HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

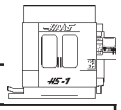
Horizontal Service Manual 96-9010 English October 10 1994

- 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 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. MACHINE OPERATION

1.1 MACHINE NOT RUNNING

MACHINE CANNOT BE POWERED ON.

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

MACHINE CAN BE POWERED ON, BUT TURNS OFF BY ITSELF.

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

MACHINE TURNS ON, KEYBOARD BEEPS, BUT NO CRT DISPLAY.

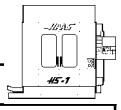
- Check for green POWER LED at front of CRT.
- Check for power connections to CRT from IOPCB.
- Check video cable (760) from VIDEO PCB to CRT.
- Replace CRT

ANY LED ON MICROPROCESSOR PCB GOES OUT (EXCEPT HALT).

- Replace Microprocessor PCB
- Replace VIDEO PCB
- Replace MOTIF PCB

MACHINE TURNS ON, CRT WORKS, BUT KEYBOARD KEYS DO NOT WORK.

- Check keyboard cable (700) from VIDEO to KBIF PCB.
- Replace keypad
- Replace KBIF PCB



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. 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.Therefore vibration noises need to be distinguished from other noises such as those coming from a bad bearing. We will assume that vibrations would be something that could be felt by putting your hand on the spindle covers. One crude method of measurement would be to take an indicator on a magnetic base extended 10 inches between the table and spindle housing and observe the reading of the indicator. A reading of more than .001 would indicate excessive vibration. The two common sources of noise are the spindle and axis drives.Most complaints about vibration, accuracy, and finish can be attributed to incorrect machining practices such as poor quality or damaged tooling, incorrect speeds or feeds, or poor fixturing. Before concluding that the machine is not working properly, ensure that good machining practices are being observed. These symptoms will not occur individually (Ex. A machine with backlash may vibrate heavily, yielding a bad finish.). Put all of the symptoms together to arrive at an accurate picture of the problem.

MACHINE VIBRATES WHILE SPINDLE IS ON AND IS NOT CUTTING. SOMETIMES ONLY AT SPECIFIC RPM.

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 when servicing the spindle motor, 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.

MACHINE VIBRATES WHILE JOGGING THE AXIS WITH THE HAND WHEEL.

The HAAS control uses very high gain accelerations curves. The vibration as you jog is simply the servos quickly trying to follow the handle divisions. If this is a problem, try using a smaller division on the handle. You will notice the vibration more at individual clicks than when you are turning the handle faster. This is normal.

THE MACHINE VIBRATES EXCESSIVELY IN A CUT.

This is a tough one to call because machining practices come into play. Generally speaking, the least rigid element of a cut is the tool because it is the smallest part. Any cutter will vibrate if pushed beyond its tensile strength. In order to eliminate the machine as the source of the problem, you need to check the spindle and the backlash of the axes as described in the following sections. Once machining practices have been eliminated as the source of vibration, observe the machine in both operation and “cutting air.” Move the axes (individually) without the spindle turning and then turn the spindle without moving the axes. Isolate whether the vibration comes from the headstock or from an axis.

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

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

? MACHINE WILL NOT INTERPOLATE A ROUND HOLE.

- Check that the machine is properly leveled.
- Check for backlash

? BORED HOLES DO NOT GO STRAIGHT THROUGH THE WORKPIECE.

- Check that the machine is properly leveled.
- Check for squareness in the Z axis.

? MACHINE BORES HOLES OUT-OF-ROUND.

- Check that the machine is properly leveled.
- Check the sweep of the machine

? BOREDHOLES 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.

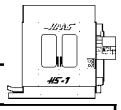
- The spindle is not parallel to the Z axis. In order to check the effective spindle sweep, place an indicator on the table and insert a 6" test tool bar into the spindle. Indicate below and to the side of the test bar in the Z-Axis.

? MACHINE MIS-POSITIONS HOLES

- Check that the machine is properly leveled.
- Check for backlash
- Check the squareness of the X axis to the Y axis.

? MACHINE LEAVES LARGE STEPS WHEN USING A SHELL MILL.

- Check that the machine is properly leveled.
- Check the sweep of the machine
- Cutter diameter too large for depth of cut.



1.4 FINISH

⍰ MACHINE YIELDS A POOR FINISH

- Check for backlash
- Check the condition of the tooling and the spindle

2. SPINDLE

2.1 NOT TURNING

⍰ SPINDLE NOT TURNING.

- Check that the spindle turns freely when machine is off.
- Command spindle to turn on 1800 RPM and check spindle drive display. If display blinks “bb”, check spindle orientation switch .
  If spindle drive does not light the RUN LED,check forward/reverse commands from IOPCB.
- Check the wiring of analog speed command from MOTIF PCB to spindle drive (cable 720).
- If spindle is still not turning, replace MOTIF PCB .
- If spindle is still not turning, replace spindle drive
- Check the drive belt .
- Disconnect the drive belt. If the spindle will not turn, it is seized and must be replaced.

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

2.2 NOISE

- Excessive noise coming from the spindle head area.
- Check the alignment of the pulleys to the belt.
- Check the machine’s drive belt tension.
  > 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
  > 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).

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.

The following program should run for 24hrs to properly break in the spindle:

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

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 SPINDLE DRIVE

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

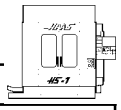
If the spindle is accelerated and decelerated frequently, the regenerative load resistor inside the control may heat up. If this resistor heats beyond 100ºC, a thermostat will generate an “overheat” alarm.

If the regen load resistors are not connected or open, this could then result in an overvoltage alarm. The overvoltage occurs because the regenerative energy being absorbed from the motor while decelerating is turned into voltage by the spindle drive. If this problem occurs,the possible fixes are to slow the decel rate or reduce the frequency of spindle speed changes.

2.6 ORIENTATION

? SPINDLE LOSES CORRECT ORIENTATION.

- Check alarm history, looking for spindle overload and axis overcurrent alarms. These alarms indicate the machine is not being properly operated.
- Check the orientation ring for tightness.



NOTE: Ensure the shaft on which the ring mounts is free of grease.

- Check the orientation ring for cracks near the bolt holes or near the balancing holes.
  > If there are cracks, replace the ring .
- Check the switch on the shot pin against the Diagnostic display.
  Replace the switch if it is found to be faulty.

2.7 TOOLS STICKING IN TAPER

TOOL STICKING IN THE TAPER CAUSES ATC TO BE PULLED ; 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.

- 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.
- Duplicate the cutting conditions under which the deflection occurs, but do not execute an automatic tool change. Try instead to release the tool using the tool release button on the front of the spindle head. If sticking is observed, the deflection is not caused by improper ATC adjustment, but is a problem in the spindle head on the machine.
- Ensure the spindle is not running too hot.

3. SERVO MOTORS/LEAD SCREWS

3.1 GENERAL INFORMATION

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.

SERVO DRIVE MOTORS OVERHEAT SENSE SWITCHES

Each servo motor contains a normally-open overtemperature sense thermostat. When the motor case temperature exceeds 150^0 F, an alarm will be generated and operation of the machine will stop. This alarm should not occur under any normal operating circumstances and usually indicates that there is serious problem with the motor or drive circuit. After September 1990, the overheat sensor was changed to normally closed. This change is specified in the parameters.

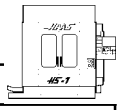
SERVO DRIVE OVERCURRENT SENSOR

Each servo motor drive circuit contains a current limit setting and an overcurrent sense circuit. When an overcurrent condition persists for more than 0.01 second, an alarm will be generated and operation of the machine will stop. This current limit is presently set at 20 amps.

SERVO CHARACTERISTICS

This machine is not capable of instantly changing speed. That is, it takes some non-zero time to accelerate and decelerate. Acceleration and deceleration in this machine have both a constant accel/decel mode and an exponential mode. Constant acceleration is used at the beginning of a rapid move and at the end of any move whose speed exceeds the exponential accel/decel time constant.

Constant acceleration is a type of motion when the amount of speed change over time is constant. This constant is set by Parameters 7, 21, 35, and 49. It has units of encoder increments per second per second.



Exponential acceleration and deceleration is a type of motion where the speed is proportional to the distance remaining in a programmed travel. The exponential accel/decel time constant is set by Parameters 113, 114, 115, and 116. It has units of 0.0001 seconds. The speed limit at which exponential accel/decel is not available is defined by the relationship between Parameters 7 and 113 (for the X-axis). Thus if Parameter 7 is 1200000 steps/sec/sec and Parameter 113 is 750 (0.075 seconds);
the maximum velocity for accurate interpolation should be:

1200000 x 0.075 = 90000 steps/second

For a 2000 line encoder and 6 mm screw, this would be:

60 x 90000 / 33867 = 159 inches/minute

In the normal feed cutting mode, with G64 active, giving continuous cutter motion, deceleration of the axes in motion begins at some distance away from the end point. If look-ahead has provided another motion, the acceleration for that motion will begin at the same instant. This means that two motions, at right angles to each other, will not produce a perfectly square corner. The corner will be rounded. It also means that if the two motions are parallel or nearly parallel, there will be a smooth transition from one stroke to the next.

Rapid moves have a slightly different operation when continuous cutter mode is active. Acceleration for the next motion is started when the axes being moved all fall within the “In Position Limit” Parameters 101, 102, 103, and 104. These parameters
have units of encoder steps. Rapid moves will also decelerate at the constant accel/decel limit until the speed drops below that for exponential accel/decel (see example above giving 159 inches per minute). Parameter 57 can be used to override this.

To prevent the rounding of corners, you can specify exact stop either with G09 (non-modal) or with G61 (modal). When either of these is active in a motion, all of the axes are brought to an exact stop, at zero speed, before the next motion is started.

The tool path in a circular move (G02 or G03) is not changed by the exponential acceleration/deceleration so there is no error introduced in the radius of the cut unless the speed exceeds that for exponential accel/decel (see example above giving 159 inches per minute).

GROUND FAULT DETECTOR

This control has a ground fault sense circuit added to the servo drive power supply. This circuit will detect a short to ground on any of the servo motor power leads or in the internal 115V AC power. A ground fault can be caused by arcing brushes in the servo motors and will shut off all servo power.

3.2 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.

SERVO MOTOR IS NOT FUNCTIONING.

- Check the power cable from rear electrical cabinet to ensure connection is tight.
- Encoder is faulty or contaminated (Alarms 139-142, 153-156, 165-168, 182-185).
- Open circuit in motor (Alarms 139-142, 153-156, 182-185).
- Motor has overheated, resulting in damage to the interior components (Alarms 135-138, 176).
- 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).
- 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.

3.3 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.

SERVO MOTOR NOISE.

- Disconnect the servo motor from the lead screw and rotate by hand. If the noise persists, replace the motor assembly
- 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.

LEAD SCREW NOISE.

- Ensure oil is getting to the lead screw through the lubrication system . Look for a plugged metering valve.
- Check for damage to the bearing sleeve.
- Check the pre-load on old-style bearing sleeves .

NOTE: The current angular contact design sleeve has a fixed pre-load; it cannot be adjusted.

- Run the axis back and forth. The motor will get very hot if the bearing sleeve is damaged. If so, turn the axis by hand and feel for roughness in the lead screw. Loosen the clamp nuts at both ends of the lead screw. If the symptom disappears, replace the bearing sleeve . Be certain to check for damage the lead screw shaft where the bearing sleeve is mounted.

> If the noise persists, the lead screw is damaged and must be replaced. When replacing the lead screw in an older machine, always replace the bearing sleeve with the current angular contact design bearing sleeve.

- Check the lead screw for misalignment.

Misalignment in the lead screw itself will tend to cause the lead screw to tighten up and make excessive noise at both ends of the travel. The ballnut may get hot. Misalignment radially at the yoke where the lead screw ball nut mounts is indicated by heating up of the ball nut on the lead screw, and noise and tightness 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.

3.4 ACCURACY/BACKLASH

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

⍰ POOR MILL TABLE POSITIONING ACCURACY.

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

INITIAL PREPARATION -

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

CHECKING X-AXIS:

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

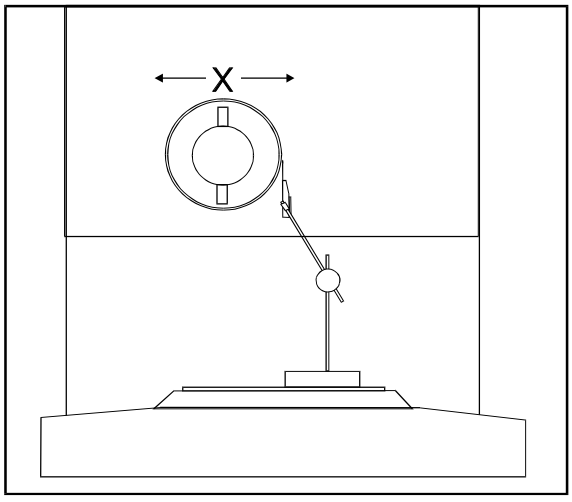


Fig. 3-1 Dial indicator in position to check X-axis.

