HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

Lathe Service Manual 96-3710 English May 15 1995

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

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

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

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

TROUBLESHOOTING

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

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

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

BEFORE YOU BEGIN:

• USE COMMON SENSE

Many problems are easily overcome by correctly evaluating the situation. All machine operations are composed of a program, tools, and tooling. You must look at all three before blaming one as the fault area. If a bored hole is chattering because of an overextended boring bar, don't expect the machine to correct the fault. Don't suspect machine accuracy if the vise bends the part. Don't claim hole mis-positioning if you don't first center-drill the hole.

• FIND THE PROBLEM FIRST

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

• DON'T TINKER WITH THE MACHINE

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

1. GENERAL MACHINE OPERATION

1.1 MACHINE NOT RUNNING

Machine cannot be powered on.

- Check input voltage to machine.
- 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.
- IOPCB may need replacement.
- POWER PCB may need replacement.

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.
- Check Parameter 57 for Power Off at E-STOP.
- IOPCB may need replacement.
- MOTIF PCB may need replacement.

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 no keyboard keys 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. Vibrations also need to be distinguished from noise such as a bad bearing. We will assume that vibrations would be something that could be felt by putting your hand on the spindle ring. One crude method of measurement would be to take an indicator on a magnetic base extended 10 inches between the turret and spindle ring 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.

Machine vibrates while jogging the axis with the hand wheel.

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

The machine vibrates excessively in a cut.

This is a tough one to call because machining practices come into play. Generally speaking, the least rigid element of a cut is the tool because it is the smallest part. 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 opera tion 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 use a wiggler test indicator for linear dimensions. They measure in an arc and have sine/cosine errors over larger distances.
- Don't use magnetic bases as accurate test stops. The high accel/decel of the axis can cause them to move.
- Don't attach test points to the sheet metal of the spindle head.
- 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.

NOTE: Out of round diameters occur when the tooling or machining practices are incorrect. Bores will be out of round due to tool deflection much more frequently than due to spindle bearing problems

Lathes always cut parallel with the Z-axis. Bores will be tapered if the tooling is inappropriate, speeds and feeds incorrect or coolant not getting to the cutting tool when required. In rare cases, the spindle may be out of alignment due to a crash.

1.4 FINISH

◈ Machining yields a poor finish.

- Check for backlash.
- Check the condition of the tooling and the spindle
- Check turret alignment.
- Is the turret clamped?
- Is the tooling tight?

2. SPINDLE

2.1 NOT TURNING

Spindle not turning.

- If there are any alarms, see See Alarm Section.
- Check that the spindle turns freely when machine is off.
  - If spindle drive does not light the RUN LED, check forward/reverse commands from IOPCB.
  - Check that the drawtube piston is not bound against the spindle shaft.
- Check the wiring of analog speed command from MOTIF PCB to spindle drive (cable 720).
- If spindle is still not turning, replace MOTIF PCB.
- 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

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

Excessive noise coming from the spindle head area.

- Remove the left end covers and 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.
  - If the noise does not change, remove the belt and go on to the next step.

- Run the motor with the drive belt disconnected. If the noise persists, the problem lies with the motor. If it disappears, go on to the next step.
- Check for the correct amount of lubrication to the spindle bearings (1cc per hour) in an air mist lubricated spindle.

3. SERVOS

3.1 NOT OPERATING

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

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. If motor is still inoperable, replace motor assembly
- Check for broken or loose coupling between the servo motor and the lead screw.
- Check for a damaged lead screw.

NOTE: If a lead screw fails, it is most often due to a failed bearing sleeve.

3.2 NOISE

Lead screw noise is usually caused by a lack of lubrication and is usually accompanied by heating. Other causes are misalignment, bearing sleeve damage, or ball nut damage. Check the alarm history of the machine and look for axis overcurrent and following error alarms.

NOTE: Do not replace lead screws or bearing sleeves without due consideration; they are extremely durable and reliable. Verify that customer complaints are not due to tooling, programming, or fixturing problems.

Servo motor noise.

- Noise is caused by motor brushes. No problems will occur and noise should eventually go away.
- Noise is caused by bearings. Rolling, grinding sound is heard coming from the motor. ENSURE NOISE IS NOT COMING FROM THE BRUSHES.
- If motor noise is caused by motor bearings, replace motor.

Lead screw noise.

- Ensure oil is getting to the lead screw through the lubrication system.
- Check for damage to the bearing sleeve.
- Disconnect the servo motor from the lead screw and rotate the lead screw by hand. If the noise persists, the lead screw may need replacing.
- Run the axis back and forth. The motor will get very hot if the bearing sleeve is damaged. If so, turn the axis by hand and feel for roughness in the lead screw. Loosen the clamp nuts at both ends of the lead screw. If the symptom disappears, replace the bearing sleeve. Be certain to check for damage to the lead screw shaft where the bearing sleeve is mounted.

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

- Check the lead screw for misalignment.

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.

3.3 ACCURACY/BACKLASH

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

Poor Z-axis accuracy.

- Check for backlash in the lead screw as outlined below.
- 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.

Initial Preparation-

Turn the lathe ON. ZERO RET the machine and move the carriage to the approximate center of its travel in the Z-axis. Move the turret to the approximate center of the X-axis travel.

X-AXIS:

1. Place a dial indicator and base on the spindle retaining ring with the tip of the indicator positioned on the outside diameter of the turret, as shown in Fig. 3-1.

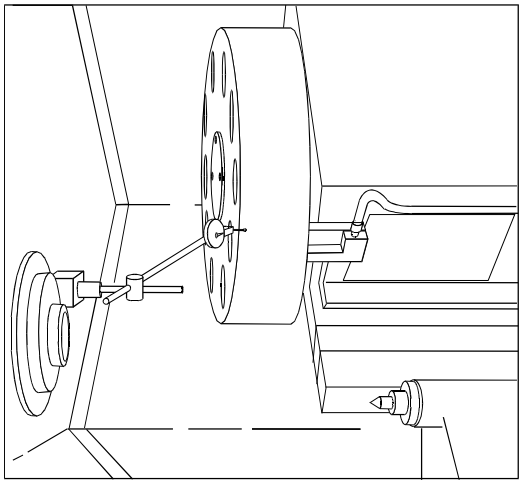


Fig. 3-1 Dial indicator in position to check X-axis.

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

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

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

Z-AXIS:

1. Place a dial indicator and base on the spindle retaining ring with the indicator tip positioned on the face of the turret as shown in Fig. 3-2.

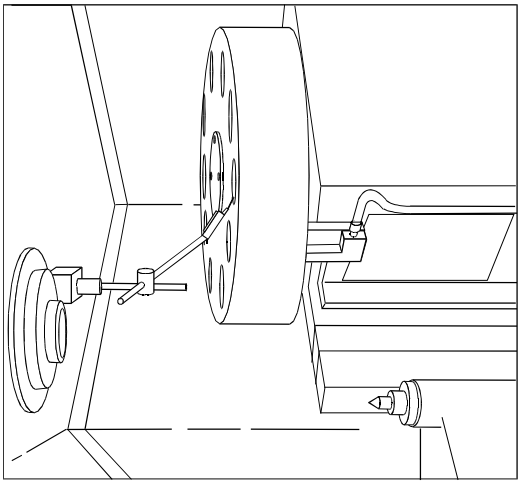


Fig. 3-2 Dial indicator in position to check Z-axis.

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 , Z=0
3. Set the rate of travel to .001 on the control panel and jog the machine .010 in the positive (+) Y direction. Jog back to zero (0) on the display. The dial indicator should read zero (0) ± .0001.
4. Repeat step three in the negative (-) direction.

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

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

3.4 VIBRATION

Excessive servo motor vibration.

- Check all Parameters of the suspected axis against the Parameters as shipped with the machine. If there are any differences, correct those and determine how the Parameters were changed. PARAMETER LOCK should normally be on.
- A bad motor can cause vibration if there is an open or short in the motor. A short would normally cause a GROUND FAULT or OVERCURRENT alarm; check the ALARMS. An ohmmeter applied to the motor leads should show between 1 and 3 ohms between leads, and over 1 megohm from leads to chassis.

3.5 OVERHEATING

Servo motor overheating.

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

4. ALARMS

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

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

4.1 ALARM LIST

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

ALARM # AND TEXT:	POSSIBLE CAUSES:
101 Motor Interface	Internal circuit board problem. The MOTIF PCB in the #2PCB Failure processor stack is tested at power-on. Call your dealer.
102 Servos Off	Indicates that the servo motors are off, the tool changer is disabled, the coolant pump is off, and the spindle motor is stopped. Caused by EMERGENCY STOP, motor faults, tool changer problems, or power fail.
103 X Following Error Too Large	Too much load or speed on X-axis motor. The difference between the motor position and the commanded position has exceeded a parameter. The motor may also be stalled, disconnected, or the driver failed. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor, or the slide being run into the mechanical stops.
104 B Following Error Too Large	Same as 103.
105 Z Following Error Too Large	same as 103.
106 A Following Error Too Large	same as 103.

