold tool release button, grasp block and try to move it. Block should be tight at .100 and loose at .110. If block does move at .100, jog Z-axis in the negative (-) direction one increment at a time. Push tool release button and check for movement between increments until block is tight.

The increments jogged in the Z negative (-) direction are the amount of shim washers that must be added to the tool release bolt (Refer to "Shim Washers" section).

4. If block is tight at .110, move Z-axis in the positive (+) direction one increment at a time. Push tool release button and check movement between increments until block is loose.

The increments jogged in the Z positive (+) direction are the amount of shim washers that must be removed from the tool release bolt (Refer to "Shim Washers" section).

5.3 SHIM WASHERS

1. To add or subtract shim washers, remove tool release piston assembly ("Tool Release Piston" section) from head casting.

NOTE: Shims may need replacement when spindle cartridge, tool release piston assembly, or drawbar is replaced. If none have been replaced, skip this section.

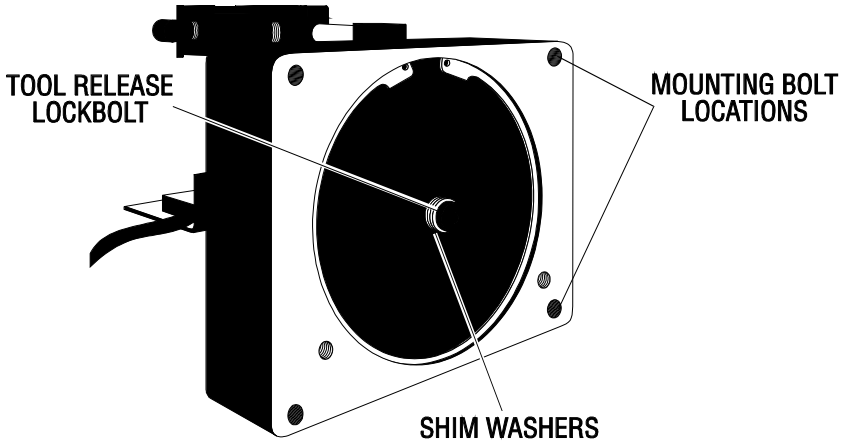


Fig. 5-2 Tool release piston assembly

2. Remove tool release bolt.

3. Add or subtract required shim washers (See previous section for correct amount to add or remove).

4. Before installing tool release bolt, put a drop of serviceable (blue) Loctite® on the threads and install.

5. Install tool release piston assembly and recheck settings. If within specifications, continue; if not, readjust.

5.4 ADJUSTMENT OF SWITCHES - LOWER (UNCLAMP) SWITCH

1. Push the PARAM/DGNOS button (top center) twice. You are now in diagnostics mode. Look at the bottom left corner of the page and you should see DB OPN 0 (tool unclamped) and directly under that, DB CLS 1 (tool clamped). If not, push PAGE DOWN until you do. A "1" means that particular switch is being tripped. A "0" means it is not being tripped.

2. With the tool holder resting on the block and set at zero ("Setting Drawbar Height" section), jog Z-axis in the positive (+) direction .06.

3. Press the tool release button and hold it. DB OPN should change from a "0" to a "1". If it does not, slightly loosen the two ¼-20 x ½" SHCS holding the unclamp switch bracket (switch on right) to the tool release assembly.

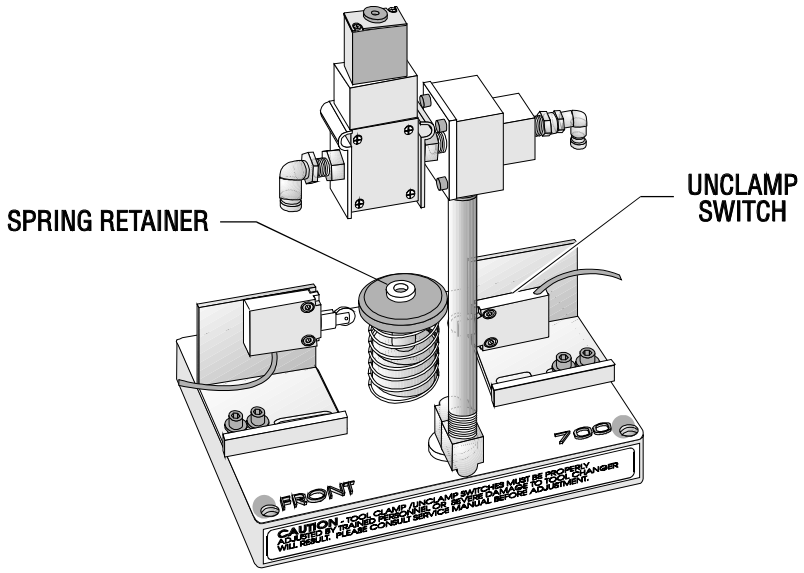


Fig. 5-3 Tool release piston assembly.

4. While activating tool release, tap unclamp switch assembly towards spring retainer until it just trips. Switch must trip at .060 +/- .010.

THIS ADJUSTMENT IS VERY IMPORTANT FOR PROPER TOOL CHANGER OPERATION, AND MUST BE PROPERLY SET!

5. Check the adjustment by setting hand wheel at .06 and activate the tool release. The DB OPN signal should be a "1". If the adjustment is not correct, adjust until it is within specifications. You may have to readjust the switch several times.

UPPER (CLAMP) SWITCH -

CAUTION! Remove the tool holder from the spindle before performing the upper (CLAMP) switch adjustment. Failure to remove could result in damage to the tool holder, the mill table, or cause severe personal injury.

6. Place a shim (approximately .020 thick), or the flexible ruler, between the tool release piston adjustment bolt and the drawbar.

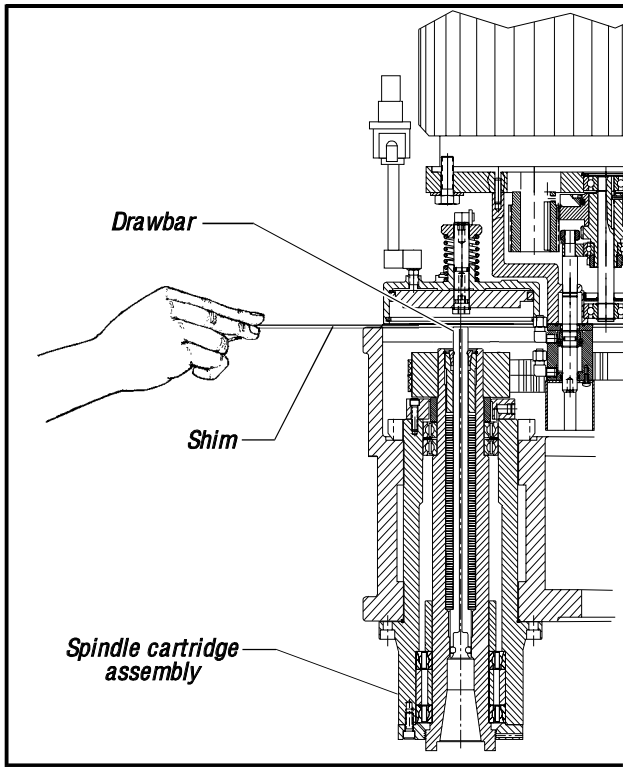


Fig. 5-4 Placement of shim before checking switch adjustment.

7. Move the tool release piston down so the shim is pressed against the drawbar. This can be done in one of the two following ways:

- Using the pipe as a lever, push down on the piston until it contacts the draw bar and the shim is held in place. For the VF-0: wedge a large, flat-tip screwdriver under the cooling fins of the motor and push the piston down.
- If machine is equipped with the "macros" option: set macro variable #1120 to 1. This will energize the pre-charge solenoid.

8. While the tool release piston is down, move the switch bracket all the way in and check for "Tool Unclmp" status on the CRT (DB OPN=0), DB CLS=0), and tighten the bracket bolts. If not, move the switch out until "Tool Unclmp" status appears on the CRT and then tighten the bolts.

9. Check the switch several times. This is done by by moving the piston up and down to ensure that the "Tool Unclmp" status appears when the piston makes contact with the shim and drawbar, and does not appear (DB OPN=0, DB CLS=1) when it is in the retracted position.

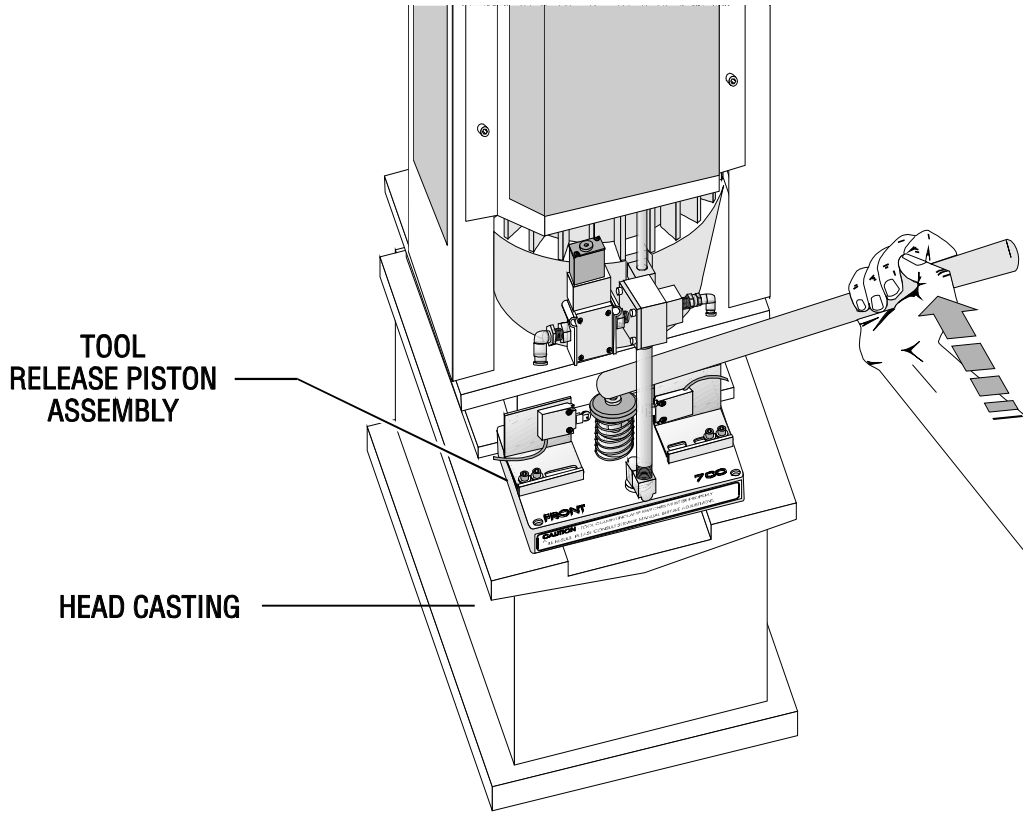


Fig. 5-5 Push piston down to hold shim in place.

6. SPINDLE ORIENTATION

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO ORIENT THE SPINDLE.

6.1 SPINDLE ORIENTATION

1. Remove cover panels from the head stock area ("Head Covers Removal"), and tool changer front cover.

2. In MDI mode, press the ORIENT SPINDLE button.

3. Loosen the four 1/4"-20 bolts on the orientation ring. Remove two of these bolts and insert them into the two threaded holes on the ring. Evenly tighten these two bolts until the taper lock is broken.

4. Remove the two 1/4"-20 bolts and place them into their original holes. Tighten them finger tight, then 1/2 of a turn more. Ensure that the orientation ring is snug, but not tight.

5. Set up a magnetic base with a 0.0005" indicator on the table. Zero the indicator on the spindle dog in the X- plane.

6. Jog the indicator across the spindle dogs and note the indicator reading. The spindle dogs should be parallel to the X axis within 0.030".

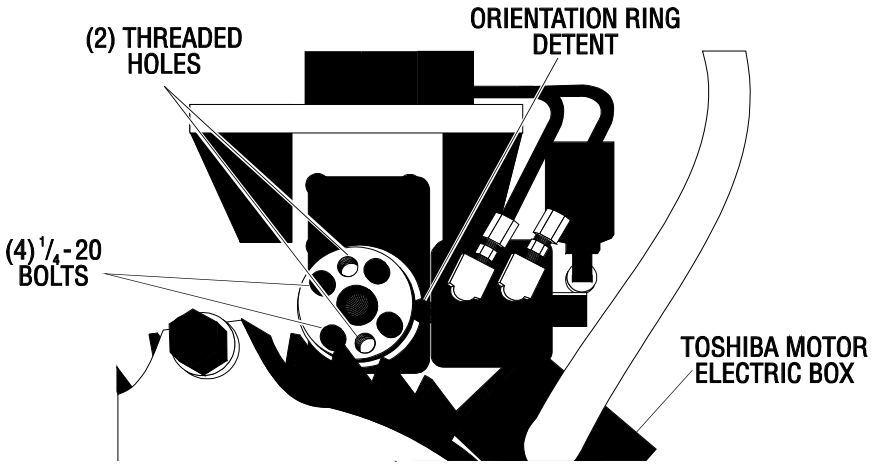


Fig. 6-1 Top view of spindle orientation components.

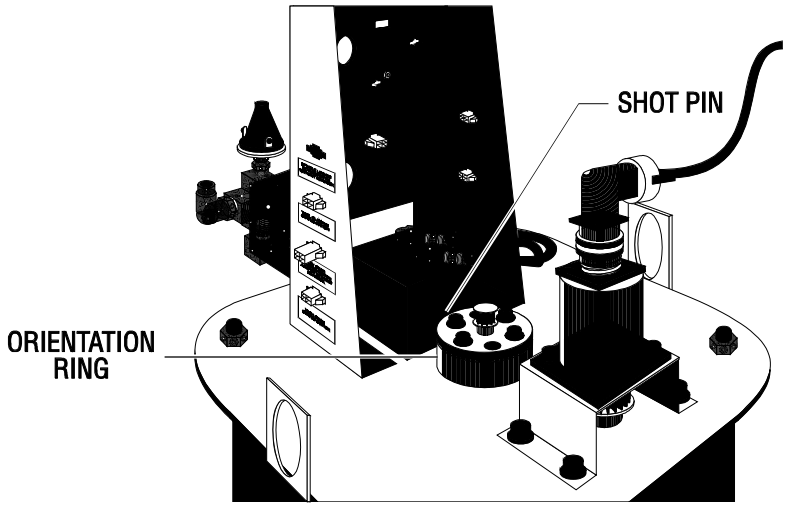


Fig. 6-2 VF-0 motor with orient ring location.

7. There is a 0.015"-0.030" backlash in the spindle system when it is oriented. Be certain to compensate for this backlash when performing the adjustment.

8. Using a 5/8" open end wrench, rotate the spindle until the appropriate alignment is attained. If the spindle is very difficult to rotate, STOP and return to Step 5.

9. Disconnect the main air line to the machine.

10. Manually turn the orientation ring and push the shot pin until it drops into the orient ring detent.

11. Tighten the orient screws (evenly) to 15 ft-lbs. Verify that spindle alignment has not changed.

NOTE: It is vital that the orient screws be tightened evenly. If not, the top of the orientation ring will run out and the ring will slip.

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

12. Make at least 50 tool changes to test the spindle orientation.

7. SETTING PARAMETER 64 (TOOL CHANGE OFFSET)

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO SET PARAMETER 64.

NOTE: Parameter 7 must be "unlocked" before setting Parameter 64.

1. WITHOUT a tool in the spindle taper, initiate a tool change and stop the tool changer using the EMERGENCY STOP button (when the Z-axis moves above the carousel, but before the carousel rotates). Insert a tool holder into the pocket facing the spindle.

2. Using a .0005 indicator and suitable 18" mag base, zero off of bottom left edge “A” of tool holder (looking directly into pocket). Move indicator to bottom right edge “B” of tool holder. Any difference between these edges should be equally divided. For example: if a difference of .002 from left side to right side edge, adjust indicator dial so that indicator reads .001 when it is on either edge. This gives you the tool offset reference.

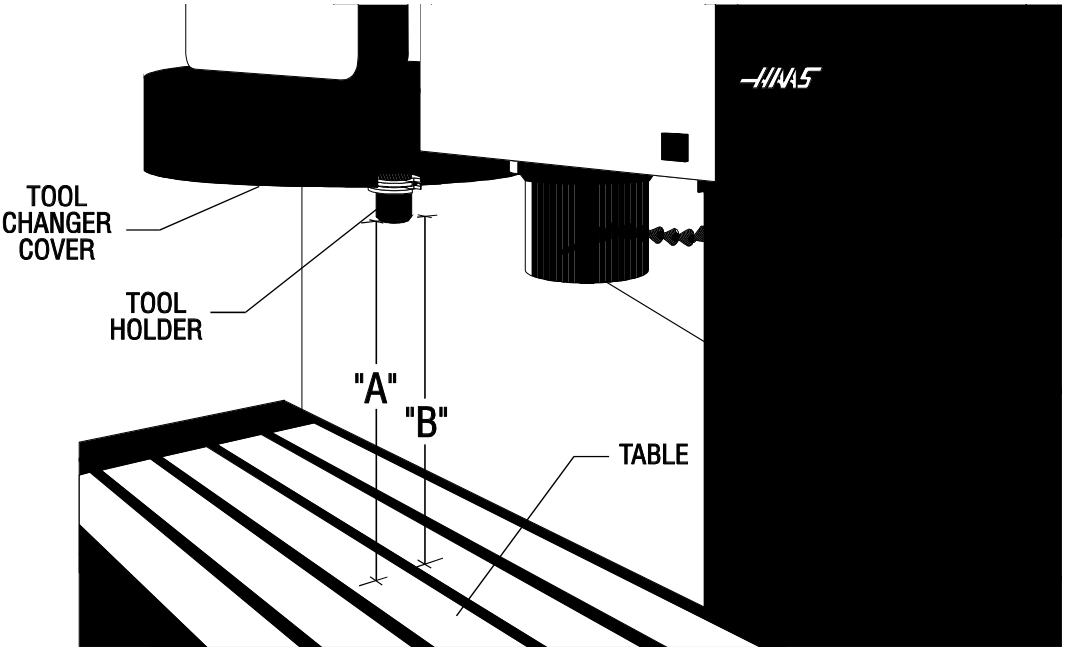


Fig. 7-1 Checking tool offset reference.

3. Carefully (so as not to disturb relative position) move the indicator to one side. Remove tool from the tool changer and place it in the spindle.

4. Zero return Z SIGL AXIS.

5. Carefully (so as not to disturb relative position) place indicator under spindle and indicate on bottom left edge of the tool holder.

If spindle head is too far in the negative (-) or the positive (+) direction, go to JOG mode and choose Z-axis. Jog Z-axis in the necessary direction until it reads zero (0).

6. Push the help button twice. This will put the machine in the calculator mode.

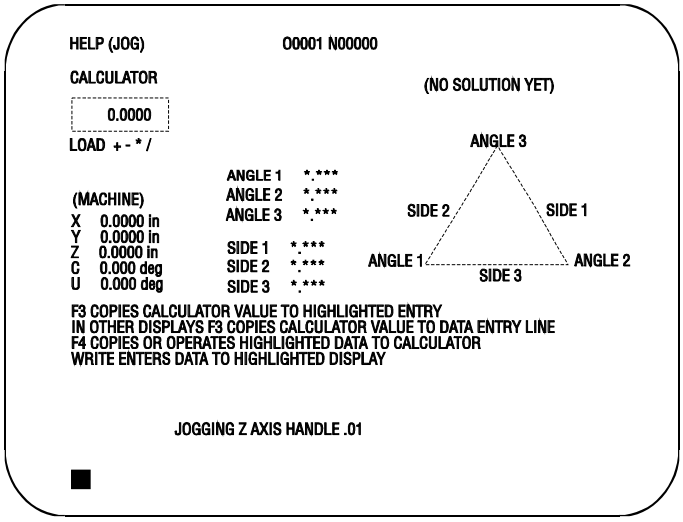


Fig. 7-2 Screen showing calculator.

7. Take the number in the Z-axis machine display (center left of page) and multiply it by Parameter 33, which is Z RATIO (STEPS/INCH).

If Z-axis work display is negative (-), add the number to the number that you calculated to Parameter 64. If the number is positive (+), subtract it from Parameter 64.

8. To insert the calculated new number, place the cursor at Parameter 64, type in new number and push write key. ZERO RET Z-axis to initialize the new Parameter 64.

9. Recheck the offset with the indicator (Steps 1-5).

10. Insert tool holder in spindle in spindle taper and initiate a tool change.
NOTE: When the Parameter 64 is changed, the tool offsets must be reset.

8. SPINDLE MOTOR & TRANSMISSION

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REMOVE OR REPLACE TRANSMISSION.

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

8.1 MOTOR REMOVAL (VF-0)

1. Ensure the VMC 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.

2. Remove the cover panels from head stock area ("Head Stock Removal" section).

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

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. Disconnect the air supply from the back panel of the machine.

6. Disconnect all of the electrical and pneumatic lines from the solenoid bracket on top of the spindle motor assembly. Mark any connections that have not been previously labeled for reassembly.

7. 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.

8. 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.

9. 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: It is recommended that the HAAS Transmission Hoist be used in this operation (Refer to "Hoist Pre-Assembly", later in this section, for assembly and setup).

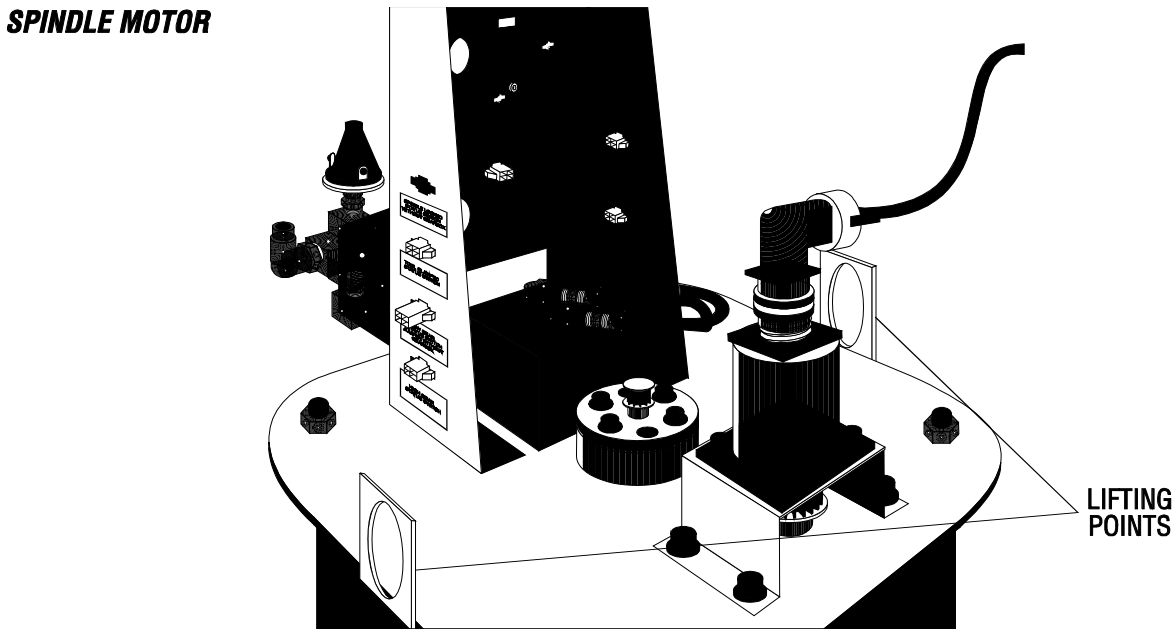


Figure 8-1 VF-0 with lifting eyeholes.

8.2 INSTALLATION (VF-0)

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 Assembly" before tightening down completely.

4. Refer to the appropriate section and set the spindle orientation.

5. Check for proper orientation of the machine and be aware of any unusual noises or vibration that may occur because of incorrect belt tension.

6. 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.

8.3 HOIST PRE-ASSEMBLY

1. Attach the mast support to the support base, using the four 3/8-16 x 1¼" SHCS, four 3/8" flat washers, four split washers, and the four 3/8-16 hex nuts. Ensure the bolts are securely tightened.

2. Attach the boom modification plates to the mast using the three ½-13 x 4½" HHB, three ½" split washers, three ½-13 hex nuts, and the three spacers.

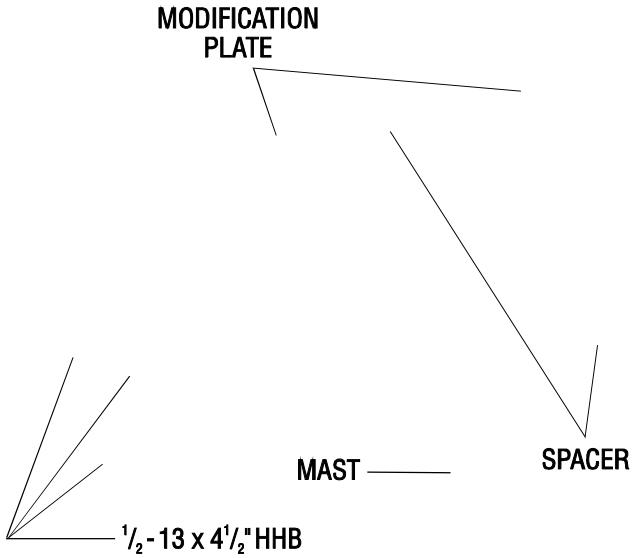


Fig. 8-2 Support base/mast support assembly.

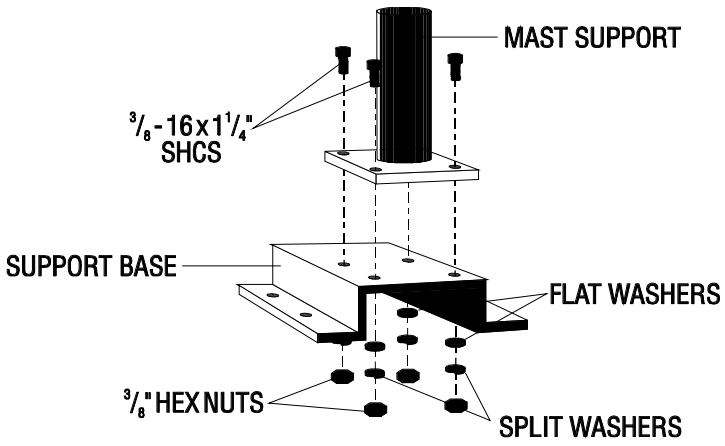


Fig. 8-3 Exploded view of boom modification plate components.

3. Assemble the boom assembly as follows:

A. Lubricate the components of the assembly:

1) Using a grease brush, apply grease to the through-hole and the side surface of the pulley wheel.
2) Wipe a thin coat of oil on the entire cable.
3) Lubricate all clevis pins with a thin layer of grease.
4) Oil all bearings on the winch and apply grease to the gear teeth.

B. Place the pulley wheel inside the cable guide and place this subassembly into the end of the boom. Ensure the clevis pin through-hole is toward the top of the boom and the rounded end of the cable guide is toward the outside. Slide the clevis pin through the hole and fasten with the

1/8" x 1" cotter pin.

C. Attach the winch base to the boom with the two 3/8-16x1" SHCS, two 3/8" lock washers, and the two 3/8" hex nuts. See owner's manual for mounting for left-or right-handed operation.

D. Feed the free end of the cable (without hook) between the pulley and cable guide and through the inside of the boom.

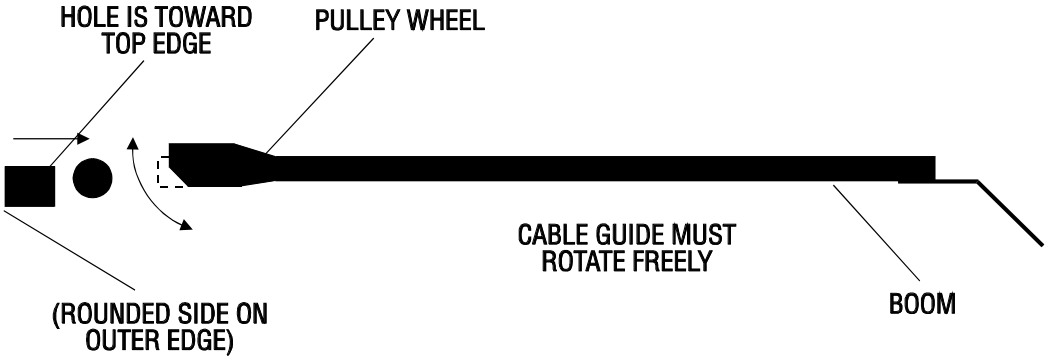


Fig. 8-4 Mounting cable guide and pulley wheel to boom.

E. Attach the cable to the winch as follows:

1) FOR LEFT-HAND OPERATION -
Pass the cable under the winch drum and through the hole in the drum flange. Form a loop of cable and securely anchor it in place using the tie-down clasp, carriage bolt, and hex nut. The cable must be underwound on the winch drum.

2) FOR RIGHT-HAND OPERATION -
Pass the cable between the frame rod and the countershaft of the winch, over the winch drum, and through the hole in the drum flange. Form a loop of cable and securely anchor it in place using the tie-down clasp, carriage bolt, and hex nut. The cable must be overwound on the winch drum.

F. Ensure all hex nuts and cap nuts are securely tightened and all cotter pins are properly bent to secure them in place. Make sure all pivots and rotation points are well-lubricated and refer to the winch owner's manual for proper lubrication before operating.

4. Place the transmission lift fixture on top of the transmission, with the rod at each end in the two lifting eyeholes of the transmission. Tighten the fixture onto the transmission by turning the handle at the end. **NOTE:** Do not over-tighten.

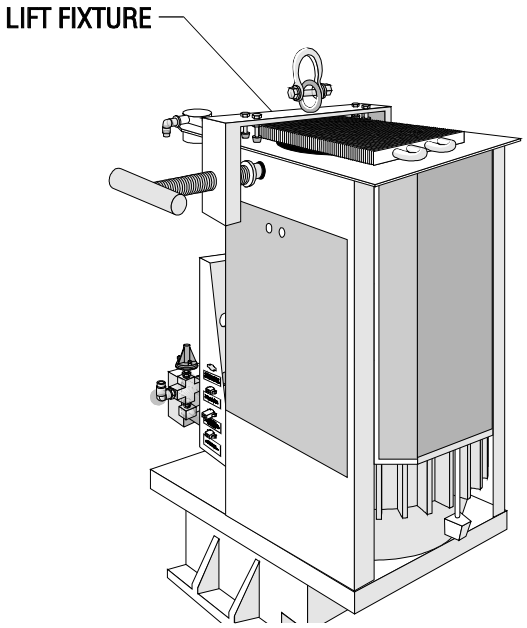


Fig. 8-5 View of transmission lift fixture.

8.4 TRANSMISSION REMOVAL

NOTE: This procedure is not for VF-0.

1. Ensure the VMC 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.

2. Remove the cover panels from head stock area ("Head Covers Removal" section).

3. 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 the new transmission.

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

5. Remove 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.

6. 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.

7. 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.

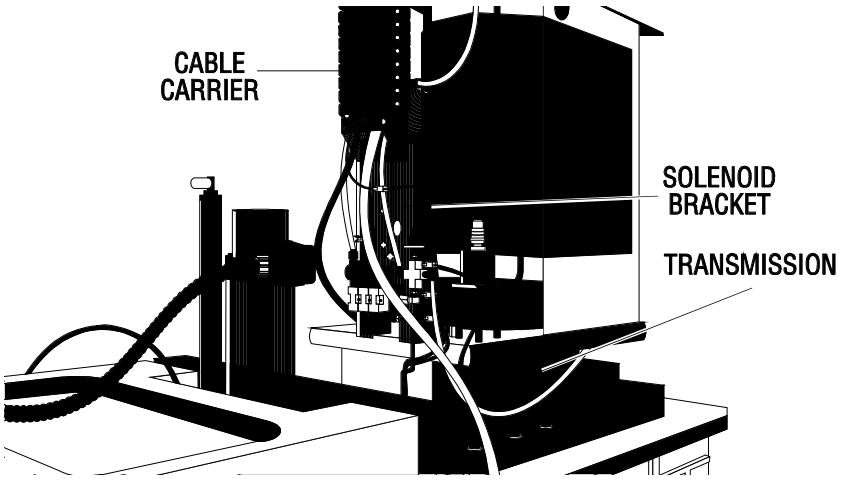


Fig. 8-6 Solenoid bracket with all lines connected.

8. 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.

9. Remove the protective cardboard from the mill table and install the support base assembly on the table, using the four SHCS, four ½" flat washers, and the four T-nuts.

CAUTION! Ensure the protective rubber pads on the bottom of the mounting base are in place and in good condition, or damage to the mill table may result.

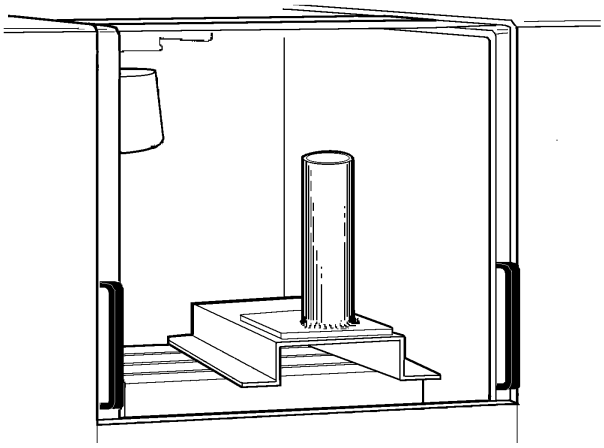


Fig. 8-7 Support base/mast support assembly location.

10. With the boom modification plate in place, insert the mast into the mast support. Using the two clevis pins, attach the boom to the mast.

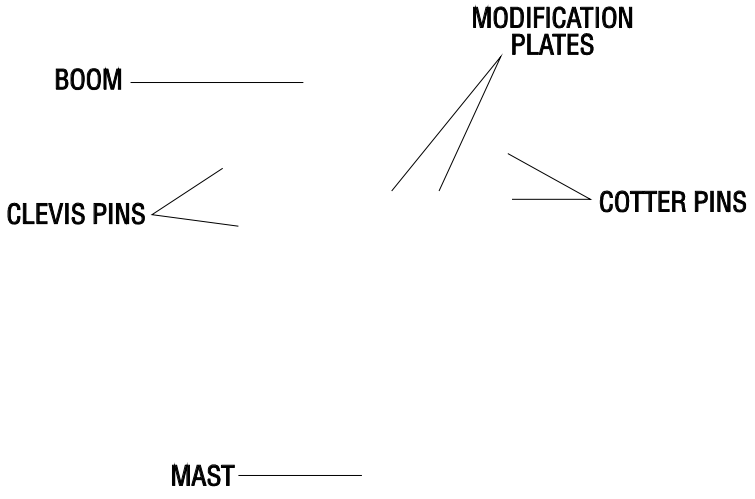


Fig. 8-8 Mounting boom assembly to mast.

11. Place the hoist directly over the transmission and attach the hook to the cradle's eye bolt.

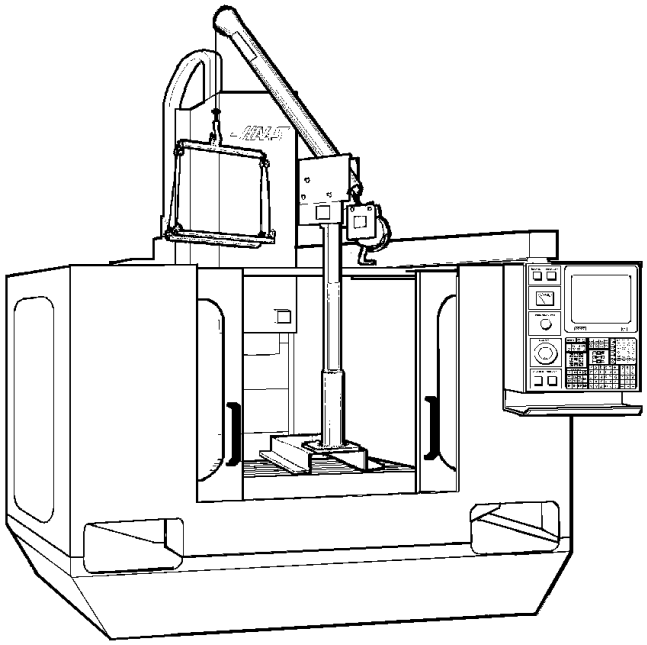


Fig. 8-9 Fully assembled hoist in position

12. Raise the transmission, ensuring the hoist is being lifted in the locking position, clearing the enclosures. Swing the boom toward the front of the machine and lower onto the wood blocks.

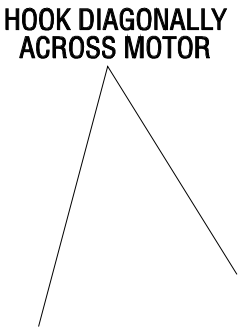


Fig. 8-10 Lifting position for VF-1 through 4.

13. For VF-1-4: Place the hoist hook in the bar's lifting eye and place the two hooks on either end of the bar into diagonally opposite lifting holes in the motor shroud. Lift just enough to ensure the hooks are seated properly, then carefully lift the motor and transmission assembly up enough to clear the VMC. Swing the boom toward the front of the machine and lower onto the wood blocks.

8.5 TRANSMISSION INSTALLATION

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

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

4. 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.

5. Lower the transmission carefully to just above the spindle head. Place the drive belt onto the transmission pulley.

6. Lower the transmission into the spindle head, taking care not to crush or bind the drive belt as you lower.

7. Insert and tighten down the six SHCS attaching the transmission to the spindle head. If these screws include gearbox isolators, ensure the following:

- The fender washer is placed below the 3/8" black washer when screw is installed.
- The 3/8" fender washer is not touching the gearbox housing.

Adjust the drive belt tension as noted in "Belt Assembly" section before tightening screws down completely.

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

NOTE: The hoist must be disassembled before removing from the mill table. Break down the hoist by removing the boom assembly, then the mast. It will not be necessary to completely break down the hoist after the first assembly.

NOTE: On shot pin assemblies that do not have a hole through the shaft, ensure the positioning ring has an adequate layer of grease around the circumference before starting operation. On those assemblies that do have a hole through the shaft, do not grease the orient ring.

9. AXIS MOTOR REMOVAL / INSTALLATION

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REMOVE OR REPLACE THE MOTORS.

9.1 X-AXIS MOTOR REMOVAL -

1. Turn the VMC ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

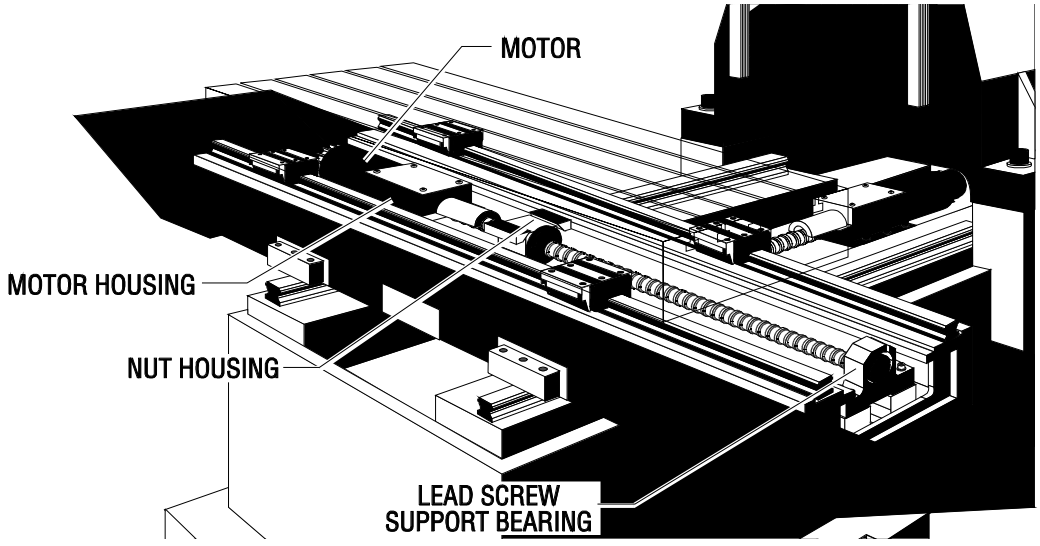


Fig. 9-1 X-axis motor and components.

2. Move the table to the far left position. Loosen the SHCS and remove the right way cover.

3. Move the table to the far right position. Loosen the SHCS and remove the left way cover.

4. Remove the side enclosure panels.

5. On the motor housing, remove the four BHCS and remove the cover plate.

6. Loosen the SHCS on the motor coupling at the lead screw.

7. Turn the machine power OFF.

8. On the motor housing, loosen the four SHCS and remove the motor from the housing.

9. Disconnect all wiring from the motor.

INSTALLATION -

1. Slide motor into motor housing, inserting the end of the lead screw in the motor coupling.

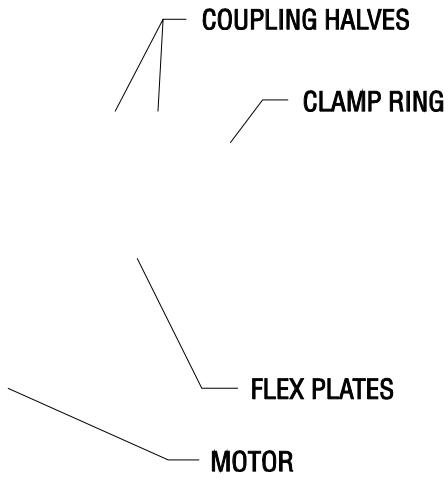


Fig. 9-2 Motor coupling components.

2. Reinstall and tighten down the four SHCS that hold the motor to the housing.

3. Visually inspect the flex plates to ensure they are parallel to the coupling halves and the slits in the coupling and clamp ring are in alignment (See Fig. 9-2). Tighten the SHCS on the motor coupling at the lead screw. (Place a drop of blue Loctite® on the screw before inserting.)

4. Replace the cover plate and fasten with the four BHCS.

5. Move the table to the far right position. Replace the left way cover with the SHCS.

6. Move the table to the far left position. Replace the right way cover with the SHCS.

7. Reinstall the side enclosures.

8. Check for backlash in the X-axis lead screw (Troubleshooting section) or noisy operation.

9.2 Y-AXIS MOTOR REMOVAL -

1. Turn the machine power ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

2. Move the table to the farthest forward position. Using a 5/32" hex wrench, remove the SHCS on the way cover at the rear of the saddle.

3. Slide the way cover back against the machine. Remove the two roller brackets from the base. Pull the way cover forward and off of the base.

4. If the bearings are to be serviced, move the table to the rear of its travel and remove the SHCS holding the front way covers to the saddle. Slide the way cover to the forward position.

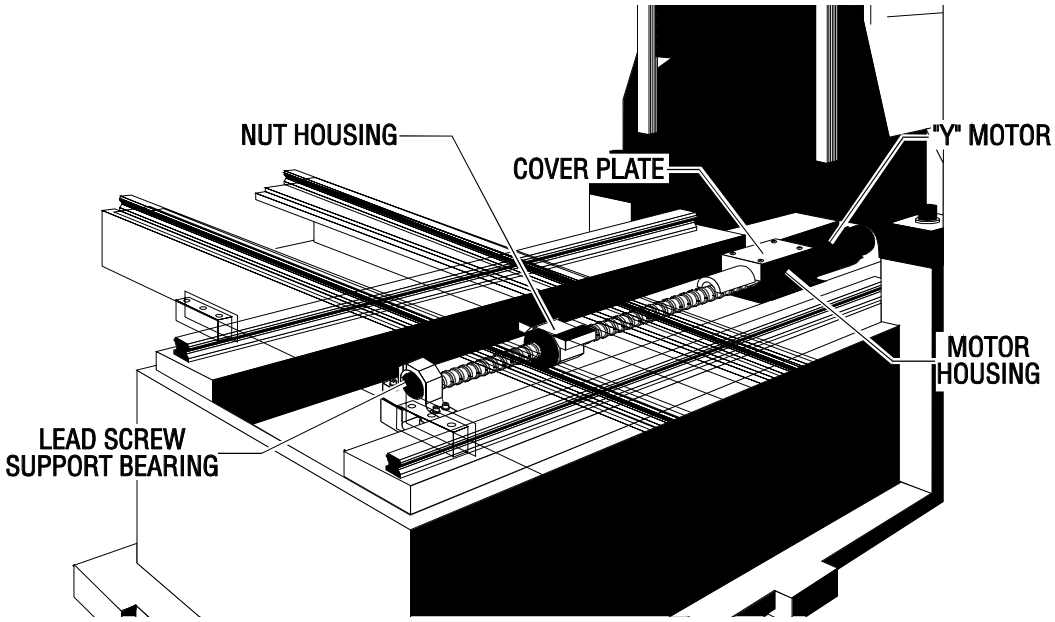


Fig. 9-3 Y-axis motor and components.

REMOVING OILER AND AIR REGULATOR PANEL -

5. Turn the machine off and disconnect the compressed air.

6. Using a 3/8" open-end hex wrench, disconnect the oil line connecting the base to the lubrication system panel.

7. Using a 7/16" open-end hex wrench, disconnect the solenoid on the front of the panel. Disconnect the other two air lines from the panel (quick-disconnect fittings) by hand.

8. Disconnect the three connections labeled 'limit switches' and remove the cords from the panel.

9. Disconnect the limit switch connection and the Y-axis connection at the side of the control panel.

10. While holding the lube/air panel assembly at the bottom edge, loosen the two SHCS and remove the panel assembly.

CAUTION! On machines with only two SHCS, remove one screw at a time. Replace the screw to hold the cabinet in place before removing the other screw. Failure to do this will result in damage to the cabinet.

11. On the motor housing, remove the four and remove the cover plate.

12. Loosen the SHCS on the motor coupling at the lead screw.

13. On the motor housing, loosen the SHCS and remove the motor from the housing.

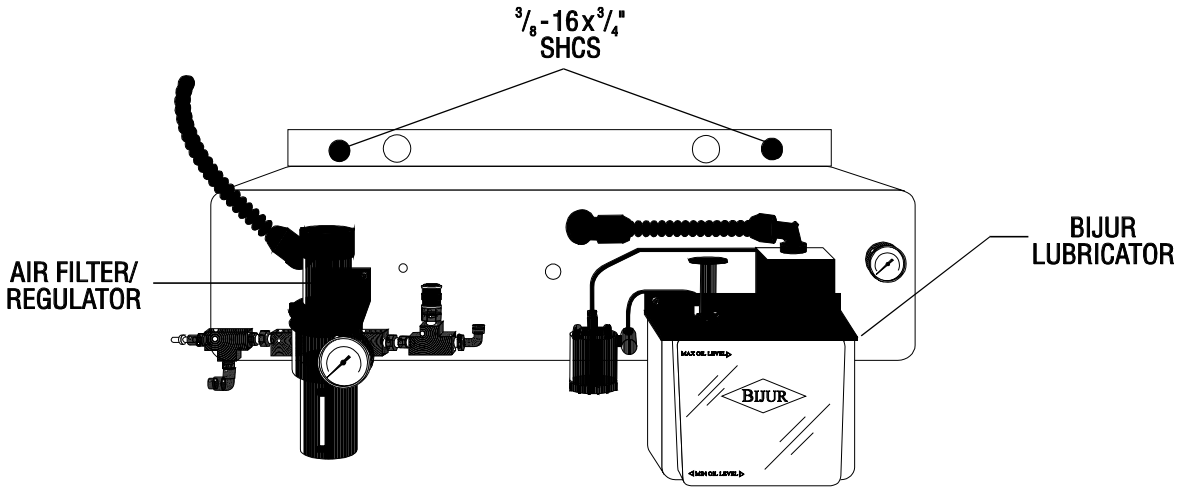


Fig. 9-4 Lubricator/air regulator panel.

INSTALLATION -

1. Slide motor into motor housing, inserting the end of the lead screw in the motor coupling.

2. Replace and tighten down the four SHCS that hold the motor to the housing.

3. Visually inspect the flex plates to ensure they are parallel to the coupling halves and the slits in the coupling and clamp ring are in alignment. Tighten the SHCS on the motor coupling at the lead screw. (Place a drop of blue Loctite® on the screw before inserting.)

4. Replace the cover plate and fasten with the four BHCS.

5. Replace the lube system panel with the two SHCS that mount it.

6. Plug in the limit switch connection and Y-axis connection at the side of the control panel.

7. Reconnect the three connections labeled "limit switches" to the panel .

8. Reconnect the two air lines to the panel, and the solenoid to the front of the panel.

9. Reconnect the oil line that connects the lube system panel to the base.

10. If the front way cover was removed, slide it back into position, and replace the SHCS that holds it to the saddle.

11. Move the table to the fully forward position. Replace the rear way cover.

12. Replace the two roller brackets onto the base.

13. Slide the way cover back into place, and attach to the saddle with the SHCS.

14. Check for backlash in the Y-axis lead screw (Troubleshooting section) or noisy operation.

9.3 Z-AXIS MOTOR REMOVAL -

ALWAYS BLOCK THE HYDRAULIC CYLINDER WITH SHAFT STOP BLOCK BEFORE SERVICING ANY Z-AXIS COMPONENTS.