2. Set dial indicator and the “Distance to go” display in the HANDLE JOG mode to zero as follows:
   - Zero the dial indicator.
   - Press the MDI button on the control panel.
   - Press the HANDLE JOG button on the control panel. The “Distance to go” display on the lower right hand corner should read:
   X=0 Y=0 Z=0

3. Set the rate of travel to .001 on the control panel and jog the machine .010 in the positive (+) X direction. Jog back to zero (0) on the display. The dial indicator should read zero (0) ± .0001.

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

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

CHECKING Y-AXIS:

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

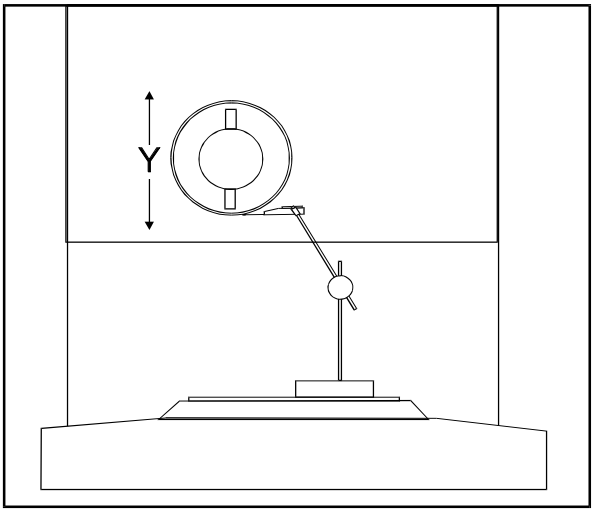


Fig. 3-2 Dial indicator in position to check Y-axis.

2. Set dial indicator and the “Distance to go” display in the HANDLE JOG mode to zero as follows:
   - Zero the dial indicator.
   - Press the MDI button on the control panel.
   - Press the HANDLE JOG button on the control panel. The “Distance to go” display on the lower right hand corner should read:
   X=0 Y=0 Z=0

3. Set the rate of travel to .001 on the control panel and jog the machine .010 in the positive (+) Y direction. Jog back to zero (0) on the display. The dial indicator should read zero (0) ± .0001.

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

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

An alternate method used in checking backlash is to 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: The servos must be on to check backlash by this method.

CHECKING Z-AXIS:

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

2. An alternate method for checking backlash is to manually push the column to the left/right and push the spindle head up/down.

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

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

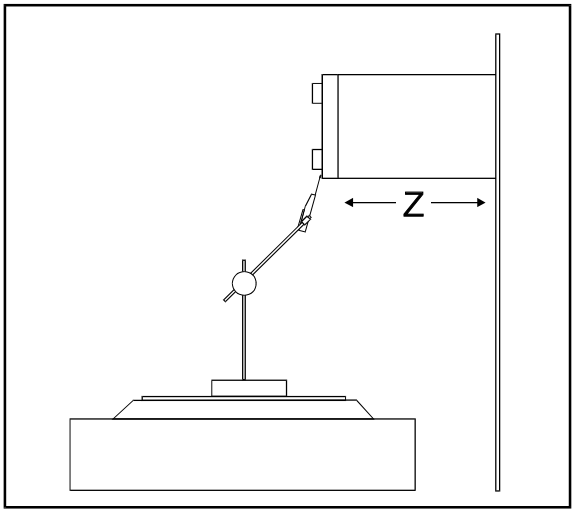


Fig. 3-3 Dial indicator in position to check Z-axis.

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

- Loose SHCS attaching the ball nut to the nut housing.
- Loose SHCS attaching the nut housing to the mill table, spindle head, or saddle, depending on the axis.

- Loose clamp nut on the bearing sleeve. Tighten the SHCS on the clamp nut.
- Loose motor coupling.
- 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.

- Loose SHCS attaching the bearing sleeve to the motor housing.
- Defective thrust bearings in the bearing sleeve.
- Loose SHCS attaching the axis motor to the motor housing. If the SHCS are found to be loose, inspect the motor for damage.
- Incorrect backlash compensation number in the parameter in the machine. Check Parameters 13, 27, and 41.
- Worn lead screw.

3.5 VIBRATION

EXCESSIVE SERVO MOTOR VIBRATION.

- If no "A" axis is present, swap the suspected bad servo motor with the "A" driver and check to see if there is a driver problem.
- 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 ground. If the motor is open or shorted, replacement it.

SERVO MOTOR OVERHEATING.

- If a motor OVERHEAT alarm occurs (ALARMS 135-138), check the Parameters for an incorrect setting. Axis flags in Parameters 1, 15, or 29 can invert the overheat switch (OVER TEMP NC).
- If the motor is actually getting hot to the touch, there is excessive load on the motor. Check the user's application for excessive load or high duty cycle.
  Check the lead screw for binding.

3.6 FOLLOWING ERROR

FOLLOWING ERROR ALARMS OCCUR ON ONE OR MORE AXES SPORADICALLY.

- 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
- Driver card replacement.
- Servo motor replacement.

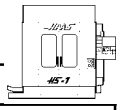
4. TOOL CHANGER

4.1 DEFLECTION

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

DURING A TOOL CHANGE, ATC APPEARS TO BE PUSHED OUT.

- Check to see if pull studs on the tool holder are correct and tight.
- Check the mechanical adjustment of the "Y" offset



- Check Parameters 71, 72, and 143 against the values that are in the documentation sent with the machine.
- Ensure the tool holders are held firmly in place by the extractor forks.
- Ensure the balls on the drawbar move freely in the holes in the drawbar when the tool release button is pressed If they do not move freely, the ATC will be pushed out about ¼" before the tool holder is seated in the taper, resulting in damage to the roller bolts on the ATC shuttle.

? TOOL HOLDER STICKING IN THE SPINDLE TAPER CAUSES THE ATC TO BE PULLED IN 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.

- Check the condition of the customer's tooling, verifying the taper on the tool holders ground and not turnedLook for damage to the taper caused by chips in the taper or rough handling. If the tooling is suspected, try to duplicate the symptoms with different tooling.
- Check the condition of the spindle taper. Look for damage caused by chips or damaged tooling. Also, look for damage such as deep gouges in the spindle taper caused by tool crashing.
- Duplicate the cutting conditions under which the deflection occurs, but do not execute an automatic tool change. Try instead to release the tool using the tool release button on the front of the spindle head. If sticking is observed, the deflection is not caused by improper ATC adjustment, but is a problem in the spindle head on the machine.

? DURING A TOOL CHANGE, ATC APPEARS TO BE PULLED IN ; NO POPPING NOISES.

- Check the mechanical adjustment of the "Y" offset .

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

- 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 out about ¼" before the tool holder is seated in the taper.

? TOOL HOLDERS TWIST AGAINST EXTRACTOR FORK DURING A TOOL CHANGE.

- Check the alignment of the ATC in the X and Z axes.
- Check rotational alignment.

? TOOL HOLDERS SPIN AT ALL POCKETS OF THE ATC

- ATC rotationally misaligned
  Check the carousel offset (parameter 215)

NOTE: Observe the direction the tool holder rotates, as this will be the direction in which the "X" axis of the ATC needs to be moved.

4.2 CRASHING

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

ATC PROPERLY DEPOSITS A TOOL HOLDER IN THE SPINDLE, BUT THE TOOLS ARE DROPPED ONTO THE MACHINE TABLE.

- Inspect the balls and the Belleville springs in the drawbar.

THE PART OR FIXTURE ON THE MILL TABLE CRASHES INTO LONG TOOLING OR INTO THE ATC ITSELF DURING A TOOL CHANGE.

- Check for damage to the trap door on the ATC cover.
- Check for missing plastic riders on the ATC shutter.

ATC OUT OF ORIENTATION WITH THE SPINDLE.

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

- Check the orientation of the machine.

ATC WILL NOT RUN

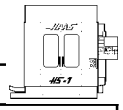
- In all cases where the tool changer will not run, an alarm is generated to indicate either a shuttle in/out problem or a turret rotation problem. These alarms will occur either on an attempt to change tools (ATC FWD) or ZERO RETURN the machine (AUTO ALL AXES).

TURRET WILL NOT ROTATE; TURRET MOTOR IS NOT GETTING POWER (COMMAND A TOOL CHANGE AND FEEL FOR POWER BEING APPLIED TO THE TURRET MOTOR).

- Check that the TC CW/ TC CCW LED on the I/O PCB is illuminated when a toolchange takes place.

ATC PROPERLY DEPOSITS A TOOL HOLDER IN THE SPINDLE BUT GIVES A SHUTTLE OUT FAULT.

- Check the shuttle in/out switch adjustment.



ALARMS

Any time an alarm is present, the lower right hand corner will have a blinking “ALARM.” Push the ALARM display key to view the current alarm. All alarms are displayed with a reference number and a complete description. If the RESET key is pressed, one alarm will be removed from the list of alarms. If there are more than 18 alarms, only the last 18 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.

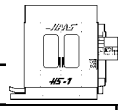
107 EMERGENCY OFF
EMERGENCY STOP button was pressed. Servos are also turned off. After the E-STOP is released, the RESET button must be pressed at least twice to correct this; once to clear the E-STOP alarm and once to clear the Servo Off alarm. This is an operator-initiated condition. If you do not 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.
Servo, servo driver and ball screw.

112 NO INTERRUPT
This alarm can be caused by electrical interference or an electronics problem.

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.
Tool changer operation.

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 Turret operation.

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.

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.
Line voltage adjustment taps.

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 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 over-heating. 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.

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. e. 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.
Replacement of Microprocessor PCB or battery.

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.

130 TOOL UNCLAMPED

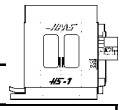
131 TOOL NOT CLAMPED
Tool release piston is energized at power up, or, tool release piston is not Home. This is a possible fault in the air solenoids, relays on the IO Assembly, the draw bar assembly, or wiring.
Tool clamp/unclamp problems.

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.
IOPCB replacement. ELECTRICAL

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.
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.
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^{0}F. This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.
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.
Check motor/encoder and wiring.
It can also be caused by the 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.

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.

149 SPINDLE TURNING
Spindle not at zero speed for tool change. A signal from the spindle drive indicating that the spindle drive is stopped is not present while a tool change operation is going on.

150 Z AND TOOL INTERLOCKED
Tool changer not at home and Z is 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.
Tool changer problems.

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.

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..

157 MOTOR INTERFACE PCB FAILURE
Internal circuit board problem. The MOTIF PCB in the processor stack is tested at POWER ON.

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.

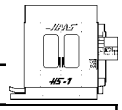
159 KEYBOARD FAILURE
Keyboard shorted or button pressed at POWER ON. A POWER ON test of the membrane keypad has found a shorted button. It can also be caused by a short in the cable from the main cabinet or by holding a switch down during POWER ON.
This can also be caused by a bad cable 700.
Be sure 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.

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.
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.
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.
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.
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.
Check 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.

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:

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.

186 SPINDLE NOT TURNING
Status from spindle drive indicates that it is not turning when it is expected.

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.

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.

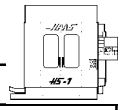
213 EPROM CRC ERROR
All of these alarms indicate a software or electronics problem.
Replace Microprocessor PCB.

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 and RS-232 communication problem or a software or electronics problem. See Programming and Operation Manual for RS-232 operation.

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.

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.

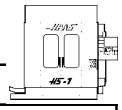
321 AUTO OFF
A fault turned off the servos automatically; occurs in debug mode only.

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 24.

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.

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.

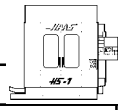
362 TOOL USAGE ALARM
Tool life limit was reached. To continue, reset the usage count in the Current Commands display and press RESET.

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.

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.

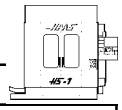
412 RS-232 UNEXPECTED END OF FILE
Check Your Program. An ASCII EOF code was found in the input data before program receive was complete. This is a decimal code 26.

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.

DIAGNOSTIC DATA

The ALARM MSGS display is the most important source of diagnostic data. At any time after the machine completes its power-up sequence, it will either perform a requested function or stop with an alarm. Refer to Section 2.5 for a complete list of alarms, their possible causes, and some corrective action.

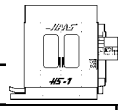
If there is an electronics problem, the controller may not complete the power-up sequence and the CRT will remain blank. In this case, there are two sources of diagnostic data; these are the audible beeper and the LED's on the processor PCB. If the audible beeper is alternating a ½ second beep, there is a problem with the main control program stored in EPROM's on the processor PCB. If any of the processor electronics cannot be accessed correctly, the LED's on the processor PCB will light or not .

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 listed in the section below.