107 Emergency Off	EMERGENCY STOP button was pressed. Servos are also turned off. After the E-STOP is released, the RESET button must be pressed at least twice to correct this; once to clear the E-STOP alarm and once to clear the Servo Off alarm.
108 X Servo Overload	Excessive load on X-axis motor. This can occur if the load on the motor over a period of several seconds or even minutes is large enough to exceed the continuous rating of the motor. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops but not much past them. It can also be caused by anything that causes a very high load on the motors.
109 B Servo Overload	same as 108.
110 Z Servo Overload	same as 108.
111 A Servo Overload	Excessive load on the turret motor. This can happen 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 the turret worm gear not having enough backlash or be in a bind when in the clamped position. This can easily be checked by pressing the E-Stop button (So the servos are off) and turning the turret motor coupling back and forth to insure the worm gear is in a bind. (See turret motor coupling adjustment.)
112 No Interrupt	Electronics fault. Call your dealer.
113 Turret Unlock Fault:	The turret took longer to unlock and come to rotation position than allowed for in parameter 62. The number in parameter 62 represents milliseconds. This may occur if the air pressure is too low, if the tool turret clamp switch is faulty or if there is a mechanical problem.
114 Turret lock Fault:	The turret took longer to lock and seat than allowed for in parameter 63. The number in parameter 63 represents milliseconds. This may occur if the air pressure is too low, if the tool turret clamp switch is faulty or if there is a mechanical problem.
115 Turret Rotate Fault	Turret motor is not in position. During a tool change operation the turret failed to start moving or failed to stop at the right position. This alarm can be caused by anything that jams the rotation of the turret. A loss of power to the tool changer can also cause this, so check CB5 and relays 1-8, 2-3, and 2-4.
116 Spindle Orientation	FUTURE

119 Over Voltage	Incoming line voltage is above maximum (about 255 volts when wired for 240 or 235 when wired for 208). The servos will be turned off and the spindle, tool changer, and coolant pump will stop. If this condition remains for 4.5 minutes, an automatic shutdown will begin.
120 Low Air Pressure	Air pressure dropped for a period defined of time set in the control. Check your incoming air pressure for at least 100 PSI and ensure that the regulator is set at 85 PSI.
121 Low Lub	Way lube is low or the system is not holding pressure. The system should hold pressure for 7 minutes and cycle every 1/2 hour. Check the tank at rear of lathe. Also check connector P5 on the side of the control cabinet. Check that the lube lines are not leaking.
122 Control Overheat	The control internal temperature is above 150 degrees F. This can be caused by almost anything in the control overheating. But is usually caused by overheat of the two regen 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.
123 Spindle Drive Fault	Overheat or failure of spindle drive or motor. The exact cause is indicated in the LED window of the spindle drive inside the control cabinet. This can be caused by a stalled motor, shorted motor, overvoltage, undervoltage, overcurrent, overheat of motor, or drive failure.
124 Low Battery	Memory batteries need replacing within 30 days. This alarm is only generated at power on and indicates that the 3.3 volt Lithium battery is below 2.5 volts. If this is not corrected within about 30 days, you may lose your stored programs, parameters, offsets, and settings.
125 Tool Turret Fault	Tool turret status inputs have been found to be in a faulted state. The inputs must be logically opposed to each other before any turret motion can occur. This condition may occur if: 1) Emergency Stop is pressed during a tool change or the tool change path is obstructed during a tool change and any one of alarms 113 through 115 occured. In this case, reset the control, clear any obstructions and press AUTO ALL AXES. If alarms 113 or 114 continue to occur for no apparent reason, call your dealer. You may have a tool changer time delay problem. 2) If alarm 125 persists, one of the turret status switches is faulty, there is a loose connection, there is an air solenoid problem or the I/O board is faulty. Should any of these be a problem, call your dealer.
127 RESERVED	

128 RESERVED	
129 M Fin Fault	M-Fin was active at power on. Check the wiring to your M code interfaces. This test is only performed at power-on.
130 RESERVED	
131 RESERVED	
132 Power Down Failure	Machine did not turn off when an automatic power-down was commanded. Check wiring to POWIF card on power supply assembly, relays on the IO assembly, and the main contactor K1.
133 Spindle Locked	(Future)
134 Low Hydraulic Pressure	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.
135 X Motor Over Heat	Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F. This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.
136 Y Motor Over Heat	same as 135.
137 B Motor Over Heat	same as 135.
138 A Motor Over Heat	same as 135.
139 X Motor Z Fault	Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at P1-P4.
140 Spindle Z Fault	same as 139.
141 Z Motor Z Fault	same as 139.
142 A Motor Z Fault	same as 139.
143 Spindle Not Locked	FUTURE
144 Time-out -	Time allocated for use prior to payment exceeded. Call your dealer.
145 X Limit Switch	Axis hit limit switch or switch disconnected. This is not normally possible as the stored stroke limits will stop the slides before they hit the limit switches. Check the wiring to the limit switches and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.
146 B Limit Switch	same as 145
147 Z Limit Switch	same as 145

148 A Limit Switch	Turret does not have a limit switch.
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 Reserved	
151 Low Coolant	P7 is broken or disconnected.
152 Self Test Fail	Control has detected an electronics fault. All motors and solenoids are shut down. This is most likely caused by a fault of the processor board stack at the top left of the control. Call your dealer.
153 X-axis Z Ch Missing	Broken wires or encoder contamination. All servos are turned off. This can also be caused by loose connectors at P1-P4.
154 Spindle Z Channel	same as 153.
155 Z-axis Z Ch Missing	same as 153.
156 A-axis Z Ch Missing	same as 153.
157 Motor Interface #1 PCB Failure	Internal circuit board problem. The MOTIF PCB in the processor stack is tested at power-on. Call your dealer.
158 Video/Keyboard PCB Failure	Internal circuit board problem. The VIDEO PCB in the processor stack is tested at power-on. This could also be caused by a short in the front panel membrane keypad. Call your dealer.
159 Keyboard Failure	Keyboard shorted or button pressed at power on. A power-on test of the membrane keypad has found a shorted button. It can also be caused by a short in the cable from the main cabinet or by holding a switch down during power-on.
160 Low Voltage	The line voltage to control is too low. This alarm occurs when the AC line voltage drops below 190 when wired for 230 volts or drops below 165 when wired for 208 volts.
161 X-axis Over Current or Drive Fault	Current in X servo motor beyond limit. Possibly caused by a stalled or overloaded motor. The servos are turned off. This can be caused by running a short distance into a mechanical stop. It can also be caused by a short in the motor or a short of one motor lead to ground.

162 B-axis Over Current	Same as 161 or Drive Fault
163 Z-axis Over Current	Same as 161 or Drive Fault
164 A-axis Over Current	Turret rotation servo. Current in the servo is beyond limit. The servos are turned off. This can be caused by the turret worm gear not having enough backlash or the turret is mechanically bound. It can also be caused by a short in the motor, one of the motor leads shorted to the ground, a drive card problem or a bad connection. If the alarm will reset this is most likely a more extreme bind of the turret the 111 alarm.
165 X Zero Ret Margin Too Small	This alarm will occur if the home/limit switches move or are misadjusted. This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder Z channel signal must occur between 1/8 and 7/8 revolution of where the home switch re leases. This will not turn the servos off but will stop the zero return operation.
166 B Zero Ret Margin Too Small	Same as 165.
167 Z Zero Ret Margin Too Small	Same as 165.
168 A Zero Ret Margin Too Small	Not normally enabled for A-axis.
169 Spindle Direction Fault	Problem with rigid tapping hardware. The spindle started turning in the wrong direction.
170 Phase Loss L1-L2	Problem with incoming line voltage between legs L1 and L2. This usually indicates that there was a transient loss of input power to the machine.
171 Phase Loss L2-L3	Problem with incoming line voltage between legs L2 and L3.
172 Phase Loss L3-L1	Problem with incoming line voltage between legs L3 and L1.
173 Spindle Ref Signal Missing	The Z channel pulse from the spindle encoder is missing for thread synchronization.
174 Tool Load Exceeded	The tool load monitor option is selected and the maximum load for a tool was exceeded in a feed. This alarm can only occur if the tool load monitor function is installed in your machine.
175 Ground Fault Detected	A ground fault condition was detected in the 115V AC supply. This can be caused by a short to ground in any of the servo motors, the tool change motors, the fans, or the oil pump.

176 Over heat Shutdown	An overheat condition persisted for 4.5 minutes and caused an automatic shutdown.
177 Over voltage Shutdown	An overvoltage condition persisted for 4.5 minutes and caused an automatic shutdown.
178 Divide by Zero	Software Error; Call your dealer.
179 Low Pressure Spindle Coolant	Spindle coolant oil is low or low pressure condition in lines.
180 RESERVED	
181 RESERVED	
182 X Cable Fault	Cable from X-axis encoder does not have valid differential signals.
183 Spindle Cable Fault	Same as 182.
184 Z Cable Fault	Same as 182.
185 A Cable Fault	Same as 182.
186 Spindle Not Turning	Status from spindle drive indicates error.
187 RESERVED	
188 RESERVED	
189 RESERVED	
190 RESERVED	
191 RESERVED	
192 RESERVED	
193 RESERVED	
194 RESERVED	
195 RESERVED	
195 B Cable Fault	Same as 182.
197 100 Hour Unpaid Bill	
198 Spindle Stalled	Control senses that no spindle fault has occurred, the spindle is at speed, yet the spindle is not turning. Possibly the belt between the spindle drive motor and spindle has slipped or is broken.
201 Parameter CRC Error	Parameters lost maybe by low battery. Check for a low battery and low battery alarm.

202 Setting CRC Error	Settings lost maybe by low battery. Check for a low battery and low battery alarm.
203 Lead Screw CRC Error	Lead screw compensation tables lost maybe by low battery. Check for CRC Error low battery and low battery alarm.
204 Offset CRC Error	Offsets lost maybe by low battery. Check for a low battery and low battery alarm.
205 Programs CRC Error	Users program lost maybe by low battery. Check for a low battery and low battery alarm.
206 Internal Program Error	Software Error; Call your dealer.
207 Queue Advance Error	Software Error; Call your dealer.
208 Queue Allocation Error	Software Error; Call your dealer.
209 Queue Cutter Comp Error	Software Error; Call your dealer.
210 Insufficient Memory	Not enough memory to store users program. Check the space available in the LIST PROG mode and possibly delete some programs.
211 Odd Prog Block	Software Error; Call your dealer.
212 Program Integrity Error	Software Error; Call your dealer.
213 EPROM CRC Error	Electronics fault; Call your dealer.
214 No. of Programs Changed	Indicates that the number of programs disagrees with the internal variable that keeps count of the loaded programs. Call your dealer.
215 Free Memory PTR Changed	Indicates the amount of memory used by the programs counted in the system disagrees with the variable that points to free memory. Call your dealer.
216 EPROM Speed Failure	Indicates that an EPROM internal driver has weakened so that data read from that EPROM may be unreliable. Call your dealer.
240 Empty Prog or	No EOB Software Error; Call your dealer.
241 Invalid Code	RS-232 load bad. Data was stored as comment. Check the program being

	received.
242 No End	Check input file for a number with too many digits.
243 Bad Number	Data entered is not a number.
244 Missing)	Comment must end with a ") ".
245 Unknown Code	Check input line or data from RS-232. This alarm can occur while editing data into a program or loading from RS-232.
246 String Too Long	Input line is too long. The data entry line must be shortened.
247 Cursor Data Base Error	Software Error; Call your dealer.
248 Number Range Error	Number entry is out of range.
249 Prog Data Begins Odd	Software Error; Call your dealer.
250 Program Data Error	Same as 249.
251 Prog Data Struct Error	Same as 249.
252 Memory Overflow	Same as 249.
253 Program Data Error	Same as 249.
254 Program Data Error	Same as 249.
255 Program Data Error	Same as 249.
256 Program Data Error	Same as 249.
257 Program Data Error	Same as 249.
258 Invalid DPRNT Format	Macro DPRNT statement not structured properly.
302 Invalid R In G02	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	Check your geometry with the HELP page. G02 or G03
304 Invalid I, J, or K In	Check your geometry with the HELP page. Radius at start must match G02 or G03 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, or Q InCanned Cycle	I, J, K, and Q in a canned cycle must be greater than zero.
307 Subroutine	Subprogram nesting is limited to nine levels. Simplify your program. Nesting Too Deep
308 Invalid Tool Offset	A tool offset not within the range of the control was used.
309 Exceeded Max Feed Rate	Use a lower feed rate.
310 Invalid G Code	G code not defined and is not a macro call.
311 Unknown Code	Possible corruption of memory by low battery. Call your dealer.
312 Program End	End of subroutine reached before M99. Need an M99 to return from subroutine.
313 No P Code In M97,M98, or G65	Must put subprogram number in P code.
314 Subprogram or Macro Not In Memory	Check that a subroutine is in memory or that a macro is defined.
315 Invalid P Code In M97, M98 or M99	The P code must be the name of a program stored in memory without a decimal point for M98 and must be a valid N number for M99.
316 X Over Travel Range	X-axis will exceed stored stroke limits. This is a parameter in negative direction and is machine zero in the positive direction. This will only occur during the operation of a user's program.
317 B Over Travel Range	Same as 316.
318 Z Over Travel Range	Same as 316.
319 A Over Travel Range	Not normally possible with A-axis.