1. Turn the machine power ON. Zero return (ZERO RET) all axes and put the machine in HANDLE JOG mode.

2. Loosen the six SHCS that attach the rear cover to the side covers, and remove from the spindle head.

NOTE: If machine is equipped with a hydraulic counterbalance, remove entire spindle head cover for VF-0/OE/1/2, VCE 500/550/700/750, or right side spindle head cover for VF-3/4, VCE 1000/1250.

3. If the bearings are to be serviced, remove the three SHCS attaching the Z-axis way cover to the spindle head and slide the cover to the bottom position.

4. Lower the spindle head to its lowest position.

5. If the machine is equipped with a hydraulic counterbalance, install cylinder shaft stop PN 99-7502 (See Fig. 9-6). HANDLE JOG Z-axis up until shaft stop blocks axis.

6. Disconnect the electrical power.

7. On the motor housing, loosen the four BHCS and remove the cover plate.

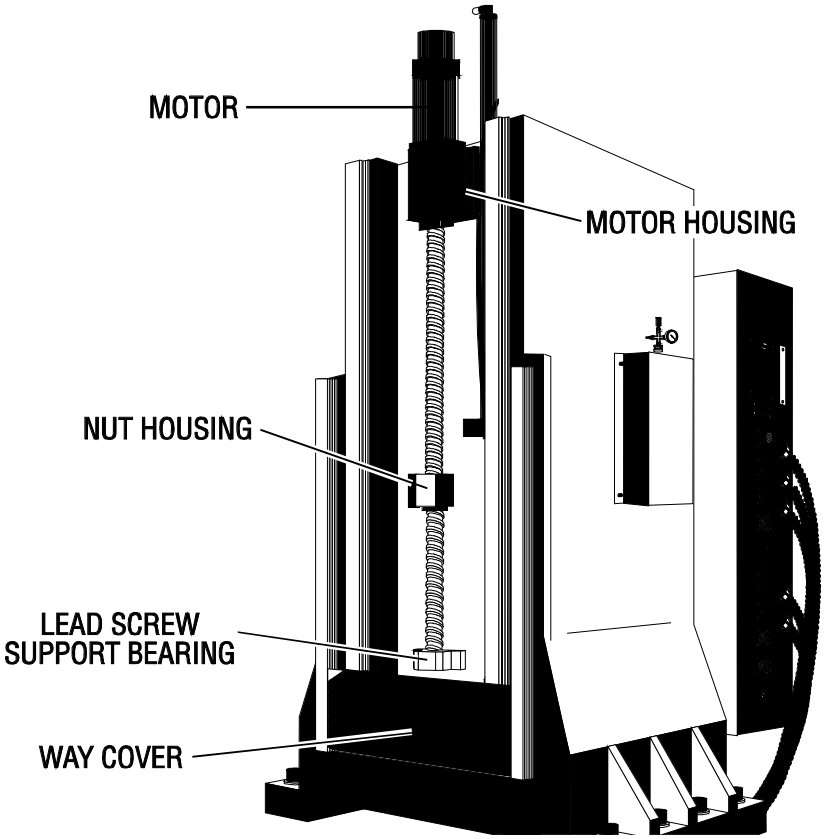


Fig. 9-5 Z-axis motor and components

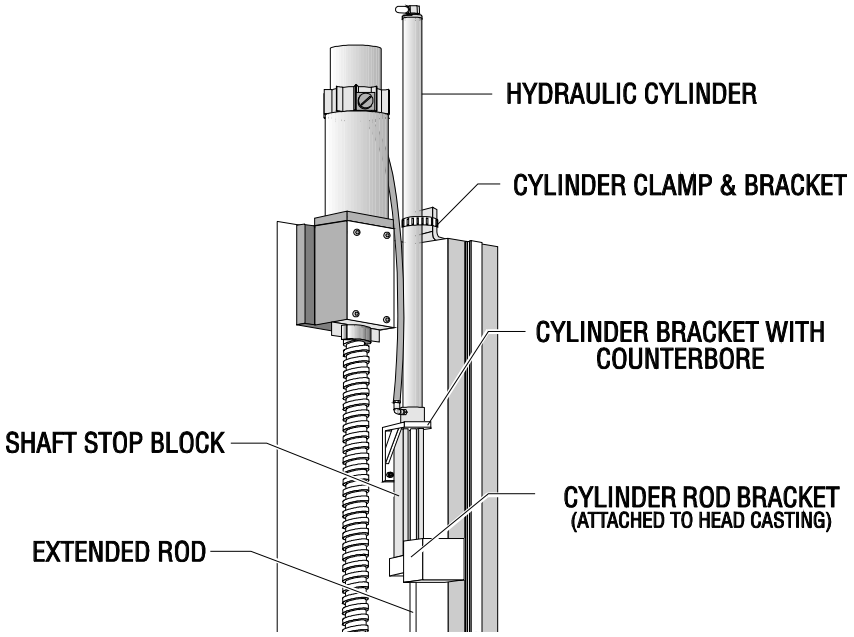


Fig. 9-6 Z-axis motor and components for machines equipped with hydraulic counterbalance.

8. Loosen the SHCS on the motor coupling at the lead screw.

9. On the motor housing, loosen the four SHCS and remove the motor from the housing.

10. Disconnect the Z-axis connection from the control panel.

INSTALLATION -

1. Slide motor into motor housing, inserting the end of the lead screw in the motor coupling.

2. Replace and tighten down the four 5/16-18 x 1¼" SHCS that hold the motor to the housing.

3. Visually inspect the flex plates to ensure that they are parallel to the coupling halves, and that the slits in the coupling and clamp ring are in alignment (See Fig. 10-2). Tighten the 10-32 x ½" SHCS on the motor coupling at the lead screw. (Place a drop of blue Loctite® on the screw before inserting.)

4. Replace the cover plate and fasten with the four BHCS.

5. Reconnect electrical power.

6. Remove shaft stop, if necessary.

7. If the front way cover was removed, slide it back into position, and replace the 10-32x3/8" SHCS that holds it to the saddle.

8. Move the table to the fully forward position. Replace the rear way cover.

9. Replace the two roller brackets onto the base.

10. Slide the way cover back into place, and attach to the saddle with the 10-32x3/8" SHCS.

11. Check for backlash in Z-axis lead screw (Troubleshooting section), or noisy operation.

9.4 COUPLING REPLACEMENT

1. Remove the axis motor in accordance with "Axis Motor Removal/Installation" section.

NOTE: It will not be necessary at this time to completely remove the motor. Do not disconnect the electrical components.

2. Completely loosen the 10-32 x ½" SHCS on the two coupling rings and remove the coupling.

3. For installation: Slide the new coupling onto the motor shaft until the coupling half is flush to the end of the shaft.

NOTE: Make sure that the collar split and coupling half split do not line up. Otherwise, the coupling will not be locked tightly to the lead screw.

4. Tighten the two 10-32 x ½" SHCS on the coupling's clamp ring. Before tightening, add one drop of blue Loctite® to each screw.

5. Reinstall the axis motor.

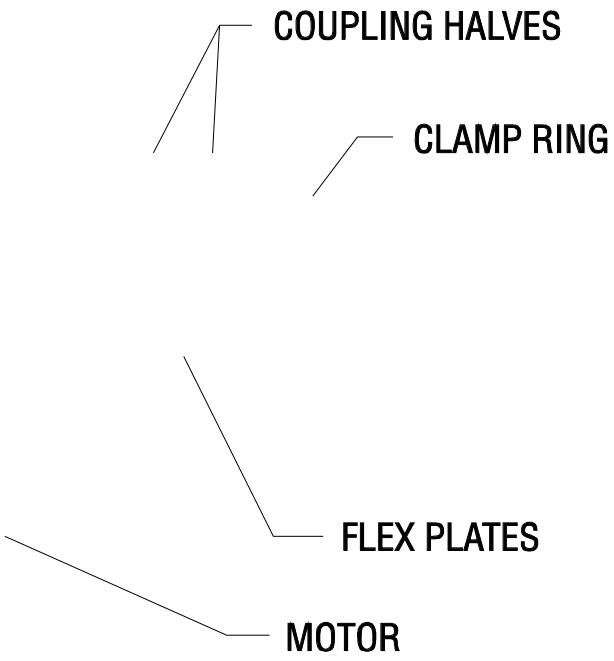


Fig. 9-7 Motor coupling.

10 LEAD SCREW REMOVAL AND INSTALLATION

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REMOVE OR REPLACE THE LEAD SCREWS.

IMPORTANT NOTICE ! ! !

The new bearing sleeves will have two ¼" diameter holes on the face, the older bearing sleeves will not. This procedure only applies to machines with new bearing sleeves. Contact your dealer for an older manual if your machine is equipped with older bearing sleeves.

TOOLS REQUIRED:

SPANNER WRENCH	**2" x 4" WOOD BLOCK (21"-23 ½" L)**
PRE-LOAD FIXTURE	**BLUE LOCTITE**

10.1 X-AXIS LEAD SCREW REMOVAL -

1. Turn the VMC ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

2. Remove the side enclosures.

3. Loosen the SHCS and remove the chip tray from the mill table.

4. Move the table to the far right position. Loosen the SHCS and remove the left way cover.

5. Move the table to the far left position. Loosen the eleven SHCS and remove the right way cover.

6. Remove the hard stop from the bearing housing on the lead screw.

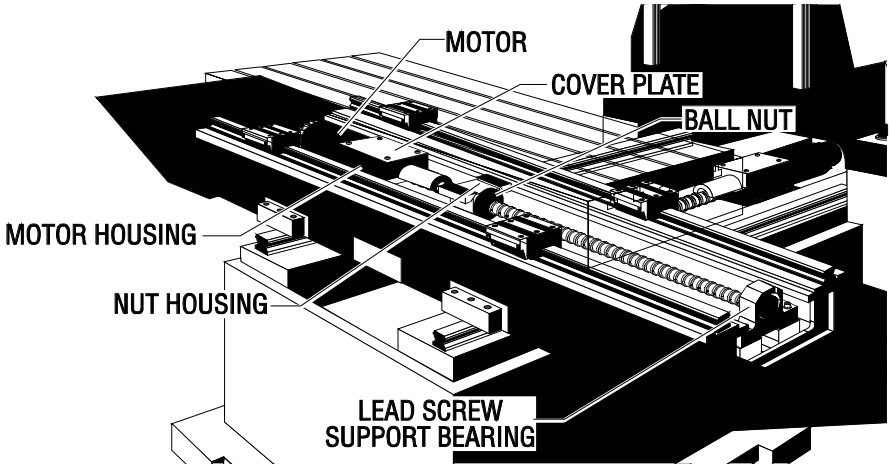


Fig. 10-1 X-axis lead screw and components.

7. Disconnect the oil line from the ball nut.

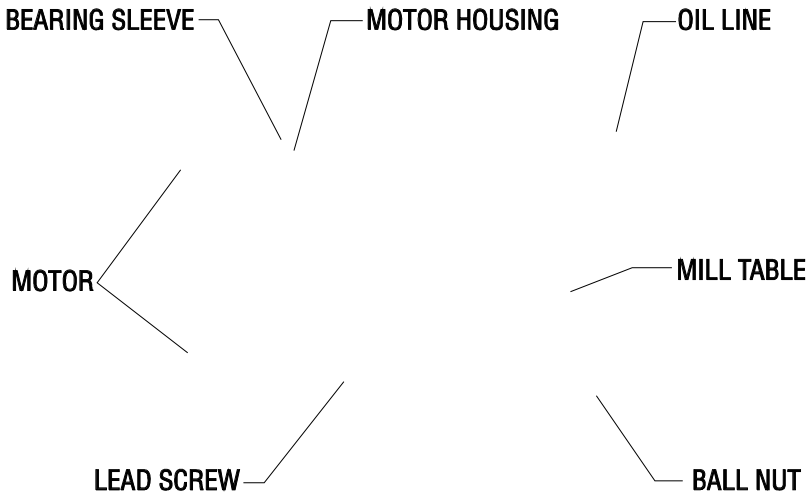


Fig. 10-2 Lead screw assembly.

8. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the lead screw support bearing end.

9. Remove the axis motor in accordance with "X-Axis Motor Removal".

NOTE: The motor's electrical connections do not need to be removed for this operation. After removing motor from the housing, set it to one side.

10. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the lead screw in the motor housing.

11. Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the mill table or the opposite end of the lead screw to loosen.

CAUTION: DO NOT PRY THE BEARING SLEEVE AWAY FROM THE HOUSING. DAMAGE TO THE SLEEVE, BEARING, OR LEAD SCREW WILL RESULT.

12. Loosen the six SHCS and remove the lead screw from the nut housing by pushing on the lead screw at the motor end.

INSTALLATION -

1. Center the mill table on the saddle.

2. 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.

3. Insert the lead screw through the nut housing and motor housing (See Fig. 10-3), taking care not to make contact with the screw threads, causing possible damage.

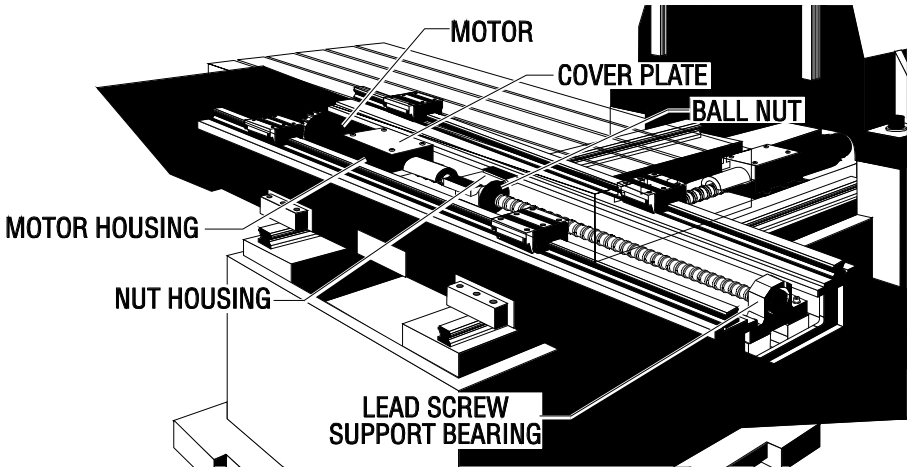


Fig. 10-3 Install lead screw from right side.

4. Place the bearing sleeve in the motor housing as shown. (It may be necessary to align the bearings in the sleeve to facilitate mounting on the lead screw.)

5. Insert the six ¼-20 x 1" SHCS, attaching the bearing sleeve to the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

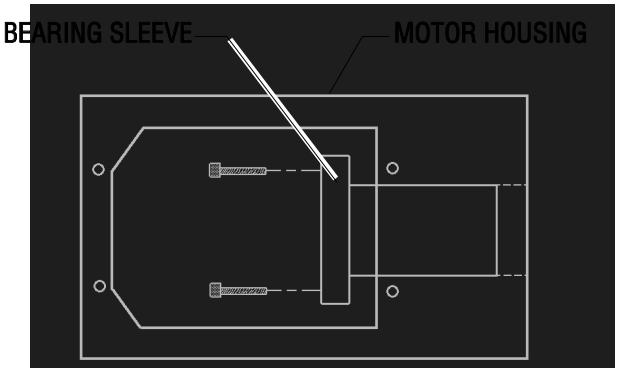


Fig. 10-4 Bearing sleeve mounting location.

6. Attach the clamp nut on the lead screw at the end opposite the motor housing. Screw on two or three turns but do not tighten down.

7. Move mill table as far right as possible, leaving room to insert two of the six ¼-20 x 1" (or ¼-20 x ¾") SHCS, one on either side, attaching the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

CAUTION: DO NOT RUN MILL TABLE PADS PAST THE END OF THE LINEAR GUIDES! IF THIS OCCURS, CEASE ALL OPERATIONS AND CONTACT THE MANUFACTURER AT ONCE.

8. Hand-turn the lead screw and move the mill table back to approximately center of the saddle. Install the remaining four SHCS, attaching the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

9. Move mill table to the far left position. ("Far left" is when the limit switch bracket touches the x-axis limit switch.)

10. Loosen all of the SHCS attaching the bearing sleeve to the motor housing approximately ¼ turn and retighten completely. DO NOT SKIP THIS STEP. It ensures the lead screw is installed and runs parallel and flat to the linear guides and the saddle.

11. Screw the clamp nut on the end of the lead screw in the motor housing. Do not tighten down completely.

12. Tighten the lead screw against the clamp nut as follows:

- Tighten the clamp nut on the motor housing end of the lead screw to 15 foot-pounds.
- Tighten the SHCS on the clamp nut.
- Tighten the clamp nut on the support bearing end of the lead screw until it contacts the bearing, then tighten further approximately 1/8 of a turn.
- Tighten the SHCS on the clamp nut.

13. Reinstall the motor.

14. Reinstall the way covers and chip tray.

15. Check for backlash in the lead screw ("Accuracy/Backlash" section) or noisy operation.

10.2 Y-AXIS LEAD SCREW REMOVAL -

1. Turn the VMC ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

2. Remove the motor in accordance with "Y-Axis Motor Removal".

3. Remove the hard stop from the lead screw support bearing end of the lead screw.

4. Loosen the 10-32 x ½" SHCS on the clamp nut at the bearing support end, then remove the clamp nut.

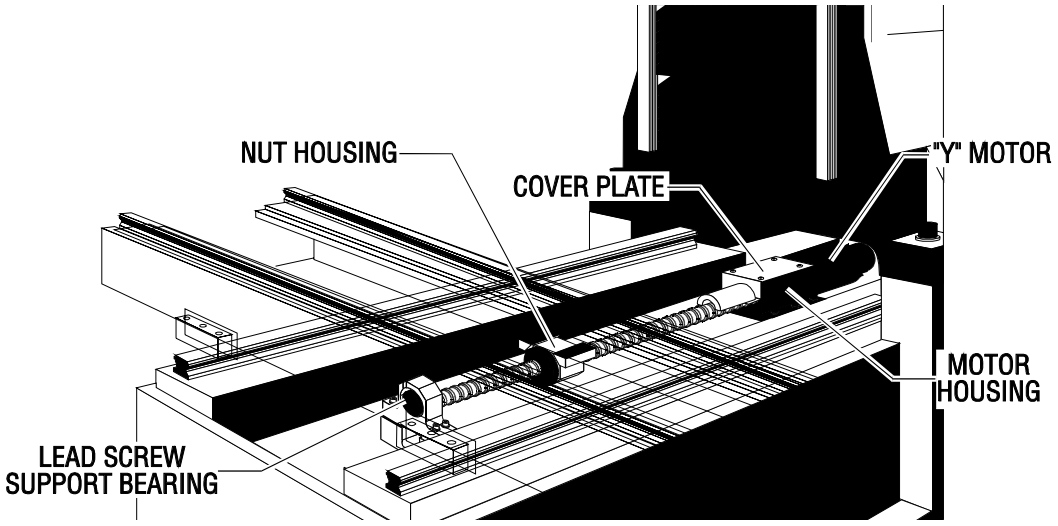


Fig. 10-5 Y-axis lead screw and components

5. Loosen the SHCS on the clamp nut at the motor end, then remove the clamp nut.

6. Loosen the six SHCS and remove the bearing sleeve from the motor housing. Push on the mill table or the opposite end of the lead screw to loosen.

CAUTION: DO NOT PRY THE BEARING SLEEVE AWAY FROM THE HOUSING. DAMAGE TO THE SLEEVE, BEARING, OR LEAD SCREW WILL RESULT.

7. Disconnect the oil line at the ball nut.

8. Loosen and remove the six SHCS attaching the ball nut to the nut housing.

9. Hand-turn the lead screw toward the rear of the machine until the front end of the lead screw clears the bearing by approximately six inches (6").

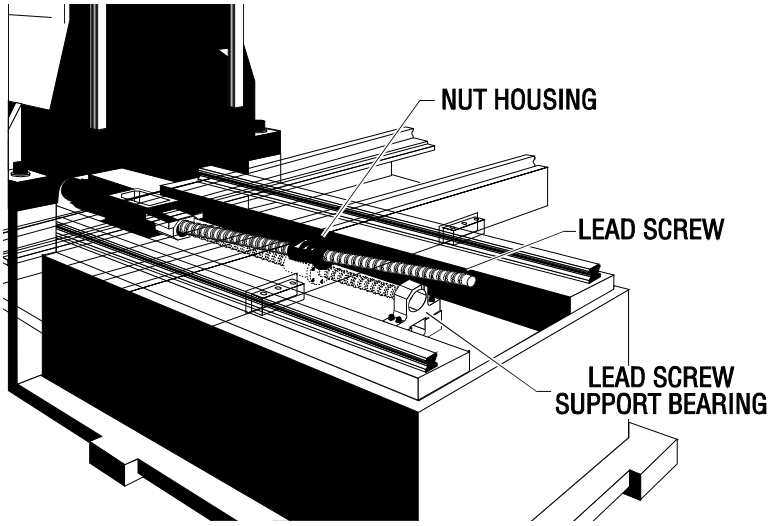
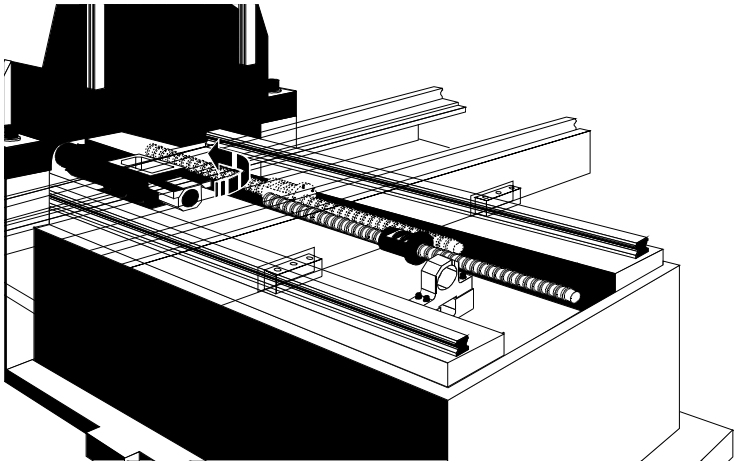


Fig. 10-6 Pull lead screw forward around bearing support,...



...push back into the machine, then pull out forward.

10. Carefully pull the lead screw forward, to the right of the support bearing, under the front way cover until the rear of the lead screw clears the nut housing. Shift the rear end of the lead screw to the right side of the nut housing and move the lead screw to the rear of the machine until it clears the front way cover. Remove lead screw from the machine.

INSTALLATION -

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 motor end of the lead screw under the saddle, taking care not to damage the screw threads. Position the lead screw to the right side of the nut housing and slide toward the rear of the machine as far as it will go.

3. Pull the lead screw forward until it is against the front way covers. Place the motor end of the lead screw through the nut housing and push the lead screw toward the back of the machine until the ball nut is seated in the nut housing.

4. Place the bearing sleeve in the motor housing. It may be necessary to align the bearings in the sleeve to facilitate mounting on the lead screw.

5. Screw the clamp nut on the motor end of the lead screw two or three turns. Do not tighten.

6. Pull the lead screw through the lead screw support bearing and loosely install the clamp nut as on the opposite end.

NOTE: DO NOT SKIP STEPS 7-10. THESE STEPS ENSURE THE LEAD SCREW IS INSTALLED AND RUNS PARALLEL AND FLAT TO THE LINEAR GUIDES AND THE SADDLE.

7. Install and tighten the six ¼-20 x 1" SHCS on the bearing sleeve. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

8. Hand-turn the lead screw until the table is as far forward as possible while still allowing room to install the SHCS on the ball nut.

9. Install the two outer SHCS of the six ¼-20 x 1" (or ¾") SHCS that secure the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

10. Loosen all of the SHCS on the bearing sleeve approximately ¼ turn, but do not remove.

11. Hand-turn the lead screw until it is at the rear of its travel. Retighten all six of the SHCS on the bearing sleeve.

12. Install and tighten down the four remaining ¼-20 x 1" (or ¾") SHCS that secure the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

13. Reinstall the hard stop on the lead screw support bearing.

14. Tighten the lead screw against the clamp nut as follows:
    - Tighten the clamp nut on the motor housing end of the lead screw to 15 foot-pounds.

- Tighten the SHCS on the clamp nut.

- Tighten the clamp nut on the support bearing end of the lead screw until it contacts the bearing, then tighten further approximately 1/8 of a turn.
- Tighten the SHCS on the clamp nut.

15. Reinstall the axis motor.

16. Check for backlash in the Y-axis lead screw (Troubleshooting section) or noisy operation.

10.3 Z-AXIS LEAD SCREW REMOVAL -

WARNING! ALWAYS BLOCK THE HYDRAULIC CYLINDER WITH SHAFT STOP BLOCK. DO NOT MOVE THE SPINDLE DURING LEAD SCREW SERVICE.

1. Remove the axis motor in accordance with "Z-Axis Motor Removal", making sure to follow all warnings included in that procedure.

2. Remove the bearing sleeve in accordance with "Z-Axis Bearing Sleeve Removal".

3. Hand-turn the lead screw to move the screw up until the bottom end clears the support bearing by approximately six inches (6").

4. Disconnect the oil line at the ball nut.

5. Loosen the six ¼-20 x 1" (or ¾") SHCS attaching the ball nut to the nut housing. Remove five of the screws.

6. Remove the last SHCS from the ball nut and lower the lead screw down and to the right of the support bearing, past the Z-axis way cover. For the VF-6, remove the lead screw from top of column.

USE EXTREME CAUTION! DO NOT DAMAGE THE THREADS ON THE LEAD SCREW.

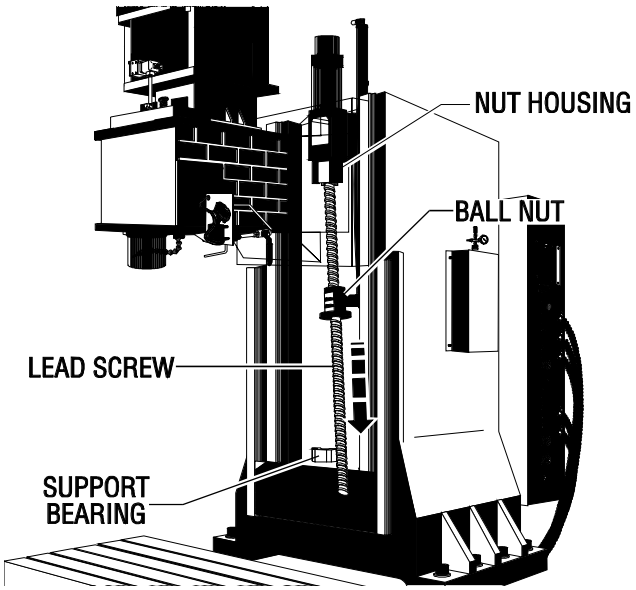


Fig. 10-7 Z-axis lead screw and components.

INSTALLATION -

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 lead screw up into the nut housing and gently lower it until it is resting in the support bearing.

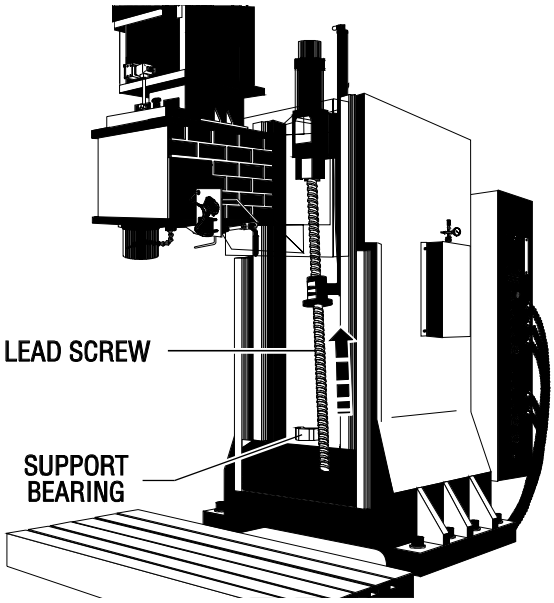


Fig. 10-8 Reinstalling the lead screw.

3. Loosely screw the clamp nut onto the support bearing end of the lead screw.

4. Reinstall the bearing sleeve. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

5. Hand-turn the ball nut until it comes into contact with the nut housing mounting surface. If necessary, turn the leadscrew to correctly position lube fitting of the ball nut.

6. Install and tighten down the two outer ¼-20 x 1" (or ¾") SHCS attaching the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

7. Loosen, but do not remove, the six ¼-20 x 1" SHCS attaching the bearing sleeve to the motor housing.

8. Hand-turn the lead screw and remove the shaft stop, accessing it from the underside of the spindle head. Allow the spindle head to move to the top of its travel.

9. Retighten the six ¼-20 x 1" SHCS attaching the bearing sleeve to the motor housing.

NOTE: DO NOT SKIP STEPS 7-10. THESE STEPS ENSURE THE LEAD SCREW IS INSTALLED AND RUNS PARALLEL AND FLAT TO THE LINEAR GUIDES AND THE COLUMN.

10. Loosely install the clamp nut on the motor housing end of the lead screw.

11. Install the remaining four ¼-20 x 1" (or ¾") SHCS attaching the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

12. Reinstall the hard stop at the support bearing end of the lead screw.

13. Tighten the lead screw against the clamp nut as follows:
    - Tighten the clamp nut on the motor housing end of the lead screw to 15 foot-pounds.
    - Tighten the SHCS on the clamp nut.
    - Tighten the clamp nut on the support bearing end of the lead screw until it contacts the bearing, then tighten further approximately 1/8 of a turn.
    - Tighten the SHCS on the clamp nut.

14. Reinstall cylinder shaft stop by hand-turning the lead screw.

15. Reinstall the axis motor in accordance with "Z-Axis Motor - Installation".

16. Check for backlash in the Z-axis lead screw (Troubleshooting section) or noisy operation.

11. BEARING SLEEVE REMOVAL AND INSTALLATION

Please read this section in its entirety before attempting to remove or replace the bearing sleeve.

TOOLS REQUIRED:
SPANNER WRENCH **WOOD BLOCK (16" L)**
PRE-LOAD FIXTURE

11.1 X-AXIS BEARING SLEEVE REMOVAL -

1. Turn the VMC ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

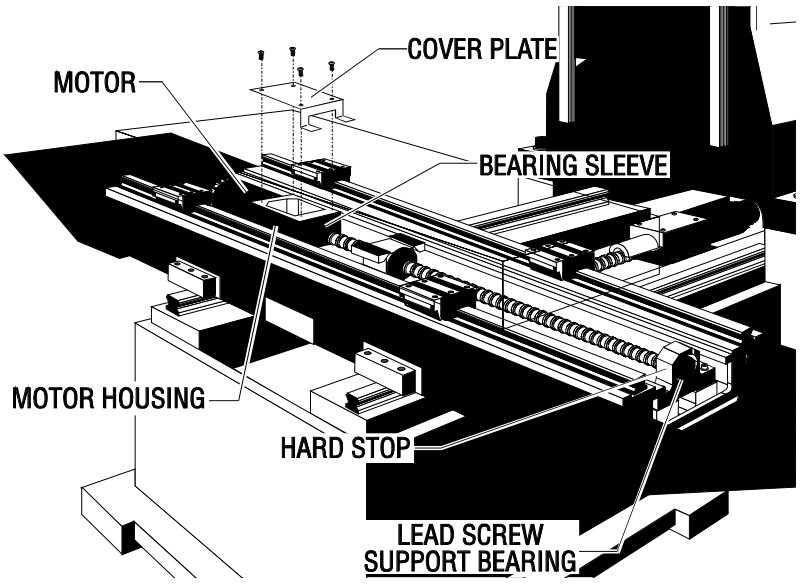


Fig. 11-1 X-axis lead screw and components.

2. Loosen the SHCS and remove the chip tray from the mill table.

3. Remove the axis motor in accordance with "X-Axis Motor Removal".

NOTE: The motor's electrical connections do not need to be removed for this operation. After removing from the motor housing, set it to one side.

4. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the lead screw in the motor housing.

5. Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the mill table or the opposite end of the lead screw to loosen.

CAUTION! DO NOT PRY THE BEARING SLEEVE AWAY FROM THE HOUSING. DAMAGE TO THE SLEEVE, BEARING, OR LEAD SCREW WILL RESULT.

INSTALLATION -

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. Move mill table to the far right.

3. Place the bearing sleeve in the motor housing as shown. (It may be necessary to align the bearings in the sleeve to

facilitate mounting.)

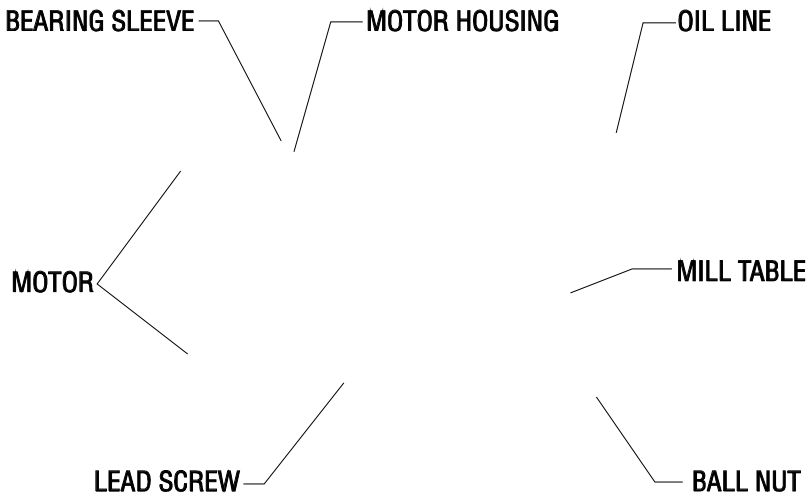


Fig 11-2 Lead screw assembly

4. Insert the six ¼-20 x 1" SHCS, attaching the bearing sleeve to the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

5. Start the clamp nuts on both ends of the lead screw. Do not tighten.

6. Hand-turn the mill table to the far left position.

7. Loosen the six ¼-20 x 1" SHCS attaching the bearing sleeve to the motor housing and retighten completely. DO NOT SKIP THIS STEP. It ensures the lead screw is installed and runs parallel and flat to the linear guides and the saddle.

NOTE: For the angular contact design bearing, no pre-load is necessary. Do the following:

- Tighten the clamp nut on the motor housing to 15 foot-pounds.
- Tighten the SHCS on the clamp nut.
- Tighten the clamp nut on the support bearing end of the lead screw until it contacts the bearing, then tighten further approximately 1/8 of a turn.
- Tighten the SHCS on the clamp nut.

9. Reinstall the axis motor in accordance with "X-Axis Motor Removal".

10. Reinstall the way covers and chip tray.

11. Check for backlash in the X-axis lead screw (Troubleshooting section) or noisy operation.

11.2 Y-AXIS BEARING SLEEVE REMOVAL -

1. Turn the VMC ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

2. Remove the axis motor in accordance with "Y-Axis Motor Removal".

3. Remove the hard stop from the bearing housing on the lead screw.

4. Loosen the 10-32 x ½" SHCS and remove the clamp nut from the bearing support end of the lead screw.

5. Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the mill table or the opposite end of the lead screw to loosen.

CAUTION: DO NOT PRY THE BEARING SLEEVE AWAY FROM THE MOTOR HOUSING. DAMAGE TO THE SLEEVE, BEARING, OR THE LEAD SCREW WILL RESULT.

INSTALLATION -

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 bearing sleeve into the motor housing and start all six ¼-20 x 1" SHCS into the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

3. Move the table to the rear of its travel.

4. Tighten the six ¼-20 x 1" SHCS that attach the bearing sleeve to the motor housing.

5. Loosely install the clamp nut on the lead screw at the motor housing end.

NOTE: For the angular contact design bearing, no pre-load is necessary (follow the procedure in "X-axis bearing sleeve" section).

6. Reinstall the axis motor.

7. Check for backlash in the Y-axis lead screw (Troubleshooting section) or noisy operation.

11.3 Z-AXIS BEARING SLEEVE REMOVAL -

WARNING! ALWAYS BLOCK THE HYDRAULIC CYLINDER WITH SHAFT SROP BLOCK BEFORE SERVICING ANY Z-AXIS COMPONENTS.

1. Turn the machine power ON. Zero return (ZERO RET) all axes and put the machine in HANDLE JOG mode.

2. Loosen the six SHCS that attach the rear cover to the side covers, and remove from the spindle head.
NOTE: If machine is equipped with a hydraulic counterbalance, remove entire spindle head cover for VF-0/OE/1/2, VCE 500/550/700/750, or right side spindle head cover for VF-3/4, VCE 1000/1250.

3. If the bearings are to be serviced, remove the three SHCS attaching the Z-axis way cover to the spindle head and slide the cover to the bottom position.

4. Remove the hard stop from the bearing housing on the lead screw.

5. Loosen the 10-32 x ½" SHCS and remove the clamp nut from the bearing support end of the lead screw.

6. Raise the spindle head until the bottom edge is approximately sixteen inches (16") above the mill table.

7. Install cylinder shaft stop PN 99-7562. HANDLE JOG Z-axis up until shaft stop block axis.

8. Place the wood block beneath the spindle head and lower the spindle head until it is resting on the block.

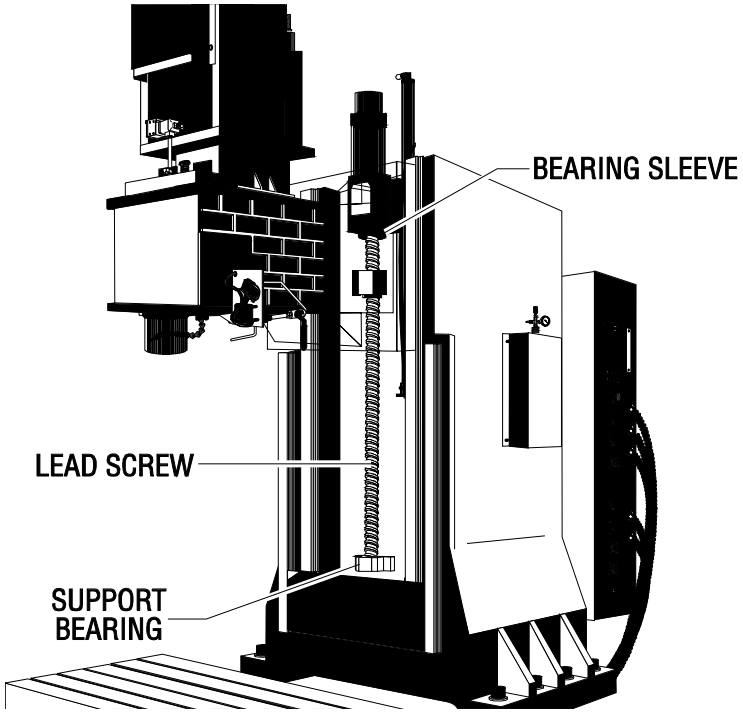


Fig. 11-3 Z-axis bearing sleeve.

9. Perform Steps 6-10 of "Z-Axis Motor Removal".

NOTE: The motor's electrical connections do not need to be removed for this operation. After removing from motor housing, set it to one side.

10. Loosen the 10-32 x ½" SHCS and remove the clamp nut from the motor housing end of the lead screw.

11. Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Hand-turn the lead screw in an upward direction to push the bearing sleeve out of the motor housing.

CAUTION! DO NOT PRY THE BEARING SLEEVE AWAY FROM THE MOTOR HOUSING. DAMAGE TO THE SLEEVE, BEARING, OR THE LEAD SCREW WILL RESULT.

INSTALLATION -

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 bearing sleeve into the motor housing and start all six ¼-20 x 1" SHCS into the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

3. Tighten the six ¼-20 x 1" SHCS that attach the bearing sleeve to the motor housing.

4. Loosely install the clamp nut on the lead screw at the motor housing end.

5. Reinstall the hard stop on the bearing housing end of the lead screw.

NOTE: For the angular contact design bearing, no pre-load is necessary. Follow the procedures as outlined in "X-Axis Bearing Sleeve" section.

6. Reinstall the axis motor in accordance with "Z-Axis Motor-Installation".

7. Remove shaft stop.

8. Check for backlash in the Z-axis lead screw (Troubleshooting section) or noisy operation.

12. AUTOMATIC TOOL CHANGER

TOOLS REQUIRED:

½" DRIVE RATCHET
10" EXTENSION (½" DRIVE)
1-2-3 BLOCK
CARDBOARD
LEVEL, STARRET #98
TWO-JAW PULLER
HYDRAULIC JACK
DIAL CALIPER

12.1 CARRIAGE CASTING REPLACEMENT

NOTE: 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.

2. Remove the left side enclosure panel of the machine.

3. 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.

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

5. 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.

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

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

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

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

9. 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.

12.2 ROLLER BOLT REPLACEMENT

1. Remove the shuttle motor cover from the back of the machine (VF-0, 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 "Spindle Orientation".

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

8. Reinstall the shuttle motor cover (VF-0, VF-1, VF-2).

12.3 AUTOMATIC TOOL CHANGER (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 in the full in position.

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.

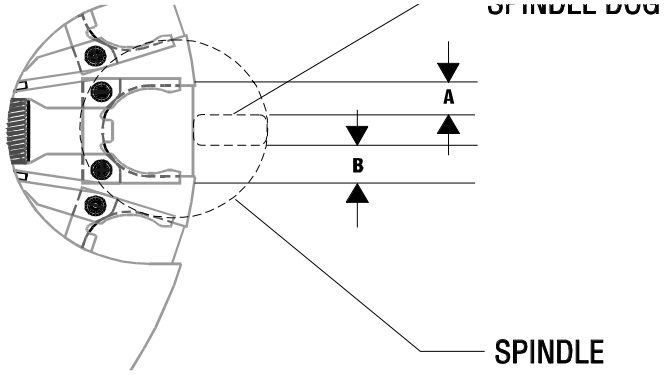


Fig. 12-1 Underside showing centering measurements.

4. Move the 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 if necessary, when the ATC is aligned.

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

12.4 SHUTTLE STROKE ADJUSTMENT -

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

7. 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 tool holder.

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

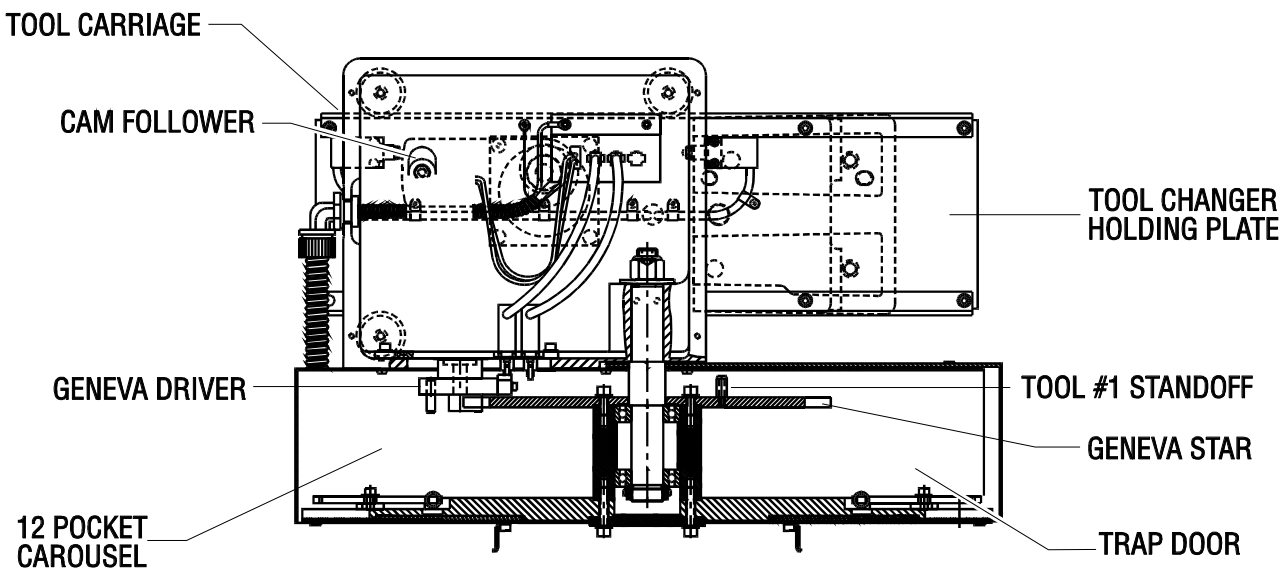


Fig. 12-2 Automatic Tool Changer - Mechanical Assembly (Side View)

12.5 EXTRACTOR FORK REPLACEMENT

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

1. With no tool holders in the spindle or in the ATC, command "ATC FWD" until the extractor fork needing replacement is facing the spindle.

2. Command "ATC FWD" again, but press the 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.

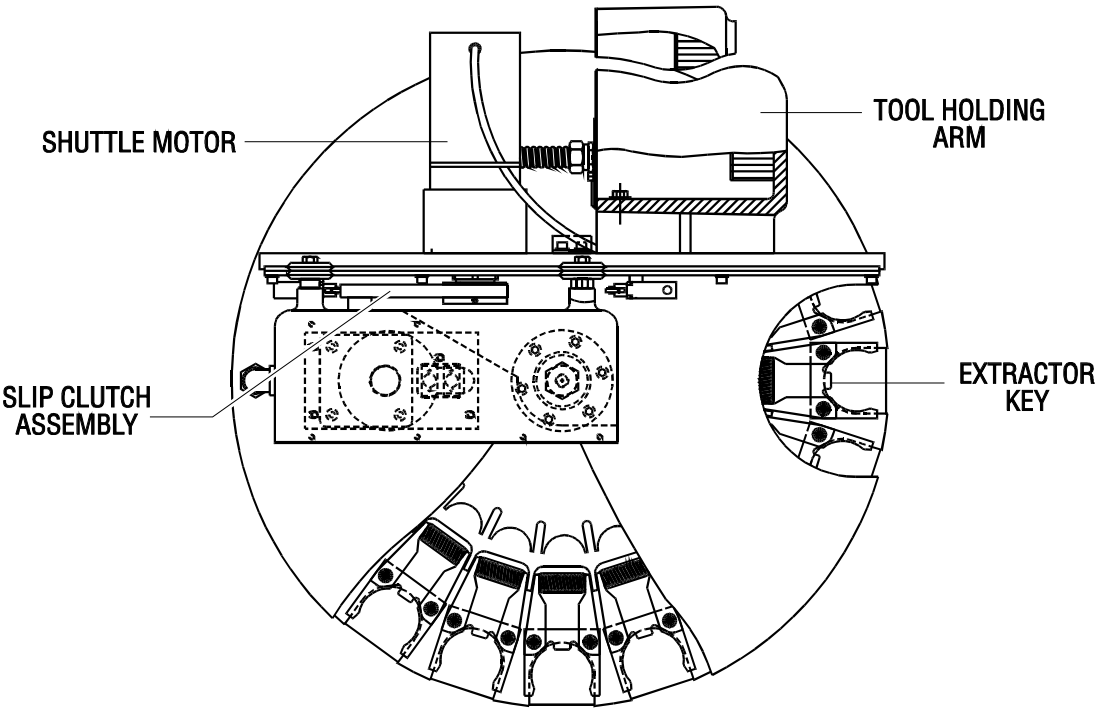


Fig. 12-3 Automatic Tool Changer - Mechanical Assembly (Top View)

4. With the extractor fork removed, inspect the alignment key mounted under the extractor. If it is damaged due to improper spindle orientation, replace it and correct the orientation (Refer to appropriate section) after the extractor fork has been replaced.

5. Put a drop of blue Loctite on each of the SHCS and attach the new extractor fork to the ATC with the SHCS. **DO NOT OVER-TORQUE!** Ensure the distance from the edge of the extractor fork to the edge of the pocket in the carousel is the same on both sides in accordance with the following section.

6. Test run the ATC to ensure proper operation.

12.6 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 the cause before resuming normal operation.

12.7 SHUTTLE MOTOR REMOVAL-

1. Turn the VMC off.

2. Remove the cover from the tool carriage casting.

3. Remove the hex bolt that attaches the cam follower to the slip clutch (see Fig. 12-2).

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

5. Loosen the set screw that secures the slip clutch assembly to the shuttle motor (see Fig. 12-3).

6. Using a small two-jaw puller, pull the slip clutch assembly (see Fig. 12-3) off the shuttle motor shaft.

7. Remove the SHCS attaching the cover to the holding arm casting on the tool changer.

8. Remove the cover from the wire channel inside the holding arm casting and unplug the shuttle motor from the wiring harness.

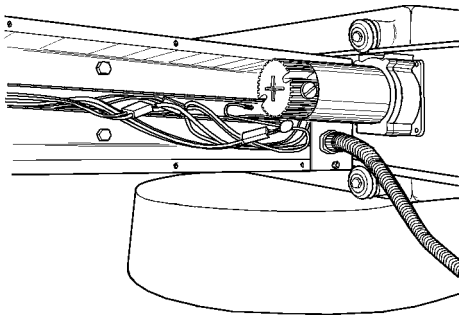


Fig. 12-4 Wiring harness for shuttle motor.

9. 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 HHB's holding the shuttle motor gear box together.

12.8 SHUTTLE MOTOR INSTALLATION -

1. Install the new motor on the tool changer holding plate using the four 10-32 x ¾" FHCS. Before inserting the FHCS, place a drop of blue Loctite® on each screw.

