



## HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

### VF-Series Service Manual 96-7045 English November 26 1993

- 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

### PROBLEM:

- ▶ Machine cannot be powered on.

### SOLUTION:

- Check input voltage to machine (Section 2, Electrical Service).
- Check main circuit breaker at top right of electrical cabinet; switch must be at the **on** position.
- Check overvoltage fuses (Section 3.1, Electrical Service).
- Check wiring to POWER OFF button on front control panel.
- Check wiring to AUTO OFF relay to IOPCB.
- Replace IOPCB (Section 4.3, Electrical Service).
- Replace POWER PCB (Section 4.4, Electrical Service).

### PROBLEM:

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

### SOLUTION:

- 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 (Section 4.3, Electrical Service).
- Check Parameter 57 for Power Off at E-STOP.

- Replace MOTIF PCB (Section 4.1, Electrical Service).

### PROBLEM:

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

### SOLUTION:

- 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 (Section 5.1, Electrical Service).

### PROBLEM:

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

### SOLUTION:

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

### PROBLEM:

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

### SOLUTION:

- Check keyboard cable (700) from VIDEO to KBIF PCB.
- Replace keypad (Section 5.5, Electrical Service).
- Replace KBIF PCB (Section 4.6, 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.

### PROBLEM:

- ▶ Machine vibrates while spindle is on and is not cutting. Sometimes only at specific RPM.

### SOLUTION:

- If the spindle alone causes vibration of the machine this is usually caused by the belt/pulley drive system. This occurs because a pulley is either out of balance, misaligned, or belt tension is incorrect. It is extremely important that when servicing the spindle transmission that pulleys are checked for runout. Balance is almost impossible to check except by trial and error. This method can be accomplished by putting additional washers under one of the allen bolts of the locking collar and observing the effect. By moving from bolt to bolt you should see better or worse results and take action

accordingly. Vibrations at different speeds are usually caused by all of the above except that harmonics are in play. If the problem is severe and cannot simply be corrected, you may have to consider replacing the gearbox and spindle with factory-balanced units.

### PROBLEM:

- ▶ Machine vibrates while jogging the axis with the hand wheel.

### SOLUTION:

- 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.

### PROBLEM:

- ▶ The machine vibrates excessively in a cut.

### SOLUTION:

- 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 headstock or from an axis. Isolate the source of vibration per Sections 2.2, 3.2, and Section 6.

## 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.

**PROBLEM:**

- ▶ Machine will not interpolate a round hole.

**SOLUTION:**

- Check the levelness of the machine (See the **Installation Manual**).
- Check for backlash (Section 3.3).

**PROBLEM:**

- ▶ Bored holes do not go straight through the workpiece.

**SOLUTION:**

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

**PROBLEM:**

- ▶ Machine bores holes out-of-round.

**SOLUTION:**

- Check the levelness of the machine (See the **Installation Manual**).
- Check the sweep of the machine (Section 5.3, Mechanical Service).

**PROBLEM:**

- ▶ Bored holes are out of round, or you bore a hole at a given X/Y position and then check at the same location using a test indicator and it indicates you are out of position.

**SOLUTION:**

- 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.

**PROBLEM:**

- ▶ Machine mis-positions holes.

**SOLUTION:**

- Check the levelness of the machine (See the **Installation Manual**).
- Check for backlash (Section 3.3).
- Check the squareness of the **X** axis to the **Y** axis.

**PROBLEM:**

- ▶ Machine leaves large steps when using a shell mill.

**SOLUTION:**

- Check the levelness of the machine (See the **Installation Manual**).
- Check the sweep of the machine (Section 5.3, Mechanical Service).
- Cutter diameter too large for depth of cut.

## 1.4 FINISH

**PROBLEM:**

- ▶ Machining yields a poor finish.

**SOLUTION:**

- Check for backlash (Section 3.3).
- Check the condition of the tooling and the spindle (Section 2).



## 2. Spindle

### 2.1 NOT TURNING

#### PROBLEM:

- ▶ Spindle not turning.

#### SOLUTION:

- If there are any alarms, see Section 6.
- Check that the spindle turns freely when machine is off.
- If motor turns but spindle does not, see Sections 3 and 9, Mechanical Service.
- Command spindle to turn on 1800 RPM and check spindle drive display. If display blinks "bb", check spindle orientation switch (Section 7, Mechanical Service). If spindle drive does **not** light the RUN LED, check forward/reverse commands from IOPCB (Section 4.3, Electrical Service).
- Check the wiring of analog speed command from MOTIFPCB to spindle drive (cable 720).
- If spindle is still not turning, replace MOTIF PCB (Section 4.1, Electrical Service).
- If spindle is still not turning, replace spindle drive (Section 5, Mechanical 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 (Section 3, Mechanical Service).
- Disconnect the drive belt. If the spindle will not turn, it is seized and must be replaced (Section 5, Mechanical Service).  
**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:

#### PROBLEM:

- ▶ Excessive noise coming from the spindle head area.

#### SOLUTION:

- On VF-1, VF-2, and VF-3 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.
- Check the alignment of the pulleys to the belt. Correct as necessary (Sections 3 and 4, Mechanical Service).
- Remove the head covers and check the machine's drive belt tension (Section 3.3, Mechanical Service).
  - ▶ 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 (Section 3, Mechanical Service).
  - ▶ 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 (1-2 cc every two hours) in an air mist-lubricated spindle.
  - ▶ If the spindle is not getting lubrication, correct the problem per the lube and air diagram at the back of this manual and replace the spindle (Section 5, Mechanical Service).
  - ▶ If the spindle is getting lubrication, replace the spindle (Section 5, Mechanical Service).



## 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, do the following:

- Run the spindle at 300 RPM for at least two (2) hours.
- Increase the spindle speed to 1000 RPM for 20 minutes.
- Increase the spindle speed to 3000 RPM for 20 minutes.
- Increase the spindle speed to 7000 RPM for 20 minutes.
- Stop the spindle and allow to cool to room temperature.
- Turn the spindle on to 7000 RPM and monitor the temperature inside the spindle taper at 15-minute intervals until the temperature drops off, then stabilizes. This will take about two (2) hours.
- Temperatures of about 140° are possible at the end of this test.

If the spindle fails this test, check the following:

- Check for correct amount of lubrication (1-2 cc every two hours). NOTE: Over lubrication is a common source of overheating. Check the oil flow carefully.
- Check the drive belt tension (Section 3, Mechanical Service). Too-tight belts will cause heating of the top bearing in the spindle housing.
- Ensure that the correct oil is being used (Lubrication Chart, page 131).

## 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.

It is important to consider what horsepower and torque is available in various speed ranges of the spindle. If your machine is a VF-1 or VF-2 (with a transmission), the following horsepower and torque are available in low gear:

SPEED (RPM)	TORQUE (ft-lb)	HORSEPOWER
0-100	45-90	less than 2
100-500	90	3 to 7.5
500-1250	90-35	7.5
1250-1840	35-25	7.5 to 5

If your machine is a VF-0 (no transmission) or a VF-1 or VF-2 and you are in high gear, the following are available:

SPEED (RPM)	TORQUE (ft-lb)	HORSEPOWER
0-400	11-22	less than 2
400-2000	22	3 to 7.5
2000-5000	22-9	7.5
5000-7500	9-6	7.5 to 5

If your machine is a VF-3, the following horsepower and torque are available in low gear:

SPEED (RPM)	TORQUE (ft-lb)	HORSEPOWER
0-125	60-120	less than 3
125-625	120	4 to 10
625-1550	120-45	10
1550-1840	45-32	10 to 7

If your machine is a VF-3 and you are in high gear, the following are available:

SPEED (RPM)	TORQUE (ft-lb)	HORSEPOWER
0-600	15-30	less than 3
600-2500	30	4 to 10
2500-6250	30-11	10
6250-7500	11-9	10 to 7

If you still have spindle torque problems and there is no mechanical cause such as binding or friction in the transmission or spindle, the motor or spindle drive are the cause. The first choice

for replacement is the spindle drive. If there is still a problem, the entire motor/transmission assembly must be replaced.

## 2.5 ORIENTATION

### PROBLEM:

- ▶ Spindle loses correct orientation.

### SOLUTION:

- Check alarm history, looking for spindle overload and axis overcurrent alarms. These alarms indicate the machine is not being properly operated.
- Check the orientation ring for tightness (Section 7, Mechanical Service). 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 (Section 7, Mechanical Service).
  - ▶ If there are no cracks, remove the drive belt (Section 3, Mechanical Service) and verify that the pulley on the transmission output shaft is tight. On most machines, there is no key on the transmission pulley.
- 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.

## 2.6 TOOLS STICKING IN TAPER

### PROBLEM:

- ▶ 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), or after

heavy milling. If sticking only occurs during these situations, no service is necessary.

### SOLUTION:

- Check the condition of the customer's 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. See Section 5, Mechanical Service, 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 Section 5, Mechanical Service, for spindle cartridge replacement.
- Ensure the spindle is not running too hot (Section 2.3).



## 3. Servo Motors/Lead Screws

There is very little that a user might do to repair a servo motor. Problems with servo motors may include open-circuited motor, shorted winding of motor, motor shorted to case, water (coolant) in motor, or overheat damage to motor. None of these can be fixed by the user so the motor must be replaced. All of the above problems would generate alarms identifying one of the servo motors as having failed. These alarms are 103-106 (following error too large), 108-111 (servo overload), 135-138 (overheat), 139-142 (Z channel fault), 153-156 (Z channel missing), and 161-164 (overcurrent).

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.

Encoders' 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.

### 3.1 NOT OPERATING

All problems that are caused by servo motor failures should also register an alarm. Check the alarm history to determine the problem's cause before any action is taken.

#### PROBLEM:

- ▶ Servo motor is not functioning.

#### SOLUTION:

- 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 (Section 10, Mechanical Service).
- Open circuit in motor (**Alarms 139-142, 153-156, 182-185**). Replace motor assembly (Section 10, Mechanical Service).

- Motor has overheated, resulting in damage to the interior components (**Alarms 135-138, 176**). Replace motor assembly (Section 10, Mechanical Service).
- 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 (Section 10, Mechanical Service).
- 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 operation. If motor is still inoperable, replace motor assembly (Section 10, Mechanical Service).

(Cont'd)

## 3.1 (Cont'd)

- Check for broken or loose coupling between the servo motor and the lead screw. Replace or repair the coupling (Section 10.4, Mechanical Service).
- Check for a broken lead screw. If cracked or broken, replace (Section 10, Mechanical Service).  
**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 (Section 12, Mechanical Service).

## 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 reliable. Verify that customer complaints are not due to tooling, programming, or fixturing problems.

### PROBLEM:

- ▶ Servo motor noise.

### SOLUTION:

- Disconnect the servo motor from the lead screw and rotate by hand. If the noise persists, replace the motor assembly (Section 10, Mechanical Service).
- 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 (Section 12, Mechanical Service).

### PROBLEM:

- ▶ Lead screw noise.

### SOLUTION:

- Ensure oil is getting to the lead screw through the lubrication system (See Air and Oil Diagrams, pages 129 & 130). Look for a plugged metering valve.
- Check for damage to the bearing sleeve.
- Check the pre-load on old-style bearing sleeves (Section 12, Mechanical Service).  
**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 (Section 12, Mechanical Service). 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 (Section 11, Mechanical Service). When replacing the lead screw in an older machine, always replace the bearing sleeve with the current angular contact design bearing sleeve (Section 12, Mechanical Service).
- Check the lead screw for misalignment. If incorrect, align as outlined in Section 11, Mechanical Service.



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 ball nut 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 throughout 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.

### 3.3 ACCURACY/BACKLASH

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

#### PROBLEM:

- ▶ Poor mill table-positioning accuracy.

#### SOLUTION:

- 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 (Sections 10, 11, Mechanical Service).
- 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.

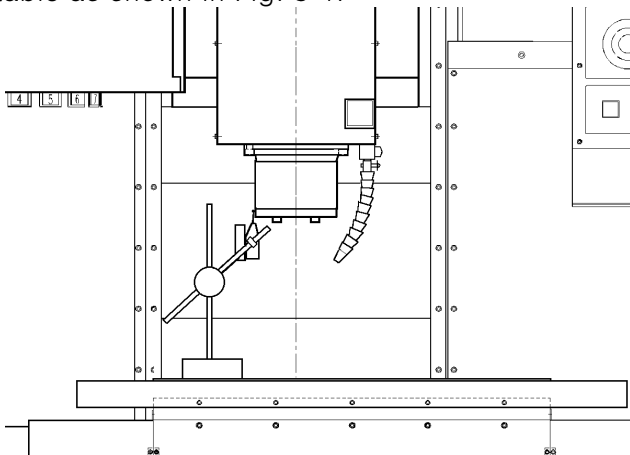


Fig. 3-1 Dial indicator in position to check X-axis.

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)  $\pm$  .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.

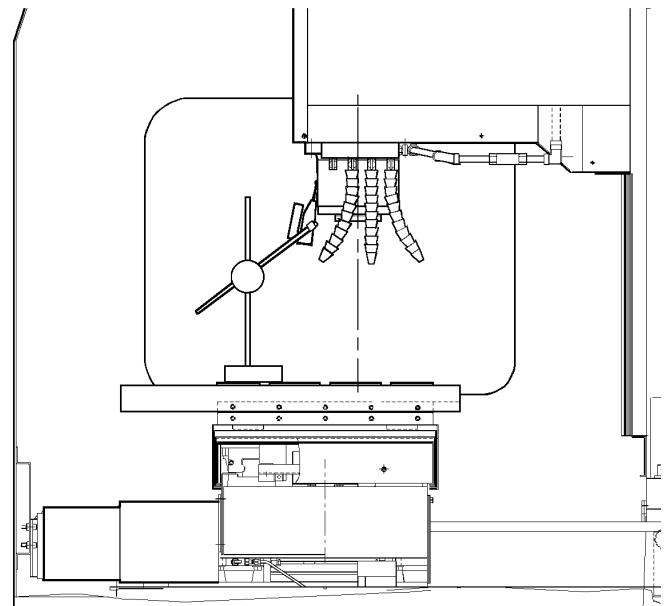


Fig. 3-2 Dial indicator in position to check Y-axis.

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

**(Cont'd)**

### 3.3 (Cont'd)

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)  $\pm$  .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.

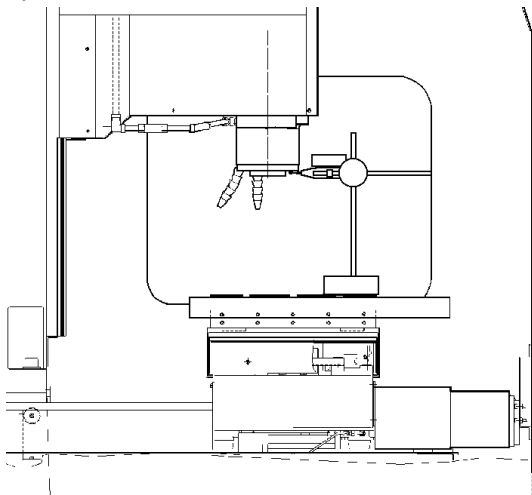


Fig. 3-3 Dial indicator in position to check Z-axis.

- ▶ 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 Section 11, 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 Section 11, Mechanical Service.
  - Loose clamp nut on the bearing sleeve. Tighten the SHCS on the clamp nut.
  - Loose motor coupling. Tighten as described in Section 10.4, 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. See Section 10.4, Mechanical Service.)
  - Loose SHCS attaching the bearing sleeve to the motor housing. Tighten as described in Section 12, Mechanical Service.
  - Defective thrust bearings in the bearing sleeve. Replace the bearing sleeve as outlined in Section 12, Mechanical Service.
  - Loose SHCS attaching the axis motor to the motor housing. If the SHCS are found to be loose, inspect the motor for damage and if none is found, tighten as described in Section 10, Mechanical Service. If damage is found, replace the motor (Section 10, Mechanical Service.)
  - Incorrect backlash compensation number in the parameter in the machine. Check Parameters 13, 27, and 41.
  - Worn lead screw. Replace as outlined in Section 11, Mechanical Service.

### 3.4 VIBRATION

#### PROBLEM:

- ▶ Excessive servo motor vibration.

**SOLUTION:**

- 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 (Section 4.2, Electrical Service).
- Check all Parameters of the suspected axis against the Parameters as shipped with the machine. If there are any differences, 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 (Section 10, Mechanical Service).

**3.5 OVERHEATING****PROBLEM:**

- ▶ Servo motor overheating.

**SOLUTION:**

- 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 excessive load or high duty cycle. Check the lead screw for binding (Section 3.3). If the motor is binding by itself, replace (Section 10, Mechanical Service).

**3.6 FOLLOWING ERROR****PROBLEM:**

- ▶ Following error alarms occur on one or more axes sporadically.

**SOLUTION:**

- Check DC bus voltage on diagnostics page #2. 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 (Section 4.2, Electrical Service).
- Replace servomotor (Section 10, Mechanical Service).





## 4. Automatic Tool Changer

Before any of the following checks are made, you must first ensure the **spindle orientation, drawbar height**, and the **tool clamp/unclamp switch adjustments** are correct. Refer to Section 6, Mechanical Service, before proceeding.

### 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.

#### PROBLEM:

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

#### SOLUTION:

- Check to see if pull studs on the tool holder are correct and tight.
- Check the adjustment of the "Z" offset (Parameter 64, Section 8, Mechanical Service). **NOTE:** If the offset is incorrect, a tool changer crash has occurred, and a thorough inspection of the ATC is necessary at this time.
- 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 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 drawbar (Section 5.3, Mechanical Service).

#### PROBLEM:

- ▶ Tool holder sticking in the spindle taper causes the ATC to be pulled up as the spindle head is traveling up after depositing the tool holder in the carousel; 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), or after heavy milling. If sticking occurs only during these circumstances, no service is necessary.

#### SOLUTION:

- 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 Section 5, Mechanical Service, 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 Section 5, Mechanical Service, for spindle cartridge replacement.

#### PROBLEM:

- ▶ During a tool change, ATC appears to be pulled up; no popping noises.

#### SOLUTION:

- Check the adjustment of the "Z" offset (Parameter 64, Section 8, Mechanical Service). **NOTE:** If the offset is incorrect, a tool changer crash has occurred, and a thorough inspection of the ATC is necessary at this time.

(Cont'd)

## 4.1 (Cont'd)

- 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 Section 14.2, Mechanical Service, 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 1/4" before the tool holder is seated in the taper, resulting in damage to the roller bolts on the ATC shuttle. Replace drawbar (Section 5.3, Mechanical Service).

### PROBLEM:

- ▶ Tool holders twist against extractor fork during a tool change.

### SOLUTION:

- Check the alignment of the ATC in the **X** and **Y** axes (Section 14.3, Mechanical Service).

### PROBLEM:

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

### SOLUTION:

- ATC is misaligned in the "Y" axis. Realign ATC (Section 14.3, Mechanical Service).  
**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.

### PROBLEM:

- ▶ Tool holders spin only at certain pockets of the ATC when the ATC shuttle retracts.

### SOLUTION:

- Check all the extractor forks to ensure they are centered in the pocket of the ATC. Also, see above. See Section 14.6, Mechanical Service, for extractor fork replacement.  
**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:

### PROBLEM:

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

### SOLUTION:

- 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.

### PROBLEM:

- ▶ Spindle crashes into top of the tool holder after a turret rotation during a tool change. 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.

### SOLUTION:

- Check all of the extractor forks on the ATC. Replace, if needed (Section 14.6, Mechanical Service).

**PROBLEM:**

- ▶ Spindle crashes into top of the tool holder after a turret rotation during a tool change. 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.

**SOLUTION:**

- 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. See Section 14.1 for ATC shuttle replacement, Section 5.3, Mechanical Service, for drawbar replacement, and 14.2, Mechanical Service, for extractor fork replacement.

**PROBLEM:**

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

**SOLUTION:**

- Inspect the balls and the Belleville springs in the drawbar. See Section 5.3, Mechanical Service, for drawbar replacement.

**PROBLEM:**

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

**SOLUTION:**

- 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.

**PROBLEM:**

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

**SOLUTION:**

- 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 Section 14.2, Mechanical Service for extractor fork replacement and Section 14.7, Mechanical Service, for sliding door replacement.

## 4.3 BREAKAGE

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

**PROBLEM:**

- ▶ ATC shuttle is broken off of the holding plate.

**SOLUTION:**

- 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 (Section 14, Mechanical Service).

**PROBLEM:**

- ▶ ATC extractor forks are damaged after breakage.

**SOLUTION:**

- Check the condition of the mounting holes in the carousel. If the threads are damaged, they must be repaired or the carousel replaced. See Section 14.6, Mechanical Service, 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:

**PROBLEM:**

- ▶ ATC makes noise as the shuttle moves.

**(Cont'd)**

## 4.4 (Cont'd)

### SOLUTION:

- Check the adjustment of the roller bolts on the ATC (Section 14.2, Mechanical Service). 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 Section 14.11, Mechanical Service, for trap door replacement.
- Check for missing plastic riders on the ATC shutter. See Section 14.11, Mechanical Service, 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 Section 14.11, Mechanical service, 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 (Section 14.8, Mechanical Service). DO NOT try to repair the motor or to further isolate the noise in the motor.

### PROBLEM:

- ▶ ATC makes noise during carousel rotation.

### SOLUTION:

- Check to ensure the Geneva driver on the turret motor is tight and properly adjusted (Section 14.8, Mechanical Service). 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 (Section 14.10, Mechanical Service).
- Check the adjustment of the Geneva driver in relation to the Geneva star (Section 14.10, Mechanical Service). 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 (Section 14.10, Mechanical Service).

- Ensure the screws holding the turret motor to the mounting plate are tight (Section 14.9, Mechanical Service).
  - 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 Section 14.9, Mechanical Service, 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.

**PROBLEM:**

- ▶ 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.

**SOLUTION:**

- Check the orientation of the machine (Section 7, Mechanical Service).

## 4.6 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:

**PROBLEM:**

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

**SOLUTION:**

- Disconnect the slip clutch arm from the ATC shuttle and ensure the shuttle can move freely. If not, see Sections 14.1, 14.3, and 14.4, Mechanical Service, for shuttle adjustment.
- Command a tool change with the shuttle disconnected.
  - ▶ If the shuttle cycles, check the slip clutch on the ATC. See Section 14.8, Mechanical Service, 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. See Section 14.8, Mechanical Service.
 

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

**PROBLEM:**

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

**SOLUTION:**

- 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. Otherwise, replace the I/O PCB (Section 4.3, Electrical Service).
  - ▶ If the LED does not light, check cables 510 and 520.

**PROBLEM:**

- ▶ ATC turret will not rotate; turret motor is getting power (command a tool change and feel for power being applied to the turret motor).

**SOLUTION:**

- 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 (Section 14.9, Mechanical Service). Check for damage to the Geneva star or the Geneva driver. See Section 14.10, Mechanical Service, for Geneva star replacement, and 14.9 for turret motor replacement. Check for a broken turret motor (See Section 14.9, Mechanical Service for turret motor replacement).
 

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

**PROBLEM:**

- ▶ ATC turret will not rotate; turret motor is not getting power (command a tool change and feel for power being applied to the turret motor).

**SOLUTION:**

- 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. Otherwise, replace the I/O PCB (Section 4.3, Electrical Service).
  - ▶ If the LED does not light, check cables 510 and 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-1, VF-2, or VF-3 gearbox as this will damage the gearbox and void the warranty.

### 5.1 NOISE

When investigating complaints of gearbox noise, also refer to Section 2 (Spindle Troubleshooting). 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.

#### PROBLEM:

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

#### SOLUTION:

- Operate the machine in both high and low gears. 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 (Section 9, Mechanical Service).
  - ▶ 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 (Section 9, Mechanical Service).
  - ▶ 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 (Section 9, Mechanical Service).

### 5.2 GEARS WILL NOT CHANGE

#### PROBLEM:

- ▶ Machine will not execute a gear change.

**NOTE:** Whenever a gear change problem occurs, an alarm will also occur. Refer to the ALARMS section (Section 6) 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, go 8,
- 9) Turn off high and low gear solenoids.

#### SOLUTION:

- 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 (Section 9, Mechanical Service).
- Check contactor CB4.

### 5.3 CORRECTING ALARMS

#### PROBLEM:

- ▶ Alarm 179 (Low Pressure Spindle Coolant) has been triggered.

#### SOLUTION:

- Check for low oil supply in reservoir.
- Check to see that pump motor is running.

(Cont'd)



## **5.3** (Cont'd)

- 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. Alarms/Diagnostics

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 will be displayed and the CURSOR DOWN key must be used to see the rest. The presence of any alarm will prevent the operator from starting a program.

Note that the 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.

The following list shows the alarm number and the cause of the alarm. Please refer to this list before resuming normal operation when an alarm occurs.

### 102 SERVOS OFF

This is not an alarm; but 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.; check for other causes.

### 103 X FOLLOWING ERROR TOO LARGE

### 104 Y FOLLOWING ERROR TOO LARGE

### 105 Z FOLLOWING ERROR TOO LARGE

### 106 A FOLLOWING ERROR TOO LARGE

These alarms can be caused by power problems, motor problems, driver problems, the slide being run into the mechanical stops, or excessive axis load. 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. See Section 2, Electrical Service, to check line voltage adjustments. See Section 3.1, Electrical Service, check the servo motors, servo drivers, and ball screw adjustment.

### 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. This is an operator-initiated condition. If you do not know why it occurred, check wiring to emergency stop circuit.

### 108 X SERVO OVERLOAD

### 109 Y SERVO OVERLOAD

### 110 Z SERVO OVERLOAD

### 111 A 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. See Section 3.1, Electrical Service, to check the servo motors, servo drivers, and ball screw adjustment.

### 112 NO INTERRUPT

This alarm can be caused by electrical interference or an electronics problem. See Section 4.1, Electrical Service, to replace Microprocessor and Motor Interface PCB's.

(Cont'd)

**6. (Cont'd)**

## 113 SHUTTLE IN FAULT

## 114 SHUTTLE OUT FAULT

Tool changer not completely to right or left. During a tool changer operation the tool in/out shuttle failed to get to the **in** or **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 fuse FU5 and relays 1-8, 2-1, and 2-2. See Section 4 for troubleshooting of the tool changer.

## 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 fuse FU5 and relays 1-8, 2-3, and 2-4. See Section 4 for troubleshooting of the tool changer.

## 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. See Section 4.5 to troubleshoot spindle orientation.

## 117 SPINDLE HIGH GEAR FAULT

## 118 SPINDLE LOW GEAR FAULT

Gearbox did not shift into high or low gear. During a gear change, the spindle is rotated slowly while air pressure is used to move the gears but the high/low 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. See Section 5 for troubleshooting of gear change problems.

## 119 OVER VOLTAGE

Incoming line voltage is above maximum (about 255V 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. This can also be caused by an electronic problem. See Section 2, Electrical Service, to check line voltage adjustment taps. See Section 4.2, Electrical Service, to replace SDIST PCB. Also check that servo regen load resistor is installed (cable 920).

## 120 LOW AIR PRESSURE

Air pressure dropped below 80 PSI for a period defined by Parameter 76. Check your incoming air pressure for at least 100 PSI and ensure the regulator is set at 85 PSI. If this is not caused by low air pressure, check pressure sensor at spindle head and wiring back to IOPCB. Check Parameter 76, which is used to delay the low air alarm condition for short outages. Air blast during tool change can cause your air supply to drop pressure; monitor the pressure drop during a tool unclamp.

## 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. This can be caused by failure of the pump to provide pressure, failure of the lube pressure sensor, a wiring error, or a parameter error. See Air and Oil Line Diagrams (p.133) to check level switch and pressure switch (cable 960).

**122 CONTROL OVER HEAT**

The control internal temperature is above 150° F. This can be caused by almost anything in the control overheating. But is usually caused by overheat of the two regen resistors 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. It is also caused by incorrect transformer tapping, SDIST PCB problem, or Spindle Drive problem. See Section 2, Electrical Service, to check line voltage adjustment taps. See Section 4.2, Electrical Service, to replace SDIST PCB. See Section 2.3 to check the spindle drive.

**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. See Section 2.3 for check of the Spindle Drive. Front of Drive indicates type of problem. If not a Drive problem, check wiring to IOPCB (cable 780).

**124 LOW BATTERY**

Memory batteries need replacing within 30 days. This alarm is only generated at POWER ON and indicates that the 3.3V Lithium battery is below 2.5V. If this is not corrected within about 30 days, stored programs, parameters, offsets, and settings may be lost. See Section 4.1, Electrical Service, for replacement of Microprocessor PCB or battery.

**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. See Section 4 for tool changer problem.

**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. See Section 5 for gear change problem.

**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 afterwards does not contain a tool. See Section 4 for tool changer problem.

**128 TOOL IN TURRET**

Pocket opposite spindle has tool in it. This alarm is not implemented.

**129 M FIN FAULT**

This indicates an external M-code wiring error was detected at power-on. Check your wiring to the M-FIN signal or see Section 4.3, Electrical Service, for replacement of the IOPCB.

**130 TOOL UNCLAMPED****131 TOOL NOT CLAMPED**

Tool release piston is energized at power up, or, 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. See Sections 2.6 and 4.1 for tool clamp/unclamp problems.

**(Cont'd)**

**6. (Cont'd)**

## 132 POWER DOWN FAILURE

The control attempted to shut-off and could not. The auto-off relay on the IOPCB did not open the main contactor circuit. Check the wiring from IOPCB to POWER PCB. See Section 4.3, Electrical Service, for IOPCB replacement.

## 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. See Section 2.5 for spindle orientation checks. Check for correct function of the shot pin.

## 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 draw bar assembly. See Sections 2.6 and 4.1 for tool clamp/unclamp problems.

## 135 X MOTOR OVER HEAT

## 136 Y MOTOR OVER HEAT

## 137 Z MOTOR OVER HEAT

## 138 A MOTOR OVER HEAT

Servo motor overheat. The temperature sensor in the motor indicates over 150°F. This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes. See Section 3 for check of servo motors and ball screws. A parameter or a wiring error can also cause this alarm.

## 139 X MOTOR Z FAULT

## 140 Y MOTOR Z FAULT

## 141 Z MOTOR Z FAULT

## 142 A 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 connectors at P1-P4. See Section 3.1 for check of motor/encoder and wiring. This is usually an encoder or wiring error. It can also be caused by the MOTIF PCB. See Section 4.1, Electrical Service, for replacement of MOTIF PCB.

## 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. See Section 2.5 for spindle orientation checks.

## 144 TIMEOUT - CALL YOUR DEALER

Time allocated for use prior to payment exceeded. Not a mechanical or electrical problem.

## 145 X LIMIT SWITCH

## 146 Y LIMIT SWITCH

## 147 Z LIMIT SWITCH

## 148 A 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. See Section 7, Electrical Service, to replace limit switches.

## 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. See Section 4.3, Electrical Service, for IOPCB replacement or Section 2 for Spindle Drive problem.

## 150 Z AND TOOL INTERLOCKED

Tool changer not at home and **Z** is neither at machine home or above tool. 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. Indicates a dangerous condition with the position of the Z axis and the tool changer. It is usually preceded by an alarm related to the tool changer. See Section 4 for troubleshooting of tool changer.

## 151 LOW COOLANT

If the low coolant sensor is installed, this indicates low coolant level in the coolant tank outside of the enclosure. Check coolant level and sensor in tank.

## 152 SELF TEST FAIL

This can be caused by an electronics problem or electrical interference. 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. See Section 4.1, Electrical Service, for replacement of MOTIF PCB.

## 153 X AXIS Z CH MISSING

## 154 Y AXIS Z CH MISSING

## 155 Z AXIS Z CH MISSING

## 156 A AXIS Z CH MISSING

These alarms indicate a problem with the servo axis encoder. All servos are turned off. It can also be caused by wiring errors, electronics problems, encoder contamination, parameter errors, or by loose connectors at P1-P4.. See Section 9, Mechanical Service, for replacement of motor/encoder. See Section 4.1, Electrical Service, for replacement of MOTIF PCB.

## 157 MOTOR INTERFACE PCB FAILURE

Internal circuit board problem. The MOTIF PCB in the processor stack is tested at POWER ON. See Section 4.1, Electrical Service, for replacement of MOTIF PCB.

## 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. See Section 5.5, Electrical Service, for replacement of keypad. See Section 4.1, Electrical Service, for replacement of VIDEO PCB.

## 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. See Section 5.5, Electrical Service, for replacement of keypad. This can also be caused by a bad cable 700. Be sure the problem is not in the cable before replacing keypad.

## 160 LOW VOLTAGE

This can be caused by a line voltage problem, a transformer tap problem, or an electronic problem. Cable 980 can cause this problem. See Section 4.1, Electrical Service, to replace MOTIF PCB or SDIST PCB.

**(Cont'd)**

**6. (Cont'd)**

- 161 X AXIS OVER CURRENT OR DRIVE FAULT
- 162 Y AXIS OVER CURRENT OR DRIVE FAULT
- 163 Z AXIS OVER CURRENT OR DRIVE FAULT
- 164 A AXIS OVER CURRENT OR DRIVE FAULT

These alarms indicate a problem with servo motor, the servo drive, or excessive load on servos. 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. See Section 4.1, Electrical Service, for replacement of servo drive cards. See Section 3 for check of servo motor and ball screw.

- 165 X ZERO RET MARGIN TOO SMALL
- 166 Y ZERO RET MARGIN TOO SMALL
- 167 Z ZERO RET MARGIN TOO SMALL
- 168 A ZERO RET MARGIN TOO SMALL

This alarm indicates a problem with limit switches, parameters, or motor encoders for servos, and this alarm will occur if the home/limit switches move or are misadjusted. This alarm also 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 operation. See Section 16, Mechanical Service, for setting grid offset parameters. See Section 3 for checking of motor and encoder. If a new motor or encoder is installed, this alarm is likely before grid offset parameters are adjusted.

- 169 SPINDLE DIRECTION FAULT

The spindle started turning in the wrong direction. This alarm occurs only for rigid tapping. It can be caused by a bad rigid tapping encoder, a wiring error, or a parameter error. See Section 6, Electrical Service, for installation of rigid tapping encoder.

- 170 PHASE LOSS L1-L2
- 171 PHASE LOSS L2-L3
- 172 PHASE LOSS L3-L1

These alarms indicate a problem with incoming line voltage. This usually indicates that there was a transient loss of input power to the machine. See Section 2, Electrical Service, for checking line voltage.

- 173 SPINDLE REF SIGNAL MISSING

The **Z** channel pulse from the spindle encoder is missing for hard tapping synchronization. This alarm occurs only for rigid tapping. See Section 6, Electrical Service, for installation/check of rigid tapping encoder.

- 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. This is not normally a machine fault. Check the setup.

- 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. If the fault occurs repeatedly, remove motors one at a time to isolate fault. If it occurs rarely, the motor in motion at the fault is the likely cause. A short of the spindle head solenoid cables can also cause this condition. See Section 9, Mechanical Service, to replace servo motors. See Section 14, Mechanical Service, to replace tool changer motors.

## 176 OVER HEAT SHUTDOWN

This alarm is actually caused by a previous Over Heat alarm. After 4 1/2 minutes of overheat, the control begins an automatic shutdown.

## 177 OVER VOLTAGE SHUTDOWN

This alarm is actually caused by a previous Over Voltage alarm. After 4 1/2 minutes of overvoltage, the control begins an automatic shutdown.

## 178 DIVIDE BY ZERO

Indicates an electronics or software problem. If intermittent or not consistent, see Section 4.1, Electrical Service, for replacement of Microprocessor PCB.

## 179 LOW PRESSURE SPINDLE COOLANT

This alarm indicates a problem with spindle cooling/transmission lubrication oil. It does not occur in a VF-0. When the spindle is in motion, the oil pump must be running to lubricate the transmission and cool the spindle. See Section 5.3 for check of oil sump, pump, and pressure sensor.

## 180 TOOL ARM ROTATION FAULT

## 181 TOOL POT POSITION FAULT

These alarms are not Implemented.

## 182 X CABLE FAULT

## 183 Y CABLE FAULT

## 184 Z CABLE FAULT

## 185 A CABLE FAULT

Cable from axis' encoder does not have valid differential signals. See Section 10, Mechanical Service, for replacement of motor, encoder, and cabling. This can also be caused by a MOTIF PCB problem. See Section 4.1, Electrical Service, for replacement of the MOTIF PCB.

## 186 SPINDLE NOT TURNING

Status from spindle drive indicates that it is not turning when it is expected. See Section 4.3, Electrical Service, for IOPCB replacement or Section 2 for Spindle Drive problem.

## 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 PROG ERROR

Software Error.

## 207 QUEUE ADVANCE ERROR

Software Error.

## 208 QUEUE ALLOCATION ERROR

Software Error.