320 No Feed Rate Specified	Must have a valid F code for interpolation functions.
321 Auto Off Alarm	A fault turned off the servos automatically; occurs in debug mode only.
322 Sub Prog Without M99	Add an M99 code to the end of program called as a subroutine.
323 RESERVED	
324 Delay time Range Error	P code in G04 is over 1000.0 or over 9999.
325 Queue Full	Control problem; call your dealer.
326 G04 Without P Code	Put a Pn.n for seconds or a Pn for milliseconds.
327 No Loop For M	L code not used here. Remove L Code. Code Except M97, M98
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 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 offset in the spindle. Correct the Hn codes, select the right tool, or turn off Setting 15.
333 X-axis Disabled	Parameters have disabled this axis. Not normally possible in HS Series CNC Mill.
334 B-axis Disabled	same as 333.
335 Z-axis Disabled	same as 333.
336 A-axis Disabled	Parameters have disabled this axis. Must enable A-axis to program it or remove programming of A-axis. The A-axis can be disabled permanently by Parameter 43 or temporarily by Setting 30.
337 Line Referenced	Subprogram is not in memory, or P code is incorrect.

By P, not Found	
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 Begin With G02 or G03	Select cutter comp earlier.
341 Cutter Comp End With G02 or G03	Disable cutter comp later.
342 Cutter Comp Path Too Small	Geometry not possible. Check your geometry with the HELP page.
343 Display Queue Record Full	A block exists that is too long for displaying queue. Shorten title block.
344 Cutter Comp With G18 and G19	Cutter comp only allowed in XB plane (G17).
345 Diff Step Ratio On G17 Plane	Parameters 5 and 19 must be same value.
346 Diff Step Ratio On G18 Plane	Parameters 5 and 33 must be same value.
347 Diff Step Ratio On G19 Plane	Parameters 19 and 33 must be same value.
348 Illegal Spiral Motion	Linear axis path is too long. For helical motions, the linear path must not be more than the length of the circular component.
349 Prog Stop W/O Cancel Cutter Comp	Information message only. Fix or Ignore.
350 Cutter Comp Look Ahead Error	There are too many non-movement blocks between motions when cutter comp is being used. Remove some intervening blocks.
351 Buffered Block Range Error	Software error. Call your dealer.
352 Aux Axis Power Off	Aux C, U, V, or W axis indicate servo off. Check auxiliary axes. Status from control was OFF.

353 Aux Axis No Home	A ZERO RET has not been done yet on the aux axes. Check auxiliary axes. Status from control was LOSS.
354 Aux Axis	Aux axes not responding. Check auxiliary axes and RS-232 connections. Disconnected
355 Aux Axis Position	Mismatch between HMC and aux axes position. Check aux axes and Mismatch 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 G12or G13	Check your geometry with the HELP page.
360 RESERVED	
361 Gear Changer Disabled	Gear changer disabled by bit in Parameter 57.
362 Tool Usage Alarm	Tool life limit was reached. To continue, reset the usage count in the Current Commands display and press RESET.
363 Coolant Locked Off	Override is off and program tried to turn on coolant.
364 No Circ Interp Aux Axis	Only rapid or feed is allowed with aux axes.
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	Use a smaller tool for cut.
370 RESERVED	

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 XBZA 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, B, A, or G49 not allowed in G37	G37 may only specify Z-axis and must have tool offset defined.
381 G43 or G44 not allowed in G36 or G136	Auto work offset probing must be done without tool offset.
382 D code required in G35	A Dnn code is required in G35 in order to store the measured tool diameter.
383 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	G10 was used to changes offsets but L, P, or R code is missing or Code In G10invalid.

386 Invalid Address Format	An address A¼Z was used improperly.
387 Cutter Comp Not Allowed With G103	If block buffering has been limited, Cutter comp cannot be used.
388 Cutter Comp Not Allowed With G10	Coordinates cannot be altered while cutter comp is active. Move G10 outside of cutter comp enablement.
389 G17, G18, G19 Illegal in G68	Planes of rotation cannot be changed while rotation is enabled.
390 No Spindle Speed	S code has not been encountered. Add an S code.
391 Feature Not Enabled	An attempt was made to use a control feature that has not yet been enabled by a parameter bit. Set the appropriate parameter bit to 1.
392 B Axis Disabled.	Same as 336.
393 Invalid Motion In	Center line Tapping can only be in the Z minus G74 or G84 direction. Make sure that the distance from the initial position to the commanded Z depth is in the minus direction.
394 Canned Cycle Using P & Q Is Active	A canned cycle using P&Q is already executing. A canned cycle can not be execute by another PQ canned cycle.
395 Invalid Code In Canned Cycle	Any canned cycle requiring a PQ path sequence may not have an M code in the same block. That is G70, G71, G72, and G73.
396 Conflicting Axes	An Incremental and Absolute command can not be used in the same block of code. For example X and U cannot be used in the same block.
397 Invalid D code	In the context that the D code was used it had an invalid value. Was it positive?
398 RESERVED	
399 Invalid U Code	In the context that the U code was used it had an invalid value. Was it positive?
403 RS-232 Too Many Progs	Cannot have more than 100 programs in memory.

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

419 Invalid Function or DNC	A code found on input of a DNC program could not be interpreted.
420 Program Number Mismatch	The O code in the program being loaded did not match the O code entered at the keyboard. Warning only.
501 Too Many Assignments In One Block	Only one assignment "=" is allowed per block. Divide block in error into multiple blocks.
502 [Or = Not First TermIn Expressn	An expression element was found where it was not preceded by "[" or "=", that start expressions.
503 Illegal Macro Variable Reference	A macro variable number was used that is not supported by this control, use another variable.
504 Unbalanced Paren. In Expression	Unbalanced brackets, "[" or "]", were found in an expression. Add or delete a bracket.
505 Value Stack Error	The macro expression value stack pointer is in error. Call your dealer.
506 Operand Stack Error	The macro expression operand stack pointer is in error. Call your dealer.
507 Too Few Operands On Stack	An expression operand found too few operands on the expression stack. Call your dealer.
508 Division By Zero	A division in a macro expression attempted to divide by zero. Re-configure expression.
509 Illegal Macro Variable Use	See Programming section (Macro Variables) for valid variables.
510 Illegal Function or Operator Use	See Programming section 14.9 (Macro Statements) for valid operators.
511 Unbalanced Right	Number of right brackets not equal to number of left brackets Brackets
512 Illegal Assignment Use	Writing to read-only macro variable.
513 Var. Ref. Not Allowed With N Or O	Alphabetic addresses N and O cannot be combined with macro variables. Do not declare N#1, etc.
514 Illegal Macro	A macro variable was used incorrectly with an alpha address. Same as

Address	Reference 513.
515 Too Many Conditionals In a Block	Only one conditional expression is allowed in any WHILE or IF-THEN block.
516 Illegal Conditional	A conditional expression was found outside of an IF-THEN, WHILE, Or No Then or M99 block.
517 Exprsn. Not Allowed With N Or O	A macro expression cannot be concatenated to N or O. Do not declare O[#1], etc.
518 Illegal Macro Exprsn	An alpha address with expression, such as A[#1+#2], evaluated reference incorrectly. Same as 517.
519 Term Expected	In the evaluation of a macro expression an operand was expected and not found.
520 Operator Expected	In the evaluation of a macro expression an operator was expected and not found.
521 Illegal Functional	An illegal value was passed to a function, such as SQRT[or ASIN[. Parameter
522 Illegal Assignment	A variable was referenced for writing. The variable referenced is read Var Or Value only.
523 Conditional Reqd Prior To THEN	THEN was encountered and a conditional statement was not processed in the same block.
525 Var. Ref. Illegal During Movement	Variable cannot be read during axis movement.
524 END Found With No Matching DO	An END was encountered without encountering a previous matching DO. DO-END numbers must agree.
526 Command Found On DO/END Line	A G-code command was found on a WHILE-DO or END macro block. Move the G-code to a separate block.
527 = Not Expected Or THEN Required	Only one Assignment is allowed per block, or a THEN statement is missing.
528 Parameter	On G65 lines all parameters must follow the G65 G-code. Place

Precedes G65	parameters after G65.
529 Illegal G65 Parameter	The addresses G, L, N, O, and P cannot be used to pass parameters.
530 Too Many I, J, or K's In G65	Only 10 occurrences of I, J, or K can occur in a G65 subroutine call. Reduce the I, J, or K count.
531 Macro Nesting Too Deep	Only four levels of macro nesting can occur. Reduce the amount of nested G65 calls.
532 Unknown Code In Pocket Pattern	Macro syntax is not allowed in a pocket pattern subroutine.
533 Macro Variable Undefined	A conditional expression evaluated to an UNDEFINED value, i.e. #0. Return True or False.
534 DO Or END Already In Use	Multiple use of a DO that has not been closed by and END in the same subroutine. Use another DO number.
535 Illegal DPRNT	A DPRNT statement has been formatted improperly, or DPRNT does Statement not begin block.
536 Command Found On DPRNT Line	A G-code was included on a DPRNT block. Make two separate blocks.
537 RS-232 Abort	While a DPRNT statement was executing, the RS-232 communications On DPRNT failed.
538 Matching END Not Found	A WHILE-DO statement does not contain a matching END statement. Add the proper END statement.
539 Illegal GOTO	Expression after "GOTO" not valid.
600 Code Not Expected	During program interpretation, the control In This Context found code out of context. This may indicate any invalid address code found in a PQ sequence. It may also indicate faulty memory hardware or lost memory. Look at the highlighted line for improper G-code.