2. Reattach the shuttle motor connection to the wiring harness in the holding arm casting.

3. Replace the cover on the holding arm casting.

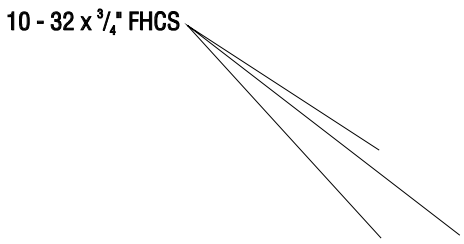


Fig. 12-5 Front view of holding plate showing FHCS location.

4. Reattach the slip clutch assembly to the shuttle motor shaft. Before placing on the shaft, put two or three drops of red Loctite® on the slip clutch hub.

5. Insert and tighten down the set screw holding the slip clutch assembly to the shuttle motor shaft. Before inserting the set screw, put a drop of blue Loctite® on the set screw.

6. Ensure the actuating arm on the slip clutch assembly contacts the shuttle IN and OUT 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 go through a performance check consisting of at least 30 tool changes, assuring correct operation.

12.9 TURRET MOTOR REMOVAL -

1. Power on the VMC and put it in MDI mode.

2. Zero Return all axes (ZERO RET - AUTO ALL AXES).

3. Press ATC FWD then the EMERGENCY STOP after the spindle head has moved during the tool change cycle. At this time, the tool changer should be at the full in position and the spindle head should be above the tool changer.

4. Turn the VMC 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's connections at the carriage casting.

7. Remove the four SHCS attaching the turret motor and mounting plate to the tool carriage casting.

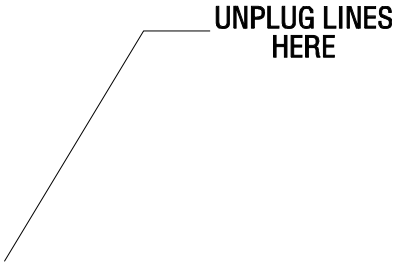


Fig. 12-6 Carriage casting with cover removed.

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 and rebuilding.

INSTALLATION -

1. Grease the locking element and drive pin on the Geneva driver. Also, grease the teeth on the Geneva star on the ATC.

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.

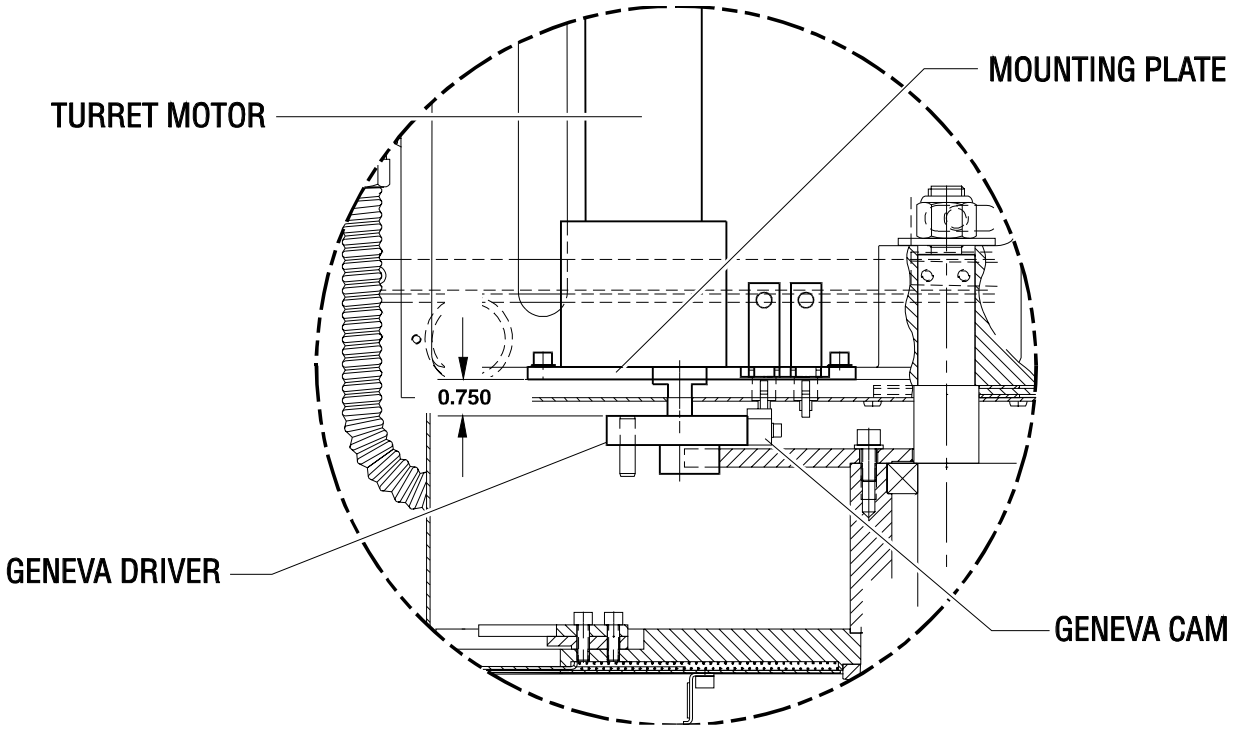


Fig. 12-7 Required spacing for Geneva driver.

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 VMC 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 8. 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 backwards. Reverse motor leads and repeat steps 7-10. Also, 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.

12.10 GENEVA STAR REPLACEMENT

NOTE: If the 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. Be certain to grease the perimeter of the star before installation and readjust the ATC in accordance with "Alignment Preparation" and "Shuttle Stroke Adjustment", if necessary.

12.11 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 be certain 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. The position of the ATC may need to be readjusted after installation.

13. GRID OFFSET CALCULATION

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO SET THE GRID OFFSET.

GUIDELINES -

The encoder Z channel signal must occur between 1/8 and 7/8 revolution from where the home switch released. If DISTANCE TO GO is less than 1/8 (.0295) or greater than 7/8 (.2065) of a revolution it will alarm to “Zero return margin too small”.

In the ZERO RETURN mode, the DISTANCE TO GO amount is the amount that the encoder rotated from when the switch was released until it found the z channel signal. The ideal amount for the DISTANCE TO GO is .118 (This equals ½ of a revolution of the encoder).

SETTING THE OFFSET -

1. Set grid offset to zero. (Parameter 125,126, or 127, depending on the axis being set.) Setting #7 (parameter lock) must be off to reset grid offset.

2. ZERO RET and ZERO SINGL AXIS for the axis you are setting (X, Y, or Z).

3. Using the following formula, write the result in the Parameter 125,126, or 127 (depending on the axis being set).

(DISTANCE TO GO - .118) x Parameter #33 = Grid Offset [Parameter #33 = Ratio Steps/Inch]

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.

14. ENCLOSURE REPLACEMENT

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)

14.1 DOOR REPLACEMENT

CAUTION! If possible, have two people performing this operation, as the weight of the doors may be a factor in removal.

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 -

6. Ensure that the lower roller hex fasteners are wrench tight and the upper roller fasteners are finger tight 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.

7. Rotate the door to the upright position, and engage the top rollers onto the top roller guide.

8. Replace the tension springs onto the upper and lower roller swivel brackets. Tighten the upper roller fasteners.

9. 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.

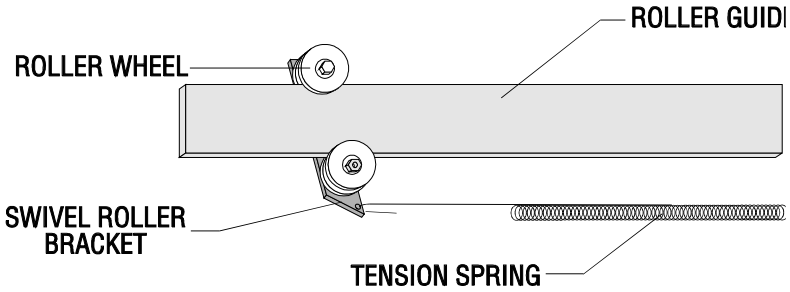


Fig. 14-1 Roller/roller guide assembly

DOOR ADJUSTMENTS -

10. 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 the door is in the desired position (the vertical gap is uniform), tighten the lower outer roller fastener.

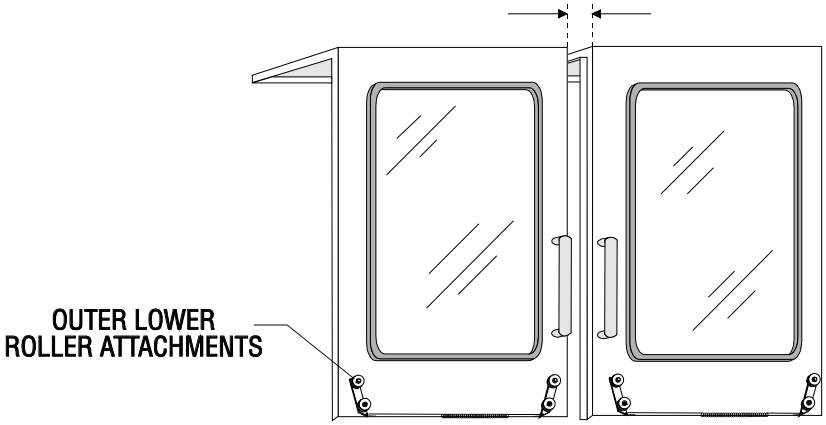


Fig. 14-2 View of vertical gap between front doors.

11. 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 the door's upper roller fasteners and tilt the door forward or back, as necessary, to adjust door position.

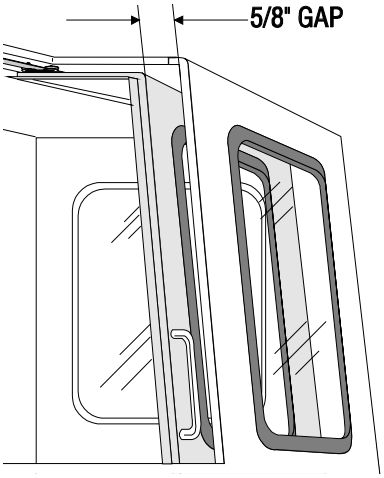


Fig. 14-3 View of gap between front of door and front panel flange.

SWITCH ADJUSTMENT -

12. Move the door to the fully closed position. Go to the "Diagnostics" page on the control panel, and ensure "DOOR S" reads "0". Move the door to the open position, 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:** 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.

14.2 WINDOW REPLACEMENT

REMOVAL -

1. Turn the machine power off.

2. Move the door to the fully closed position so the window is accessible. Use a trim installation tool to pull the locking tab out of the inside of the window seal (the tab is a part of the seal).

3. Remove the window panel from the seal. The tool can be placed between the window panel and the seal to aid in removing the window panel.

4. Remove the seal from the enclosure's cutout.

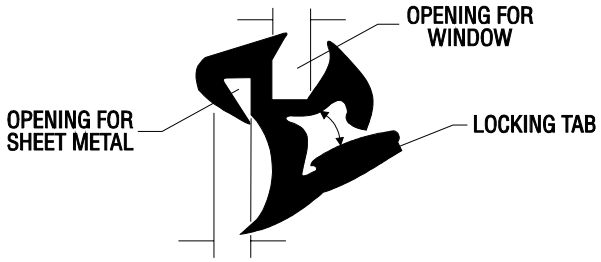


Fig. 14-4 Cross-section of window seal.

INSTALLATION -

5. Replace the seal around the enclosure's cutout, with the locking tab facing the inside of the machine.

6. Replace the window panel into the seal. The tool can be placed between the window panel and the seal to aid in replacing the window panel into the seal.

15. HYDRAULIC COUNTERBALANCE

Tools Required
(1) 4x4x14" Head Support Block
Hydraulic Counter Balance Service Kit consists of :
Pressure tank with manifold assembly, prefilled with (2) Quarts DTE-25 Hydraulic Oil.
Hydraulic cylinder with hose attached (if necessary).

15.1 HYDRAULIC TANK REPLACEMENT

REMOVAL -

1. **CAUTION!** While performing this procedure, the spindle head may drop if the control loses power or alarms. Raise spindle head by HANDLE JOG up to 14.5" above table. Insert wood block and lower head casting onto it. EMERGENCY STOP the machine. Head should rest securely on table block. Power OFF VMC.

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 tank is equipped with sensor.

3. Remove cap to Schrader filler valve, attach discharging hose and release any remaining pressure from the tank.
NOTE: Oil may drain out with releasing gas so it is necessary to discharge the system into a container.

4. Disconnect hydraulic hose from the tank assembly.

5. Remove tank assembly from column by removing the four SHCS from tank holding bracket.

INSTALLATION -

6. Connect the hose to the tank before mounting the tank in the inverted position. This prevents hydraulic oil from spilling.

7. Mount the tank assembly to the column with the tank holding bracket and four SHCS. Ensure the hydraulic hose is not twisted.

8. Connect the two-pin end of the pressure sensor cable(s) to the pressure sensor(s).

If replacing a tank without a pressure sensor, perform steps 9-11. Otherwise, skip to Step 12.

9. Use cable ties (P/N 70-0020) to secure the cable to the hydraulic hose.

10. Install the strain relief provided on the cable in 0.813" diameter hole in the control cabinet and tighten the nut that secures the cable.

11. Rout the section of cable in the control cabinet inside the wire channels.

12. Connect the charging system to the Schrader filling valve. Pressurize system with dry nitrogen gas (welding grade acceptable).

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.
- Verify cylinder is seated in counterbore.

10. 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.

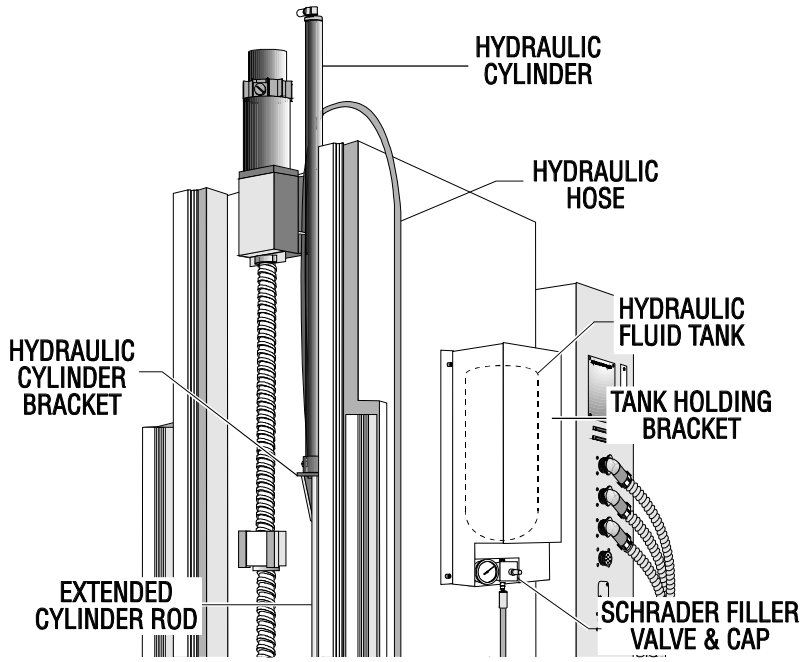


Fig. 15-1 Hydraulic Counterbalance view.

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

15.2 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 the Z-axis way cover to the spindle head.

3. Remove the cotter pin and lock nuts from the threaded end of the cylinder rod.

4. Loosen the two SHCS holding the cylinder clamp to the column, and the bracket screw, and remove both.

5. Remove the hydraulic cylinder from the top of the column.

NOTE: Do not disassemble unit. Keep the hose attached to the cylinder.

6. Return complete assembly to HAAS Automation.

INSTALLATION

7. 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.

8. Orient cylinder body with hydraulic hose facing away from lead screw.

9. Install lock nuts, at threaded end of cylinder rod, wrench tight. Install safety cotter pin.

10. Install the hydraulic tank as described in the previous section, but **DO NOT power up the machine**.

11. 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.

12. Install cylinder clamp with two SHCS and bracket at top of column with bracket screw.

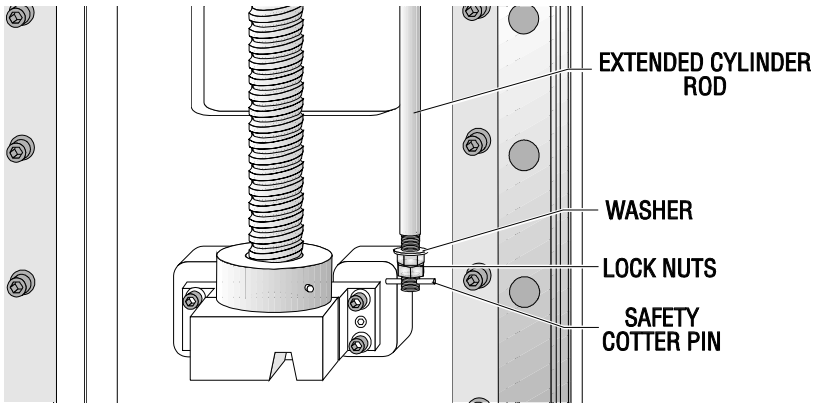


Fig. 15-2 Hydraulic Cylinder Rod Installation.

13. Zero return (ZERO RET) machine. HANDLE JOG Z-axis in 0.1 increments. Verify full Z travel.

14. 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

15. If Z-axis overcurrents alarm 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.

16. Reinstall Z-axis way cover with three SHCS that hold it to the spindle head.

	VF - 0/1/2/6/8	VF - 3/4
Machine at top of travel	750 psi	1150 psi
Machine at full travel	790 psi	1210 psi

Fig. 15-3 Tank pressure requirements.

16. THROUGH THE SPINDLE COOLANT SYSTEM

TOOLS REQUIRED:
0-15 PSI gauge
0-160 PSI gauge

16.1 TOOL RELEASE PISTON ASSEMBLY - TSC

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REPLACE TOOL RELEASE PISTON ASSEMBLY.

REMOVAL-

1. Place a tool holder in the spindle.

2. Remove the cover panels from the headstock area in accordance with "Head Covers Removal and Installation".

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

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

5. Remove the tool release air hose (at the fitting as shown in Figure 2-2), the precharge air hose, and the coolant hose.

6. Remove the four SHCS holding the tool release piston assembly to the head casting.

7. Lift up the entire tool release piston assembly and remove carefully.

8. Remove the seal housing from the TRP with the drain line attached.

9. Remove the drain line from the seal housing.

INSTALLATION-

10. Remove the seal housing from the Tool Release Piston (TRP).

11. Install the TRP.

12. Install coolant hose (3/8" diameter x 9" long plastic tubing) and precharge line. **NOTE:** VF-0/0E uses 3/8" diameter

If machine is equipped with Through the Spindle Coolant option:

NOTE: "Tool Clamped" jumper is necessary to start the spindle.

If the drawbar has been replaced, perform the following:

- Place a tool holder in the spindle.
- Remove the Tool Release Piston.
- Run the spindle at 1000-2000 RPM. **NOTE:** New spindle must be run at 300 RPM for two hours before running at 1000-2000 RPM. Polish the sides and top surface of the drawbar using 600 grit sandpaper. The sides of the drawbar must be mirror smooth for the first 1/8". Round off the corner of the chamfer so the seal can ride over it safely. The top of the drawbar needs to be smooth.

ELECTRICAL SERVICE

1. SOLENOIDS

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REPLACE ANY SOLENOID ASSEMBLIES.

1.1 AIR SOLENOID ASSEMBLY

REMOVAL:

1. Turn machine power on and raise spindle head to uppermost position. Turn power off.

2. Remove spindle head covers (Mechanical Service).

3. Remove air supply from machine.

4. Disconnect all air lines going to and from the air solenoid assembly on the bottom rear of the solenoid bracket. Do not remove the fittings --- remove the lines from the fittings.
5. Disconnect the two leads to the low air pressure sensor.

6. Unplug the wiring leading to the plug marked on the solenoid bracket as "880 FROM I/O PCB TO SOLENOID VALVES" and the plug marked "SPARE".

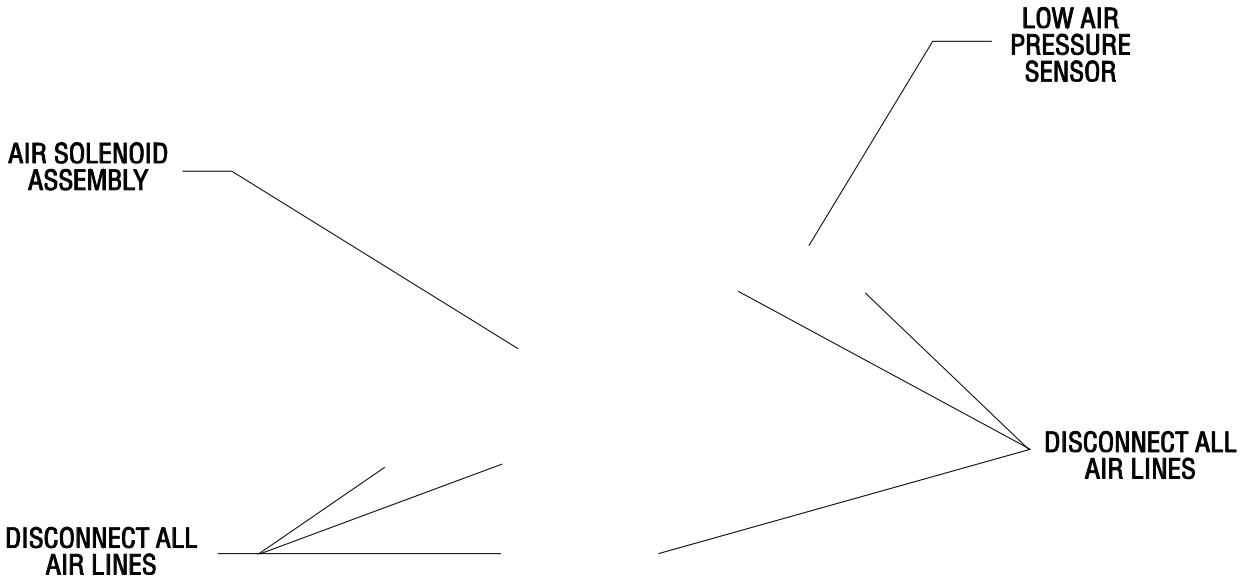


Fig. 1-1 Air solenoid assembly.

7. Remove the SHCS holding the assembly to the bracket and remove the assembly.

INSTALLATION:

8. Replace the air solenoid assembly and attach to the bracket with the SHCS previously removed. Tighten securely.

9. Reconnect all air lines at this time, ensuring that all connections are tight and do not leak.

10. Reconnect the two leads to the low air pressure sensor.

11. Reconnect the wiring to the plugs on the solenoid bracket (See step 6).

12. Reconnect air supply to the machine.

1.2 TOOL RELEASE PISTON ASSEMBLY AIR SOLENOID

1. Turn machine power on and raise spindle head to uppermost position. Turn power off.

2. Remove spindle head covers (Mechanical Service).

3. Remove air supply from machine.

4. Remove the tool release piston assembly (Mechanical Service).

5. Unscrew the air solenoid assembly from the tool release piston assembly, taking care to not disturb the position of the clamp/unclamp switches.

6. Unscrew the air solenoid from the air solenoid assembly.

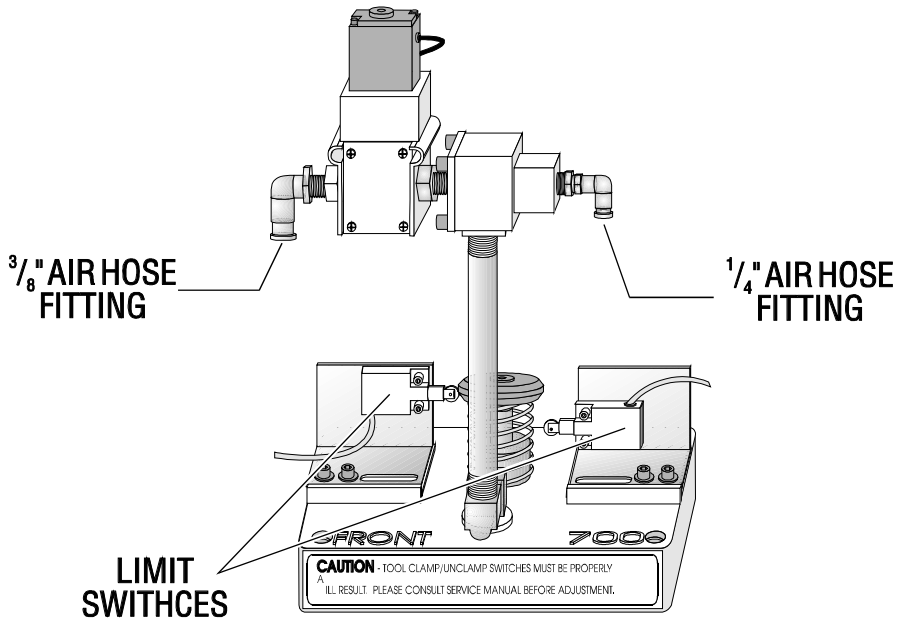


Fig. 1-2 Tool release piston assembly with air solenoid assembly.

7. Install the new air solenoid on the air solenoid assembly. Reinstall the air solenoid assembly onto the tool release piston assembly. Take care to not disturb the position of the clamp/unclamp switches.

8. Reinstall the tool release piston assembly (Mechanical Service).

9. Ensure all air lines are reconnected to their proper fitting!

1.3 SPINDLE LUBE AIR SOLENOID

1. Turn the machine power off and remove the air supply from the machine.

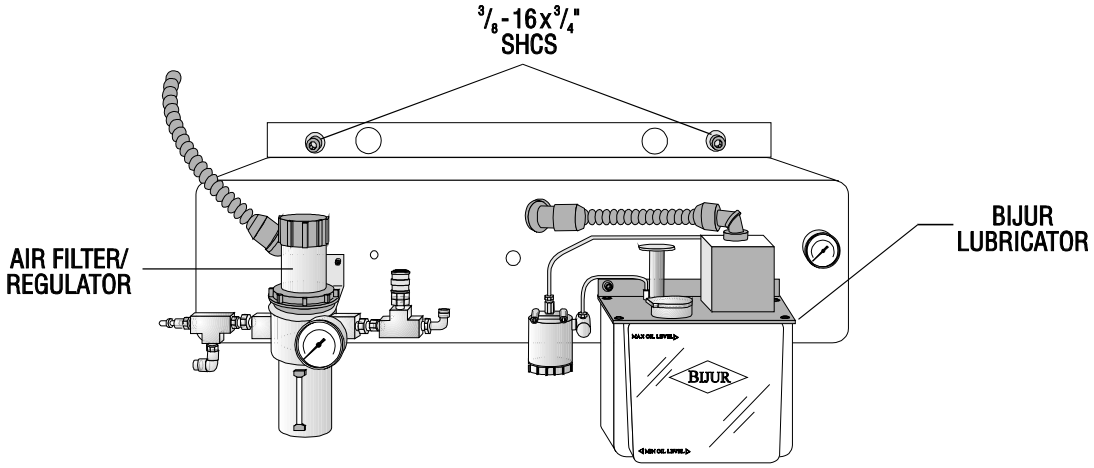


Fig. 1-3 Front side of lube/air panel.

2. Disconnect the air lines from the spindle lube air solenoid assembly.

3. Unplug the electrical leads at the quick-disconnect. You will have to slide the wiring channel cover back to disconnect the leads.

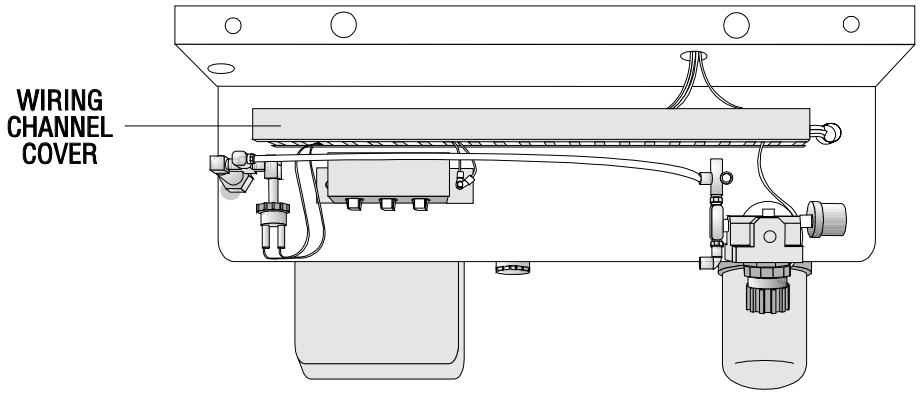


Fig. 1-4 Top view of spindle lube/air solenoid assembly.

4. Unscrew the assembly from the T-fitting.

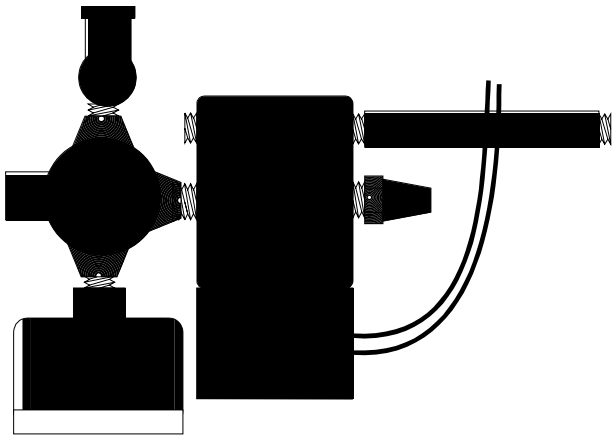


Fig. 1-5 Top view of spindle lube/air solenoid assembly.

5. Replace the assembly, ensuring it is approximately horizontal to the floor, and tighten fittings securely.

6. Reconnect all air lines.

7. Reconnect wiring leads at the quick-disconnect in the wiring channel. Slide cover back into place.

8. Restore air supply to the machine.

2. LINE VOLTAGE ADJUSTMENTS

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO ADJUST THE LINE VOLTAGE.

TOOLS REQUIRED:
LARGE FLAT TIP SCREWDRIVER
DIGITAL VOLTMETER

ADJUSTING VOLTAGE
NOTE: The machine must have air pressure at the air gauge or an interlock will prevent it from powering up.

CAUTION! Working with the electrical services required for the VMC can be extremely hazardous. The electrical power must be off and steps must be taken to ensure that it will not be turned on while you are working with it. In most cases this means turning off a circuit breaker in a panel and then locking the panel door. However, if your connection is different or you are not sure how to do this, check with the appropriate personnel in your organization or otherwise obtain the necessary help BEFORE you continue.

WARNING! The electrical panel should be closed and the three screws on the door should be secured at all times except during installation and service. At those times, only qualified electricians should have access to the panel. When the main circuit breaker is on, there is high voltage throughout the electrical panel (including the circuit boards and logic circuits) and some components operate at high temperatures. Therefore extreme caution is required.

1. Hook up the three power lines to the terminal on top of the main switch at upper right of electrical panel and the separate ground line to the ground bus to the left of the terminals. It is not necessary to be concerned with phase rotation (which wire is connected to L1, L2, and L3).

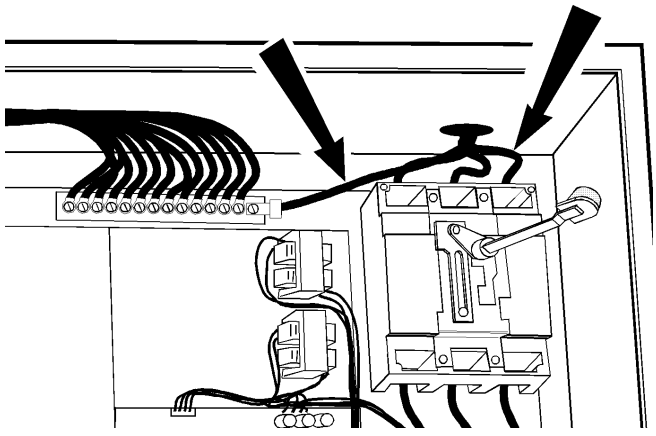


Fig. 2-1 Power lines; hookup location.

NOTE: Make sure that the service wires actually go into the terminal-block clamps. [It is easy to miss the clamp and tighten the screw. The connection looks fine but the machine runs intermittently or has other problems, such as servo overloads.] To check, simply pull on the wires after the screws are tightened.

2. After the line voltage is connected to the machine, make sure that main circuit breaker (at top-right of rear cabinet) is off (rotate the shaft that connects to the breaker counterclockwise until it snaps off). Turn on the power at the source. Using an accurate digital voltmeter and appropriate safety procedures, measure the voltage between all three pair phases at the main circuit breaker and write down the readings. The voltage must be between 195 and 260 volts.

NOTE: wide voltage fluctuations are common in many industrial areas; you need to know the minimum and maximum voltage which will be supplied to the machine while it is in operation. U.S. National Electrical Code specifies that machines should operate with a variation of +5% to -5% around an average supply voltage. If problems with the line voltage occur, or low line voltage is suspected, an external transformer may be required. If you suspect voltage prob lems, the voltage should be checked every hour or two during a typical day to make sure that it does not fluctuate more than +5% or -5% from an average.

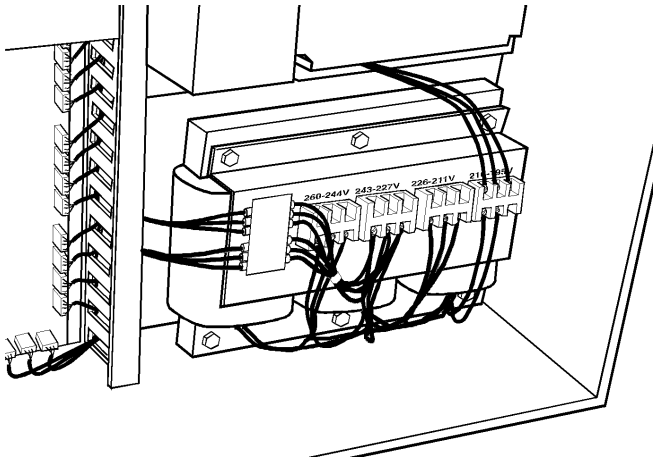


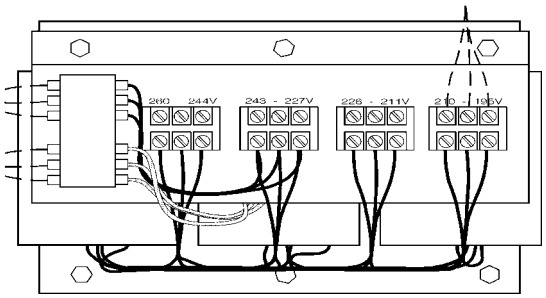
Fig. 2-2 Transformer connections.

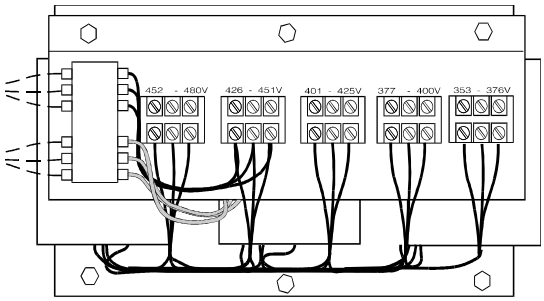
CAUTION! Make sure that the main breaker is set to OFF and the power is off at your supply panel BEFORE you change the transformer connections. Make sure that all three black wires are moved to the correct terminal block and that they are tight.

3. Check the connections on the transformer at the bottom-right corner of the rear cabinet. The three black wires labeled 74, 75, and 76 must be moved to the terminal block triple which corresponds to the average voltage measured in step

195 to 210	right side
211 to 226	right center
227 to 243	left center
244 to 260	left side

353 to 376	right side
377 to 400	right center
401 to 425	left center
452 to 480	left side





2 above. There are four positions for the input power to this transformer. The input voltage range for each terminal block is as follows:

Fig. 2-3 Transformers with 195-210V (left) and 452-480V(right) range.

4. Set the main switch to on (rotate the shaft that engages the handle on the panel door clockwise until it snaps into the on position). Check for evidence of problems, such as the smell of overheating components or smoke. If such problems are indicated, set the main switch to off immediately and call the factory before proceeding.

5. After the power is on, measure the voltage across the upper terminals on the contactor K1 (located below the main circuit breaker. It should be the same as the measurements where the input power connects to the main breaker. If there are any.

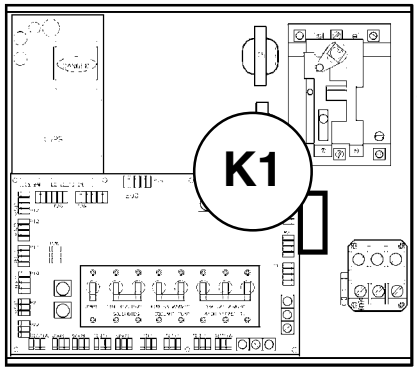


Fig. 2-4 Measure voltage here. problems, call the factory.

6. Check the DC voltage displayed in the second page of Diagnostic data on the CRT. It is labeled DC BUS. This voltage must be between 150 and 175 volts. If the voltage is outside these limits, turn off the power and recheck the incoming power and the transformer wiring (repeat steps 2 and 3). If the voltage is still incorrect, turn off the power and call the factory.

7. Turn off the power (rotate the shaft that engages the handle on the panel door counterclockwise until it snaps into the off position). Also, set the main switch handle on the panel door to off. (Both the handle and the switch must be set to off before
the door can be closed). Close the door, screw the screws into place, and turn the power back on.

3. FUSE REPLACEMENT

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REPLACE ANY FUSES.

3.1 OVERVOLTAGE FUSES

WARNING! The electrical panel will have residual voltage, even after power has been shut off and/or disconnected . Never work inside this cabinet until the small red CHARGE light on the servo drive assembly goes out. The servo drive assembly is on the left side of the main control cabinet and about halfway down. This light is at the top of the circuit card at the center of the assembly. Until this light goes out, there are dangerous voltages in the assembly EVEN WHEN POWER IS SHUT OFF.

1. T urn machine power off.

2. Turn the main switch (upper right of electrical cabinet) to the off position.

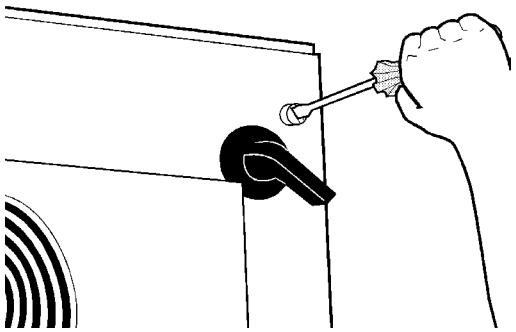


Fig. 3-1 Unscrew the three screws to open the cabinet door. (Newer control cabninets may require a key)

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until at least the red CHARGE light on the servo drive assembly goes out before beginning any work inside the electrical cabinet.

4. On the POWER SUPPLY board there are three fuses located in a row at the upper right of the board; these are the overvolt age fuses. An orange light will be on to indicate the blown fuse(s).

5. Using a flat tip screwdriver, turn the fuse(s) counterclockwise to remove and replace the blown fuse(s) with ones having the same type and rating (½ amp, type AGC, 250V).

CAUTION! When the left fuse is blown, it is still possible to operate the machine, thereby making an overvoltage situation possible. VERIFY absolute voltage to the machine does not exceed 260 volts.

3.2 OPERATOR'S LAMP FUSE

1. Turn the main switch (upper right of electrical cabinet) to the off position.

2. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until at least the red CHARGE light on the servo drive assembly goes out before beginning any work inside the electrical cabinet.

3. The Operator's Lamp Fuse is located at the lower left of the Power Supply Board. An orange light will be on to indicate the blown fuse.

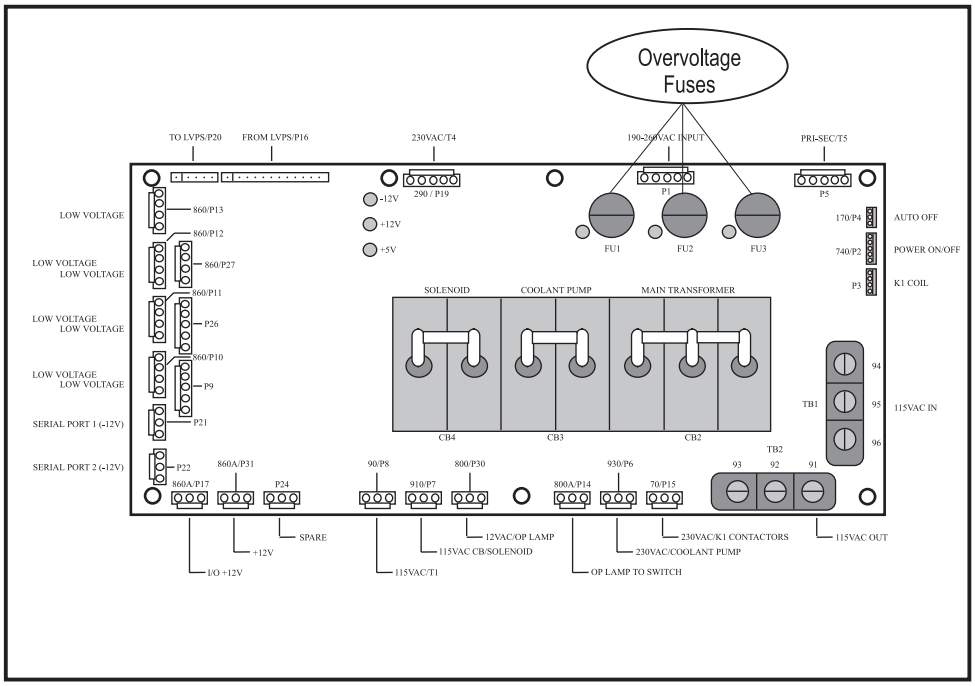


Fig. 3-3 Power supply board; fuse locations.

4. Using a flat tip screwdriver, turn the fuse counterclockwise to remove and replace the blown fuse with ones having the same type and rating (operator's lamp:½ amp, type AGC, 250V).

3.3 SERVO DRIVER & SDIST FUSES

1. Turn the main switch (upper right of electrical cabinet) to the off position.

2. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until at least the red CHARGE light on the servo drive assembly goes out before beginning any work inside the electrical cabinet.

3. On the SERVO DRIVE ASSEMBLY, there are three fuses on the SDIST panel, and three individual fuses on each of the SERVO DRIVE boards (See Fig. 3-4; the F3 fuses are not shown).

4. On the SDIST panel, use a flat tip screwdriver to turn the fuse(s) counterclockwise to remove. Replace the blown fuse(s) with ones having the same type and rating (FU1, FU2: ½ amp, type AGC, 250V; FU3: 5 amp, type ABC, 250V).

5. On each of the SERVO DRIVER boards, the fuses (F1, F2, F3) may be replaced by simply pulling out the fuses by hand and replacing with fuses of the same type and rating (F1, F2: 20 amp, type ABC, 250V; F3: 10 amp, type ABC, 250V).

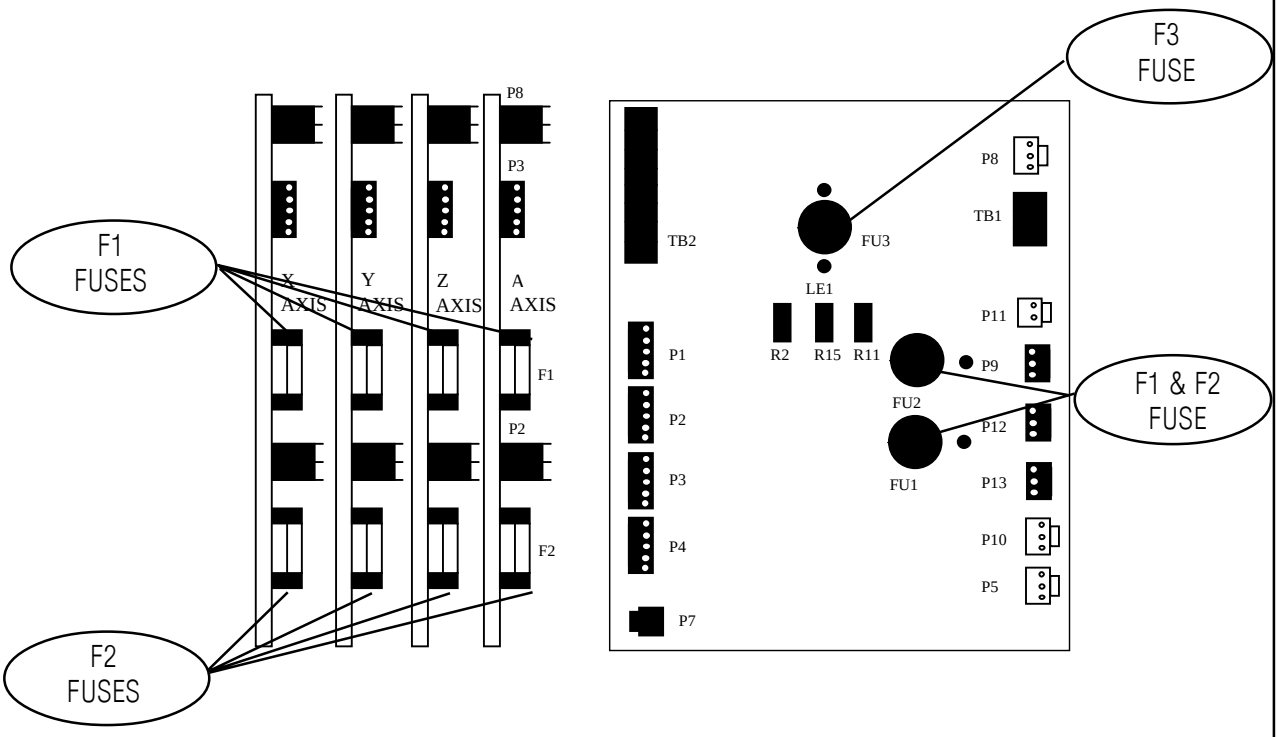


Fig 3-4 Servo Drive Assembly; fuse locations

4. PCB REPLACEMENT

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REPLACE ANY PCB 'S.

4.1 MICROPROCESSOR, VIDEO, MOTIF & KEYBOARD

NOTE: The arrangement of these boards may differ from the order of replacement that follows. The steps for replacement will only differ in which board may need to be removed before getting to the necessary board.

WARNING! The electrical panel will have residual voltage, even after power has been shut off and/or disconnected . Never work inside this cabinet until the small red CHARGE light on the servo drive assembly goes out. The servo drive assembly is on the left side of the main control cabinet and about halfway down. This light is at the top of the circuit card at the center of the assembly. Until this light goes out, there are dangerous voltages in the assembly EVEN WHEN POWER IS SHUT OFF.

MOTIF BOARD -

1. Turn machine power off.

2. Turn the main switch (upper right of electrical cabinet) to the off position.

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until at least the red CHARGE light on the servo drive assembly goes out before beginning any work inside the electrical cabinet.

4. Disconnect all leads to the Motor Interface (MOTIF) board. Ensure all cables are properly labeled for reconnecting later. Figure 4-1 shows all cable numbers and the locations on the MOTIF board.

5. After all cables have been disconnected, unscrew the standoffs, taking care to hold the board in place until all standoffs have been removed.

   NOTE: If the VIDEO, KEYBOARD or PROCESSOR boards need replacing, please skip the next step.

6. Replace the Motor Interface (MOTIF) board, attaching it to the VIDEO and KEYBOARD (beneath the MOTIF board) with the standoffs.

7. Reconnect all leads (previously removed) to their proper connections.

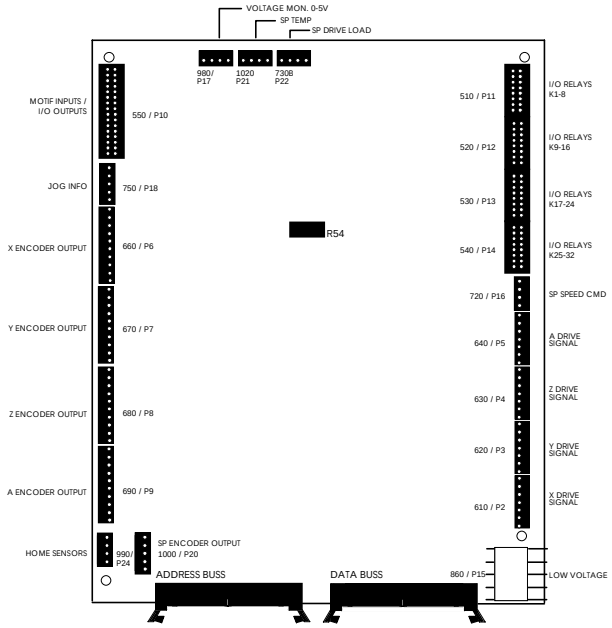


Fig. 4-1 Motor Interface board.

VIDEO BOARD AND KEYBOARD -

8. Remove the MOTIF board as described in steps 1-5.

9. Disconnect all leads to the Video board and Keyboard. Ensure all cables are properly labeled for reconnecting later. The
following illustration shows all cable numbers and the locations on the Video and Keyboard.

10. After all cables have been disconnected, unscrew the standoffs, taking care to hold the board in place until all standoffs have been removed.