DISCRETE INPUTS

#	Name	Description	#	Name	Description
1	TC IN	Tool Changer In	17	SPLO	SpindleLocked
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	



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.

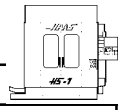
The second page of diagnostic data is displayed using the PAGE UP and PAGE DOWN keys. It contains:

INPUTS 2

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. TOOL RELEASE PISTON

CAUTION! In order to keep the spindle crashing down place a two-by-four between the air cylinder bracket and the bottom of the column casting.

REMOVAL:
1. Power off the machine

2. Disconnect the main air supply at the air lube panel.

3. Disconnect air lines at the tool unclamp solenoid and precharge line.

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

5. Remove the four 3/8-16 x 1 3/4" SHCS holding the tool release piston assembly to the head casting.

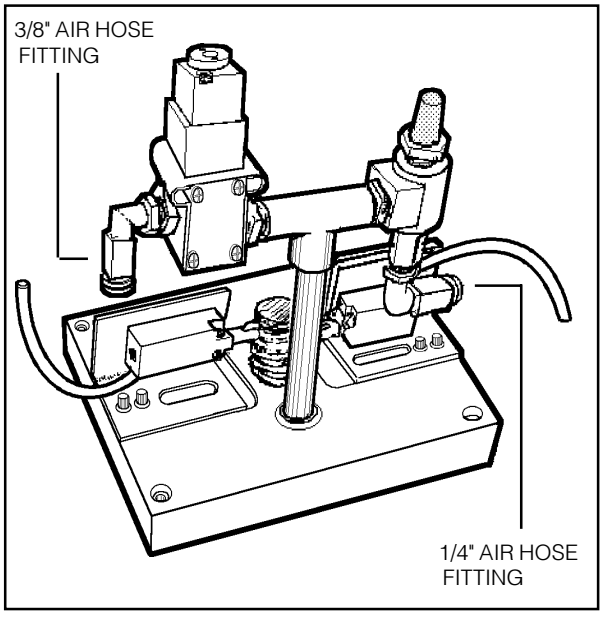


Fig. 1-1 TRP assembly

6. Remove entire tool release piston assembly.

INSTALLATION:
1. Ensure spindle, drawbar and drive belt have been properly replaced .

2. Re-install the tool release piston assembly and evenly tighten down the four 3/8-16 x 1 3/4" SHCS until completely tightened.

3. Re-connect the airlines in reverse order as they were removed and connect all solenoid and switch wiring.

4. Shim TRP Assembly.

5. Verify tool clamp/unclamp switch has been properly adjusted .

2. SPINDLE CARTRIDGE

REMOVAL:
1. Remove tool release piston assembly.

2. Remove Spindle drive belt.

3. Remove quick disconnect air line (1/4" O.D., 3/16" I.D.) at backside of spindle cartridge .

4. Loosen the two locking set screws located on the spanner nut at the rear of the spindle. Loosen the large spanner nut and completely remove.

5. Remove front bolts that mount spindle to head casting.

6. Spindle should slide out from front side of machine.

INSTALLATION:

7. Inspect the mating surface for high spots on the spindle and head casting before installing spindle.

8. Carefully install new spindle into bored sleeve of head casting. O-ring grease may be applied to the O-rings on the spindle.

NOTE: The spindle nose has a drain hole and should be pointed down.

9. Evenly tighten the mounting bolts on the front side of the spindle in a cross pattern until all bolts are compltely tight.

NOTE: Spindle is a greased packed cartridge.

10 Install spindle belts.

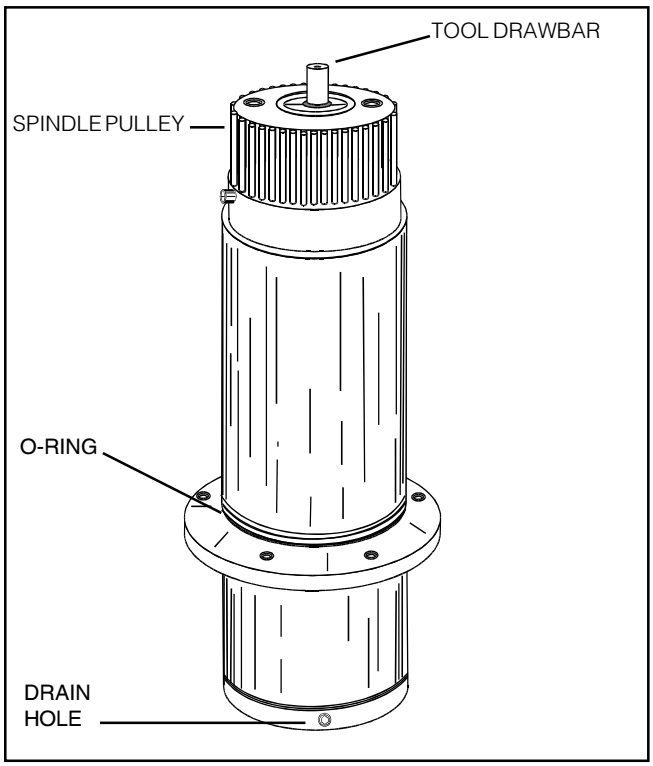


Fig. 2-1 *Spindle Cartridge*

11. Connect the air line at the rear of the spindle cartridge. Air pressure should be at 3PSI.

12. Install the tool release piston assembly and adjust for proper tool push and switch settings.

13. Reset orientation of spindle and check tool changer adjustment.

3. SPINDLE DRIVE BELT

REMOVAL:

1. Remove the tool release piston assembly.

2. Slightly loosen the $^{3}/_{8}$-16 SHCS bolts that mount the spindle motor. Loosen the encentric bolt until the belt is loose enough for removal. Pull the bottom portion of the belt off the spindle pulley then remove the belt from the top of the motor pulley.

NOTE: Encentric adjusting bolt is located at the bottom right of the motor mounting plate.

3. Install the new belts ensuring the belts are properly seated.

4. Tighten the drive belt by turning the adjusting bolt until the belt is at the correct tension.

5. Install tool release piston assembly and reconnect all switches and air lines .

6. Reset the orientation of the spindle.

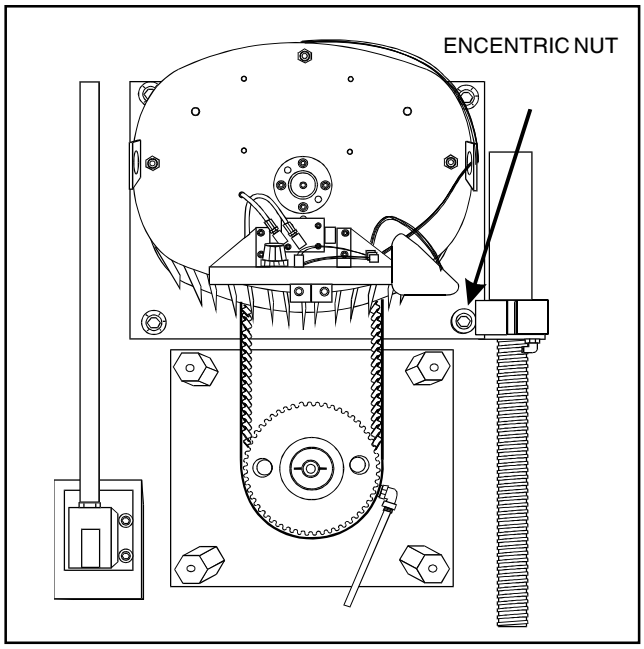


Fig. 3-1 Spindle pulley and belt

4. DRAWBAR REPLACEMENT

REMOVAL:
1.Remove back panel

2. Place a tool holder without a cutter in the spindle.

3. Remove cover panels.

4. Remove the tool release piston.

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

6. Reinstall the tool release piston .

7. Remove the tool holder from the spindle.

8. Remove the spindle.

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

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

11. Insert four new balls in the replacement drawbar and insert into the spindle shaft. Be sure that as the shaft is installed, the balls do not fall out of the bores in the drawbar.

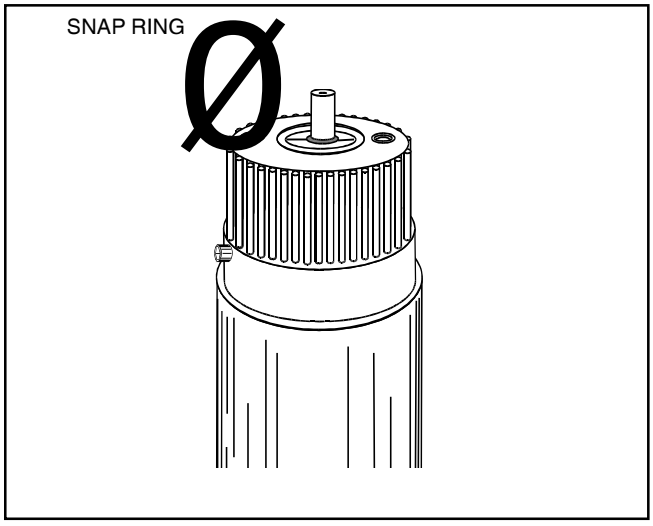


Fig. 4-1 Snap ring removal

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

12. Install the spindle cartridge. The tool release piston will have to be reinstalled at this time .

13. Install a tool holder without a cutter into the spindle taper.

14. Remove the tool release piston .

15. Install the snap ring on the spindle shaft.

16. Reinstall the tool release piston .

16. Finish installation of the spindle.

17. Set the drawbar height, clamp and unclamp switches

NOTE: Step 18 must be followed or damage to the ATC will result.

18. Set the spindle orientation.

19. Reinstall the back panel.

20. Test-run the machine and adjust the ATC as necessary

5. TOOL CLAMP/UNCLAMP SWITCH ADJUSTMENT; SHIM WASHERS/ DRAW BAR HEIGHT SETTING

IMPORTANT! In order to perform the following proceedure a right angle plate must be installed on the HMC.

1. Remove back panel.

2. Right angle plate should be in place at this time.

3. Power on the machine.

4. Insert a tool holder WITHOUT A CUTTER into the spindle taper.

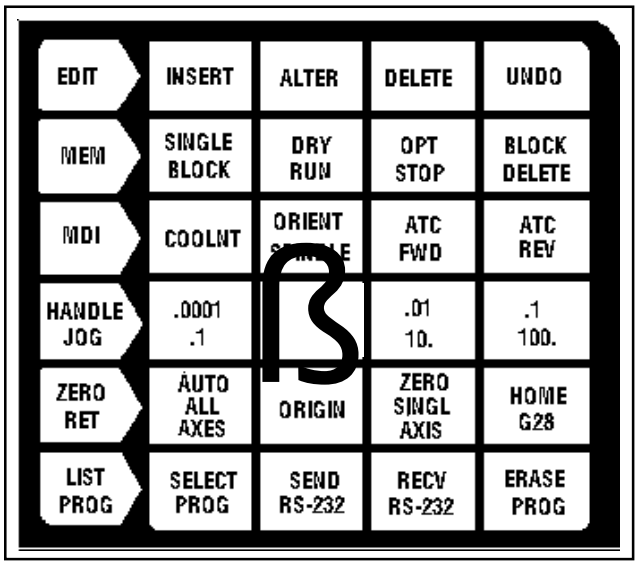


Fig. 5-1 Z-axis jog increment setting

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

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

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

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

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

5.1 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 .060".

3. Press and hold tool release button, grasp block and try to move it. Block should be tight at .060" and loose at .070". If block does move at .060", 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 .

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

5.2 SHIM WASHERS

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

NOTE: Shims may need replacement when spindle cartridge, tool release piston assembly, or drawbar is replaced.