601 Maximum PQ Blocks	The maximum number of blocks making up a PQ Exceeded sequence was exceeded. Currently no more than 65535 blocks can be between P and Q.
602 Non Monotonous PQ	The Path defined by PQ was not monotonic in Blocks in X the X axis. A monotonic path is one which does not change direction starting from the first motion block.
603 Non Monotonous PQ	The Path defined by PQ was not monotonic in Blocks in Z the Z axis. A monotonic path is one which does not change direction starting from the first motion block.
604 RESERVED	
605 Invalid Tool Nose	An invalid Angle for the cutting tool tip Angle was specified. This will occur in a G76 block if the A address has a value that is not from 0 to 120 degrees.
606 Invalid A Code	An invalid Angle for linear interpolation was specified. This will occur in a G01 block if the A address was congruent to 0 degrees or 180 degrees.
607 Invalid W Code	In the context that the W code was used it had an invalid value. Was it positive?

MECHANICAL SERVICE

1. TURRET

1.1 LATHE TURRET CRASH RECOVERY PROCEDURE

The following procedure describes how to clear the turret when a tool change is attempted with the quick change wrench still in the turret. In the future, this procedure will be replaced with a front panel, single-key sequence.

1. Move to Parameter 43 on the Parameters Display. This is the tool turret motor parameters. Change INVIS AXIS from "1" to "0" (zero).

2. Move to the Alarm Display and type "DEBUG" and then press the WRITE key. Parameter Lock, Setting 7, must be OFF. Verify that the debug line is displayed.

3. Press the MDI key. Enter "M43" into MDI and press CYCLE START. This will unlock the turret by pushing it in the Z-direction.

4. Press the HANDLE JOG key, and then the POSIT key to get into the Position Display and Jog mode. The A axis should be displayed below the X and Z axes.

5. Press the BLANK key, which is just left of the X+ key and above the Z- key. A message should indicate that the A axis is being jogged.

6. Turn the JOG handle until the obstruction is cleared and the turret rotates freely. If an OVERCURRENT alarm is received, reset the control and turn the JOG handle in the opposite direction.

7. Move to Parameter 43 on the Parameter Display and change INVIS AXIS back to "1".

8. Turn the control power off and then back on. The turret can now be positioned by pressing either POWER UP or AUTO ALL AXES.

1.2 TURRET MOTOR COUPLING ADJUSTMENT

NOTE: The turret must be at tool #1 to perform this procedure.

1. Remove the sliding tool changer cover.

2. Go to Setting 7 and turn off the Parameter Lock.

3. Go to Parameter 43 and change “Z CH ONLY” to “1”.

4. Loosen the turret motor coupling clamp screw closest to the motor.

5. Press the ZERO RETURN button, then the A button, and the ZERO SINGLE AXIS button. This will cause the motor to go to the first encoder Z pulse.

6. Move the turret motor coupling back and forth to find the center of it’s backlash, and tighten the clamp screw as close to the center of the backlash as possible.

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

7. Change Parameter 43, “Z CH ONLY” back to “0” (zero).

8. Press the ZERO RETURN button, A button, and ZERO SINGLE AXIS button. This will home the turret at tool #1.

9. Press the EMERGENCY STOP button and turn the turret motorcoupling back and forth to verify that the backlash is centered.

10. Go to Setting 7 and turn on the Parameter Lock.

11. Replace the sliding tool changer cover.

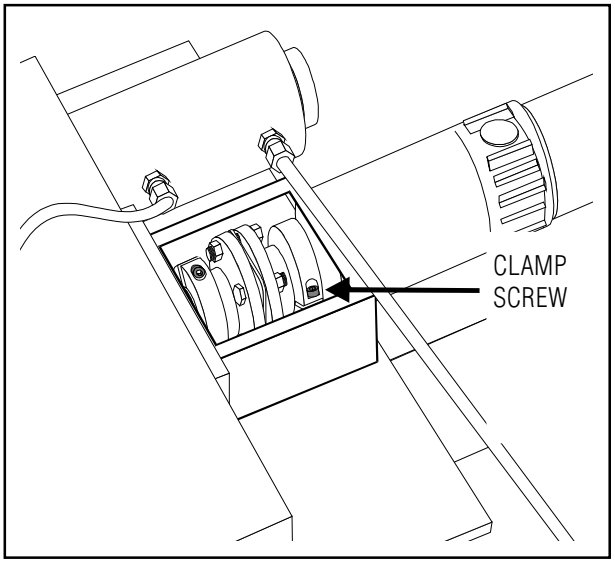


Fig 1-1 Turret motor adjustment.

1.3 TURRET ALIGNMENT VERIFICATION

TOOLS REQUIRED:
A BAR APPROXIMATELY 12"x 4"x 1" (GROUND TO WITHIN 0.0001" ON THE 1" WIDTH SIDE)
MAGNETIC INDICATOR BASE
DIAL INDICATOR (0.0005" OR LESS RESOLUTION)

1. Remove all tool holders and fittings from the turret.

2. Clean the turret pockets and tool holders.

3. Place the turret at tool #1.

4. Place a clean and undamaged tool holder loosely (do not thread nuts) in pocket #2, and another in pocket #5.

5. Place the 12" x 4" x 1" bar across the small diameter of the 2 tool holders (ground side down).

6. Jog the X axis to the center of it's travel.

7. Place the magnetic indicator base on the Z axis way cover. Place the indicator at the center of the bottom edge of the bar.

8. Jog the X axis so the indicator is at one end of the bar, and zero the indicator.

9. Jog the X axis to the other end of the bar, and check your reading (tolerance is 0.0010" TIR).
Note: If the the reading is greater than the tolerance specified see sections 1.4-1.6.

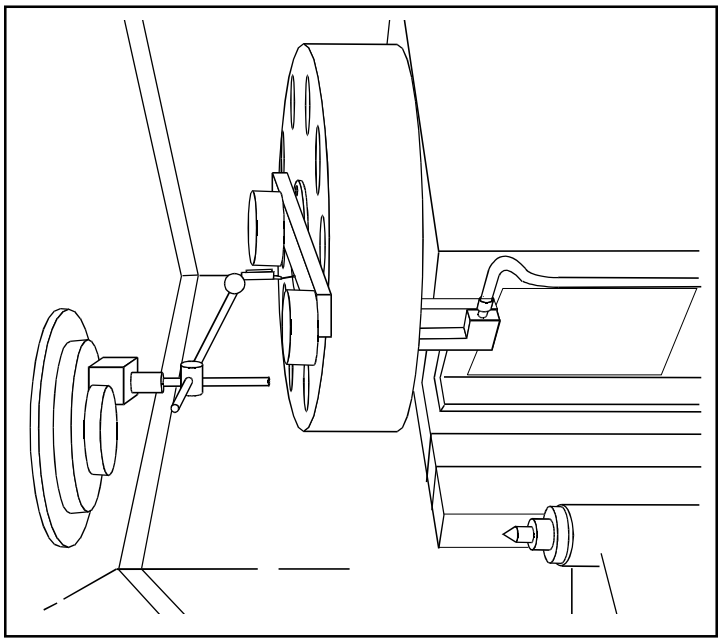


Fig 1-2 Turret alignment

1.4 TURRET ALIGNMENT OF THE OUTER COUPLING

1. Change Parameter 76 from “500” to “50,000” and disconnect the main air line.

2. Remove the sliding tool changer cover and the turret assembly cover.

3. Loosen, and then re-tighten by hand the 10 turret coupling bolts located on the front of the turret.

4. Put a 3/4" wrench on the bolt at the end of the air cylinder. Pull forward until the turret starts to unclamp, then push it back in until the turret no longer moves in the clamped position.

NOTE: This is to relieve some of the pressure on the coupling but not to separate the 2 couplings. If the shaft will not move back after pulled forward , reconnect the main air line and then attempt to move it back.

5. Tap on the appropriate tool holder (#2 or #5) to align the bar in the X axis plane.

6. Retighten the turret bolts, jog the X axis back to center, remove the bar, and reconnect the main air line.

7. Press the ZERO RETURN button, then the A button and the ZERO SINGLE AXIS button. The turret will then home and reclamp at tool #1.

8. Go to Step 1 of section 1.3 Turret Alignment Verification and verify your readings. When the readings are within tolerance, change Parameter 76 from “50,000” back to “500” and reinstall all covers.

NOTE: If turret cannot be adjusted enough to be within tolerance, it may be necessary to adjust the inner coupling to center. If it will not adjust at all, either the couplings have been separated too much or there is still too much tension on the couplings. Refer to sections 1.5 or 1.6.

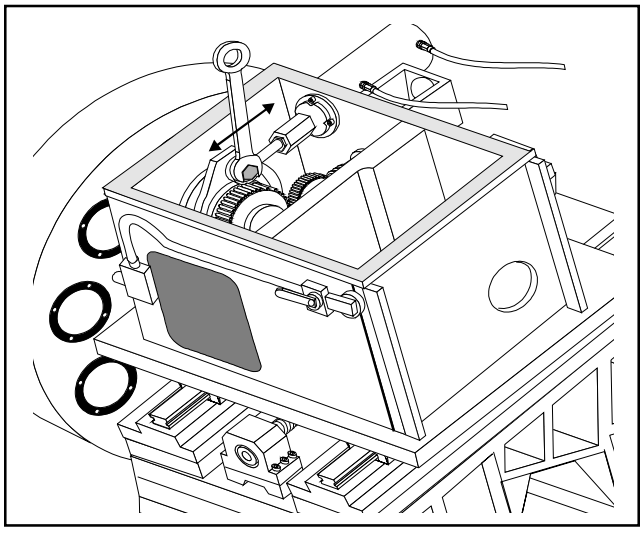


Fig 1-3 Turret clamp / unclamp position.

1.5 CENTERING INNER TURRET COUPLING. (WITHOUT BRASS PLUG)

NOTE: This procedure is only to be performed if there is not enough adjustment to perform an outer coupling alignment.

NOTE: If the turret has a 1/4" brass plug, proceed to section 1.6.

1. Pull the turret air cylinder all the way forward (unclamp) and place something snugly between the back of the turret shaft and the casting to keep the turret shaft from shifting.