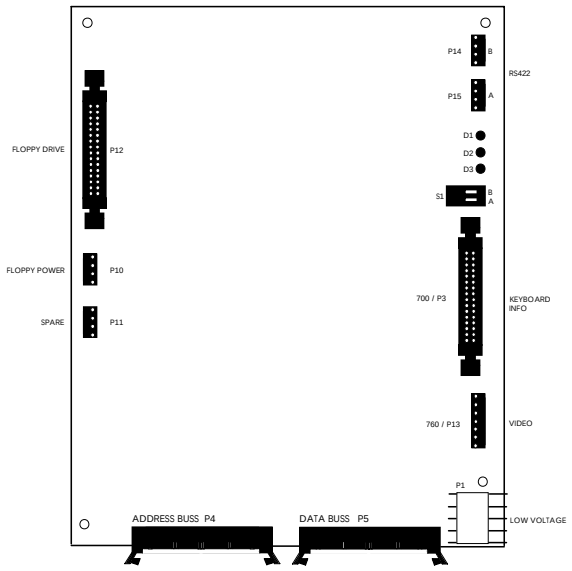


Fig. 4-2 Video board.

NOTE: If the PROCESSOR board need replacing, please skip the next step.

11. Replace the Video and Keyboard, attaching it to the PROCESSOR board (beneath the Video and Keyboard) with the standoffs.

12. Reconnect all leads (previously removed) to their proper connections (refer to Fig. 4-2).

PROCESSOR BOARD -

13. Remove the MOTIF board as described in steps 1-5, and the Video and Keyboard as described in steps 8-9.

14. Disconnect all leads to the Processor (68020) board. Ensure all cables are properly labeled for reconnecting later. The following illustration shows all cable numbers and the locations on the 68030 board.

15. After all cables have been disconnected, unscrew the standoffs, taking care to hold the board in place until all standoffs have been removed.

16. Replace the Processor (68030) board, attaching it to the electrical cabinet (beneath the 68030 board) with the standoffs

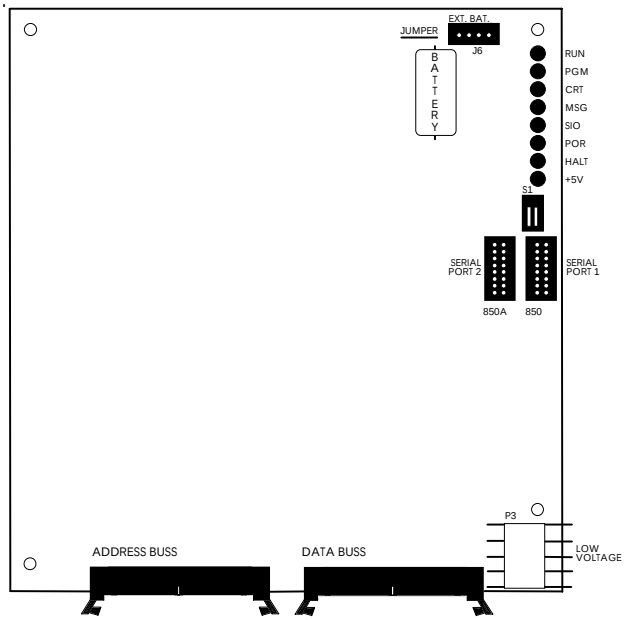


Fig. 4-3 Processor board.

17. Reconnect all leads (previously removed) to their proper connections (refer to Fig. 4-3).

4.2 SERVO DRIVER & SDIST

WARNING! The electrical panel will have residual voltage, even after power has been shut off and/or disconnected . Never work inside this cabinet until the small red CHARGE light on the servo drive assembly goes out. The servo drive assembly is on the left side of the main control cabinet and about halfway down. This light is at the top of the circuit card at the center of the assembly. Until this light goes out, there are dangerous voltages in the assembly EVEN WHEN POWER IS SHUT OFF.

1. Turn machine power off.

2. Turn the main switch (upper right of electrical cabinet) to the off position.

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until at least the red CHARGE light on the servo drive assembly goes out before beginning any work inside the electrical cabinet.

SDIST BOARD -

4. Disconnect all leads to the Servo Distribution (SDIST) board. Ensure all cables are clearly marked for reconnecting later. The following illustration (Fig. 4-4) shows all cable numbers and the locations on the SDIST board.

NOTE: The connection labeled "860A" on the board should be used for the cable marked "860B". Some boards, the connection for cable 920 has been incorrectly marked as "1030".
Please note its location for future reference.

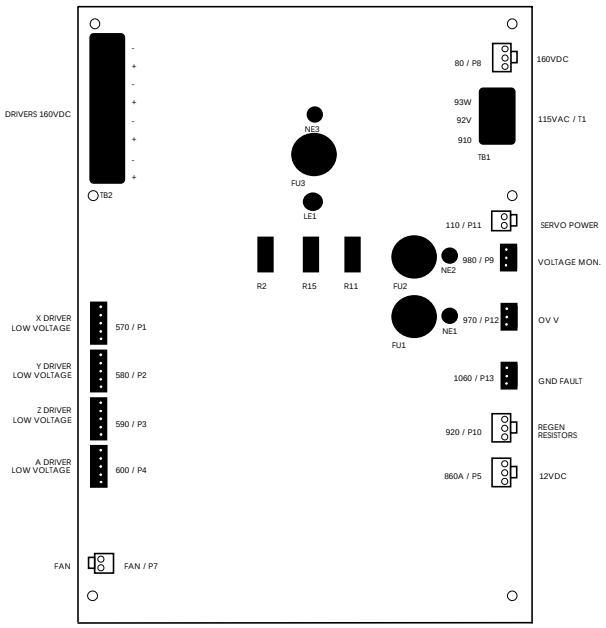


Fig. 4-4 SDIST board.

NOTE: On some SDIST boards, there may be cables attached to the capacitors with a plastic strap. This will have to be cut off and the cables moved aside in order to remove the board. It will be necessary to replace this strap after the board is replaced.

5. After all cables have been disconnected, remove the eight screws attaching the board to the cabinet. Take care to hold the board in place until all screws have been removed.

6. Replace the SDIST board, attaching it with the eight screws previously removed, using one of the screws as a grounding connection.

7. Reconnect all leads (previously removed) to their proper connection (refer to Fig. 4-4).

SERVO DRIVER BOARDS -

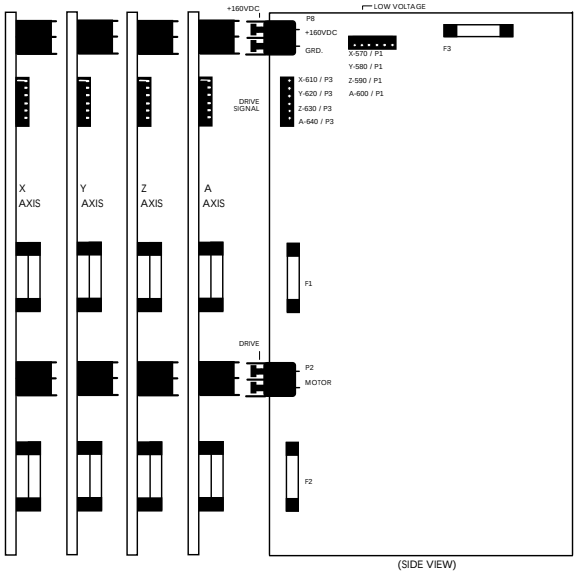


Fig. 4-5 Servo DRIVER boards.

1. Follow all precautions noted previously before working in the electrical cabinet

2. Turn the main switch (upper right of electrical cabinet) to the off position.

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.

4. Disconnect all leads to the Servo Driver (DRIVER) board that you wish to replace. Ensure all cables are properly labeled for reconnecting later. Figure 4-6 shows all cable numbers and the locations on the DRIVER boards (X, Y, Z, A).

NOTE: When replacing any DRIVER board, it will be necessary to disconnect all leads on all DRIVER boards in order to remove or replace the board.

5. Remove the board by first removing the two screws that fasten it to the cabinet. Take care to hold the board in place until both screws have been removed.

6. Replace the DRIVER board, attaching it to the cabinet with the two screws previously removed.

7. Reconnect all leads to all boards at this time (refer to Fig. 4-5 for proper connections). Ensure the red and black leads go to the appropriate connections.

4.3 I/O BOARD

1. Follow all precautions noted previously before working in the electrical cabinet.

2. Turn the main switch (upper right of electrical cabinet) to the off position.

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.

4. Disconnect all leads to the Input/Output board and move aside for removal. Ensure all cables are properly labeled for reconnecting later. The following illustration shows all cable numbers and the locations on the I/O board.

5. Remove the board by first removing the twelve screws that fasten it to the cabinet. Take care to hold the board in place until all screws have been removed.

6. Replace the I/O board, attaching it to the cabinet with the twelve screws previously removed.

7. Reconnect all leads to the I/O board at this time (refer to Fig. 4-6 for proper connections)

.

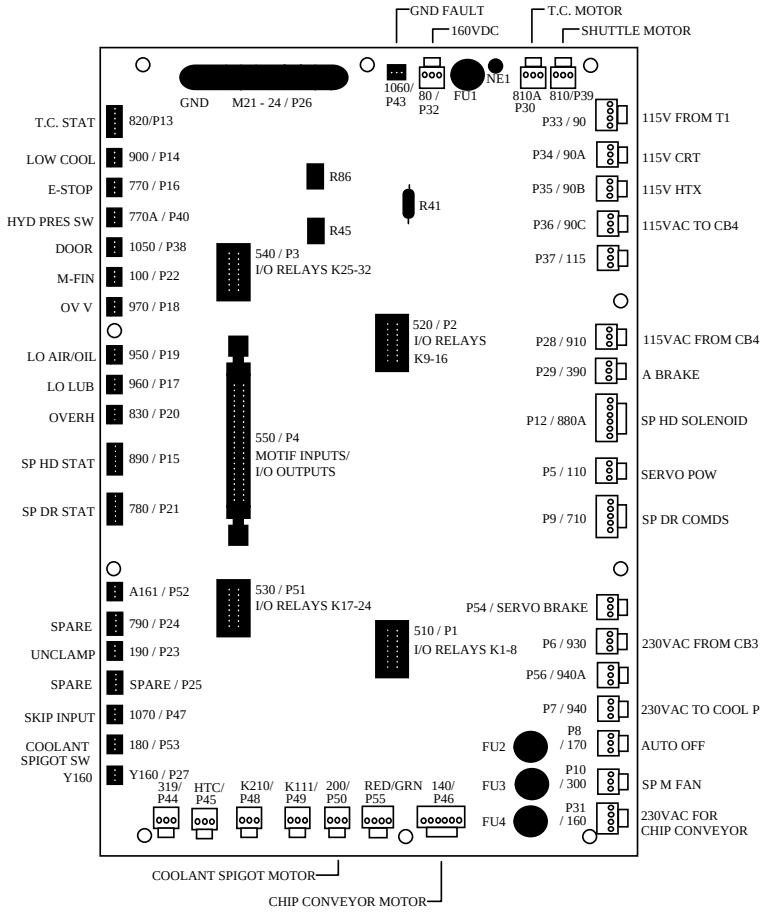


Fig. 4-6 I/O board.

4.4 POWER & LOW VOLTAGE SUPPLY

POWER BOARD -

1. Follow all precautions noted previously before working in the electrical cabinet (See warning at beginning of "Servo Driver & SDIST" section).

2. Turn the main switch (upper right of electrical cabinet) to the off position.

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.

4. Disconnect all leads to the Power Distribution (POWER) board and move aside for removal. Ensure all cables are properly labeled for reconnecting later. The illustration on the following page shows all cable numbers and the locations on the POWER board.

5. After all cables have been disconnected, remove the seven screws holding the POWER board to the cabinet and remove the board. Take care to hold the POWER board in place until all screws have been removed.

NOTE: If you need to replace the LOW VOLTAGE POWER SUPPLY board, please skip the next step.

6. Replace the POWER board, attaching it with the seven screws previously removed. Don't forget to use the lower left screw for a ground connection.

7. Reconnect all cables to the POWER board at their proper location (refer to Fig. 4-7).

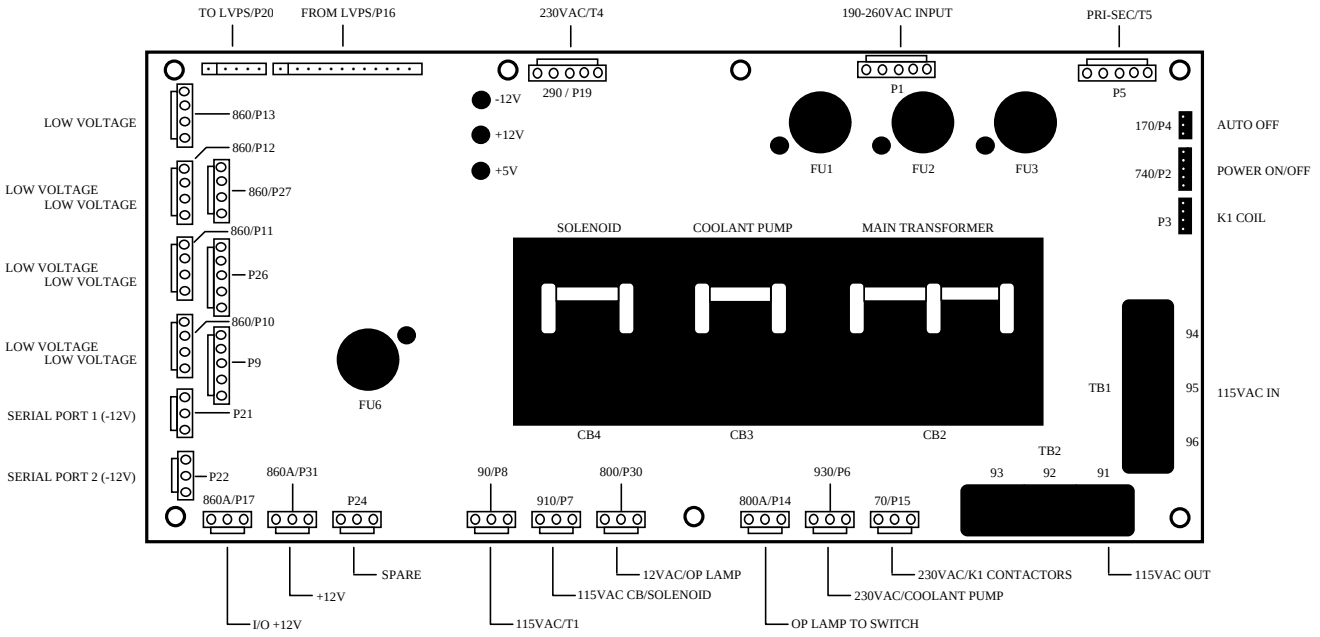


Fig. 4-7 Power Distribution (POWER) board.

LOW VOLTAGE POWER SUPPLY -

8. Remove the Power Distribution (POWER) board as described in steps 1-5.

9. Disconnect all leads to the Low Voltage Power Supply (LVPS) board. Ensure all cables are properly labeled for reconnecting later. The following illustration shows all cable numbers and the locations on the LVPS board.

10. After all cables have been disconnected, unscrew the two standoffs at the bottom of the board. Unscrew the remaining

two screws at the top of the LVPS board, taking care to hold the board in place until all screws have been removed.

11. Replace the LVPS board, attaching it to the cabinet with the two screws and two standoffs previously removed

12. Replace the POWER board as described in steps 6-7.

4.5 RS-232 DB25

1. Follow all precautions noted previously before working in the electrical cabinet (See warning at beginning of "Servo Driver & SDIST" section).

2. Turn the main switch (upper right of electrical cabinet) to the off position.

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.

NOTE: It is suggested to make use of a step ladder high enough to allow you to work from the top of the electrical cabinet. It will be necessary, when replacing the RS-232 DB25 board, to work from the inside and outside of the cabinet at the same time.

4. On the left side of the cabinet, at the top of the side panel are two serial port connections labeled "SERIAL PORT #1" and "SERIAL PORT #2", SERIAL PORT #1 being the upper connection.

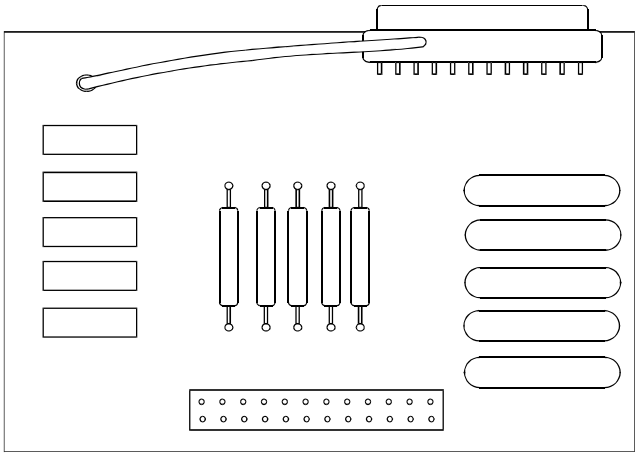


Fig. 4-8 RS-232 DB25 board.

5. To remove the RS-232 DB25 board, unscrew the two hex screws (on the exterior of the cabinet) holding the connector to the cabinet. From the inside of the cabinet, pull the connector through the panel, and disconnect the cable (see Fig. 4-9 for location).

6. Replace the RS-232 DB25 board by first connecting the appropriate cable to the board (850 to SERIAL PORT #1, 850A to SERIAL PORT #2, then inserting the board (cable side up) through the left side panel. Attach with the two hex screws previously removed. Ensure the board for Serial Port #1 is the upper connector and the board for Serial Port #2 is the lower connector.

6. Replace the KBIF board, using the four screws previously removed, starting at the top right. Attach the screw and standoff loosely, then all other screws and standoffs, until all are mounted. Tighten down completely.

7. Reconnect all cables to the KBIF board at their proper locations.

5. FRONT PANEL

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REPLACE ANY COMPONENT OF THE CONTROL PANEL.

5.1 CRT ASSEMBLY REPLACEMENT

1. Turn the power off and disconnect power to the machine.

2. Remove the screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. At this time, remove the end cap on the support arm and unplug the white cable at the connection inside, then unplug the black cable at the connection in the control panel. It may be necessary to cut straps off the black cable's connector to unplug.

4. Unscrew the four hex nuts on the bottom row of the CRT bracket and remove, along with the washers. Set aside in a safe place.

5. While holding up the CRT assembly, remove the four hex nuts on the top row of the CRT bracket, along with the washers.

   CAUTION! Take extreme care to not drop or damage the CRT assembly when removing from the control panel.

6. CAREFULLY pull the CRT assembly out toward the rear until it is clear of the control panel and all wiring. Set CRT assembly down in a safe place so as not to damage.

7. Replace by sliding the new assembly onto the eight bolts (four each on top and bottom). Starting with the bottom right, place the washers and hex nuts on the bolts to hold in place. Refer to Fig. 5-1 for the order of replacement.Once all washers have been attached and nuts have been hand-tightened, tighten down completely with the socket.

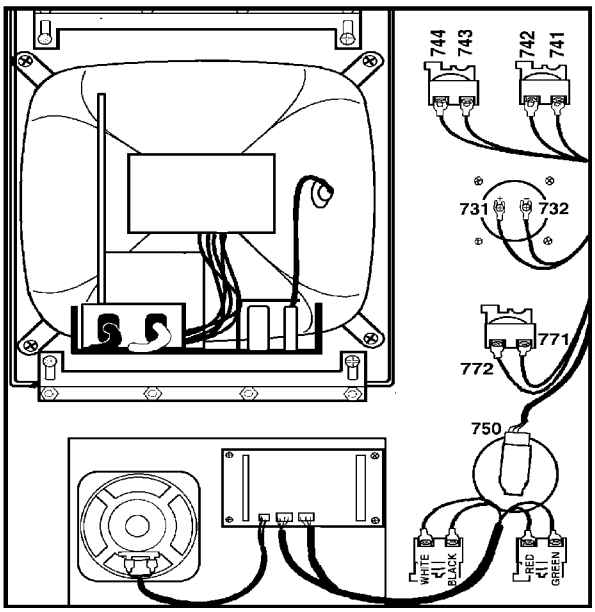


Fig. 5-1 Interior of control panel (rear).

8. Plug the black cable and white cable into the matching cables. Feed the white cable through the opening in the top of the control panel.

9. Replace the back cover panel and attach with the four screws previously removed.

5.2 JOG HANDLE REPLACEMENT

The JOG handle is actually a 100-line-per-revolution encoder. We use 100 steps per revolution to move one of the servo axes. If no axis is selected for jogging, turning of the crank has no effect. When the axis being moved reaches its travel limits, the handle inputs will be ignored in the direction that would exceed the travel limits.

Parameter 57 can be used to reverse the direction of operation of the handle.

1. Turn the machine power off.

2. Remove the screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

4. Unplug the cable leading to the jog handle encoder. IMPORTANT! The blank pin side of the connector must face as shown in Fig. 5-2 when reconnecting; otherwise, damage may occur to the machine.

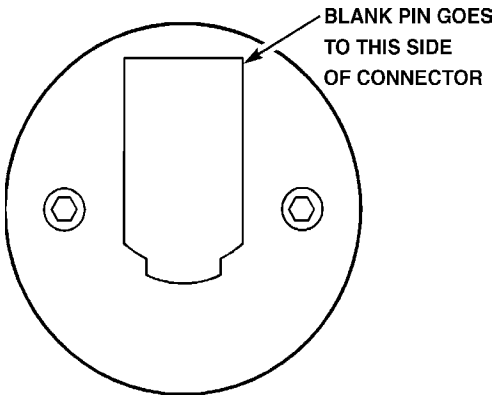


Fig. 5-2 Jog handle encoder.

4. Using the 5/64" allen wrench, loosen the two screws holding the knob to the control panel and remove.

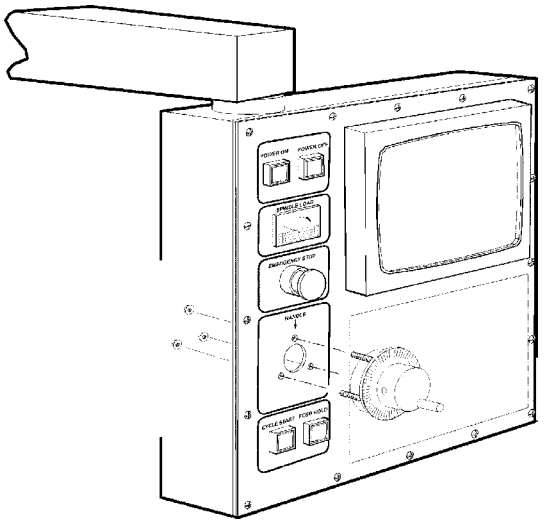


Fig. 5-3 Jog Handle removal

5. Remove the three screws holding the jog handle encoder to the control panel and remove.

6. Replacement is reverse of removal. Keep in mind the important notice in step three.

5.3 SWITCH REPLACEMENT

NOTE: This section is applicable for the POWER ON, POWER OFF, EMERGENCY STOP, CYCLE START, and FEED HOLD switches.

1. Turn the machine power off.

2. Remove the four screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. Disconnect all leads to the switch's connectors. Ensure all leads are properly marked for reconnecting later. Refer to Fig. 5-1 for proper locations.

4. Unscrew the two small set screws, one on top and one on the bottom, and turn the switch counter clockwise to loosen. Separate from the front portion and pull out.

5. For replacement, screw the front and rear portions together (reverse of removal) and tighten down the two small set screws when the switch is properly positioned.

NOTE: The POWER ON, POWER OFF, and EMERGENCY STOP switches must all have the connectors on the bottom of the switch.

6. Reconnect all leads to the correct switch.

5.4 SPINDLE LOAD METER REPLACEMENT

1. Turn the power off and disconnect power to the machine.

2. Remove the four screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. Disconnect the two leads at the back of the spindle load meter assembly. Ensure the two leads are properly marked for reconnecting later.

4. Unscrew the four screws that hold the spindle load meter assembly to the control panel. Take care to hold the assembly in place until all screws have been removed. Remove the assembly.

5. Installation is reverse of removal. Ensure leads go the correct location.

5.5 KEYPAD REPLACEMENT

1. Turn the power off and disconnect power to the machine.

2. Remove the four screws holding the rear cover panel to the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. Remove all switches, spindle load meter, and the jog handle as described in the previous sections.

4. Unplug the keypad's 24-pin ribbon cable from the Keyboard Interface board.

5. Remove the screws from the front of the control panel. Take care to hold the front cover panel and bezel spacer in place until all screws have been removed. Remove the two pieces and set aside in a safe place.

6. Using a flat, blunt tool, such as putty knife, pry the keypad away from the control panel. Pull the ribbon cable through the opening in the control to remove.

7. To replace, first put the bezel spacer in place and fasten temporarily with screws in the top corners.

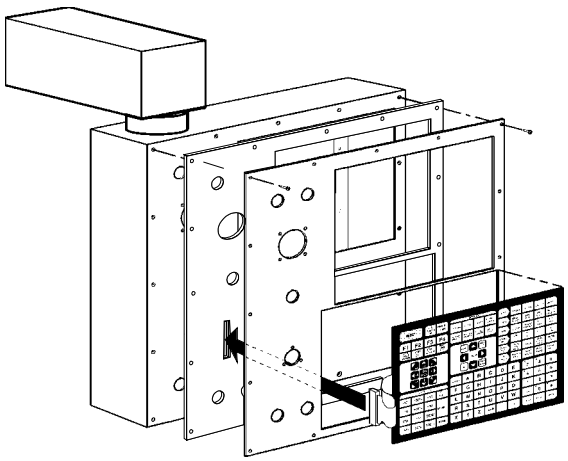


Fig. 5-4 Keypad installation.

8. Insert the ribbon cable through the opening in the control panel and place the keypad in the upper right corner of the lower opening and press to the control panel to mount. Plug the ribbon cable into the Keyboard Interface board, taking care to not bend the pins on the board.

9. While holding the bezel spacer in place, remove the two screws holding the spacer, put the front cover panel in place, and fasten with all screws previously removed.

10. Reinstall all switches, spindle load meter, and the jog handle as described in the previous sections.

11. Replace the rear cover panel and fasten with the screws that were previously removed.

4.6 KEYBOARD INTERFACE

1. Follow all precautions noted previously before working in the control cabinet (See warning at beginning of Section 5).

2. Turn the main switch (upper right of electrical cabinet) to the off position.

3. Remove the four screws on the back of the control box, then remove the cover panel. Take care to hold the panel in place until all screws have been removed.

4. Disconnect all leads to the Keyboard Interface (KBIF) board. Ensure all cables are properly labeled for reconnecting later. Refer to Fig. 4-10 for locations.

5. After all cables have been disconnected, unscrew the four screws holding the KBIF board to the control box. Take care to hold the board in place until all screws have been removed. Place the screws and standoffs aside for later use.

6. Replace the KBIF board, using the four screws previously removed, starting at the top right. Attach the screw and standoff loosely, then all other screws and standoffs, until all are mounted. Tighten down completely.

7. Reconnect all cables to the KBIF board at their proper locations

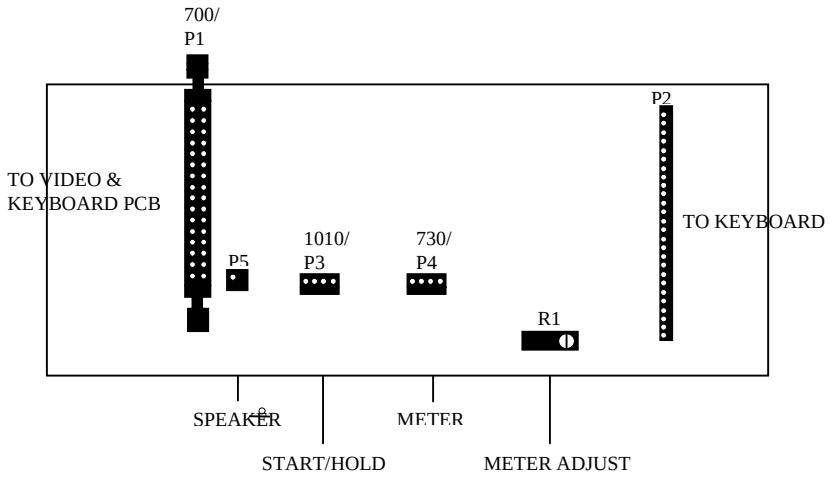


Fig. 5-5 Keyboard Interface

6. SPINDLE ENCODER REPLACEMENT

PLEASE READ THIS SECTION IN ITS ENTIRETY BEFORE ATTEMPTING TO REMOVE OR REPLACE ENCODER.

REMOVAL -

1. Turn machine power on. Raise or lower spindle head to a position that will allow you to easily work on the encoder (must be above the enclosures). Turn machine off.

2. Remove head covers (Mechanical Service).

3. Disconnect the encoder cable at the top of the encoder.

4. Unscrew and remove the four 10-32 screws holding the encoder to the four standoffs (VF-1, VF-2, VF-3,VF-4) or mount ing bracket (VF-0). Remove the encoder, leaving the belt on the pulley at the orient ring.

INSTALLATION -

If you wish to install an encoder on a machine start at step 5; if this is just a replacement, skip to step 13. Please note the differences in installation between the VF-0, VF-1, VF-2, and the VF-3,VF-4.

5. For the VF-1, VF-2, and VF-3, VF-4, put some blue Loctite on the threads of the four set screws and screw approximately halfway into the standoffs. Screw the hex end of the set screws into the standoffs.

6. Screw the standoffs into the four holes located at the rear of the transmission's top plate.

7. For the VF-0, place the mounting bracket in place. Fasten to the top plate with the four screws and four lock washers.

8. Place the 18-tooth pulley onto the pulley bushing and tighten down. Place the SHCS through the center axis of the pulley.

9. Screw this assembly into the spindle orientation ring.

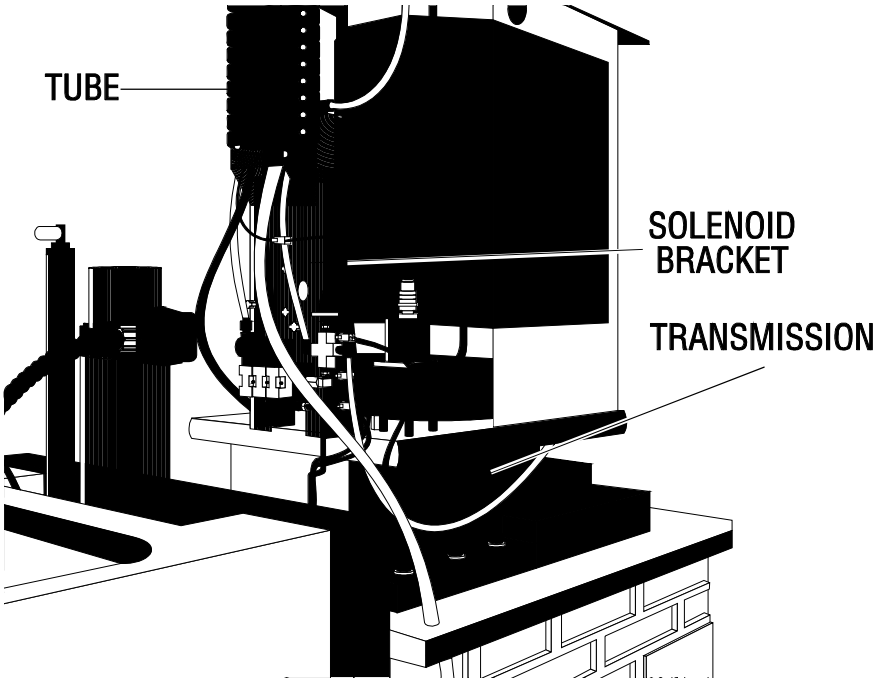


Fig. 6-1 Spindle encoder installation (VF-1/VF-2).

10. Place the 36-tooth pulley onto the encoder, making the top of the pulley flush with the end of the shaft. Tighten down with the 5/64" hex wrench.

11. Unscrew the four screws and remove the cover panel on the box at the base of the flexible tube.

TECHNICAL REFERENCE SECTION

1. TOOL CHANGER

The tool changer is an all electric fixed shuttle type. 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 P6 on the side of the control cabinet.

The tool holders used are CT #40 taper, V flange, commonly called "CT 40". Use A "45 Degree, P40T Type 1, inch threads" pull stud built to JMTBA standard "MAS 403-1982". This pull stud is characterized by a long shaft and a 45° shoulder under the head. Do not use the short shaft or pull studs with a sharp right angle (90°) head as they will not work and will cause serious damage.

Tool holders and pull studs must be in good condition and tightened together with wrenches or they may stick in the spindle taper. Clean the tool tapers with a lightly-oiled rag to leave a film to prevent rusting. Tools that make a loud bang when being released indicate a problem and should be checked before serious damage to the shuttle occurs. When the TOOL RELEASE button is pressed, the tool should be pushed out of the spindle by a small amount (approximately .07"). This is an indication that the pull stud is correctly touching the release mechanism.

Low air pressure or insufficient volume will reduce the pressure applied to the tool unclamp piston and will slow down tool change time or will not release the tool.

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. Push the ZERO RETURN and the AUTO ALL AXES keys to reset the Z-axis and tool changer. Never put your hands near the tool changer when powered unless the EMERGENCY STOP button is pressed.

FU1 on the I/O PCB or the Power PCB is a fuse for the 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 CB4.1.2
Tool Change Sequence

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

1) Z axis moves up to machine zero,
2) If the spindle is turning, it is commanded to stop,
3) Spindle oriented to Tool Changer,
4) Turn TSC pump off, (optional)
5) Pre-charge is on,
6) Shuttle moves in to grab tool,
7) Tool unclamps,
8) Z axis moves up,
9) Tool Changer rotates,
10) Z axis moves down,
11) Tool clamps,
12) Pre-charge off,
13) Shuttle moves out.
14) TSC on (optional)

1.1 TOOL CHANGER LUBRICATION

Place a few drops of lubricating oil on the outside edge of the Geneva wheel star and guide rails of the tool changer and run through all tools.

1.2 SHUTTLE IN/OUT MOTOR

A DC brush motor is used to move the tool changer assembly towards and away from the spindle. This is called the shuttle. The motor is geared down to a low RPM and then connected to an arm that rotates through 180° and pushes the shuttle in and out.

NOTE: This motor should never be disassembled

1.3 TURRET ROTATION MOTOR

A DC brush motor is used to rotate the tool turret between tool changes. This motor is geared down to a low RPM and connected to a Geneva mechanism. One revolution of the Geneva mechanism moves the tool turret one tool position forward or backward.

NOTE: This motor should never be disassembled.

2. TOOL CLAMP/UNCLAMP

The tool holder draw bar is held 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 a program (but this is quite dangerous), from the keyboard, and from the button on the front of the spindle head. The two manual buttons only operate in MDI or JOG modes.

2.1 TOOL CLAMP/UNCLAMP AIR SOLENOIDS

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

2.2 TOOL CLAMP/UNCLAMP SENSE SWITCHES

There are two switches used to sense the position of the tool clamping mechanism. They are both normally closed and one will activate at the end of travel during unclamping and the other during clamping. When both switches are closed, it indicates that the draw bar is between positions.

A tool change operation will wait until the unclamped switch is sensed before the Z-axis pulls up from the tool. This prevents any possibility of breaking the tool changer or its support mounts.

The diagnostic display can be used to display the status of the relay outputs and the switch inputs.

The Precharge and Through the Spindle Coolant system applies low air pressure and releases the clamped switch.

2.3 REMOTE TOOL UNCLAMP SWITCH

The Remote Tool Unclamp switch is mounted on the front 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.

While the tool is unclamped, air is forced down the spindle to clear chips, oil, or coolant away from the tool holder.

3. SPINDLE OPERATION

Spindle speed is selectable from 1 to 7500 RPM. For the VF-1 through 6, speeds at and below 1250 RPM automatically select low gear. Speeds at and above 1251 RPM automatically select high gear. Spindle speed accuracy is best at the higher speeds and in low gear.

The spindle is hardened and ground to the precise tool holder dimensions providing an excellent fit to the holder.

3.1 SPINDLE ORIENTATION

Orientation of the spindle is automatically performed for tool changes and can be programmed with M19. Orientation is performed by turning the spindle slowly until an air pressure driven pin drops into a detent and locks the spindle in place. This pin is located behind the spindle motor and above the gear box. If the spindle is oriented and locked, commanding spindle forward or reverse will release the lock.

3.2 SPINDLE ORIENTATION LUBRICATION

The spindle orientation mechanism does not require regular lubrication.

3.3 SPINDLE ORIENTATION AIR SOLENOID

A solenoid controls the air valve supplying pressure to the orientation lock pin. The diagnostic display can be used to display the status of the relay output and the switch inputs. Circuit breaker CB4 will interrupt power to this solenoid.

3.4 SPINDLE ORIENTATION SEQUENCE

When spindle orientation is commanded, the following sequence of operations occurs:

1) If the spindle is turning, it is commanded to stop,
2) Pause until spindle is stopped,
3) Spindle orientation speed is commanded forward,
4) Pause until spindle is at orientation speed,
5) Command spindle lock air solenoid active,
6) Pause until spindle locked status is active and stable,
7) If not locked after time-out time, alarm and stop.

4. SERVOS BRUSH / BRUSHLESS

4.1 SERVO ENCODERS (BRUSH)

Attached to each DC servo motor, there is an incremental encoder that is 2000 lines per revolution. These encoders also supply a Z channel pulse once per revolution. The encoders and Z channel are continuously monitored to ensure the number of pulses matches for each revolution of the motor. If the encoders become contaminated, these pulse counts will be wrong and an alarm will be generated. This ensures that the data from the encoders is reliable. There can never be a loss of servo position due to accumulated encoder errors. The alarms generated will indicate that either the Z pulse occurred and the encoder pulse was wrong or, after one and one half motor revolutions, the Z pulse did not occur.

Encoder faults can be caused by contamination of the encoder or by a wiring problem. If the encoder is contaminated, it must be replaced. Wiring problems may be a broken wire, shorted wire, or missing shield. All wires to the encoder are enclosed in their own shielded cable. In addition, all power wires to the motor are enclosed in a separately shielded cable. Failure of either of these shields may cause noise in the encoder circuits and result in the encoder fault alarms.

Never connect or disconnect the servo motor cables with the control powered as this will cause an apparent encoder fault.

The servo motor encoders are differential line drivers. This means that the A, B, and Z signals are transmitted to the control as signal pairs. A cable test is performed on these signals to ensure the differential pair are always present.

4.2 SERVO CHARACTERISTICS (BRUSH)

This machine is not capable of instantly changing speed. That is, it takes some non-zero time to accelerate and decelerate. Acceleration and deceleration in this machine have both a constant accel/decel mode and an exponential mode. Constant acceleration is used at the beginning of a rapid move and at the end of any move whose speed exceeds the exponential accel/decel time constant.

Constant acceleration is a type of motion when the amount of speed change over time is constant. This constant is set by Parameters 7, 21, 35, and 49. It has units of encoder increments per second per second.

Exponential acceleration and deceleration is a type of motion where the speed is proportional to the distance remaining in a programmed travel. The exponential accel/decel time constant is set by Parameters 113, 114, 115, and 116. It has units of 0.0001 seconds. The speed limit at which exponential accel/decel is not available is defined by the relationship between Parameters 7 and 113 (for the X-axis). Thus if Parameter 7 is 1200000 steps/sec/sec and Parameter 113 is 750 (0.075 seconds); the maximum velocity for accurate interpolation should be:

1200000 x 0.075 = 90000 steps/second

For a 2000 line encoder and 6 mm screw, this would be:

60 x 90000 / 33867 = 159 inches/minute

In the normal feed cutting mode, with G64 active, giving continuous cutter motion, deceleration of the axes in motion begins at some distance away from the end point. If look-ahead has provided another motion, the acceleration for that motion will begin at the same instant. This means that two motions, at right angles to each other, will not produce a perfectly square

corner. The corner will be rounded. It also means that if the two motions are parallel or nearly parallel, there will be a smooth transition from one stroke to the next.

Rapid moves have a slightly different operation when continuous cutter mode is active. Acceleration for the next motion is started when the axes being moved all fall within the "In Position Limit" Parameters 101, 102, 103, and 104. These parameters have units of encoder steps. Rapid moves will also decelerate at the constant accel/decel limit until the speed drops below that for exponential accel/decel (see example above giving 159 inches per minute). Parameter 57 can be used to override this.

To prevent the rounding of corners, you can specify exact stop either with G09 (non-modal) or with G61 (modal). When either of these is active in a motion, all of the axes are brought to an exact stop, at zero speed, before the next motion is started.

The tool path in a circular move (G02 or G03) is not changed by the exponential acceleration/deceleration so there is no error introduced in the radius of the cut unless the speed exceeds that for exponential accel/decel (see example above giving 159 inches per minute).

4.3 SERVO DRIVE ASSEMBLY (BRUSH)

The servo drive assembly is on the left side of the main control cabinet and about halfway down. Never work on the servo drive assembly until the small red CHARGE light goes out. This light is at the top of the circuit card at the center of the assembly. Until this light goes out, there are dangerous voltages in the assembly EVEN WHEN POWER IS SHUT OFF. This assembly contains four servo drive cards, a Servo Distribution card, and a fan.

4.4 160 VOLT DC POWER SUPPLY (BRUSH)

The Servo Distribution card contains a DC power supply that produces an unregulated voltage between 145 and 175 volts. This is derived from the three-phase 115V AC coming from transformer T1. The nominal 160V DC is supplied to the four servo drive cards for the X, Y, Z, and A axes and to the tool changer. This supply is filtered by two capacitors in parallel for a total of 4000 Mfd. A soft charge-up of these capacitors is provided by a small resistor that is bypassed by a relay when the servos are on.

The negative side of the 160V power supply is always connected to chassis ground. This means that when the relays on SDIST are released, all DC power is disconnected and the drives are safe. This also includes the tool changer that uses the 160V buss to drive the tool changer motors.

The minimum DC buss voltage is 145V and anything lower will result in an alarm. The maximum voltage is 185V and anything above this will cause heating of the servo regen load resistor. Anything above 190V will cause an alarm.

4.5 SERVO COOLING FAN (BRUSH)

There is a cooling fan on the servo drive assembly to help cool the servo drive cards. It blows air up past the servo drive cards in order to support convection cooling. The fan power is supplied from SDIST by P7.

4.6 SERVO DISTRIBUTION PCB (SDIST)

The Servo Distribution PCB is used to provide the 160V DC buss for the servo drives, the low voltage AC power for the drives, and to monitor the supply voltage for the servos.

There are three pots on this card. They are:

R2 This pot adjusts the buss voltage at which the regen load resistor is applied as a load to the power supply. This will consume any excess power causes by the regenerative effects of decelerating the servo motors. This should be set to turn on the load between 183 and 187V DC.

R11 This pot adjusts the fraction of the buss voltage that is sent to the Motor Interface PCB A-to-D converter. This is a full scale 5V input and the program will interpret full scale as 200V on the buss.

R15 This pot adjusts the voltage at which an overvoltage alarm discrete is generated. This should be set to alarm between 188 and 192V DC (about 265 AC).

The red "CHARGE" LED is also mounted on the SDIST PCB. It indicates that the supply capacitors still contain a charge. The discharge resistors provide a load through this LED. It will dim and appear off when the voltage is below 20 volts.

The connectors on the SDIST PCB are:

P1 Low voltage AC power to X drive card (570)
P2 Low voltage AC power to Y drive card (580)
P3 Low voltage AC power to Z drive card (590)
P4 Low voltage AC power to A drive card (600)
P5 12V DC from power supply (860A)
P7 115V AC to fan
P8 160V DC supply to tool changer(80)
P9 Voltage monitor to A-D (980)
P10 Regen load resistor (920)
P11 Relay #1 contacts from IOPCB (110)
P12 Overvoltage status to IOPCB (970)
P13 Ground fault detect signal to IOPCB (1060)
TB1 Three phase 115V AC to SDIST
TB2 +160V DC and return to each servo drive card

There are three fuses mounted on the SDIST PCB; FU1 and FU2 protect the primaries of the fan and transformers. They are ½ amp, 240V AC, AGC type. FU3 protects the regenerative load circuit from a short circuit.

4.7 SERVO DRIVE PCB'S (DRIVER)

NOTE: REFER TO THE PCB AND CABLE LOCATION SECTION FOR BOARD DIAGRAMS.

The servo drive PCB's are H drive with PWM control. There are eight states used in the H drive providing free-wheeling current during PWM and very low current ripple. The PWM frequency is 16 kHz. All drive cards are current limited at 20 to 22 amps. They operate from a nominal supply voltage of 160 volts. The peak power output is thus about 3000 watts, or 4 H.P. The continuous power output is, however, limited by a microprocessor based fuse setting, overcurrent shutdown, and motor thermal protection. Short circuit protection is provided by the drive card and, if sustained for over 0.01 second, the microprocessor will shut the servo drives off and generate an alarm.

The motor output circuit is fuse protected at 20 amps but this will only blow if there is a drive failure as the current limit circuit is much faster than the fuses.

The PWM signal is provided by the Motor Interface PCB along with direction and H drive state control. The processor also monitors the overcurrent status from the drive card.

The connectors on the servo drive cards are:

P8	160V DC from SDIST PCB
P1	low voltage AC power from SDIST PCB
P3	PWM and H drive control signals
P2	Power connection to servo motor

There are three fuses on each servo drive card. One is in series with each leg of the servo motor. These fuses are type ABC and are rated at 20 amps, 200V DC A third fuse on each driver card limits the plus (+) side of the power supplied to each card; this fuse is an ABC, 250V.

4.8 SERVO ENCODERS (BRUSHLESS)

Some Haas machines are equipped with brushless motors, which provides for better performance, and no maintenance. In addition to the performance differences, these machines differ from brush type machines, which have already been discussed, in the following areas:

The brushless motors have 8192 line encoders built in, which result in differences in acceleration parameters 7, 21,35,49 and 157. The exponential accel/decel time is set by parameters 115, 116 and 168. "In Position" parameters 101, 102, 103, 104 and 165 are also affected by brushless motors.

The motor controller board has a dedicated processor which does all the servo control algorithm.

There is no servo distribution board anymore, therefore there is no CHARGE light present. Care should still be taken however, since there are high voltages present on the amplifiers, even when power is shut off. The high voltage comes from the spindle drive, which does have a CHARGE light.

The servo drive cards are replaced by Brushless Servo Amplifiers, and are controlled differently.

A low voltage power supply card is added to the servo drive assembly to supply the low voltage requirement to the amplifiers.

The CNC software is version 9.xx.

The user interface and motion profiling have not changed however, and the user should not see any functional differences between a brush type machine and a brushless machine.

4.9 SERVO CHARACTERISTICS (BRUSHLESS)

Servo characterstics are explained in detail in the previous chapter. The following is an example of how to achieve 130 inches/minute.

The exponential accel/decel time constant is set by Parameters 113, 114, 115, 116 and 168. It has units of 0.0001 seconds. The speed limit at which exponential accel/decel is not available is defined by the relationship between Parameters 7 and 113 (for the X-axis). Thus if Parameter 7 is 8000000 steps/sec/sec and Parameter 113 is 375 (0.0375 seconds); the maximum velocity for accurate interpolation should be:

8000000 x 0.0375 = 300000 steps/second

For a 8192 line encoder and 6 mm screw, this would be:

60 x300000 / 138718 = 130 inches/minute

4.10 SERVO AMPLIFIERS (BRUSHLESS)

NOTE: REFER TO PCB AND CABLE LOCATION SECTION FOR BOARD DIAGRAMS.

The brushless servo amplifier is a PWM based current source. The PWM outputs control the current to a three phase brushless motor. The PWM frequency is 16 KHz. The amplifiers are current limited to 30 amps peak. 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 H.P. The amplifiers also have short circuit and over temperature and over heat protection.

There is a 10 amp supply fuse for failure protection. This fuse is relatively slow, therefore it can handle the 30 amp peak. Actual continues current limit to the motor is controlled by software.

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 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.

5. INPUT/OUTPUT ASSEMBLY

NOTE: REFER TO THE PCB AND CABLE LOCATION SECTION FOR BOARD DIAGRAMS.

The IOPCB contains a circuit for electronically turning the tool changer power on and off. This prevents any arcing of the tool changer relays and increases their life tremendously. This includes an adjustable current limit to the tool changer. Potentiometer R45 adjusts the current limit to the tool changer motors. R45 should be set to limit current to between four and six amps.

The IOPCB also contains a circuit for sensing a ground fault condition of the servo power supply. If more than 0.5 amps is detected flowing through the grounding connection of the 160V DC buss, a ground fault alarm is generated and the control will turn off servos and stop.

Relay K6 is for the coolant pump 230V AC It is a plug-in type and is double-pole. Relays K9 through K12 are also plug in types for controlling the tool changer.

The Input/Output Assembly consists of a single printer circuit board called the IOPCB.