**(Cont'd)**



**6. (Cont'd)**

- 209 QUEUE CUTTER COMP ERROR  
Software Error.
- 210 INSUFFICIENT MEMORY  
Not enough memory to store user's program. Check the space available in the LIST PROG mode and possibly delete some programs.
- 211 ODD PROG BLOCK  
Software Error.
- 212 PROG INTEGRITY ERROR  
Software Error.
- 213 EPROM CRC ERROR  
All of these alarms indicate a software or electronics problem. See Section 4.1, Electrical Service, for replacement of Microprocessor PCB.
- 240 EMPTY PROG OR NO EOB  
Software Error.
- 241 INVALID CODE  
RS-232 load bad. Data was stored as comment (RS-232 communications problem or RS-232 program format problem). Check the program being received. See the [Programming and Operation Manual](#).
- 242 NO END  
Software Error.
- 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  
These alarms usually indicate an operator illegal action., such as input line too long. The data entry line must be shortened. See the [Programming and Operation Manual](#).
- 247 CURSOR DATA BASE ERROR  
Software Error.
- 248 NUMBER RANGE ERROR  
Number entry is out of range.
- 249 PROG DATA BEGINS ODD
- 250 PROG DATA ERROR
- 251 PROG DATA STRUCT ERROR
- 252 MEMORY OVERFLOW
- 253 PROG DATA ERROR
- 254 PROG DATA ERROR
- 255 PROG DATA ERROR

256 PROG DATA ERROR

257 PROG DATA ERROR

All of these alarms indicate an RS-232 communication problem or a software or electronics problem. See Programming and Operation Manual for RS-232 operation. See Section 4.1, Electrical Service, for replacement of Microprocessor PCB.

258 INVALID DPRNT FORMAT

This alarm is caused by an error in the way the programmer uses the macro DPRNT function. See the Programming and Operation Manual.

302 - 390

All of the 302 through 390 alarms are caused by programming problems in the users NC program. See the Programming and Operation Manual.

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, OR K IN CANNED CYCLE

**I**, **J**, and **K** in a canned cycle must be greater than zero.

307 SUBPROGRAM CALL NESTING TOO DEEP

Subprogram nesting is limited to nine levels. Simplify your program.

308 CANNED CYCLE NESTING TOO DEEP

Software Error.

309 MAX FEED RATE EXCEEDED

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 M98

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.

(Cont'd)

**6. (Cont'd)**

## 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

## 317 Y OVER TRAVEL RANGE

## 318 Z OVER TRAVEL RANGE

## 319 A OVER TRAVEL RANGE

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.

## 320 NO FEED RATE SPECIFIED

Must have a valid **F** code for interpolation functions.

## 321 AUTO OFF

A fault turned off the servos automatically; occurs in debug mode only.

## 324 INVALID P CODE IN G04

**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 LOOPING 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 CODES 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

## 334 Y-AXIS DISABLED

## 335 Z-AXIS DISABLED

Parameters have disabled this axis. Not normally possible in VMC.

- 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.
- 338 INVALID IJK AND XYZ IN G02 OR G03  
There is a problem with circle definition; check your geometry.
- 339 MULTIPLE CODE  
Only one **M**, **X**, **Y**, **Z**, **A**, **Q**, etc. allowed in any block or two **G** codes in the same group.
- 340 CUTTER COMP BEGINS WITH G02 OR G03  
Select cutter comp earlier.
- 341 CUTTER COMP ENDS WITH G02 OR G03  
Disable cutter comp later.
- 342 CUTTER COMP PATH TOO SMALL  
Geometry not possible. Check your geometry with the Help page.
- 344 CUTTER COMP WITH G18 OR G19  
Cutter comp only allowed in XY plane (G17).
- 345 SCALING PARAMETERS WONT ALLOW G17 PLANE  
Parameters 5 and 19 must be same value.
- 346 SCALING PARAMETERS WONT ALLOW G18 PLANE  
Parameters 5 and 33 must be same value.
- 347 SCALING PARAMETERS WONT ALLOW 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 STOPPED WITHOUT CANCEL OF CUTTER COMP  
Information message only. Fix or Ignore.
- 350 CUTTER COMP LOOK AHEAD TOO SMALL  
There are too many non-movement blocks between motions when cutter comp is being used. Remove some intervening blocks.
- 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 YET  
A ZERO RET has not been done yet on the aux axes. Check auxiliary axes. Status from control was LOSS.
- 354 AUX AXIS NOT CONNECTED  
Aux axes not responding. Check auxiliary axes and RS-232 connections.
- 355 AUX AXIS POSITION LOST  
Mismatch between VMC and aux axes position. Check aux axes and interfaces. Make sure no manual inputs occur to aux axes.

**(Cont'd)**

## 6. (Cont'd)

- 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 CIRC POCKET MILLING  
Check your geometry with the Help page.
- 360 TOOL CHANGER DISABLED BY PARAMETERS  
Check Parameter 57. Not a normal condition for VMC.
- 361 GEAR CHANGE DISABLED BY PARAMETERS  
Check Parameter 57. Not a normal condition for VMC.
- 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  
Override is off and program tried to turn on coolant.
- 364 NO CIRCULAR INTERP ALLOWED ON AUX AXIS  
Only rapid or feed is allowed with aux axes.
- 365 CUTTER COMP INTERFERENCE  
G02 or G03 cut cannot be done with tool size.
- 366 CUTTER COMP INTERFERENCE  
Tool doesn't fit inside of cut.
- 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 FOR CUTTER COMP  
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  
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 INCHES 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.
- 403 - 420  
All of the 403 through 420 alarms are caused by communications problems with RS-232.  
See the [Programming and Operation Manual](#).
- 403 RS-232 DIRECTORY FULL  
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 PROGRAM 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.

(Cont'd)

**6. (Cont'd)**

- 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 FILE  
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.
- 501 - 538  
All of the 501 through 538 alarms are caused by errors in macro programming. See the Programming and Operation Manual.

## 6.1 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 1/2 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 light or not as described in Section 24.1.

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 SP*	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	A161	Safety Interlock status
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	LO PH B	Low voltage in phase 2
12	LO AIR	Low Air Pressure	28	LO PH C	Low voltage in phase 3
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	spare	
16	DB CLS	Tool Clamped	32	spare	

(Cont'd)



**6.1 (Cont'd)****DISCRETE OUTPUTS**

#	Name	Description	#	Name	Description
1	SRV PO	Servo Power On	17	M21	Spare M Functions
2	SP FOR	Spindle Forward	18	M22	
3	SP REV	Spindle Reverse	19	K111	Spindle & T.C. Enable
4	SP RST	Spindle Reset	20	K210	E-Stop Enable
5	4TH BK	4th Axis Brk Rel	21	UNCLPR	Unclamp pre-charge
6	COOLNT	Coolant Pump	22	M26	
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	spare	
10	TC OUT	Tool Changer Out	26	spare	
11	TC CW	Tool Changer CW	27	spare	
12	TC CCW	Tool Changer CCW	28	spare	
13	SP HIG	Spindle High Gear	29	spare	
14	SP LOW	Spindle Low Gear	30	spare	
15	T UNCL	Tool Unclamped	31	spare	
16	SP LOK	Spindle Lock Cmd	32	spare	

The 32 inputs are numbered the same as the 32 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:

**INPUTS2**

Name	Description	Name	Description
X Z CH	X-axis Z Channel	X ZIRQ	X-axis Z channel interrupt
Y Z CHY	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

**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



# MECHANICAL SERVICE

1. HEAD COVERS .....	45
2. TOOL RELEASE PISTON ASSEMBLY .....	47
3. DRIVE BELT .....	51
4. SPINDLE PULLEY .....	55
5. SPINDLE CARTRIDGE .....	57
6. TOOL CLAMP/UNCLAMP SWITCH .....	61
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# 1. Head Covers Removal/Installation

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

## TOOLS REQUIRED:

- 5/32" HEX WRENCH
- CARDBOARD

## HEAD COVERS REMOVAL

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

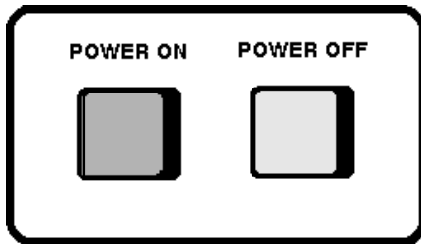


Fig. 1-1 Power on/off button.

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

EDIT	INSERT	ALTER	DELETE	UNDO
MEM	SINGLE BLOCK	DRY RUN	OPT STOP	BLOCK DELETE
MDI	COOLNT	ORIENT SPINDLE	ATC FWD	ATC REV
HANDLE JOG	.0001 .1	.001 1.	.01 10.	.1 100.
ZERO RET	AUTO ALL AXES	ORIGIN	ZERO SINGL AXIS	HOME G28
LIST PROG	SELECT PROG	SEND RS-232	RECY RS-232	ERASE PROG

Fig. 1-2 Spindle control panel.

3. Protect table surface with a piece of cardboard.
4. Remove cover panels. Remove top cover and remove the rear cover (on newer models only), then the front cover. Carefully pull the front cover from the bottom until you can disconnect the tool release cable (quick disconnect), if equipped. Place front cover aside.

5. Remove side covers one at a time. Z-axis may be jogged to make removal of screws easier. After screw removal, the side covers are removed from the top side of the enclosure.

□ Be very careful not to run the head covers into the enclosure.

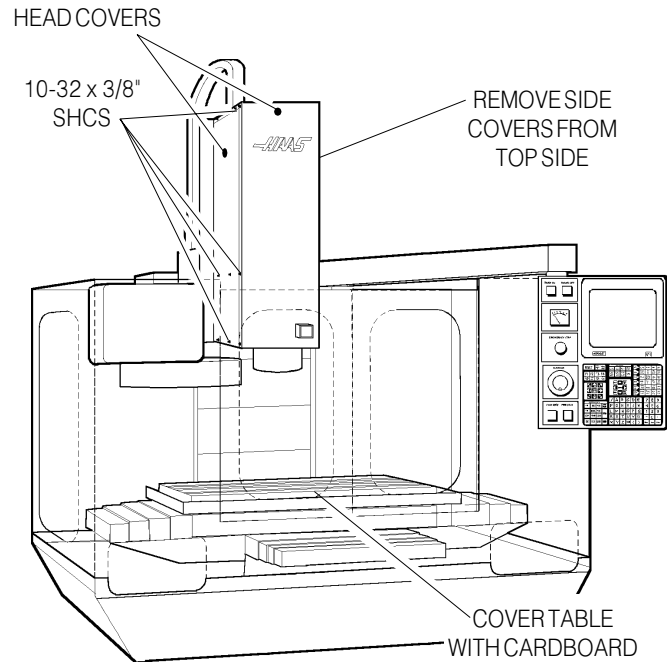


Fig. 1-3 The VF Series Machining Center.  
(Shown with covers to be removed.)

**NOTE:** For installation, ensure all previously removed parts have been replaced, then install in reverse order of removal.



## 2. Tool Release Piston Assembly Removal/Installation

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

### TOOLS REQUIRED:

- 5/16" HEX WRENCH

### 2.1 TOOL RELEASE PISTON ASSEMBLY REMOVAL

1. Remove **cover panels** from headstock area (Section 1.1).
2. Remove the four 3/8-16 x 1<sup>3</sup>/<sub>4</sub>" 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. (On earlier machines, the clamp/unclamp cables are located on the **tool release piston assembly** and must be unscrewed.)

5. Remove the tool-release air hose at the fitting noted (See Figs. 2-2 and 2-3).

6. Remove entire **tool release piston assembly**.

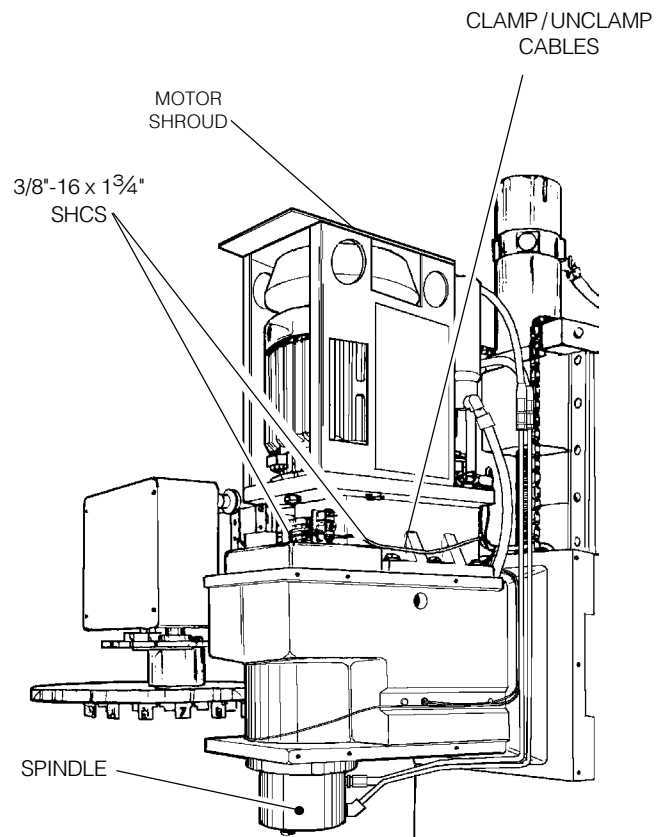
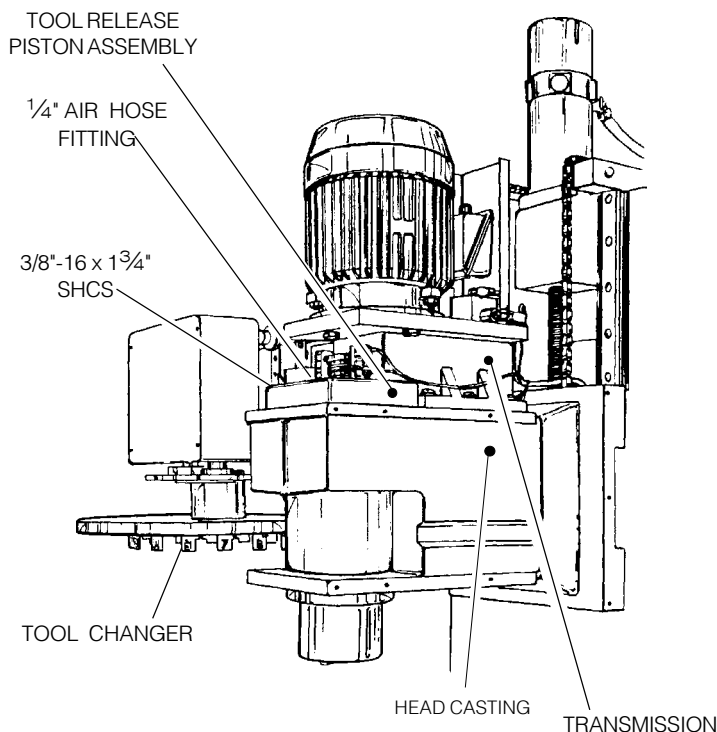


Fig. 2-1 VF-1 spindle and headstock area shown with covers removed. VF-0 will have no transmission. Left: Older models Right: Newer models.



## 2.2 TOOL RELEASE PISTON ASSEMBLY INSTALLATION

1. Ensure **spindle pulley** and **drive belt** have been properly replaced in accordance with the instructions in Sections 3.2 and 4.2.
2. Verify **spindle sweep adjustment** is correct before proceeding (Section 5.3, Mechanical Service). If not correct, re-shim as necessary.
3. Reinstall **tool release piston assembly**, tightening down the four  $3/8-16 \times 1\frac{3}{4}$ " SHCS alternately until all are completely tight.
4. Reconnect the **air hose** at the applicable fitting (Fig. 2-2 or 2-3) on the tool release piston assembly.
5. Reconnect the **clamp/unclamp cables** to the sides of the solenoid bracket. Older models may have a screw-on attachment on the tool release piston assembly.
6. Continue with reassembly and adjustments (Sections 6-9).

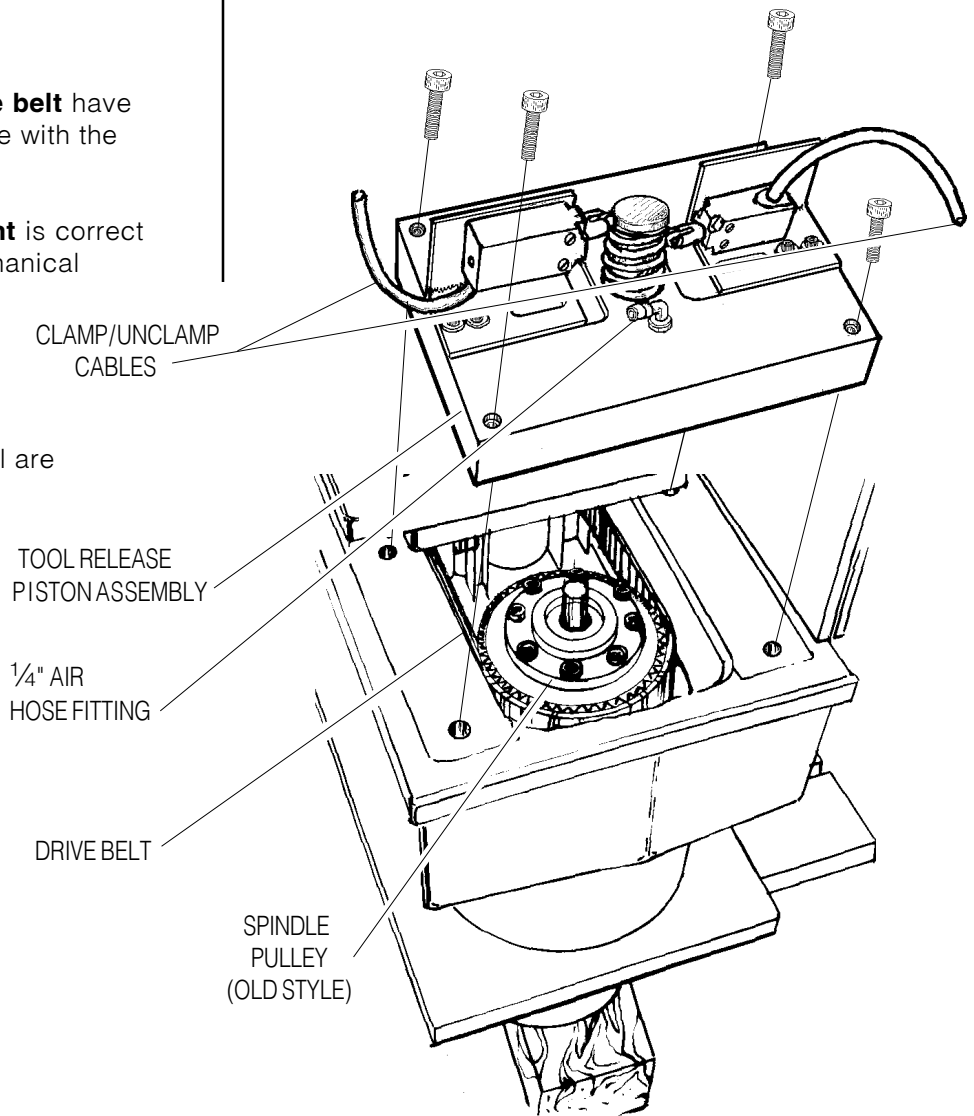


Fig. 2-2 Mounting location for tool release piston assembly.

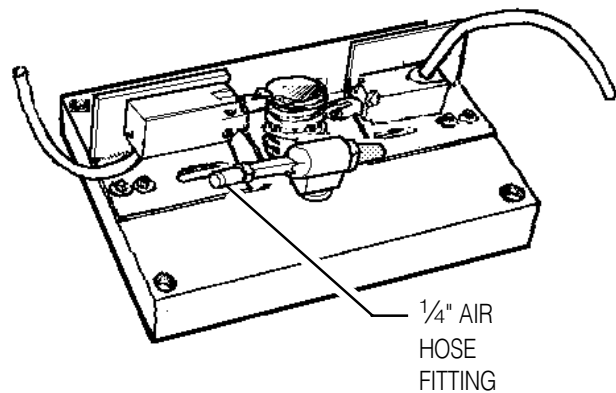
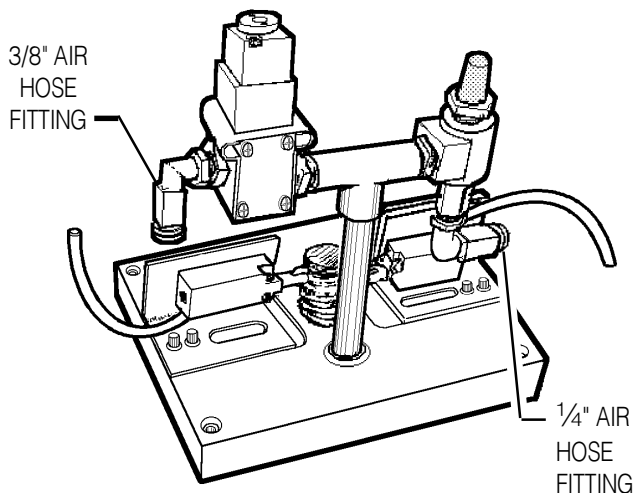


Fig. 2-3 Variations of the tool release piston. Left: Solenoid valve. Right: Quick exhaust valve

## 2.3 SETTING PRE-CHARGE

**NOTE:** This section applies only to machines having a tool release piston assembly with a pre-charge solenoid installed.

1. Remove the **cover panels** (Section 1, Mechanical Service). 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.

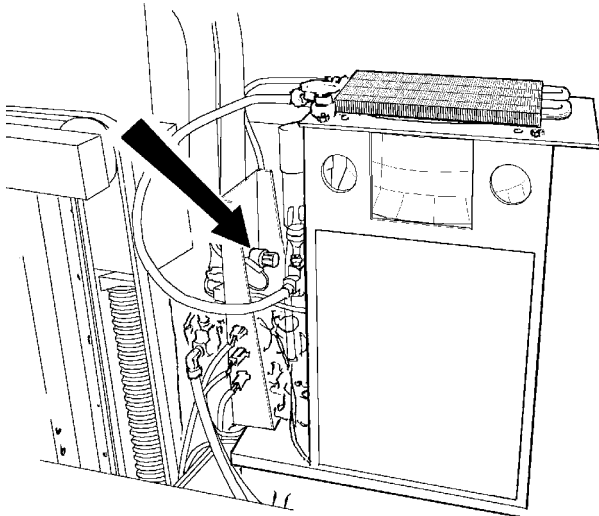


Fig. 2-4 Air pressure regulator adjustment knob.

3. Go to the PARAMETERS page of the CRT and ensure the 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 draw bar.
  5. Turn the air pressure regulator  $\frac{1}{2}$  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.
- NOTE:** 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 Removal/Installation

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

### TOOLS REQUIRED:

- 5/16" HEX WRENCH
- 1/2" ALLEN WRENCH
- 5/8" HEX WRENCH
- 7/16" ALLEN WRENCH
- 5/32" HEX WRENCH
- 3/4" BOX-END WRENCH
- PRY BAR
- GATES BELT TENSION TESTER (PART #12998-F)

### 3.1 BELT REMOVAL

**NOTE:** FOR EASIER REMOVAL, PLACE TRANSMISSION IN **HIGH** GEAR BEFORE BEGINNING.

1. Remove **cover panels** from head stock area (Section 1).
2. Remove the **tool release piston assembly** (Section 2.1).

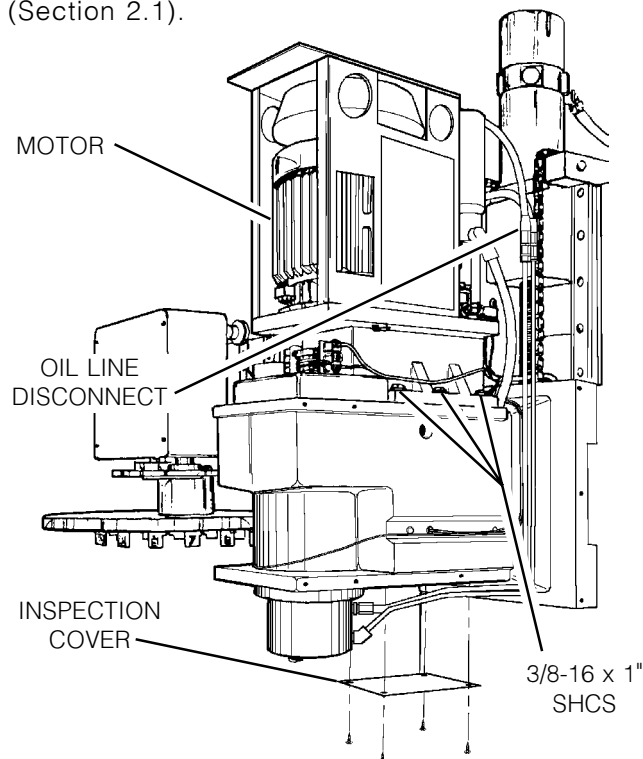


Fig. 3-1 Spindle head casting disconnect points (VF-1, VF-2)

**NOTE:** Steps 3 through 7 apply to the only the first 50 VF-2 machines built, and any VF-1 machines built between January 1, 1992 and March 31, 1992. These machines can be identified by removing the inspection cover from the spindle head and inspecting the clearance between the center web in the spindle head

casting and the transmission sump tank. If there is very little clearance (less than belt thickness), the machine is an early model. Go to step 3. For later machines, skip to step 4.

3. For early machines, remove the six 3/8-16 x 1 1/4" SHCS holding the transmission to the spindle head casting. Using a 5/8" wrench, disconnect the spindle **oil lines** from the motor and transmission assembly.
4. Lift the transmission and motor assembly to the point where the **sump tank** clears the center web in the spindle head casting. (It is highly recommended that you use the Haas Transmission Lift at this time. See Section 9 for the correct removal procedures.)

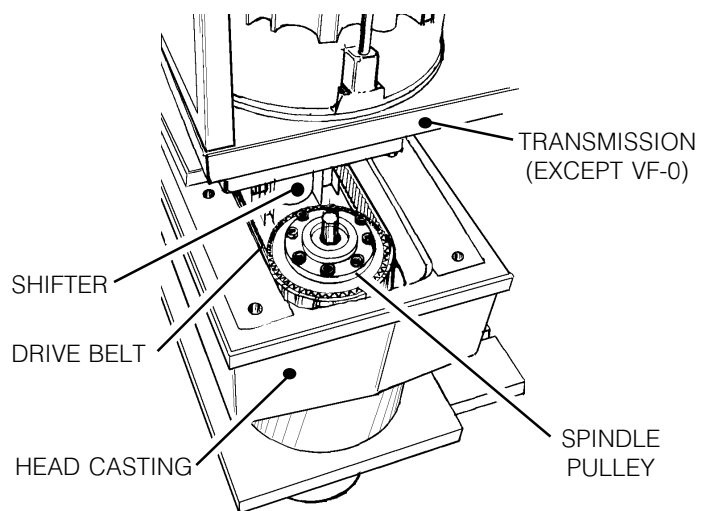


Fig. 3-2 Head casting area showing belt location (VF-1/VF-2 shown).

5. For all other VF-1's, VF-2's, and VF-3's, remove the six 3/8-16 x 1 1/4" SHCS holding the transmission to the head casting and pull the transmission forward enough (1/2" to 3/4" max.) to allow the **drive belt** to be pulled upward over the spindle pulley.
6. For the VF-0, remove the four 3/8-16 x 1 1/4" 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.
7. Remove the **inspection cover** from the bottom of the spindle head casting (Fig. 3-1) and carefully slide the **drive belt** between the sump tank and the web in the casting.

(Cont'd)

### 3.1 (Cont'd)

8. 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 the early machines, push the **belt** down into the head casting between the shifter and spindle pulley and loop it onto the transmission pulley.

2. For all other VF-1's, VF-2's, and all VF-3's (two belts on all VF-3's), slide the replacement belt(s) under the sump tank and lower the transmission down onto the spindle head casting.

**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. 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.

4. Tighten the **drive belt** in accordance with the instructions in Section 3.3.

5. Set the Spindle orientation as described in Section 7.

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

6. Double-check the **spindle sweep** (Section 5.4) to assure that nothing has moved during the previous steps. If sweep is within tolerance, continue; if not, sweep must be readjusted. (If this is the case, there is no need to completely disassemble the spindle assembly. Simply loosen the set screws, the spindle lock ring, and the six 3/8-16 x 3/4" SHCS and re-shim as necessary.)

**NOTE:** Drive belt's tension must be adjusted after every installation. See Section 3.3 for specifications.

### 3.3 TENSION ADJUSTMENT

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

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

2. Remove the **cover panels** from the head stock area (Section 1).

3. Remove the **tool release piston assembly** (Section 2.1).

4. Screw a 3/8-16 x 1 1/4" bolt into each of the rearmost mounting holes for the tool release piston assembly on the spindle head casting. The bolt should protrude 1/2"-3/4" above the casting.

#### **VF-1, VF-2, VF-3:**

5. Loosen the six 3/8-16 x 1 1/4" 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 according to the following chart.

**NOTE:** On all machines built after approximately 10/91, a hole has been drilled in the spindle head casting to allow the use of the Gates Belt Tension Tester.

7. Tighten the 3/8-16 x 1 1/4" SHCS holding the **transmission** to the **spindle head casting**.

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

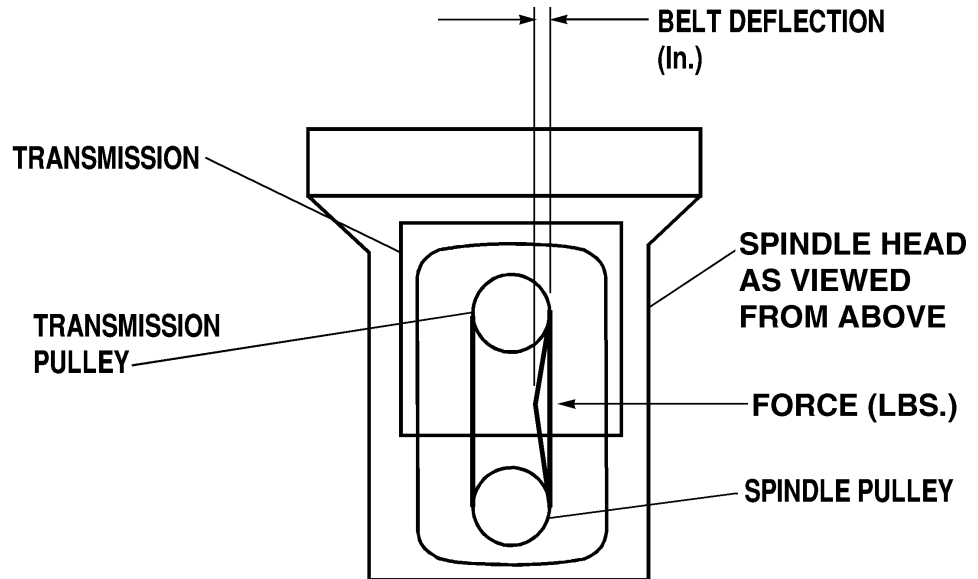
#### **VF-0:**

9. Loosen the four 3/8-16 x 1 1/4" 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 according to the following chart.

11. Retighten the 3/8-16 x 1 1/4" SHCS holding the **motor plate** to the **spindle head casting**.

12. Recheck the belt tension and repeat steps 9-11, if necessary.



MACHINE MODEL	BELT MODEL	BELT WIDTH	FORCE (LBS.)	BELT DEFLECTION
VF-1 BUILT PRIOR TO APPROX. 10/91	HTD	30 mm	3 to 6	9/64
VF-1 BUILT PRIOR TO APPROX. 10/91; ALL VF-2's AND VF-3's	GT	18 mm	7.2	1/8
		21 mm	8.5	
VF-0	GT	21 mm	7.8	1/8

Fig. 3-3 Spindle head casting and belt tension chart.



## 4. Spindle Pulley Removal/Installation

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

### TOOLS REQUIRED:

- 7/16" SOCKET or 3/16" HEX SOCKET
- 1/4" STUBBY BLADE SCREWDRIVER

**NOTE:** On machines built after February 1993, the pulley is shrink-fitted onto the spindle and is not field-serviceable. This also applies to all VF-3's.

### 4.1 SPINDLE PULLEY REMOVAL

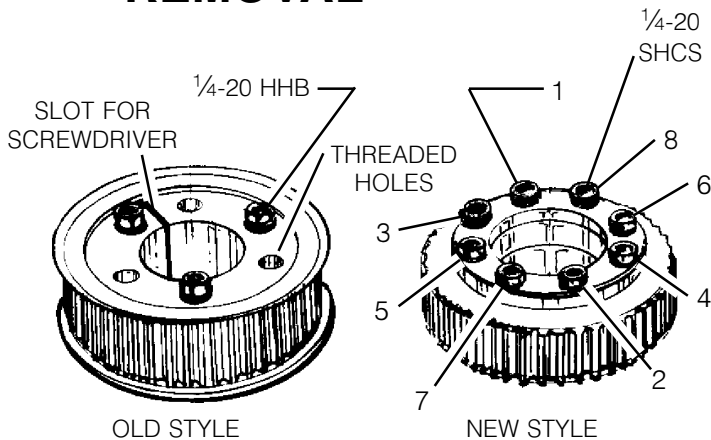


Fig. 4-1 Spindle pulleys.

1. Remove **cover panels** from head stock area (Section 1).
2. Remove the **tool release piston assembly** (Section 2.1).

#### [Old Style Pulley]

3. Remove the three 1/4" HHB's located on the **spindle pulley** and insert them in the holes next to them.
4. Evenly tighten these bolts until the taper lock is broken.
5. Insert the 1/4" stubby blade screwdriver into the pulley hub relief slot located at the keyway.
6. Lightly tap the screwdriver until the center hub is loosened.

7. Remove **pulley** and **key** from spindle shaft.

#### [New Style Pulley]

8. Remove the eight 1/4-20 SHCS.
9. Remove **pulley** from shaft.

## 4.2 SPINDLE PULLEY INSTALLATION

1. After sweep is within tolerance (Section 5.4), install spindle **lock ring** and then tighten set screws and install the pulley key.

#### [Old Style Pulley]

2. Remove bolts from pulley and reinstall in original holes. Tighten finger-tight. Tap 1/4" stubby blade screwdriver into relief slot.

3. Install **pulley** onto spindle shaft and, using a flexible ruler, set top right side of spindle pulley 1 1/8" from top of head casting (Dimension "A" in Fig. 4-2), where tool release piston assembly normally sits.

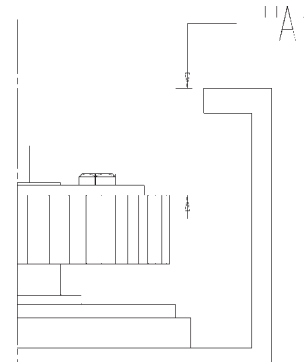


Fig. 4-2 Pulley installation location.

4. Remove screwdriver and recheck height. As you evenly tighten the hex bolts, the pulley will be drawn up into the center hub taper. The final height should be 1" with all bolts firmly tightened.

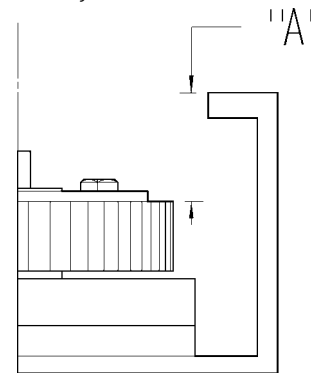


Fig. 4-3 Pulley with oil injection cover.

#### [New Style Pulley]

5. Install the eight 1/4-20 SHCS and tighten finger-tight.

(Cont'd)



## **4.2** (Cont'd)

6. Install **pulley** onto spindle shaft. Torque the screws in the sequence shown in Fig. 4-1 to five (5) ft.-lb.

7. Torque the screws a second time, now to 10 ft.-lb. The final height should be 1" with all bolts firmly tightened (Dimension "A" in Figs. 4-2, 4-3).

***DO NOT OVER TIGHTEN BOLTS.***

## 5. Spindle Replacement

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

### TOOLS REQUIRED:

- 1/8" HEX WRENCH
- 5/16" HEX WRENCH
- 3/16" ALLEN WRENCH
- WOOD BLOCK (6" x 6" x 6")
- SHIMS (.0005, .001, .0015, .002)
- CARDBOARD
- 1/2" HEX WRENCH
- 7/16" HEX WRENCH
- RUBBER Mallet

### 5.1 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.



USE EXTREME CAUTION WHEN PERFORMING THIS OPERATION.

2. Remove **cover panels** from head stock area (Section 1).
3. Disconnect the **air cooling tube** or, on newer models, disconnect the two **oil lines** from the back side of the spindle, whichever is applicable. Plug the oil lines to prevent fluid from siphoning out of the transmission.
4. Remove the **tool release piston assembly** (Section 2.1).
5. Remove the spindle **drive belt** from the spindle pulley (Section 3.1). It is not possible to completely remove the belt at this time.
6. Remove the spindle **pulley** (Section 4.1).
7. On newer models, first disconnect the **oil line** from the fitting at the **oil injection cover**, then remove the **brass fitting** (Fig. 5-1).
8. Loosen the two 1/4-20 set screws that anchor the lock rings.
9. Using a soft metal punch, gently tap to loosen and remove the **lock ring**. It is *right-hand thread*; turn counterclockwise.