2. Remove the 4 bolts from the center turret shaft cover.

3. To gain access to the rear coupling, either remove the turret or install a turret shaft extension and slide the turret onto it. (Be careful not to loosen the key way, it will be facing down at this point.)

4. Loosen the 10 bolts on the inner coupling and center the coupling to the bolt holes. Retighten them to 25FT LBS.

5. Install the thrust bearing and both thrust bearing washers to the shoulder of the turret shaft.

6. Go to Parameter 43 and change the INVIS AXIS to zero. Then go to the alarms page, type “DEBUG” and press the WRITE button. Push the HANDLE JOG button. Press the key in the lower right corner of the jog keys (it’s unmarked and directly below the “Z+” jog key). Then jog the A axis so the key way slot is on top. NOTE: This can only be done while the turret is unclamped.

7. Reinstall the turret and turret shaft cover. Make sure that the turret makes it over the O-ring before the bolts are tightened completely. If the bolts tighten up and the O-ring is still visible, one of the thrust washers is not on the shoulder of the turret shaft.

8. Return to Step 1 of section 1.3 Turret Alignment Verification and verify your readings.

9. When the turret alignment is complete, go to the alarms page and type “DEBUG” and press the WRITE button. Change Parameter 43, “INVIS AXIS” to 1 and Parameter 76 to 500.

1.6 CENTERING THE INNER TURRET COUPLING (IF EQUIPPED WITH 1/4" BRASS PLUG)

NOTE: This procedure is only to be performed if there is not enough adjustment to perform an outer coupling alignment.

NOTE: This procedure is to be performed if the turret is equipped with a 1/4" brass plug.

1. Remove the 1/4" brass plug to gain access to the rear coupling.

2. Pull the turret air cylinder all the way forward (unclamp) with a wrench. .

3. Go to Parameter 43 and change the INVIS AXIS to zero. Then go to the alarms page, type “DEBUG” and press the WRITE button. Push the HANDLE JOG button. Press the key in the lower right corner of the jog keys (it’s unmarked and directly below the “Z+” jog key). NOTE: This can only be done while the turret is unclamped.

4. Loosen, then lightly retighten all ten inner coupling bolts (jogging the A axis for access) and center the coupling to the bolt holes.

5. Clamp the couplings by pushing the turret air cylinder back to it’s original position.

6. Return to Step 1 of section 1.3 Turret Alignment Verification and verify your readings.

7. When coupling is in place, unlock the turret, as in Step 2.

8. Tighten all ten inner coupling bolts (jogging the A axis for access) and torque them to 25 ft-lbs.

9. Replace the 1/4" brass plug.

10. Relock the turret.

11. Repeat step 6.

12. When the turret alignment is complete, go to the alarms page and type “DEBUG” and press the WRITE button. Change Parameter 43, “INVIS AXIS” to 1 and Parameter 76 to 500.

2. SPINDLE

2.1 REMOVAL

NOTE: POWER OFF THE MACHINE BEFORE PERFORMING THE FOLLOWING PROCEDURE.

1. Detach the drain box from the left end panel by removing the four connecting bolts.

2. Remove the left end panel by detaching the 18 connecting bolts.

3. Remove the drain box from the left front panel by removing the five connecting bolts.

4. Remove the drawtube assembly .

5. Disconnect the main air line from lube air panel

6. Disconnect the air line from the 1/4" fitting on the drawtube cylinder.

7. Remove the four drawtube cylinder mounting bolts, and the cylinder spacers. Remove the drawtube cylinder from the Outside Diameter (OD) spring housing.

8. Remove the OD spring housing.

9. Remove the belleville washers.

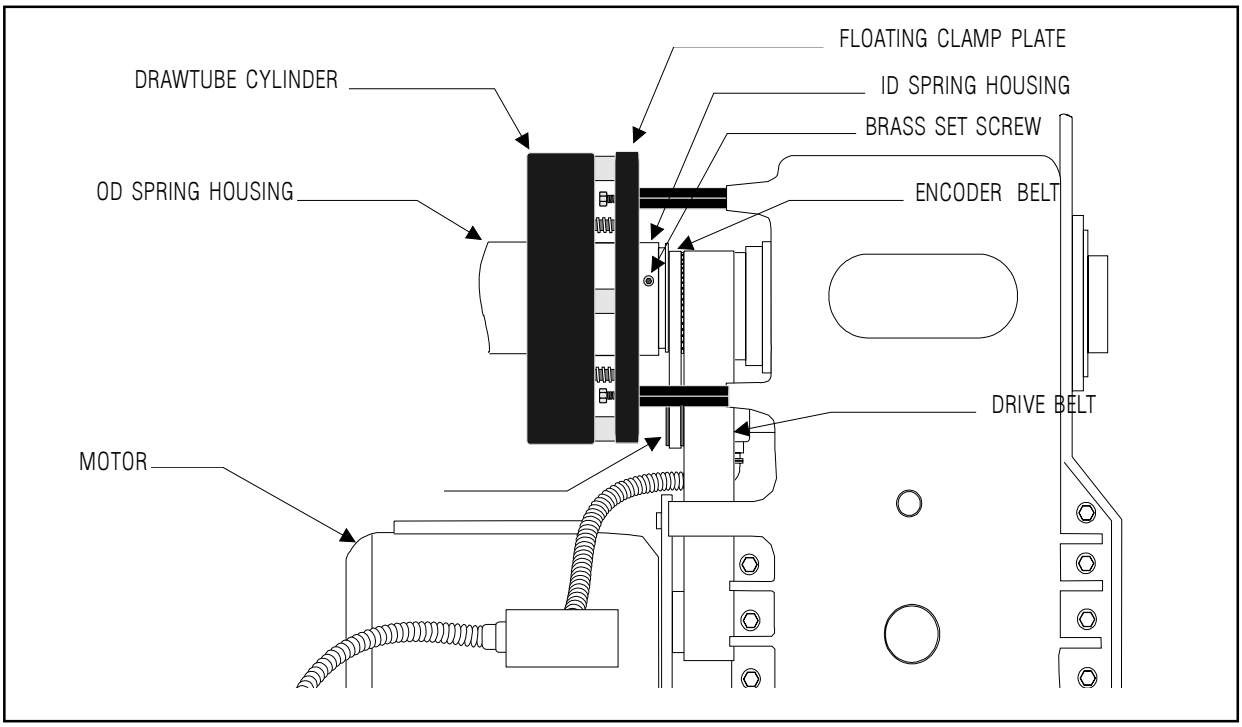


Fig 2-1 Spindle Housing (side view)

10. Remove the brass set screw from the from the ID spring housing on the turret side of the floating clamp plate.

11. Unscrew the ID spring housing. To break it free, it may be necessary to place a punch in one of the holes on the side of the spring housing and tap.

NOTE: It will be necessary to keep the spindle from turning to unscrew the spring housing.

11. Remove the four floating clamp plate mounting bolts, and then the floating clamp plate.

12. Loosen the two spindle encoder mounting bolts. Slide the encoder up so the encoder belt can be removed from it's pulleys. Remove the encoder.

13. Loosen the four motor mounting bolts so the motor can be moved, but do not remove them.

14. Remove the spindle drive belt.

15. Disconnect the two 1/4" nylon tubes from the oil mist swivel fittings on the rear of the spindle housing.

16. Loosen the hex nuts on the oil mist nozzles and remove.

17. Remove the six retainer ring mounting bolts, then the retainer ring.

18. Carefully remove the spindle.

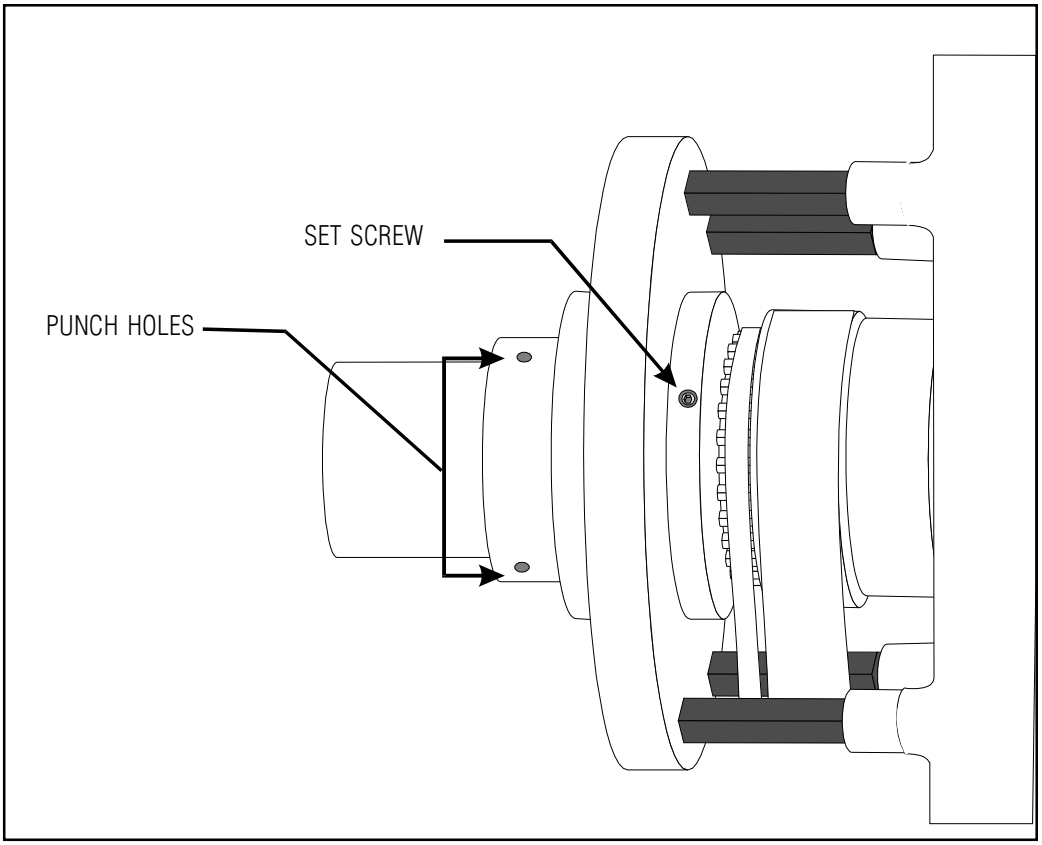


Fig 2-2 Set screw and punch locations

2.2 INSTALLATION

1. Place the draw tube in the spindle to assist in positioning it.

2. Clean and oil the bearing bore of the spindle housing.

3. Ensure the two oil mist holes in the spindle line up with those in the spindle housing.

4. Carefully place the spindle into the spindle housing, pulley end first. The spindle is in place when it cannot be pushed in any further by hand. If the spindle fit is too tight, remove and reinstall.