The connectors on the IOPCB are:

P1	16-pin relay drivers from MOCON 1 to 8 (510)
P2	16-pin relay drivers from MOCON 9 to 16 (520)
P3	16-pin relay drivers from MOCON 17 to 24 (M21-M24) (540)
P4	34-pin inputs to MOCON (550)
P5	Servo power on relay 1-1 (110)
P6	230V AC from CB3 (930)
P7	230V AC to coolant pump (940)
P8	Auto-off relay 1-7 (170)
P9	Spindle drive commands (710)
P10	Spindle fan and oil pump 115V AC (300)
P12	115V AC to spindle head solenoids (880A)
P13	Tool changer status inputs (820)
P14	Low TSC(900)
P15	Spindle head status inputs (890)
P16	Emergency stop input (770)
P17	Low Lube input (960)
P18	Over Voltage Input (970)
P19	Low Air Input (950)
P20	Overheat input (830)
P21	Spindle drive status inputs (780)
P22	M-FIN input (100)
P23	Remote Unclamp input (tool release) (190)
P24	Spare 2 (790)
P25	Spare 3 (200)
P26	Spare terminals for M21 to M24
P27	Door lock (1040)
P28	115V AC from CB4 (910)
P29	A-axis brake solenoid output (390)
P30	Tool changer shuttle motor output (810A)
P31	230 VAC for Chip Conveyor (160)
P33	115V AC three-phase input from power supply assembly (90)

P34	115V AC to CRT (90A)
P35	115V AC to heat exchanger (90B)
P36	115V AC to CB4 (90C)
P37	115V AC spare (870)
P38	Door open (1050)
P39	Tool changer turret motor output (810)
P40	(770A) A/B
P43	Ground fault sense signal input (1060) Axis Brake
P44	5TH axis brake (319)
P45	HTC Shuttle
P46	Chip Conveyor (140)
P47	Skip input signal (1070)
P48	spare 1
P49	spare 2
P50	Spigot Motor (200)
P51	16 PIN Relay drivers 17-24 (530)
P52	spare 1
P53	Spigot Sense (180)
P54	Servo Brake (350)
P55	Red/green lights (280)
P56	Thru spindle coolant pump(940A)
P57	115V spare
P58	115V spare

6. TWO-SPEED GEAR TRANSMISSION VF-1/2/3/4/6

The spindle head contains a two-speed gear transmission. The spindle motor is directly coupled to the transmission and the transmission is cog belt-coupled to the spindle.

6.1 GEAR BOX LUBRICATION

Gear Box: Mobil DTE 25 oil.

The spindle is air-pressurized and oil drip lubricated. The gear box uses an oil sump in the VF-1 thru 6 and is cooled by gear oil. The VF-0 does not have a gearbox and is air cooled.

6.2 GEAR BOX AIR SOLENOIDS

There is a double solenoid valve controlling air to the gear box. 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 of low gear. Circuit breaker CB4 will interrupt power to these solenoids. Power is left on the solenoid which is commanded last.

6.3 GEAR BOX SENSE SWITCHES

On the VF-1 thru VF-6, there are two switches in the gear box 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 status of these switches and the CURNT COMDS display shows which gear is selected. If the switches indicate that the gear box is between gears, the display will indicate “No Gear”.

6.4 GEAR CHANGE SEQUENCE

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

1) If the spindle is turning, it is commanded to stop,
2) Pause until spindle is stopped,
3) Gear change spindle speed is commanded forward,
4) Pause until spindle is at speed,
5) Command high or low gear solenoid active,
6) Pause until in new gear or reversal time,
7) Alarm and stop if max gear change time elapsed,
8) If not in new gear, reverse spindle direction,
9) Turn off high and low gear solenoids

7. CONTROL PANEL

7.1 JOG HANDLE

The JOG handle is actually a 100-line-per-revolution encoder. We use 100 steps per revolution to move one of the servo axes. If no axis is selected for jogging, turning of the crank has no effect. When the axis being moved reaches its travel limits, the handle inputs will be ignored in the direction that would exceed the travel limits.

Parameter 57 can be used to reverse the direction of operation of the handle.

7.2 POWER ON/OFF SWITCHES

The POWER ON switch engages the main contactor. The on switch applies power to the contactor coil and the contactor thereafter maintains power to its coil. The POWER OFF switch interrupts power to the contactor coil and will always turn power off. POWER ON is a normally open switch and POWER OFF is normally closed. The maximum voltage on the POWER ON and POWER OFF switches is 24V AC and this voltage is present any time the main circuit breaker is on.

7.3 SPINDLE LOAD METER

The Load meter measures the load on the spindle motor as a percentage of the rated continuous power of the motor. There is a slight delay between a load and the actual reflection of the meter. The eighth A-to-D input also provides a measure of the spindle load for cutter wear detection. The second page of diagnostic data will display % of spindle load. The meter should agree with this display within 5%. The spindle drive display #7 should also agree with the load meter within 5%.

There are different types of spindle drive that are used in the control. They are all equivalent in performance but are adjusted differently.

7.4 EMERGENCY STOP SWITCH

The EMERGENCY STOP switch is normally closed. If the switch opens or is broken, power to the servos will be removed instantly. This will also shut off the tool changer, spindle drive, and coolant pump. The EMERGENCY STOP switch will shut down motion even if the switch opens for as little 0.005 seconds.

Be careful of the fact that Parameter 57 contains a status switch that, if set, will cause the control to be powered down when EMERGENCY STOP is pressed.

You should not normally stop a tool change with EMERGENCY STOP as this will leave the tool changer in an abnormal position that takes special action to correct.

Note that tool changer alarms can be easily corrected by first correcting any mechanical problem, pressing RESET until the alarms are clear, selecting ZERO RETURN mode, and selecting “AUTO ALL AXES”.

If the shuttle should become jammed, the control will automatically come to an alarm state. To correct this, p u s h t h e EMERGENCY STOP button and remove the cause of the jam. Push the RESET key to clear any alarms. Push the ZERO RETURN and the AUTO ALL AXES keys to reset the Z-axis and tool changer. Never put your hands near the tool changer when powered unless the EMERGENCY STOP button is pressed.

7.5 KEYBOARD BEEPER

There is a speaker inside the control panel that is used as an audible response to pressing keyboard buttons and as a warning beeper. The beeper is a one kHz signal that sounds for about 0.1 seconds when any keypad key, CYCLE START, or FEED HOLD is pressed. The beeper also sounds for longer periods when an auto-shut down is about to occur and when the "BEEP AT M30" setting is selected.

If the beeper is not audible when buttons are pressed, the problem could be in the keypad, keyboard interface PCB or in the speaker. Check that the problem occurs with more than one button and check that the speaker volume is not turned down.

8. MICROPROCESSOR ASSEMBLY

The microprocessor assembly is in the rear cabinet at the top left position. It contains three large boards. They are: microprocessor, the keyboard and the MOCON. All three boards of the processor assembly receive power from the low voltage power supply. The three PCB's are interconnected by a local buss on dual 50-pin connectors. At power-on of the control, some diagnostic tests are performed on the processor assembly and any problems found will generate alarms 157 or 158. In addition, while the control is operating, it continually tests itself and a self test failure will generate Alarm 152.

8.1 MICROPROCESSOR PCB (68EC030)

The Microprocessor PCB contains the 68EC030 processor running at 40 MHz, one 128K EPROM; between 256K and 8MB of CMOS RAM and betwen 512K and 1MB of FAST STATIC RAM. It also contains a dual serial port, a five year battery to backup RAM, buffering to the system buss, and eight system status LED's.

Two ports on this board are used to set the point at which an NMI* is generated during power down and the point at which RESET* is generated during power down.

The eight LED's are used to diagnose internal processor problems. As the system completes power up testing, the lights are turned on sequentially to indicate the completion of a step. The lights and meanings are:

+5V +5V logic power supply is present. (Normally On)
If this light does not come on, check the low voltage power supply and check that all three phases of 230V input power are present.

HALT Processor halted in catastrophic fault. (Normally Off)
If this light comes on, there is a serious problem with the processor PCB. Check that the EPROM is plugged in. Test the card with the buss connectors off.

POR Power-on-reset complete. (Normally On)
If this light does not come on, there is a serious problem with the processor PCB. Check that the EPROM is plugged in. Test the card with the buss connectors off.

SIO Serial I/O initialization complete. (Normally On)
If this light does not come on, there is a problem with the serial ports. Disconnect anything on the external RS-232 and test again.

MSG Power-on serial I/O message output complete. (Normally On)
If this light does not come on, there is a problem with serial I/O or interrupts. Disconnect anything on the external RS-232 and test again.

CRT/VIDEO Initialization complete. (Normally On)
If this light does not come on, there is a problem communicating with the VIDEO PCB. Check the buss connectors and ensure the VIDEO PCB is getting power.

PGM Program signature found in memory.(Normally On)
If this light does not come on, it means that the main CNC program package was not found in memory or that the auto-start switch was not set. Check that switch S1-1 is on and the EPROM is plugged in.

RUN Program running without fault exception.(Normally On)
If this light does not come on or goes out after coming on, there is a problem with the microprocessor or the software running in it. Check all of the buss connectors to the other two PCB's and ensure all three cards are getting power.

There 1 two-position DIP switch on the processor PCB labled S1. Switch S1-1 must be ON to auto-start the CNC operational program. If S1-1 is OFF, the PGM light will remain off.

Switch S2-1 is used to enable FLASH. If it is disabled it will not be possible to write to FLASH.

The processor connectors are:
J1 Address buss
J2 Data buss
J4 Serial port #1 (for upload/download/DNC) (850)
J5 Serial port #2 (for auxiliary 5th axis) (850A)
J3 Power connector
J6 Battery

8.2 MEMORY RETENTION BATTERY

The memory retention battery is initially soldered into the processor PCB. This is a 3.3V Lithium battery that maintains the contents of CMOS RAM during power off periods. Prior to this battery being unusable, an alarm will be generated indicating low battery. If the battery is replaced within 30 days, no data will be lost. The battery is not needed when the machine is powered on. Connector J6 on the processor PCB can be used to connect an external battery.

8.3 VIDEO KEYBOARD PCB WITH FLOPPY

The VIDEO and KB PCB generates the video data signals for the monitor and the scanning signals for the keyboard. In addition, the keyboard beeper is generated on this board. There is a single jumper on this board used to select inverse video. The video PCB connectors are:

P1 Power connector
J3 Keyboard (700)
J4 Address bus
J5 Data
J10 Floppy V+
J11 SPARE
J12 Floppy
J13 Video (760)
J14 RS422 B
J15 RS422 A

8.4 MOTOR INTERFACE PCB (MOTIF)

NOTE: REFER TO PCB AND CABLE LOCATION SECTION FOR BOARD DIAGRAMS.

The Motor Interface PCB provides all of the interfaces to motors and discrete inputs and outputs. It contains a single pot R54 to adjust the output of the D-A converter. The MOTIF PCB connectors are:

P1	Data buss
P2	X drive control and overcurrent sense (610)
P3	Y drive control and overcurrent sense (620)
P4	Z drive control and overcurrent sense (630)
P5	A drive control and overcurrent sense (640)
P6	X-axis encoder, Z, home, and overheat (660)
P7	Y-axis encoder, Z, home, and overheat (670)
P8	Z-axis encoder, Z, home, and overheat (680)
P9	A-axis encoder, Z, home, and overheat (690)
P10	32 discrete inputs (550)
P11	Relay drives 1 to 8 (510)
P12	Relay drives 9 to 16 (520)
P13	Relay drives 17 to 24 (530)
P14	Relay drives 25 to 32 (540)
P15	Power connector (+5,+12+)
P16	D-to-A output and -12V DC (720)
P17	A-to-D inputs for DC buss voltage (980)
P18	Jog Crank input and aux 1,2 (750)
P19	Address buss
P20	Spindle encoder inputs (1000)
P21	A-to-D input for spindle temperature (1020)
P22	A-to-D input for spindle load monitor (730B)
P24	Home switch inputs X, Y, Z (990)

8.5 MOTOR CONTROLLER (MOCON) BRUSHLESS

NOTE: REFER TO PCB AND CABLE LOCATION SECTION FOR BOARD DIAGRAMS.

The brushless machining centers are equipped with a microprocessor based brushless motor controller board (MOCON)that replaces the motor interface in the brush type controls. It runs in parallel with the main processor, receiving servo commands and closing the servo loop around the servo motors.

In addition to controlling the servos and detecting servo faults, the motor controller board, (MOCON), is also in charge of processing discrete inputs, driving the I/O board relays, commanding the spindle and processing the jog handle input. Another significant feature is that it controls 6 axes, so there is no need for an additional board for a 5 axis machine.

P1	Data Bus
P2	X amplifier control and fault sensing (610)
P3	Y amplifier control and fault sensing (620)
P4	Z amplifier control and fault sensing (630)
P5	A amplifier control and fault sensing (640)
P32	B amplifier control and fault sensing (640B)
P33	C amplifier control and fault sensing (640C)
P6	X encoder input (660)

P7	Y encoder input (670)
P8	Z encoder input (680)
P9	A encoder input (690)
P30	B encoder input (690B)
P31	C encoder input (690C)
P18	Jog encoder input (750)
P20	Spindle encoder input (1000)
P10	Inputs from I/O board (550)
P11	I/O relays K1-8 (510)
P12	I/O relays K9-16 (520)
P13	I/O relays K17-24 (530)
P14	I/O relays K25-32 (540)
P15	Low Voltage Power (860)
P16	Spindle command output (720)
P19	Address bus
P24	Axis home switches (990)

9. SPINDLE DRIVE ASSEMBLY

The spindle drive is located in the main cabinet on the right side and halfway down. It has a blue cover on it. It operates from three-phase 200 to 240V AC. It has a 5 H.P. continuous rating, a 7.5 H.P. five-minute rating, and a 9 H.P. one-minute rating. The spindle drive is protected by CB1 at 30 amps. Never work on the spindle drive until the small red CHARGE light goes out. Until this light goes out, there are dangerous voltages inside the drive, even when power is shut off.

For all other data on the spindle drive, refer to the supplied documentation for your drive.

10. RESISTOR ASSEMBLY

The Resistor Assembly is located on top of the control cabinet. It contains the servo and spindle drive regen load resistors.

10.1 SPINDLE DRIVE REGEN RESISTOR

A 15-ohm, 900-watt resistor or 20-ohm, 600 watt resistor 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 accelerated and decelerated again in rapid succession repeatedly, this resistor will get hot. In addition, if the line voltage into the control is above 255V, this resistor will begin to heat. This resistor is overtemp protected at 100^0 C. At that temperature, an alarm is generated and the control will begin an automatic shutdown. If the resistor is removed from the circuit, an alarm may subsequently occur because of an overvoltage condition inside the spindle drive.

10.2 SERVO DRIVE REGEN RESISTOR

A 500-ohm, 100-watt resistor is used by the servo drives to dissipate excess power caused by the regenerative effects of decelerating the servo motors. If the servo motors are accelerated and decelerated again in rapid succession repeatedly, this resistor will get hot. In addition, if the line voltage into the control is above 255V, this resistor will begin to heat. This resistor is overtemp protected at 100^0 C. At that temperature, an automatic control shutdown is begun. If that resistor is removed from the circuit, an alarm may subsequently occur because of an overvoltage condition for the servo buss.

10.3 OVERHEAT SENSE SWITCH

There is an overtemperature sense switch mounted near the above-mentioned regen resistors. This sensor is a normally-closed switch that opens at about 100^0 C. It will generate an alarm and all motion will stop. After four minutes of an overheat condition, an automatic shutdown will occur in the control.

11. POWER SUPPLY ASSEMBLY

All power to the control passes through the power supply assembly. It is located on the upper right corner of the control cabinet.

11.1 MAIN CIRCUIT BREAKER CB1

Circuit breaker CB1 is rated at 30 amps and is used to protect the spindle drive and to shut off all power to the control. The locking On/Off handle on the outside of the control cabinet will shut this breaker off when it is unlocked. A trip of this breaker indicates a SERIOUS overload problem and should not be reset without investigating the cause of the trip. These 30 amps could correspond to as much as 15 horsepower.

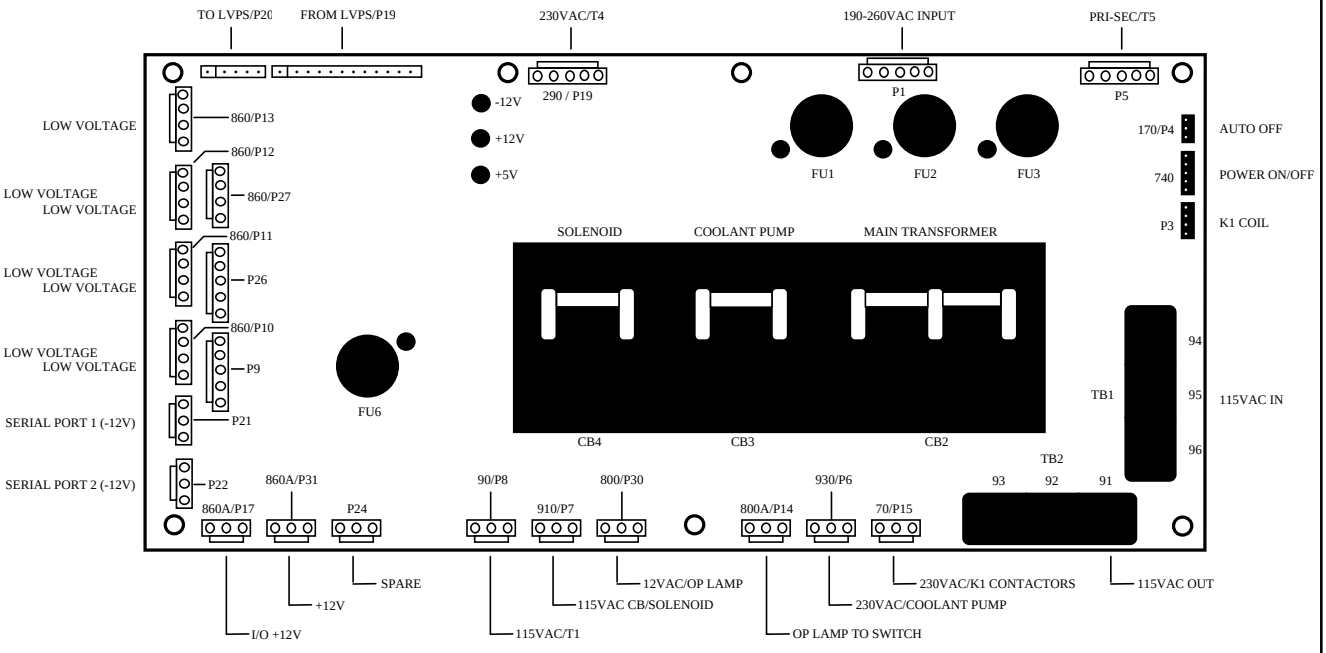


Figure 11-1 Power Supply PCB.

11.2 MAIN CONTACTOR K1

Main contactor K1 is used to turn the control on and off. The POWER ON switch applies power to the coil of K1 and after it is energized, an auxiliary switch on K1 continues to apply power to the coil. The POWER OFF switch on the front panel will always remove power from this contactor.

When the main contactor is off, the only power used by the control is supplied through two ½ amp fuses to the circuit that activates the contactor. An overvoltage or lightning strike will blow these fuses and shut off the main contactor.

The power to operate the main contactor is supplied from a 24V AC control transformer that is primary fused at ½ amp. This ensures that the only circuit powered when the machine is turned off is this transformer and only low voltage is present at the front panel on/off switches.

11.3 LOW VOLTAGE POWER SUPPLY

The low voltage power supply provides +5V DC, +12V DC, and -12V DC to all of the logic sections of the control. It operates from 115V AC nominal input power. It will continue to operate correctly over a 90V AC to 133V AC range.

11.4 POWER PCB (POWER)

The low voltage power distribution and high voltage fuses and circuit breakers are mounted on a circuit board called the POWER PCB. The following connectors are on it:

P1 Five-pin brings 230V AC three ph from main breaker
P2 On/Off connections to front panel (740)
P3 Coil and aux connections to contactor K1
P4 Auto-off connection to IOPCB (170)
P5 Low voltage control transformer to power K1
P6 230V AC from CB3 to coolant pump (930)
P7 115V AC from CB4 to IOPCB for solenoids (910)
P8 115V AC /T1 (90)
P9 Tool changer fuse circuit from FU5 to IOPCB (840)
P10 +5/+12/Gnd form low volt supply to logic boards (860)
P11 +5/+12/Gnd form low volt supply to logic boards (860)
P12 +5/+12/Gnd form low volt supply to logic boards (860)
P13 +5/+12/Gnd form low volt supply to logic boards (860)
P14 12V AC to operator's lamp (800A)
P15 230V AC from contactor K1 for coolant pump (70)
P16 Low voltage power from power supply
P17 +12V DC to IOPCB (860A)
P18 Not used
P19 Connector to op. lamp transformer T4 (290)
P20 115V AC to low voltage supply
P21 -12V DC to processor PCB
P22 -12V DC to MOTIF PCB

P26 +12V DC option connector
P27 +5/+12/Gnd form low volt supply to logic boards (860)

P30 12V AC OP Lamp (800)
P31 +12V (860A)

For older internal transformer with 208/230 taps:
TB1 230V AC from contactor K1
TB2 230V AC to T1 primary

11.5 POWER-UP LOW VOLTAGE CONTROL TRANSFORMER (T5)

The low voltage control transformer, T5, supplies power to the coil of the main contactor K1. It guarantees that the maximum voltage leaving the Power Supply assembly when power is off is 12V AC to earth ground. It is connected via P5 to the POWER PCB.

11.6 SECONDARY CIRCUIT BREAKERS

Three more circuit breakers are on the Power supply assembly.

CB2 controls the 115volt power from the main transformer to the servo transformers and, if tripped, will turn off the servo motors and air solenoids. CB2 could be blown by a severe servo overload.

CB3 controls the power to coolant pump only. It can be blown by an overload of the coolant pump motor or a short in the wiring to the motor.

CB4 controls the 115V AC to the air solenoids, 4th axis brake, and the oiler. It is never expected to trip. If it does trip, it is likely caused by a short circuit in the wiring on the I/O assembly or the wiring to the solenoids on the spindle head.

11.7 OPERATOR'S LAMP TRANSFORMER

Transformer T4 supplies low voltage to the operator's lamp. The primary is 115V AC and the secondary is 10V AC. The primary is protected at ½ amp by F6. It is connected to the POWER PCB by connector P19.

12. POWER TRANSFORMER ASSEMBLY (T1)

The power transformer assembly is used to convert three-phase 190/260V to three-phase 115V and is primarily used by the servo drives. The video monitor, solenoids, fans, and oiler also use 115V AC. This transformer's maximum input voltage is 260V @ 60 Hertz, and 240V @ 50 Hertz. It is located in the main cabinet in the lower right corner. It is rated at 12KVA and its primary is protected to 40 amps.

This transformer has four voltage connections that allow for a range of inputs from 195V to 260V. The transformer has an autotransformer primary to supply240V , three- phase to the spindle drives other 240V applications.

74, 75, 76

195 to 210 right side
211 to 226 right center
227 to 243 left center
244 to 260 left side

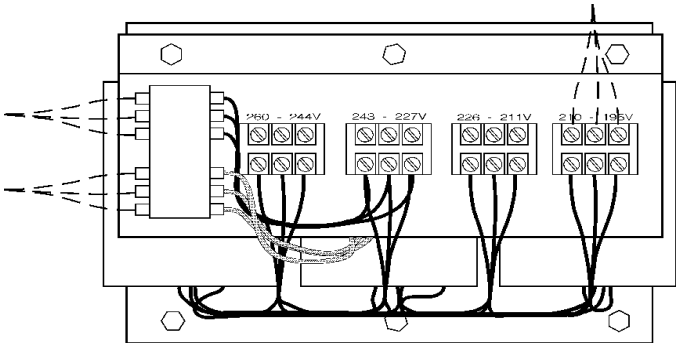


Fig. 12-1 Polyphase bank transformer.

12.1 PRIMARY CONNECTION TO T1

Input power to T1 is supplied through CB1, the 40 amp three-phase main circuit breaker. Three-phase 230 to T1 is connected to the first three terminals of TB10.

12.2 VOLTAGE SELECTION TAPS

There are four labeled plastic terminal blocks. Each block has three connections for wires labeled 74, 75, and 76. Follow the instructions printed on the transformer.

12.3 SECONDARY CONNECTION TO T1

The secondary outputfrom T1 is 115V AC three-phase CB2 protects the secondary of transformer T1 and is rated at 25 amps.

12.4 OPTIONAL 480 TRANSFORMER

Voltage Selection Taps for the 480 Transformer:

Right to left:

353 to 376
377 to 400
401 to 425
426 to 451
452 to 480*

* 480 V transformer has additional terminal block

13. FUSES

The servo drive (DRIVER) cards have three fuses on each of the X, Y, Z, and A PCB's (F1, F2, F3). If these fuses are ever blown, the associated motor will stop. This will only happen if there is a failure of the drive card and the user should never attempt to replace these fuses.

The POWER PCB contains three ½-amp fuses located at the top right (FU1, FU2, FU3). If the machine is subject to a severe overvoltage or a lightning strike, these fuses will blow and turn off all of the power. Replace these fuses only with the same type and ratings. The other two fuses protect the tool changer (FU5) and the operator's lamp (FU6).

On the servo drive assembly, there is a printed circuit board (SDIST) containing three one-amp fuses (FU1, FU2, FU3). Two of these fuses protect the contactor and small transformers. They are never expected to blow. The third fuse protects the regen load circuit load from shorts.

FUSE NAME	TYPE	RATING	VOLTAGE (amps)	LOCATION	
FU1	AGC	½	250V	POWER pcb,	upper right
FU2	AGC	½	250V	" "	
FU3	AGC	½	250V	" "	
LAMP	AGC	½	250V	"	lower left
FU1	AGC	½	250V	SDIST pcb,	right center
FU2	AGC	½	250V	" "	
FU3	AGC	5	250V	"	top center
F1	ABC	20	250V	SDRIVER pcb's (X, Y, Z, A)	
F2	ABC	20	250V	"	
F3	ABC	10	250V	"	
FU1	ABC	5	250V	I/O PCB	
FU2	ABC	5	250V	I/O PCB	
FU3	ABC	5	250V	I/O PCB	
FU4	ABC	5	250V	I/O PCB	

14. SPARE USER M CODE INTERFACE

The M code interface uses outputs M21-24 and one discrete input circuit. M codes M21 through M24 will activate relays labled M21-24. These relay contacts are isolated from all other circuits and may switch up to 120V AC at one amp. The relays are SPDT.

WARNING! POWER CIRCUITS AND INDUCTIVE LOADS MUST HAVE SNUBBER PROTECTION.

The M-FIN circuit is a normally open circuit that is made active by bringing it to ground. The one M-FIN applies to all eight of the user M codes.

The timing of a user M function must begin with all circuits inactive, that is, all circuits open. The timing is as follows:

The Diagnostic Data display page may be used to observe the state of these signals.

14.1 M FUNCTION RELAYS

The IOPCB contains position for four relays (M21-M24) and all are available to the user. In addition, M21 is already wired out to P12 at the side of the control cabinet. This is a four-pin DIN connector and includes the M-FIN signal.

14.2 M-FIN DISCRETE INPUT

The M-FIN discrete input is a low voltage circuit. When the circuit is open, there is +12V DC at this signal. When this line is brought to ground, there will be about 10 milliamps of current. M-FIN is discrete input #10 and is wired from input #10 on the Inputs PCB on the Input/Output Assembly. The return line for grounding the circuit should also be picked up from that PCB. For reliability, these two wires should be routed in a shielded cable where the shield is grounded at one end only. The diagnostic display will show this signal a "1" when the circuit is open and a "0" when this circuit is grounded.

14.3 TURNING M FUNCTIONS ON AND OFF

The eight optional M code relays can also be separately turned on and off using M codes M51-M54 and M61- M64. M51 to M54 will turn on one of the eight relays and M61 to M64 will turn the relays off. M51 and M61 correspond to M21, etc.

15. LUBRICATION PUMP

The lubrication pump is powered whenever the spindle is on or any axes are in motion. It operates from 115V AC On a cyclic basis, it will pump oil to the screws and guides. It cycles at least once every 30 minutes and pumps 2.8cc- 3.8cc of lubrication.

15.1 LOW LUBRICATION AND LOW 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 an lube pressure switch that senses the lube pressure. Parameter 117 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 90000. Parameter 57, bit "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.

16. SWITCHES

16.1 LAMP ON/OFF SWITCH

An on/off switch is supplied for the operator's lamp. It is located on the side of the control cabinet below all of the motor connectors.

16.2 DOOR OPEN SENSE SWITCH

The DOOR OPEN sense switch is a magnetic reed switch type and consists of two switches; one on each half of the enclosure front doors. These switches are normally closed and wired in series. When the doors open, one or both of these switches will open and the machine will stop with a "Door Hold" function. When the door is closed again, operation will continue normally.

The wiring for the door switches is wired in either of two paths. The first one applies to machines built before March 1990; this uses connector P5 at the side of the cabinet and routes the wires past the oiler and through the base of the mill. The second wiring routes through the front panel support arm and down through the top of the plastic enclosure.

If the doors are open, you will not be able to start a program. Door hold will not stop a tool change operation, will not turn off the spindle, and will not turn off the coolant pump.

The door hold function can be temporarily disabled with Setting 51, but this setting will return to OFF when the control is turned off.

16.3 LIMIT SWITCHES

NOTE: There are fourteen (14) limit switches located on the VMC, and some are difficult to reach. Ensure the problem is the switch before beginning removal procedures. The following is a list of all switches, their general location, and a functional description:

CLAMP/UNCLAMP SWITCHES

[Tool Release Piston Assembly (2)]

There are two switches used to sense the position of the tool clamping mechanism. They are both normally closed and one will activate at the end of travel during unclamping and the other during clamping. When both switches are closed, it indicates that the draw bar is between positions.

A tool change operation will wait until the unclamped switch is sensed before the Z-axis pulls up from the tool. This prevents any possibility of breaking the tool changer or its support mounts.

The diagnostic display can be used to display the status of the relay outputs and the switch inputs.

SPINDLE ORIENT SWITCH

[Top rear of transmission]

A normally-open switch that is held closed is used to sense when the pin drops in to lock the spindle. When the pin drops the switch opens, indicating orientation is complete.

The normally-closed side of the same switch that is held open, is wired to the spindle drive and commands it into a "Coast Stop" condition. This is done to ensure the spindle motor is not powered when the pin is locking the spindle.

DOOR HOLD SWITCHES

[Top outer edges of door opening (2)]

The DOOR OPEN sense switch consists of two switches; one on each side of the enclosure front doors. These switches are normally closed and wired in series. When the doors open, one or both of these switches will open and the machine will stop with a "Door Hold" function. When the door is closed again, operation will continue normally.

If the doors are open, you will not be able to start a program. Door hold will not stop a tool change operation, will not turn off the spindle, and will not turn off the coolant pump.

The door hold function can be temporarily disabled with Setting 51, but this setting will return to OFF when the control is turned off.

Prior to performing an AUTO POWER UP or an AUTO ALL AXES operation, there are no travel limits. Thus, you can jog into the hard stops in either direction for X, Y, or Z. After a ZERO RETURN has been performed, the travel limits will operate unless an axis hits the limit switch. When the limit switch is hit, the zero returned condition is reset and an AUTO ALL AXES must be done again. This is to ensure that if you hit the limit switch, you can still move the servo back away from it.

The limit switches are normally closed. When a search for zero operation is being performed, the X, Y, and Z axes will move towards the limit switch unless it is already active (open); then they will move away from the switch until it closes again; then they will continue to move until the encoder Z channel is found. This position is machine zero.

Auto search for zero in the Z-axis is followed by a rapid move from the limit switch position down to the tool change position. This makes the Z-axis a little different from the other axes. The position found with the limit switch is not machine zero but is the position used to pull tools out of the spindle. Machine zero for Z is below this by Parameter 64. Be careful during the Z zero search and stay clear of that rapid move.

WHAT CAN GO WRONG WITH LIMIT SWITCHES?

If the machine is operated without connector P5, a LOW LUBE and DOOR OPEN alarm will be generated. In addition, the Home search will not stop at the limit switch and will instead run into the physical stops on each axis.

If the switch is damaged and permanently open, the zero search for that axis will move in the negative direction at about 0.5 in/min until it reaches the physical travel stops at the opposite end of travel.

If the switch is damaged and permanently closed, the zero search for that axis will move at about 10 in/min in the positive direction until it reaches the physical stops.

If the switch opens or a wire breaks after the zero search completes, an alarm is generated, the servos are turned off, and all motion stops. The control will operate as though the zero search was never performed. The RESET can be used to turn servos on but you can jog that axis only slowly.

TOOL CHANGER POSITION SWITCHES

[Inside of Tool Carriage (2)]

GENEVA WHEEL POSITION MARK

The turret rotation mechanism has a switch mounted so that it is activated for about 30° of travel of the Geneva mechanism. When activated, this switch indicates that the turret is centered on a tool position. This switch is normally closed. The diagnostic display will show this status of this input switch as "TC MRK". A "1" indicates the Geneva wheel is in position.

TOOL #1 SENSE SWITCH

The tool rotation turret has a switch that is activated when tool one is in position or facing towards the spindle. At POWER ON this switch can indicate that tool #1 is in the spindle. If this switch is not active at power-on, the first tool change will rotate the turret until the switch engages and then move to the selected tool. The diagnostic display will show this status of this input switch as “TOOL #1”. A “1” indicates that tool #1 is in position.

SHUTTLE IN/OUT SWITCHES

[Tool Changer Holding Plate (2)]

Two switches are used to sense the position of the tool changer shuttle and the arm that moves it. One switch is activated when the shuttle 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.

TRANSMISSION HIGH/LOW GEAR POSITION SWITCHES

[Bottom of Gearbox Assembly (2)]

On the VF-1, VF-2, VF-3 and VF-4, there are two switches in the gear box 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 status of these switches and the CURNT COMDS display shows which gear is selected. If the switches indicate that the gear box 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 and are extremely difficult to reach. Removal of this assembly is necessary to replace these switches. See Mechanical Service, for Spindle Motor and Transmission removal.

17. HYDRAULIC COUNTERBALANCE

The spindle head weight is balanced by the upward pull of a hydraulic cylinder. The hydraulic oil forces the piston to retract into the cylinder body. The oil is then pressurized by a nitrogen resevoir. The system is self contained and passive (no pump is required to maintain the lift). Normal Z-Axis of the gas/oil counter balance has the initial pressure to balance the weight at full system volume, plus an additional 50-75 psi overcharge for longevity.

18. LUBRICATION SYSTEM

The lubrication system is a resistance type system which forces oil through metering units at each of the 16 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 3.0 cc of oil every 30 minutes throughout the oil lines to the lube points. Every lube point receives approximately 1/16 of oil. The control monitors this system through an internal level switch in the reservoir and and external pressure switch on the lube panel.

19. DIAGNOSTIC DATA

The ALARM MSGS display is the most important source of diagnostic data. At any time after the machine completes its power-up sequence, it will either perform a requested function or stop with an alarm. Refer to Section 2.5 for a complete list of alarms, their possible causes, and some corrective action.

If there is an electronics problem, the controller may not complete the power-up sequence and the CRT will remain blank. In this case, there are two sources of diagnostic data; these are the audible beeper and the LED's on the processor PCB. If the audible beeper is alternating a ½ second beep, there is a problem with the main control program stored in EPROM's on the processor PCB. If any of the processor electronics cannot be accessed correctly, the LED's on the processor PCB will or will not be lit.

If the machine powers up but has a fault in one of its power supplies, it may not be possible to flag an alarm condition. If this happens, all motors will be kept off and the top left corner of the CRT will have the message:

POWER FAILURE ALARM

and all other functions of the control will be locked out.

When the machine is operating normally, a second push of the PARAM/DGNOS key will select the diagnostics display page. The PAGE UP and PAGE DOWN keys are then used to select one of two different displays. These are for diagnostic purposes only and the user will not normally need them. The diagnostic data consists of 32 discrete input signals, 32 discrete output relays and several internal control signals. Each can have the value of 0 or 1. In addition, there are up to three analog data displays and an optional spindle RPM display. Their number and functions are:

DISCRETE INPUTS

#	Name	Description	#	Name	Description
1	TC IN	Tool Changer In	17	SP LOK	Spindle Locked
2	TC OUT	Tool Changer Out	18	SP FLT	Spindle Drive Fault
3	T ONE	At Tool One	19	SP ST*	Spindle Not Stopped
4	LO CNT	Low Coolant	20	SP AT*	Spindle Not At Speed
5	TC MRK	T.C. Geneva Mark	21	LO OIL	Spindle/GB coolant low
6	SP HIG	Spindle In High	22	spare	
7	SP LOW	Spindle In Low	23	spare	
8	EM STP	Emergency Stop	24	spare	
9	DOOR S	Door Open Switch	25	UNCLA*	Remote tool unclamp
10	M-FIN*	Not M Func Finish	26	LO PH A	Low voltage in phase 1
11	OVERV*	Not Over Voltage	27	spare	
12	LO AIR	Low Air Pressure	28	spare	
13	LO LUB	Low Lube Oil	29	GR FLT	Ground fault
14	OVRHT*	Not Over Heat	30	SKIP	Skip Signal
15	DB OPN	Tool Unclamped	31	SPIGOT	
16	DB CLS	Tool Clamped	32	CNVEYR	

DISCRETE OUTPUTS

#	Name	Description	#	Name	Description
1	SRV PO	Servo Power On	17	SPGCW	Spigot clockwise
2	SP FOR	Spindle Forward	18	SPGCCW	Spigot counter/clockwise
3	SP REV	Spindle Reverse	19	Spare	
4	SP RST	Spindle Reset	20	Spare	
5	4TH BK	4th Axis Brk Rel	21	PRE-CH	Pre-charge
6	COOLNT	Coolant Pump	22	HTC SH	Horizontal T.C. shuttle
7	AUT OF	Auto Turn Off	23	5TH BK	5th Axis Brake
8	SP FAN	Spind Motor Fan	24	Y160	Door Lock
9	TC IN	Tool Changer In	25	M21	
10	TC OUT	Tool Changer Out	26	M22	
11	TC CW	Tool Changer CW	27	M23	
12	TC CCW	Tool Changer CCW	28	M24	
13	SP HIG	Spindle High Gear	29	GRNBCN	Red beacon worklight
14	SP LOW	Spindle Low Gear	30	RDBCN	Red beacon worklight
15	T UNCL	Tool Unclamped	31	CNVENA	Conveyor Enabled
16	SP LOK	Spindle Lock Cmd	32	CNVREV	Conveyor reverse

The 38 inputs are numbered the same as the 38 connections on the inputs printed circuit board. The last eight outputs are reserved for expansion by HAAS.

The second page of diagnostic data is displayed using the PAGE UP and PAGE DOWN keys. It contains:

INPUTS 2

Name	Description	Name	Description
X Z CH	X-axis Z Channel	X ZIRQ	X-axis Z channel interrupt
Y Z CH	Y-Axis Z Channel	Y ZIRQ	Y-axis Z channel interrupt
Z Z CH	Z-axis Z Channel	Z ZIRQ	Z-axis Z channel interrupt
A Z CH	A-axis Z Channel	A ZIRQ	A-axis Z channel interrupt
X HOME	X-axis Home/Lim Switch	1K IRQ	1 kHz Interrupt
Y HOME	Y-axis Home	Z IRQ	Z channel interrupt
Z HOME	Z-axis Home	SPZIRQ	Spindle encoder Z interrupt
A HOME	A-axis Home	SELF T	Self-Test Input
X OVRH	X Motor OverTemp	X CABL	Broken cable to X encoder
Y OVRH	Y Motor OverTemp	Y CABL	Broken cable to Y encoder
Z OVRH	Z Motor OverTemp	Z CABL	Broken cable to Z encoder
A OVRH	A Motor OverTemp	A CABL	Broken cable to A encoder
OVC X	X Drive Overcurrent	spare	
OVC Y	Y Drive Overcurrent	spare	
OVC Z	Z Drive Overcurrent	spare	
OVC A	A Drive Overcurrent	AD EOC	A-to-D End of Conversion
		B Z CH	B-axis Z Channel
		B HOME	B-axis Home
		B OVRH	B Motor OverTemp
		OVC B	B Drive Overcurrent
		B ZIRQ	B-axis Z channel interrupt
		B CABL	Broken cable to B encoder

ANALOG DATA

Name	Description
DC BUSS	DC Servo Buss Voltage
SP TEMP	Spindle temperature F
SP LOAD	Spindle load in %
AUX TMP	Not used
SP SPEED	Spindle RPM CW or CCW

20. PARAMETERS

Parameters are seldom-modified values that change the operation of the machine. These include servo motor types, gear ratios, speeds, stored stroke limits, lead screw compensations, motor control delays and macro call selections. These are all rarely changed by the user and should be protected from being changed by the parameter lock setting. If you need to change parameters, contact HAAS or your dealer. Parameters are protected from being changed by Setting 7.

The Settings page lists some parameters that the user may need to change during normal operation and these are simply called "Settings". Under normal conditions, the parameter displays should not be modified. A complete list of the parameters is provided here.

There are 226 parameters in this control. The first 56 apply to the individual servo axes, 14 each. The first 14 of these will be described. The other axes parameters (15 through 56) are identical in function.

PARAMETER LIST

Parameter 1 X SWITCHES

Parameter 1 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

REV ENCODER	Used to reverse the direction of encoder data.
REV POWER	Used to reverse direction of power to motor.
REV PHASING	Used to reverse motor phasing.
DISABLED	Used to disable any axis.
Z CH ONLY	With **A** only, indicates that no home switch.
AIR BRAKE	With **A** only, indicates that air brake is used.
DISABLE Z T	Disables encoder **Z** test (for testing only).
SERVO HIST	Graph of servo error (for diagnostics only).
INV HOME SW	Inverted home switch (N.C. switch).
INV Z CH	Inverted **Z** channel (normally high).
CIRC. WRAP.	(***Future Option - Not Yet Implemented)*** With **A** only, causes 360 wrap to return to 0.
NO I IN BRAK	With **A** only, removes **I** feedback when brake is active.
LOW PASS +1X	Adds 1 term to low pass filter.
LOW PASS +2X	Adds two terms to low pass filter.
OVER TEMP NC	Selects a normally closed overheat sensor in motor.
CABLE TEST	Enables test of encoder signals and cabling.
Z TEST HIST	History plot of Z channel test data.
SCALE FACT/X	If set to 1, the scale ratio is interpreted as divided by X; where X depends on bits SCALE/X LO and SCALE/X HI.
INVIS AXIS	Used to create an invisible axis.
ROT ALM LMSW	Rotary alarms at the limit switch.
ROT TRVL LIM	Rotary travel limits are used.
UNDEFINED	
UNDEFINED	
UNDEFINED	
TORQUE ONLY	For HAAS only.

3 EREV/MREV	For HAAS only.
2 EREV/MREV	For HAAS only.
UNDEFINED	
BRUSH MOTOR	Enables the brushless motor option.
LINEAR DISPL	This bit changes the display from degrees to inches (or millimeters) on the A and B axes.
SCALE/X LO	With SCALE/X HI bit, determines the scale factor used in bit SCALE FACT/X,
SCALE/X HI	With SCALE/X LO bit, determines the scale factor used in bit SCALE FACT/X. See below:

HI	LO	
0	0	3
0	1	5
1	0	7
1	1	9

Parameter 2 X P GAIN
Proportional gain in servo loop.

Parameter 3 X D GAIN
Derivative gain in servo loop.

Parameter 4 X I GAIN
Integral gain in servo loop.

Parameter 5 X RATIO (STEPS/UNIT)
The number of steps of the encoder per unit of travel. Encoder steps supply four times their line count per revolution. Thus a 2000 line en coder and a 6mm pitch screw give:
2000 x 4 x 25.4 / 6 = 33867

Parameter 6 X MAX TRAVEL (STEPS)
Max negative direction of travel from machine zero in encoder steps. Does not apply to A-axis. Thus a 20 inch travel and 2000 line encoder and 6 mm pitch screw give:
20.0 x 33867 = 677340

Parameter 7 X ACCELERATION
Maximum acceleration of axis in steps per second per second.

Parameter 8 X MAX SPEED
Max speed for this axis in steps per second.

Parameter 9 X MAX ERROR
Max error allowed in servo loop before alarm is generated. Units are encoder steps.

Parameter 10 X FUSE LEVEL
Fuse level in % of max power to motor. Applies only when motor in motion.

Parameter	11	X	BACK EMF Back EMF of motor in volts per 1000 RPM times 10. Thus a 63 volt/ KRPM motor gives 630.
Parameter	12	X	STEPS/REVOLUTION Encoder steps per revolution of motor. Thus a 2000 line encoder gives: **2000 x 4 = 8000**.
Parameter	13	X	BACKLASH Backlash correction in encoder steps.
Parameter	14	X	DEAD ZONE Dead zone correction for driver electronics. Units are 0.0000001 seconds.
Parameter	15	Y	SWITCHES See Parameter 1 for description.
Parameter	16	Y	P GAIN See Parameter 2 for description.
Parameter	17	Y	D GAIN See Parameter 3 for description.
Parameter	18	Y	I GAIN See Parameter 4 for description.
Parameter	19	Y	RATIO (STEPS/UNIT) See Parameter 5 for description.
Parameter	20	Y	MAX TRAVEL (STEPS) See Parameter 6 for description.
Parameter	21	Y	ACCELERATION See Parameter 7 for description.
Parameter	22	Y	MAX SPEED See Parameter 8 for description.
Parameter	23	Y	MAX ERROR See Parameter 9 for description.
Parameter	24	Y	FUSE LEVEL See Parameter 10 for description.
Parameter	25	Y	BACK EMF See Parameter 11 for description.
Parameter	26	Y	STEPS/REVOLUTION See Parameter 12 for description.

Parameter	27	Y	BACKLASH See Parameter 13 for description.
Parameter	28	Y	DEAD ZONE See Parameter 14 for description.
Parameter	29	Z	SWITCHES See Parameter 1 for description.
Parameter	30	Z	P GAIN See Parameter 2 for description.
Parameter	31	Z	D GAIN See Parameter 3 for description.
Parameter	32	Z	I GAIN See Parameter 4 for description.
Parameter	33	Z	RATIO (STEPS/UNIT) See Parameter 5 for description.
Parameter	34	Z	MAX TRAVEL (STEPS) See Parameter 6 for description.
Parameter	35	Z	ACCELERATION See Parameter 7 for description.
Parameter	36	Z	MAX SPEED See Parameter 8 for description.
Parameter	37	Z	MAX ERROR See Parameter 9 for description.
Parameter	38	Z	FUSE LEVEL See Parameter 10 for description.
Parameter	39	Z	BACK EMF See Parameter 11 for description.
Parameter	40	Z	STEPS/REVOLUTION See Parameter 12 for description.
Parameter	41	Z	BACKLASH See Parameter 13 for description.
Parameter	42	Z	DEAD ZONE See Parameter 14 for description.

Parameter 43 A SWITCHES
See Parameter 1 for description AND make sure that this parameter is set to enable the fourth axis before you try to enable the fourth axis from settings.

Parameter 44 A P GAIN
See Parameter 2 for description.

Parameter 45 A D GAIN
See Parameter 3 for description.

Parameter 46 A I GAIN
See Parameter 4 for description.

Parameter 47 A RATIO (STEPS/UNIT)
See Parameter 5 for description.

Parameter 48 A MAX TRAVEL (STEPS)
See Parameter 6 for description.

Parameter 49 A ACCELERATION
See Parameter 7 for description.

Parameter 50 A MAX SPEED
See Parameter 8 for description.

Parameter 51 A MAX ERROR
See Parameter 9 for description.

Parameter 52 A FUSE LEVEL
See Parameter 10 for description.

Parameter 53 A BACK EMF
See Parameter 11 for description.

Parameter 54 A STEPS/REVOLUTION
See Parameter 12 for description

Parameter 55 A BACKLASH
See Parameter 13 for description.

Parameter 56 A DEAD ZONE
See Parameter 14 for description.

Parameters 57 through 128 are used to control other machine dependent functions. They are:

Parameter 57 COMMON SWITCH 1
Parameter 57 is a collection of general purpose single bit flags used to turn some functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

REV CRANK	Reverses direction of jog handle.
DISABLE T.C.	Disables tool changer operations.
DISABLE G.B.	Disables gear box functions.
POF AT E-STP	Causes power off at EMERGENCY STOP.
RIGID TAP	Indicates hardware option for rigid tap.
REV SPIN ENC	Reverses sense direction of spindle encoder.
REPT RIG TAP	Selects repeatable rigid tapping.
EX ST MD CHG	Selects exact stop in moves when mode changes.
SAFETY CIRC.	This enables safety hardware, if machine is so equipped.
SP DR LIN AC	Selects linear deceleration for rigid tapping. 0 is quadratic.
PH LOSS DET	When enabled, will detect a phase loss.
COOLANT SPGT	Enables coolant spigot control and display.
OVER T IS NC	Selects control over temp sensor as N.C.
SKIP OVERSHT	Causes Skip (G31) to act like Fanuc and overshoot sense point.
NONINV SP ST	Non-inverted spindle stopped status.
SP LOAD MONI	Spindle load monitor option is enabled.
SP TEMP MONI	Spindle temperature monitor option is enabled.
ENA ROT & SC	Enables rotation and scaling.
ENABLE DNC	Enables DNC selection from MDI.
ENABLE BGEDT	Enables BACKGROUND EDIT mode.
ENA GRND FLT	Enables ground fault detector.
KEYBD SHIFT	Enables use of keyboard with shift functions.
ENABLE MACRO	Enables macro functions.
SPIN COOLANT	Enables spindle low oil pressure detection.
INVERT SKIP	Invert sense of skip to active low=closed.
HANDLE CURSR	Enable use of jog handle to move cursor.
NEG WORK OFS	Selects use of work offsets in negative direction.
ENA CONVERSE	Enables conversational programming.
OILER ON/OFF	Enables oiler power when servos or spindle is in motion.
NC OVER VOLT	Inverts sense of over voltage signal.
ALT CHAR SET	Enables alternate character set on CRT.
DOOR STOP SP	Enables functions to stop spindle and manual ops at door switch.