2. Remove tool release bolt.

3. Add or subtract required shim washers

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

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

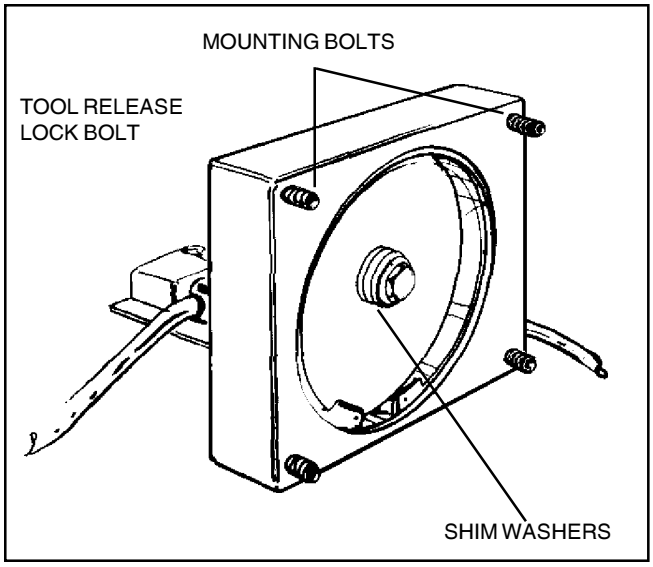


Fig. 5-2 Shim location

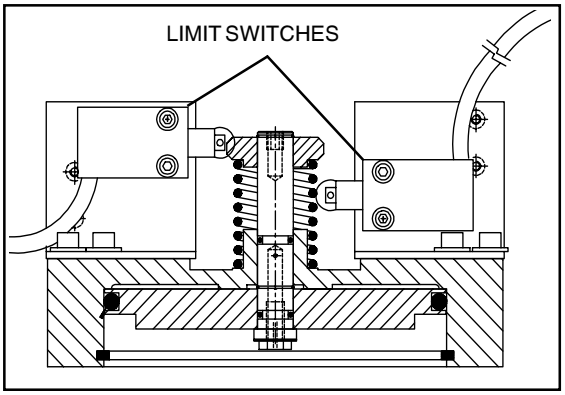
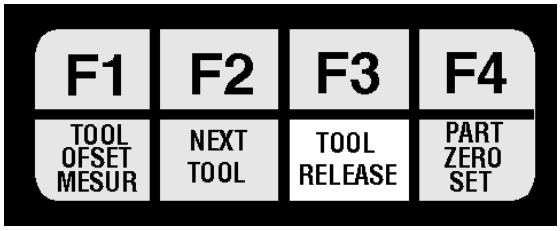


Fig. 5-3 Tool Release piston Assembly

5.3 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, jog Z-axis in the positive (+) direction .030".



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 ¼-20 x ½” SHCS holding the unclamp switch bracket (switch on right) to the tool release assembly.

4. While activating tool release tap unclamp switch assembly towards spring retainer until it just trips. . Switch must trip at .030" +/- .010".

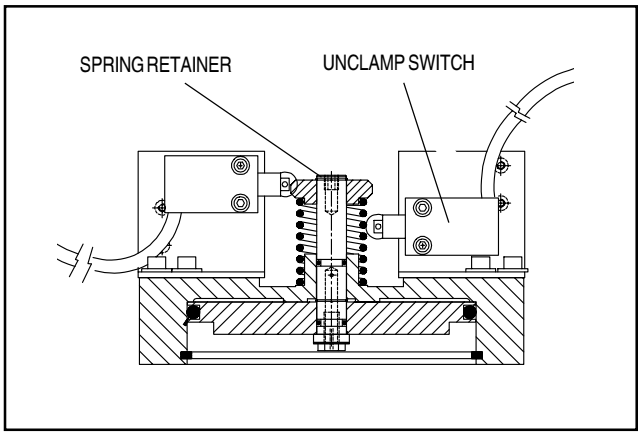


Fig. 5-4 TRP spring retainer location

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

5. Check the adjustment by setting hand wheel at .030" 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.

5.4 UPPER (CLAMP) SWITCH -

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

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. Wedge the pipe under the cooling fins of the motor and push the piston down.

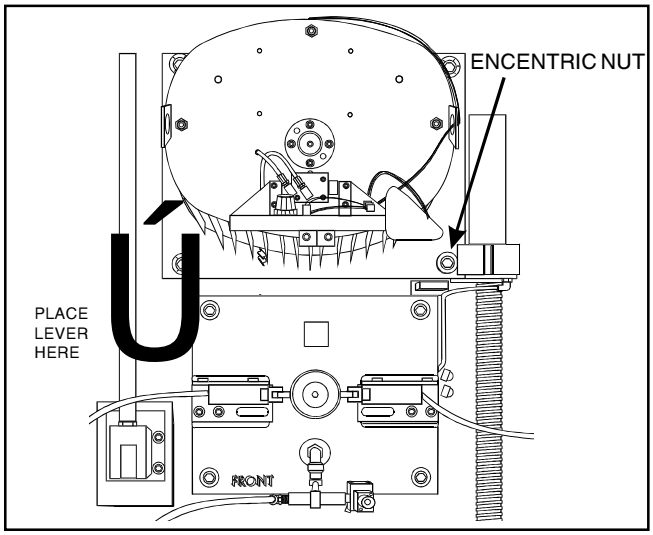


Fig. 5-5 Place lever under cooling fins here.

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.)

6. TOOL CHANGER ASSEMBLY

6.1 CT-EXTRACTOR REPLACEMENT

REMOVAL :

1. Zero return all axes and remove tooling.

2. Rotate the carousel into position by pressing M39 T_ (Enter the tool position number that needs replacment.)

3. Lower the Y-Axis head away from the tool changer.

4. Power off the machine.

5. Retract the carousel door and clamp open.

CAUTION! The extractor spring is under high tension

6. Remove the bolts that fasten the extractor to the carousel. Once they are both removed the complete assembly should come out.

INSTALLATION:

Assembly Parts:

(2) extractor clips
(2) extractor sleeves
(2) bolts and (2) washers
(1) extractor block
(1) compression spring.

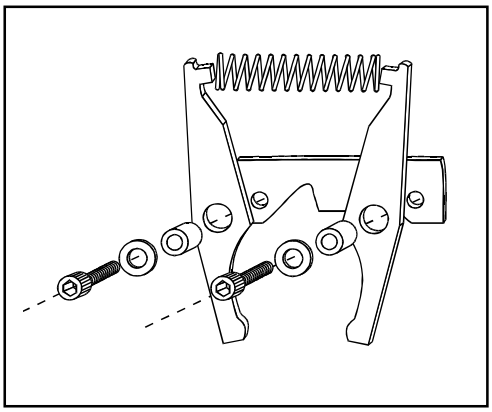


Fig. 6-1 C-T Extractor Assembly

7. Insert sleeve into pivot hole of each extractor and assemble each extractor with a bolt and hardwasher(round edge facing head of bolt.) Before mounting the assembly to the carousel, apply a small amount of semi-permanent Locktite® to the bolts, then thread the bolts just a few turns.

8. Place one end of the spring onto the top notch of the extractor and pivot the opposite extractor until both ends are firmly seated.

9. Evenly tighten the extractor bolts to the carousel housing.

10. Check carousel alignment.

6.2 TOOL CHANGER ALIGNMENT

1. Check that main air regulator is set at 85psi. and the counter balance regulator is set to 55psi.

2. Zero return all axes.

3. In MDI program T1 M6;

4.Select the alarm page. Type debug and press the WRITE key.

5. Orientate the spindle in MDI.

NOTE: Ensure tool push switch adjustment for tool clamp/unclamp adjustment has been completed.

6. Select handle mode and select Y-Axis. Slowly move Y-Axis (after Y-Axis is locked in) towards the spindle until the extractor on station #1 is close to engaging the tool holder.

7. Check that the tool carousel in/out adjustment is correct by checking the centerline of the tool extractor groove in reference to the extractor centerline. Adjustments may be made by loosening the 1/2" locknut and turning the setscrew clockwise or counter/clockwise, located at the nose of the actuation cylinder.

NOTE: Do not loosen 1/4" nut located at center. Tighten the 1/2" locknut without turning the adjustment screw.

8. After completing the carousel adjustment the switch adjustments for carousel in/out must also be completed. Check the diagnostics page for TC in and TC out on the discrete inputs .

9. In the Jog handle mode raise the spindle with tool holder towards the tool changer. When the tool changer extractor is close to engaging the tool holder confirm that the carousel rotation is in line with the tool side to side engagement. If the carousel is too far in the clockwise direction, Parameter 215 CAROUSEL OFFSET must be set to a lower value. Increase the value if carousel is too far counterclockwise.

10. Jog the handle slowly until the extractors have fully engaged the tool, ensuring that the spindle orientation is still present. Ensure the extractor is fully engaged, but not overloading the Y-Axis servo. There should be a small amount of clearance to prevent the extractor from knocking when the Y-Axis moves into position. Parameter 211 Y-AXIS TOOL CHANGE OFFSET will adjust this distance.

11. IMPORTANT! Once you have completed this proceedure type DEBUG on the alarms page and press the WRITE key to exit .

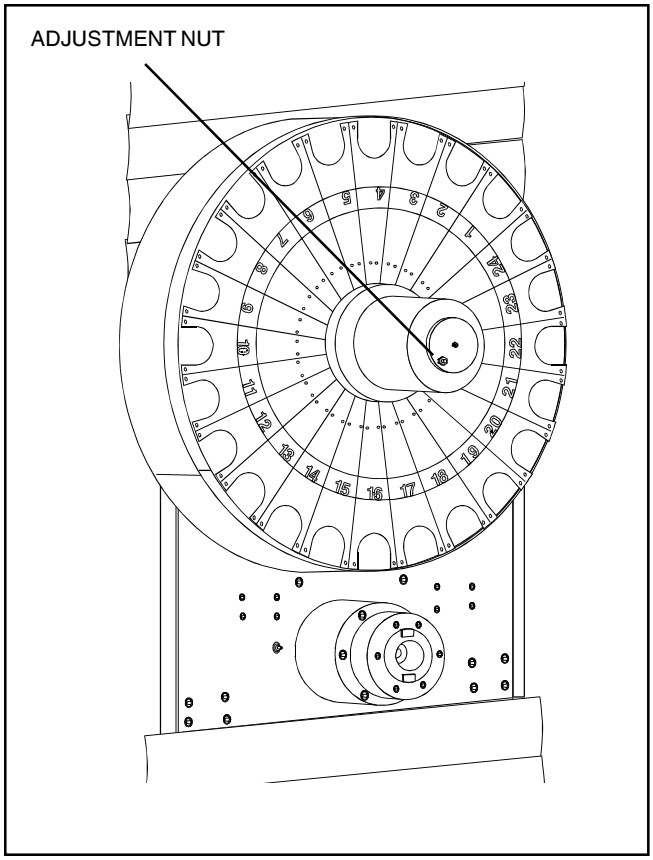


Fig. 6-2 Tool Changer IN/OUT adjustment nut.

6.3 ORIENTATION

1. Slightly loosen the 1/4 - 20 orientation ring bolts.

2. Load a tool into the spindle.

NOTE: In order to perform the following proceedure you must you must have turned the PARAM LOCK OFF and be in DEBUG.

3. In DEBUG press ORIENT SPINDLE.

4. Jog the head of the spindle into the carousel.

5. Disconnect the main air supply hose at the air/ lube panel.

6. Turn the orientation ring until the shot pin is lined up with the orientation ring detent.

7. Manualy engage the shot-pin into the detent.

8. Tighten the 1/4 - 20 bolts to 15ft-lbs.

9. Re-connect the main air supply.
10. Check orientation with dial indicator. Spindle should be parallel to Y-Axis within 0.0005"

11. Return to the ALARMS PAGE and ensure PARAM LOCK is back on.

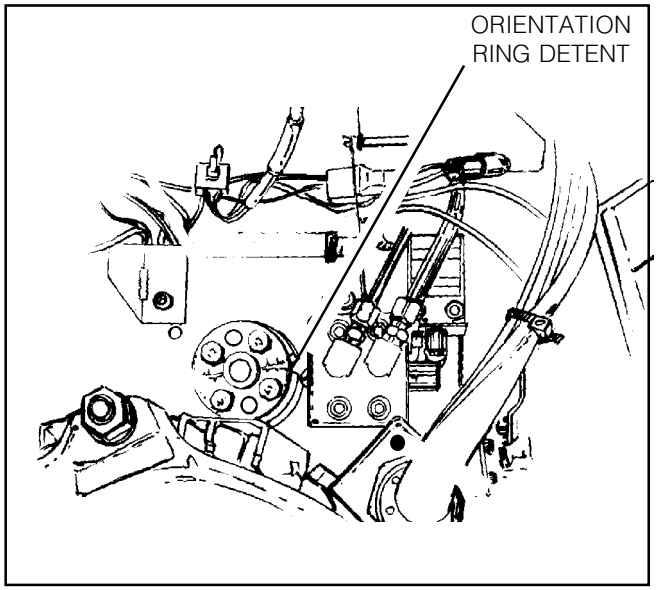


Fig. 6-3 Top view of spindle orientation components

7. SPINDLE MOTOR

REMOVAL

1. Remove back cover to machine.

2. Position axes for easy access to spindle motor.

NOTE: Motor removal requires a hoist and lifting harness.

3. Power off machine.

4. Remove solenoid mounting bracket attached to motor plate.

5. Remove spindle belts.

6. Remove wire harness from spindle motor junction box.

7. Securely attach a lifting harness to the motor ensuring the motor remains balanced throughout removal.
Loosen the motor mounting bolts

8. Carefully lift the hoist until the motor rests securely into the harness and is balanced. Once the weight of the motor is on the harness, remove the spindle motor bolts.