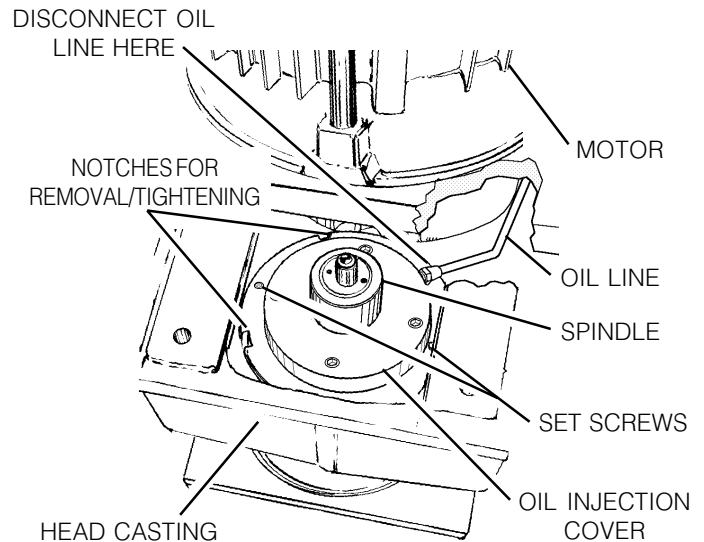


Fig. 5-1 Oil injection cover and oil line disconnect.

10. With the 5/16" hex wrench, loosen approximately two turns the six 3/8-16 x 3/4" SHCS holding the spindle to the underside of the head casting.

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

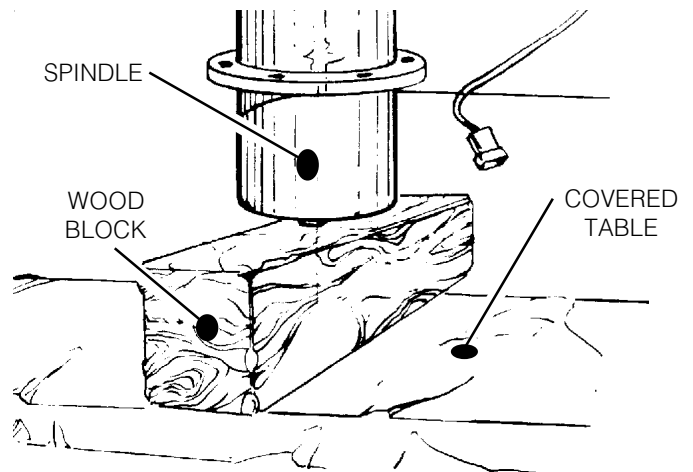


Fig. 5-2 Position wood block under spindle.

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

(Cont'd)

## 5.1 (Cont'd)

13. Jog Z-axis in the positive (+) direction until spindle is half way out of the head casting.
14. Grasp **spindle** with one hand and continue to jog in Z in the positive (+) direction until it is completely free of the casting.

## 5.2 SPINDLE CARTRIDGE INSTALLATION

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. Clean **spindle cartridge** threads by screwing on and off the lock ring.

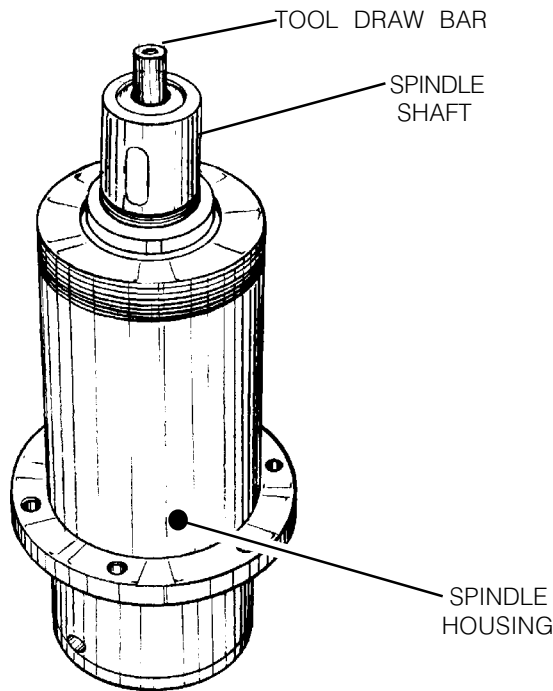


Fig. 5-3 Spindle cartridge.

3. Place spindle on wood block making sure both spindle dogs contact the block. Align the two 10-32 holes located on the spindle lock (see Figure 5-5) so they are approximately 90 degrees (90°) from the front of the spindle on the right side.

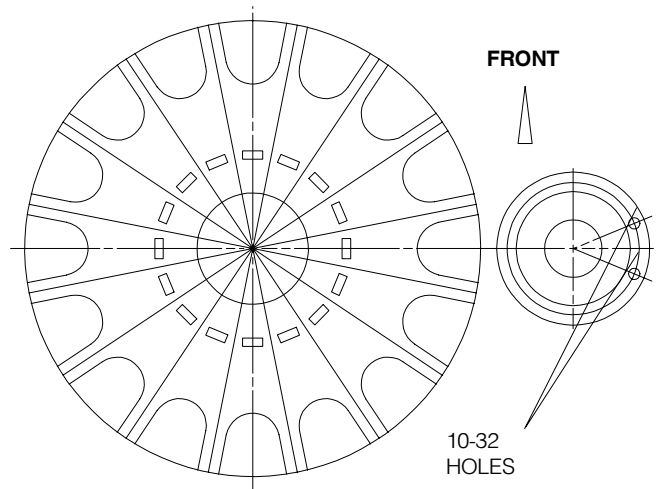
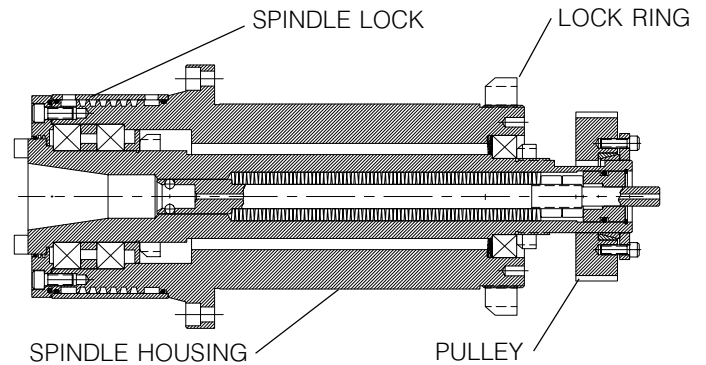


Fig. 5-4 Underside view of spindle cartridge.

4. 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.*

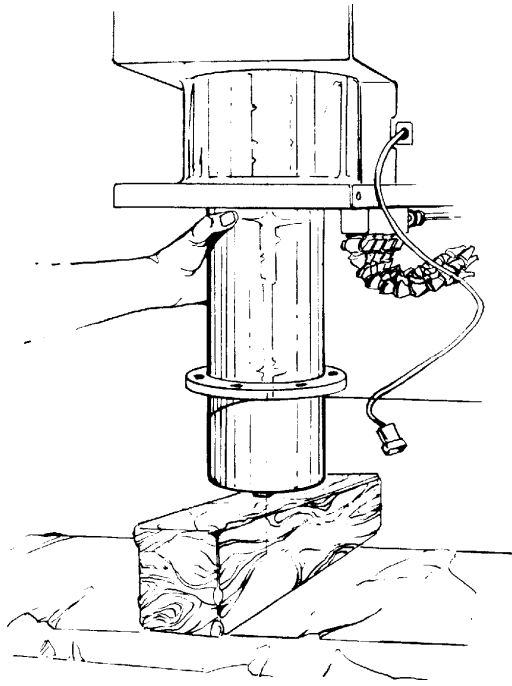


Fig. 5-6 Spindle cartridge alignment.

5. 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.***

6. Install the six 3/8-16 x 3/4" SHCS and tighten down completely.
7. Screw the lock ring onto the spindle shaft and fasten with the two 1/4-20 set screws.
8. Screw the locking ring onto the spindle cartridge (clockwise) until it is snug.
9. Replace and tighten down the two 1/4-20 set screws previously removed.
10. Reattach the brass fitting to the oil injection cover and connect the oil line to the fitting.  
**CAUTION!** Do not over tighten the fittings when replacing on the oil injection cover. Overtightening will result in damage to the spindle cartridge and leaks in the spindle cooling/gearbox lubrication system, and this damage can only be repaired at the factory.
11. Reinstall the spindle pulley (Section 4.2).
12. Reinstall the drive belt (Section 3.2) and adjust the tension as needed (Section 3.3).

13. Reinstall the tool release piston assembly (Section 2.2).
14. Reconnect the air cooling tube or, on newer machines, the two oil lines on the back side of the spindle.

## 5.3 DRAWBAR REPLACEMENT

### REMOVAL:

1. Place a tool holder with no cutter in the spindle.
2. Remove **cover panels** (Section 1).
3. Remove the **tool release piston** (Section 2.1).
4. Remove the **snap ring** from the top of the spindle shaft.
5. Reinstall the **tool release piston** (Section 2.2).
6. Remove the **tool holder** from the spindle.
7. Remove the **spindle** (Section 5.1).
8. Remove the **drawbar** and the **distance tube** from the spindle assembly.

### INSTALLATION:

9. Thoroughly coat the replacement **drawbar** with "Never-Seize", including the end of the shaft where the four **holding balls** are located.
10. 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.

**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.

11. Insert the **distance tube** onto the end of the **drawbar**.

(Cont'd)

## 5.3 (Cont'd)

12. Install the **spindle cartridge** (Section 5.2, Mechanical Service). The **tool release piston** will have to be reinstalled at this time (Section 2.2).
13. Install a tool holder with no cutter into the spindle taper.
14. Remove the **tool release piston** (Section 2.1).
15. Install the snap ring on the spindle shaft.
16. Reinstall the **tool release piston** (Section 2.2).
17. Finish installation of the **spindle** (Section 5.4).
18. Set the drawbar height, clamp and unclamp switches (Section 6).  
**NOTE:** Step 18 must be followed or damage to the ATC will result.
19. Set the **spindle orientation** (Section 7).
20. Reinstall the **head covers** (Section 1).
21. Test-run the machine and adjust the ATC as necessary (Sections 14.3, 14.4).

## 5.4 SPINDLE SWEEP ADJUSTMENT

1. Loosen the two  $\frac{1}{4}$ -20 set screws that anchor the lock ring.
2. Using a soft metal punch, gently tap to loosen and remove the **lock ring**. It is a *right-hand thread*; turn counterclockwise.
3. 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.
4. Establish reference zero at rear of the table. Sweep the three remaining points (left, front, and right) and record the reading.

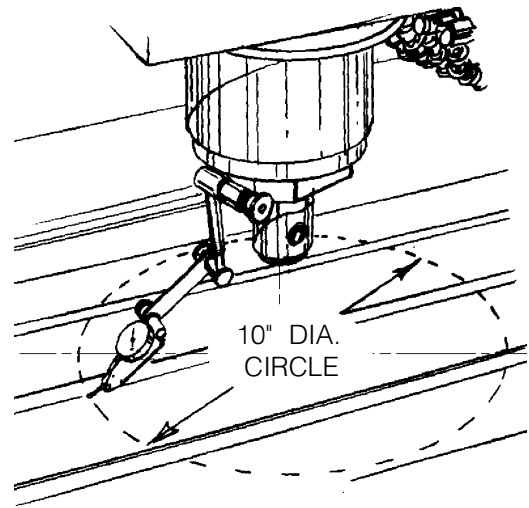


Fig. 5-7 Spindle sweep area.

5. Shim the spindle if necessary to correct the spindle sweep to specifications.
6. 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.
7. Reassemble VMC in reverse order (spindle pulley then drive belt). Refer to Sections 1 - 4, Mechanical Service, for correct procedures. Ensure there is at least 0.0015 gap between spindle shaft and oil injection cover. Continue with reassembly and adjustment steps (Sections 6-9).

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

## 6. Tool Clamp/Unclamp Switch Adjustment; Shim Washer Addition/Removal; Draw Bar Height Setting

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")
- 1" DIA. PIPE (APPROX. 1' LONG)
- 3/16" HEX WRENCH
- 5/16" HEX WRENCH
- HAMMER
- 6" FLEXIBLE RULER or .020" SHIM

### 6.1 TOOL CLAMP/UNCLAMP SWITCH ADJUSTMENT - INITIAL PREPARATION

1. Remove **cover panels** (Section 1).
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.
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.

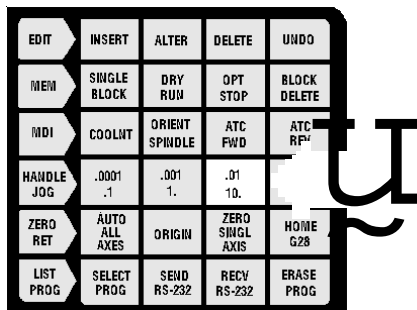


Fig. 6-1 Z-axis jog increment setting (.01).

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.

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

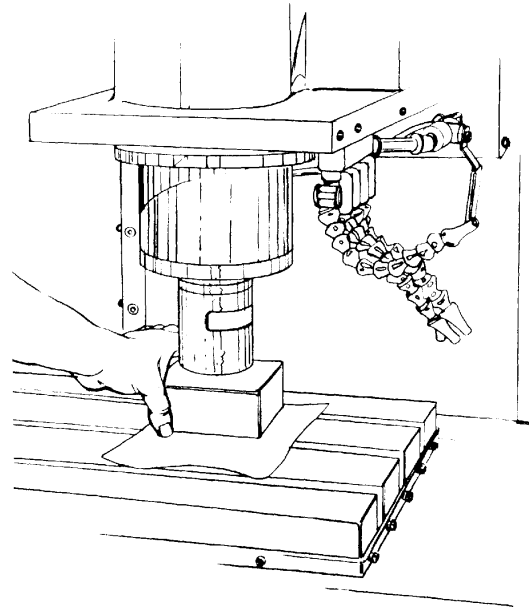


Fig. 6-2 Placement of aluminum block under spindle.

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).

*Do not jog too far in the negative (-) direction! This will cause overcurrent in the Z-axis!*

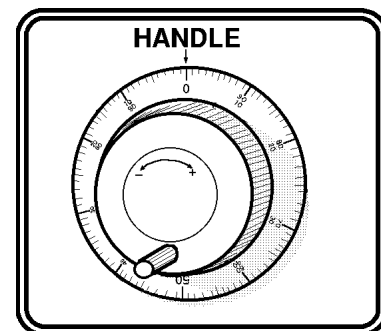


Fig. 6-3 Hand wheel.

## 6.2 SETTING DRAWBAR HEIGHT

1. Set **hand wheel** to 0 by pushing MDI and turning hand wheel to zero (0).

2. Push handle jog button and set increments to .01. Jog Z-axis in the positive (+) direction .100".

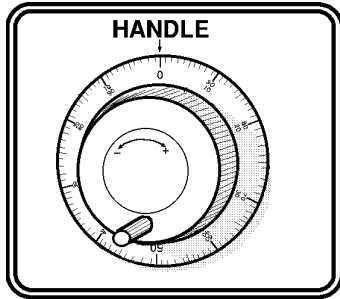


Fig. 6-4 Hand wheel.

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 (See Section 6.3).*

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 (See Section 6.3).*

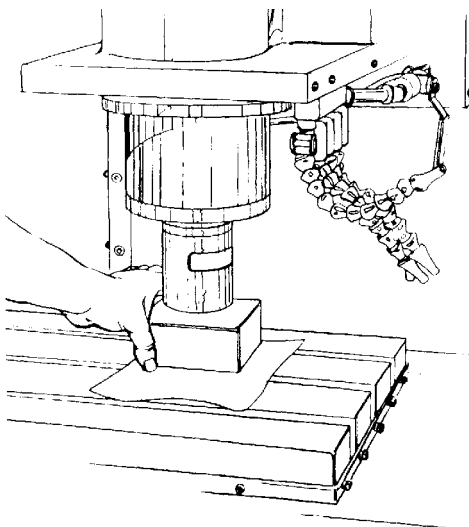


Fig. 6-5 Checking block movement.

## 6.3 SHIM WASHERS

1. To add or subtract shim washers, remove **tool release piston assembly** (Section 2.1) from head casting.

*Shims may need replacement when spindle cartridge, tool release piston assembly, or drawbar is replaced. If none have been replaced, skip to Section 6-4.*

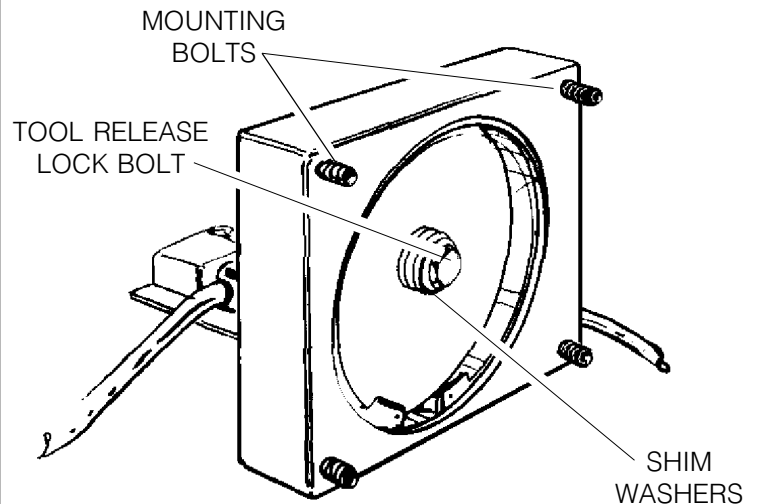


Fig. 6-6 Tool release piston assembly (bottom view).

2. Remove tool release **bolt** (See Fig. 6-6).

3. Add or subtract required **shim washers** (See Section 6.2 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.

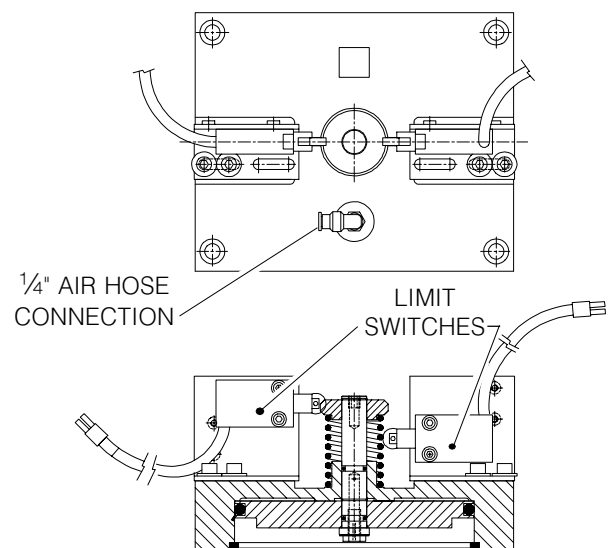


Fig. 6-7 Tool release piston assembly (Old assembly shown).

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

## 6.4 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 (Section 6.2), jog Z-axis in the positive (+) direction .06.

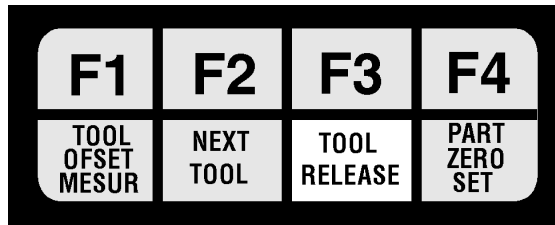


Fig. 6-8 Control panel highlighting tool release button.

3. Press tool release button and hold it. DB OPN should change from a "0" to a "1". If it does not, slightly loosen the two 1/4-20 x 1/2" SHCS holding the unclamp switch bracket (switch on right) to the tool release assembly. *On earlier machines, loosen nut that holds the switch to the bracket.*

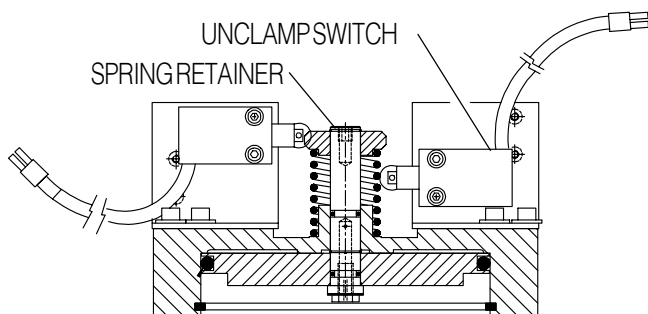


Fig. 6-9 Tool release piston assembly (cutaway).

4. While activating tool release (Figure 6-8), tap unclamp switch assembly towards spring retainer until it just trips. *On earlier machines, loosen or*

*tighten nuts accordingly. 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.

**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.

### UPPER (CLAMP) SWITCH -

6. Place a **shim** (approximately .020 thick), or the flexible ruler, between the **tool release piston** and the draw bar (See Fig. 6-10).

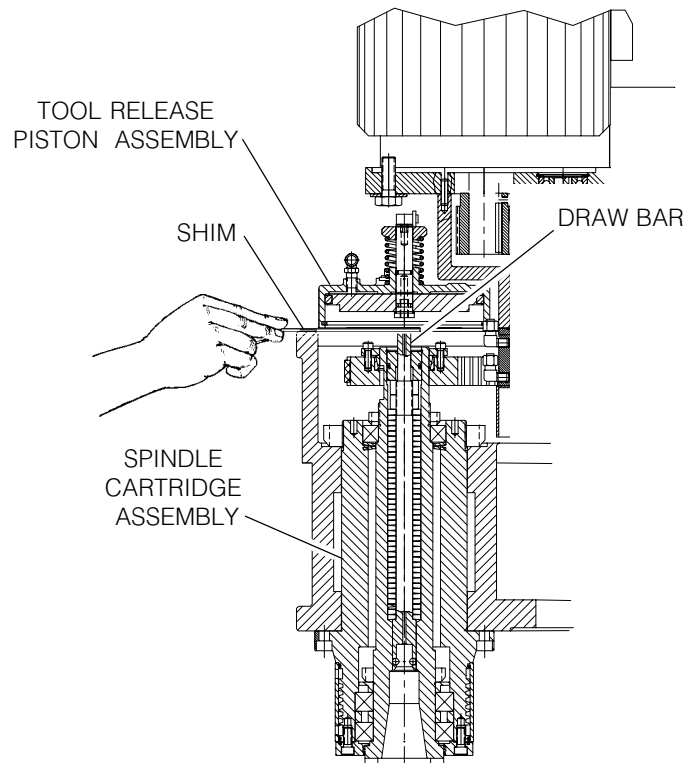


Fig. 6-10 Placement of shim before checking switch adjustment.

(Cont'd)



## 6.4 (Cont'd)

7. 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 (Fig. 6-12).

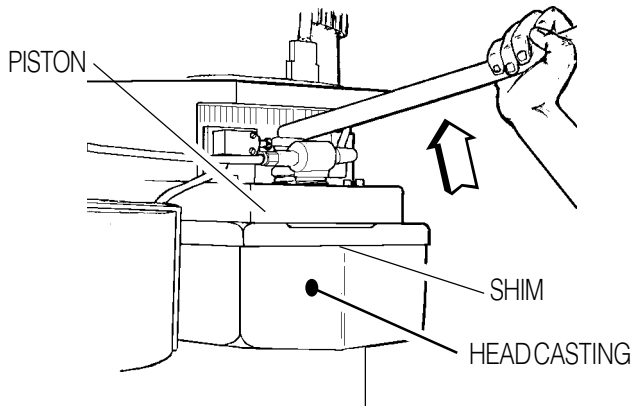


Fig. 6-11 Push piston down to hold shim in place (VF-1, VF-2).

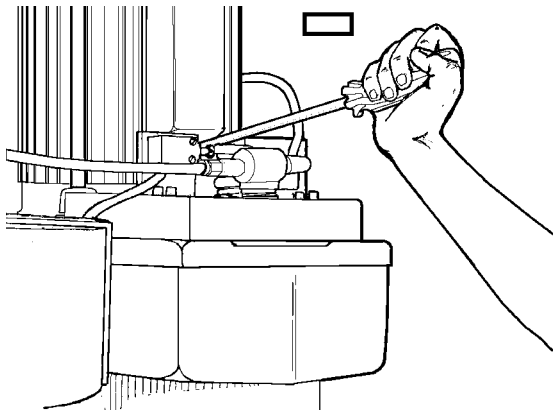


Fig. 6-12 VF-0 tool release piston adjustment.

8. Push down on the tool release piston again until it contacts the draw bar. Monitor the TOOL UNCLAMP light on the screen.

9. Using a hammer, *lightly* tap the bottom of the switch mounting bracket until the TOOL UNCLAMP light goes off. *Do not* tap the switch too far, only enough to trip the TOOL UNCLAMP light.

10. Tighten the **switch** in place.

*(Check for correct operation by again pushing down on the tool release piston. Hit the tool release button and hold the piston down with the pipe. The TOOL UNCLAMP light should be on. Release the pipe and the light should go off.)*

## 7. Spindle Orientation

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

### TOOLS REQUIRED:

- 7/16" SOCKET W/RATCHET or 3/16" HEX SOCKET
- 5/32" HEX WRENCH
- 3/4" WRENCH
- SCREWDRIVER

### SPINDLE ORIENTATION:

1. Remove **cover panels** from head stock area (Section 1.1) and tool changer **front cover**.
2. On Toshiba motor only: with the 3/4" wrench, remove the three hex head bolts that hold the **spindle motor** to the transmission (Initiate a tool release to facilitate access to the front bolt.).
3. With a tool holder in the spindle, initiate a tool change.

**STOP THE TOOL CHANGER BEFORE IT ENGAGES TOOL HOLDER BY PRESSING EMERGENCY STOP.**

4. With a screwdriver, push **tool changer arm** so that tool changer moves towards tool holder. While doing this, turn tool holder so that keyway is aligned with the **extractor key**. Push arm all the way over, so that the tool changer fully engages tool holder.

5. Disconnect the air supply to the machine, pivot the spindle motor to the right side of the machine (Toshiba motor only).

6. 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 taper. Evenly tighten these two bolts until the taper lock is broken.

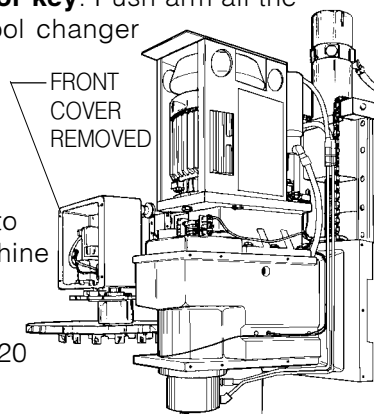


Fig. 7-1 Carriage casting. (VF-1/VF-2 shown.)

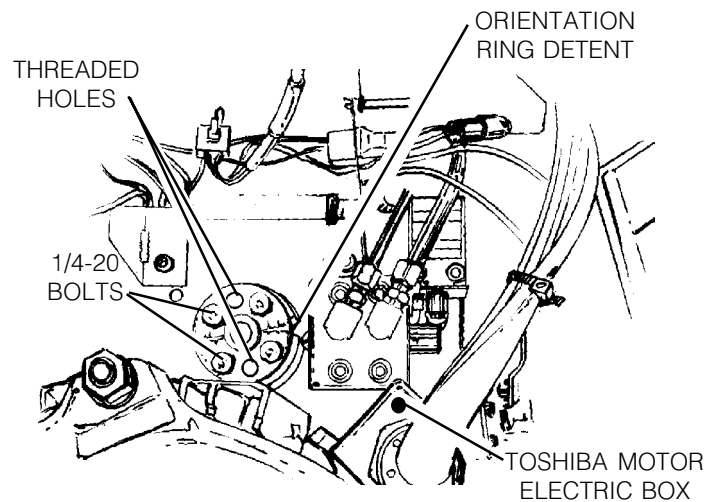


Fig. 7-2 Top view of spindle orientation components (VF-1/VF-2).

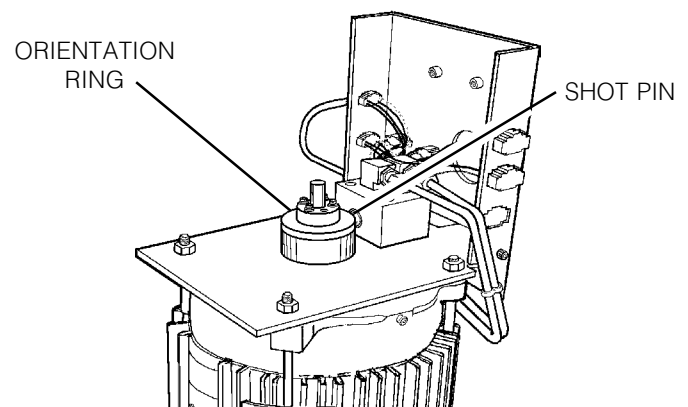


Fig. 7-3 VF-0 motor with orient ring location. Motor shroud not shown.

7. Manually turn the **orientation ring** and push the **shot pin** until it drops into the orientation ring detent.
8. Remove the two 1/4" bolts and place them in their original holes. While pushing shot pin into detent, tighten the four bolts. *These bolts must be tight.*
9. Reconnect the air line.
10. Reset alarms and zero return the Z-axis by going into ZERO RET mode, push Z, then push ZERO SIGL AXIS to bring shuttle out and home the axis.
11. Reinstall the three hex head bolts that hold spindle motor to transmission and tighten (Toshiba motor only).



## 8. Setting Parameter 64

Please read this section in its entirety before attempting to set Parameter 64.

### SETTING PARAMETER 64: (TOOL CHANGE OFFSET)

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

1. *WITHOUT* a tool in the spindle taper, initiate a tool change and stop the tool changer using the **EMERGENCY STOP** button. 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 flange "A" of tool holder (looking directly into pocket). Move indicator to bottom right flange "B" of tool holder. Any difference between these flanges should be equally divided. For example: if a difference of .002 from left side to right side flange, adjust indicator dial so that indicator reads .001 when it is on either flange. This gives you the tool offset reference.

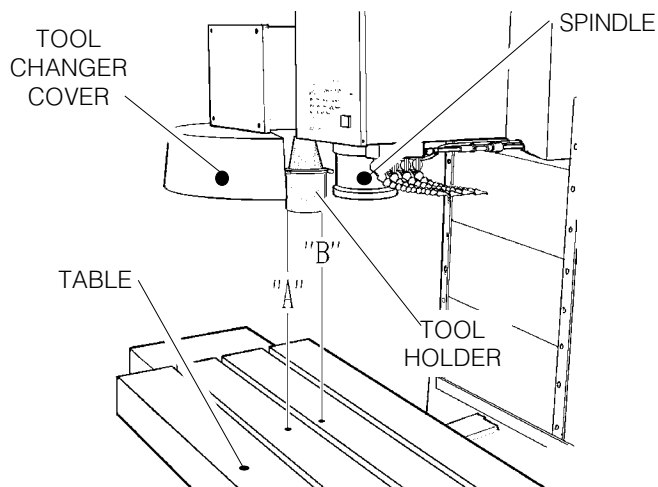


Fig. 8-1 Checking tool offset reference.

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 the bottom left flange of the tool holder.

If spindle head is too far in the negative (-) or the positive (+) direction, go to the 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.

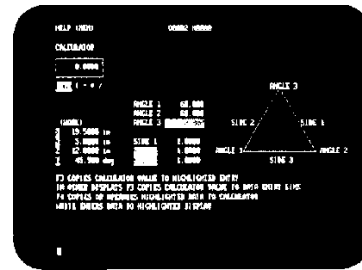


Fig. 8-2 Screen showing calculator.

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.

Make sure the tool changer operates properly.

**NOTE:** When the Parameter 64 is changed, the tool offsets must be reset.



## 9. Spindle Motor & Transmission

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

### TOOLS REQUIRED:

- 5/32" HEX WRENCH
- 3/8" HEX WRENCH
- 1/2" DRIVE RATCHET
- RUBBER Mallet
- 3/8" DRIVE RATCHET
- CARDBOARD
- ADJUSTABLE PLIERS
- 1/4" STUBBY BLADE SCREWDRIVER
- TWO WOOD BLOCKS (6"x 6"x 6")
- 2" x 4" x 4" ALUMINUM BLOCK
- SHIM WASHERS (.001, .0015, .002, .0005, .010)
- 5/16" HEX WRENCH
- 9/16" x 3/8" DRIVE SOCKET
- 7/16" x 3/8" DRIVE SOCKET
- 3/4" x 1/2" DRIVE SOCKET
- 3/4" BOX-END WRENCH
- GREASE

### 9.1 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.



USE EXTREME CAUTION WHEN PERFORMING THIS OPERATION.

2. Remove the **cover panels** from head stock area (Section 1).
3. Remove the **tool release piston assembly** (Section 2.1).
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.

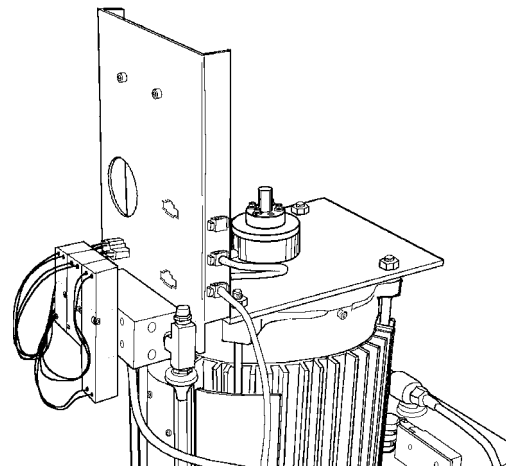


Figure 9-1 Older model VF-0 without lifting eyeholes.

7. Remove the two 1/4-20 x 1/2" SHCS holding the tube to the **solenoid bracket** and position the tube so as to not interfere with removal of the motor. It may be necessary to tie the tube back to the Z-axis motor to keep it in place.

8. Remove the four 3/8-16 x 1" 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 (See Section 9.3 for assembly and setup). Older models will not have a lift point and will have to be lifted manually, so extreme caution should be used. Newer models will have two lifting eyes to be used as lift points (See Fig. 9-2).

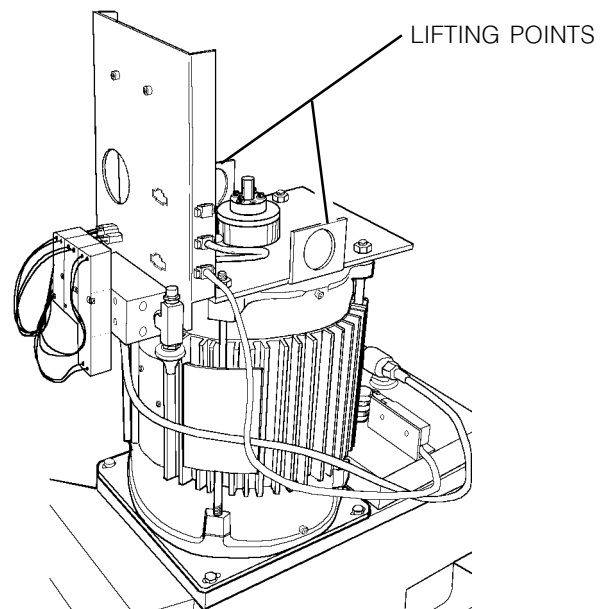


Figure 9-1 Newer model VF-0 with lifting eyeholes.

## 9.2 INSTALLATION (VF-0)

- Carefully lower the motor assembly down to just above the spindle head casting, taking care to not damage the drive pulley or pinch the drive belt.
- Place the drive belt on the motor's drive pulley and lower the motor down onto the spindle head casting.
- Insert and tighten down the four 3/8-16 x 1" SHCS attaching the motor to the spindle head casting. Adjust the drive belt as noted in Section 3.3 before tightening down completely.
- Set the spindle orientation as noted in Section 7.
- Check for proper orientation of the machine and be aware of any unusual noises or vibration that may occur because of incorrect belt tension.
- Reattach the tube 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.

## 9.3 HOIST PRE-ASSEMBLY

- Attach the **mast support** to the **support base**, using the four 3/8-16 x 1 1/4" SHCS, four 3/8" flat washers, four split washers, and the four 3/8-16 hex nuts (Fig. 9-1). Ensure the bolts are securely tightened.

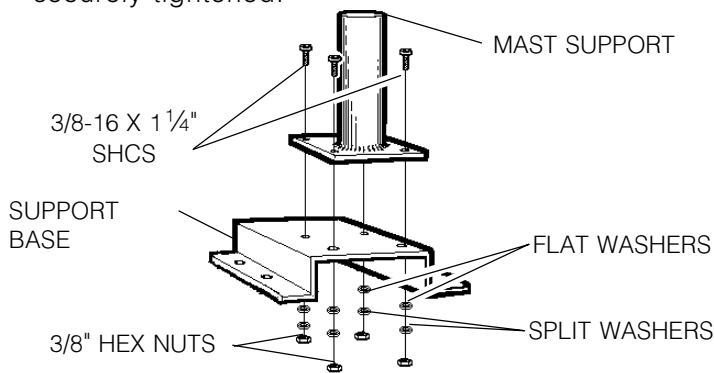


Fig. 9-3 Support base/mast support assembly.

- Attach the boom **modification plates** to the mast (Fig. 9-2) using the three 1/2-13 x 4 1/2" HHB, three 1/2" split washers, three 1/2-13 hex nuts, and the three spacers.

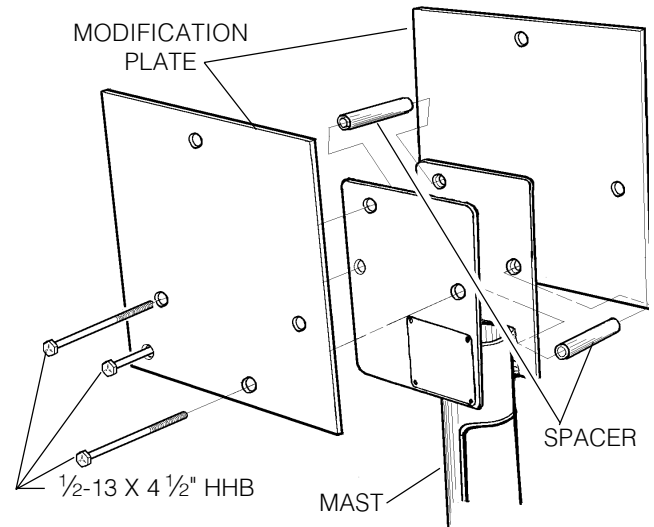


Fig. 9-4 Exploded view of boom modification plate components. (Hex nuts and washers not shown.)