Parameter 58 LEAD COMPENS SHIFT
Shift factor when applying lead screw compensation. Lead screw compensation is based on a table of 256 offsets; each +\-127 encoder steps. A single entry in the table applies over a distance equal to two raised to this parameter power encoder steps.

Parameter 59 MAX FEED RATE (INCH)
Maximum feed rate in inches per minute.

Parameter 60 TURRET START DELAY
Maximum delay allowed in start of tool turret. Units are milliseconds. After this time, an alarm is generated.

Parameter 61 TURRET STOP DELAY
Maximum delay allowed in motion of tool turret. Units are milliseconds. After this time, an alarm is generated.

Parameter 62 SHUTTLE START DELAY
Maximum delay allowed in start of tool shuttle. Units are milliseconds. After this time, an alarm is generated.

Parameter 63 SHUTTLE STOP DELAY
Maximum delay allowed in motion of tool shuttle. Units are milliseconds. After this time, an alarm is generated.

Parameter 64 Z TOOL CHANGE OFFSET
For Z-axis; displacement from home switch down to tool change position and machine zero. About 4.6 inches so for a 2000 line encoder this gives:
4.6 x 33867 = 155788

Parameter 65 NUMBER OF TOOLS
Number of tool positions in tool changer. This number must be 20 for the present VMC configuration.

Parameter 66 SPINDLE ORI DELAY
Maximum delay allowed when orienting spindle. Units are milliseconds. After this time, an alarm is generated.

Parameter 67 GEAR CHANGE DELAY
Maximum delay allowed when changing gears. Units are milliseconds. After this time, an alarm is generated.

Parameter 68 DRAW BAR MAX DELAY
Maximum delay allowed when clamping and unclamping tool. Units are milliseconds. After this, time an alarm is generated.

Parameter 69 A AIR BRAKE DELAY
Delay provided for air to release from brake on A-axis prior to moving. Units are milliseconds.

Parameter 70 MIN SPIN DELAY TIME
Minimum delay time in program after commanding new spindle speed and before proceeding. Units are milliseconds.

Parameter 71 DRAW BAR OFFSET
Offset provided in motion of Z-axis to accommodate the tool pushing out of the spindle when unclamping tool. Units are encoder steps.

Parameter 72 DRAW BAR Z VEL UNCL
Speed of motion in Z-axis to accommodate tool pushing out of the spindle when unclamping tool. Units are encoder steps per second.

Parameter 73 SP HIGH G/MIN SPEED
Command speed used to rotate spindle motor when orienting spindle in high gear. Units are 5000/256 RPM.

Parameter 74 SP LOW G/MIN SPEED
Command speed used to rotate spindle motor when orienting spindle in low gear. Units are 5000/256 RPM.

Parameter 75 GEAR CHANGE SPEED
Command speed used to rotate spindle motor when changing gears. Units are 5000/256RPM.

Parameter 76 LOW AIR DELAY
Delay allowed after sensing low air pressure before alarm is generated. Alarm skipped if air pressure returns before delay. Units are 1/50 seconds.

Parameter 77 SP LOCK SETTLE TIME
Required time in milliseconds that the spindle lock must be in place and stable before spindle orientation is considered complete.

Parameter 78 GEAR CH REV TIME
Time in milliseconds before motor direction is reversed while in a gear change.

Parameter 79 SPINDLE STEPS/REV
Sets the number of encoder steps per revolution of the spindle. Applies only to rigid tapping option.

Parameter 80 MAX SPIN DELAY TIME
The maximum delay time control will wait for spindle to get to commanded speed or to get to zero speed. Units are milliseconds.

Parameter 81 M MACRO CALL O9000
M code that will call O9000. Zero causes no call.

Parameter 82 M MACRO CALL O9001 same as 81
Parameter 83 M MACRO CALL O9002 same as 81
Parameter 84 M MACRO CALL O9003 same as 81
Parameter 85 M MACRO CALL O9004 same as 81
Parameter 86 M MACRO CALL O9005 same as 81
Parameter 87 M MACRO CALL O9006 same as 81
Parameter 88 M MACRO CALL O9007 same as 81
Parameter 89 M MACRO CALL O9008 same as 81
Parameter 90 M MACRO CALL O9009 same as 81
Parameter 91 G MACRO CALL O9010
G code that will call O9010. Zero causes no call.

Parameter 92 G MACRO CALL O9011 same as 91
Parameter 93 G MACRO CALL O9012 same as 91
Parameter 94 G MACRO CALL O9013 same as 91
Parameter 95 G MACRO CALL O9014 same as 91
Parameter 96 G MACRO CALL O9015 same as 91
Parameter 97 G MACRO CALL O9016 same as 91
Parameter 98 G MACRO CALL O9017 same as 91
Parameter 99 G MACRO CALL O9018 same as 91

Parameter 100 G MACRO CALL O9019 same as 91

Parameter 101 IN POSITION LIMIT X
How close motor must be to endpoint before any move is considered complete when not in exact stop (G09 or G61). Units are encoder steps.

Parameter 102 IN POSITION LIMIT Y
Same definition as Parameter 101.

Parameter 103 IN POSITION LIMIT Z
Same definition as Parameter 101.

Parameter 104 IN POSITION LIMIT A
Same definition as Parameter 101.

Parameter 105 X MAX CURRENT
Fuse level in % of max power to motor. Applies only when motor is stopped.

Parameter 106 Y MAX CURRENT
Same definition as Parameter 105.

Parameter 107 Z MAX CURRENT
Same definition as Parameter 105.

Parameter 108 A MAX CURRENT
Same definition as Parameter 105.

Parameter 109 D*D GAIN FOR X
Second derivative gain in servo loop.

Parameter 110 D*D GAIN FOR Y
Second derivative gain in servo loop.

Parameter 111 D*D GAIN FOR Z
Second derivative gain in servo loop.

Parameter 112 D*D GAIN FOR A
Second derivative gain in servo loop.

Parameter 113 X ACC/DEC T CONST
Exponential acceleration time constant. Units are 1/10000 seconds. This pa rameter provides for a constant ratio between profiling lag and servo velocity. It is also the ratio between velocity and acceleration. In conjunction with Param eter 7, it defines the speed above which exponential accel/decel is not provided. Thus if Parameter 7 is 1200000 steps/sec/sec and this parameter is 750 (0.075 seconds); the maximum velocity for accurate interpolation should be:

1200000 x 0.075 = 90000 steps/second

For a 2000 line encoder and 6 mm screw, this would be 60 x 90000 / 33867 = 159 inches min

Parameter 114 Y ACC/DEC T CONST
Same definition as Parameter 113

Parameter 115 Z ACC/DEC T CONST
Same definition as Parameter 113

Parameter 116 A ACC/DEC T CONST
Same definition as Parameter 113

Parameter 117 LUB CYCLE TIME
If this is set nonzero, it is the cycle time for the lube pump and the Lube pressure switch option is checked for cycling in this time. It is in units of 1/50 seconds.

Parameter 118 SPINDLE REV TIME
Time in milliseconds to reverse spindle motor.

Parameter 119 SPINDLE DECEL DELAY
Time in milliseconds to decelerate spindle motor.

Parameter 120 SPINDLE ACC/DECEL
Accel/decel time constant in steps/ms/ms for spindle motor.

Parameter 121 X PHASE OFFSET
The motor phase offset for **X** motor. This is arbitrary units.

Parameter 122 Y PHASE OFFSET
See Parameter 121 for description.

Parameter 123 Z PHASE OFFSET
See Parameter 121 for description.

Parameter 124 A PHASE OFFSET
See Parameter 121 for description.

Parameter 125 X GRID OFFSET
This parameter shifts the effective position of the encoder **Z** pulse. It can correct for a positioning error of the motor or home switch.

Parameter 126 Y GRID OFFSET
See Parameter 125 for description.

Parameter 127 Z GRID OFFSET
See Parameter 125 for description.

Parameter 128 A GRID OFFSET
See Parameter 125 for description.

Parameter 129 GEAR CH SETTLE TIME
Gear change settle time. This is the number of one millisecond samples that the gear status must be stable before considered in gear.

Parameter 130 GEAR STROKE DELAY
This parameter controls the delay time to the gear change solenoids when performing a gear change.

Parameter 131 MAX SPINDLE RPM
This is the maximum RPM available to the spindle. When this speed is programmed, the D-to-A output will be +10V and the spindle drive must be calibrated to provide this.

Parameter 132 SPIN. Y TEMP. COEF.
This parameter controls the amount of correction to the Y-axis in response to heating of the spindle head. It is 10 times the number of encoder steps per degree F.

Parameter 133 SPIN. Z TEMP. COEF.
This parameter controls the amount of correction to the Z-axis in response to heating of the spindle head. It is 10 times the number of encoder steps per degree F.

Parameter 134 X EXACT STOP DIST.
Parameter 135 Y EXACT STOP DIST.
Parameter 136 Z EXACT STOP DIST.
Parameter 137 A EXACT STOP DIST.
These parameters control how close each axis must be to its end point when exact stop is programmed. They apply only in G09 and G64. They are in units of encoder steps. A value of 34 would give 34/33867 = 0.001 inch.

Parameter 138 X FRICTION FACTOR
Parameter 139 Y FRICTION FACTOR
Parameter 140 Z FRICTION FACTOR
Parameter 141 A FRICTION FACTOR
These parameters compensate for friction on each of the four axes. The units are in 0.004V.

Parameter 142 HIGH/LOW GEAR CHANG
This parameter sets the spindle speed at which an automatic gear change is performed. Below this parameter, low gear is the default; above this, high gear is the default.

Parameter 143 DRAW BAR Z VEL CLMP
This parameter sets the speed of the Z-axis motion that compensates for tool motion during tool clamping. Units are in encoder steps per second.

Parameter 144 RIG TAP FINISH DIST
This parameter sets the finish tolerance for determining the end point of a rigid tapping operation.

Parameter 145 X ACCEL FEED FORWARD
This parameter sets the feed forward gain for the X-axis servo. It has no units.

Parameter 146 Y ACCEL FEED FORWARD
Same as Parameter 145.

Parameter 147 Z ACCEL FEED FORWARD
Same as Parameter 145.

Parameter 148 A ACCEL FEED FORWARD
Same as Parameter 145.

Parameter 149 PRE-CHARGE DELAY
This parameter sets the delay time from pre-charge to tool release. Units are milliseconds.

Parameter 150 MAX SP RPM LOW GEAR
Max spindle RPM in low gear.

Parameter 151 B SWITCHES
See Parameter 1 for description.

Parameter 152 B P GAIN
See Parameter 2 for description.

Parameter 153 B D GAIN
See Parameter 3 for description.

Parameter 154 B I GAIN
See Parameter 4 for description.

Parameter 155 B RATIO (STEPS/UNIT)
See Parameter 5 for description.

Parameter 156 B MAX TRAVEL (STEPS)
See Parameter 6 for description.

Parameter 157 B ACCELERATION
See Parameter 7 for description.

Parameter 158 B MAX SPEED
See Parameter 8 for description.

Parameter 159 B MAX ERROR
See Parameter 9 for description.

Parameter 160 B FUSE LEVEL
See Parameter 10 for description.

Parameter 161 B BACK EMF
See Parameter 11 for description.

Parameter 162 B STEPS/REVOLUTION
See Parameter 12 for description.

Parameter 163 B BACKLASH
See Parameter 13 for description.

Parameter 164 B DEAD ZONE
See Parameter 14 for description.

Parameter 165 IN POSITION LIMIT B
Same definition as Parameter 101.

Parameter 166 B MAX CURRENT
Same definition as Parameter 105.

Parameter 167 D*D GAIN FOR B
Second derivative gain in servo loop.

Parameter 168 B ACC/DEC T CONST
Same definition as Parameter 113.

Parameter 169 B PHASE OFFSET
See Parameter 121 for description.

Parameter 170 B GRID OFFSET
See Parameter 125 for description.

Parameter 171 B EXACT STOP DIST.
See Parameters 134 for description.

Parameter 172 B FRICTION FACTOR
See Parameter 138 for description.

Parameter 173 B ACCEL FEED FORWARD
Same description as Parameter 145.

Parameter 174 SPINDLE B TEMP. COEF.
This parameter controls the amount of correction to the B-axis in response to heating of the spindle head. It is 10 times the number of encoder steps per degree F.

Parameter 175 B AIR BRAKE DELAY
Delay provided for air to release from brake on B-axis prior to moving. Units are milliseconds.

Parameter 201 X SPINDLE TEMP. COEF.
This parameter controls the amount of correction to the X-axis in response to heating of the spindle head. It is 10 times the number of encoder steps per degree F.

Parameter 202 X AIR BRAKE DELAY
This parameter is not used.

Parameter 203 Y AIR BRAKE DELAY
This parameter is not used.

Parameter 204 Z AIR BRAKE DELAY
This parameter is not used.

Parameter 205 A SPINDLE TEMP. COEF.
This parameter controls the amount of correction to the A-axis in response to heating of the spindle head. It is 10 times the number of encoder steps per degree F.

Parameter 206 SPIGOT POSITIONS
Maximum number of spigot positions.

Parameter 207 SPIGOT TIMEOUT (MS)
Maximum timeout allowed for spigot to traverse one spigot location.

Parameter 208 SPIN. FAN OFF DELAY
Delay for turning the spindle fan off after the spindle has been turned off.

Parameter 209 COMMON SWITCH 2
Parameter 209 is a collection of general purpose single bit flags used to turn some functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

HORZ T.C. Enables tool changer for horizontal machining centers (HS models only).
RST STOPS T.C. Tool changer can be stopped with RESET button.
M21-28 @ 540 When enabled (1), M21-M28 is installed at cable 540.
ENA CONVEYOR Enables chip conveyor, if machine is so equipped.

50% RPD KBD When (1) the control will support the new style keyboards with the 50% rapid traverse key. For controls without a 50% rapid keypad set this bit to (0).

FRONT DOOR When enabled the control will look for an additional door switch and will generate an operator message.

TC Z NO HOME In Horizontal mills only. This bit prevents Z-axis motion to machine zero prior to a tool change.

M36 AUTO MOT READY In Horizontal only. When set to (1), an M36 rotates the A-axis after the PART button is pressed.

AUX AXIS TC In Horizontal mills only. When enabled, means the tool changer carousel is driven by an aux. axis.

SPIGOT KEY INV When (1) the commands to the conveyor motor are reversed so that forward becomes reverse. If the conveyor is wired incorrectly, this bit can be set so that the conveyor runs in the proper direction.

T SUBROUTINE	Reserved for future use.
SPIN Y ENCDR	For Lathe only. When enabled, spindle encoder input is to the Y-axis.
REV CONVEYOR	Reverses the direction of the chip conveyor.
M27-M28 CONVYR	Usually the chip conveyor motor and direction relays are attached to the user relays M21 M22. When this bit is set, the control expects to see the conveyor hooked up to M27 and M28.
LOPH A ONLY	When (0) three discrete inputs are used to detect power phase loss. When (1) only LOPH A is used to detect phase loss.
GREEN BEACON	When (1) user relay M25 is used to flash a beacon. If the control is in a reset state, the beacon will be off. If the control is running normally, the beacon will be steadily on. If the control is in a M00, M01, M02, M30 feedhold, or single block state, then the beacon will flash.
RED BEACON	When (1) user relay M26 is used to flash a beacon. The beacon flashes if the control is experiencing an alarm or emergency stop condition.
CONVY DR OVRD	When (1) the conveyor will continue to run with the door open. When (0) the conveyor will stop when the door is open, but will resume when the door is closed. For safety it is recommended that the bit be set to (0).
DSBL CLNT IN	If set to 1 low coolant input will not be used.
DSC INP PR	Discrete pallet rotate/part ready; inputs enabled if set to 1.
RMT TOOLS RLS	If set to 1, allows use of remote tool release button on spindle head.
FLOPPY ENABL	If set to 1, enables the optional floppy drive.
TCR KEYPAD	If set to 1, enables tool changer restore button on keypad.
MCD RLY BRD	If set to 1, adds 8 additional relays, for a total of 40.
TSC ENABLE	When set to 1, “DSBL CLNT IN” bit is ignored, and TSC will operate. When set to zero, the control functions normally.
AUX JOG NACC	Does not allow accumulation on auxiliary axis jog.
ALISM PRGRST	Alias M codes during program restart.
DSBL JOG TST	Disables the encoder test for the jog handle.
AIR DR @ M24	On horizontal mill, air door uses M24. When set to zero, air door output is M23 and pallet ready light is at output K19.
ACC FEED LIM	Setting 85 limits feed in circles.
SPNDL NOWAIT	When (1), the machine will not wait for the spindle to come up to speed imme diately after an M03 or M04 command. Instead, it will check and/or wait for the spindle to come up to speed immediately before the next interpolated motion is initiated. This bit does not affect rigid tapping or the TSC option.
UNDEFINED	

Parameter 210 X TOOL CHANGE OFFSET
For X-axis; displacement from home switch to tool change position and ma chine zero. About 4.6 inches so for a 2000 line encoder this gives:
4.6 x 33867 = 155788

Parameter 211 Y TOOL CHANGE OFFSET
For Y-axis; displacement from home switch to tool change position and ma chine zero. About 4.6 inches so for a 2000 line encoder this gives:
4.6 x 33867 = 155788

Parameter 212 A TOOL CHANGE OFFSET
For A-axis; displacement from home switch to tool change position and ma chine zero. About 4.6 inches so for a 2000 line encoder this gives:
4.6 x 33867 = 155788

Parameter 213 B TOOL CHANGE OFFSET
For B-axis; displacement from home switch to tool change position and ma chine zero. About 4.6 inches so for a 2000 line encoder this gives:
4.6 x 33867 = 155788

Parameter 214 RESERVED

Parameter 215 CAROUSEL OFFSET
Parameter used to align tool 1 of tool changing carousel precisely. Units are encoder steps.

Parameter 216 CNVYR RELAY DELAY
Delay time in 1/50 seconds required on conveyor relays before another action can be commanded. Default is 5.

Parameter 217 CNVYR IGNORE OC TIM
Amount of time in 1/50 seconds before overcurrent is checked after conveyor motor is turned on. Default is 50.

Parameter 218 CONVYR RETRY REV TIM
Amount of time that the conveyor is reversed in 1/50 seconds after overcurrent is sensed. Default is 200.

Parameter 219 CONVYR RETRY LIMIT
Number of times that the conveyor will cycle through the reverse/forward sequencing when an overcurrent is sensed before the conveyor will shut down. An overcurrent is sensed when chips jam the conveyor. By reversing and then forwarding the conveyor, the chip jam may be broken. Default is 3.

Parameter 220 CONVYR RETRY TIMEOUT
Amount of time in 1/50 seconds between consectutive overcurrents in which the overcurrents is considered another retry. If this amount of time passes between overcurrents then the retry count is set to (0). Default is 1500, 30 minutes.

Parameter 221 MAX TIME NO DISPLAY
The maximum time (in 1/50 sec.) between screen updates.

Parameter 222 ROTARY AXIS INCRMNT
For Horizontal mills only. This parameter sets the degrees of rotation of the A-axis at an M36 or Pallet Rotate.

Parameter 223 AIR TC DOOR DELAY
For Horizontal mills only. This parameter sets the delay to open the tool changer door (in milliseconds). If the tool changer does not have a pneumatic door, this parameter is set to zero.

Parameter 224 ROT AXIS ZERO OFSET
This parameter shifts the zero point of A for a wheel fixture or tombstone.

Parameter 225 MAX ROT AXIS ALLOW
For Horizontal mills with a wheel fixture only. This parameter sets the maximum rotation (in degrees) allowed before stopping at front door.

Parameter 226 RESERVED

Parameter 227 FLOPPY DIR NAME
This parameter sets the program numbers to store in the floppy directory.

Parameter 228 QUICKCODE FILE
This parameter set the program numbers to store in the Quickcode definition.

Parameter 229 X LEAD COMP 10E9
This parameter sets the X-axis lead screw compensation signed parts per billion.

Parameter 230 Y LEAD COMP 10E9
This parameter sets the Y-axis lead screw compensation signed parts per billion.

Parameter 231 Z LEAD COMP 10E9
This parameter sets the Z-axis lead screw compensation signed parts per billion.

Parameter 232 A LEAD COMP 10E9
This parameter sets the A-axis lead screw compensation signed parts per billion.

Parameter 233 B LEAD COMP 10E9
This parameter sets the B-axis lead screw compensation signed parts per billion.

Parameter 235 TSC PISTON SEAT
With the TSC option, the amount of time given for the piston to seat during system start-up. The default is 1500 milliseconds.

Parameter 236 TSC CLNT STABILIZE
With the TSC option, the amount of time given for the coolant to stabilize during system start-up. The default is 4000 milliseconds.

Parameter 237 TSC CLNT LINE PURGE
The amount of time given for the coolant to purge when the TSC system is shut off. The default is 5000 milliseconds.

Parameter 238 MAX TSC SPINDLE RPM
When Through the Spindle Coolant (TSC) is enabled and in use, this parameter limits the maximum spindle speed.

Parameter 239 SPNDL ENC STEPS/REV
This parameter sets the number of encoder steps per revolution of the spindle encoder.

Parameter 240 C AXIS MAX TRAVEL
This parameter sets the C-axis maximum travel in the positive direction, scaled by the default axis.

Parameter 241 U AXIS MAX TRAVEL
This parameter sets the U-axis maximum travel in the positive direction, scaled by the default axis.

Parameter 242 V AXIS MAX TRAVEL
This parameter sets the V-axis maximum travel in the positive direction, scaled by the default axis.

Parameter 243 W AXIS MAX TRAVEL
This parameter sets the W-axis maximum travel in the positive direction, scaled by the default axis.

Parameter 244 C AXIS MIN TRAVEL
This parameter sets the C-axis minimum travel in the negative direction, scaled by the default axis.

Parameter 245 U AXIS MIN TRAVEL
This parameter sets the U-axis minimum travel in the negative direction, scaled by the default axis.

Parameter 246 V AXIS MIN TRAVEL
This parameter sets the V-axis minimum travel in the negative direction, scaled by the default axis.

Parameter 247 W AXIS MIN TRAVEL
This parameter sets the W-axis minimum travel in the negative direction, scaled by the default axis.

20.1 Lead Screw Compensation

Separate lead screw compensation is provided for each of the **X**, **Y**, and **Z** axes. The operator-entered compensation values are spaced at 0.5 inch intervals within the machine coordinate system. The compensation values are entered in inches with a resolution of 0.0001 inch. The operator entered values are used to interpolate into a table of 256 entries. The spacing between two entries in the table of 256 is defined by Parameter 58. The entered values are limited to +/-127 encoder steps; so the limit in inches is dependent on Parameters 5, 19, and 33.

Note that the first entry corresponds to machine position zero and subsequent entries are for increasingly negative positions in the machine coordinate system. The user should not ever need to adjust the lead screw compensation tables.

MAINTENANCE SCHEDULE FOR THE VF-SERIES MILL

The following is a list of required regular maintenance for the HAAS VF Series Vertical Machining Centers. Listed are the frequency of service, capacities, and type of fluids required. These required specifications must be followed in order to keep your machine in good working order and protect your warranty.

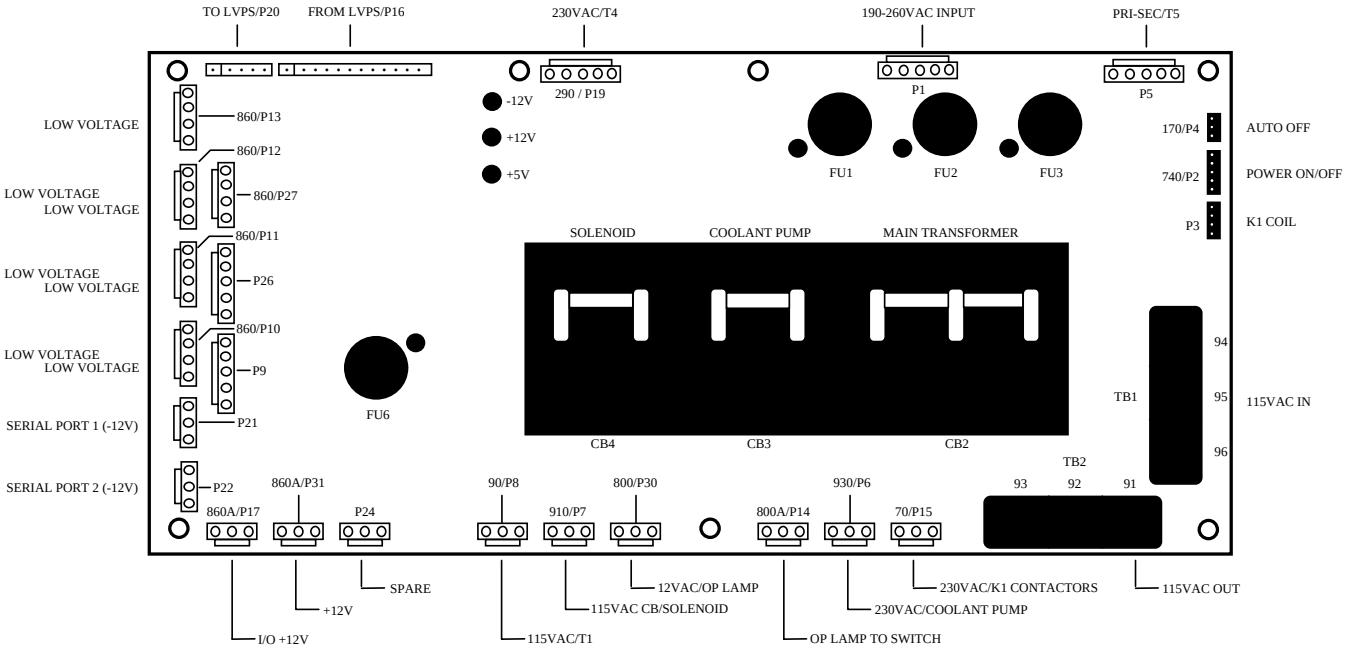
INTERVAL	MAINTENANCE PERFORMED
DAILY	☐ Check coolant level. ☐ Check way lube lubrication tank level. ☐ Clean chips from way covers and bottom pan. ☐ Clean chips from tool changer. ☐ Wipe spindle taper with a clean cloth rag and apply light oil.
WEEKLY	☐ Check Through the Spindle Coolant (TSC) filters. Clean or replace element if needed. ☐ Check automatic dump air line's water trap for proper operation. ☐ On machines with the TSC option, clean the chip basket on the coolant tank. Remove the tank cover and remove any sediment inside the tank. Be careful to disconnect the coolant pump from the controller and POWER OFF the control before working on the coolant tank. Do this MONTHLY for machines without the TSC option. ☐ Check air gauge/regulator for 85 psi. ☐ For machines with the TSC option, place a dab of grease on the V-flange of tools. Do this MONTHLY for machines without the TSC option. ☐ Check aluminum air filters on control heat exchanger and at top of spindle motor. ☐ Clean exterior surfaces with mild cleaner. DO NOT use solvents. ☐ Check the hydraulic counterbalance pressure according to the machine's specifications.
MONTHLY	☐ Inspect way covers for proper operation and lubricate with light oil, if necessary. ☐ Dump the oil drain bucket. ☐ Place a dab of grease on the outside edge of the Geneva wheel star and guide rails of the tool changer and run through all tools.
SIX MONTHS	☐ Replace coolant and thoroughly clean the coolant tank. ☐ Check oil level in gear box by adding oil until it begins dripping from the drain tube. ☐ Check all hoses and lubrication lines for cracking. ☐ On machines with TSC option, check drawbar height every 6 months or after 1000 hrs of use. Replace coolant tip if drawbar height is more than .010" out of spec.
ANNUALLY	☐ With the air pressure OFF, disassemble and clean the small filter at end of lubricator (left side of machine). ☐ Replace the gearbox oil. Drain the oil from the bottom of the gearbox. Slowly refill with oil until it overflows at bottom of the gearbox reservoir. ☐ Check oil filter and clean out residue at bottom of filter.

SYSTEM:	WAY LUBE AND PNEUMATICS	TRANSMISSION	COOLANT TANK

LUBRICATION CHART FOR THE VF-SERIES MILL

LOCATION	**Under the control panel at the rear of the machine**	**Above the spindle head**	**Side of machine**
DESCRIPTION	**Piston pump with 30-minute cycle time. Pump is only on when spindle is turning or when axis is moving.**		
LUBRICATES	**Linear guides and ball nuts**	**Transmission only**	
QUANTITY	**1-QT. Tank**	**2-QT. Tank**	**40 gallons**
LUBRICANT	**Mobil Vactra #2**	**Mobil DTE 25**	**Water soluble, synthetic**

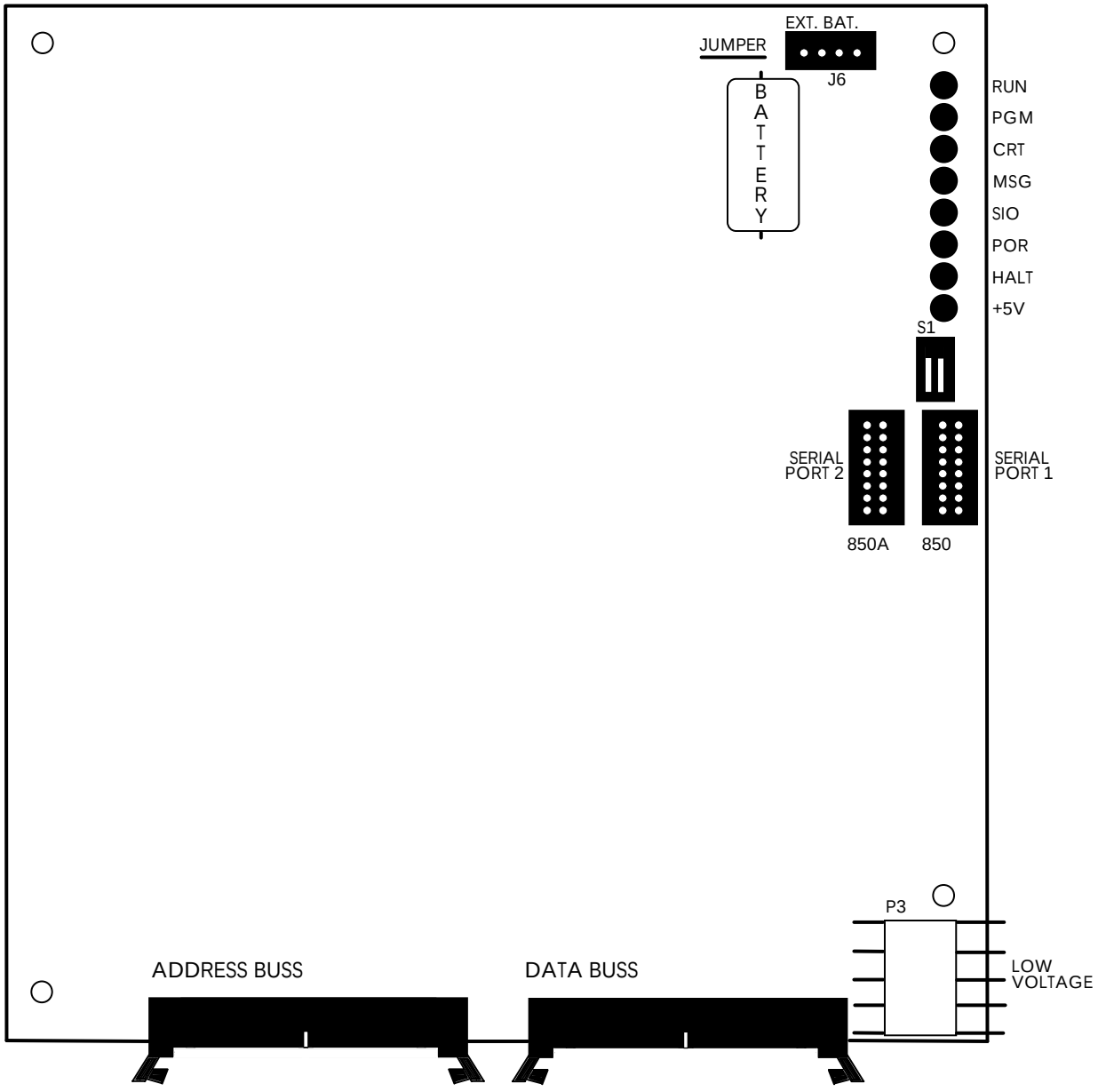
PCB'S
CABLE LOCATIONS
AND
BOARD DIAGRAMS



POWER PCB 32-5010

POWER PCB 32-5010
CABLE CONNECTIONS

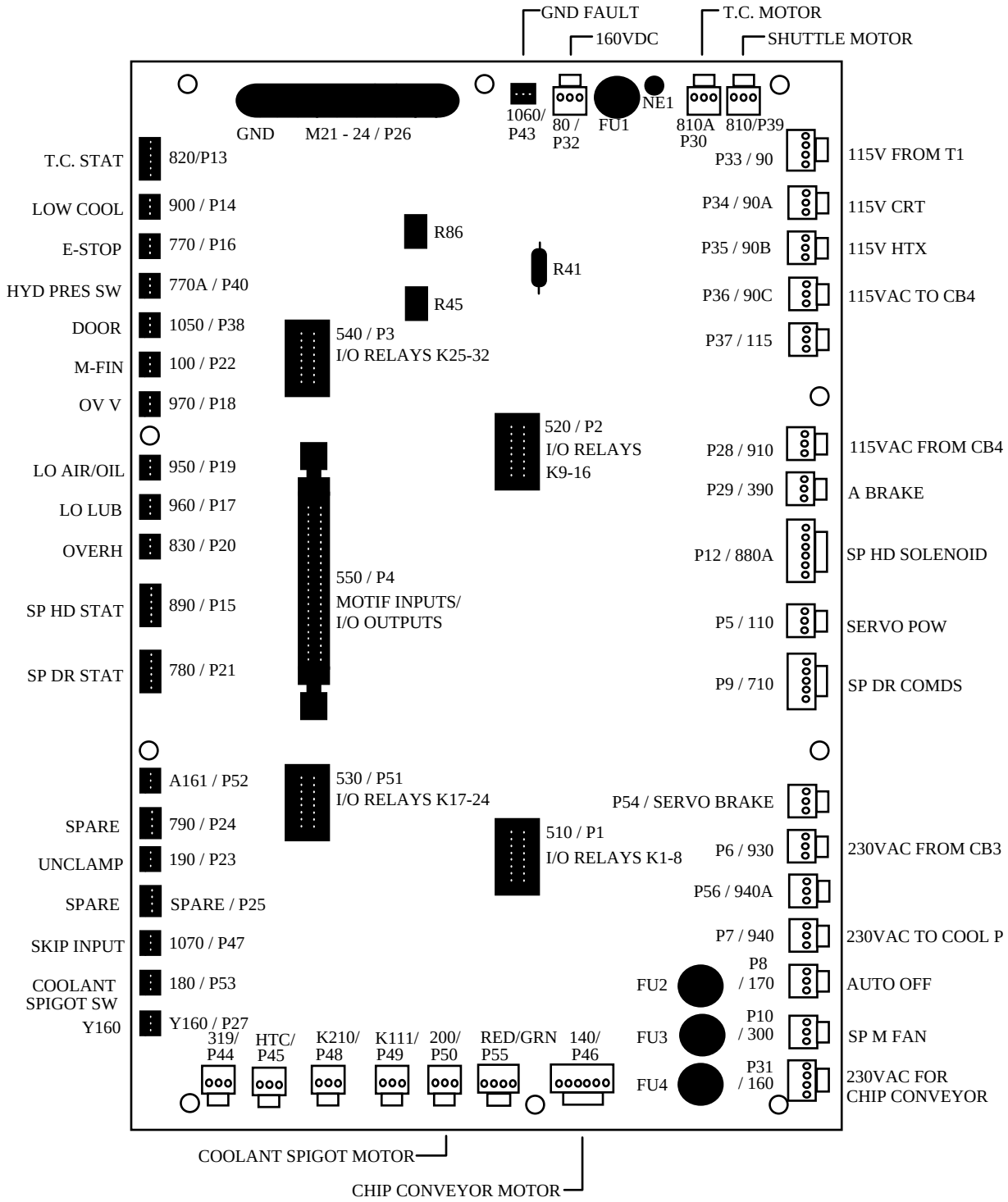
POWER PLUG#	CABLE#	SIGNAL NAME	→ TO:	LOCATION	PLUG#
P1	——-	190-260VAC INPUT	→ TO:	CB1	——-
P3	——-	K1 COIL	→ TO:	K1 CONTACTOR	——-
P4	170	AUTO OFF	→ TO:	I/O PCB	P8
P5	PRI-SEC	PRI-SEC/T5	→ TO:	T5	——-
P6	930	230VAC/COOLANT PUMP	→ TO:	I/O PCB	P6
P7	910	115VAC CB/SOLENOID	→ TO:	I/O PCB	P28
P8	90	115VAC/T1	→ TO:	I/O PCB	P36
P9	860	LOW VOLTAGE	→ TO:	POWER	——-
P10	860	LOW VOLTAGE	→ TO:	POWER	——-
P11	860	LOW VOLTAGE	→ TO:	POWER	——-
P12	860	LOW VOLTAGE	→ TO:	POWER	——-
P13	860	LOW VOLTAGE	→ TO:	POWER	——-
P14	800A	OP LAMP TO SWITCH	→ TO:	OP LAMP SWITCH	——-
P15	70	230VAC/K1 CONTACTORS	→ TO:	K1 CONTACTOR	——-
P17	860A	I/O +12VDC	→ TO:	POWER	——-
P19	290	230VAC/T4	→ TO:	T4	——-
P21	PORT 1&2	-12VDC PORT 1 & 2	→ TO:	PROCESSOR PCB	P3
P22	——-	-12VDC	→ TO:	——-	——-
P24	SPARE	SPARE	→ TO:	SPARE	N/A
P26	860	LOW VOLTAGE	→ TO:	POWER	——-
P27	860	LOW VOLTAGE	→ TO:	POWER	——-
P30	800	12VAC/OP LAMP	→ TO:	OPERATORS LAMP	——-
P31	860A	+12VDC	→ TO:	POWER	——-
TB1	——-	115VAC IN	→ TO:	T1 - SECONDARY	——-
TB2	——-	115VAC OUT	→ TO:		
POWER ON/OFF		740 POWER ON/OFF	→ TO:	ON/OFF SWITCH	——-



MICRO PROCESSOR PCB 32-3090

MICRO PROCESSOR PCB 32-3090
CABLE CONNECTIONS

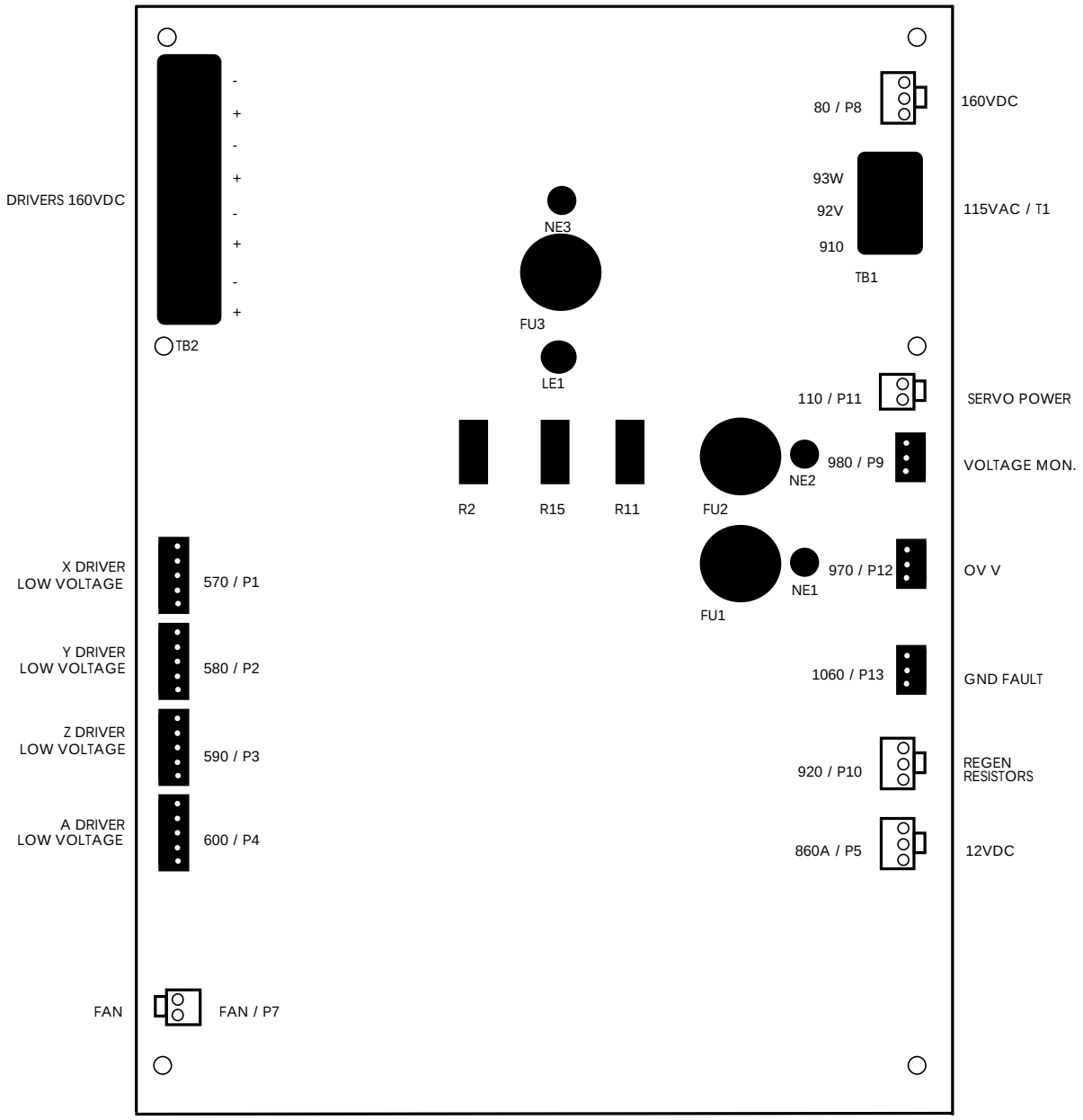
PROC. PLUG#	CABLE#	SIGNAL NAME	→TO:	LOCATION	PLUG#
ADDRESS		ADDRESS BUSS	→TO:	VIDEO PCB	——-
& DATA		DATA BUSS		MOTIF PCB	——-
P3	860	LOW VOLTAGE	→TO:	POWER SUPPLY PCB	——-
P6	N/A	EXTERNAL BATTERY	→TO:	(EXT. BATTERY)	——-
PORT 1	850	SERIAL PORT #1	→TO:	SERIAL PORT #1	——-
PORT 2	850A	SERIAL PORT #2	→TO:	SERIAL PORT #2	——-



I/O PCB 32-3080

I/O PCB 32-3080
CABLE CONNECTIONS

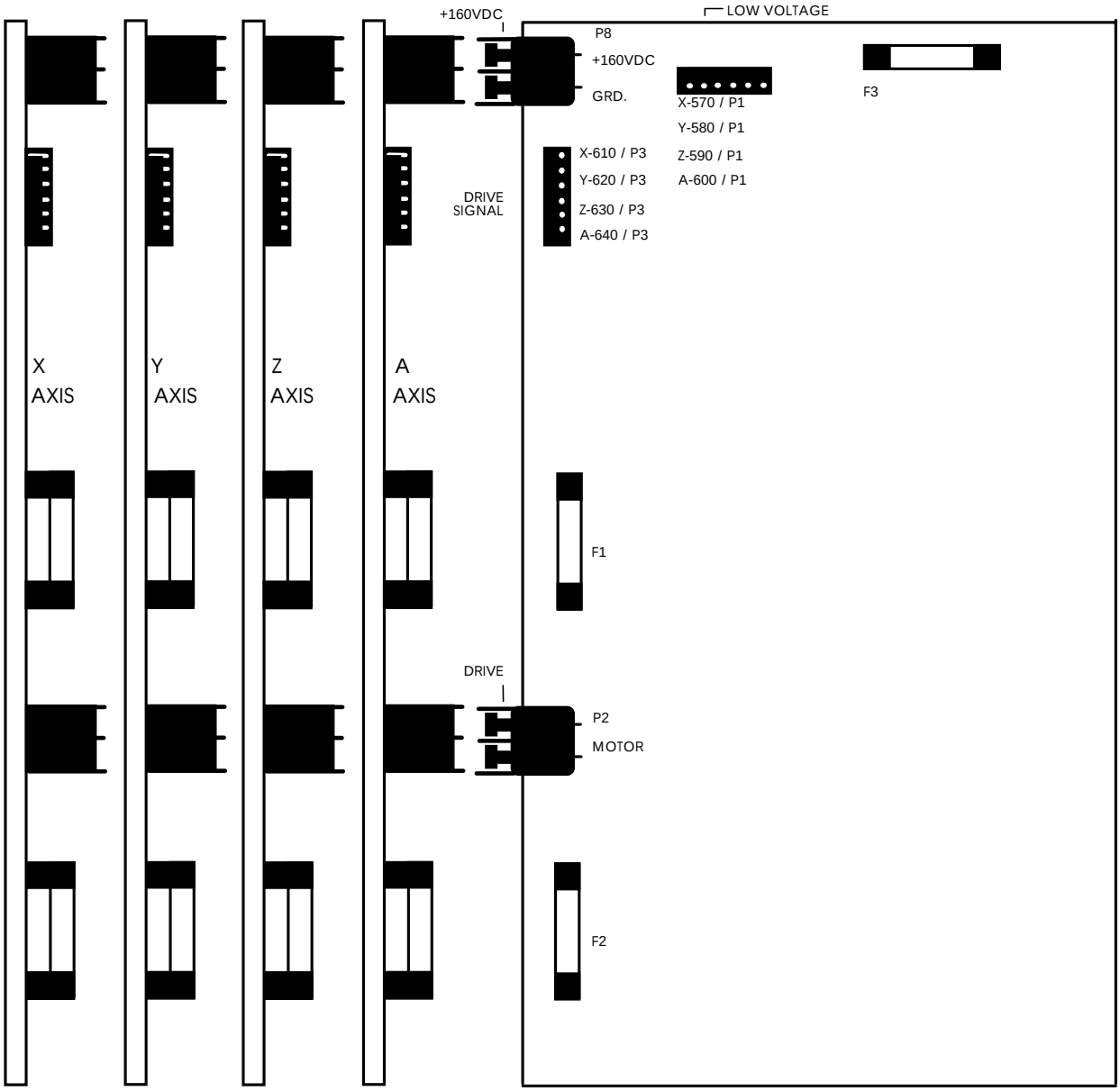
I/O PLUG#	CABLE#	→TO:	LOCATION	PLUG#
P1	510	→TO:	MOTIF PCB	P11
P2	520	→TO:	MOTIF PCB	P12
P3	540	→TO:	MOTIF PCB	P14
P4	550	→TO:	MOTIF PCB	P10
P5	110	→TO:	SDIST PCB	P11
P6	930	→TO:	POWER PCB	P6
P7	940	→TO:	COOL PUMP	——-
P8	170	→TO:	POWER PCB	P4
P9	710	→TO:	SPINDLE DRIVE	——-
P10	300	→TO:	SP.FAN/GEAR BOX	——-
P12	880A	→TO:	SPINDLE HEAD	——-
P13	820	→TO:	TOOL CHANGER	——-
P14	900	→TO:	COOLANT TANK	——-
P15	890	→TO:	SPINDLE HEAD	——-
P16	770	→TO:	E-STOP SWITCH	——-
P17	960	→TO:	AIR/OIL	——-
P18	970	→TO:	SDIST PCB	P12
P19	950	→TO:	AIR/OIL	——-
P20	830	→TO:	REGEN RESISTORS	——-
P21	780	→TO:	SPINDLE DRIVE	——-
P22	100	→TO:	(EXTERNAL)	——-
P23	190	→TO:	SHOT PIN	——-
P24	790	→TO:	SPARE	N/A
P25	SPARE	→TO:	SPARE	N/A
P26	M21-24	→TO:	(EXTERNAL)	——-
P28	910	→TO:	POWER PCB	P7
P27	Y160	→TO:	PT RDY SW	——-
P29	390	→TO:	(EXTERNAL)	——-
P30	810A	→TO:	SHUTTLE MOTOR	——-
P31	160	→TO:	230VAC	——-
P32	80	→TO:	SDIST PCB	P8
P33	90	→TO:	T1	——-
P34	90A	→TO:	CRT	——-
P35	90B	→TO:	FANS	——-
P36	90C	→TO:	POWER PCB	P8
P37	115	→TO:	SPARE	N/A
P38	1050	→TO:	DOOR SWITCH	——-
P39	810	→TO:	TURRET MOTOR	——-
P40	770A	→TO:	HYD PRESSURE TANK	——-
P43	1060	→TO:	SDIST PCB	P13
P44	319	→TO:	SPARE	N/A
P45	——-	→TO:	HTC	——-
P46	140	→TO:	CHIP CONVEYOR	——-
P47	1070	→TO:	(EXTERNAL)	——-
P48	K210	→TO:	SPARE	——-
P49	K111	→TO:	SPARE	——-
P50	200	→TO:	COOLANT TANK	——-
P51	530	→TO:	MOTIF PCB	P13
P52	A161	→TO:	SPARE	——-
P53	180	→TO:	COOLANT TANK	——-
P54	SERVO BRK	→TO:	(EXTERNAL)	——-
P55	——-	→TO:	RED/GREEN LTS	——-
P56	940A	→TO:		——-