5. Remove the drawtube.

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

8. Insert the six retainer ring mounting bolts and torque to 25 ft-lbs. **NOTE:** The bolts should be torqued in a star pattern. **CAUTION:** Do not use Loctite on these bolts or else serious damage could result.

9. Ensure that the spindle can spin freely and the spindle and housing oil mist holes are aligned. If not, remove the retainer ring and spindle and reinstall.

10. Screw the oil mist nozzles in by hand, ensuring that the holes on the nozzles and those in the spindle housing are aligned correctly.

11. Tighten the hex nut on the nozzles, ensuring the nozzles do not spin. After tightening the nuts, verify the nozzle oil mist holes are still positioned correctly.

12. Attach the two 1/4" nylon tubes onto the swivel fittings.

13. Install the drive belt onto the spindle and motor pulleys.

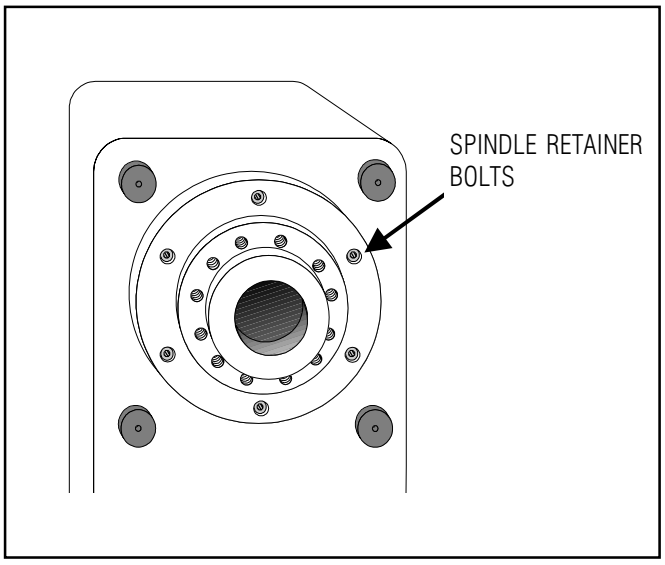


Fig 2-3 Spindle retaining bolts

15. Remove all slack in the belt, then tighten the four motor mounting bolts.
NOTE: The motor must be forced downward to get the proper tension on the belt (gravity alone is not sufficient).

CAUTION: The belt may slip during operation if not properly tightened.

16. Place the 3/8" timing belt on the spindle pulley, with the other end on the encoder pulley.

17. Mount the encoder onto the spindle housing below the spindle shaft with two mounting bolts. Verify the encoder spins freely.

18. Set the floating clamp plate on the pulley end of the spindle with the counterbore holes facing the motor.

19. Place a blue spring onto each of the four floating clamp plate mounting bolts. Insert them through the holes in the floating clamp plate and into the standoff clamp cylinders.

20. Screw the Inside Diameter (ID) spring housing onto the end of the spindle with it's shaft facing away from the turret. Tighten the housing slightly more by placing a punch in a hole on the side of the ID spring housing, and tapping.

NOTE: While screwing the ID spring housing on, it will be necessary to keep the spindle from turning.

21. The space between the ID spring housing and the floating clamp plate should be {0.010-0.030} inches.

22. Set the magnetic base on the floating clamp plate with the indicator touching the top of the ID spring housing shaft.

23. Spin the ID spring housing shaft to ensure the indicator never reads greater than 0.003 inches. Refer to illustration 2-4.

24. Insert the brass set screw into the ID spring housing on the turret side of the floating clamp plate.

25. Grease the shaft of the ID spring housing.

26. Grease all sides of the 14 belleville washers.

27. Place the belleville washers on the ID spring housing shaft with the first one concave towards the housing and with them alternating, so that each one is facing in an opposite direction.

28. Slide the Outside Diameter (OD) spring housing over the belleville washers.

29. Place the compression springs onto the 4 studs of the draw-tube cylinder.

30. Place the drawtube cylinder on the OD spring housing with the springs facing the housing. Ensure the 1/4" air nozzle is at the bottom of the drawtube cylinder.

31. Insert the four drawtube cylinder mounting bolts through the holes in the cylinder, through the cylinder spacers, and into the floating clamp plate.

CAUTION: These bolts must be very tight, or serious damage could occur.

32. Connect the 1/4" air line to the fitting on the drawtube cylinder.

33. Reconnect the main air line in the rear.

34. Step on the chuck actuator foot pedal. When the assembly moves forward, a groove on the ID spring housing will become visible. Place the retainer ring in this groove.

35. Step on the foot pedal again to ensure that the spindle assembly moves smoothly.

36. Secure the drain box to the left front panel with the five mounting bolts.

37. Replace the left end panel with the 18 mounting bolts.

38. Secure the drain box to the left end panel with four bolts.

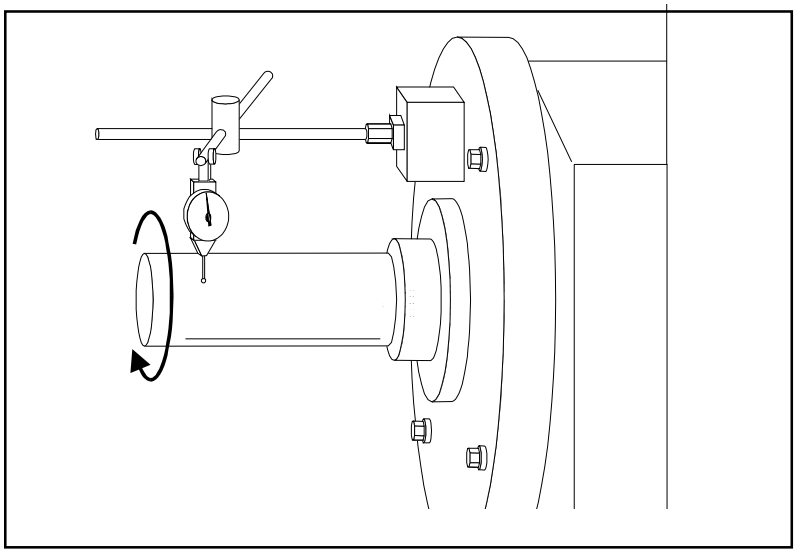


Fig 2-4 Indicating ID Spring housing shaft

2.3 SPINDLE ALIGNMENT

TOOLS NEEDED:
Three magnetic base indicators
250 ft-lb torque wrench
spindle head alignment shaft

1. Remove the door.

2. Loosen the 18 left front panel mounting bolts, then remove the panel.

3. Attach the alignment shaft to the spindle with 3 hex bolts.

4. Set up a magnetic base indicator, with the base on the turret face and the indicator on the side of the shaft closest to the operator, at the spindle end of the shaft.

5. Jog the turret until the tangent to the X-axis is found on the shaft.

6. Spin the spindle and verify that the indicator reads zero for an entire revolution.

7. Jog the indicator to the turret end of the shaft and repeat Step 6. Read the maximum indication at this end of the shaft.

8. Set the indicator for one half of this deviation, and place it at the turret end of the shaft.

9. Loosen (break free) the eight spindle mounting bolts.
NOTE: The spindle adjusting bolts can not be moved until the mounting bolts are loosened.

10. Adjust the spindle adjusting bolts until the indicator reads zero NTE 0.0004 / 10". Turn the adjusting bolt(s) to move the corresponding side of the spindle up or down.

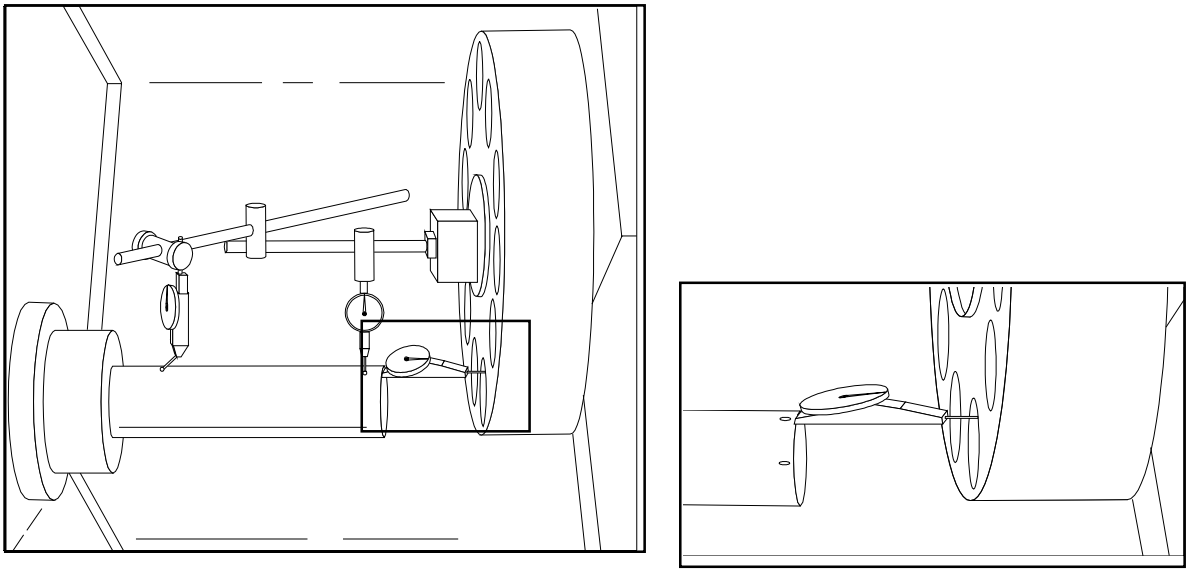


Fig 2-5 Spindle Alignment (Indicator placement)

11. Mount the indicator onto the alignment shaft by placing its mounting pin in the hole at the end of the shaft.

12. Place the indicator just barely inside pocket #1. Rotate the turret so the indicator moves to the exact opposite side of the pocket. If the indicator does not read zero at either side, jog the X-axis until it does.

13. When these two readings equal zero, check the top and bottom of the pocket (tolerance within 0.001).

14. If these readings are within tolerance, the spindle does not need adjustment. Go to Step 20.

15. If these readings are not within tolerance, the spindle position must be adjusted.

16. Set up two more magnetic base indicators on the turret, with one indicator on each end of the alignment shaft (on the top of the shaft).

17. Turn the adjusting bolts located at the bottom of the spindle housing to adjust the center line of the spindle to the Z-axis. While doing so, ensure the indicators to not show any change in the position of the spindle shaft.