- Assemble the **boom assembly** as follows:
  - Lubricate the components of the assembly:
    - Using a grease brush, apply grease to the through-hole and the side surfaces of the pulley wheel.
    - Wipe a thin coat of oil on the entire cable.
    - Lubricate all clevis pins with a thin layer of grease.
    - Oil all bearings on the winch and apply grease to the gear teeth.
  - Place the **pulley wheel** inside the cable guide and place this subassembly into the end of the boom (Fig. 9-5). 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.
  - Attach the **winch base** to the boom with the two 3/8-16 x 1" 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.
  - Feed the free end of the cable (without hook) between the pulley and cable guide and through the inside of the boom.

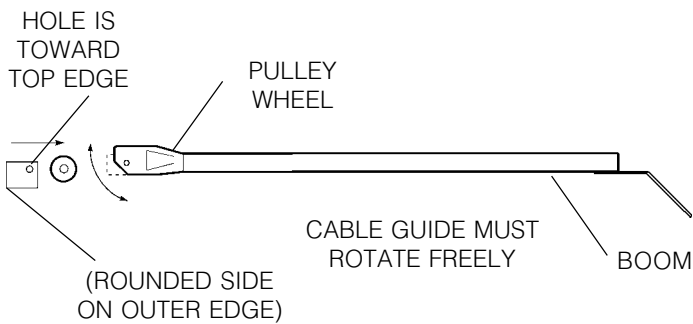


Fig. 9-5 Mounting cable guide and pulley wheel to boom.

- 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. Assemble the **cradle** as follows:
  - A. Attach frame C to frames A and B as shown, using two 1/4-20 x 1/2" SHCS, two 1/4" medium split washers, and two 1/4-20 hex nuts. Do not over tighten the bolts - the frame sections must slide over the transmission during removal.
  - B. Attach the **transmission stops** (frame D) to frames A and B as shown, using one 1/4-20 x 1/2" SHCS, one 1/4" medium split washer, and one 1/4-20 hex nut for each part. Adjust the stops as necessary and tighten securely.
  - C. Fasten all the 5/16-18 shoulder **eye bolts** to the frame members with the 5/16" split washers and 5/16-18 hex nuts. Assemble as shown and tighten securely.

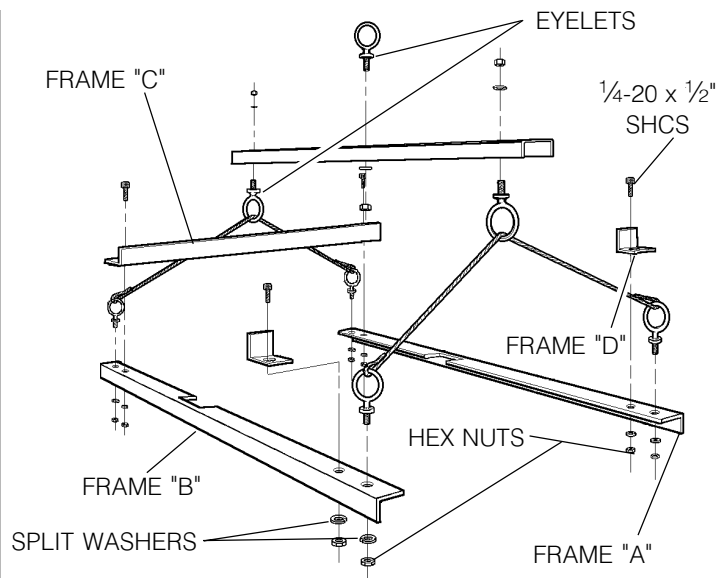


Fig. 9-6 Exploded view of cradle assembly.

## 9.4 TRANSMISSION REMOVAL (VF-1/2/3/4)

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 (Section 1).
3. Remove the **tool release piston assembly** (Section 2.1).
4. Remove the six 3/8-16 x 1 1/4" SHCS holding the transmission to the head casting. Slide the transmission forward enough to release the **drive belt** from the transmission and spindle pulleys.
5. 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.
6. 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.

(Cont'd)



**9.4 (Cont'd)**

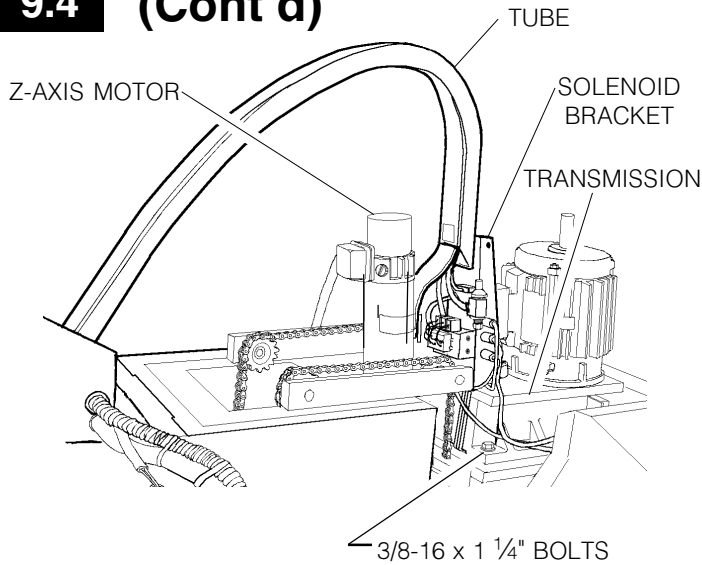


Fig. 9-7 Solenoid bracket with all lines connected (Old VF-1).

7. Remove the two 1/4-20 x 1/2" SHCS holding the **flexible tube** to the solenoid bracket and position the tube so as to not interfere with the transmission removal. It may be necessary to tie the tube back to the Z-axis motor to keep it in place.

8. Remove the protective cardboard from the mill table and install the **support base** assembly on the table, using the four 1/2-13 x 1" SHCS, four 1/2" flat washers, and the four T-nuts.

NOTE: 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.

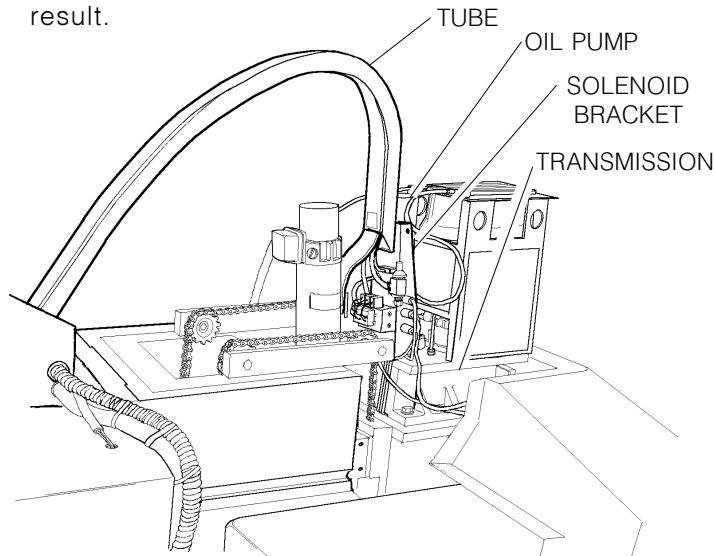


Fig. 9-8 Newer VF-1 and all VF-2's configuration.

9. 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.

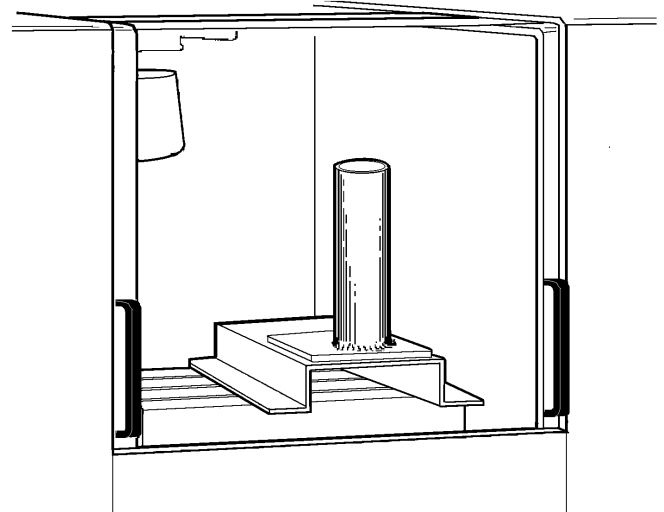


Fig. 9-9 Support base/mast support assembly location.

10. For VF-1's built before January 1992, slide the **cradle assembly** under the transmission plate. Position the cables behind the solenoid bracket before attempting to lift the transmission.

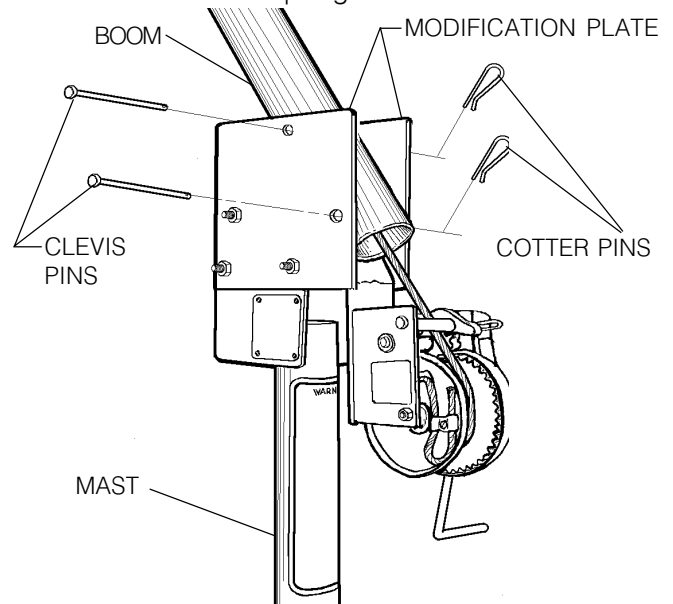


Fig. 9-10 Mounting boom assembly to mast.

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

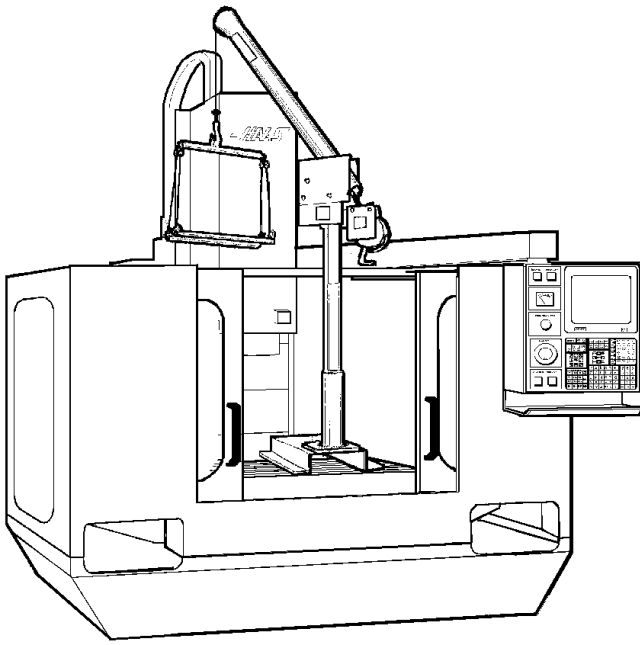


Fig. 9-11 Fully-assembled hoist in position.

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.

HOOK DIAGONALLY  
ACROSS MOTOR

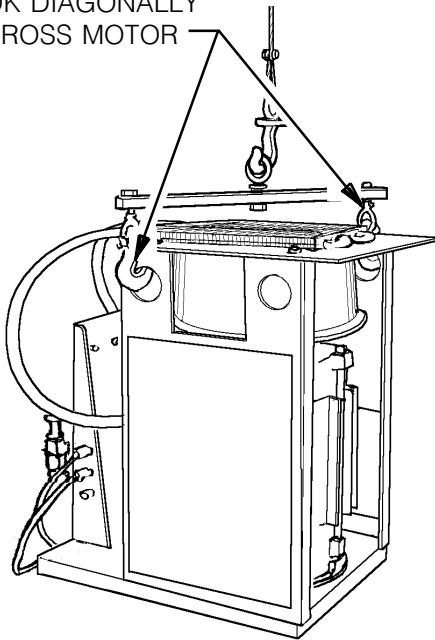


Fig. 9-12 Lifting position for newer VF-1's and all VF-2's.

13. For VF-1's built after January 1992 and all VF-2's and VF-3's: 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.

## 9.5 TRANSMISSION INSTALLATION

1. Place **cradle** under new transmission and lift just enough to put tension on the cables.
2. Ensure new transmission is seated securely and lift. Only lift high enough to clear the enclosure and to swing into place.
3. Slowly swing boom around to center the cradle and transmission over the spindle head.
4. Lower the transmission carefully to just above the spindle head. Place the **drive belt** onto the transmission pulley.
5. Lower the transmission into the spindle head, taking care not to crush or bind the drive belt as you lower.
6. Insert and tighten down the six 3/8-16 x 1 1/4" SHCS attaching the transmission to the spindle head. Adjust the drive belt tension as noted in Section 3.3 before tightening down completely.
7. Reattach the **flexible tube** 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.



## 10. Axis Motor Removal/Installation

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

### TOOLS REQUIRED:

- 1/8" HEX WRENCH
- 3/8" OPEN-END WRENCH
- 5/32" HEX WRENCH
- 7/16" OPEN-END WRENCH
- 1/4" HEX WRENCH
- PHILLIPS SCREWDRIVER
- 3/16" HEX WRENCH
- BLUE LOCTITE

### 10.1 X-AXIS MOTOR

#### REMOVAL -

1. Turn the VMC **ON**. ZERO RETURN all axes and put the machine in HANDLE JOG mode.
2. Move the table to the far left position. Loosen the 10-32 x 3/8" SHCS and remove the right **way cover**.

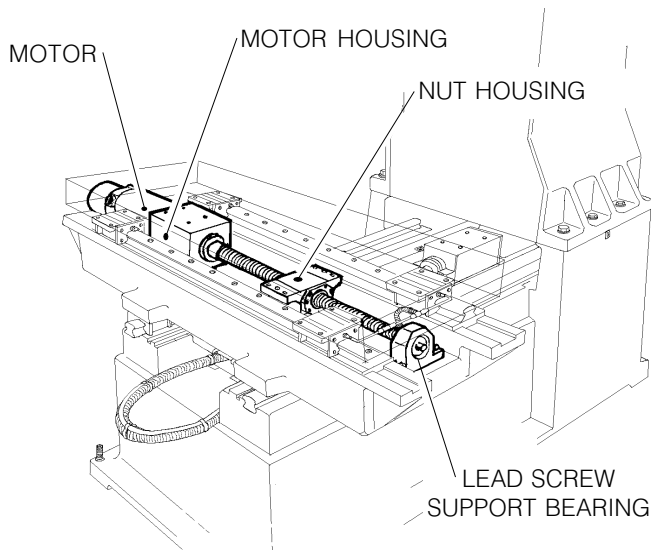


Fig. 10-1 X-axis motor and components.

3. Move the table to the far right position. Loosen the 10-32 x 3/8" SHCS and remove the left **way cover**.
4. Remove the side enclosure panels.
5. On the **motor housing**, remove the four 10-32 x 3/8" BHCS and remove the **cover plate**.
6. Loosen the 10-32 x 1/2" SHCS on the **motor coupling** at the lead screw.

7. Turn the machine power **OFF**.
8. On the **motor housing**, loosen the four 5/16-18 x 1 1/4" 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.

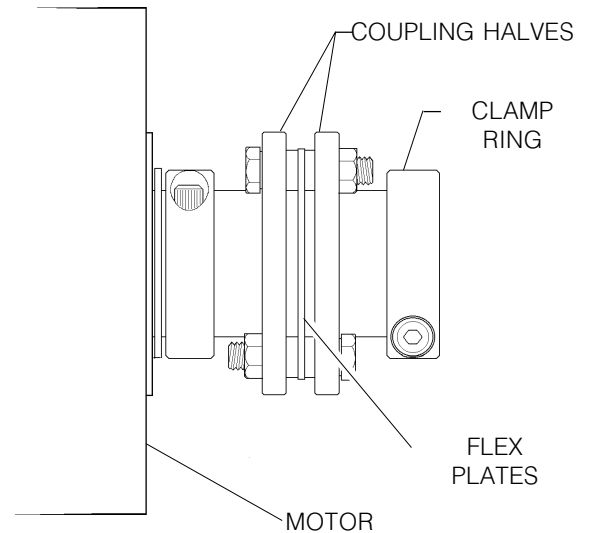


Fig. 10-2 Motor coupling components.

2. Reinstall and tighten down the four 5/16-18 x 1 1/4" 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. 10-2). Tighten the 10-32 x 1/2" 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 10-32 x 3/8" BHCS.
5. Reinstall the **way covers**.
6. Reinstall the side enclosures.
7. Check for backlash in the lead screw (Section 3.3, Troubleshooting) or noisy operation.

## 10.2 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 the 5/32" hex wrench, remove the 10-32 x 3/8" 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.

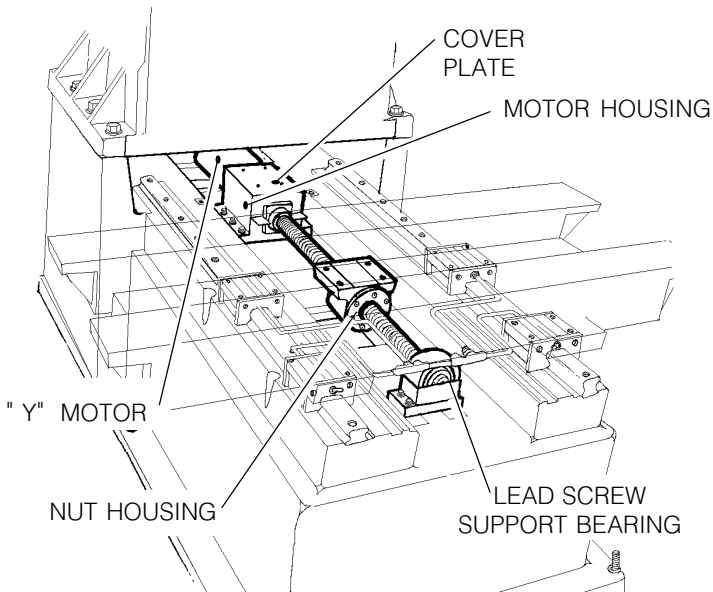


Fig. 10-3 Y-axis motor and components. (Saddle assembly shown transparent for illustration purposes.)

4. If the bearings are to be serviced, move the table to the rear of its travel and remove the 10-32 x 3/8" SHCS holding the front way covers to the saddle. Slide the way cover to the forward position.

### REMOVING OILER AND AIR REGULATOR PANEL -

5. Turn the machine off and disconnect the compressed air.
6. Using the 3/8" open-end hex wrench, disconnect the **oil line** connecting the base to the **lubrication system panel**.
7. Using the 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. Unplug 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 3/8-16 x 3/4" 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.

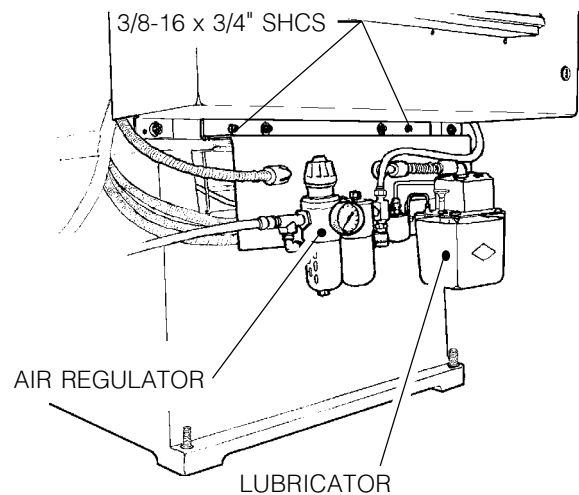


Fig. 10-4 Lubricator/air regulator panel.

11. On the **motor housing**, remove the four 10-32 x 3/8" BHCS and remove the **cover plate**.
12. Loosen the 10-32 x 1/2" SHCS on the **motor coupling** at the lead screw.
13. On the **motor housing**, loosen the 5/16-18 x 1 1/4" SHCS and remove the **motor** from the housing.

### 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 1 1/4" 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 **clamping** are in alignment (See Fig. 10-2). Tighten the 10-32 x 1/2" 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 10-32 x 3/8" BHCS.
5. Reinstall the **lube/air regulator panel** in reverse order of steps 5-10.
6. Reinstall the **way covers**.
7. Check for backlash in the lead screw (Section 3.3, Troubleshooting) or noisy operation.

## 10.3 Z-AXIS MOTOR

### REMOVAL -

1. Turn the machine power **ON**. ZERO RETURN all axes and put the machine in HANDLE JOG mode.
2. Remove the **back panel** from the **spindle head**.
3. If the bearings are to be serviced, remove the three 10-32 x 1/2" SHCS attaching the Z-axis **way cover** to the **spindle head** and slide the cover to the bottom position.

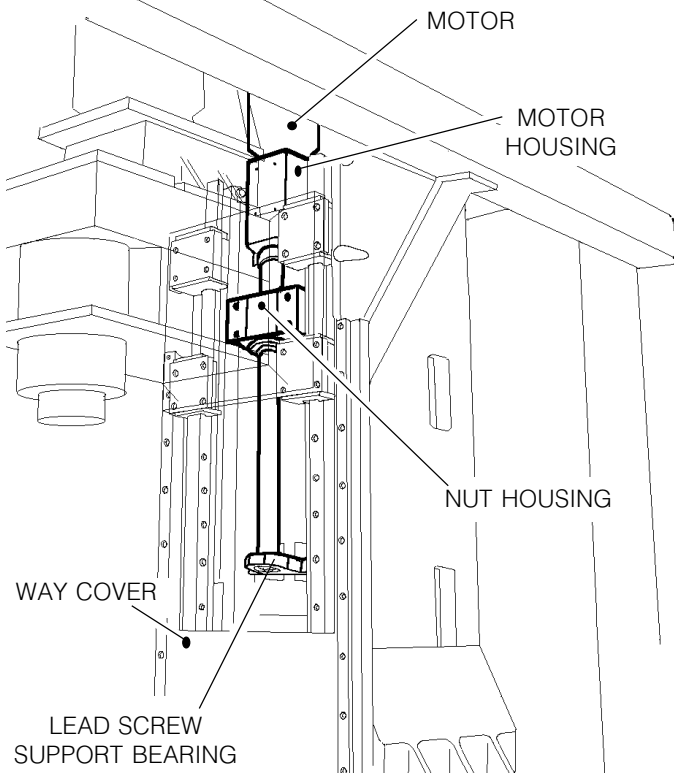


Fig. 10-5 Z-axis motor and components

4. Lower the **spindle head** to its lowest position.
5. Disconnect the electrical power.
6. On the **motor housing**, remove the four 10-32 x 3/8" BHCS and remove the **cover plate**.
7. Loosen the 10-32 x 1/2" SHCS on the **motor coupling** at the lead screw.
8. On the **motor housing**, loosen the four 5/16-18 x 1 1/4" SHCS and remove the **motor** from the housing.
9. Unplug 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 1 1/4" 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. 10-2). Tighten the 10-32 x 1/2" 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 10-32 x 3/8" BHCS.
5. Reconnect electrical power.
6. Reinstall the **way covers**.
7. Check for backlash in the lead screw (Section 3.3, Troubleshooting) or noisy operation.

## 10.4 COUPLING REPLACEMENT

1. Remove the **axis motor** (Section 9).  
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 1/2" SHCS on the two **coupling rings** and remove the coupling.

(Cont'd)

**10.4** (Cont'd)

3. For installation: Slide the new **coupling** onto the **motor shaft** until the **coupling half** is flush to the end of the shaft.
4. Tighten the two 10-32 x 1/2" SHCS on the coupling's **clamp ring**. Before tightening, add one drop of blue Loctite<sup>®</sup> to each screw.
5. Reinstall the **axis motor** (Section 10).

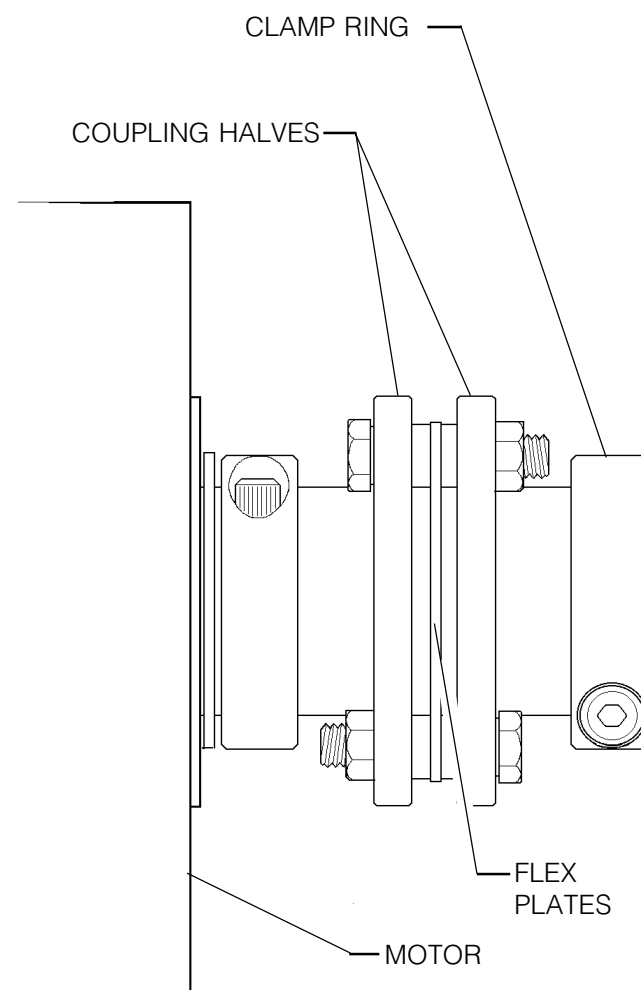


Fig. 10-6 Motor coupling.

## 11. Lead Screw Removal/Installation

Please read this section in its entirety before attempting to remove or replace the lead screws.

### IMPORTANT NOTICE !!!

Lead screws may not be replaced without also replacing the old-style bearing sleeves! These installation procedures do not account for the old-style bearing sleeves, so the bearing sleeve type should be verified **before** replacement.

The new bearing sleeves will have two  $\frac{1}{4}$ " diameter holes on the face, the older bearing sleeves will not.

### TOOLS REQUIRED:

- 1/8" HEX WRENCH
- 5/32" HEX WRENCH
- 1/4" HEX WRENCH
- 5/16" HEX WRENCH
- BLUELOCTITE
- SPANNER WRENCH
- 3/8" OPEN-END WRENCH
- 7/16" OPEN-END WRENCH
- PRE-LOAD FIXTURE
- 2" x 4" WOOD BLOCK  
(21"-23 1/2" L)

### 11.1 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 10-32 x  $\frac{3}{8}$ " SHCS and remove the **chip tray** from the mill table.
4. Move the table to the far right position. Loosen the 10-32 x  $\frac{3}{8}$ " SHCS and remove the left **way cover**.
5. Move the table to the far left position. Loosen the eleven 10-32 x  $\frac{3}{8}$ " SHCS and remove the right **way cover**.
6. Remove the **hard stop** from the **bearing housing** on the lead screw.

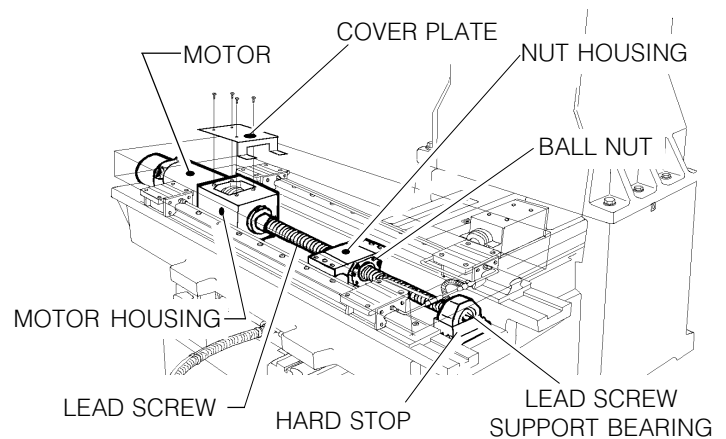


Fig. 11-1 X-axis lead screw and components. (Mill table shown transparent for clarity.)

7. Disconnect the oil line from the **ball nut**.
8. Loosen the 10-32 x  $\frac{1}{2}$ " SHCS and remove the **clamp nut** on the lead screw **support bearing** end.

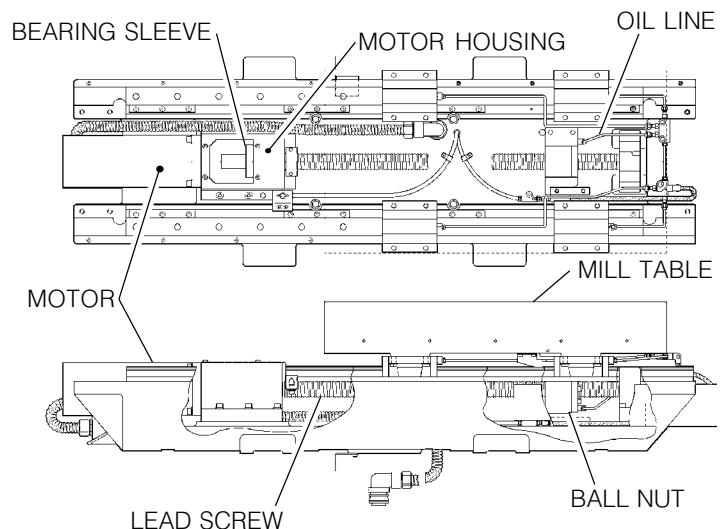


Fig. 12-2 Lead screw assembly.

9. Remove the **axis motor** (Section 10.1). 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  $\frac{1}{2}$ " SHCS and remove the **clamp nut** on the lead screw in the **motor housing**.
11. Loosen the six  $\frac{1}{4}$ -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.

(Cont'd)



## 11.1 (Cont'd)

**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  $\frac{1}{4}$ -20 x 1" (or  $\frac{1}{4}$ -20 x  $\frac{3}{4}$ ") SHCS and remove the **lead screw** from the **nut housing** by pushing on the lead screw at the motor end.

### INSTALLATION -

- Center the mill table on the saddle.
- 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.*

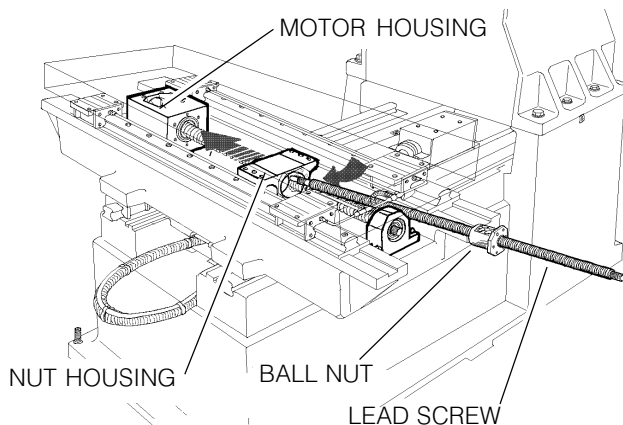


Fig. 11-3 Install lead screw from right side.

- Insert the **lead screw** through the **nut housing** and **motor housing** (See Fig. 11-3), taking care not to make contact with the screw threads, causing possible damage.
- 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.)
- Insert the six  $\frac{1}{4}$ -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.

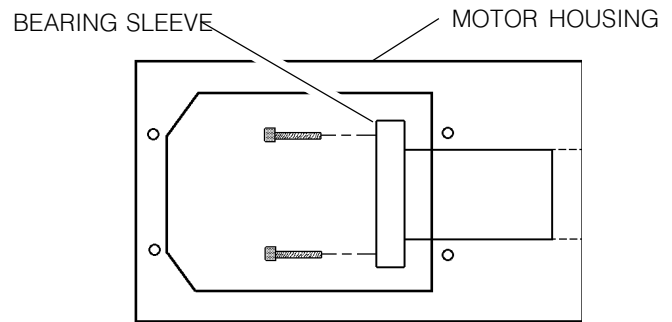


Fig. 11-4 Bearing sleeve mounting location.

- 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.
  - Move mill table as far right as possible, leaving room to insert two of the six  $\frac{1}{4}$ -20 x 1" (or  $\frac{1}{4}$ -20 x  $\frac{3}{4}$ ") 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.
- Hand-turn the lead screw and move the mill table back to approximately center of the saddle. Install the remaining four  $\frac{1}{4}$ -20 x 1" (or  $\frac{1}{4}$ -20 x  $\frac{3}{4}$ ") SHCS, attaching the **ball nut** to the **nut housing**. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.
  - Move mill table to the far left position. ("Far left" is when the **limit switch bracket** touches the **x-axis limit switch**.)

- Loosen all of the SHCS attaching the **bearing sleeve** to the **motor housing** approximately  $\frac{1}{4}$  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.
- Screw on the **clamp nut** on the end of the lead screw in the motor housing. Do not tighten down completely.
- 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.

**NOTE:** For the older type bearing sleeves, set the lead screw **pre-load** (Section 12.1).

13. Reinstall the **motor** (Section 10.1).
14. Reinstall the **way covers** and **chip tray**.
15. Check for backlash in the lead screw (Section 3.3, Troubleshooting) or noisy operation.

## 11.2 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** (Section 10.2).
3. Remove the **hard stop** from the **lead screw support bearing** end of the lead screw.
4. Loosen the 10-32 x 1/2" SHCS on the **clamp nut** at the bearing support end, then remove the clamp nut.
5. Loosen the 10-32 x 1/2" SHCS on the **clamp nut** at the motor end, then remove the clamp nut.

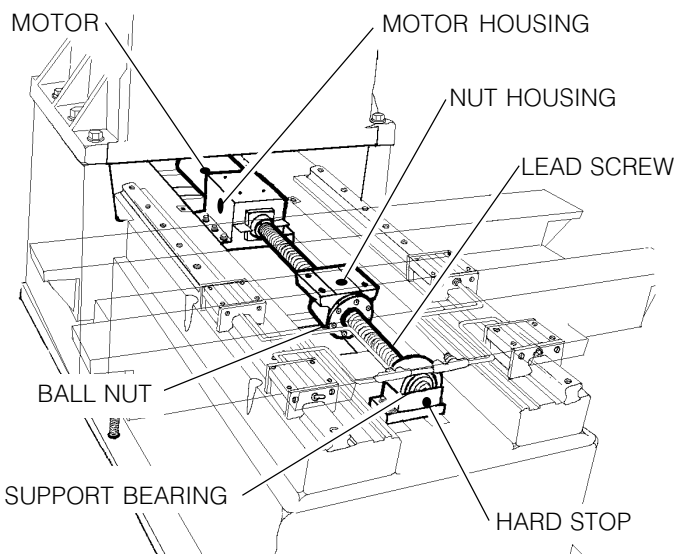


Fig. 11-5 Y-axis lead screw and components. (Way covers not shown for clarity.)

6. Loosen the six 1/4-20 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.

7. Disconnect the **oil line** at the **ball nut**.
8. Loosen and remove the six 1/4-20 x 1" 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").

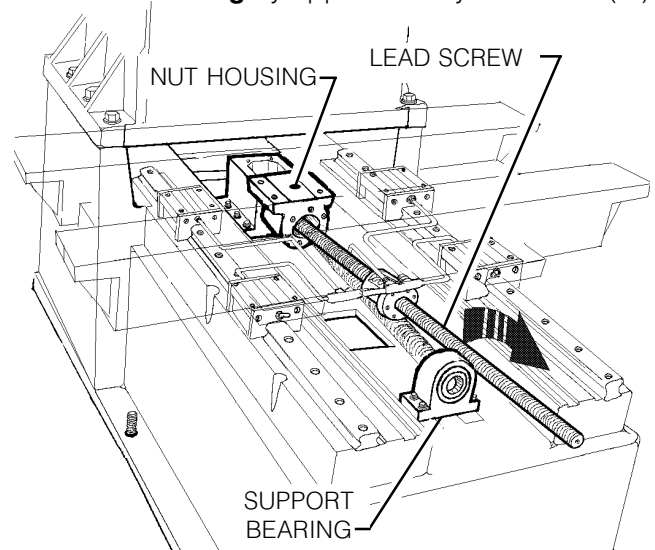
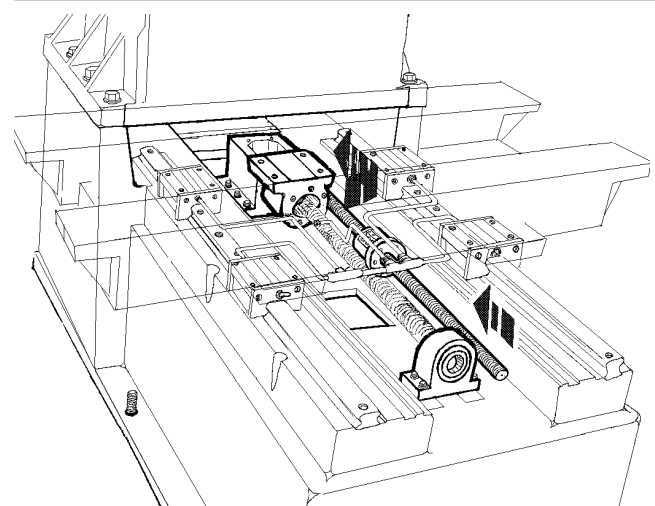


Fig. 11-6 Pull lead screw forward around bearing support,...