9. Slowly remove motor from machine.

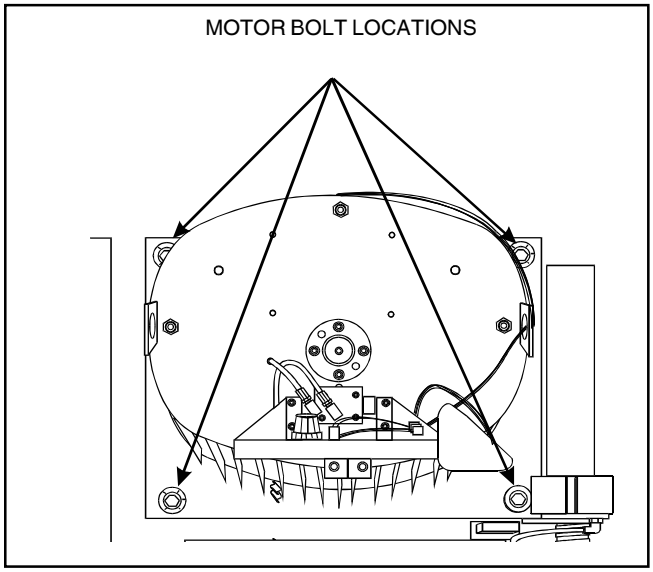


Fig. 7-1 Spindle motor; bolt hole locations

INSTALLATION:

10. Reconnect the harness to the motor.

11. Install the spindle motor bolts,
IMPORTANT! Ensure encentric bolt is mounted into the bottom right hole of the mounting plate and is fastened with the adjustment collar.

12 Reconnect the belts and set the correct belt tension. Ensure all bolts are securely fastened after belt adjustment is completed.

13. Reconnect the wire harness to the motor ensuring the motor phase is wired correctly. *Use electrical tape to insulate all motor screw connections.*

13. Install solenoid mounting bracket to the motor plate.

14. Adjust the spindle orientation.

15. Install machine rear cover.

8. CAROUSEL MOTOR

REMOVAL:

1. Power off machine.

2. Disconnect carousel wire harness at carousel motor junction box.

3. Remove bolts mounting motor to carousel reduction transmission.

4. Motor output shaft locates on a keyway and will pull directly out.

INSTALLATION:

5. Line up keyway with output shaft and slide motor into place.

6. Tighten motor bolts to the carousel transmission box.

7. Reconnect the wire harness to the carousel motor.

8. Check the carousel indexing alignment is correct.

9. BRAKE REMOVAL

1. Power off the machine.

CAUTION! To keep the Spindle head from drifting down, place a 4"x4" between the head and the base of the column casting. .

2. Unfasten lower Y-AXIS way cover at the top mounting bracket and allow covers to fully collapse.

3. Unplug the wires leading to the brake.

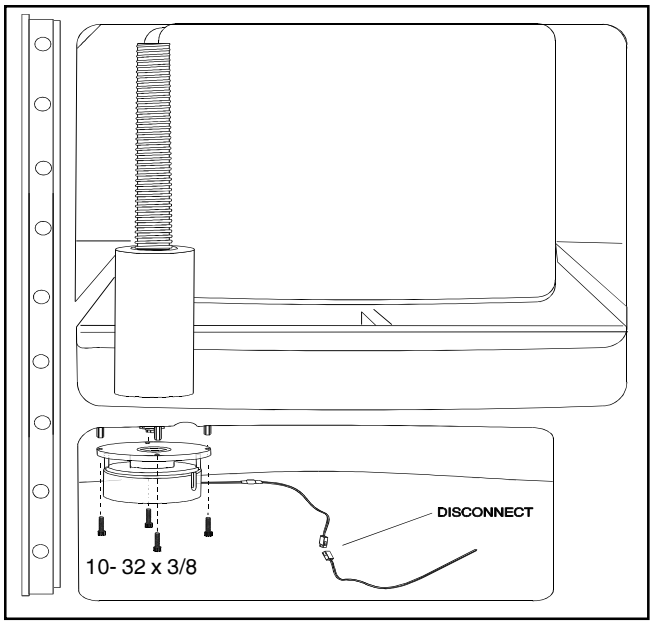


Fig. 9-1 Brake Removal

4. Remove the four screws that fasten the brake to the casting.

5. Re-install in reverse order .

10. WAY COVERS

10.1 UPPER Y-AXIS WAY COVER

REMOVAL:
1. Zero return all axes.

2. Turn off power to machine.

3. Remove upper and lower 10-32 screws that attach way covers to column.

4. Way cover must be fully collapsed before removal.

5. Remove covers through left side in between tool changer mounting bracket and column.

INSTALLATION:
1. To install a new Y-Axis way cover, strap both ends with nylon tie wraps while the cover is fully collapsed.

2. Carefully install cover into Y-Axis track guides without damaging cover or guides. Once the covers are in place cut and remove the tie-wraps.

3. Install the top bolts. Ensure the cover moves freely by lifting the bottom of the way cover up and down.

4. Evenly tighten all bottom cover bolts.

10.2 LOWER Y-AXIS WAY COVER.

REMOVAL:
1. Zero return all axes.

2. Turn off power to machine.

3. Remove the X-Axis chip guard directly below the lower Y-Axis way cover.

4. Remove upper and lower bolts that attach way cover to column.
NOTE: Way covers must be fully collapsed before it can be removed.

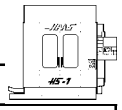
5. Remove covers from the bottom side of column.

INSTALLATION:
1. To install new Y-Axis way covers, use tie wraps to keep the covers collapsed for easier installation.

2. Fasten the top bracket of the way-covers with the 10-32 bolts.

3. Cut the tie-wraps and check that the covers engage the guide on all sections and that they move up and down freely.

4. Install bottom bolts and tighten evenly.



11. DOOR REMOVAL

1. Reach underneath the door panel and release the door springs.

2. Loosen the bottom 1/4 x 20 SHCS that fasten the rollers to the door panel.

CAUTION! Both the springs and rollers are under high tension and should be removed carefully. Protective eyeware is highly recommended.

3. Completely remove one of the top roller assemblies from the door panel. At this time the door rollers will disengage from the door and fall inside the machine.

4. In order to re-install the door, fasten the roller assemblies to the door.

5. Place the door back into the machine and mount the top rollers to the top guide rails.

6. Once the rollers are all in place, reconnect the springs at the top and bottom.

ELECTRICAL SERVICE

1. SOLENOIDS

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

1.1 AIR SOLENOID ASSEMBLY

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

2. Remove air supply from machine.

3. 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.

4. Disconnect the two leads to the low air pressure sensor.

5. 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”.

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

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

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

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

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

11. 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 air supply from machine.

3. Remove the tool release piston assembly

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

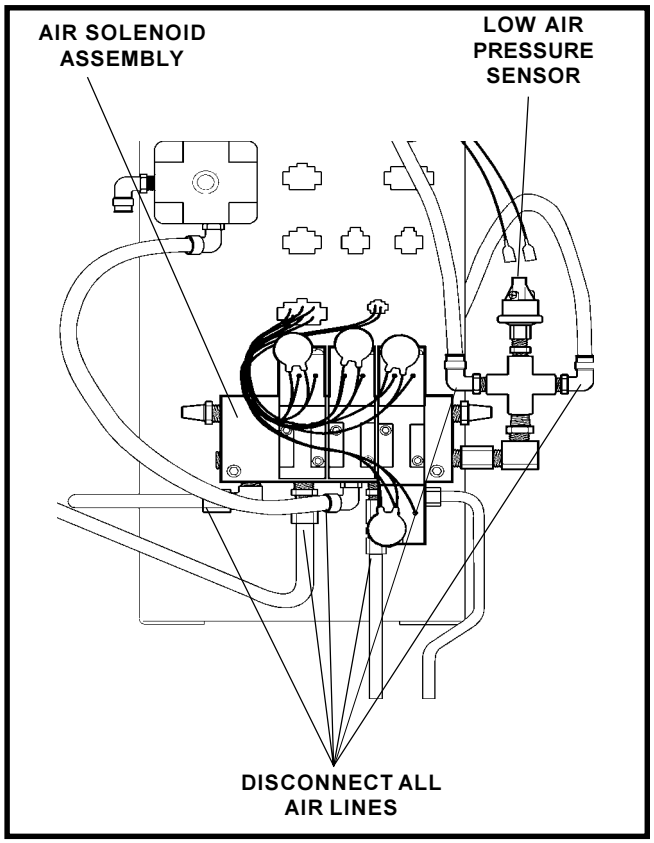


Fig. 1-1 *Tool release piston assembly with air solenoid assembly.*

5. Unscrew the air solenoid from the air solenoid assembly.

6. 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.

7. Reinstall the tool release piston assembly

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

1.3 SPINDLE AIR SOLENOID

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

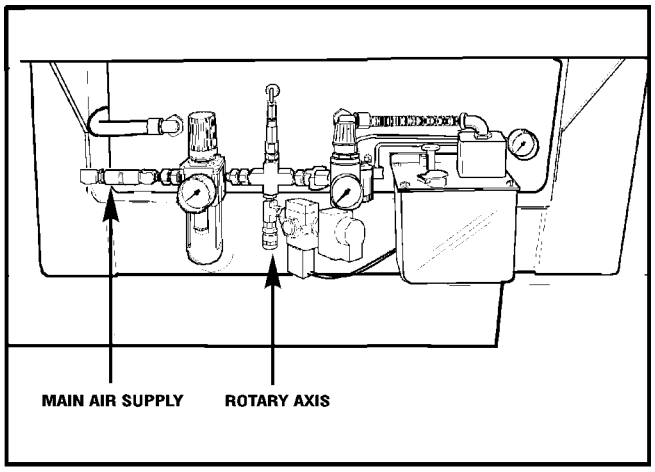


Fig. 1-2 *lube/air panel.*

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

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

4. Disconnect the spindle air solenoid assembly from the (nonadjustable) air regulator.

5. Disconnect the spindle 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 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

2.1 ADJUSTING VOLTAGE

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

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).

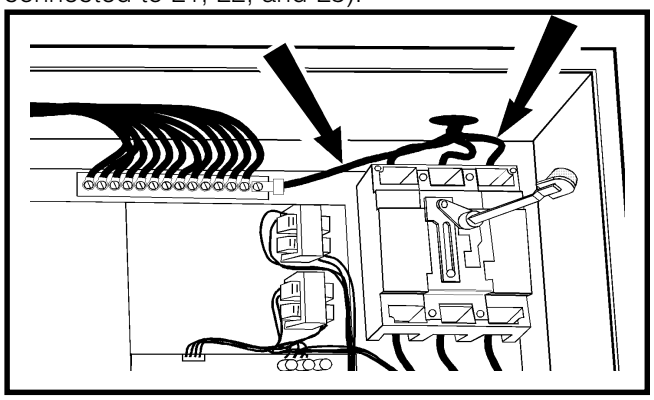


Fig. 2-1 *Power Lines: hookup locations*

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.

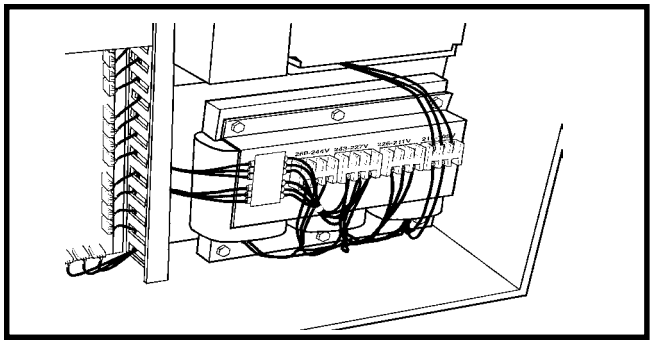


Fig. 2-2 *Transformer connections.*

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

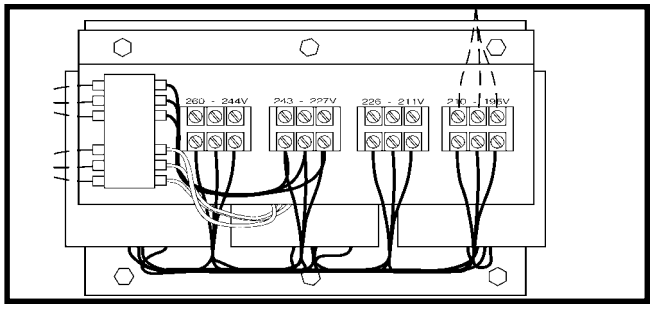


Fig. 2-3 *Transformer with 195-210V range.*

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.

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.

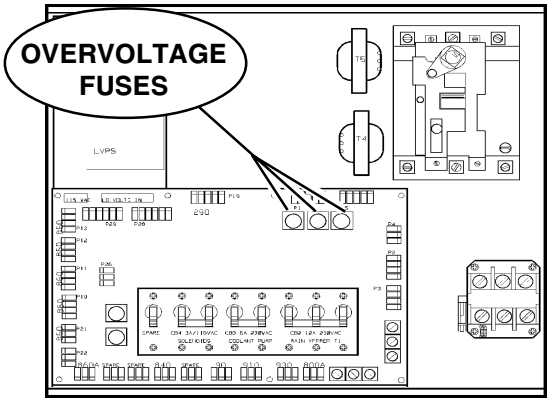


Fig. 2-4 *Power lines; hookup location.*

7. Turn off the power . Also, set the main switch handle on the panel door to off. . Close the door, screw the screws into place, and turn the power back on.