18. Once the readings for pocket #1 are all within tolerance, torque the eight spindle mounting bolts to 250 ft-lbs carefully so as not to change the spindle's position. Tighten the bolts at approximately the same rate by tightening those opposite each other.

19. Screw the jam nuts up to the spindle housing until tight.

20. Write down the "Machine X Coordinate" from the control panel, to use as a center point if the test has to be reperformed.

21. Repeat Steps 4-7 to ensure that the shaft has remained horizontal. If the shaft has moved, return to Step 11 and recheck the pocket position.

22. Test the other pockets in the same way as pocket #1 (Step 11). The tolerances for these are 0.003 inches. NOTE: Inside the pockets, there may be a slight bump, made when the pins near the pockets were machined.

23. Replace the drain box and left front panel.

24. Re-install the door.

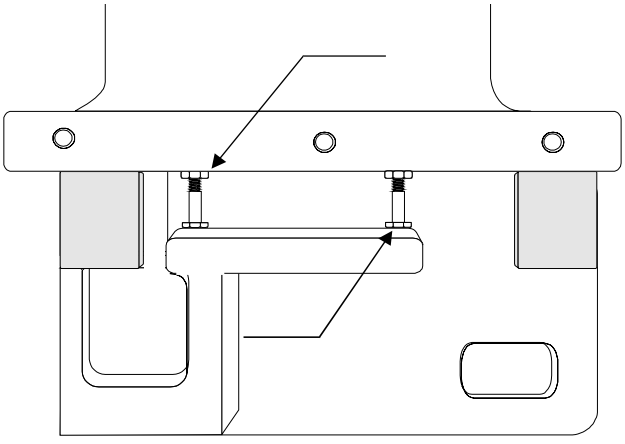


Fig 2-6 Adjutment bolts for spindle alignment.

3. DOOR

3.1 REMOVAL

Note: This procedure is for doors on HL-1/2 (S/N 60013 or later)

1. ZERO RETURN all axes.
2. POWER OFF machine.
3. Slide coolant tank out from under machine.
4. Remove the (11) screws to the lower front panel.
5. Remove door splash guard.
6. Remove door switch trip bracket.
7. Remove the (17) screws to the top front panel.
8. Remove the door rollers. The door must be closed in order to access the rollers.
9. Brace the control arm in order to remove any load from the top front panel.
10. Slide the top front panel forward approx. 1-1/2".
11. Remove the rollers, springs and hardware from the door.
12. Slide the door towards the turret housing, working the left end past the door seal channel.
13. Remove the door from the machine.

3.2 INSTALLATION

14. Install the rollers, springs and hardware to door.

15. Using 18GA. wire or equivalent, stretch the springs so all the rollers are aligned. Tie the wire in order to hold the springs in place during assembly.

Note: Tighten the top roller bolts, but leave the bottom bolts loose.

16. Install door onto bottom rail, then lift the door to engage top rail.

17. Slide the top front panel back and and reinstall screws.

18. Cut the wire supports.

19. Tighten bottom roller bolts.

20. Reinstall the panels, brackets and splash guard.

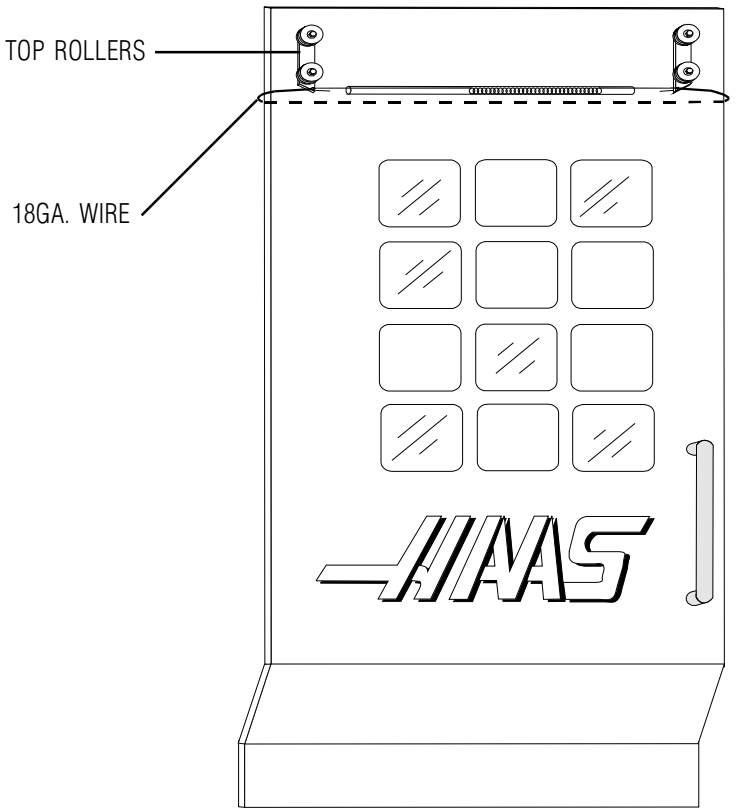
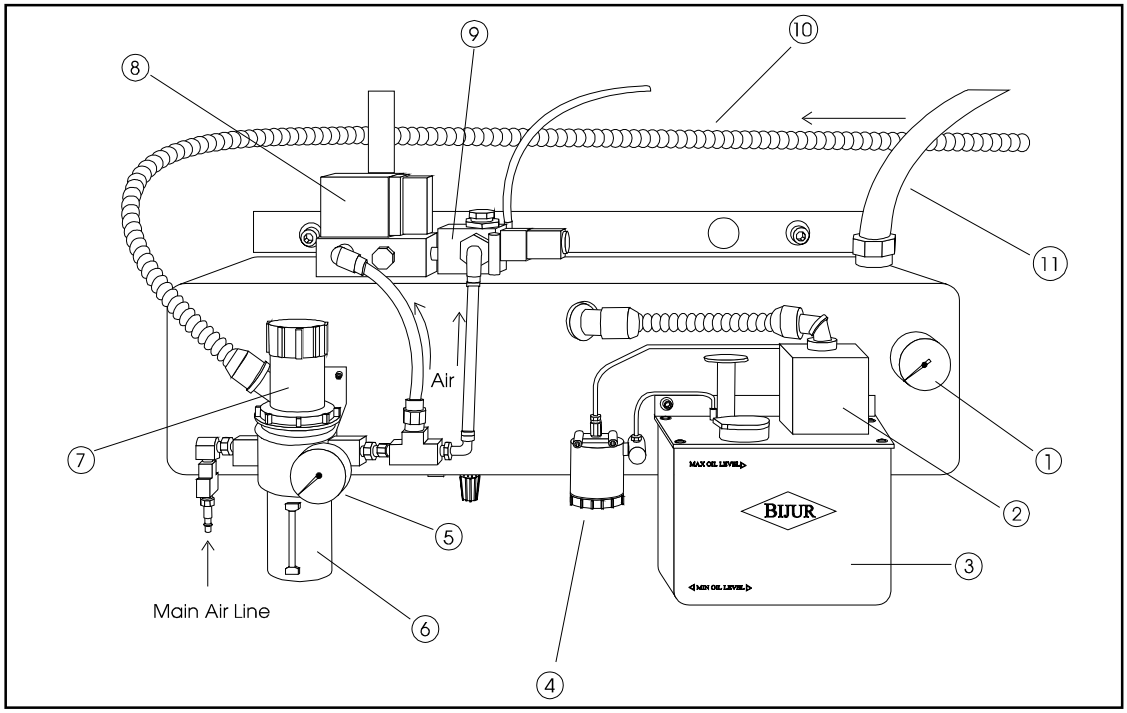


Fig 4-1 Roller preparation for installation

4. LUBE AIR PANEL



Lube Air Panel (FRONT)

The following is a list of the Lube Air Panel Assembly components, each with a description of its specific function.

1. **Oil Pressure Gauge** - Indicates the pressure (in psi) at which the oil is pumped from the reservoir.

2. **Oil Pump** - Pumps the oil from the reservoir to various parts of the lathe. Every 45 minutes the pump cycles and pumps a certain amount of oil (at approximately 15 psi).

3. **Oil Reservoir** - Stores the oil (Vactra #2) that is used for lubrication in the linear guides and lead screws. Oil is also mixed with air and sent to the spindle bearing for lubrication and cooling.

4. **Oil Filter** - Filters the oil from the reservoir before it is pumped to the necessary areas.

5. **Air Pressure Gauge** - Indicates the pressure (in psi) at which the air is being regulated.

6. **Air Filter** - Filters the air before it is sent to the solenoid valves.

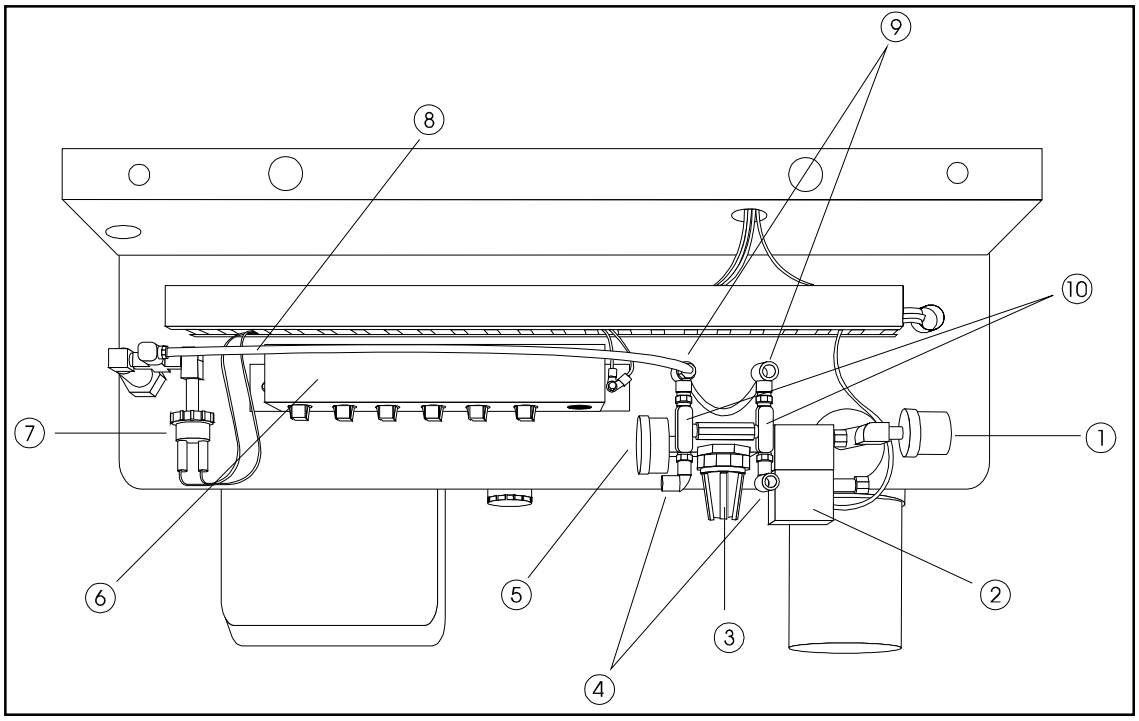
7. **Air Pressure Regulator** - Maintains the air supplied from the outside source (via the main air line) at a constant, desired pressure (approximately 85-90 psi).