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

(Cont'd)

## 11.2 (Cont'd)

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 (Fig. 11-4). 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 1/4-20 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 1/4-20 x 1" (or 3/4") 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 1/4 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 1/4-20 x 1" (or 3/4") 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.

**NOTE:** For the older type bearing sleeves, set the lead screw **pre-load** (Section 12.2).

15. Reinstall the **axis motor** (Section 10.2).

16. Check for backlash in the lead screw (Section 3.3, Troubleshooting) or noisy operation.

## 11.3 Z-AXIS LEAD SCREW

### REMOVAL -

1. Remove the **axis motor** (Section 10.3).
2. Remove the **bearing sleeve** (Section 12.3).

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 1/4-20 x 1" (or 3/4") SHCS attaching the **ball nut** to the **nut housing**. Remove **five** of the screws.
6. Manually push the **spindle head** to the top of its travel and block it in position with the 2" x 4". Place a piece of paper between the board and table.

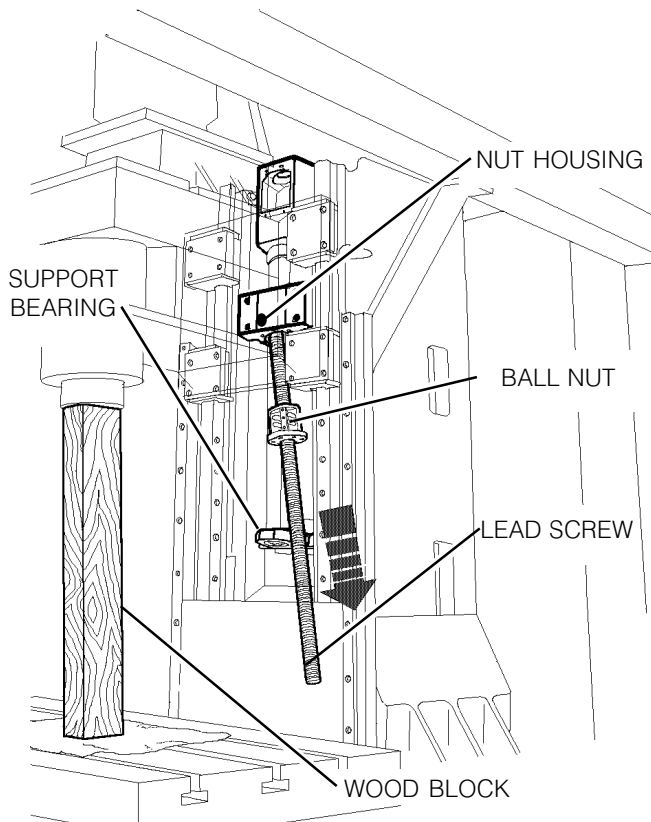


Fig. 11-7 Z-axis lead screw and components.

**CAUTION:** FAILURE TO BLOCK THE SPINDLE HEAD IN POSITION MAY RESULT IN A SPINDLE HEAD FREE-FALL, CAUSING DAMAGE TO THE SPINDLE HEAD AND/OR MILL TABLE, OR SERIOUS PERSONAL INJURY.

7. 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**.

**USE EXTREME CAUTION TO NOT DAMAGE THE THREADS ON THE LEAD SCREW.**

## 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.

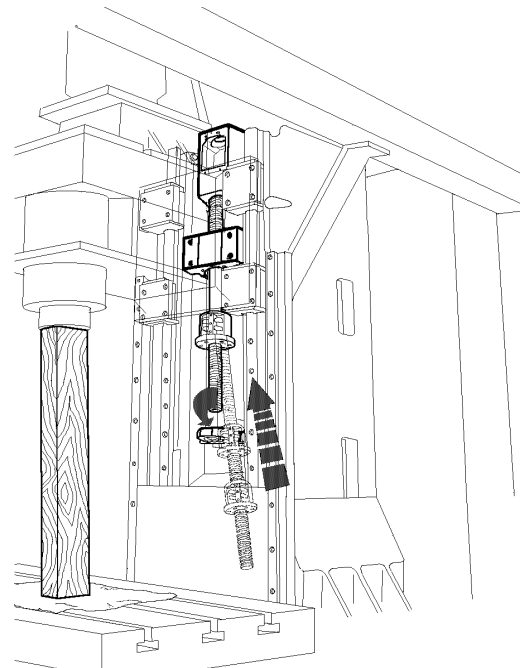


Fig. 11-8 Reinstalling the lead screw.

3. Loosely screw on the **clamp nut** on 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 **lead screw** until the face of the **ball nut** is approximately six inches (6") from the **support bearing** face.
6. **CAREFULLY** remove the wood block and lower the **spindle head** until the **nut housing** is resting on the **ball nut**.

(Cont'd)

## 11.3 (Cont'd)

7. Install and tighten down the two outer  $\frac{1}{4}$ -20 x 1" (or  $\frac{3}{4}$ ") 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.

8. Loosen, but do not remove, the six  $\frac{1}{4}$ -20 x 1" SHCS attaching the **bearing sleeve** to the **motor housing**.

9. Hand-turn the lead screw until **spindle head** is at the top of its travel.

10. Retighten the six  $\frac{1}{4}$ -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.

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

12. Install the remaining four  $\frac{1}{4}$ -20 x 1" (or  $\frac{3}{4}$ ") 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.

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

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  $\frac{1}{8}$  of a turn.
- Tighten the SHCS on the clamp nut.

**NOTE:** For the older type bearing sleeves, set the lead screw **pre-load** (Section 12.3).

15. Reinstall the **axis motor** (Section 10.3).

16. Check for backlash in the lead screw (Section 3.3, Troubleshooting) or noisy operation.

## 12. Lead Screw Pre-load Adjustments

### INTRODUCTION:

The lead screw test fixture is designed to adjust pre-load on the lead screw bearings in the field. When used properly, the fixture will accurately set the pre-load on the thrust bearings in the lead screw.

### GENERAL DESCRIPTION:

The test fixture operates by air pressure to apply tension on the lead screw. This, in turn, pre-loads the bearings in the motor housing to optimize bearing life and minimize backlash.

**NOTE:** VMC's built after approximately October 1, 1992 will not need pre-load adjustments. Skip this procedure for those machines as applicable.

*Please read this section in its entirety before attempting to set the pre-load.*

### TOOLS REQUIRED:

- 1/8" HEX WRENCH
- 5/32" HEX WRENCH
- 1/4" HEX WRENCH
- 5/16" HEX WRENCH
- SPANNER WRENCH
- 3/8" OPEN-END WRENCH
- 7/16" OPEN-END WRENCH
- PRE-LOAD FIXTURE

### 12.1 X-AXIS

1. Turn the VF-1 **ON**. ZERO RETURN all axes and put the machine in HANDLE JOG mode.
2. Remove the **motor** (Section 11.1).
3. Loosen the 10-32 x 3/8" SHCS on the **clamp nut** inside the motor housing on the lead screw and unscrew the **clamp nut** one turn.
4. Loosen the **clamp nut** on the **support bearing** at least four turns.
5. Slide the pre-load fixture onto the lead screw and tighten the four 5/16-18 x 1 1/4" SHCS attaching it to the **motor housing**.
6. Tighten the two 10-32 x 1/2" SHCS on the clamp rings on the fixture coupling.

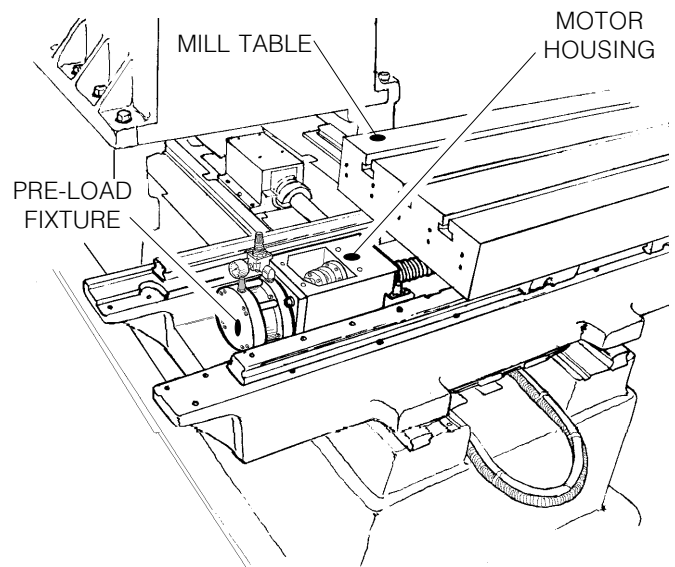


Fig. 12-1 Pre-load fixture in place. (Way covers and enclosures are not shown for clarity.)

7. Tighten the **clamp nut** on the lead screw in the motor housing with a spanner to ensure that the bearings are seated.
8. Connect compressed air to the fixture and set the air pressure to **105 psi (+0/-5 psi)**. Loosen the clamp nut on the lead screw on the motor housing at least four full turns.
9. Hand-tighten the clamp nut back down until it just contacts the **bearing** on the motor housing.

**CAUTION! DO NOT TIGHTEN THE CLAMP NUT AGAINST THE BEARING.**

10. Tighten the 10-32 x 1/2" SHCS on the **clamp nut**. The lead screw may need to be rotated to allow access. (To rotate the lead screw, disconnect the compressed air from the fixture and rotate the lead screw by hand. Repeat steps 9 and 10).

**CAUTION! DO NOT OVER TIGHTEN THE 10-32 x 1/2" SHCS AS DAMAGE TO THE LEAD SCREW AND THE CLAMP NUT WILL RESULT.**

11. Disconnect the compressed air supply from the fixture and remove the fixture from the motor housing.

(Cont'd)

## 12.1 (Cont'd)



**WARNING! THE COMPRESSED AIR SUPPLY MUST BE REMOVED PRIOR TO REMOVING THE FIXTURE FROM THE MOTOR HOUSING. FAILURE TO DO SO WILL CAUSE THE CYLINDER TO RETRACT RAPIDLY, CAUSING DAMAGE TO THE FIXTURE AND PERSONAL INJURY.**

### REASSEMBLY-

12. Reinstall the motor (Section 11.1). 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.

13. Reconnect electric power to the machine and POWER ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

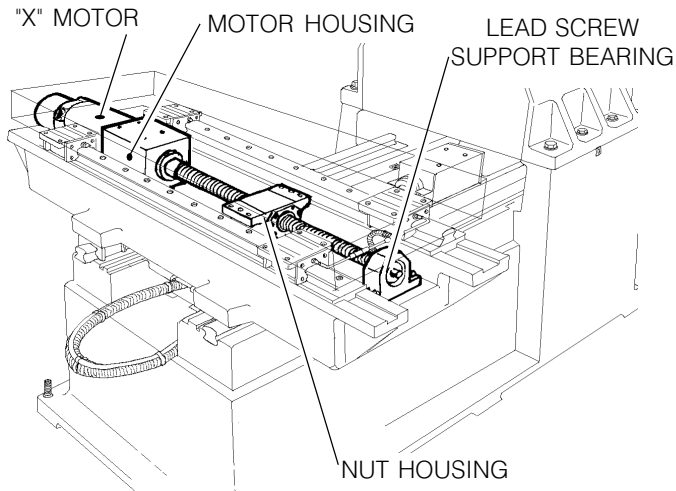


Fig. 12-2 X-axis motor and components.

14. Tighten the clamp nut on the **lead screw support bearing** on the end opposite the motor housing until it contacts the bearing, then tighten the 10-32 x 1/2" SHCS on the clamp nut.

**CAUTION! DO NOT OVER TIGHTEN THE 10-32 x 1/2" SHCS AS DAMAGE TO THE LEAD SCREW AND THE CLAMP NUT WILL RESULT.**

15. Reinstall the **way covers**.

16. Check for backlash in the lead screws (Section 3.3, Troubleshooting) or noisy operation.

## 12.2 Y-AXIS

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

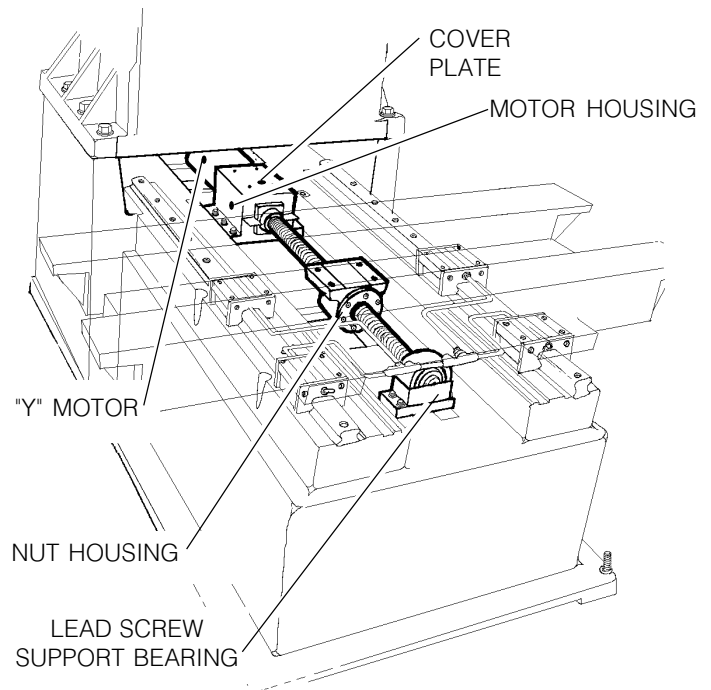


Fig. 12-3 Y-axis motor and components. (Saddle assembly shown transparent for illustration purposes.)

2. Remove the **motor** (Section 11.2).

3. Loosen the 10-32 x 3/8" SHCS on the **clamp nut** inside the motor housing on the lead screw and unscrew the **clamp nut** one turn.

4. Loosen the 10-32 x 3/8" SHCS on the **clamp nut** on the support bearing. Loosen the clamp nut *at least* four turns.

5. Slide the **pre-load fixture** onto the lead screw and tighten the four 5/16-18 x 1 1/4" SHCS that attach it to the motor housing.

6. Tighten the two 10-32 x 3/8" SHCS on the clamp rings on the fixture coupling.

7. Tighten the **clamp nut** on the lead screw in the motor housing with a spanner to ensure that the bearings are seated.

8. Connect compressed air to the fixture and set the air pressure to **105 psi (+0/-5 psi)**. Loosen the clamp nut on the lead screw on the motor housing at least four full turns.

9. Screw the clamp nut back down until it just contacts the bearing on the motor housing.

**CAUTION! DO NOT TIGHTEN THE CLAMP NUT AGAINST THE BEARING.**

10. Tighten the 10-32 x 3/8" SHCS on the **clamp nut**. The lead screw may need to be rotated to allow access. (To rotate the lead screw, disconnect the compressed air from the fixture and rotate the lead screw by hand. Repeat steps 9 and 10).

**CAUTION! DO NOT OVER TIGHTEN THE 10-32 x 1/2" SHCS AS DAMAGE TO THE LEAD SCREW AND CLAMP NUT WILL RESULT.**

11. Disconnect the compressed air supply from the fixture and remove the fixture from the motor housing.



**WARNING! THE COMPRESSED AIR SUPPLY MUST BE REMOVED PRIOR TO REMOVING THE FIXTURE FROM THE MOTOR HOUSING. FAILURE TO DO SO WILL CAUSE THE CYLINDER TO RETRACT RAPIDLY CAUSING DAMAGE TO THE FIXTURE AND PERSONAL INJURY.**

#### REASSEMBLY -

12. Reinstall the motor (Section 11.2). 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.

13. Reconnect electric power to the machine and POWER ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

14. Move the table to the rear of its travel. Tighten the clamp nut on the **lead screw support bearing** on the end opposite the motor housing until it just contacts the bearing (See Fig. 12-3), then tighten the 10-32 x 1/2" SHCS on the **clamp nut**.

**CAUTION! DO NOT OVER TIGHTEN THE 10-32 x 1/2" SHCS AS DAMAGE TO THE LEAD SCREW AND CLAMP NUT WILL RESULT.**

15. Reinstall the **way covers**.

16. Check for backlash in the lead screws (Section 3.3, Troubleshooting) or noisy operation.

## 12.3 Z-AXIS

1. Turn the machine power **ON**. ZERO RETURN all axes. Put the machine in HANDLE JOG mode.
2. Remove the **motor** (Section 11.3).
3. Loosen the 10-32 x 3/8" SHCS on the **clamp nut** inside the motor housing on the lead screw and unscrew the **clamp nut** one turn.
4. Loosen the 10-32 x 3/8" SHCS on the clamp rung on the support bearing. Loosen the clamp nut *at least* four turns.
5. Slide the **pre-load** fixture onto the lead screw and tighten the four 5/16-18 x 1 1/4" SHCS that attach it to the motor housing.
6. Tighten the two 10-32 x 3/8" SHCS on the clamp rings on the fixture coupling.

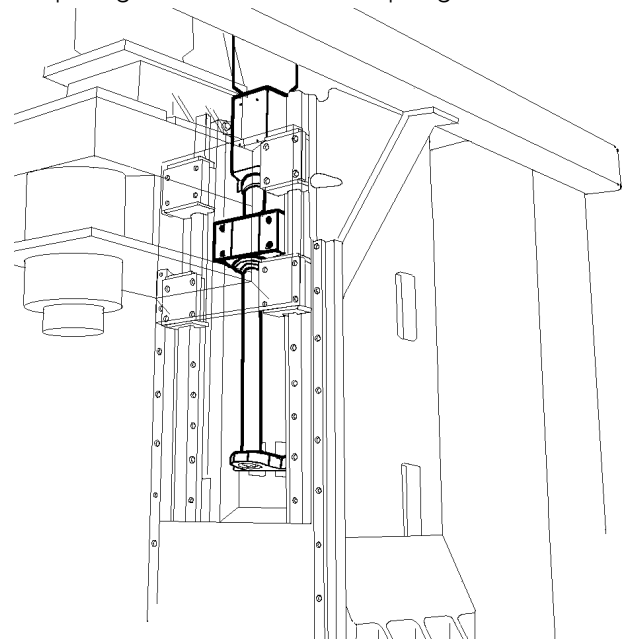


Fig. 12-4 "Z" motor and components. (Spindle assembly shown transparent for illustration purposes.)

7. Tighten the clamp nut on the lead screw in the motor housing with a spanner to ensure that the bearings are seated.
8. Connect compressed air to the fixture and set the air pressure to **105 psi (+0/-5 psi)**. Loosen the clamp nut on the lead screw on the motor housing at least four full turns.

(Cont'd)



## 12.3 (Cont'd)

9. Screw the **clamp nut** back down until it just contacts the **bearing** on the motor housing.

**CAUTION: DO NOT TIGHTEN THE CLAMP NUT AGAINST THE BEARING.**

10. Tighten the 10-32 x 1/2" SHCS on the clamp nut. The lead screw may need to be rotated to allow access. (To rotate the lead screw, disconnect the compressed air from the fixture and rotate the lead screw by hand. Repeat steps 9 and 10).

**CAUTION! DO NOT OVER TIGHTEN THE 10-32 x 1/2" SHCS AS DAMAGE TO THE LEAD SCREW AND CLAMP NUT WILL RESULT.**

11. Disconnect the compressed air supply from the fixture and remove the fixture from the motor housing.



**WARNING! THE COMPRESSED AIR SUPPLY MUST BE REMOVED PRIOR TO REMOVING THE FIXTURE FROM THE MOTOR HOUSING. FAILURE TO DO SO WILL CAUSE THE CYLINDER TO RETRACT RAPIDLY CAUSING DAMAGE TO THE FIXTURE AND PERSONAL INJURY.**

### REASSEMBLY -

12. Reinstall the **motor** (See Section 11.3). Make sure the **flex plates** are parallel to the **coupling halves** and the slits in the coupling and clamp ring are in alignment.
13. Reconnect electric power to the machine and POWER ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.
14. Tighten the clamp nut on the **lead screw support bearing** (the end opposite the motor housing) until it just contacts the bearing, then tighten the 10-32 x 1/2" SHCS on the clamp nut.

**CAUTION! DO NOT OVER TIGHTEN THE 10-32 x 1/2" SHCS AS DAMAGE TO THE LEAD SCREW AND THE CLAMP NUT WILL RESULT.**

15. Reinstall the **way covers**.
16. Check for backlash in the lead screws (Section 3.3, Troubleshooting) or noisy operation.

## 13. Bearing Sleeve Removal/Installation

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

### TOOLS REQUIRED:

- 1/8" HEX WRENCH
- SPANNER WRENCH
- 5/32" HEX WRENCH
- 3/8" OPEN-END WRENCH
- 1/4" HEX WRENCH
- 7/16" OPEN-END WRENCH
- 5/16" HEX WRENCH
- PRE-LOAD FIXTURE
- WOOD BLOCK (16" L)

### 13.1 X-AXIS BEARING SLEEVE

#### REMOVAL -

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

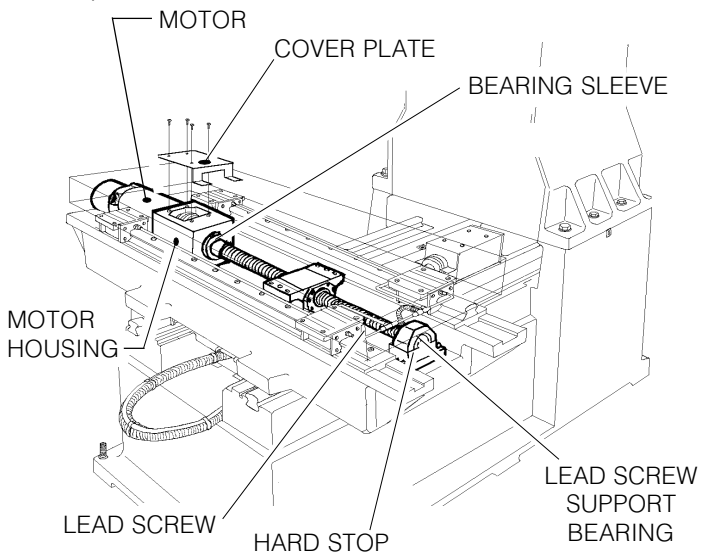


Fig. 13-1 X-axis lead screw and components. (Mill table shown transparent for illustration purposes.)

- Loosen the 10-32 x 3/8" SHCS and remove the **chip tray** from the mill table.
- Remove the **axis motor** (Section 10.1).  
**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.

- Loosen the 10-32 x 1/2" SHCS and remove the **clamp nut** on the lead screw in the **motor housing**.

- Loosen the six 1/4-20 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.

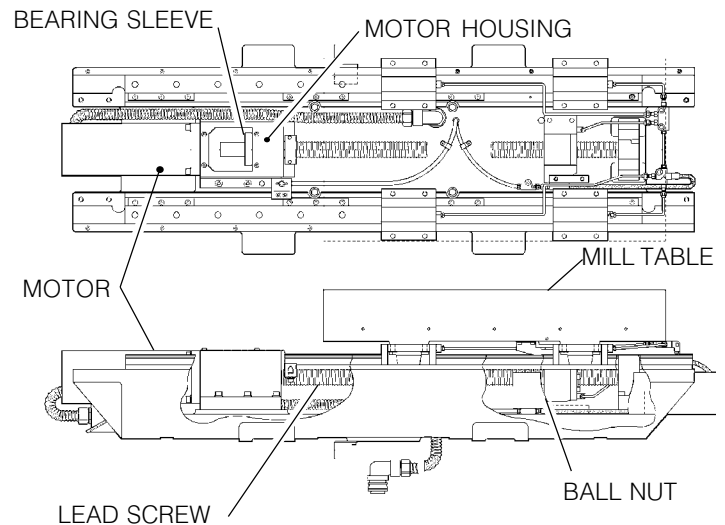


Fig. 13-2 Lead screw assembly.

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

#### INSTALLATION -

- 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.*

- Move mill table to the far right.
- Place the **bearing sleeve** in the motor housing as shown. (It may be necessary to align the bearings in the sleeve to facilitate mounting.)
- Insert the six 1/4-20 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.

(Cont'd)

## 13.1 (Cont'd)

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.

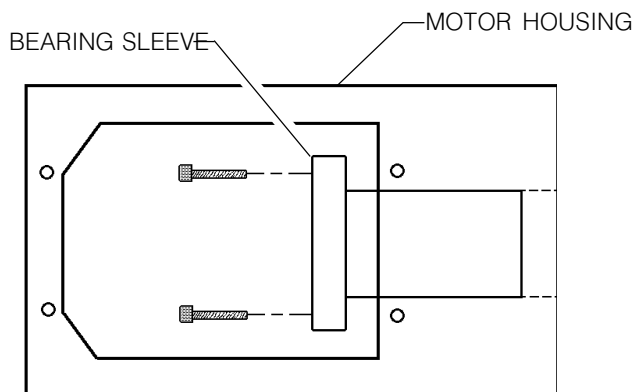


Fig. 13-3 Bearing sleeve mounting location.

7. Loosen the six  $\frac{1}{4}$ -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.
8. Set the lead screw **pre-load**, when applicable (Section 12.1).
 

**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  $\frac{1}{8}$  of a turn.
  - Tighten the SHCS on the clamp nut.
9. Reinstall the **axis motor** (Section 10.1).
10. Reinstall the **way covers** and **chip tray**.
11. Check for backlash in the lead screw (Section 3.3, Troubleshooting) or noisy operation.

## 13.2 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** (Section 10.2).
3. Remove the **hard stop** from the **bearing housing** on the lead screw.
4. Loosen the 10-32 x  $\frac{1}{2}$ " SHCS and remove the **clamp nut** from the bearing support end of the lead screw.
5. Loosen the six  $\frac{1}{4}$ -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  $\frac{1}{4}$ -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  $\frac{1}{4}$ -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.
6. Set the lead screw **pre-load**, when applicable (Section 12.2).

**NOTE:** For the angular contact design bearing, no pre-load is necessary. Follow the procedures as outlined in Section 13.2, step 8.

7. Reinstall the **axis motor** (Section 10.2).
8. Check for backlash in the lead screw (Section 3.3, Troubleshooting) or noisy operation.

## 13.3 Z-AXIS BEARING SLEEVE

### REMOVAL -

1. Remove the **axis motor** (Section 10.3).  
**NOTE:** Follow *ONLY* Steps **1-3** of motor removal instructions.
2. Remove the **hard stop** from the **bearing housing** on the lead screw.
3. Loosen the 10-32 x  $\frac{1}{2}$ " SHCS and remove the **clamp nut** from the bearing support end of the lead screw.
4. Raise the **spindle head** until the bottom edge is approximately sixteen inches (16") above the mill table.
5. Place the **wood block** beneath the spindle head and lower the spindle head until it is resting on the block (See Fig. 13-4.).
6. Continue with the motor removal as outlined in Steps 6-10 in Section 10.3.  
**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.
7. Loosen the 10-32 x  $\frac{1}{2}$ " SHCS and remove the **clamp nut** from the motor housing end of the lead screw.
8. Loosen the six  $\frac{1}{4}$ -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.

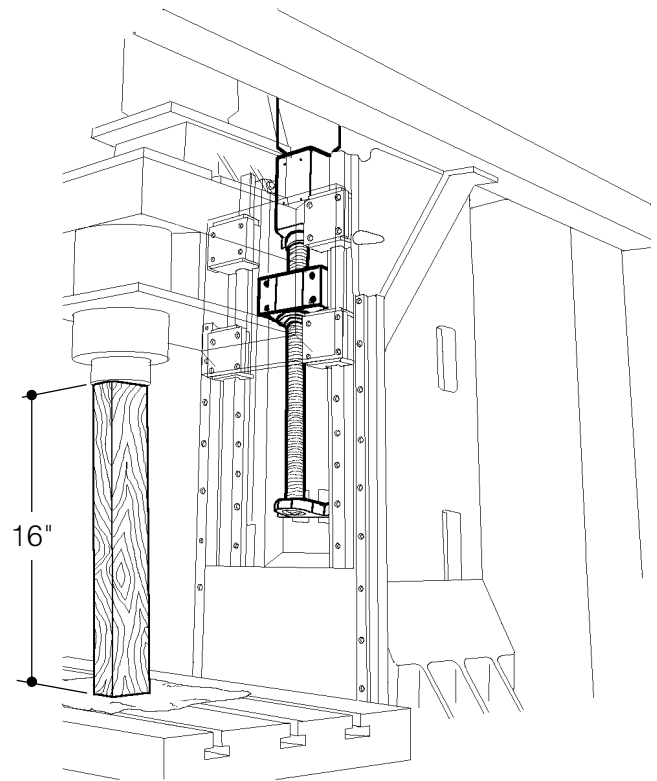


Fig. 13-4 Block spindle head before removing bearing sleeve.

**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  $\frac{1}{4}$ -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  $\frac{1}{4}$ -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.

(Cont'd)

## 13.3 (Cont'd)

6. *Carefully* remove the wood block from under the spindle head. **CAUTION:** The spindle head may drop slightly when the block is removed.

7. Set the lead screw **pre-load**, when applicable (Section 12.3).

**NOTE:** For the angular contact design bearing, no pre-load is necessary. Follow the procedures as outlined in Section 13.2, step 8.

8. Reinstall the **axis motor** (Section 10.3).

9. Check for backlash in the lead screw (Section 3.3, Troubleshooting) or noisy operation.

## 14. Automatic Tool Changer

Please read this section in its entirety before attempting to align the automatic tool changer.

### TOOLS REQUIRED:

- 1/2" DRIVE RATCHET
- 10" EXTENSION (1/2" DRIVE)
- 1/2" SOCKET (1/2" DRIVE)
- 3/4" SOCKET (1/2" DRIVE)
- CARDBOARD
- LEVEL, STARRET # 98
- LARGE-BLADE FLAT TIP SCREWDRIVER
- PHILLIPS SCREWDRIVER
- HYDRAULIC JACK
- DIAL CALIPER
- 1-2-3 BLOCK
- 1/8" ALLEN WRENCH
- 5/32" ALLEN WRENCH
- 3/16" ALLEN WRENCH
- TWO-JAW PULLER

NOTE: Before making any adjustments, make sure all pull studs on the tool holder are tight. Verify the problem is misalignment and not orientation.

### 14.1 ATC REPLACEMENT

**NOTE:** If the ATC shuttle is damaged in a crash, it must be replaced. Look specifically for broken bosses where the roller bolts mount to the casting. If the ATC shuttle 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 ATC shuttle and remove any bolts holding the ATC to the holding plate.  
**NOTE:** If the ATC's casting has been damaged, replacement is necessary; move the ATC to a bench and remove all components from the damaged ATC 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 ATC shuttle (with carousel) onto the machine table.
5. If the ATC 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 ATC shuttle. 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 ATC shuttle.

8. With the **ATC assembly** securely supported, install the lower roller bolts and adjust (Section 14.2).

9. Repair or replace any cables damaged and adjust the ATC. Align the ATC assembly (Sections 14.3 —14.5) and set Parameter 64 (Section 8).

### 14.2 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) as outlined in Section 8.
7. Verify the ATC alignment (Sections 14.3 — 14.5).
8. Reinstall the shuttle motor cover (VF-0, VF-1, VF-2).

## 14.3 ALIGNMENT PREPARATION

**NOTE:** Machine *must* be level before proceeding.

1. Remove ATC covers.
2. Insert a  $\frac{3}{4}$ " tool holder into the spindle, with set screw to the right side.
3. Initiate a tool change and stop just before it reaches the tool holder by pressing the **EMERGENCY STOP** button.
4. Using the large-blade flat tip screwdriver, push up on the bolt holding the **cam follower** (Item 63, Fig. 14-2). Do this to engage shuttle completely to the **in** position.
5. While pushing the shuttle in, align slot in the tool holder to the **key extractor** (Item 17, Fig. 14-3). **Cam follower** must reach the full **up** position to ensure the shuttle has reached the full **in** position. If ATC is fully engaged and cam follower cannot be pushed all the way up, the **shuttle stroke** must be adjusted.

### SHUTTLE STROKE ADJUSTMENT -

6. Move the ATC away from the spindle and loosen the four  $\frac{1}{2}$ -13 HHB's 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** (Item 9, Fig. 14-2) until ATC is fully engaged on the tool holder.
8. Ensure the **extractor** (Item 16, Fig. 14-3) is making full contact on the tool **flange**.

## 14.4 TOOL CHANGER ALIGNMENT

**NOTE:** Tool changers with dowel pins in the holding arm require no adjustments. (The dowel pins may be seen on the holding plate when looking from the front of the machine.)

### CHECKING LEVELNESS IN THE X-AXIS PLANE -

1. To check levelness, place the **level** on the machined surface directly in front of the Geneva

drive motor (Item 71, Fig. 14-2) and read the **level**. It should be within one increment of the level. If it is not, remove the three 10-32 x  $\frac{1}{2}$ " SHCS holding the Z-axis way cover to the spindle head casting and slide to the lowest position.

2. Loosen the four  $\frac{1}{2}$ -13 HHB's in the X-axis plane located in the tool holding arm (Item 5, Fig. 14-3).
3. After placing a sheet of cardboard on the mill table (to protect the surface), place the jack directly under the ATC. Block the jack up as necessary to reach the ATC.
4. Actuate the jack so that there is only slight pressure supporting the ATC. By manually turning the Z-axis lead screw, the ATC can be pivoted to the desired level.
5. Once at the proper level, alternately tighten the four  $\frac{1}{2}$ -13 HHB's until all bolts are tight.

### CHECKING LEVELNESS IN THE Y-AXIS PLANE -

6. Place the **1-2-3 block** on the right side of the **carriage casting** (Item 6, Fig. 14-3) in the Y-axis plane.
7. Place the **level** on top of the **1-2-3 block**. It should be within one increment of the level. If not, loosen the lower two  $\frac{1}{2}$ -13 HHB's and slightly loosen the upper two bolts.
8. Adjust the levelness by moving the **hydraulic jack** up and down as necessary. Do not force the tool changer into position with the jack. Move only as much as clearance between the bolt and slot will allow.

## 14.5 CENTERING THE SPINDLE

1. With the ATC leveled in the X- and Y-axes, the spindle must be centered in the ATC pocket. To check the centering, insert the appropriate hex wrench in the tool holder set screw and pivot the tool holder toward the rear of the machine.
2. Using the dial calipers, measure from the left side of the spindle dog to the left side of the turret pocket (Measurement "B" in Fig. 14-1).
3. Pivot the tool holder toward the front of the machine and measure from the right side of the

spindle dog to the right side of the turret pocket (Measurement "A" in Fig. 14-1).

4. Measurements "A" & "B" must be equal to within  $\pm .010$ . If the measurements are not within the tolerance, adjust by moving the entire ATC to front or back as needed by prying against HHB's and ATC arm casting until centered.

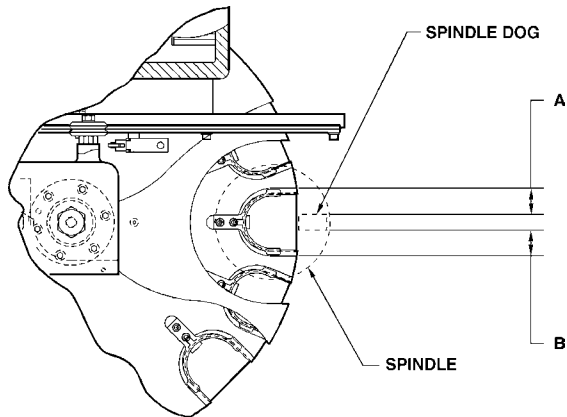


Fig. 14-1 Underside showing centering measurements.