3. 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.

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).

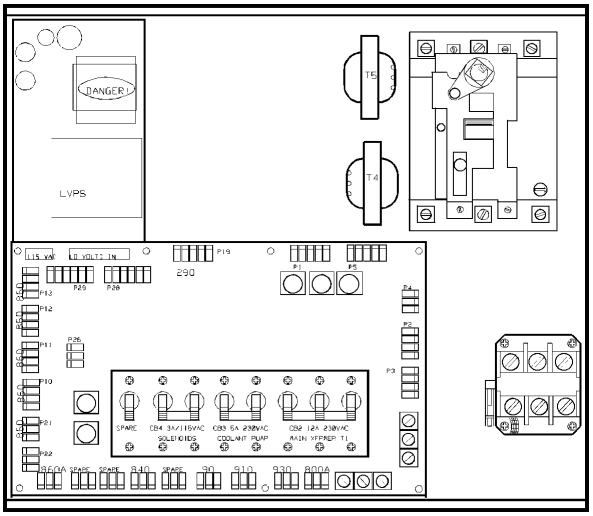


Fig. 3-1 *Power supply assembly; fuse locations.*

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 (½ amp, type AGC, 250V).

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

4. 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).

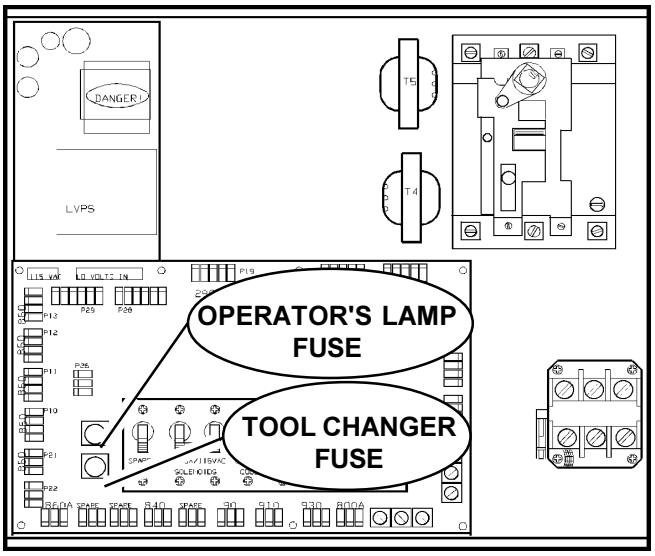


Fig. 4.1 *Power supply board; fuse locations.*

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).

5. 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).

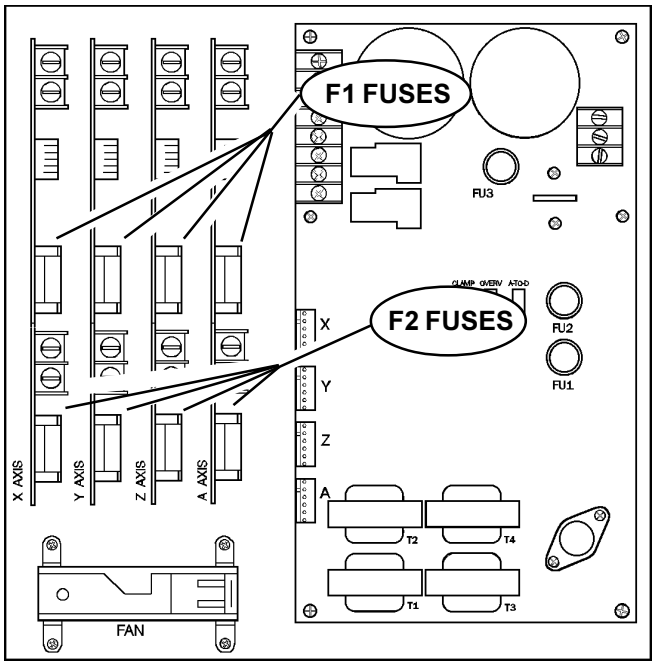


Fig. 5-1 *Servo drive assembly; fuse locations.*

6. PCB REPLACEMENT

6.1 MOTIF,VIDEO,PROCESSOR BOARD

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.

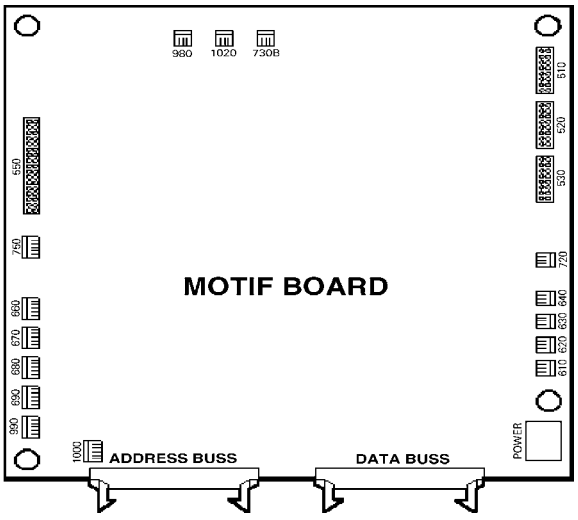


Fig. 6-1 *Motor Interface board.*

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.

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 .

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.

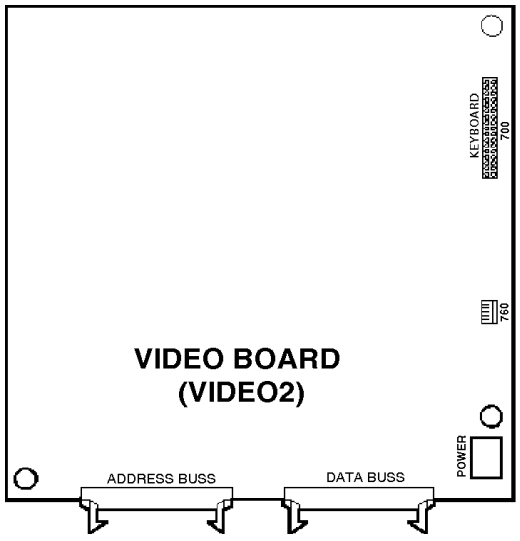


Fig. 6-2 *Video board.*

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.

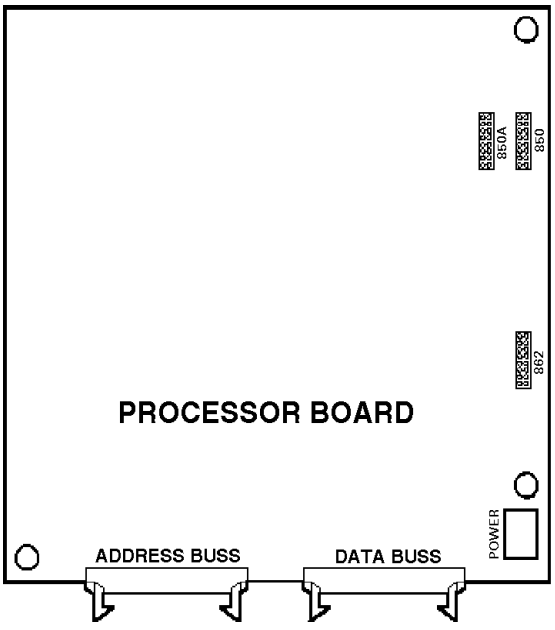


Fig. 6-3 *Processor board.*

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

6.2 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”.

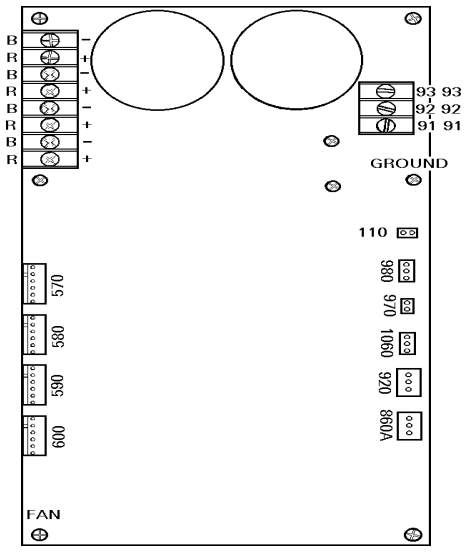


Fig. 6-4 *SDIST board.*

Please note its location for future reference.

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 .

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.

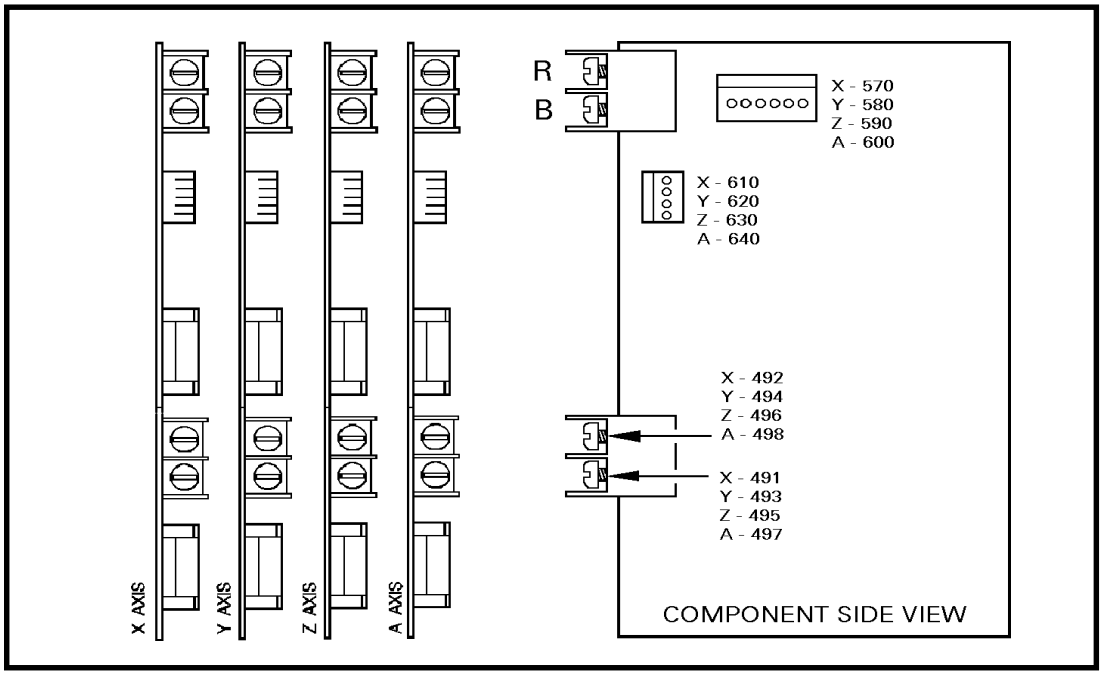


Fig. 6.5 *Servo Driver Boards*

6.3 I/O BOARD

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

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

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

4. Disconnect all leads to the Input/Output (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).

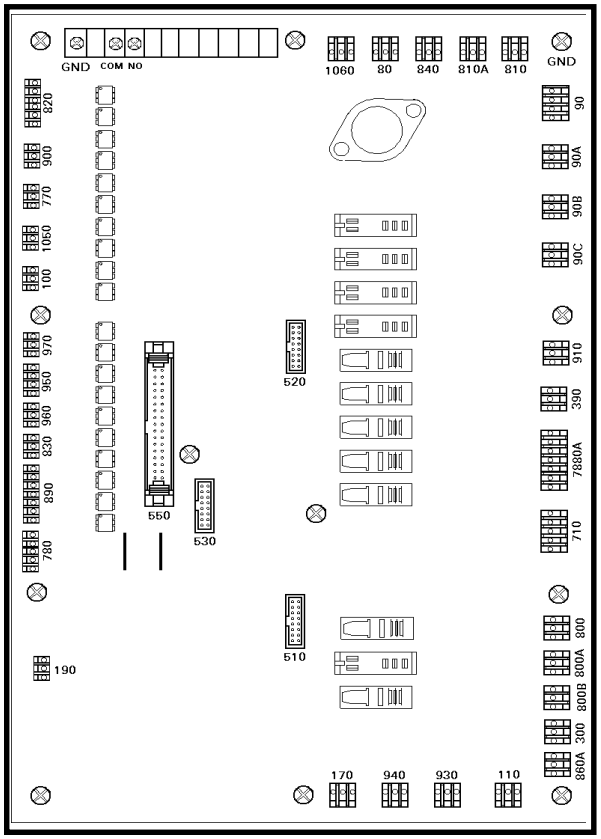


Fig. 6-6 *I/O board.*

6.4 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.