SERVO DISTRIBUTION PCB 32-5020

SERVO DISTRIBUTION (SDIST)PCB 32-5020 CABLE CONNECTIONS

I/O PLUG#	CABLE#		→TO:	LOCATION	PLUG#
P1	570	X DRIVER LOW VOLTAGE	→TO:	X SERVO DRIVER	P1
P2	580	Y DRIVER LOW VOLTAGE	→TO:	Y SERVO DRIVER	P1
P3	590	Z DRIVER LOW VOLTAGE	→TO:	Z SERVO DRIVER	P1
P4	600	A DRIVER LOW VOLTAGE	→TO:	A SERVO DRIVER	P1
P5	860A	12VDC	→TO:	POWER SUPPLY PCB	——-
P7	FAN	FAN VOLTAGE	→TO:	FAN (SERVO)	——-
P8	80	160VDC	→TO:	I/O PCB	P32
P9	980	VOLTAGE MONITOR	→TO:	MOTIF PCB	P17
P10	920	REGEN RESISTORS	→TO:	REGEN RESISTORS	——-
P11	110	SERVO POWER	→TO:	I/O PCB	P5
P12	970	OV V	→TO:	I/O PCB	P18
P13	1060	GND FAULT	èTO:	I/O PCB	P43
TB1	N/A	115VAC FROM T1	èTO:	T1	——-
TB2	N/A	160VDC TO AMPS.	èTO:	SERVO DRIVERS	P8

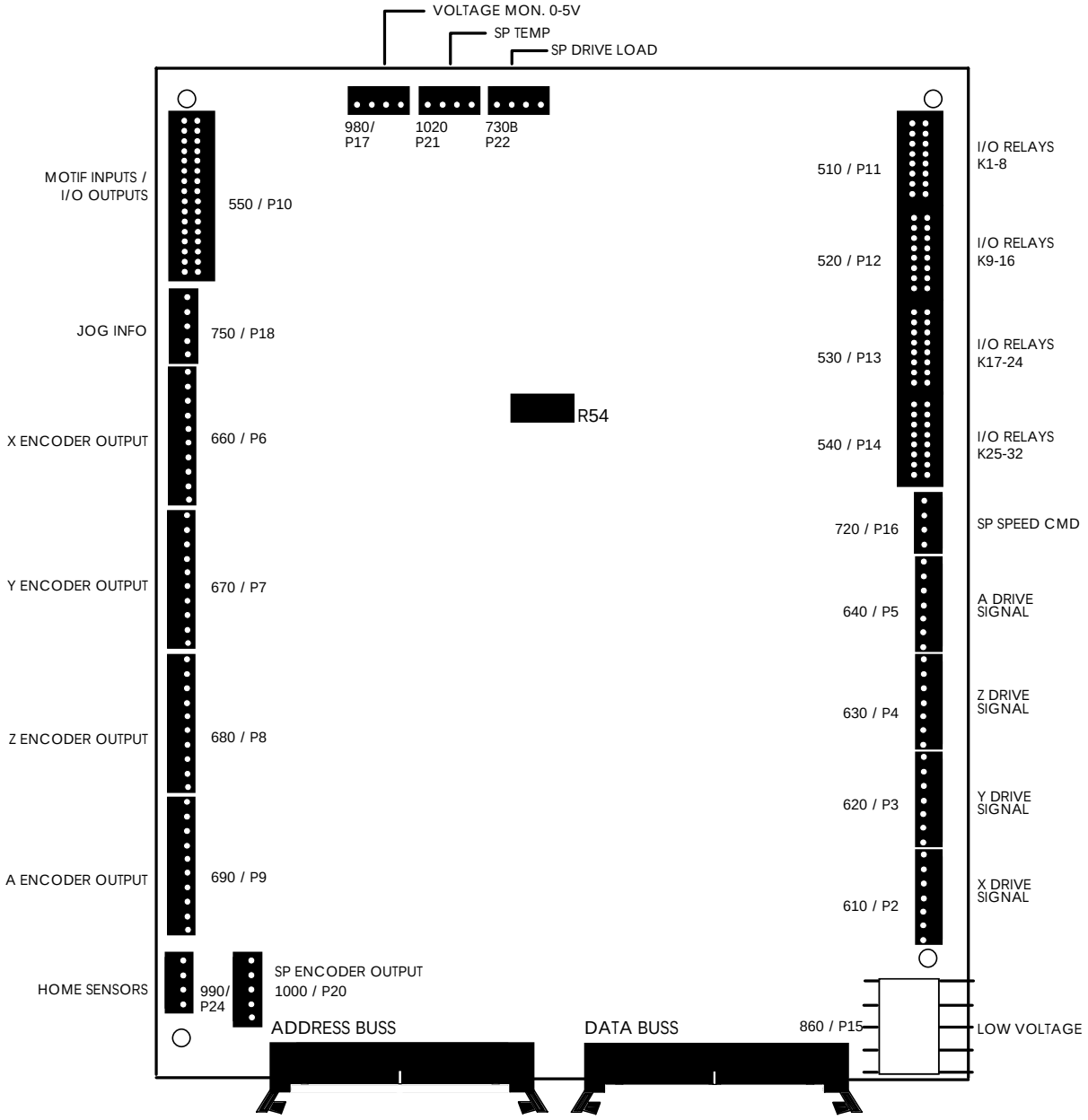


(SIDE VIEW)

SERVO DRIVER PCB's 32-4070

SERVO DRIVER PCB's 32-4070 CABLE CONNECTIONS

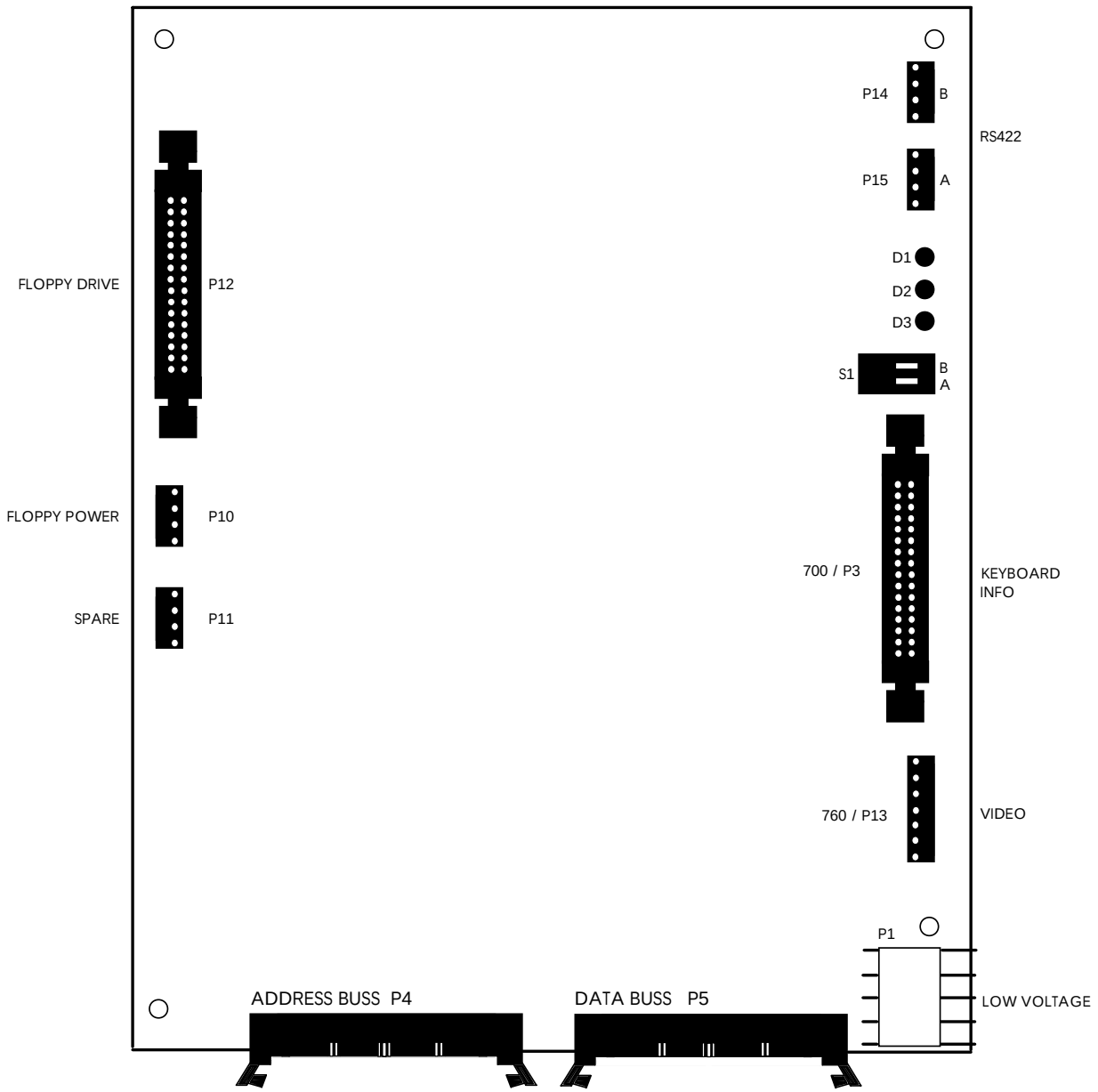
I/O PLUG#	CABLE#		→TO:	LOCATION	PLUG#
X AXIS					
P1	570	LOW VOLTAGE	→TO:	SDIST PCB	P1
P2	——-	MOTOR DRIVE	→TO:	X SERVO MOTOR	——-
P3	610	X DRIVE SIGNAL	→TO:	MOTIF PCB	P2
P8	——-	+160VDC	→TO:	SDIST PCB	TB2
Y AXIS					
P1	580	LOW VOLTAGE	→TO:	SDIST PCB	P2
P2	——-	MOTOR DRIVE	→TO:	Y SERVO MOTOR	——-
P3	620	X DRIVE SIGNAL	→TO:	MOTIF PCB	P3
P8	——-	+160VDC	→TO:	SDIST PCB	TB2
Z AXIS					
P1	590	LOW VOLTAGE	→TO:	SDIST PCB	P3
P2	——-	MOTOR DRIVE	→TO:	Z SERVO MOTOR	——-
P3	630	X DRIVE SIGNAL	→TO:	MOTIF PCB	P4
P8	——-	+160VDC	→TO:	SDIST PCB	TB2
A AXIS					
P1	600	LOW VOLTAGE	→TO:	SDIST PCB	P4
P2	——-	MOTOR DRIVE	→TO:	A SERVO MOTOR	——-
P3	640	X DRIVE SIGNAL	→TO:	MOTIF PCB	P5
P8	——-	+160VDC	→TO:	SDIST PCB	TB2



MOTIF PCB 32-4020

MOTIF PCB 32-4020
CABLE CONNECTIONS

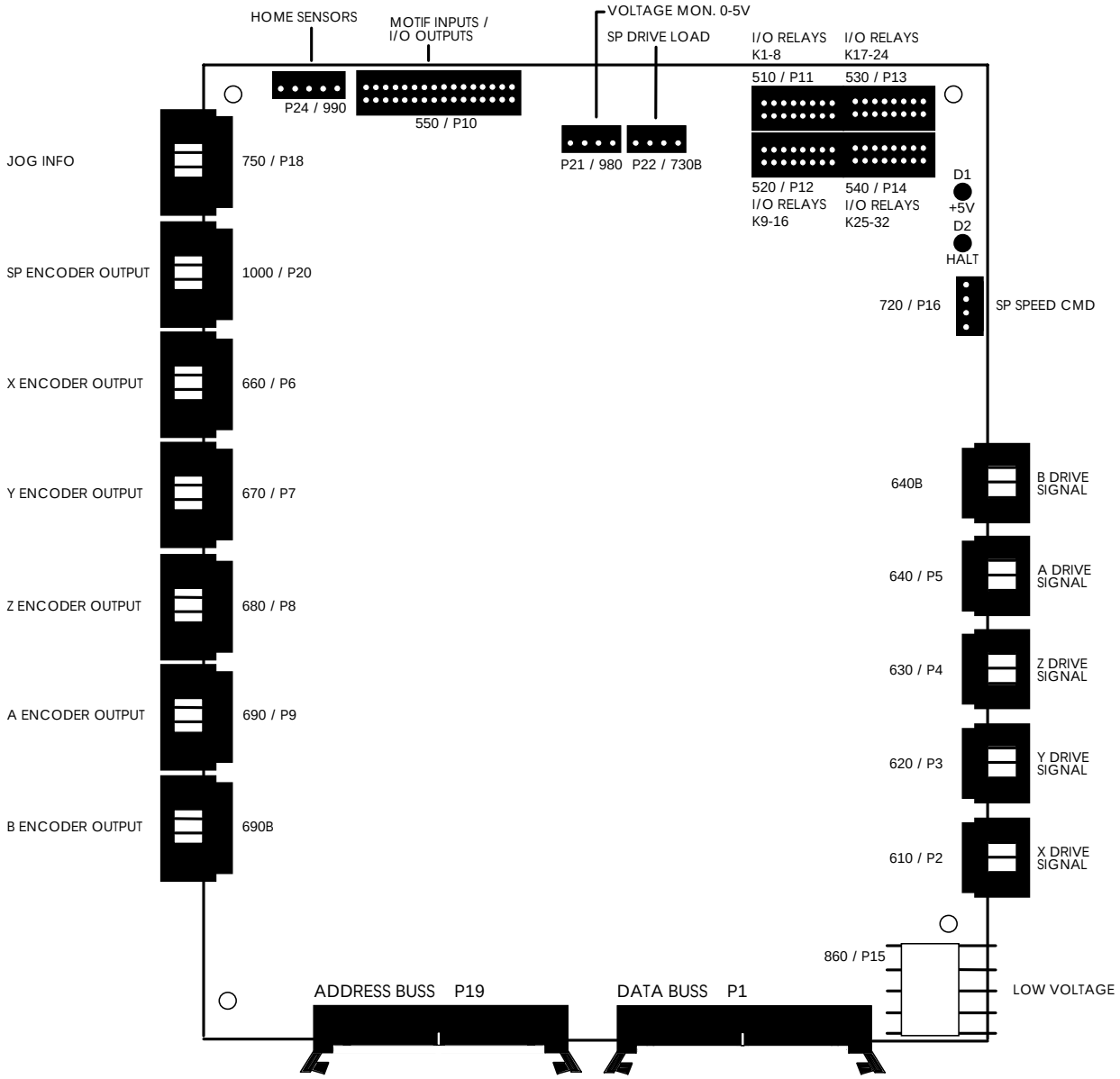
MOTIF PLUG#		CABLE#	→TO:	LOCATION	PLUG#
ADDRESS		ADDRESS BUSS	→TO:	VIDEO PCB	——-
& DATA		DATA BUSS		MICRO PROC. PCB	——-
P2	610	X DRIVE SIGNAL	→TO:	X SERVO DRIVE	P3
P3	620	Y DRIVE SIGNAL	→TO:	Y SERVO DRIVE	P3
P4	630	Z DRIVE SIGNAL	→TO:	Z SERVO DRIVE	P3
P5	640	A DRIVE SIGNAL	→TO:	A SERVO DRIVE	P3
P6	660	X ENCODER OUTPUT	→TO:	X ENCODER	——-
P7	670	Y ENCODER OUTPUT	→TO:	Y ENCODER	——-
P8	680	Z ENCODER OUTPUT	→TO:	Z ENCODER	——-
P9	690	A ENCODER OUTPUT	→TO:	A ENCODER	——-
P10	550	MOTIF INPUTS/I/O OUTPUTS	→TO:	I/O PCB	P4
P11	510	I/O RELAYS 1-8	→TO:	I/O PCB	P1
P12	520	I/O RELAYS 9-16	→TO:	I/O PCB	P2
P13	530	I/O RELAYS 17-24	→TO:	I/O PCB	P51
P14	540	I/O RELAYS 25-32	→TO:	I/O PCB	P3
P15	860	LOW VOLTAGE	→TO:	POWER SUPPLY PCB	——-
P16	720	SP. SPEED COMMAND	→TO:	SPINDLE DRIVE	——-
P17	980	VOLTAGE MONITOR	→TO:	SDIST PCB	P9
P18	750	JOG INFO.	→TO:	JOG HANDLE	——-
P20	1000	SP. ENCODER OUTPUT	→TO:	SPINDLE ENCODER	——-
P21	1020	SP. TEMP	→TO:	SPINDLE	——-
P22	730B	SP. DRIVE LOAD	→TO:	SPINDLE DRIVE	——-
P24	990	HOME SENSORS	→TO:	X, Y & Z LIMIT SW.	——-



VIDEO & KEYBOARD PCB 32-3201

VIDEO & KEYBOARD PCB 32-3201 WITH FLOPPY DRIVE CABLE CONNECTIONS

VIDEO PLUG#	CABLE#		→TO:	LOCATION	PLUG#
P1	860	LOW VOLTAGE	→TO:	POWER SUPPLY PCB	——-
P3	700	KEYBOARD INFO.	→TO:	KEYBOARD INT.	——-
P4	——-	ADDRESS BUSS	→TO:	MICRO PROC.PCB	——-
P5	——-	DATA BUSS		MOTIF PCB	——-
P10	——-	FLOPPY DR. POWER	→TO:	FLOPPY DRIVE	——-
P11	——-	SPARE	→TO:	N/A	N/A
P12	——-	FLOPPY DR. SIGNAL	→TO:	FLOPPY DRIVE	——-
P13	760	VIDEO SIGNAL	→TO:	CRT	——-
P14	——-	RS422 B	→TO:	N/A	N/A
P15	——-	RS422 A	→TO:	N/A	N/A

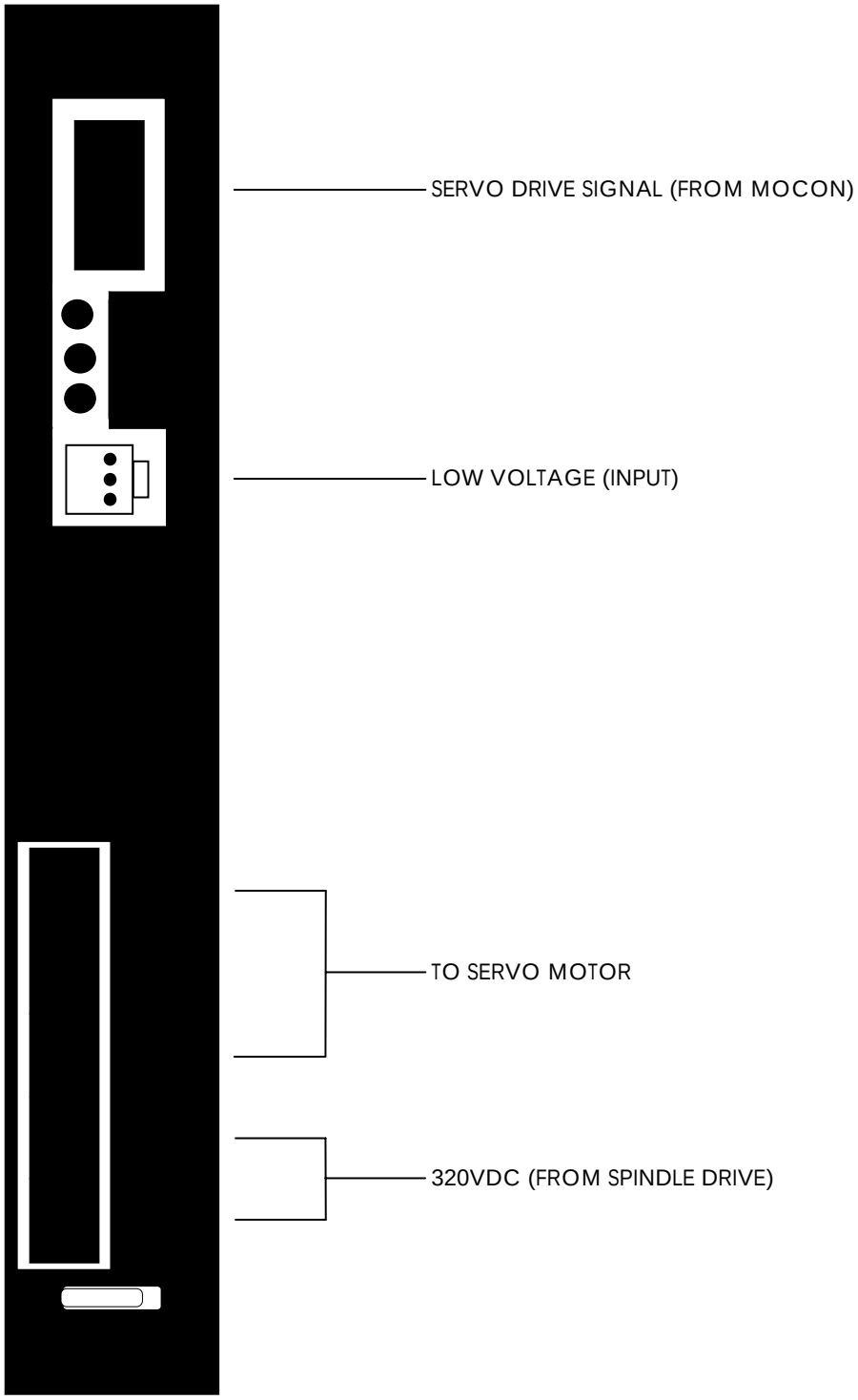


MOCON PCB 32-4023 C

MOCON PCB 32-4023 C
CABLE CONNECTIONS

MOCON

PLUG#	CABLE	SIGNAL NAME	→TO:	LOCATION	PLUG#
P1		DATA BUSS	→TO:	VIDEO PCB	——-
			→TO:	MICRO PROC. PCB	——-
P2	610	X DRIVE SIGNAL	→TO:	X SERVO DRIVE AMP.	P
P3	620	Y DRIVE SIGNAL	→TO:	Y SERVO DRIVE AMP.	P
P4	630	Z DRIVE SIGNAL	→TO:	Z SERVO DRIVE AMP.	P
P5	640	A DRIVE SIGNAL	→TO:	A SERVO DRIVE AMP.	P
	640B	B DRIVE SIGNAL	→TO:	B SERVO DRIVE AMP.	P
P6	660	X ENCODER OUTPUT	→TO:	X ENCODER	——-
P7	670	Y ENCODER OUTPUT	→TO:	Y ENCODER	——-
P8	680	Z ENCODER OUTPUT	→TO:	Z ENCODER	——-
P9	690	A ENCODER OUTPUT	→TO:	A ENCODER	——-
	690B	B ENCODER OUTPUT	→TO:	B ENCODER	——-
P10	550	MOTIF INPUTS/			
		I/O OUTPUTS	→TO:	I/O PCB	P4
P11	510	I/O RELAYS 1-8	→TO:	I/O PCB	P1
P12	520	I/O RELAYS 9-16	→TO:	I/O PCB	P2
P13	530	I/O RELAYS 17-24	→TO:	I/O PCB	P51
P14	540	I/O RELAYS 25-32	→TO:	I/O PCB	P3
P15	860	LOW VOLTAGE	→TO:	POWER SUPPLY PCB	——-
P16	720	SP. SPEED COMMAND	→TO:	SPINDLE DRIVE	——-
P18	750	JOG INFO	→TO:	JOG HANDLE	——-
P19		ADDRESS BUSS	→TO:	VIDEO PCB	——-
			→TO:	MICRO PROC. PCB	——-
P20	1000	SP. ENCODER OUTPUT	→TO:	SPINDLE ENCODER	——-
P21	980	VOLTAGE MONITOR	→TO:	N/A	N/A
P22	730B	SP. DRIVE LOAD	→TO:	SPINDLE DRIVE	——-
P24	990	HOME SENSORS	→TO:	X, Y & Z LIMIT	——-

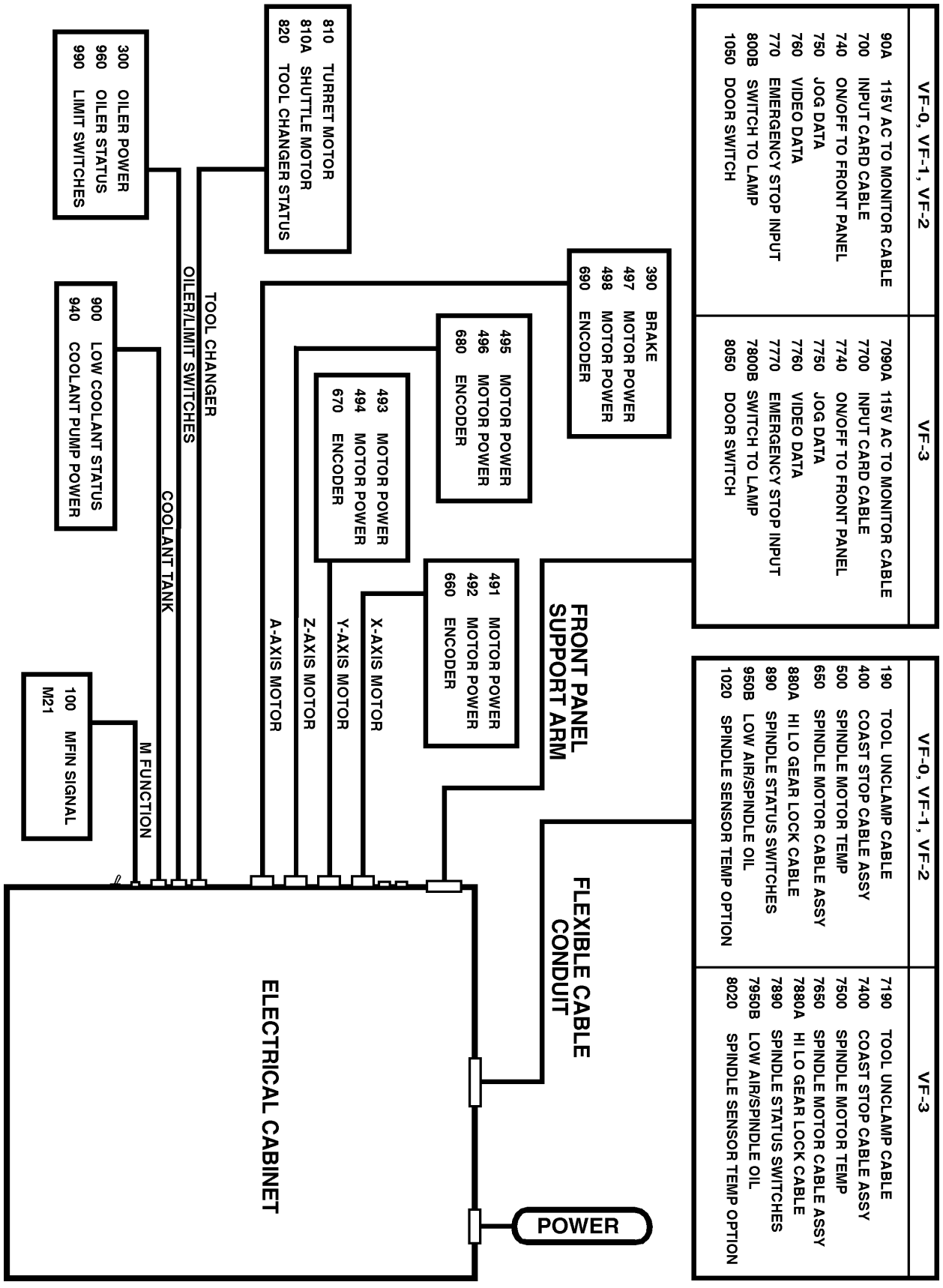


BRUSHLESS SERVO AMPLIFIER 32-5550

BRUSHLESS SERVO AMPLIFIER 32-5550 (REV C) CABLE CONNECTIONS

DRIVER PLUG#	CABLE #	SIGNAL NAME	→TO:	LOCATION	PLUG#
X AXIS AMP					
P	570	LOW VOLTAGE	→TO:	L. V. POWER SUPPLY	——-
TB A, B, C	——-	MOTOR DRIVE	→TO:	X SERVO MOTOR	——-
P	610	X DRIVE SIGNAL	→TO:	MOCON PCB	P2
TB -HV +HV	——-	320VDC	→TO:	SPINDLE DRIVE	——-
Y AXIS AMP					
P	580	LOW VOLTAGE	→TO:	L. V. POWER SUPPLY	——-
TB A, B, C	——-	MOTOR DRIVE	→TO:	X SERVO MOTOR	——-
P	620	X DRIVE SIGNAL	→TO:	MOCON PCB	P3
TB -HV +HV	——-	320VDC	→TO:	SPINDLE DRIVE	——-
Z AXIS AMP					
P	590	LOW VOLTAGE	→TO:	L. V. POWER SUPPLY	——-
TB A, B, C	——-	MOTOR DRIVE	→TO:	X SERVO MOTOR	——-
P	630	X DRIVE SIGNAL	→TO:	MOCON PCB	P4
TB -HV +HV	——-	320VDC	→TO:	SPINDLE DRIVE	——-
A AXIS AMP					
P	600	LOW VOLTAGE	→TO:	L. V. POWER SUPPLY	——-
TB A, B, C	——-	MOTOR DRIVE	→TO:	X SERVO MOTOR	——-
P	640	X DRIVE SIGNAL	→TO:	MOCON PCB	P5
TB -HV +HV	——-	320VDC	→TO:	SPINDLE DRIVE	——-

CABLE LOCATION DIAGRAM



CABLE LIST

The following is a summary of the cables used in the wiring of this control:

WIRE/ TERMINAL NUMBER	FUNCTION NAME:
GND	INCOMING EARTH GROUND #8 -FROM INCOMING POWER GROUND -TO CHASSIS GROUND -TO 160 VDC RETURN -TO SHIELD OF ALL BULK CABLES -TO LOGIC RETURN (D GROUND 65)
L1	INCOMING 230VAC, PHASE 1, TO CB1-1 #10
L2	INCOMING 230VAC, PHASE 2, TO CB1-2 #10
L3	INCOMING 230VAC, PHASE 3, TO CB1-3 #10
L4	230VAC, PHASE 1, CB1 TO K1-1 #10
L5	230VAC, PHASE 2, CB1 TO K1-2 #10
L6	230VAC, PHASE 3, CB1 TO K1-3 #10
R/L7	230VAC FROM K1 TO SPINDLE DRIVE, PHASE 1 #10
S/L8	230VAC FROM K1 TO SPINDLE DRIVE, PHASE 2 #10
T/L9	230VAC FROM K1 TO SPINDLE DRIVE, PHASE 3 #10
71/L4	FUSED 230 VAC (FROM MAIN CB1-4 TO K1-1) #10
72/L5	FUSED 230 VAC (FROM MAIN CB1-5 TO K1-2) #10
73/L6	FUSED 230 VAC (FROM MAIN CB1-6 TO K1-3) #10
74/R	230 VAC (FROM MAIN CONTACTOR K1-4) #12
75/S	230 VAC (FROM MAIN CONTACTOR K1-5) #12
76/T	230 VAC (FROM MAIN CONTACTOR K1-6) #12
77	230VAC FUSED 12A TO 3 PH XFORMER T1 #12
78	230VAC FUSED 12A TO 3 PH XFORMER T1 #12
79	230VAC FUSED 12A TO 3 PH XFORMER T1 #12
80	DISTRIBUTED 160 VDC - SHIELD +2
81	+160 VDC HIGH VOLTAGE SUPPLY #16
82	160 VDC RETURN #16
90	115 VAC FROM TRANSFORMER T1
91/U	STEPPED-DOWN 115 VAC (FROM XFRMER T1) #12
92/V	STEPPED-DOWN 115 VAC (FROM XFRMER T1) #12
93/W	STEPPED-DOWN 115 VAC (FROM XFRMER T1) #12
90A	115 VAC TO CRT - SHIELD +2
92	LEG 1 #16

93 LEG 2 #16

90B 115 VAC TO HEAT EXCHANGER - SHIELD +2
91 LEG 1 #16
93 LEG 2 #16

90C 115 VAC TO CB4 - SHIELD +2
91 LEG 1 #16
92 LEG 2 #16

100 M-FIN (IOASM TO SIDE OF BOX)
101 LEG 1 #16
102 LEG 2 #16

110 SERVO POWER CONTROL - SHIELD +2
111 GROUND RETURN
112 RELAY DRIVER SINKS 12VDC TO GROUND

120 CHIP CONVEYOR COMMAND CABLE SHIELD +4 #20
(REMOVED IN REV J IOPCB)

130 OVERCURRENT SENSE FROM CHIP CONVEYOR
(REMOVED IN REV J IOPCB)

140 230VAC 3PH POWER TO CHIP CONVEYOR MOTOR (5 +SHIELD)
141 PHASE A 230VAC
142 PHASE B 230VAC
143 PHASE C 230VAC
144 STARTING WINDING 230VAC
145 STARTING WINDING 230VAC

140A 230VAC 3PH POWER IN CONDUIT TO CHIP CONVEYOR

150 12VDC TO CHIP CONVEYOR CONTROL PCB
(REMOVED IN REV J IOPCB)

160 3PH 230VAC TO CHIP CONVEYOR CONTROLLER
161 PHASE A 230VAC
162 PHASE B 230VAC
163 PHASE C 230VAC

170 AUTO OFF FUNCTION - SHIELD +2
172 RELAY 1-7 COMMON (C7) ; AUTO OFF
173 RELAY 1-7 N.O.

180 COOLANT SPIGOT DETENT SWITCH
181 SIGNAL
182 COMMON

190 UNCLAMP FROM SPINDLE HEAD TO IOASM
191 INPUT 25

192 DIGITAL RETURN

200 COOLANT SPIGOT MOTOR (12VDC)
201 MOTOR +
202 MOTOR -

210 DATA CABLE TO 3" FLOPPY DISK DRIVE (40 PINS)

220 SERVO BRAKE 115VAC - SHIELD +2
221 115VAC COMMON
222 115VAC SWITCHED

230 5'th AXIS BRAKE - SHIELD +2
231 115VAC COMMON
232 115VAC SWITCHED

240 SPARE INPUTS FROM IOPCB P25
241 COMMON
242 SPARE 3
243 SPARE 4

250 HORIZONTAL TOOL CHANGER SHUTTLE VALVE - SHIELD +2
251 COMMON 115VAC
252 SWITCHED 115VAC

260 K210 CABLING FOR EC

270 K111 CABLING FOR EC

280 RED/GREEN STATUS LIGHT WIRING
281 RED LAMP 115VAC
282 GREEN LAMP 115VAC
283 COMMON 115VAC

290 230VAC TO TRANSFORMER T2 (deleted 1-Aug-90)

300 115VAC TO SPINDLE MOTOR FAN/OIL PUMP/OILER
301 LEG 1 115VAC FUSED AT 3 A #18
302 LEG 2 115VAC FUSED AT 3 A #18

310 SOLENOIDS OUTPUT TO HORIZONTAL PALLET CHANGER
311 115VAC COMMON
312 UNSCREW
313 SCREW
314 DB DOWN
315 PALLET UP
316 PALLET CW
317 PALLET CCW

320 SWITCH INPUTS FROM HORIZONTAL PALLET CHANGER

321 SWITCHES COMMON
322 DB DOWN
323 PALLET UP
324 PALLET DOWN
325 PALLET CW
326 PALLET CCW
327 SCREW IN *
328 FIXTURE CLAMPED *

330 230V 3PH FROM CB6 TO K2 (LATHE HYDRAULICS)
331
332
333

340 230V 3PH FROM K2 TO HYDRAULIC PUMP (LATHE)
341
342
343

350 SERVO BRAKE RELEASE 115VAC - SHIELD +2
351 LEG 1 COMMON
352 LEG 2 SWITCHED

360-389 RESERVED

390 115VAC TO 4'TH AXIS BRAKE (LATHE PART DOOR) - SHIELD +2
391 LEG 1 #18
392 LEG 2 SWITCHED #18

400 SPINDLE DRIVE COAST COMMAND - SHIELD +2
401 LOGIC COMMON #20
402 SPINDLE COAST COMMAND #20

410-483 reserved

490 ALL WIRES CARRYING SERVO MOTOR DRIVE POWER (all #14)
491 X-AXIS FUSED MOTOR POWER + (P1-E)
492 X-AXIS FUSED MOTOR POWER - (P1-F)
493 Y-AXIS FUSED MOTOR POWER + (P2-E) (LATHE T.S)
494 Y-AXIS FUSED MOTOR POWER - (P2-F) (LATHE T.S)
495 Z-AXIS FUSED MOTOR POWER + (P3-E)
496 Z-AXIS FUSED MOTOR POWER - (P3-F)
497 A-AXIS FUSED MOTOR POWER + (P4-E)
498 A-AXIS FUSED MOTOR POWER - (P4-F)

500 OVERTEMP SENSOR FROM SPINDLE MOTOR - SHIELD +2
501 OVERTEMP WIRE 1 #20 (N.C.)
502 OVERTEMP WIRE 2 #20

510 RELAY CARD 1 DRIVE CABLE - 16 WIRE RIBBON #24

520 RELAY CARD 2 DRIVE CABLE - 16 WIRE RIBBON #24

530 RELAY CARD 3 DRIVE CABLE - 16 WIRE RIBBON #24

540 RELAY CARD 4 DRIVE CABLE - 16 WIRE RIBBON #24

550 INPUTS CARD CABLE (MOTIF-P10) 34 WIRE RIBBON #24

560 TO MICROPROCESSOR P8 (REMOVED NOV-94)
561 -12V FROM 862 AT SUPPLY TO P8-1 #24
562 Gnd FROM 865 AT SUPPLY TO P8-4 #24

570 X AXIS DRIVER LOW VOLTAGE POWER - 6 WIRE RIBBON
571 14 VAC LEG 1 (DRIVER P2-1 #24
572 14 VAC LEG 2 (DRIVER P2-2 #24
573 16 VAC LEG 1 (DRIVER P2-3 #24
574 16 VAC LEG 2 (DRIVER P2-4 #24
575 CHASSIS GROUND (DRIVER P2-5 #24
576 CHASSIS GROUND (DRIVER P2-6 #24

580 Y AXIS DRIVER LOW VOLTAGE POWER (LATHE T.S)
(SAME AS 571 to 576)

590 Z AXIS DRIVER LOW VOLTAGE POWER
(SAME AS 571 to 576)

600 A AXIS DRIVER LOW VOLTAGE POWER
(SAME AS 571 to 576)

610 X AXIS DRIVER CONTROL CABLE - SHIELD +6
611 LOW ENABLE* (MOTIF P2-1) #24
612 HIGH ENABLE* (MOTIF P2-2) #24
613 DRIVE DIRECTION (MOTIF P2-3) #24
614 +5 VDC (MOTIF P2-4) #24
615 OVERCURRENT SIGNAL (MOTIF P2-5) #24
616 LOGIC RETURN (MOTIF P2-6) #24

620 Y AXIS DRIVER CONTROL CABLE - SHIELD +6 (LATHE T.S)
(SAME AS 611-616)

630 Z AXIS DRIVER CONTROL CABLE - SHIELD +6
(SAME AS 611-616)

640 A AXIS DRIVER CONTROL CABLE - SHIELD +6
(SAME AS 611-616)

650 THREE PHASE POWER TO SPINDLE MOTOR - SHIELD +3
651 LEG 1 OF 230VAC #14
652 LEG 2 #14
653 LEG 3 #14

660 X-ENCODER CABLE - SHIELD +7
661 LOGIC RETURN (D GROUND) #24
662 ENCODER A CHANNEL #24
663 ENCODER B CHANNEL #24
664 +5 VDC #24
665 ENCODER Z CHANNEL #24
666 HOME/LIMIT SW #24
667 OVERHEAT SWITCH #24
668 ENCODER A*
669 ENCODER B*
66T ENCODER Z*

670 Y-ENCODER CABLE - SHIELD +7 (LATHE SPINDLE ENCODER)
(SAME AS 661-66T)

680 Z-ENCODER CABLE - SHIELD +7
(SAME AS 661-66T)

690 A-ENCODER CABLE - SHIELD +7
(SAME AS 661-66T)

700 KEYBOARD CABLE - 34 WIRE RIBBON WITH IDC
(FROM VIDEO P4 TO KBIF P1)

710 FORWARD/REVERSE/RESET TO SPINDLE - SHIELD +4
711 FORWARD COMMAND (SP DR CN1-18 TO IO P9-4) #24
712 REVERSE COMMAND (CN1-19 TO IO P9-3) #24
713 RESET COMMAND (CN1-21 TO IO P9-2) #24
714 COMMON (CN1-14 TO IO P9-1) #24

720 ANALOG SPEED COMMAND TO SPINDLE - SHIELD +2
721 0 TO +10 VOLTS SPEED COMMAND (SPINDLE DRIVE CN1-1) #24
722 SPEED COMMAND REFERENCE (A GROUND) (CN1-17) #24

730 POWER METER FROM SPINDLE DRIVE TO KBIF - SHIELD +2
731 METER + (SPINDLE DRIVE CN1-5 TO KBIF) #24
732 METER - (CN1-6 TO KBIF) #24

730A POWER METER FROM KBIF TO METER - SHIELD +2
733 METER + AFTER TRIM POT (KBIF TO METER) #24
734 METER - AFTER TRIM POT (KBIF TO METER) #24

730B ANALOG SIGNAL FROM SPINDLE DRIVE LOAD MONITOR
731 SIGNAL 0..5V
732 GROUND

740 POWER ON/OFF CABLE TO FRONT PANEL - SHIELD +4
741 POWER ON SWITCH LEG 1 (24 VAC) #24
742 POWER ON SWITCH LEG 2 #24 N.O.
743 POWER OFF SWITCH LEG 1 (24 VAC) #24
744 POWER OFF SWITCH LEG 2 #24 N.C.