5. Recheck the level in the Y-axis and adjust, if necessary.

6. Recheck Parameter 64. The position of the ATC may have changed and a change in Parameter 64 will be necessary.

7. Retighten all HHB's, remove the hydraulic jack, and ensure the ATC functions properly before operating.

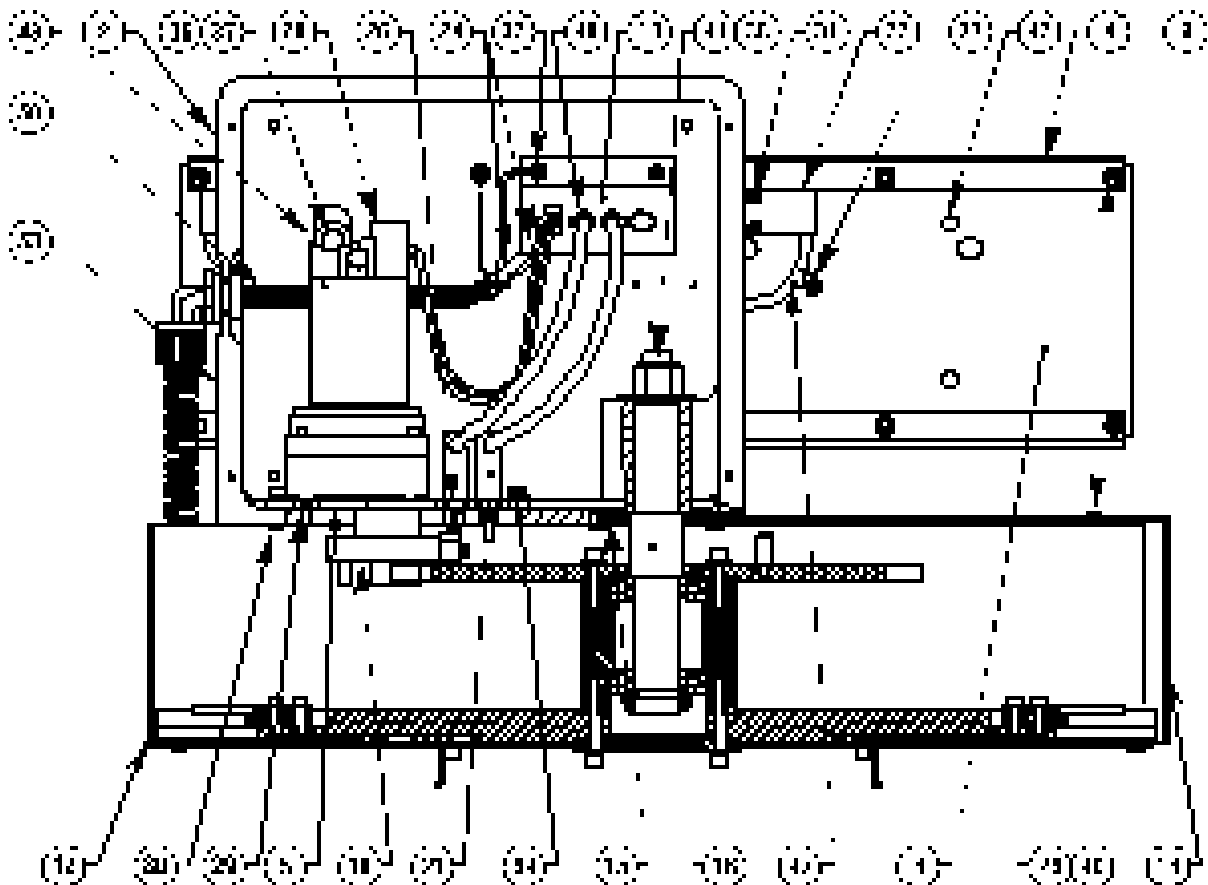
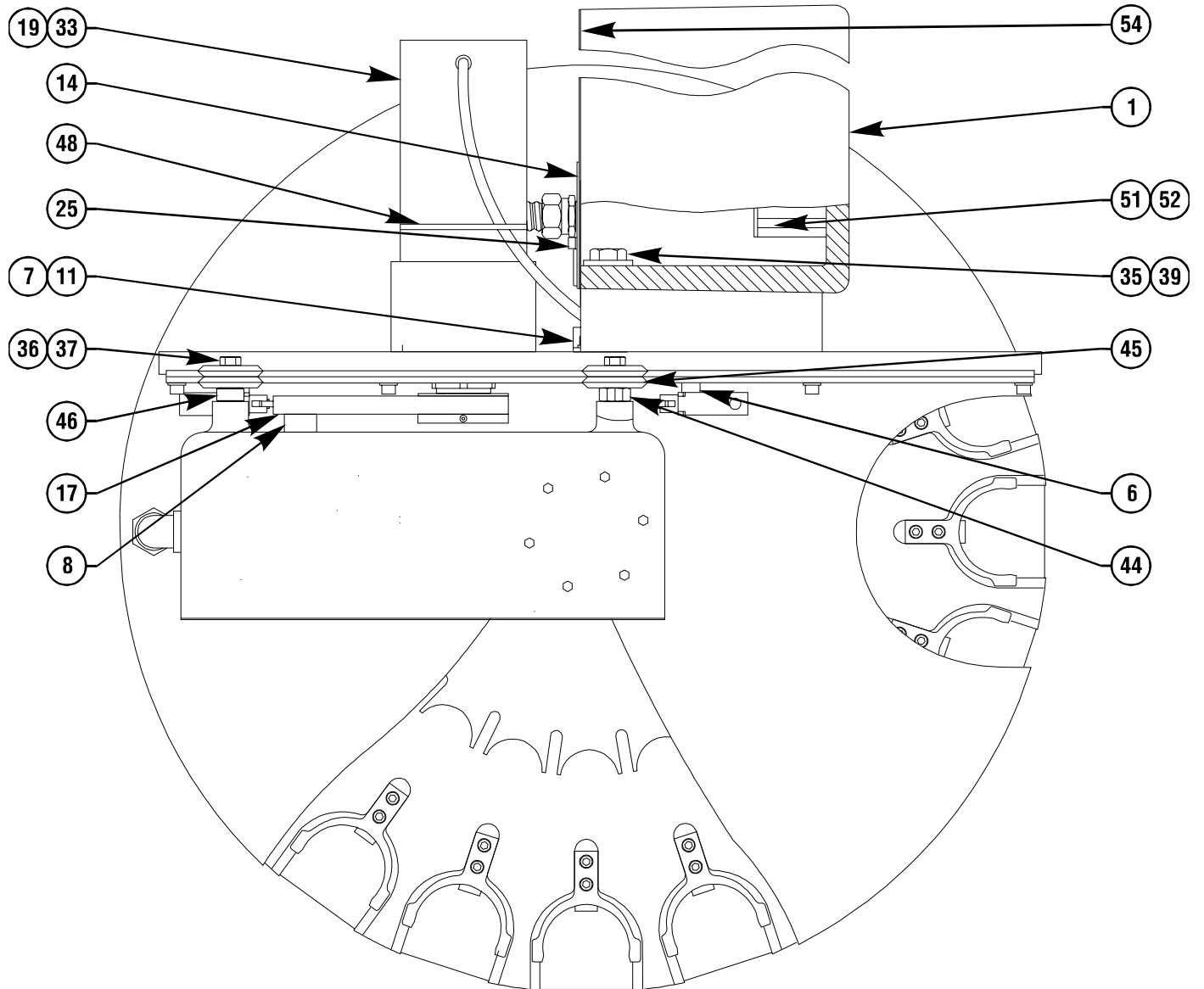


Fig. 14-2 Automatic Tool Changer - Mechanical Assembly (Cont'd)



**14.5** (Cont'd)



**Fig. 14-3 Automatic Tool Changer - Mechanical Assembly, Page 2.**

## 14.6 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.

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 (Section 7) 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 (Section 14.7).

6. Test run the ATC to ensure proper operation.

## 14.7 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.

## 14.8 SHUTTLE MOTOR

### REMOVAL -

1. Turn the VMC **off**.

2. Remove the cover from the **tool carriage casting** (Item 6, Fig. 14-3).

3. Remove the hex bolt that attaches the **cam follower** to the **slip clutch** (Item 63, Fig. 14-2).

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** (Items 15 and 72, Fig. 14-3).

6. Using a small two-jaw puller, pull the **slip clutch assembly** (Item 15, Fig. 14-3) 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 (See Fig. 14-4).

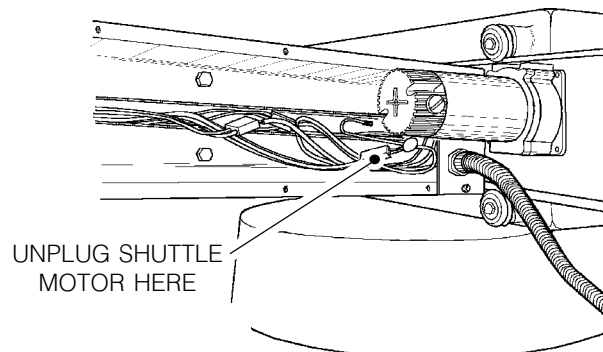


Fig. 14-4 Wiring harness for shuttle motor.

(Cont'd)

## 14.8 (Cont'd)

9. Remove the four FHCS attaching the shuttle motor to the holding plate on the tool changer (See Fig. 14-6). The FHCS are visible from the front of the VMC. Do not remove the HHB's holding the shuttle motor gear box together.

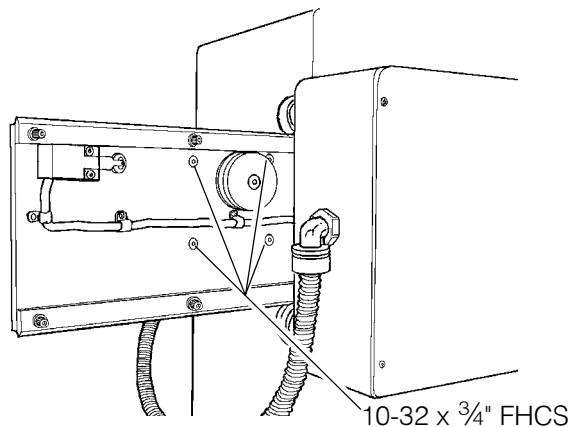


Fig. 14-6 Front view of holding plate showing FHCS location.

### INSTALLATION -

1. Install the new motor on the tool changer holding plate using the four 10-32 x  $\frac{3}{4}$ " FHCS. Before inserting the FHCS, put 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.
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 (Fig. 14-2).
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.

## 14.9 TURRET MOTOR

**NOTE:** Turret motor assemblies produced after approximately November 1, 1992 will be shrink-fit assembled and are not field-serviceable. If there is a problem with the turret assembly, it will be necessary to return it to Haas for disassembly and repair. Turret motors are currently available as a complete assembly.

### 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.

EDIT	INSERT	ALTER	DELETE	UNDO
MEM	SINGLE BLOCK	DRY RUN	OPT STOP	BLOCK DELETE
MDI	COOLNT	ORIENT SPINDLE	ATC FWD	ATC REV
HANDLE JOG	.0001 .1	.001 1.	.01 10.	.1 100.
ZERO RET	AUTO ALL AXES	ORIGIN	ZERO SINGL AXIS	HOME G28
LIST PROG	SELECT PROG	SEND RS-232	RCV RS-232	ERASE PROG

Fig. 14-7 ZERO RET, AUTO ALL AXES, MDI, ATC FWD button locations.

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 1/4-20 SHCS attaching the **turret motor** and mounting plate to the **tool carriage casting**.

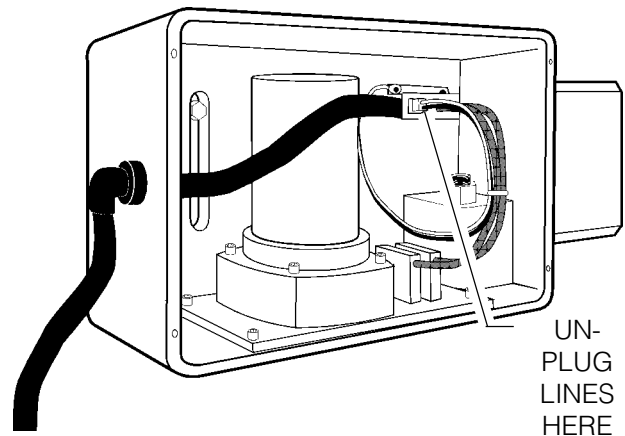


Fig. 14-8 Carriage casting with cover removed.

8. Carefully lift the **turret motor assembly** off of the tool carriage casting.
9. Loosen the set screw (or screws on machines built between 2/92-11/92) and with a small two- or three-jaw puller, pull the **driver** from the **motor shaft**.
10. Unscrew the four FHCS attaching the motor to the motor plate.

**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. Install the replacement **motor assembly** onto the mounting plate with the four 10-32 FHCS.
2. Slide the Geneva driver onto the shaft.

**NOTE:** On machines built prior to 2/92, the Geneva driver will have a keyway and one set screw. On these machines, the set screw must be used. If the replacement motor has no keyway, a Geneva driver with no keyway and two set screws must be used. Correspondingly, motors with a keyway and no flat on the output shaft require a Geneva driver with a keyway.

The clearance between the mounting plate and the driver should be 0.750 (See Fig. 14-9). Use red Loctite on the shaft and blue Loctite on the set screw(s).

(Cont'd)

## 14.9 Cont'd

3. Grease the locking element and drive pin on the Geneva driver. Also, grease the teeth on the Geneva star on the ATC.
4. Rotate the Geneva driver until the **cam** depresses the limit switch on the turret motor assembly.
5. 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.

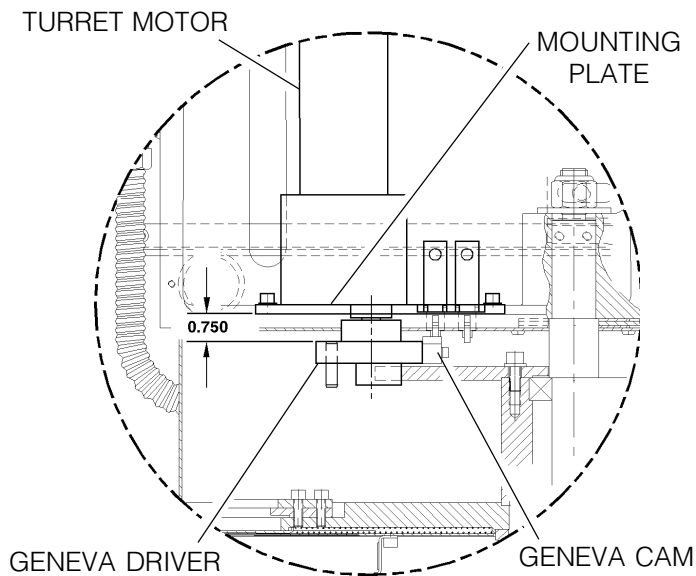


Fig. 14-9 Required spacing for Geneva driver.

6. Attach the **turret motor assembly** to the **carriage casting** with the four SHCS.
7. Reconnect the power and limit switch lines to the turret motor.
8. Power on the VMC and ZERO RETURN all axes (ZERO RET - AUTO ALL AXES).
9. 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.

10. 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.

11. Reinstall the tool carriage casting cover.
12. Test the tool changer for proper operation.

## 14.10 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** (Previous section, 14.10).
4. Place a support for the ATC under the center of the carousel.
5. Loosen the nut inside the shuttle casting (Item 57, Figure 14-2) 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** (Item 8, Figure 14-3) to the bearing housing on the ATC carousel.
8. Install the **Tool #1 standoff** (Item 21, Figure 14-2) 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 (Sections 14.3 & 14.4), if necessary.

## 14.11 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** (Previous section, 14.10).
3. Place a support for the ATC under the center of the carousel.
4. Loosen the nut inside the shuttle casting (Item 57, Figure 14-2) 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 (Sections 14.3 & 14.4).



## 15. Quick Exhaust Valve Installation

Please read this section in its entirety before attempting to install quick exhaust valve.

### TOOLS REQUIRED:

- PHILLIPS SCREWDRIVER
- 7/16" OPEN-END WRENCH
- 9/16" OPEN-END WRENCH
- 8" ADJUSTABLE WRENCH

### INSTALLATION

1. Remove the front **head cover** (Section 1).
2. Disconnect the  $\frac{1}{4}$ " **air line** and remove the 90° fitting from the **tool release piston assembly**.
3. Install the  $\frac{1}{8}$ " **hex nipple** on the tool release piston assembly as shown.

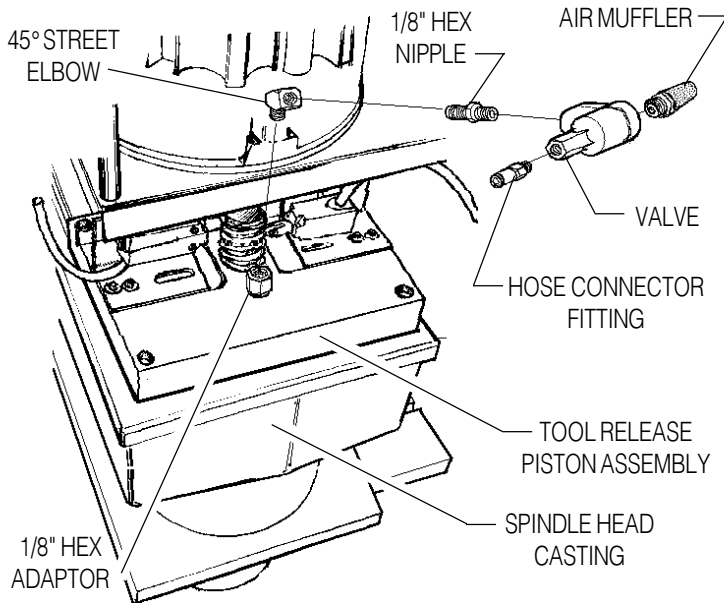


Fig. 15.1 Exploded view of quick exhaust valve.

4. Install the  $\frac{1}{8}$ " **45° street elbow** on the adapter.
5. Remove the  $\frac{1}{4}$ " **air muffler** and **hose connector fitting** from valve.
6. Install **valve** on the 45° street **elbow** with the exhaust to the *right* side of the machine.

7. Install the  $\frac{1}{4}$ " **muffler** and **hose connector fitting** to the valve.
8. Connect the  $\frac{1}{4}$ " **air line**.
9. Change **Parameter 71** (Drawbar Offset) to **2000**.
10. Change **Parameter 72** (Drawbar Z Velocity) to **30000**.





## 16. 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 1/2 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).

$$(\text{DISTANCE TO GO} - .118) \times 33867 = \text{Grid Offset}$$

[ 33867 = 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. If *any* axis is reset, the user's **work offset** must be reset also.

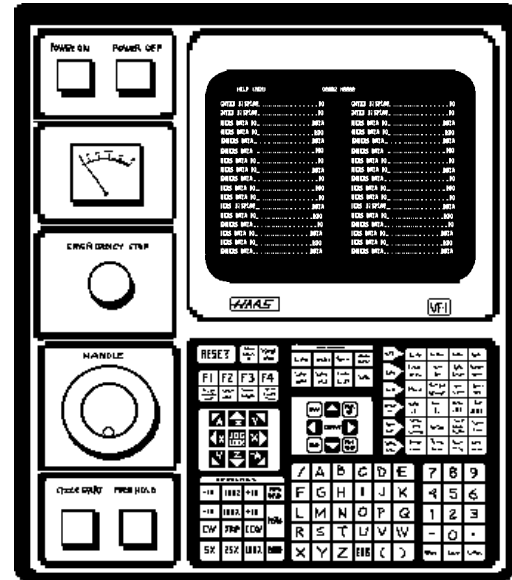


Fig. 16-1 Control panel and screen.



## 17. Enclosure Component Replacement

Please read this section in its entirety before attempting to replace the doors or windows.

### TOOLS REQUIRED:

- 7/16" HEX WRENCH
- FLAT-TIP SCREWDRIVER

### 17.1 DOOR REPLACEMENT (VF-0, VF-1, VF-2)

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

#### REMOVAL -

1. Turn machine power **off**.
2. Slide doors to the full **open** position.
3. Remove the **tension springs** connecting the two **swivel roller brackets**.
4. Using a flat-tip screwdriver, pry the **swivel roller brackets** away from the top **wheel plate**.
5. Slide the door to the center of the opening and pull the top out toward the front of the machine. The **guide wheels** on the bottom should release from the bottom **wheel plate**.

#### INSTALLATION -

6. Place the bottom of the door into the opening with the **guide wheels** resting on the bottom **wheel plate**.
7. Position the door upright, placing the **guide wheels** onto the top **wheel plate**.
8. Slide the door to the open position.
9. Align the **swivel roller brackets** with the vertical edge of the door and pop into place with your hand. (The bottom two wheels should have popped into place when the door was put in the upright position.)
10. Place the **tension springs** on the upper and lower **swivel roller brackets**.

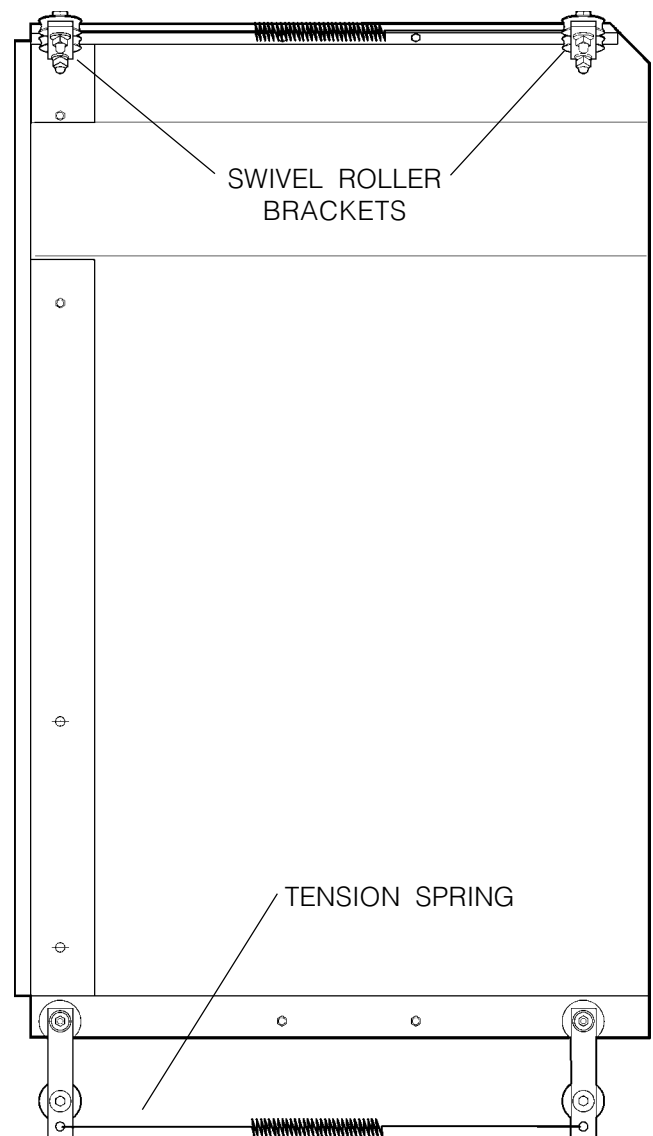


Fig. 17-1 VF-0, VF-1, VF-2 door assembly.

## 17.2 DOOR REPLACEMENT (VF-3, VF-4)

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

**NOTE:** On early VF-3's, it may be necessary to loosen the cap screws holding the guide wheels in place before removing the door.

### REMOVAL -

1. Turn the machine power **off**.
2. Unhook the **tension springs** from the **swivel roller brackets**.

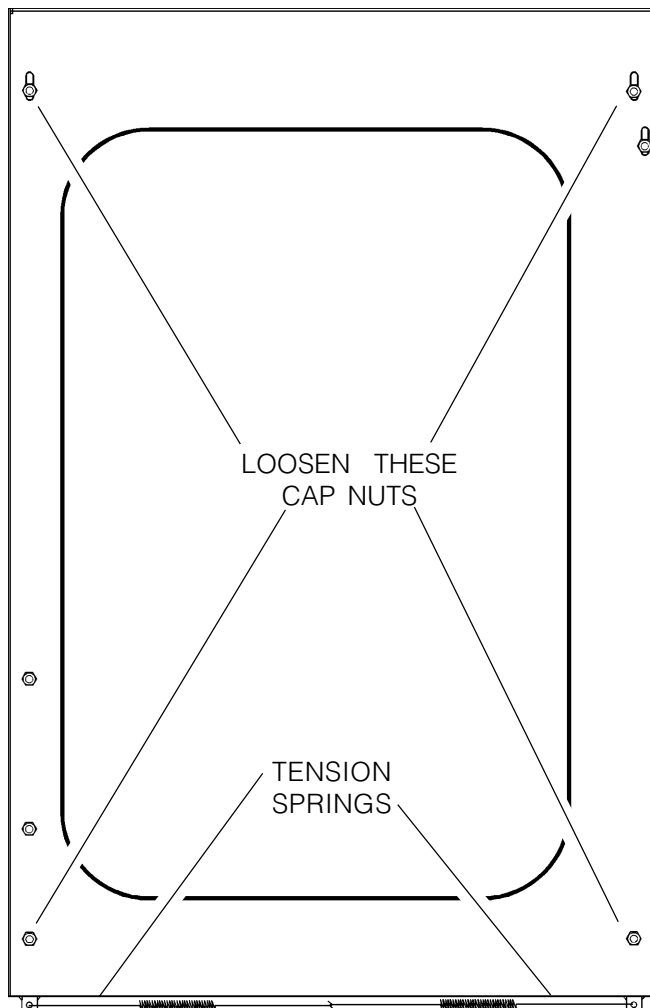


Fig. 17-2 VF-3 door assembly.

3. Slide the door to the center of the opening.
4. Push the door in toward the machine to free from the **wheel plates** and remove.

### INSTALLATION -

5. Place the door inside the enclosure opening, with the bottom of the door having its **wheel guides** resting on the **wheel plate**.
6. Push the bottom two **swivel roller brackets** into the **wheel plate** to put into place. Slide the door to the open position.
7. Push the top two **swivel roller brackets** into the **wheel plate** to put into place.
8. Reattach all **tension springs** to the appropriate **swivel roller brackets**.

## 17.3 HOOD REPLACEMENT

### REMOVAL -

1. Turn machine power **off** and disconnect the power source.
2. Unscrew the 1/4-20 screws and remove the **side enclosure panels**.
3. Remove the **doors** (Section 17.1).

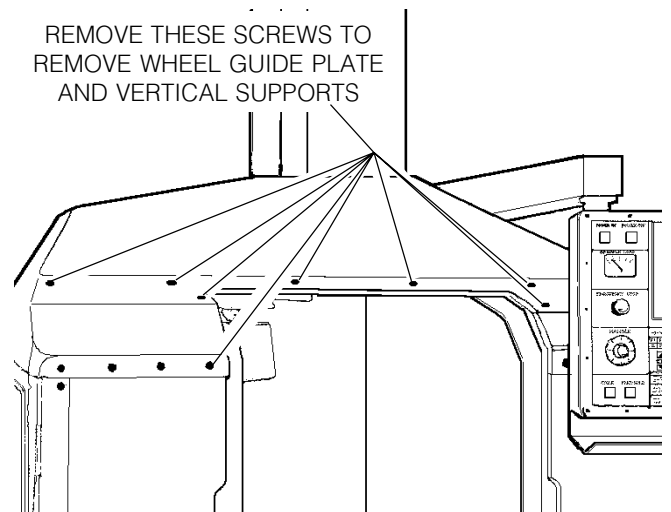


Fig. 17-3 Screw locations for wheel plate removal.

4. Disconnect the DOOR OPEN SWITCH cable at the plug and the ground cable at the limit switches.
5. Remove the two **straps** fastening the cables to the hood.
6. Unscrew the 9/16" bolt that holds the **work light** to the hood and remove the light. Take care to hold the work light in place until the bolt is removed.

7. Remove the top **wheel guide plate** and **hood stiffeners** from the hood.
8. Remove the four **corner braces**.

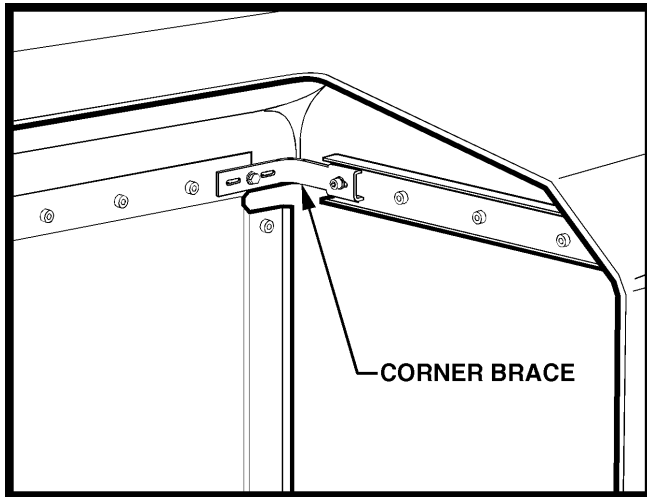


Fig. 17-4 Corner brace location.

9. Unscrew all remaining screws holding the hood to the front and rear panels.
10. Starting at the left rear of the hood, pull up and forward, turn sideways (left rear is now at the top), then pull the right rear up and pull the hood out.

11. Remove the metal **braces** from each end of the hood.

### INSTALLATION -

12. Install the appropriate metal **braces** at each end of the hood.
13. Start with the right rear of the **hood**, placing the right end under the control box support arm and into place, resting on the front and rear panels.
14. Push the left end of the **hood** around and down so it is also resting on the front and rear panels.
15. Once in place, fasten the **hood** to the front and rear panels with the screws previously removed.
16. Reinstall the four **corner braces**. All braces are interchangeable to any corner.
17. Reinstall the **wheel guide plate** to the hood. Make sure the guiding edge is on the lower side.
18. Reinstall the **hood stiffeners** on either side of the door opening.

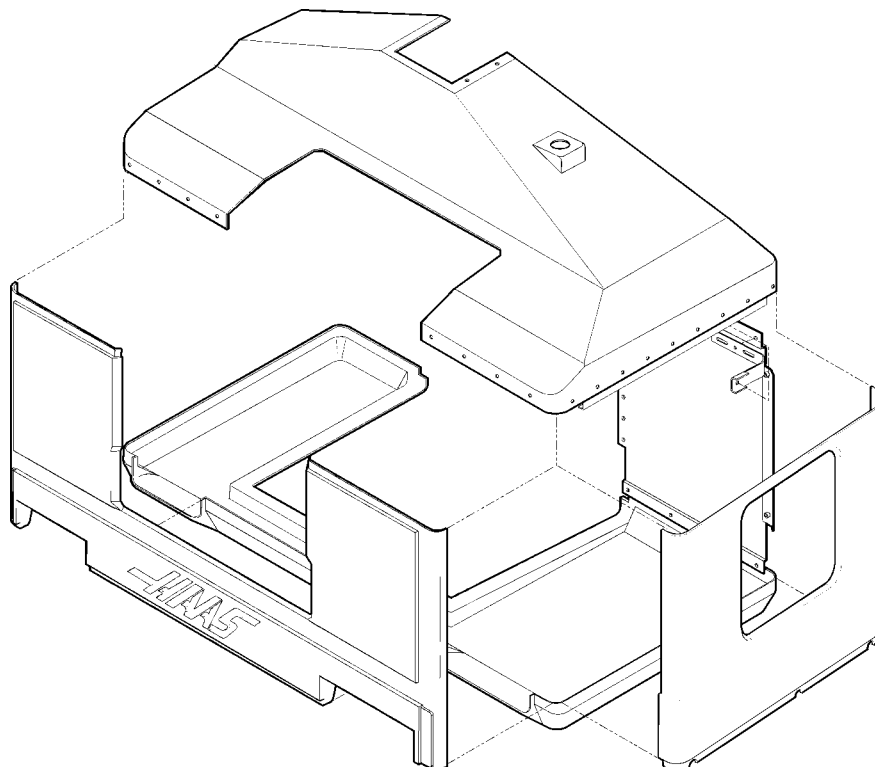


Fig. 17-5 Exploded view of enclosure panels.

## 17.3 (Cont'd)

19. Reinstall the **work light**, pulling the previously-removed cables through the bolt.
20. Replace the two **straps** to hold the cables to the hood. Reconnect the DOOR OPEN SWITCH cable at the plug and the ground cable at the limit switches.
21. Replace the **doors** (Section 17.1).
22. Replace the enclosure **side panels**.

## 17.4 WINDOW REPLACEMENT

1. Turn machine power **off**.
2. To remove the window, it will be necessary to separate the **window panel** from the rubber seal (sealed with silicone sealant on the inner side). Use a dull-edged knife or caulking spatula to do this.
3. Remove the **locking trim** from the inner side of the window and remove **window panel**. Remove the **rubber seal** from the enclosure panel.
4. To replace the window, first replace the **rubber seal** around the enclosure's cutout (See Fig. 17-6).
5. Seat the new **window panel** inside the **rubber seal** and adjust the rubber trim to fit the panel around the edges.
6. Run a bead of silicone sealant around the entire circumference of the inner side of the **window panel**.
7. Fit the **locking trim** in place around the **rubber seal** to lock in the panel.

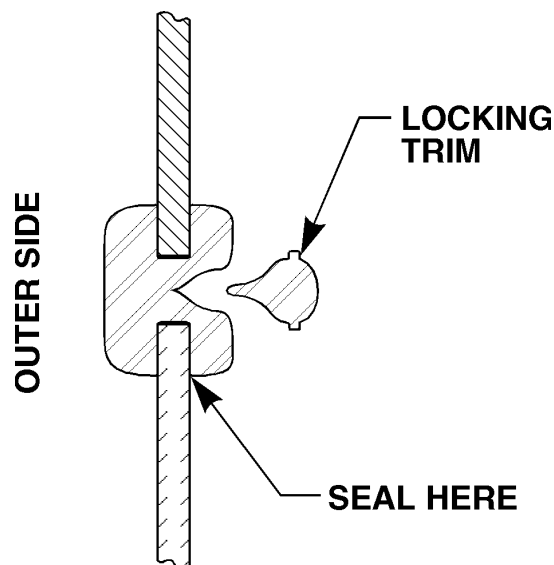


Fig. 17-6 Window seal detail.

# **ELECTRICAL SERVICE**

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# 1. Solenoids

*Please read this section in its entirety before attempting to replace any solenoid assemblies.*

## TOOLS REQUIRED:

- 1/8" HEX WRENCH
- 1/2" WRENCH
- PHILLIPS SCREWDRIVER

## 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 (Section 1, Mechanical Service).

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".
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).

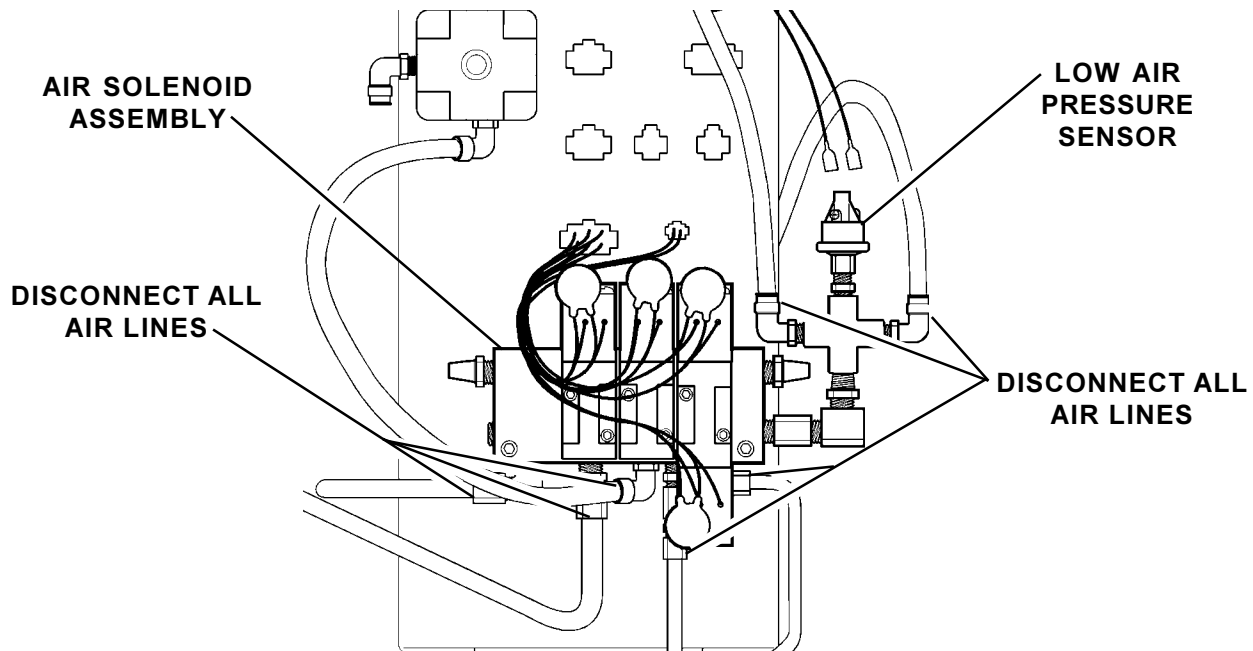


Fig. 1-1 Air solenoid assembly.

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.

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 (Section 1, Mechanical Service).
3. Remove air supply from machine.
4. Remove the **tool release piston assembly** (Section 2.1, 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.