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.

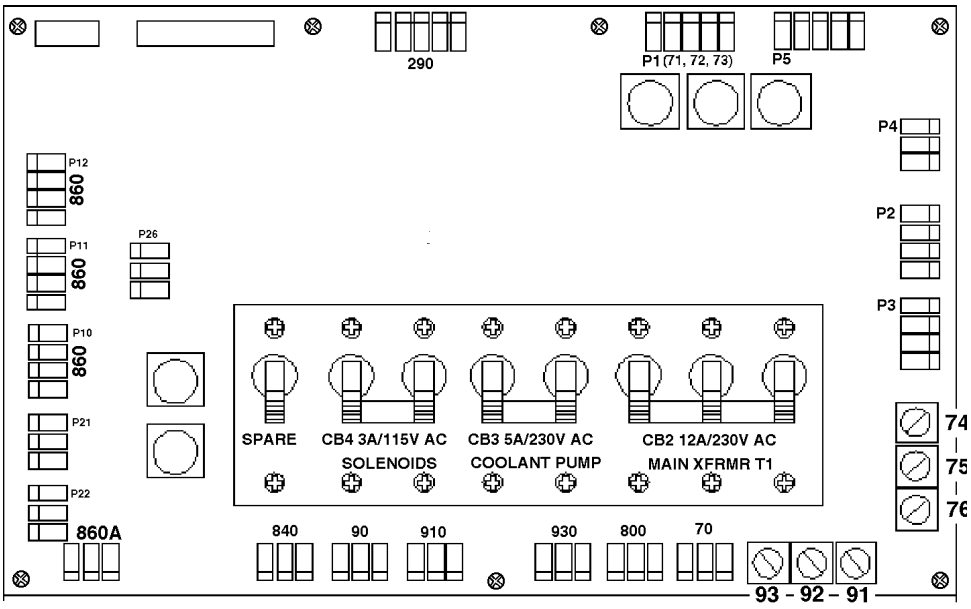


Fig. 6-7 *Power Distribution (POWER) board.*

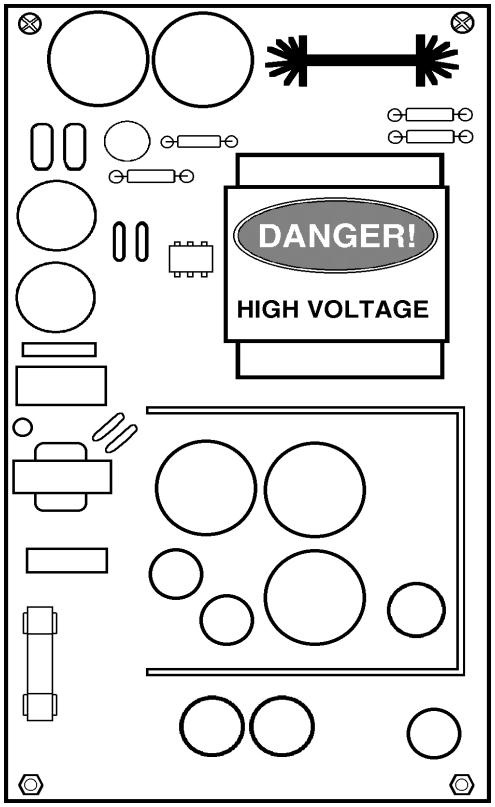


Fig. 6-8 Low Voltage Power Supply board.

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.

6.5 RS-232 DB25

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

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

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

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.

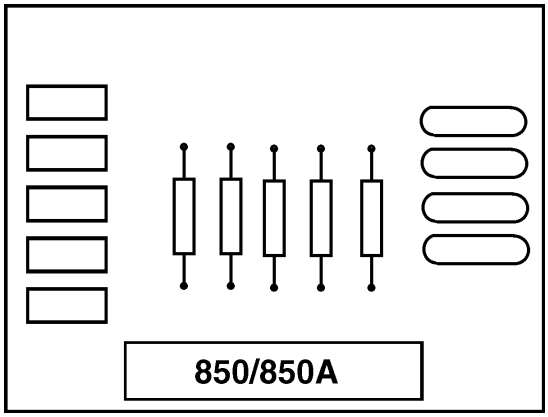


Fig. 6-9 RS-232 DB25 board.

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.

6.6 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.

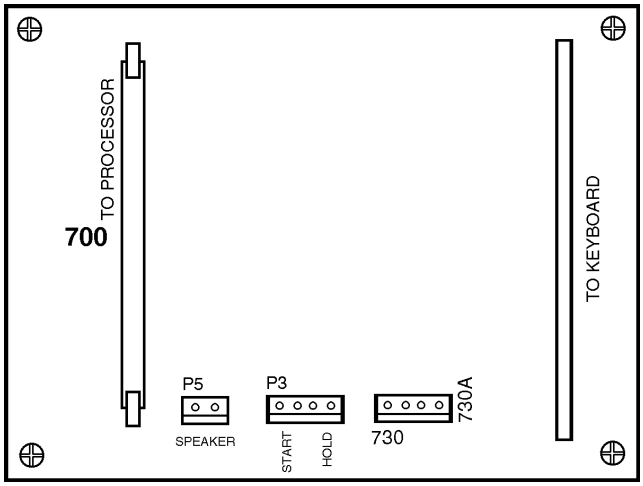


Fig. 6-10 *Keyboard Interface board.*

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.

7. FRONT PANEL

7.1 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.

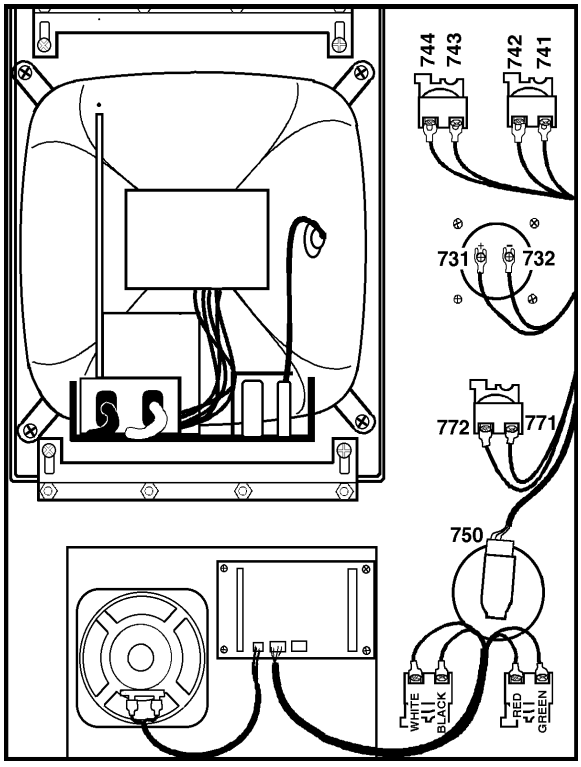


Fig. 7-1 Interior of control panel (rear).

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.

7.2 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.7-2 when reconnecting; otherwise, damage may occur to the machine.

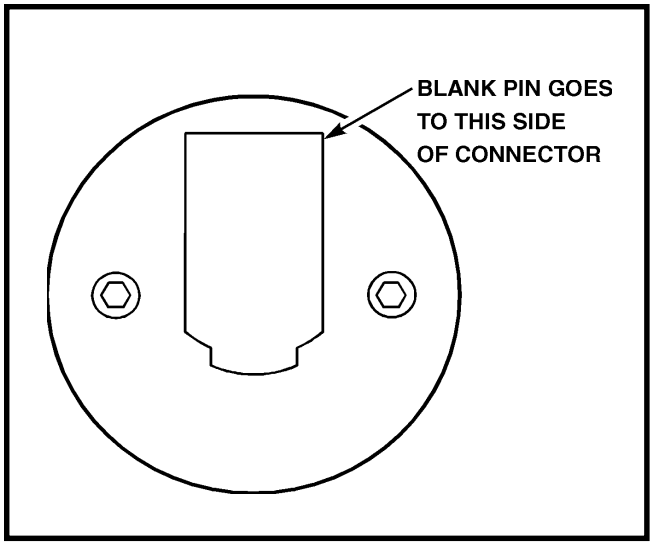


Fig. 7.2 *Jog handle encoder.*

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

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

6. Replacement is reverse of removal. Keep in mind the important notice in step three.

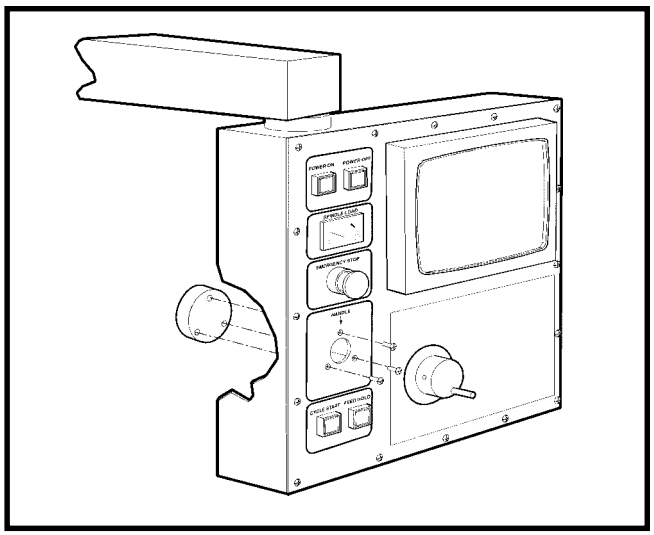


Fig. 7.3 Jog Handle removal.

7.3 SWITCH REPLACEMENT

NOTE: This section is applicable for the POWER ON, POWER OFF, EMERGENCY STOP, CYCLE START, and FEED HOLD switches.

1. Turn the machine power off.

2. Remove the four screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. Disconnect all leads to the switch's connectors. Ensure all leads are properly marked for reconnecting later.

4. Unscrew the two small set screws, one on top and one on the bottom, and turn the switch counter clockwise to loosen. Separate from the front portion and pull out.

5. For replacement, screw the front and rear portions together (reverse of removal) and tighten down the two small set screws when the switch is properly positioned.

NOTE: The POWER ON, POWER OFF, and EMERGENCY STOP switches must all have the connectors on the bottom of the switch.

6. Reconnect all leads to the correct switch.

7.4 SPINDLE LOAD METER REPLACEMENT

1. Turn the power off and disconnect power to the machine.

2. Remove the four screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. Disconnect the two leads at the back of the spindle load meter assembly. Ensure the two leads are properly marked for reconnecting later.

4. Unscrew the four screws that hold the spindle load meter assembly to the control panel. Take care to hold the assembly in place until all screws have been removed. Remove the assembly.

5. Installation is reverse of removal. Ensure leads go the correct location.

7.5 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.

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.

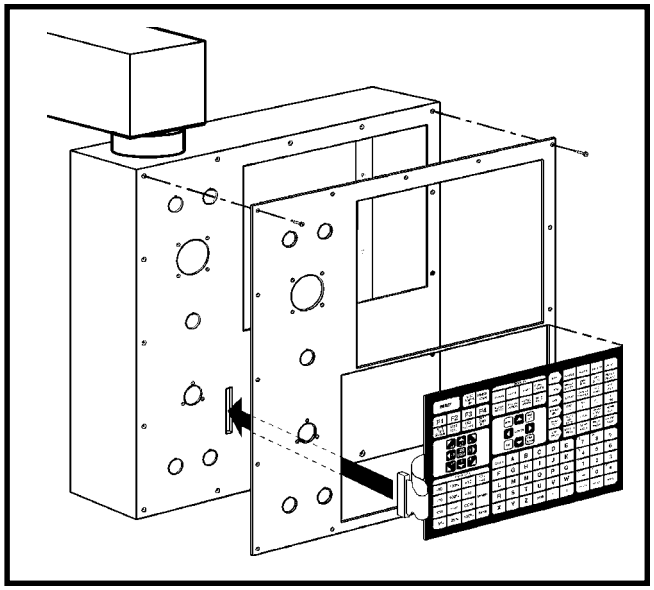


Fig. 7-4 *Keypad installation.*

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.

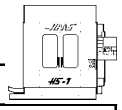
11. Replace the rear cover panel and fasten with the screws that were previously removed.

8. SPINDLE ENCODER

8.1 REPLACEMENT:

1. Turn machine power on. Raise or lower spindle head to a position that will allow you to easily work on the encoder. Turn machine off.

2. Disconnect the encoder cable at the top of the encoder.



3. Unscrew and remove the four 10-32 screws holding the encoder to the four standoffs Remove the encoder, leaving the belt on the pulley at the orient ring.

8.2 INSTALLATION -

NOTE: Field installation of the spindle encoder is NOT RECOMMENDED.