750 JOG-CRANK DATA CABLE - SHIELD +4
751 LOGIC RETURN (D GROUND) (65) #24
752 ENCODER A CHANNEL #24
753 ENCODER B CHANNEL #24
754 +5 VDC #24

760 MONITOR VIDEO DATA CABLE - SHIELD +9 (all #24)
(FROM VIDEO P3 TO CRT)

770 EMERGENCY STOP INPUT CABLE - SHIELD +2
771 SIGNAL (INPUT 8) #20
772 RETURN (D GROUND) (65) #20

770A SECOND E-STOP INPUT FOR HORIZONTAL

780 STATUS CABLE FROM SPINDLE DRIVE - SHIELD +4
781 +12 VDC (SPINDLE DRIVE CN1-25) #24
782 FAULT (INPUT 18 TO CN1-24) #24
783 AT SPEED (INPUT 20 TO CN1-23) #24
784 STOPPED (INPUT 19 TO CN1-22) #24

790 SPARE INPUTS FROM IOPCB P24
791 SPARE 1
792 SPARE 2
793 COMMON

800 12VAC TO LAMP - SHIELD +2
801 UNSWITCHED LEG 1 #20
802 SWITCHED LEG 2 #20

800A CABLE FOR LAMP SWITCH - SHIELD +2

800B CABLE WITH 10VAC FROM TRANSFORMER T2 - SHIELD +2

810 TOOL CHANGER MOTORS - SHIELD +2 #20
811 TURRET MOTOR + (IO P30-2 TO P6-J) #14
812 TURRET MOTOR - (IO P30-1 TO P6-I) #14

810A TOOL CHANGER MOTORS - SHIELD +2 #20
813 SHUTTLE MOTOR - (IO P30-4 TO P6-A) #14
814 SHUTTLE MOTOR + (IO P30-3 TO P6-B) #14

820 TOOL CHANGER STATUS - SHIELD +7
821 LOGIC RETURN (D GROUND) (P6-F/H/L/M) #24
822 GENEVA MARK (INPUT 5 TO P6-G) #24 (LATHE PART DOOR)
823 TOOL #1 (INPUT 3 TO P6-E) #24
824 SHUTTLE IN (INPUT 1 TO P6-C) #24 (LATHE TURRET CLAMPED)
825 SHUTTLE OUT (INPUT 2 TO P6-D) #24 (LATHE TURRET UNCLAMPED)

830 OVERHEAT THERMOSTAT - SHIELD +2

831 OVERHEAT SIGNAL (INPUT 14) #20
832 OVERHEAT RETURN (D GROUND) (65) #20

840 CIRCUIT BREAKER FOR 160 VDC - SHIELD +2
841 LEG 1 (TO 81) #14
842 LEG 2 #14

850 SERIAL PORT #1 INTERFACE CABLE (16 WIRE RIBBON #24)

850A SERIAL PORT #2 INTERFACE CABLE (16 WIRE RIBBON #24)

860 +12V/+5V/Gnd POWER CABLES - 4 WIRE (all #18)
861 +12 VOLTS
862 -12 VOLTS FROM LOW V SUPPLY TO 68020 PCB
863 +5 VOLTS
864 -5 VOLTS
865 LOGIC POWER RETURN (D GROUND)
866 POWER GOOD SIGNAL FROM SUPPLY

860A 12 VOLT POWER TO IOPCB - SHIELD +2
861 +12 VOLTS
865 LOGIC POWER RETURN (D GROUND)

860B +5 POWER TO 3" FLOPPY DRIVE

860C +5,+12,-12 POWER TO 68030

870 115VAC TO OILER - SHIELD +2
871 115VAC LEG 1 #18
872 115VAC LEG 2 #18

880A HIGH/LOW GEAR UNCLAMP/LOCK SOLENOID POWER - SHIELD +6
881 115 VAC SOLENOID COMMON (IO P12-5) #18
882 HIGH GEAR SOLENOID (IO P12-4) #18
883 LOW GEAR SOLENOID (IO P12-3) #18
884 TOOL UNCLAMP SOLENOID (IO P12-2) #18
885 SPINDLE LOCK SOLENOID (IO P12-1) #18
886 PRE-CHARGE SOLENOID #18 (IO P12-7)

880B TRANSMISSION HIGH/LOW GEAR SOLENOIDS FOR LATHE
881 115 VAC SOLENOID COMMON (IO P12-5) #18
882 HIGH GEAR SOLENOID (IO P12-4) #18
883 LOW GEAR SOLENOID (IO P12-3) #18

890 SPINDLE STATUS SWITCHES SHIELD +6
891 SIGNAL RETURN (D GROUND) (65) #24
892 HIGH GEAR (INPUT 6) #24
893 LOW GEAR (INPUT 7) #24
894 TOOL UNCLAMPED (INPUT 15) #24
895 TOOL CLAMPED (INPUT 16) #24
896 SPINDLE LOCKED (INPUT 17) #24

900 LOW COOLANT STATUS - SHIELD +2
901 LOW COOLANT SIGNAL (INPUT 4 TO P7-C) #20
902 LOW COOLANT RETURN (D GROUND) (65 TO P7-D) #20

910 115 VAC CIRCUIT BREAKER TO SOLENOIDS - SHIELD +2
911 LEG 1 #18
912 LEG 2 #18

920 REGENERATIVE LOAD RESISTOR FOR SERVO - SHIELD +2
921 LEG 1 #18
922 LEG 2 #18

930 FUSED 230 VAC FOR COOLANT PUMP - SHIELD +2
931 LEG 1 #14
932 LEG 2 #14

940 230 VAC TO COOLANT PUMP - SHIELD +2
941 LEG 1 (P7-A) #14
942 LEG 2 (P7-F) #14

950 LOW AIR PRESSURE SENSOR - SHIELD +3
951 LOW AIR SIGNAL (INPUT 12) #20
952 LOW AIR/OIL RETURN (D GROUND) (65) #20
953 LOW OIL PRESSURE SWITCH FOR VERTICAL TRANSMISSION #20

950A LOW HYDRAULIC PRESSURE SWITCH FOR LATHE - SHIELD +2
952 LOW HYDRAULIC RETURN (D GROUND) (65) #20
953 LOW HYD PRESSURE SWITCH FOR VERTICAL TRANSMISSION #20

960 LOW LUB/DOOR OPEN SENSORS - SHIELD +4
961 LOW LUB SIGNAL (INPUT 13) #24
962 LOW LUB RETURN (D GROUND) (65) #24
963 DOOR OPEN SIGNAL (INPUT 9) #24 (OBSOLETE OPTION)
964 DOOR OPEN RETURN (D GROUND) (65) #24 (OBSOLETE OPTION)

970 LOW VOLTAGE SENSOR - SHIELD +2
971 LOW VOL SIGNAL (INPUT 11 FROM PMON P9-3) #24
972 LOW VOL RETURN (D GROUND) (PMON P9-4) #24

980 VOLTAGE MONITOR - SHIELD +2
981 VOLTAGE MONITOR 0 TO +5 (PMON P9-1 / MOTIF P17-1) #24
982 VOLTAGE MON RET (A GND) (PMON P9-2 / MOTIF P17-2) #24

990 HOME SENSORS - SHIELD +4
991 X HOME SWITCH (MOTIF P24-2 TO P5-B) #24
992 Y HOME SWITCH (MOTIF P24-3 TO P5-D) #24 (LATHE TAIL STOCK)
993 Z HOME SWITCH (MOTIF P24-4 TO P5-L) #24
994 HOME SWITCH RETURN (MOTIF P24-1 TO P5-C) #24

1000 SPINDLE ENCODER CABLE - SHIELD +5 (LATHE TAIL STOCK)

1001 LOGIC RETURN (D GROUND) (TO MOTIF P20-1) #24
1002 ENCODER A CHANNEL (TO MOTIF P20-2) #24
1003 ENCODER B CHANNEL (TO MOTIF P20-3) #24
1004 +5 VDC (TO MOTIF P20-4) #24
1005 ENCODER Z CHANNEL (TO MOTIF P20-5) #24

1010 KEYBOARD INPUTS FROM HORIZONTAL OPERATOR PANEL
1011 CYCLE START
1012 CYCLE START
1013 FEED HOLD
1014 FEED HOLD
1015 PART READY
1016 FIXTURE ROTATE
1017 PART RDY/FIX ROT COMMON

1020 SPINDLE TEMPERATURE SENSOR CABLE - SHIELD +3
1021 SIGNAL
1022 ANALOG RETURN
1023 +5 VOLTS TO SENSOR
1024 SHIELD GROUND

1030 SPINDLE LOAD RESISTOR - SHIELD +2
1031 REGEN LOAD RESISTOR FOR SPINDLE DRIVE (B1) #18
1032 REGEN LOAD RESISTOR FOR SPINDLE DRIVE (B2) #18

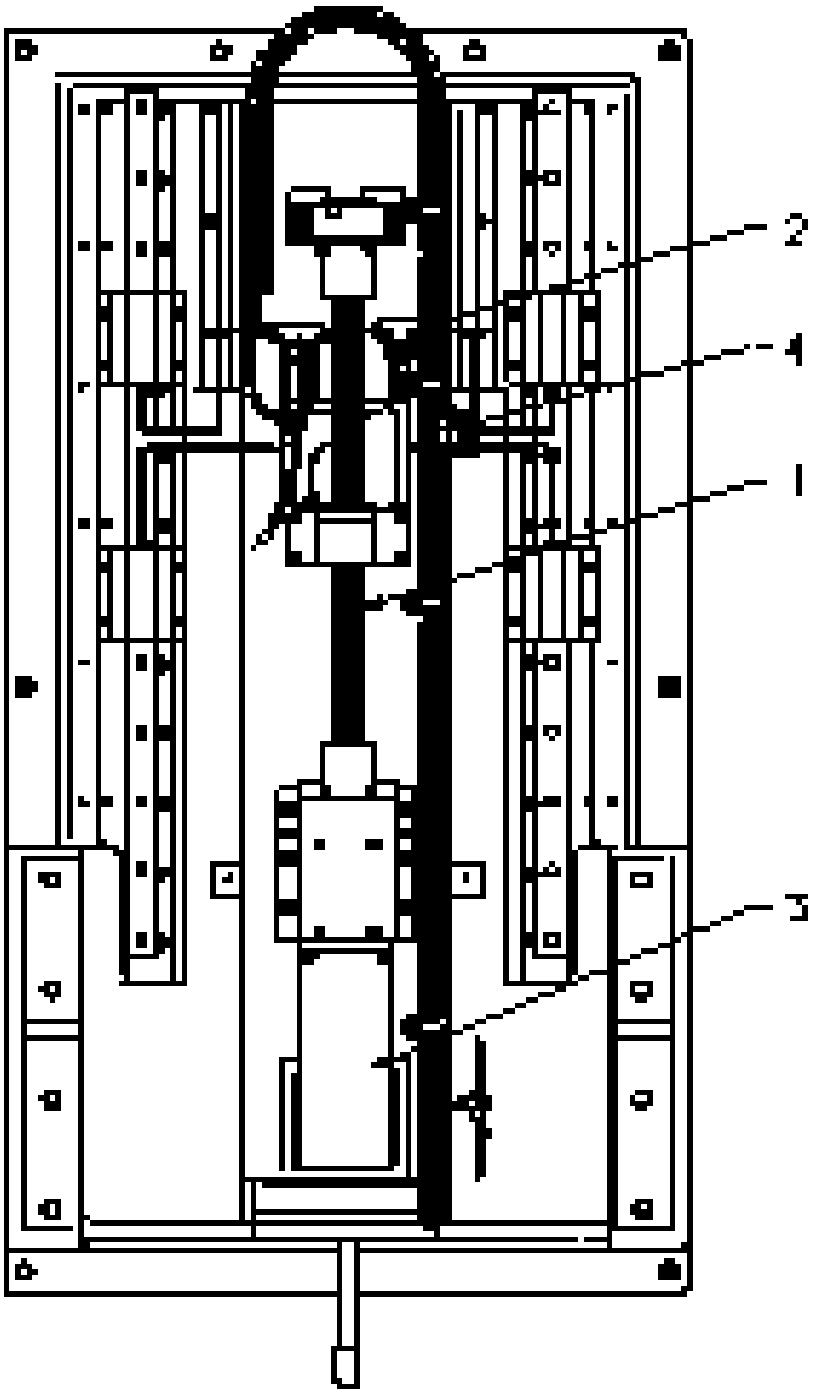
1040 Y160 (MIKRON DOOR LOCK OR HORIZONTAL PART READY LAMP)
1041 SWITCHED RELAY CONTACT
1042 SWITCHED RELAY CONTACT

1050 DOOR SWITCH WIRING THRU SUPPORT ARM - SHIELD +2
1051 DOOR OPEN SIGNAL (INPUT 9) #24
1052 DOOR OPEN RETURN (D GROUND) (65) #24

1060 GROUND FAULT DETECTION SENSE INPUT
1061 + INPUT FROM SENSE RESISTOR
1062 - INPUT FROM SENSE RESISTOR

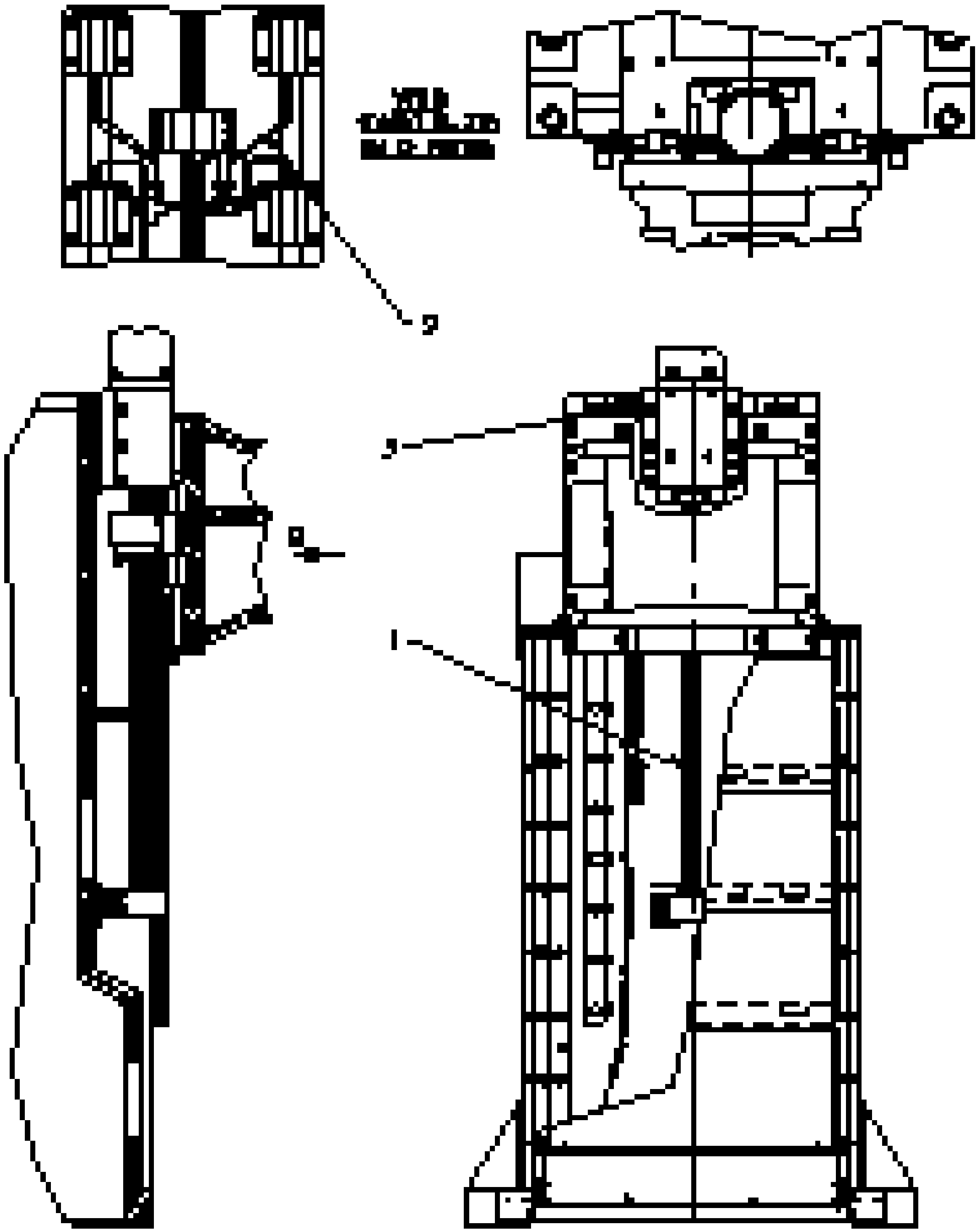
1070 SKIP INPUT FROM SENSOR - SHIELD +2
1071 LOGIC COMMON
1072 SKIP SIGNAL

CHAPTER 25
ASSEMBLY DRAWINGS



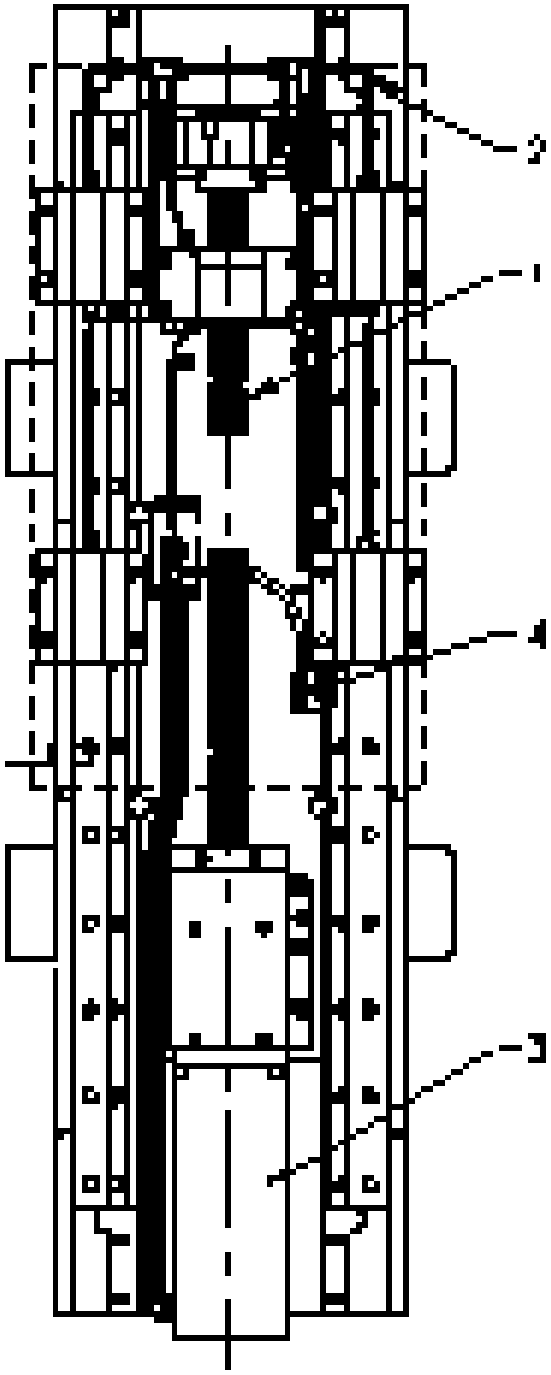
1 - 30-1100 - LEAD SCREW ASSEMBLY
2 - 30-7524 - BASE OIL LINE ASSEMBLY
3 - 32-1600 - Y AXIS MOTOR ASSEMBLY
4 - 32-2030 - TELEMECHANIQUE SWITCH ASSEMBLY

VF -1 BASE



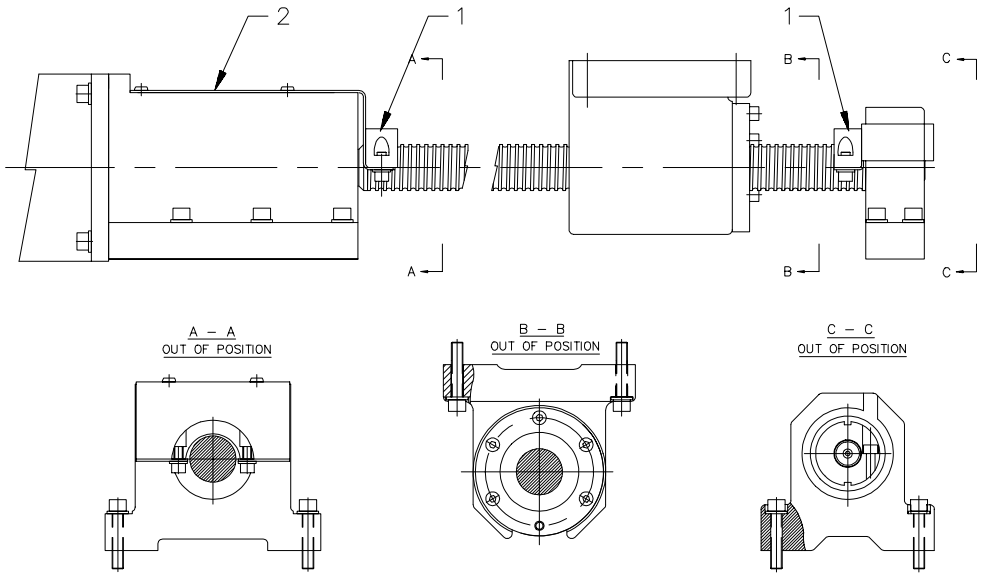
1 - 30-1100 - HEAD [illegible] ASSEMBLY
2 - 30-7575 - COLUMN OIL LINE ASSEMBLY
3 - 32-2040 - COUNTERBALANCE SWITCH ASSEMBLY

VF -1 COLUMN

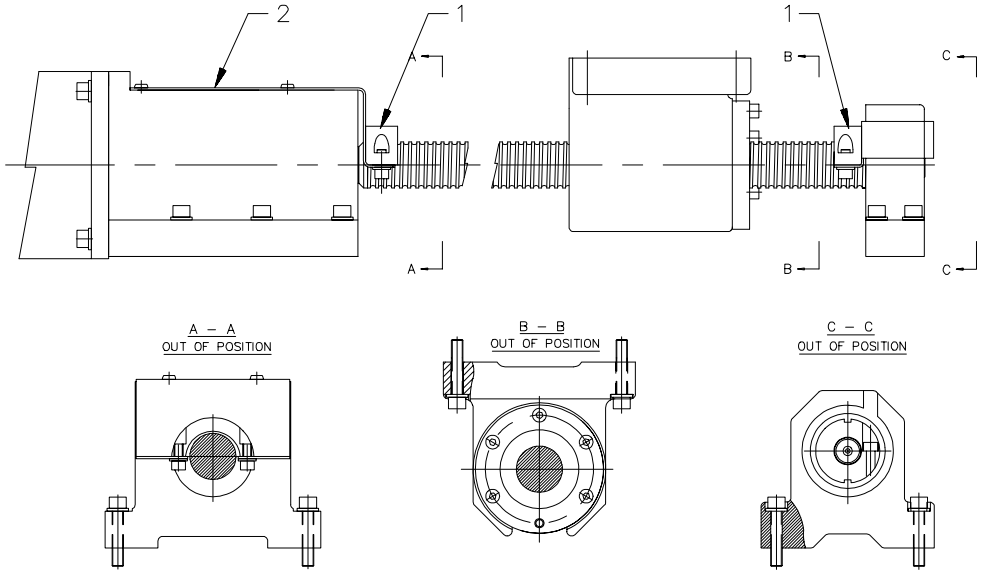


1 - 30-1100 - LEAD SCREW ASSEMBLY
2 - 30-2500 - SADDLE OIL LINE ASSEMBLY
3 - 93-1400 - X AXIS MOTOR ASSEMBLY
4 - 93-2050 - TOUCH PROBE SWITCH ASSEMBLY

VF -1 SADDLE

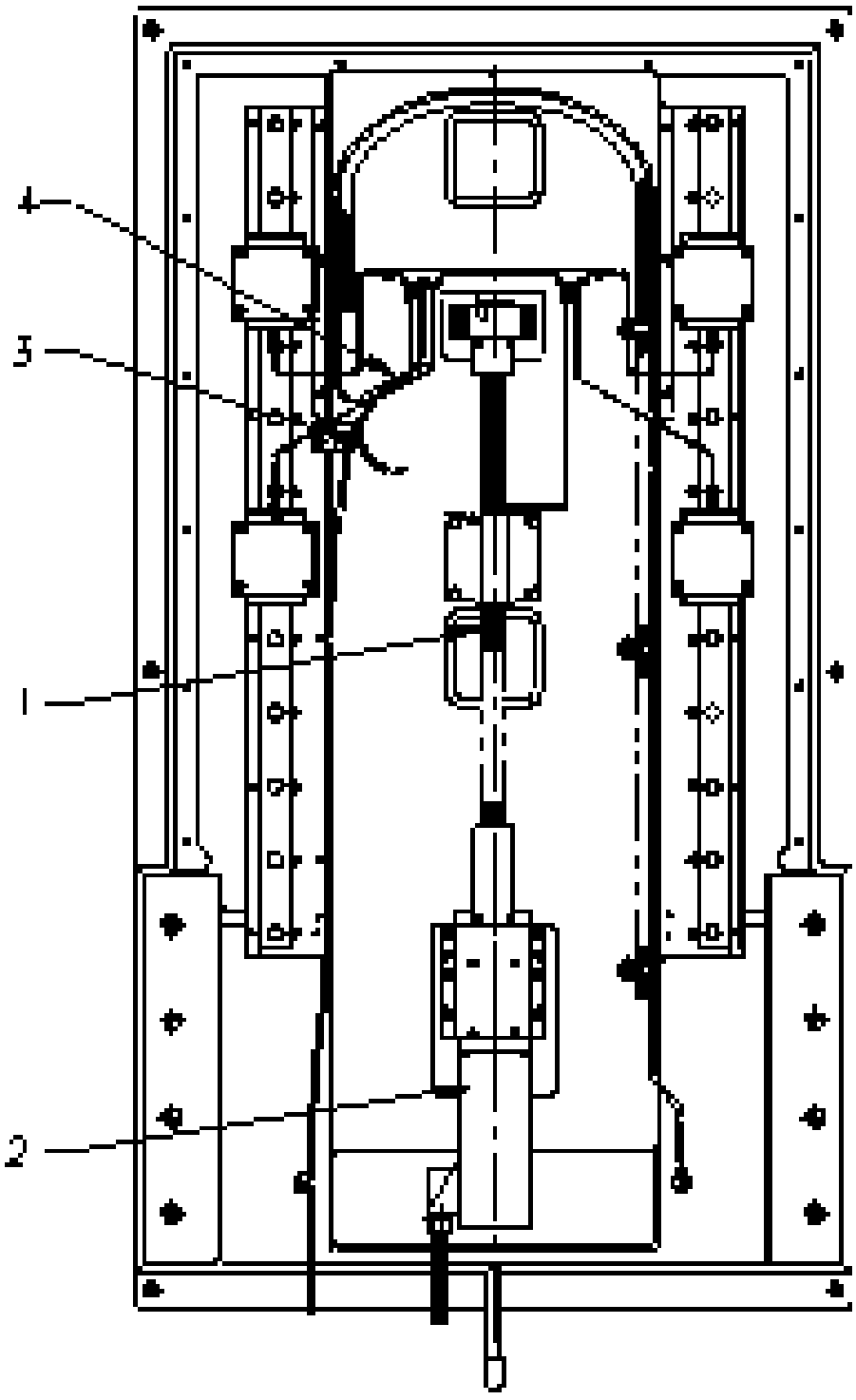


1 – 20–7185 – BUMPER
2 – 25–7042 – COVER PLATE, LEAD SCREW



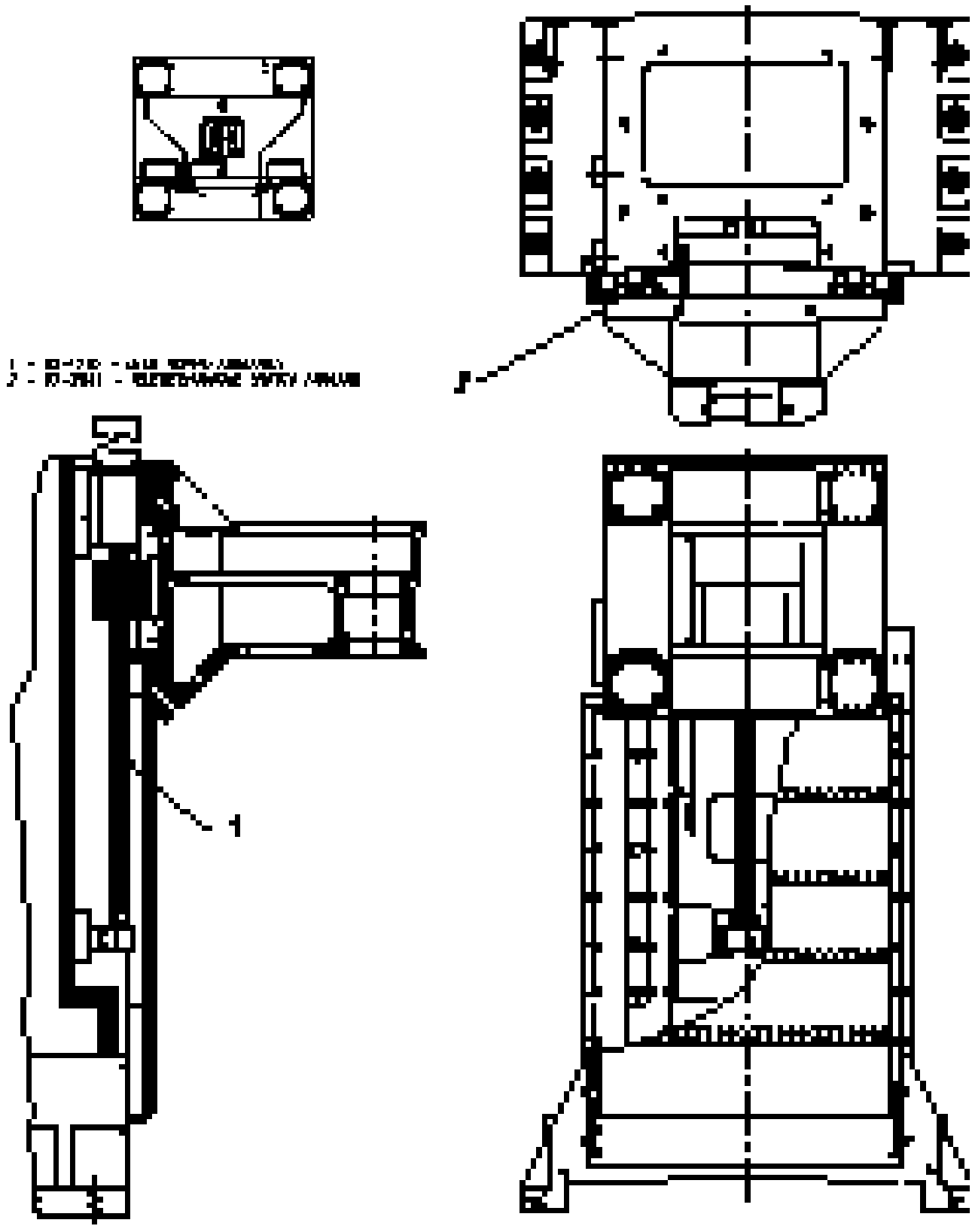
1 – 20–7186 – BUMPER
2 – 25–7042 – COVER PLATE, LEAD SCREW

VF -1 LEADSCREW

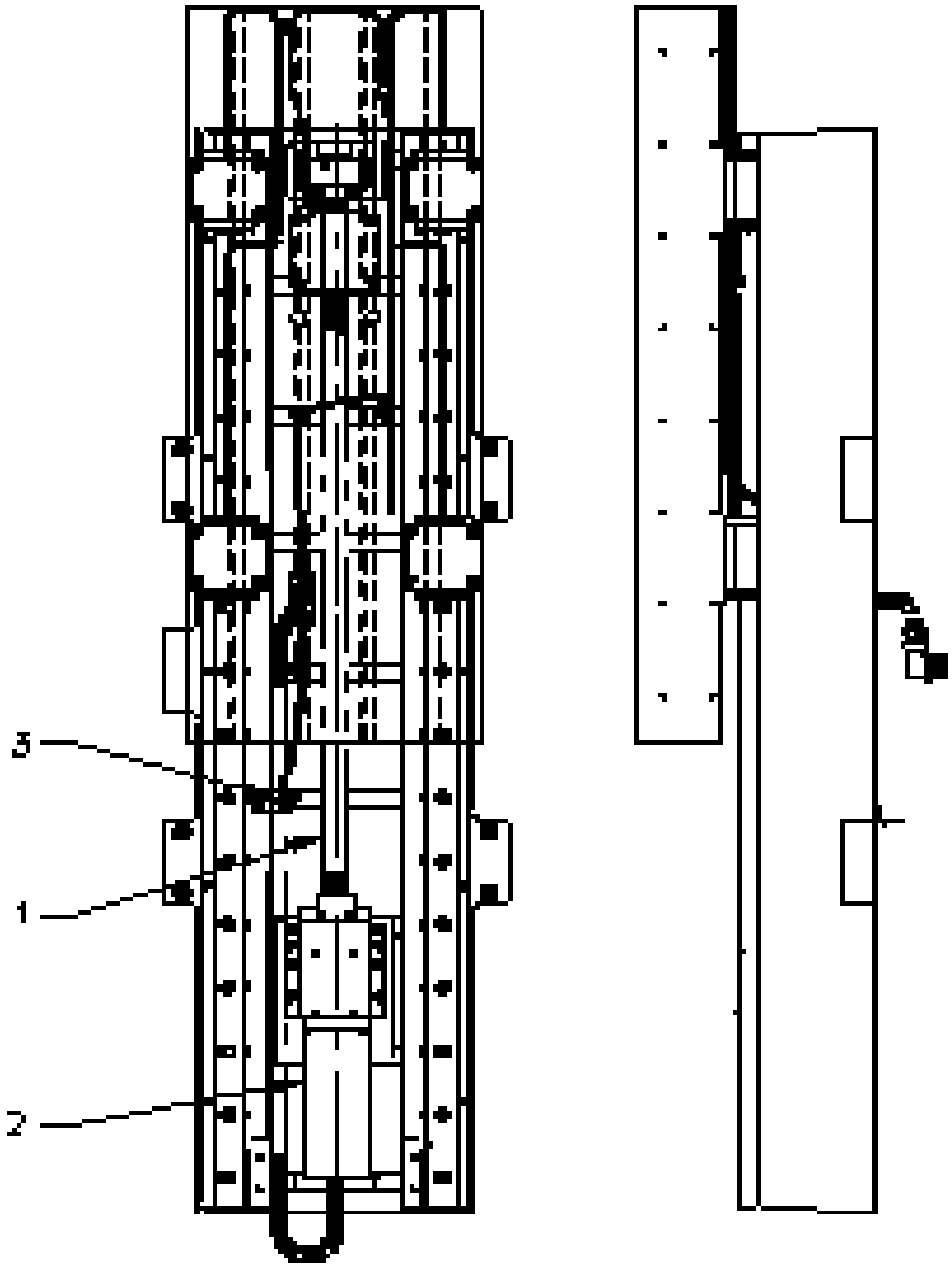


1 - 30-1710 - LEAD SCREW ASSEMBLY
2 - 57-1630 - MOTOR ASSEMBLY
3 - 57-2051 - TOOL CHANGE SWITCH ASSEMBLY
4 - 30-7026 - BASE GA TAB ASSEMBLY

VF -3 BASE

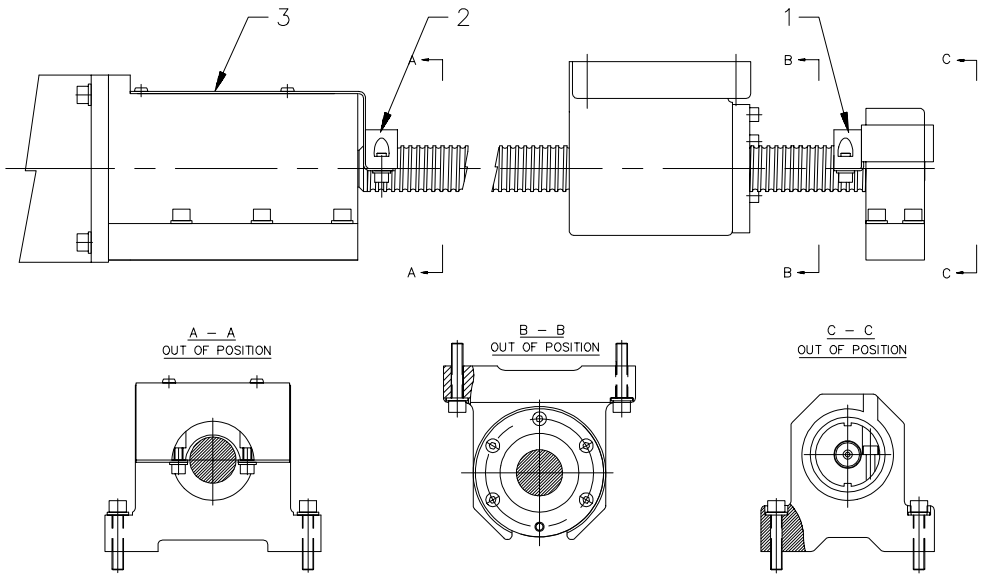


VF -3 COLUMN

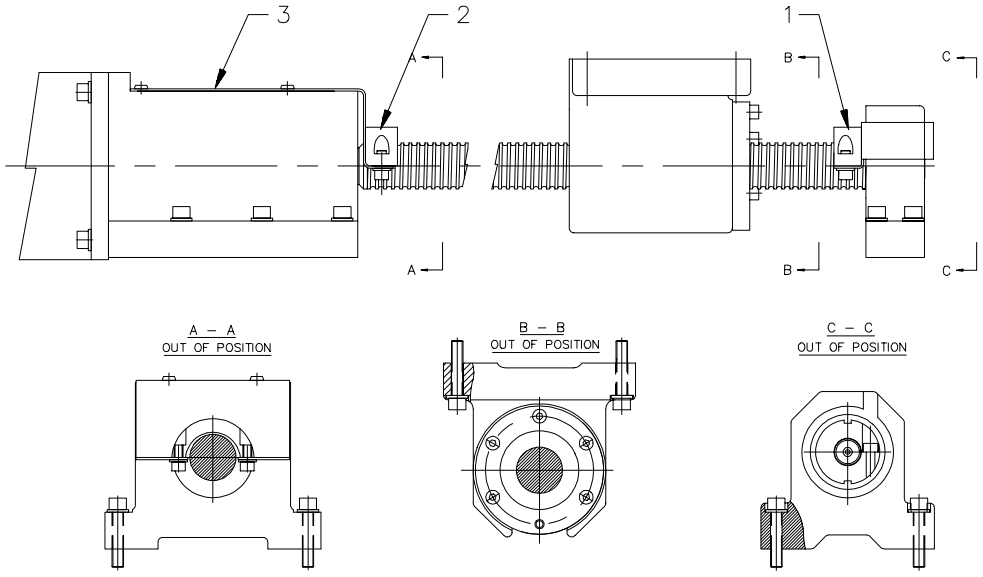


1 - 30-1200 - LEAD SCREW ASSEMBLY
1 - 30-1401 - MOTOR ASSEMBLY
1 - 32-2050 - TELEMECHANIQUE SWITCH ASSEMBLY

VF-3 SADDLE

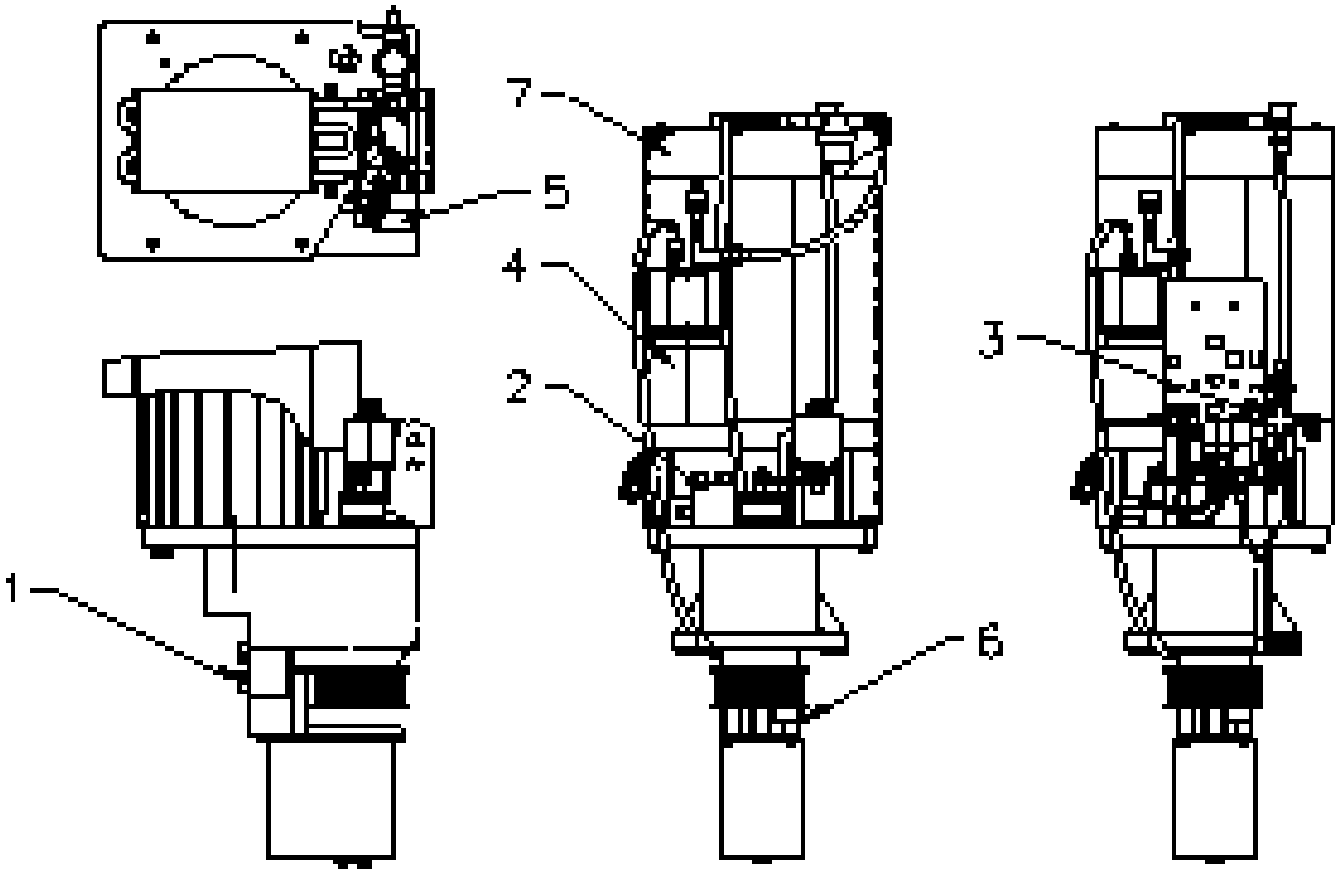


1 – 20–9057 – BUMPER
2 – 20–9058 – BUMPER
3 – 25–7042 – COVER PLATE, LEAD SCREW



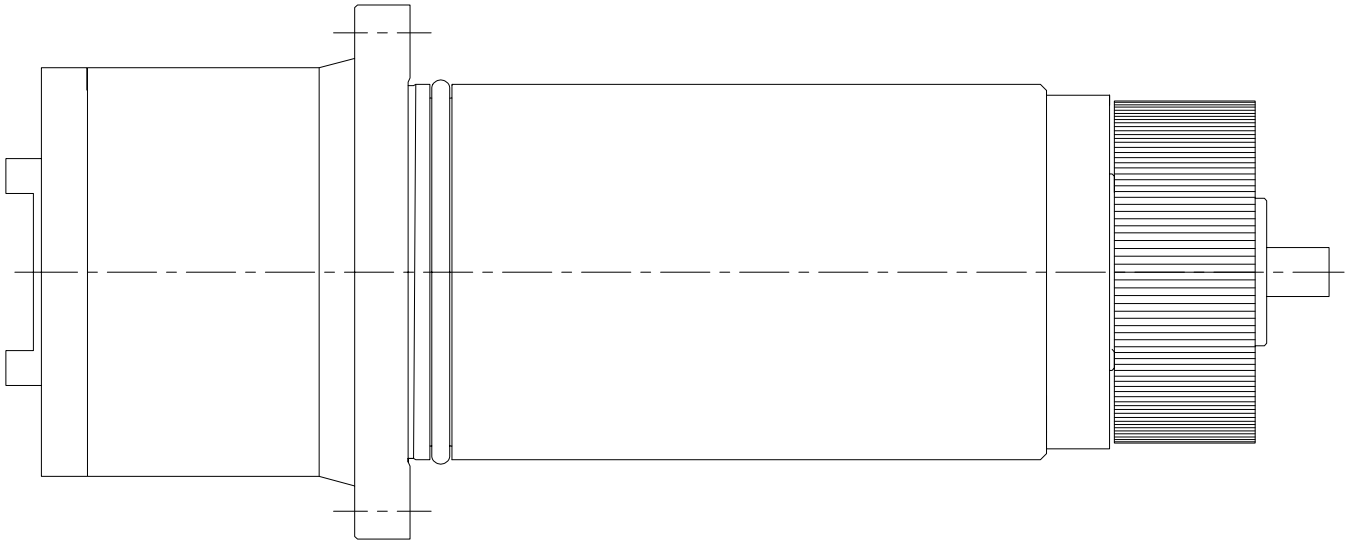
1 – 20–9095 – BUMPER
2 – 20–9096 – BUMPER
3 – 25–7042 – COVER PLATE, LEAD SCREW

VF -3 LEADSCREW

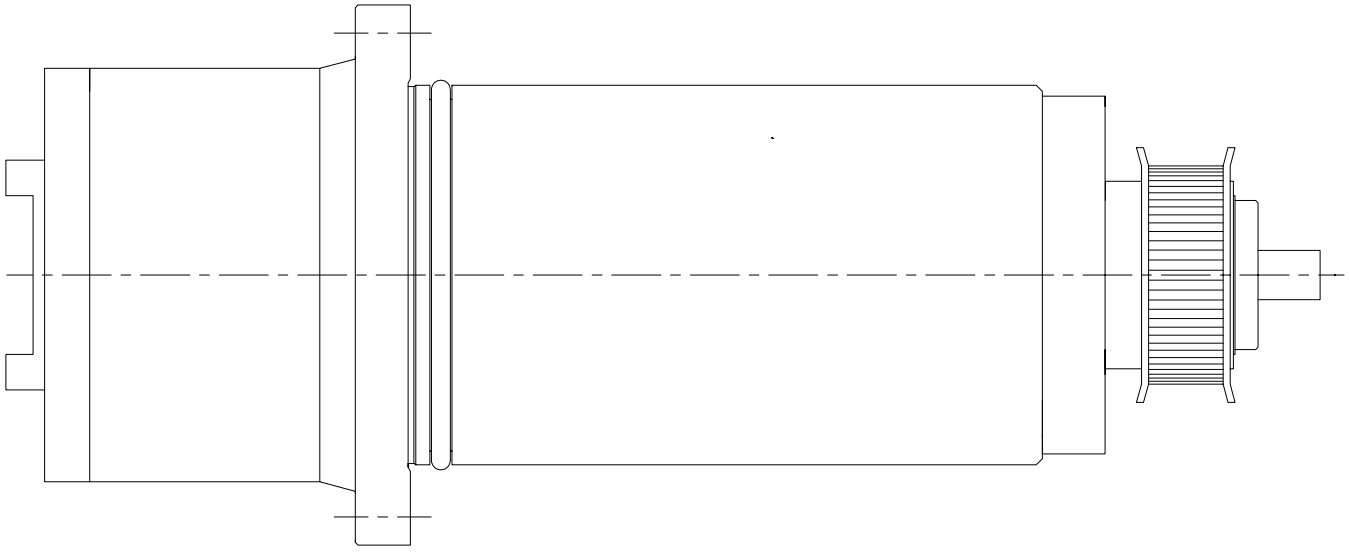


1 - 30-8130B - PISTON ASSEMBLY
2 - 30-3140A - SHOT PIN ASSEMBLY
3 - 30-3150C - AIR MANIFOLD ASSEMBLY
4 - 30-5260 - OIL GEAR PUMP ASSEMBLY
5 - 32-2010 - TELEMECHANIQUE SWITCH ASSEMBLY
6 - 32-2011 - TELEMECHANIQUE SWITCH ASSEMBLY
7 - 30-3135A - SPINDLE MOTOR FAN ASSEMBLY

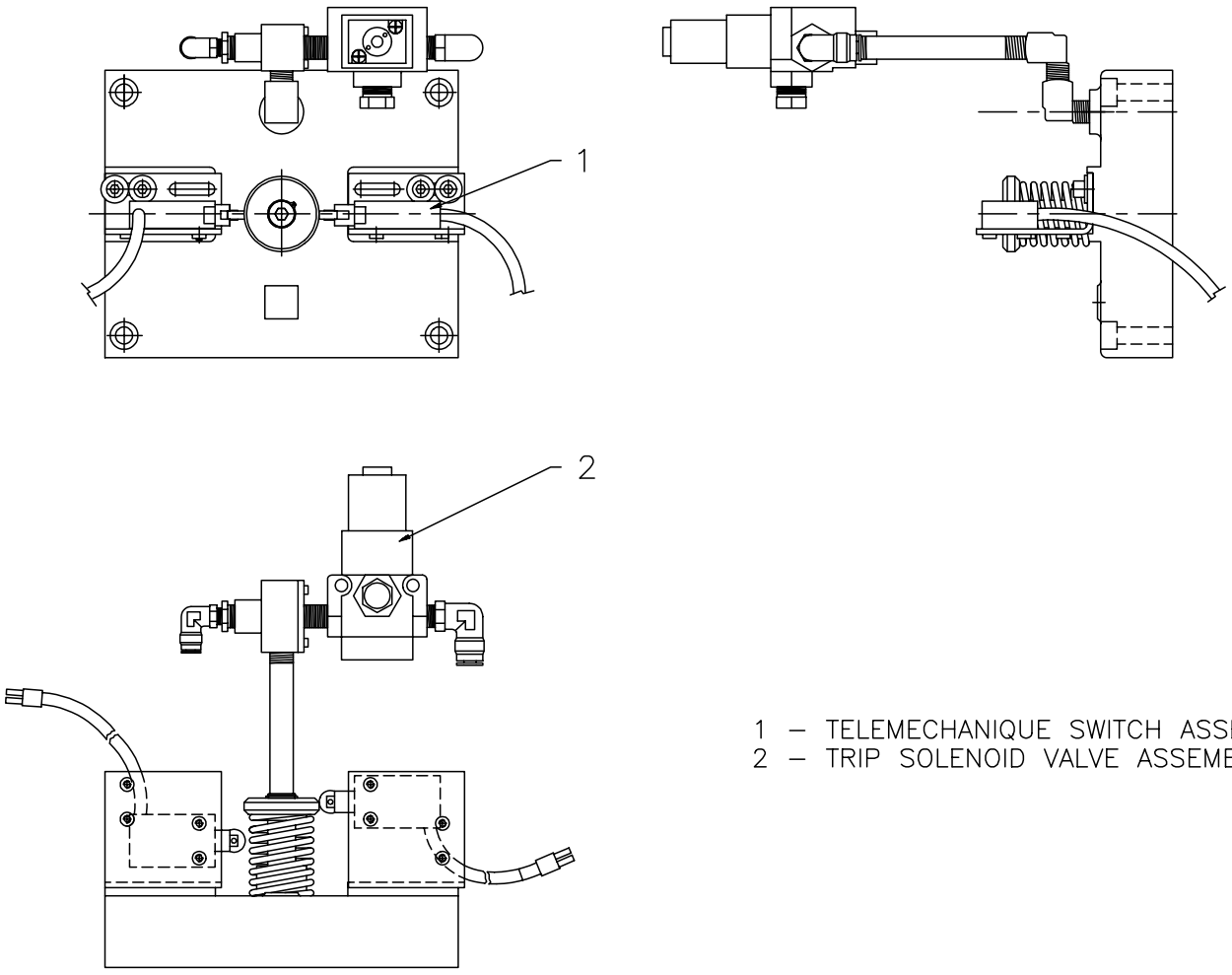
VF -GEARBOX ASSEMBLY



VF -SERIES SPINDLE 7.5K / 10K

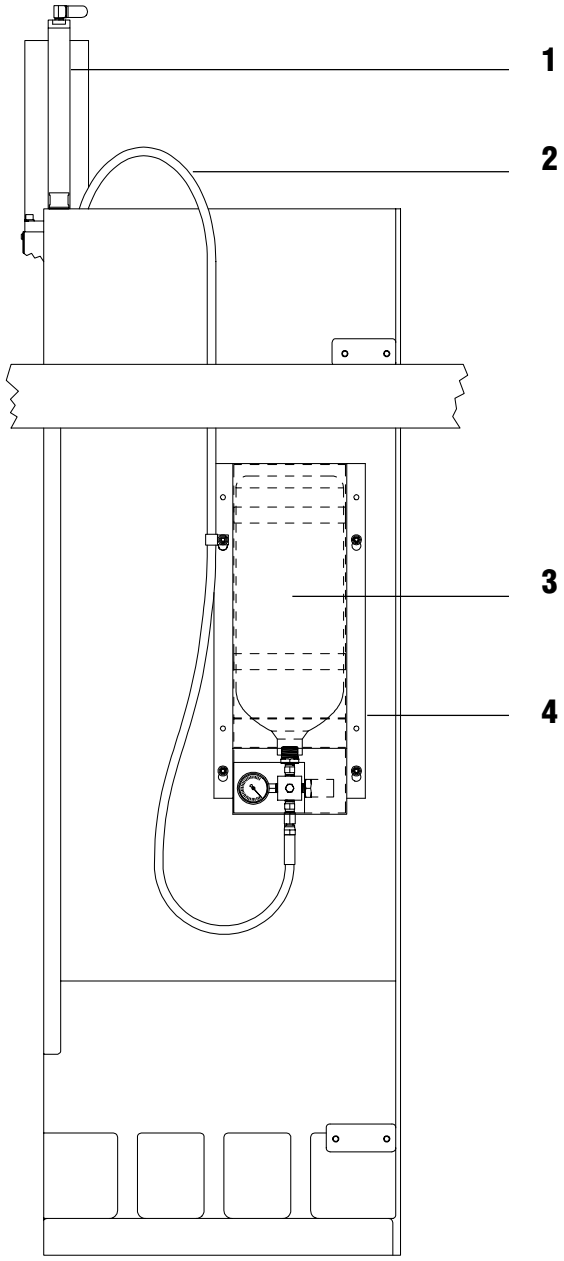


VF -0 SPINDLE 10K



1 – TELEMECHANIQUE SWITCH ASSEMBLY
2 – TRIP SOLENOID VALVE ASSEMBLY

THROUGH THE SPINDLE COOLANT - TOOL RELEASE PISTON



VF-3/4 COLUMN, RIGHT SIDE

(HYDRAULIC PRESSURE SENSOR CABLE NOT SHOWN)

	P/N	DESCRIPTION	VF-0/1/2	VF-3/4	VF-6/8
③	30-3250A	Fluid Tank Assy, VF-0/1/2/6	1	-	2
	30-3251A	Fluid Tank Assy, VF-3/4	-	1	-
①	30-3170A	Hydraulic Cylinder Assy, VF-0/1/2	1	-	-
	30-3970A	Hydraulic Cylinder Assy, VF-3/4	-	1	-
	30-3980A	Hydraulic Cylinder Assy, VF-6/8	-	-	2
②	58-1730A	90" Hydraulic Hose	1	1	-
	58-1729A	138" Hydraulic Hose	-	-	2
④	25-7560B	Hydraulic Fluid Tank Mount	1	"	2
	33-0771	Hydraulic Pressure Sensor Cable, VF-0 thru 4	1	1	-
	33-6771	Hydraulic Pressure Sensor Cable, VF-6/8	-	-	1
	59-4016	Hydraulic Hose Clamp	1	1	equipped