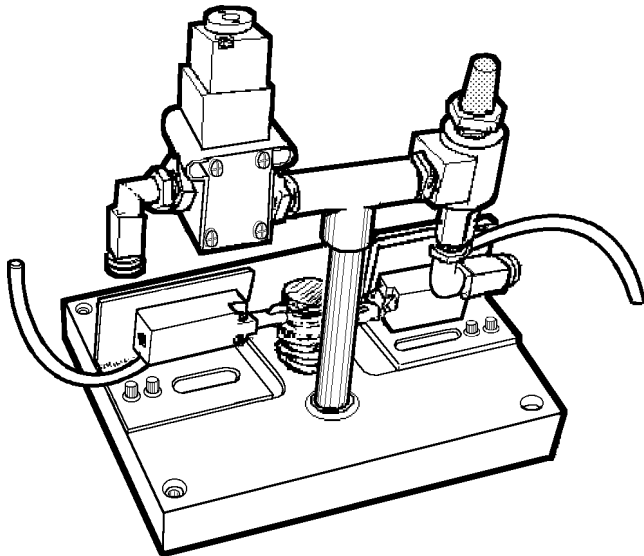


Fig. 1-2 *Tool release piston assembly with air solenoid assembly.*

6. Unscrew the **air solenoid** from the **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.

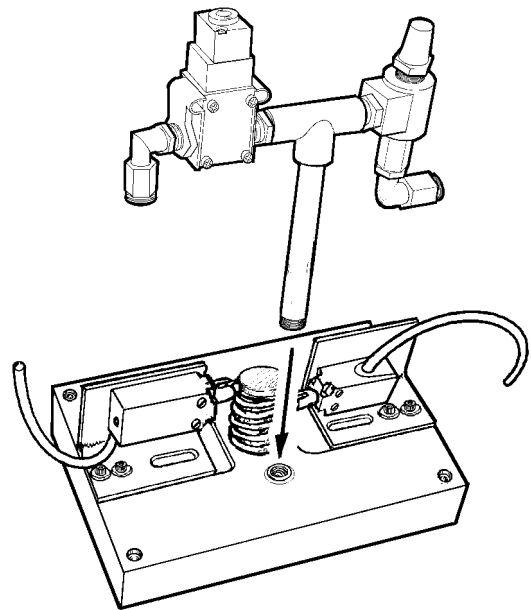


Fig. 1-3 *Air solenoid assembly installation.*

8. Reinstall the **tool release piston assembly** (Section 2.2, 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.

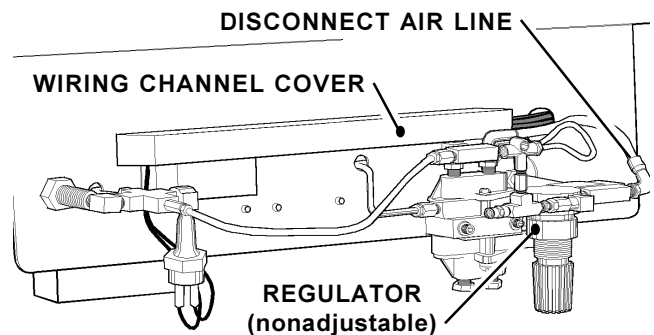


Fig. 1-4 *Back side of lube/air panel.*

2. Disconnect the air lines from the spindle lube **air solenoid assembly** (See Fig. 2-4).
3. Unplug the electrical leads at the quick-disconnect. You will have to slide the wiring channel cover back to disconnect the leads.

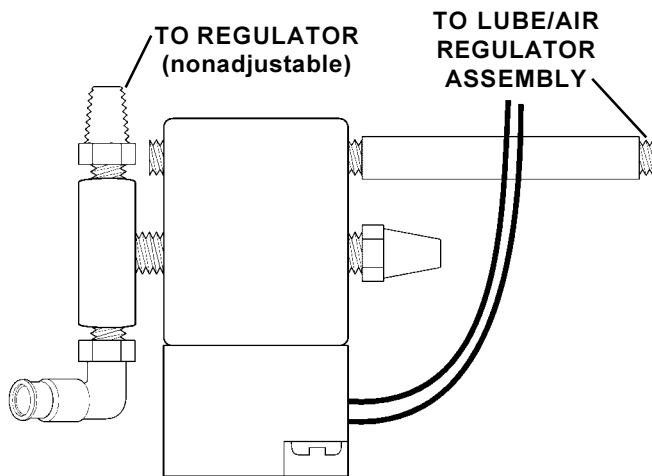


Fig. 1-5 Top view of spindle lube/air solenoid assembly.

4. Disconnect the spindle lube **air solenoid assembly** from the (nonadjustable) **air regulator**.
5. Disconnect the spindle lube **air solenoid assembly** from the **air regulator assembly** (on opposite side of lube/air panel). Pipe fitting must be disconnected at fitting on regulator.
6. Replace spindle lube **air solenoid assembly**, ensuring assembly is approximately horizontal to the floor, and tighten fittings securely.
7. Reconnect the (nonadjustable) **air regulator** to the T-fitting.
8. Reconnect all air lines.
9. Reconnect wiring leads at the quick-disconnect in the wiring channel. Slide cover back into place.
10. 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).

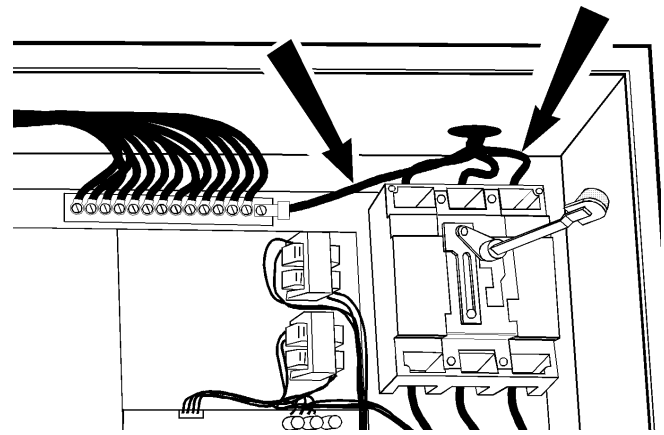


Fig. 2-1 Power lines; hookup location.

**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 problems, 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.

(Cont'd)

**2.** (Cont'd)

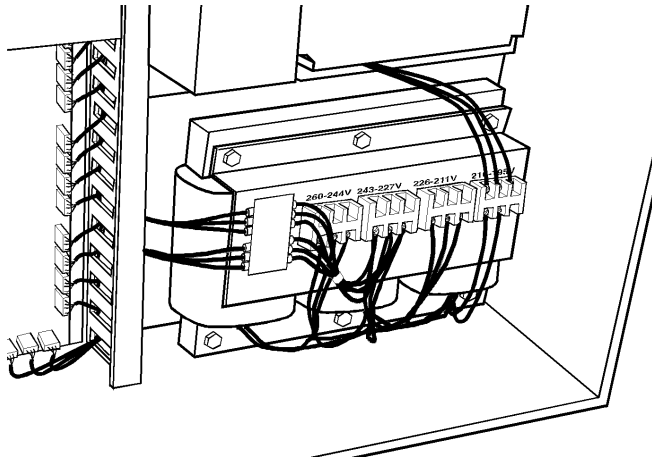


Fig. 2-2 Transformer connections.

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

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

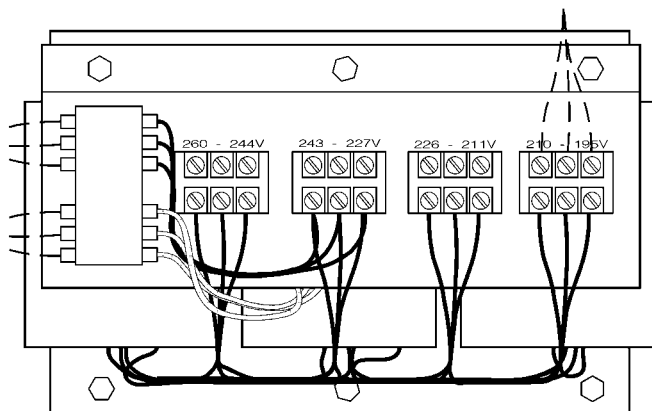


Fig. 2-3 Transformer with 195-210V range.

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 problems, call the factory.

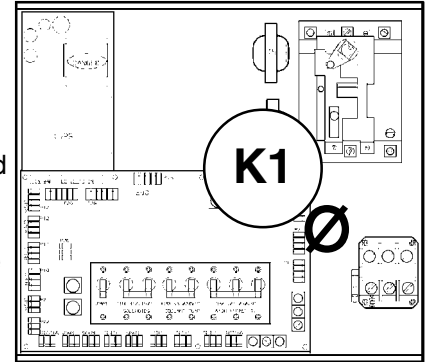
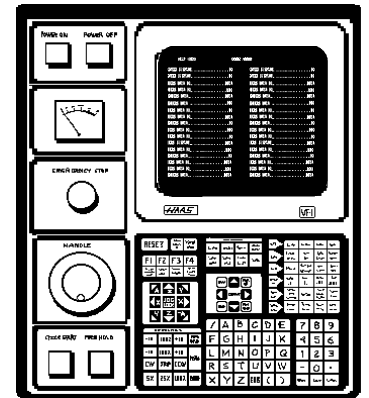


Fig. 2-4 Measure voltage here.

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 counter-clockwise 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.*

### TOOLS REQUIRED:

- LARGE & SMALL FLAT TIP SCREWDRIVERS
- 1/4" HEX WRENCH                      • 3/16" HEX WRENCH
- REPLACEMENT FUSE(S)

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

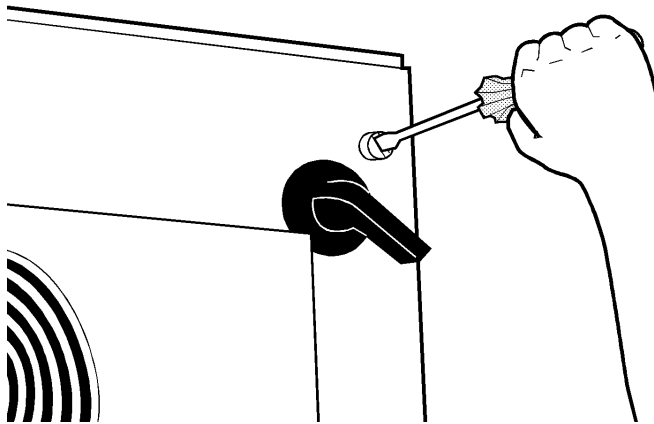


Fig. 3-1 *Unscrew the three screws to open the cabinet door.*

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 **overvoltage** fuses. An orange light will be **on** to indicate the blown fuse(s).

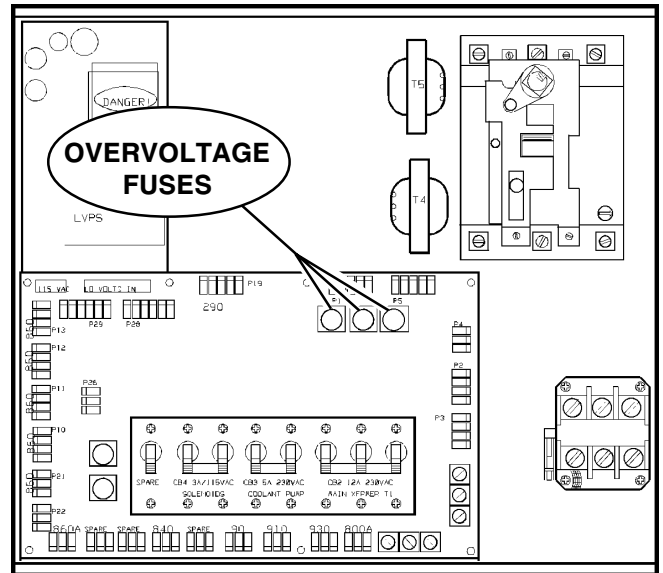


Fig. 3-2 *Power supply assembly; fuse locations.*

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 (1/2 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 & TOOL CHANGER 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 POWER SUPPLY board there are two fuses located, one above the other, at the lower left of the board; these are the **operator's lamp** and **tool changer** fuses (they are marked accordingly). An orange light will be **on** to indicate the blown fuse(s).

**(Cont'd)**



## 3.2 (Cont'd)

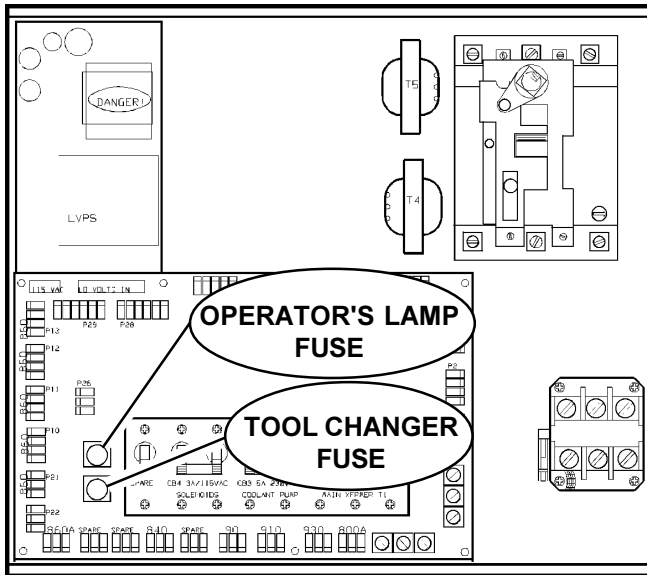


Fig. 3-3 Power supply board; fuse locations.

4. 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 (**operator's lamp**: ½ amp, type AGC, 250V; **tool changer**: 5 amp, type ABC, 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).

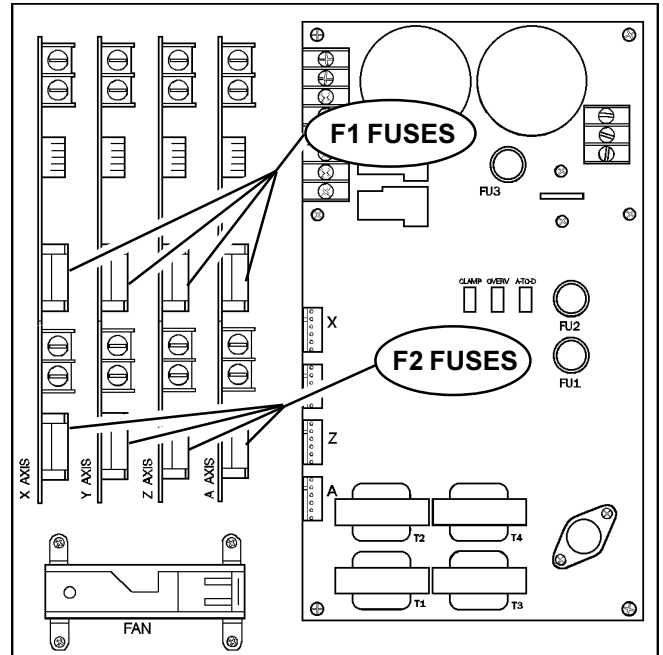


Fig. 3-4 Servo drive assembly; fuse locations.

## 4. PCB Replacement

*Please read this section in its entirety before attempting to replace any PCB 's.*

### TOOLS REQUIRED:

- PHILLIPS SCREWDRIVER
- FLAT-TIP SCREWDRIVER
- 1/4" HEX WRENCH

### 4.1 MICROPROCESSOR, VIDEO, & MOTIF

**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. The following illustration shows all cable numbers and the locations on the MOTIF board.

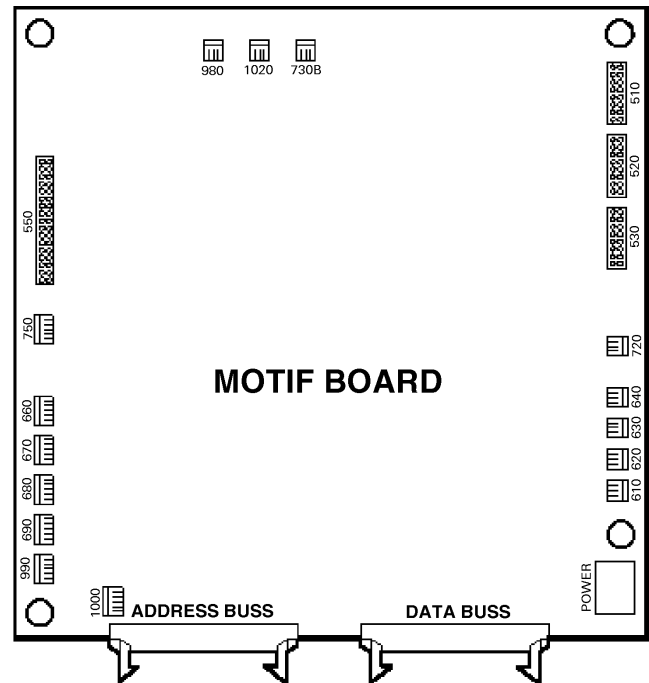


Fig. 4-1 Motor Interface board.

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 or PROCESSOR boards need replacing, please skip the next step.

6. Replace the Motor Interface (MOTIF) board, attaching it to the VIDEO board (beneath the **MOTIF** board) with the standoffs.
7. Reconnect all leads (previously removed) to their proper connections (refer to Fig. 4-1).

#### VIDEO BOARD -

8. Remove the MOTIF board as described in steps 1-5.
9. Disconnect all leads to the Video (VIDEO2) board. Ensure all cables are properly labeled for reconnecting later. The following illustration shows all cable numbers and the locations on the VIDEO2 board.
10. After all cables have been disconnected, unscrew the standoffs, taking care to hold the board in place until all standoffs have been removed.

(Cont'd)

## 4.1 (Cont'd)

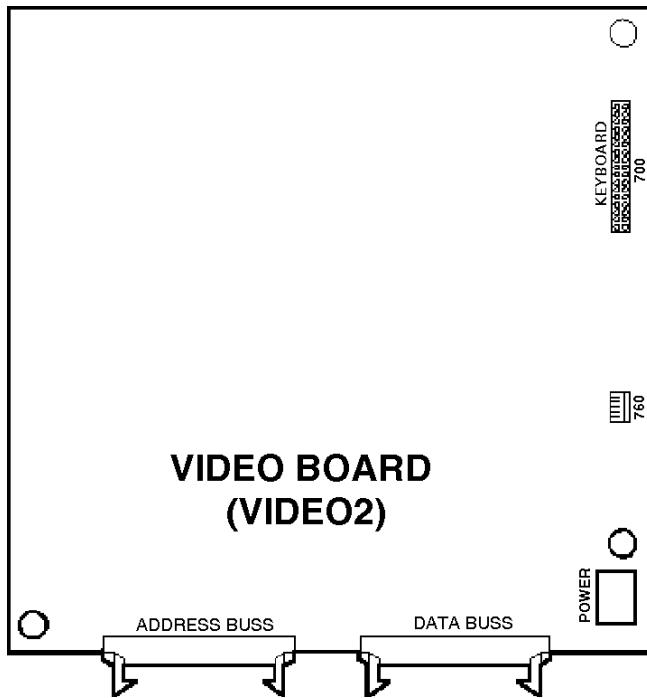


Fig. 4-2 Video board.

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

11. Replace the Video (VIDEO2) board, attaching it to the PROCESSOR board (beneath the VIDEO2 board) 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 VIDEO2 board 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 68020 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 (68020) board, attaching it to the electrical cabinet (beneath the 68020 board) with the standoffs.

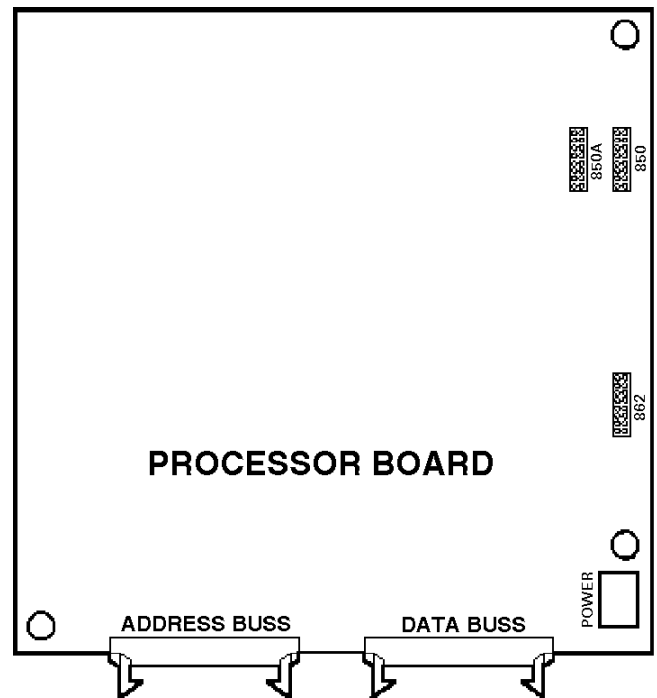


Fig. 4-3 Processor board.

7. 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". On some boards, the connection for cable 920 has been incorrectly marked as "1030". Please note its location for future reference.

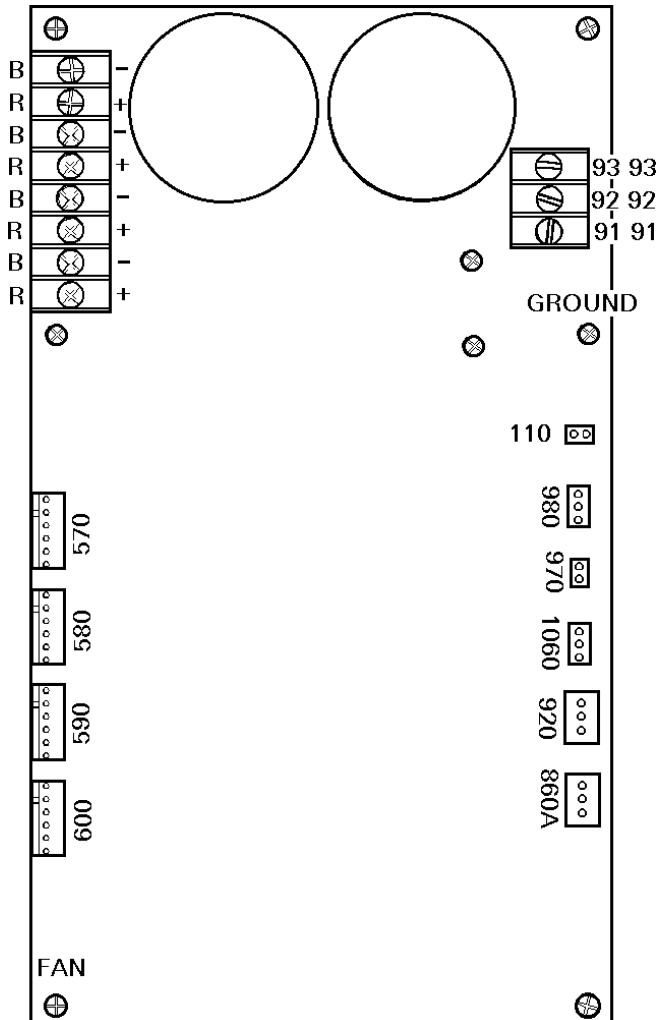


Fig. 4-4 SDIST board.

**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 -

1. Follow all precautions noted previously before working in the electrical cabinet (See warning at beginning of Section 4.2).

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. The following illustration 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.

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## 4.2

(Cont'd)

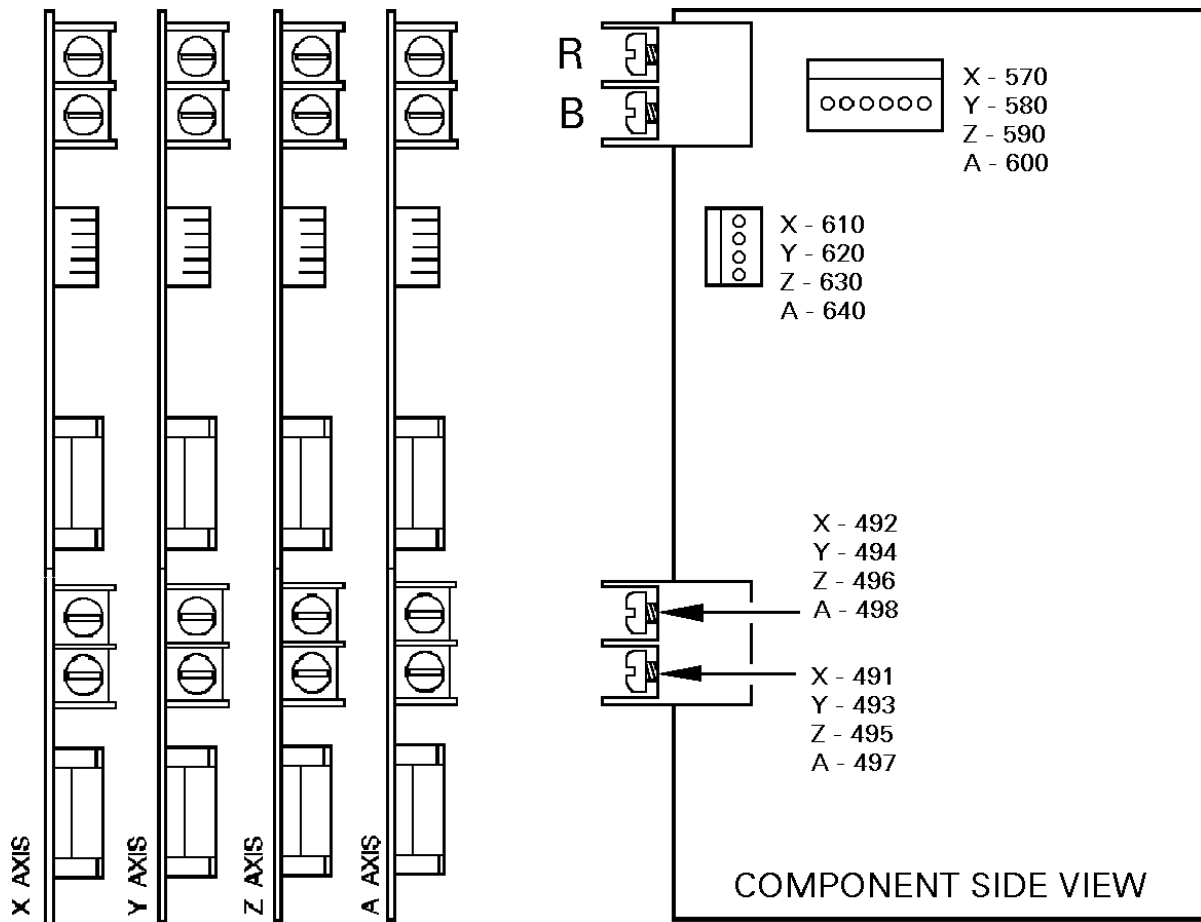


Fig. 4-5 Servo DRIVER boards.

## 4.3 I/O BOARD

1. Follow all precautions noted previously before working in the electrical cabinet (See warning at beginning of Section 4.2).
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 (I/O) 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).

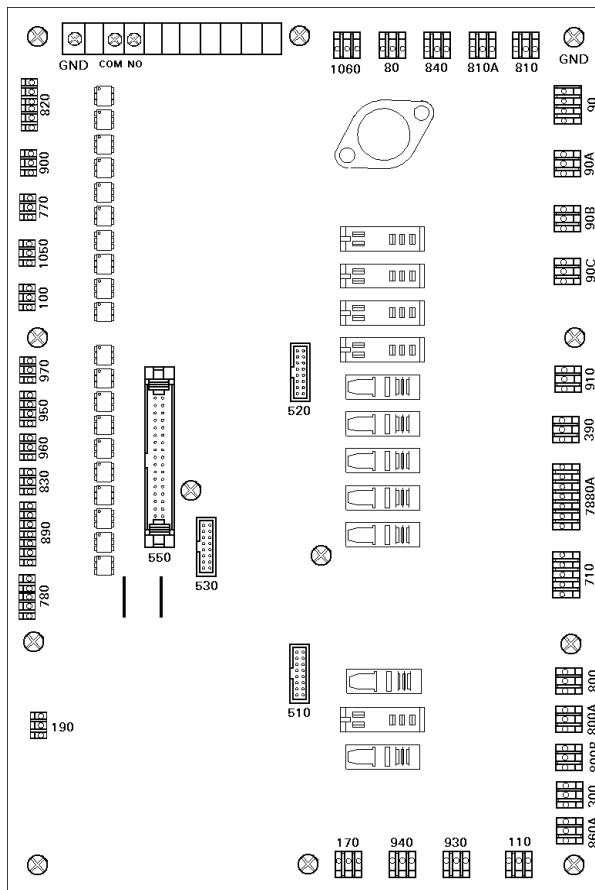


Fig. 4-6 I/O board.

## 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 Section 4.2).
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.

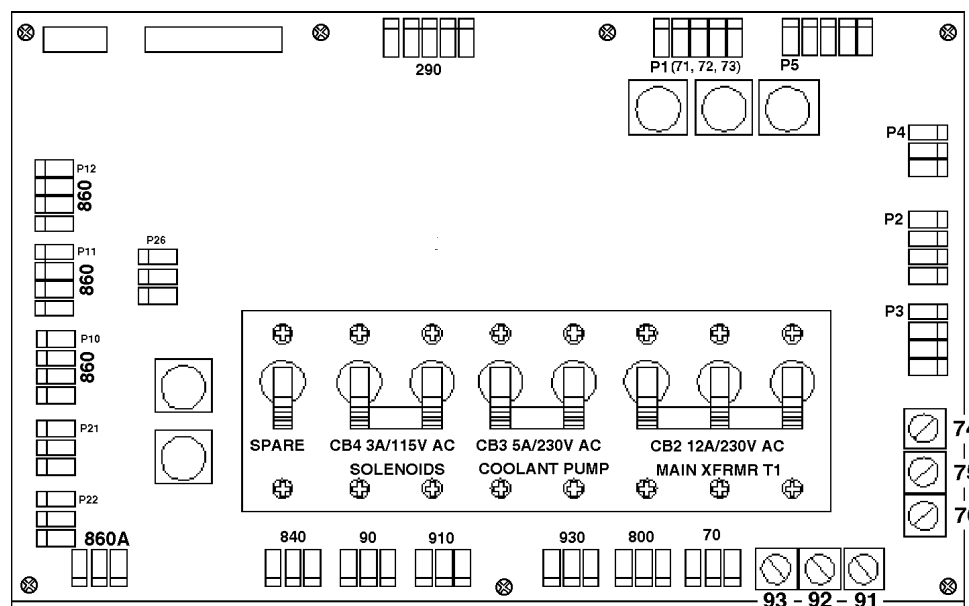


Fig. 4-7 Power Distribution (POWER) board.

(Cont'd)

## 4.4 (Cont'd)

**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).

### 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.

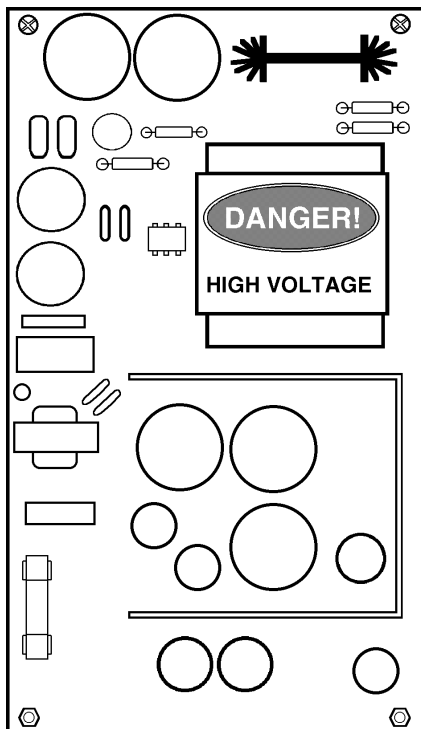


Fig. 4-8 Low Voltage Power Supply board.

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 Section 4.2).
  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.

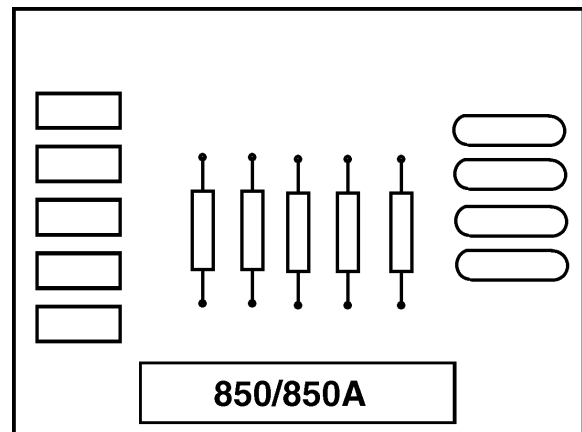


Fig. 4-9 RS-232 DB25 board.

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.

## 4.6 KEYBOARD INTERFACE

1. Follow all precautions noted previously before working in the control cabinet (See warning at beginning of Section 4.2).
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.

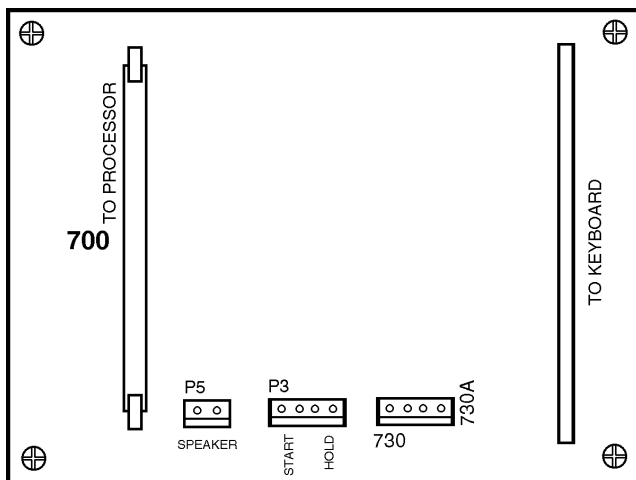


Fig. 4-10 Keyboard Interface board.

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 (refer to Fig. 4-10).





## 5. Front Panel

Please read this section in its entirety before attempting to replace any component of the control panel.

### TOOLS REQUIRED:

- PHILLIPS SCREWDRIVER
- 3/8" SOCKET WRENCH
- 5/64" ALLEN WRENCH
- SMALL FLAT-TIP SCREWDRIVER

### 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.

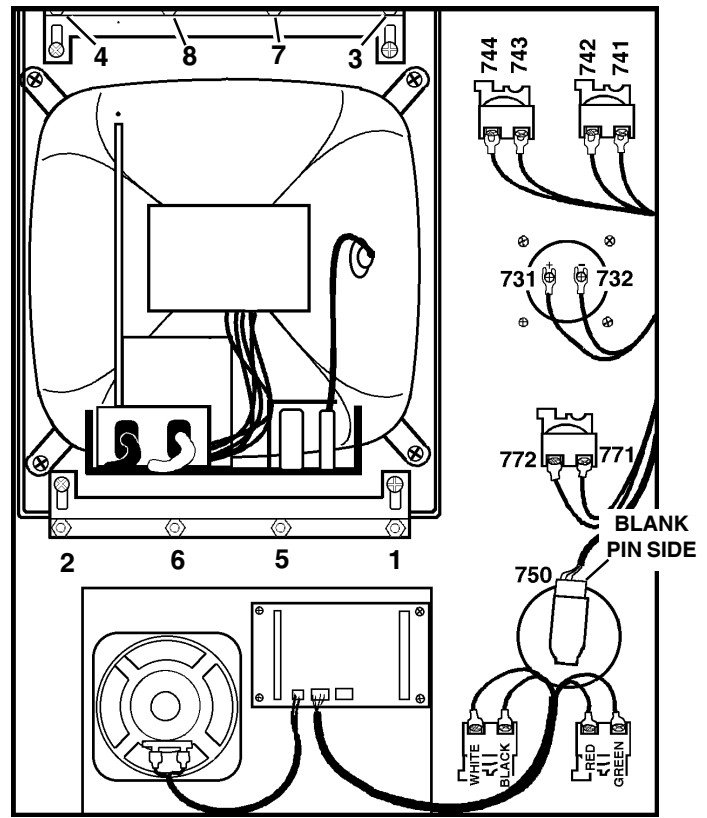


Fig. 5-1 Interior of control panel (rear).

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

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.

(Cont'd)

## 5.2

(Cont'd)

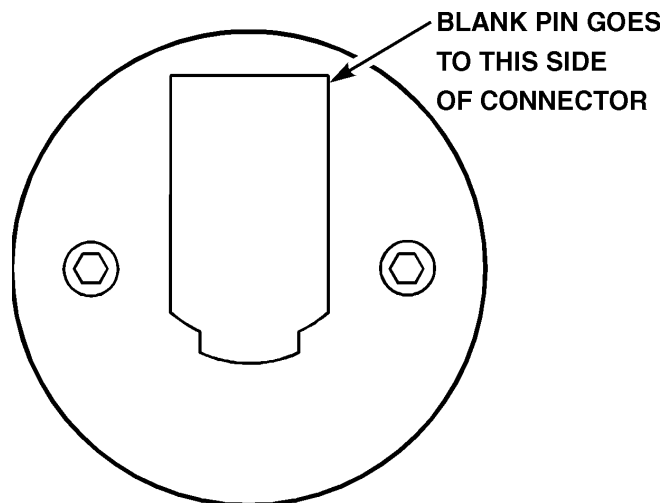


Fig. 5-2 Jog handle encoder.

- Using the 5/64" allen wrench, loosen the two screws holding the **knob** to the control panel and remove.

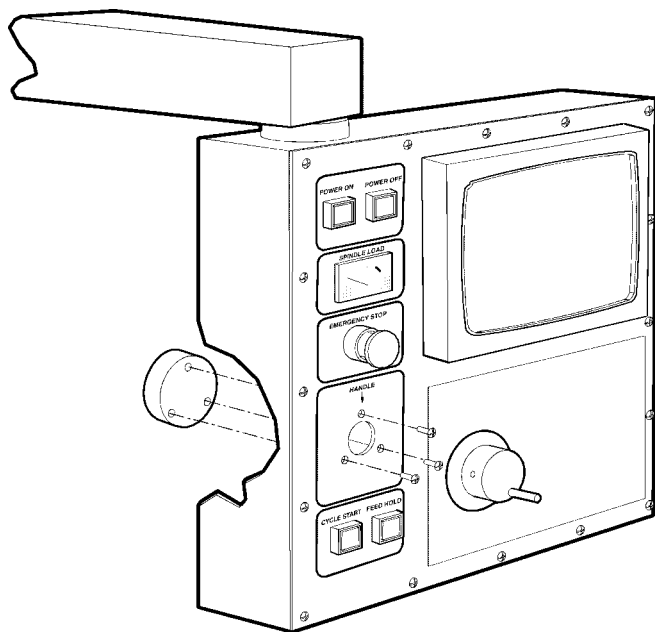


Fig. 5-3 Jog Handle removal.