4. Place some blue Loctite on the threads of the four ¼-20 x ¾" set screws and screw approximately halfway into the standoffs. Screw the hex end of the set screws *into* the standoffs.

5. Screw the standoffs into the four holes located at the rear of the transmission's top plate.

6. Fasten to the top plate with the four ¼-20 x 1" screws and four lock washers.

7. Place the 18-tooth pulley onto the pulley bushing and tighten down, using the 5/64" hex wrench. Place the 8-32 x ¾" SHCS through the center axis of the pulley.

8. Screw this assembly into the spindle orientation ring.

9. Place the 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.

10. Unscrew the four screws and remove the cover panel on the box at the base of the flex- tube.

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

12. Place the belt on the 36-tooth pulley, then loop over the 18-tooth pulley. Place the encoder assembly on the four standoffs and attach with the four 10-32 SHCS.

13. Connect the encoder cable to the encoder assembly.

TECHNICAL REFERENCE

1. SWITCHES

NOTE: There are fourteen (14) limit switches located on the HMC, 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:

1.1 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. 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.

1.2 SPINDLE ORIENT SWITCH

[Top of motor plate]

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.

1.3 DOOR HOLD SWITCHES

[Top outer edges of door opening (4)]

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.

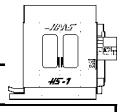
1.4 X, Y, Z TRAVEL LIMIT SWITCHES

[X: Left side of saddle by X-axis motor]
[Z: Rear of base by Z-axis motor]
[Y: Top of column by Y-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. Be careful during the Z zero search and stay clear of that rapid move.

1.5 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.

1.6 TOOL CHANGER SWITCHES

The tool changer has an encoder and is referenced from station #1 position, which adjusted by the carousel offset (parameter 215)

The shuttle IN/OUT Switches are mounted on a single bracket and may cause a tool unclamp alarm if not properly set.

2. 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.

SIOSerial I/O initialization complete.
: If thislight does not come on, there is a problem with the serial ports. Disconnect anything on the external RS-232 and test gain.

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.

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

2.1 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.

2.2 VIDEO AND KEYBOAR PCB (VIDEO2)

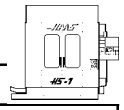
The VIDEO and KB PCB generates the video data signals for the monitor and the scanning signals for the keyboard. In addition, the keyboard beeper is generated on this board. There is a single jumper on this board used to select inverse video. The video PCB connectors are:

P1 Power connector
P4 Keyboard (700)
P2 Address buss
P5 EGA extended video connector (option)
P3 Video connector (760)
P6 Data buss

2.3 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)
P1032 discrete inputs (550)
P11Relay drives 1 to 8 (510)
P12Relay drives 9 to 16 (520)
P13Relay drives 17 to 24 (530)
P14Relay drives 25 to 32 (540)
P15Power connector (+5,+12+)
P16D-to-A output and -12V DC (720)
P17A-to-D inputs for DC buss voltage (980)
P18Jog Crank input and aux 1,2 (750)
P19Address buss
P20Spindle encoder inputs (1000)
P21A-to-D input for spindle temperature (1020)
P22A-to-D input for spindle load monitor (730B)
P23A-to-D input spare
P24Home switch inputs X, Y, Z (990)
P25Spare inputs
P26A-to-D input spare
P27A-to-D inputs spare
P28A-to-D inputs spare
P29A-to-D inputs spare



3. 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.

3.1 160 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.

3.2 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.

3.3 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

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.

3.4 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, overcurrent shutdown, and motor thermal protection. Short circuit protection is provided by the drive card and, if sustained for over 0.01 second, the microprocessor will shut the servo drives off and generate an alarm.

The motor output circuit is fuse protected at 20 amps but this will only blow if there is a drive failure as the current limit circuit is much faster than the fuses.

The PWM signal is provided by the Motor Interface PCB along with direction and H drive state control. The processor also monitors the overcurrent status from the drive card.

The connectors on the servo drive cards are:

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.

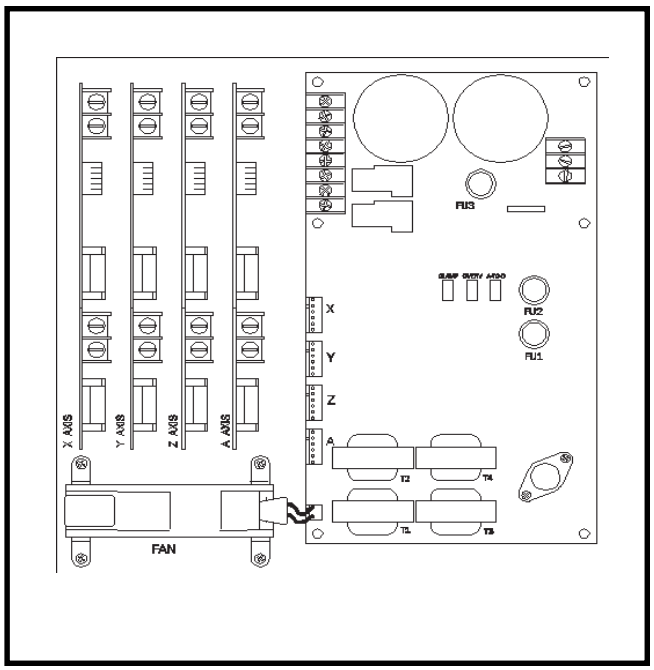


Fig. 3-1 *Servo Drive Assembly.*

4. 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

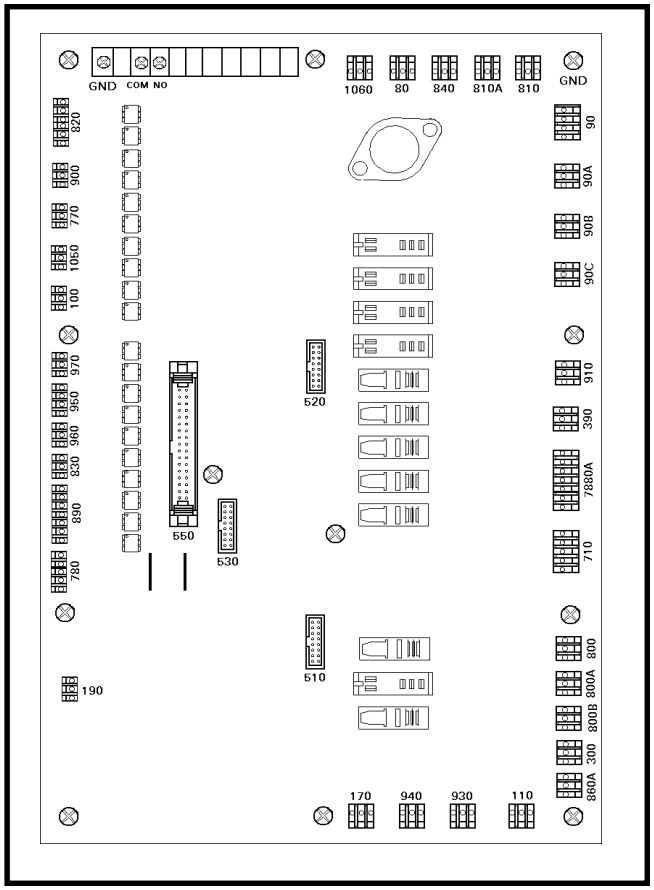


Fig. 4-1 *Input/Output board.*

4.1 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.

4.2 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.

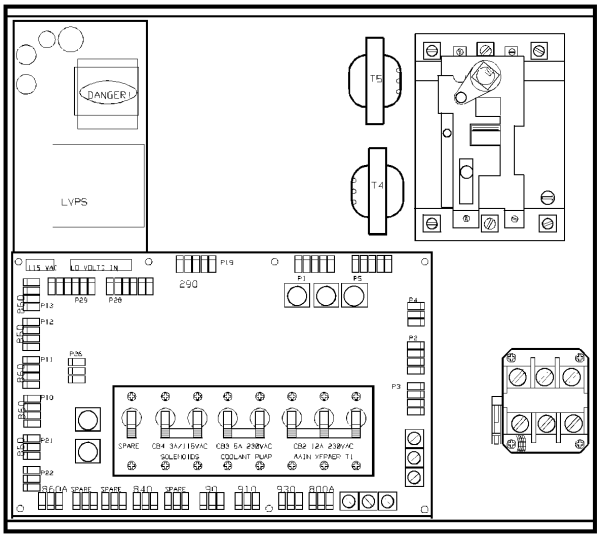


Fig. 4.2 *Power Supply Assembly.*

4.3 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.

4.4 LOW VOLTAGE POWER SUPPLY

The low voltage power supply provides +5V DC, +12V DC, and -12V DC to all of the logic sections of the control. It operates from 115V AC nominal input power. It will continue to operate correctly over a 90V AC to 133V AC range. 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.

4.5 POWER PCB (POWER)

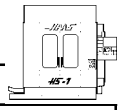
The low voltage power distribution and high voltage fuses and circuit breakers are mounted on a circuit board called the POWER PCB (See Fig. 12-1). The following connectors are on it:

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



TB1115V AC from T1 secondary
TB2115V 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.

4.6 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.

4.7 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.

4.8 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 ½ amp by F6. It is connected to the POWER PCB by connector P19.

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.

5. SUPPLY VOLTAGE SENSOR

A sensor circuit on the SDIST circuit board is used to monitor the voltage applied to the control. It actually monitors the DC buss voltage developed for the servo drives. When this voltage drops below a set point, an alarm is generated. The voltage being monitored is rectified from the 115V AC secondary of transformer T1. Cable 980 carries the analog voltage from the SDIST PCB to the MOTIF PCB.

6. SUPPLY VOLTAGE DISPLAY

The Diagnostic Data display page is used to display this voltage. It has a range of zero to 200V DC. If the machine is wired for 230V AC, a primary service voltage of 230V will provide a secondary voltage of about 120V; that will produce a servo buss voltage of about 168V DC.

Note that load variations on the servo motors and spindle drive will cause slight variations in this display. If the voltage varies by more than 10V under load, it indicates that the wiring to the control is dropping too much voltage and may need a larger gauge wire.

7. LOW VOLTAGE TRIP POINT

If this voltage drops below the following limits:

205V AC when wired for nominal 230V AC service
190V AC when wired for nominal 208V AC service

an alarm will be generated. The sensor actually converts the servo DC buss analog voltage to digital and monitors the digital value. Both alarm trip points correspond to 140V DC on the servo buss.

If one leg of the three-phase incoming power is lost, there may not be an alarm. In this case, the machine may turn off completely, the electronics may shut down, or the servos and the video monitor may shut off.

8. UNDER/OVER VOLTAGE SENSORS

An overvoltage sensor monitors the DC servo motor buss. When this voltage exceeds 185V DC, a load is applied to the servo buss. That load is called the regen load resistor. When this voltage exceeds 190V DC, an alarm is generated and machine operation stops. If the voltage remains between these two values for more than a few seconds, an overtemperature alarm may be generated. That alarm is caused by an overheat of the regen resistor.

The overvoltage alarm will be generated for different input service voltages depending on how the machine is configured. The following limits apply:

260V AC when wired for nominal 230V AC service
235V AC when wired for nominal 208V AC service

It is also possible that an overvoltage condition will be detected first by the spindle drive. This would initially show only a “spindle drive fault”. A check of the status on the spindle drive LED’s will show what the actual alarm is.

In controls built after April 1990, there is an undervoltage sensor that monitors the voltage of all three inputs’ power phases. If this voltage drops below 180V AC for 208 input or drops below 200 for 230 input for any phase, an alarm will be generated. This phase sensor is built into the IOPCB circuit board in the lower left hand corner of the control

The overvoltage alarm will be generated for different input service voltages depending on how the machine is configured. The following limits apply:

260V AC when wired for nominal 230V AC service
235V AC when wired for nominal 208V AC service

It is also possible that an overvoltage condition will be detected first by the spindle drive. This would initially show only a “spindle drive fault”. A check of the status on the spindle drive LED’s will show what the actual alarm is.

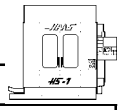
In controls built after April 1990, there is an undervoltage sensor that monitors the voltage of all three inputs’ power phases. If this voltage drops below 180V AC for 208 input or drops below 200 for 230 input for any phase, an alarm will be generated. This phase sensor is built into the IOPCB circuit board in the lower left hand corner of the control

9. FRONT SWITCH BOX ASSEMBLY

The front switch box assembly is located on the right front panel of the machine. The box contains five control buttons which are wired to the keypad interface located inside the control panel. Only the E-STOP button is hardwired to the I/O Board in the control cabinet.

The control buttons are "normally open" circuits and should any be closed while powering up, ALARM 159, "KEYBOARD FAILURE" will appear on the monitor.

The buttons produce the same beeping sound when pressed as those on the main keypad.



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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