- Remove the three screws holding the **jog handle encoder** to the control panel and remove.
- 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.

- Turn the machine power **off**.
  - 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.
  - 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.
  - 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.
  - 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.
- Reconnect all leads to the correct switch. Refer to Fig. 5-1 for proper location(s).

## 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. Refer to Fig. 5-1 for locations.
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 Sections 5.2 through 5.4.
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.

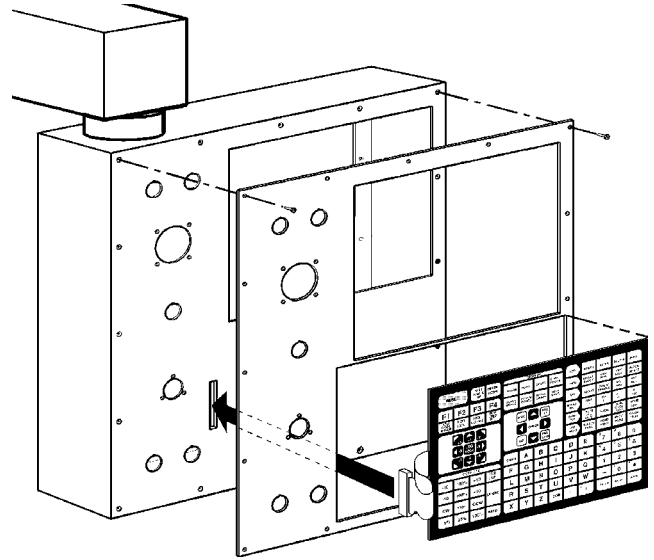


Fig. 5-4 Keypad installation.

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 Sections 5.2 through 5.4.
11. Replace the rear **cover panel** and fasten with the screws that were previously removed.



## 6. Spindle Encoder Replacement

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

### TOOLS REQUIRED:

- 5/32" HEX WRENCH    □ BLUE LOCTITE
- 5/64" HEX WRENCH
- 3/8" OPEN-END WRENCH

### REPLACEMENT:

#### 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** (Section 1.1, 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) or mounting bracket (VF-0). Remove the encoder, leaving the belt on the pulley at the orient ring.

#### INSTALLATION -

**NOTE:** Field installation of the spindle encoder is NOT RECOMMENDED. For machines built before 1/92, it is NOT POSSIBLE. If, however, you wish to install an encoder on a newer 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.

5. For the VF-1, VF-2, and VF-3, put some blue Loctite on the threads of the four 1/4-20 x 3/4" 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 (Fig. 6-2). Fasten to the top plate with the four 1/4-20 x 1" screws and four lock washers.

8. Place the 18-tooth pulley onto the pulley bushing and tighten down, using the 5/64" hex wrench. Place the 8-32 x 3/4" SHCS through the center axis of the pulley.

9. Screw this assembly into the spindle orientation ring.

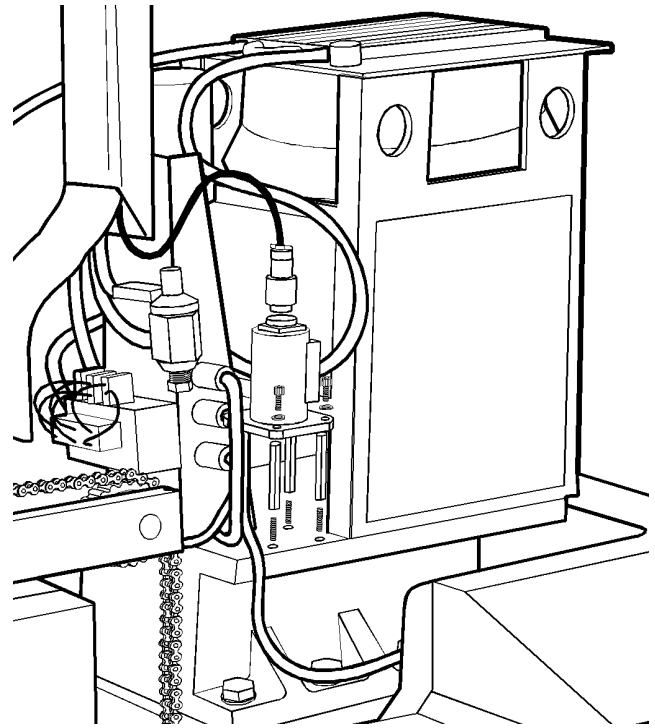


Fig. 6-1 Spindle encoder installation (VF-1/VF-2).

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.

12. Feed the **encoder cable** through the flexible tube and connect at the plug in the box on top of the electrical cabinet.

(Cont'd)

**6.** (Cont'd)

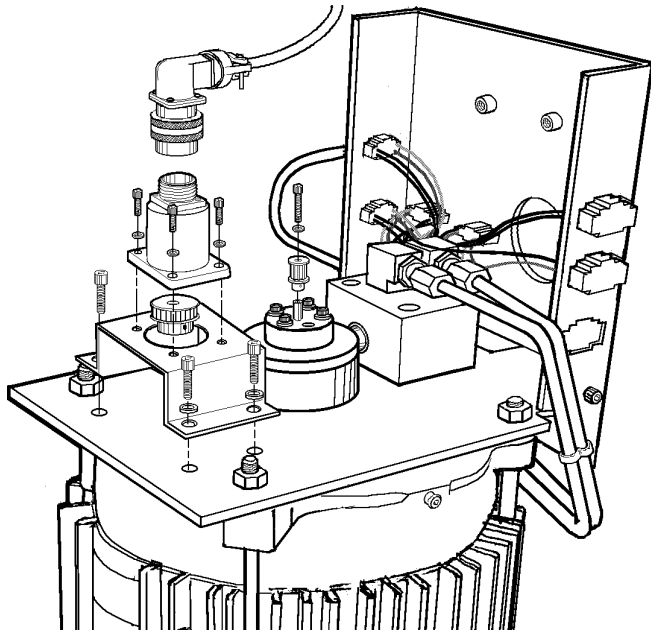


Fig. 6-2 VF-0 encoder installation.

13. Place the belt on the 36-tooth pulley, then loop over the 18-tooth pulley. Place the **encoder assembly** on the four **standoffs (mounting bracket)** on the VF-0) and attach with the four 10-32 SHCS, placing the #10 lock washers between the socket head and the encoder base.

14. Connect the encoder cable to the **encoder assembly**.

## 7. Limit Switches

### TOOLS REQUIRED:

- 2.5 mm ALLEN WRENCH
- 1/8" ALLEN WRENCH
- 9/64" ALLEN WRENCH

**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-closed 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 the same 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.

### 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.

### X, Y, Z TRAVEL LIMIT SWITCHES

[X: Left side of saddle by X-axis motor]

[Y: Rear of base by Y-axis motor]

[Z: Top of column by Z-axis motor]

The machine zero position is defined by a limit switch for each of the X, Y, and Z axes. After the search for machine zero has been completed, these switches are used to limit travel in the positive



direction. In addition, travel in the negative direction is limited by stored stroke limits. It is not normally possible to command the servo axes past the machine zero as servo travel lookahead will decelerate and stop each motor prior to exceeding the stroke limits. All limit switches are wired through connector P5 on the side of the control cabinet. P5 also contains the wiring to the lubrication pump and an alternate connection to the DOOR OPEN switches.

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.

### [Tool Changer Holding Plate (2)]

- SHUTTLE IN/OUT SWITCHES

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)]

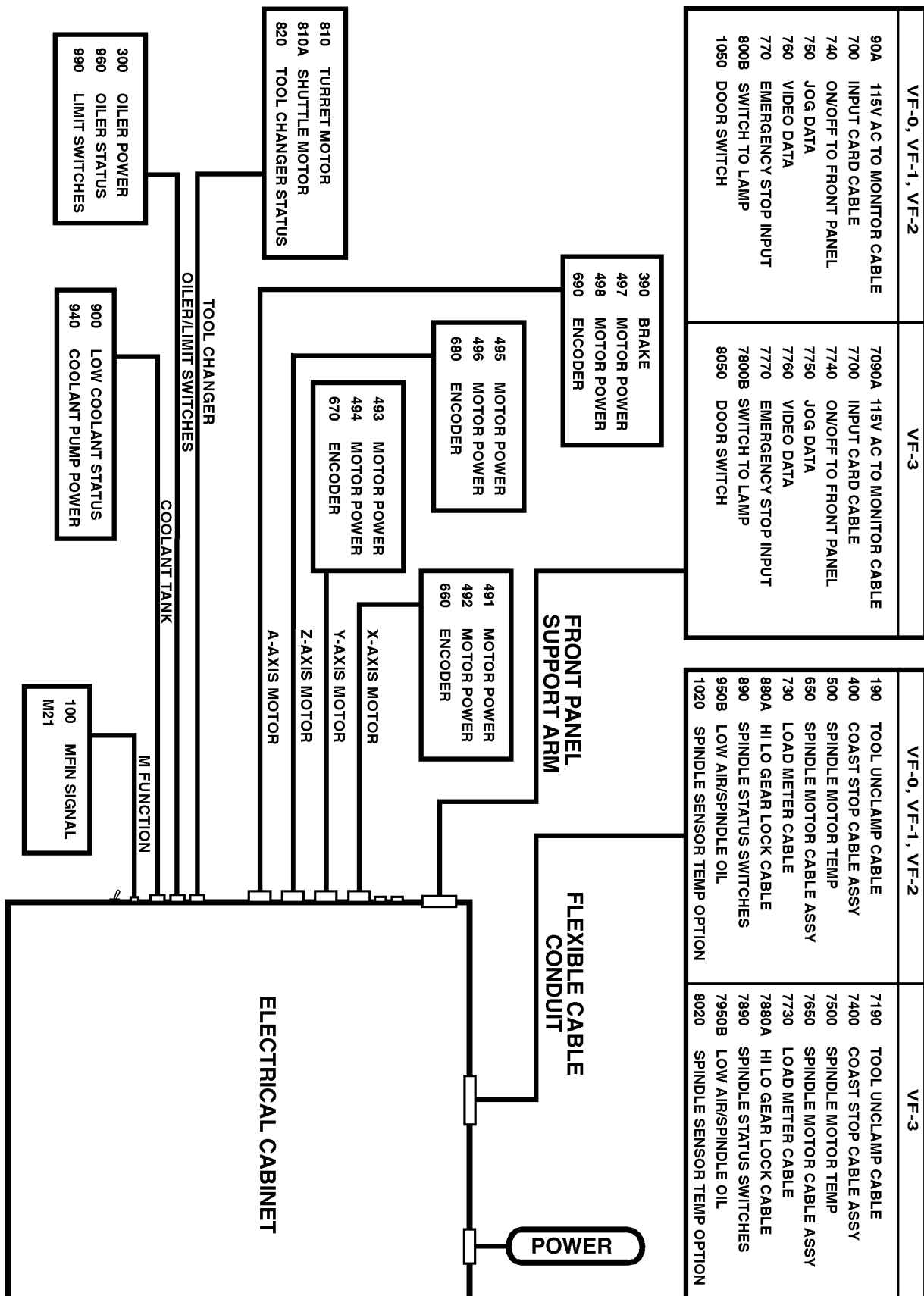
On the VF-1, VF-2, and VF-3, there are two switches in the gear box used to sense the position of the gears. One switch indicates HIGH by opening and the other indicates LOW by opening. Between gears, both switches are closed indicating a between-gear condition. The diagnostic display shows the status 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 Section 9, Mechanical Service, for **Spindle Motor and Transmission** removal.

Please note the instructions for the CLAMP/UNCLAMP switches in Section 6, Mechanical Service.



# 8. Cables' Location Diagram





The following four sections are descriptions and helpful tips on the major pcb's and their components. Use these sections when troubleshooting the pcb's to determine the location of the problem and its possible solution; this will reduce the repair and service time on the machine.

Also listed in these sections are the connectors for each pcb and its function. An illustration for each major pcb assembly is given showing each removable connector.

Refer to the appropriate section in the Electrical Service section for removal and replacement.

## 9. Microprocessor Assembly

The microprocessor assembly is in the rear cabinet at the top left position. It contains three large boards. They are: 68020, VIDEO, and MOTIF. 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. They are 157 and 158. In addition, while the control is operating, it continually tests itself and a self test failure will generate Alarm 152.

### 9.1 MICROPROCESSOR PCB (68020)

The Microprocessor PCB contains the 68020 processor running at 16 MHz, between 128K and 512K bytes of EPROM, and between 128K and 384K bytes of CMOS 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 pots 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. 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. If this light comes on, there is a serious problem with the processor PCB. Check that all of the EPROM's are plugged in. Test the card with the buss connectors off.
- POR Power-on-reset complete. If this light does not come on, there is a serious problem with the processor PCB. Check that all of the EPROM's are plugged in. Test the card with the buss connectors off.
- SIO Serial I/O initialization complete. 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. 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 CRT/VIDEO initialization complete. 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. 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 check that all of the EPROM's are plugged in.
- RUN Program running without fault exception. 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.

(Cont'd)

## 9.1 (Cont'd)

There is a two-position DIP switch on the processor PCB called S1. Position S1-1 must be ON to auto-start the CNC operational program. If S1-1 is OFF, the PGM light will remain off. Switch S1-2 is used to change the default data rate for power-up communications. If the switch is OFF, the rate is 9600; if S1-2 is ON, the rate is 38400.

The processor connectors are:

- P1 Address buss
- P2 Data buss
- P3 Serial port #1 (for upload/download/DNC) (850)
- P4 Serial port #2 (for auxiliary 5th axis) (850A)
- P5 Power connector
- P6 Battery
- P7 Battery
- P8 -12V DC / NMI\* / ext clk

## 9.2 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. Connectors P6 and P7 on the processor PCB can be used to connect an external battery.

## 9.3 VIDEO AND KEYBOARD PCB (VIDEO2)

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
- P4 Keyboard (700)

- P2 Address buss
- P5 EGA extended video connector (option)
- P3 Video connector (760)
- P6 Data buss

## 9.4 MOTOR INTERFACE PCB (MOTIF)

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)
- P23 A-to-D input spare
- P24 Home switch inputs X, Y, Z (990)
- P25 Spare inputs
- P26 A-to-D input spare
- P27 A-to-D inputs spare
- P28 A-to-D inputs spare
- P29 A-to-D inputs spare

## 10. Servo Drive Assembly

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.

### 10.1 160 VOLT DC POWER SUPPLY

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.

### 10.2 SERVO COOLING FAN

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.

## 10.3 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 (860)
- P7 115V AC to fan
- P8 160V DC supply to tool changer
- 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

(Cont'd)



### 10.3 (Cont'd)

There are three fuses mounted on the SDIST PCB; FU1 and FU2 protect the primaries of the fan and transformers T1, T2, T3 and T4. They are ½ amp, 240V AC, AGC type. FU3 protects the regenerative load circuit from a short circuit.

## 10.4 SERVO DRIVE PCB'S (DRIVER)

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, over-current 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:

- P1 160V DC from SDIST PCB
- P2 low voltage AC power from SDIST PCB
- P3 PWM and H drive control signals from Motor Interface and overcurrent sense back
- P4 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, 10A.

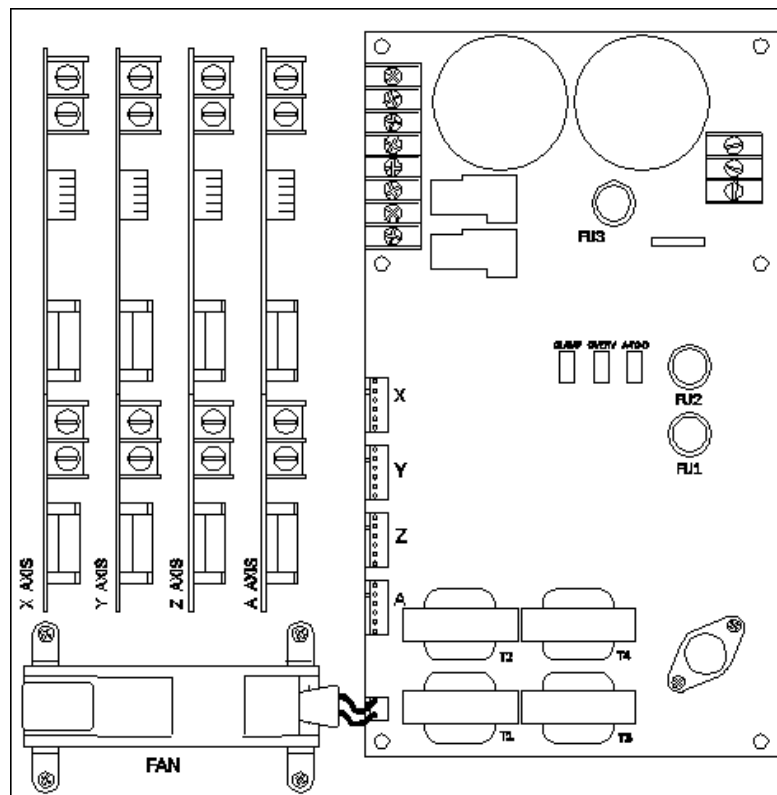


Fig. 10-1 Servo Drive Assembly.

## 11. Input/Output Assembly

The Input/Output Assembly consists of a single printer circuit board called the IOPCB. It contains the following connectors:

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 connectors on the IOPCB are:

- P1 16-pin relay drivers from MOTIF 1 to 8 (510)
- P2 16-pin relay drivers from MOTIF 9 to 16 (520)
- P3 16-pin relay drivers from MOTIF 17 to 24 (M21-M28) (530)
- P4 34-pin inputs to MOTIF (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)
- P11 +12V DC from power supply (860A)
- P12 115V AC to spindle head solenoids (880)
- P13 Tool changer status inputs (820)
- P14 Low coolant input (900)
- P15 Spindle head status inputs (890)
- P16 Emergency stop input (770)
- P17 Low Lube input (960)
- P18 Low 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 inputs 21-24 (790)
- P25 Spare inputs 31-32 (200)

- P26 Spare terminals for M21 to M24
- P27 M28 output
- P28 115V AC from CB4 (910)
- P29 A-axis brake solenoid output (390)
- P30 Tool changer shuttle motor output (810A)
- P31 FU5 connection for tool changer (840)
- P32 160V DC for tool changer (80)
- 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 to oiler (870)
- P38 Door open (1050)
- P39 Tool changer turret motor output (810)
- P40 12V AC from lamp transformer (800)
- P41 Operator lamp switch connection (800A)
- P42 12V AC to operator lamp (800B)
- P43 Ground fault sense signal input (1060)
- P44 M25 output
- P45 M26 output
- P46 M27 output
- P47 Skip input signal

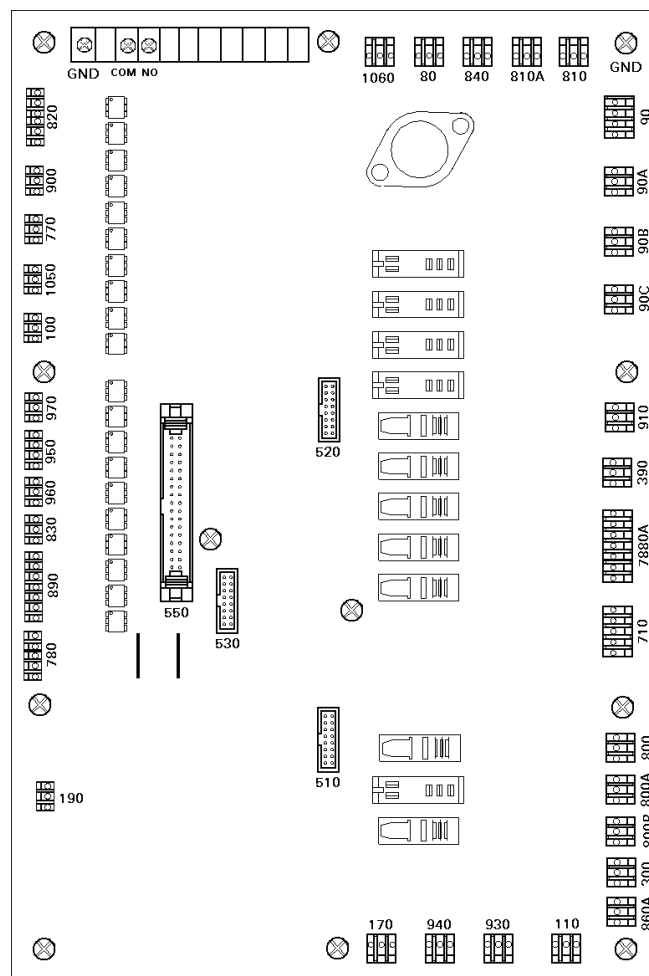


Fig. 11-1 Input/Output board.



## 12. Power Supply Assembly

All power to the control passes through the power supply assembly. Main incoming power is brought to this assembly and any fuses or circuit breakers that might trip in operation are located on this assembly. It is located on the upper right corner of the control cabinet.

### 12.1 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.

## 12.2 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.

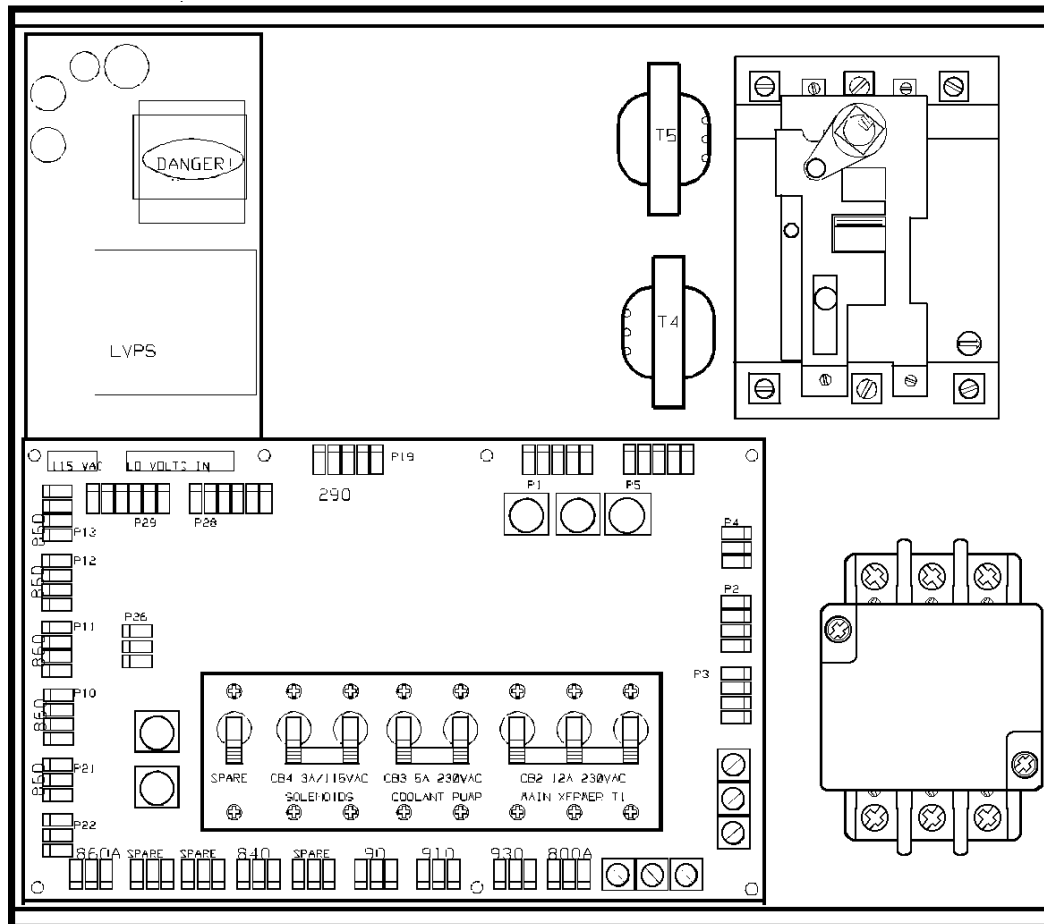


Fig. 12-1 Power Supply Assembly.

(Cont'd)

## 12.3 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 continues to operate correctly over a 90V AC to 133V AC range. Power is provided to the processor assembly through three carrying +12V/+5V/Gnd. The +5, +12, and -12V power is supplied to other circuits through TB2.

## 12.4 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 (See Fig. 12-1). 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
- P8 115V AC from IOPCB for low voltage supply and solenoids (910)
- 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 (800)
- 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 operator's lamp transformer T4 (290)
- P20 115V AC to low voltage supply
- P21 -12V DC to processor PCB
- P22 -12V DC to MOTIF PCB
- P23 Spare circuit breaker CB5
- P24 Spare fuse FU7

- P25 Spare fuse FU8
- P26 +12V DC option connector
- P27 +5/+12/Gnd form low volt supply to logic boards (860)
- P28 Option connector for alternate supply
- P29 Option connector for alternate supply

For older internal transformer with 208/230 taps:

- TB1 230V AC from contactor K1
- TB2 230V AC to T1 primary

For newer internal transformer with 200/215/235/250 taps

- TB1 115V AC from T1 secondary
- TB2 115V AC to servo assembly and IOPCB

The POWER PCB contains three fuses that will blow if the voltage applied to the control exceeds about 280V. This may be caused by a line transient or a lightning strike. Power must be shut off this way in order to protect the rest of the machine. In the event that these fuses blow, you should check the line voltages (all three phases), replace the fuses, and continue operation. No other equipment in the control should be damaged by such an overvoltage condition.

## 12.5 POWER-UP LOW VOLTAGE CONTROL TRANSFORMER (T5)

In controls built after November 1989, the low voltage control transformer, T5, supplies power to the coil of the main contactor T1. 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.

## 12.6 SECONDARY CIRCUIT BREAKERS

Five more circuit breakers are on the Power supply assembly.

In older controls, CB2 controls the power to the servo transformers and, if tripped, will turn off the CRT, cooling fans, servo motors, and air solenoids. It might be blown by a severe servo

overload. In newer controls, CB2 controls the 115V AC from the T1 secondary.

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.

## **12.7 OPERATOR'S LAMP TRANSFORMER**

Transformer T2 supplies low voltage to the operator's lamp. The primary is 115V AC and the secondary is 10V AC. The primary is protected at  $\frac{1}{2}$  amp by F6. It is connected to the POWER PCB by connector P19.



# LUBRICATION CHART

## LUBRICATION CHART FOR VF-SERIES VERTICAL MACHINING CENTERS (VF-0, VF-1, VF-2, VF-3)

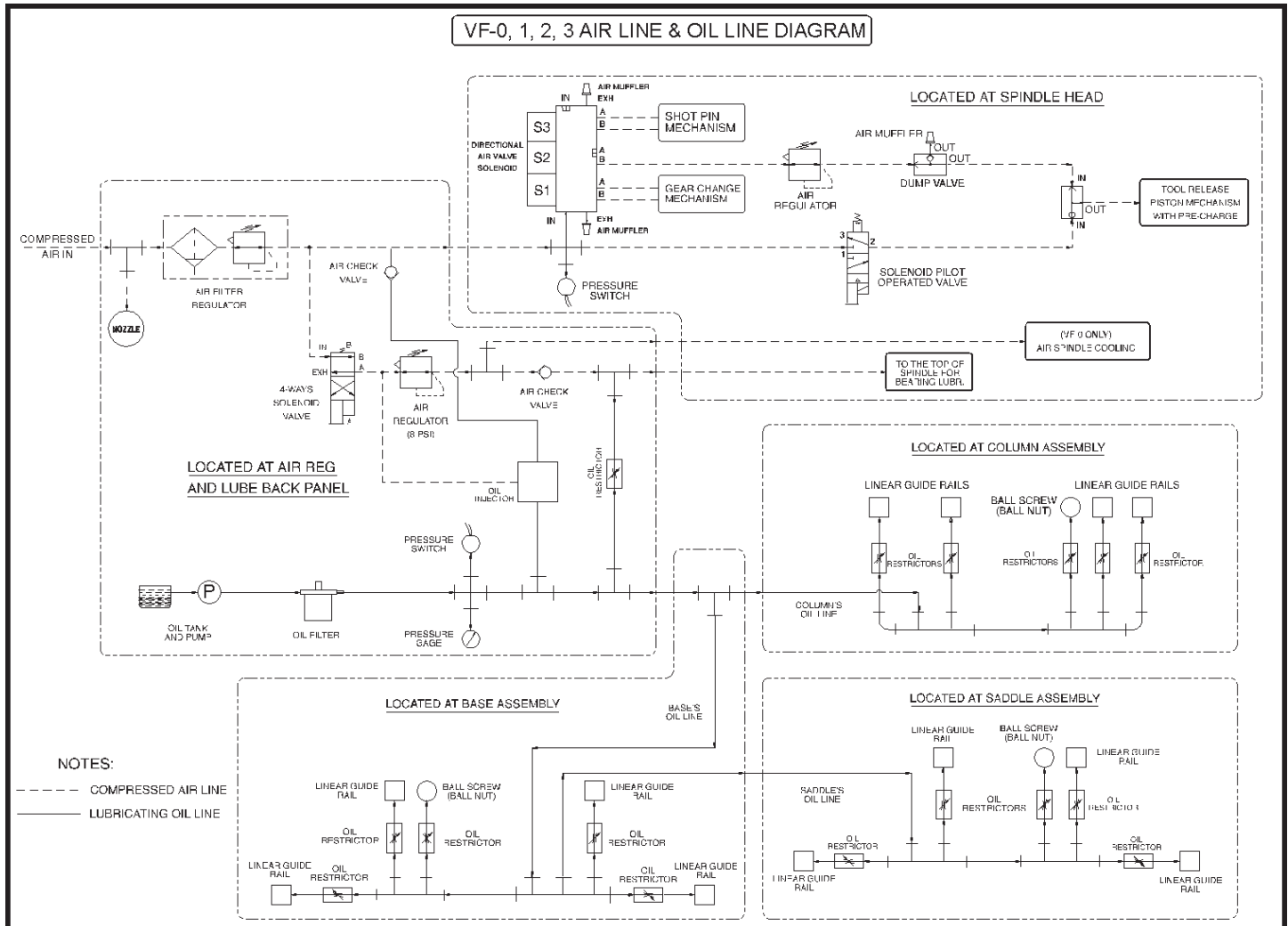
<b>SYSTEM:</b>	WAY LUBE and PNEUMATICS	TRANSMISSION (VF-1, VF-2, VF-3)	LEAD SCREW BEARINGS AND (PRIOR TO JAN. '92) SPINDLES
<b>LOCATION:</b>	UNDER THE CONTROL PANEL AT THE BACK OF THE MACHINE	ABOVE SPINDLE HEAD	VARIES
<b>DESCRIPTION:</b>	1. PISTON PUMP WITH A 13- OR 30-MINUTE CYCLE TIME. PUMP IS ON ONLY WHEN THE SPINDLE IS TURNING OR WHEN AN AXIS IS MOVING. 2. ON SYSTEMS PRIOR TO JAN. '92, THE PUMP WILL BE ON WHENEVER THE SERVOS ARE ON.	1. OIL BATH; NO PUMP PRIOR TO JAN. '92. 2. GEAR PUMP, DRY SUMP TRANSMISSION, SPASH-LUBRICATED.	<b>THESE PARTS</b>
<b>LUBRICATES:</b>	1. LINEAR GUIDES AND BALL NUTS. 2. SPINDLE BEARINGS ON MACHINES AFTER JAN. '92. 3. TOOL RELEASE PISTON. 4. SOLENOID VALVE ASSEMBLY. 5. SHOT PIN. 6. GEAR CHANGE PISTON ASSEMBLY.	1. TRANSMISSION ONLY PRIOR TO JAN. '92. 2. TRANSMISSION; ALSO PROVIDES COOLING OIL TO SPINDLE CARTRIDGE.	<b>ARE</b>
<b>QUANTITY:</b>	1-QT. TANK	1. 1-QT. PRIOR TO JAN. '92. 2. 2-QT.	<b>LUBRICATED AND ARE</b>
<b>LUBRICANT:</b>	MOBIL VACTRA 2 OR EQUAL	1. MOBIL SHC 600 OR EQUAL (PRIOR TO JAN. '92) 2. MOBIL DTE 25 OR EQUAL	<b>NOT USER- SERVICEABLE.</b>





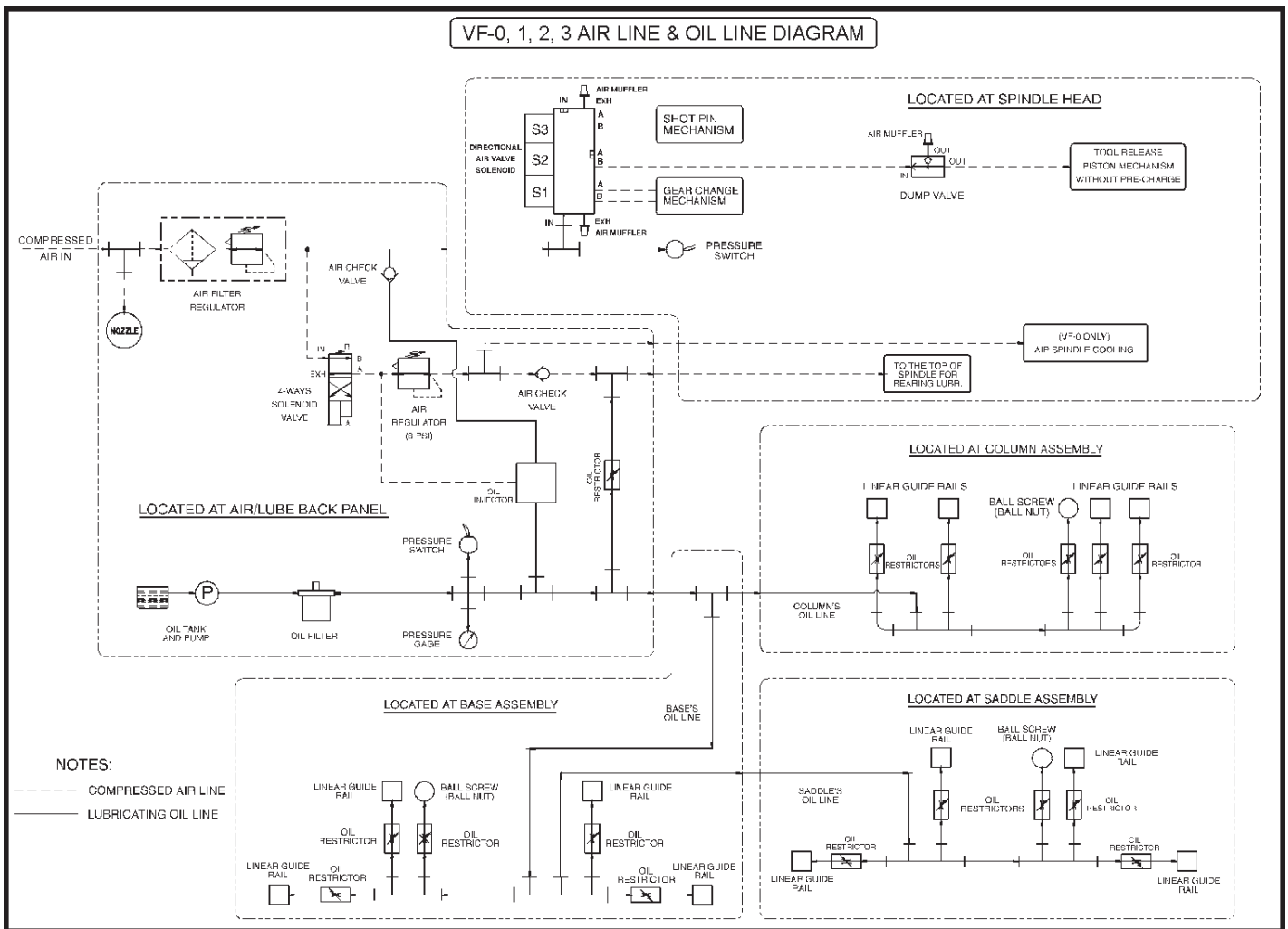
# AIR & OIL LINE DIAGRAMS

## VF SERIES WITH PRE-CHARGE



# AIR & OIL LINE DIAGRAMS

## VF SERIES WITHOUT PRE-CHARGE



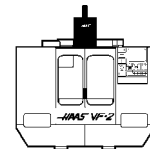
Way Lube: Medium Way Lube Vactra #2 or equivalent; one quart. Add oil through the large cap at the top.

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.

There is a low lube sense switch in the oil tank. When the oil is low, and alarm will be generated. This alarm will not occur until the end of a program is reached. There is also an lube pressure switch which 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.







This manual has been prepared for your benefit and instruction in servicing the HAAS Vertical Machining Center. If you find any errors or omissions, or if you have any suggestions/complaints, please feel free to contact us at the number below or write to us on the form provided.

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