8. **Air Solenoid Assembly** - 4-way 2-position valve that controls the air to the turret air cylinder.

9. **Air Solenoid Assembly**- 3-way 2-position valve that controls the air to the drawtube air cylinder.

10. **Power Cable** - Supplies power to the Lube Air Panel from the main control box.

11. **Power Cable** - Supplies power to the chuck actuator foot pedal.



Lathe - Lube Air Panel (Rear)

The following is a list of the Lube Air Panel Assembly components on the rear of the panel, each with a description of it's specific function.

1. **Air Pressure Switch** - Monitors the air supply pressure, and sends a signal to the control panel to "alarm out", or stop, the machine when the air pressure falls below 70 psi.

2. **Solenoid Valve** - Opens when the spindle is turning to permit air to be sent to the spindle bearings.

3. **Air Regulator** - Maintains the correct air pressure (15 psi) being sent to the spindle bearings.

4. **Oil Mist Ports** - Connect to nylon tubing that carries the oil-air mist to the spindle bearings. One port supplies the front spindle bearing, and one supplies the rear bearing.

5. **Air Pressure Gauge** - Indicates the pressure of the air being mixed with oil and supplied to the spindle bearings.

6. **Connector Plate** - Contains all of the connectors for the Lube Air Panel.

7. **Pressure Switch** - Monitors the oil supply pressure, and sends a signalto the control panel to stop the machine if the pressure drops below the minimum level for a set period of time.

8. **Oil Line** - Carries oil to the ports, where it is then sent to the lead screws, linear guides, and spindle bearings.

9. **Oil Ports** - Connect to nylon tubing that carries the oil to the lead screws and linear guides.

10. **Flowmeters** - Maintain the correct amount of oil dropping from the upper ports to the lower ports where they are mixed with air and sent to the spindle bearings.

LUBE PANEL REMOVAL

IMPORTANT! POWER OFF THE MACHINE BEFORE PERFORMING THE FOLLOWING PROCEDURE.

1. Remove the rear panel

2. Disconnect the main air line.

3. Disconnect the following switches:
   a. X and Z limit switches
   b. clamp / unclamp switches
   c. foot and door switches

4. Disconnect spindle air line.

5. Disconnect oil line at lube panel.

6. Disconnect fan wire and remove the connector from the conduit.

NOTE: All plastic ties must be cut in order to remove the lube air panel.

7. Disconnect air blast line.

8. Disconnect limit switches from lube panel.

9. Remove all conduits.

10. Remove the mounting screws located at the top of the lube panel.

NOTE: If removing HL-2 lube panel:

11. Disconnect oil line to tailstock.

12. Disconnect main oil line.

ELECTRICAL SERVICE

1. LINE VOLTAGE ADJUSTMENTS

Please read this section in its entirety before attempting to adjust the line voltage.

TOOLS REQUIRED:
3 LARGE FLAT TIP SCREWDRIVER
3 DIGITAL VOLTMETER

1.1 ADJUSTING VOLTAGE

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

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

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

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

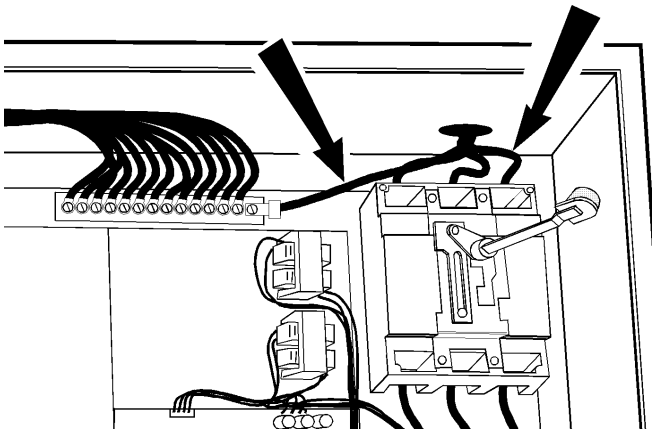


Fig. 1-1 Power lines; hookup location.

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

2. After the line voltage is connected to the machine, make sure that main circuit breaker (at top-right of rear cabinet) is off (rotate the shaft that connects to the breaker counterclockwise until it snaps into position). 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 260V or 353 and 480V, depending on which transformer is in the machine.

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.

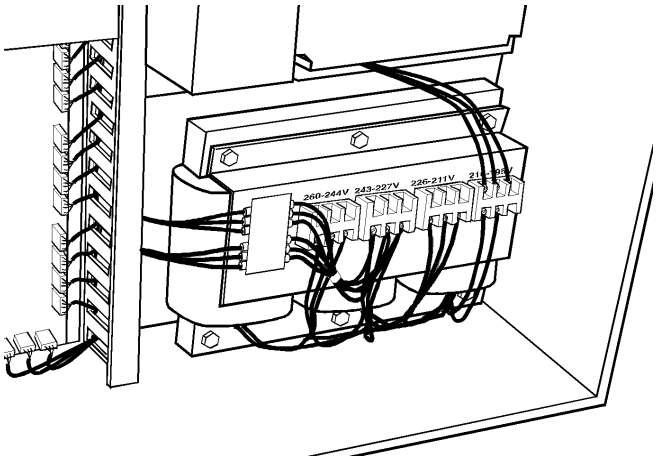


Fig. 1-2 Transformer connections.

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

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

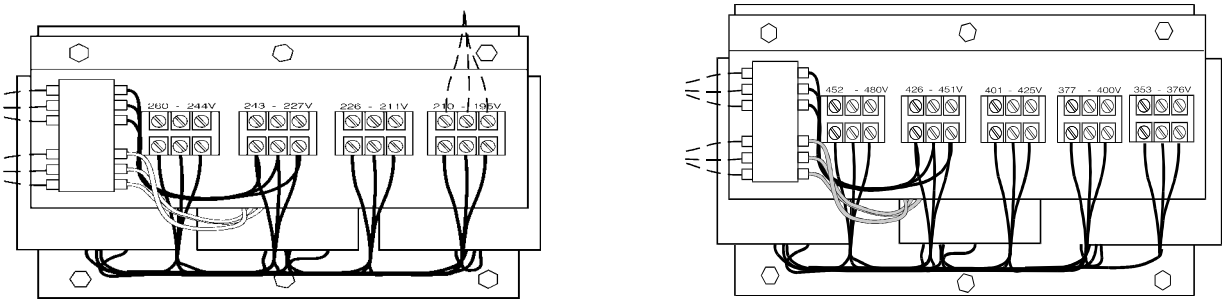


Fig. 1-3 Transformers with 195-210V (left) and 452-480V(right) range.

4. Set the main switch to on (rotate the shaft that engages the handle on the panel door clockwise until it snaps into the on position). Check for evidence of problems, such as the smell of over heating 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.

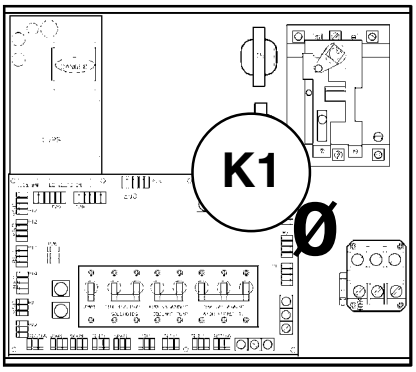


Fig. 1-4 Measure voltage here.

6. Check the DC voltage displayed in the second page of Diagnostic data on the CRT. It is labeled DC BUS. This voltage must be between 155 and 175 volts. If the voltage is outside these limits, turn off the power and recheck the incoming power and the transformer wiring (repeat steps 2 and 3). If the voltage is still incorrect, turn off the power and call the factory.

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

2. FUSE REPLACEMENT

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

TOOLS REQUIRED:
3 LARGE & SMALL FLAT TIP SCREWDRIVERS
3 ¼" HEX WRENCH
3 REPLACEMENT FUSE(S)
3 3/16" HEX WRENCH

2.1 OVERVOLTAGE FUSES

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

1. Turn machine power off.

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

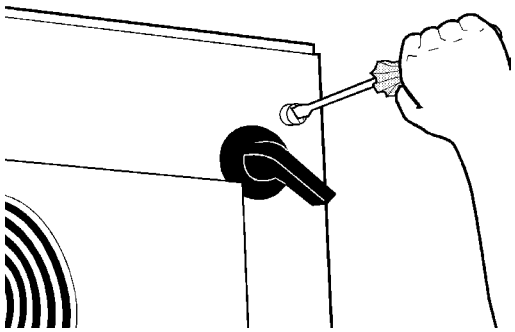


Fig. 2-1 Unscrew the three screws to open the cabinet door.

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

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

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!

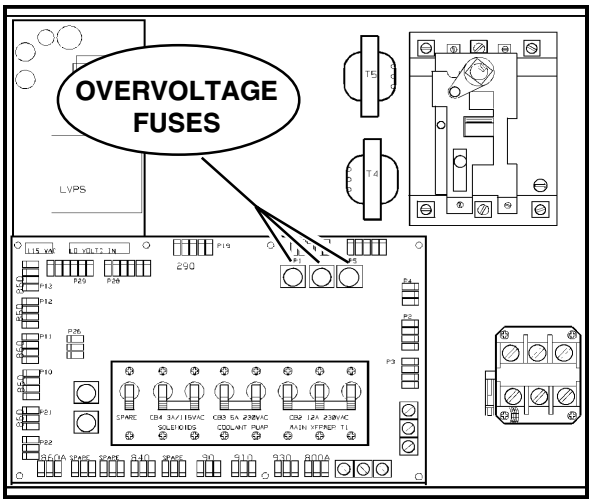


Fig. 2-2 Power supply assembly; fuse locations.

2.2 OPERATOR'S LAMP & TOOL CHANGER FUSES

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

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

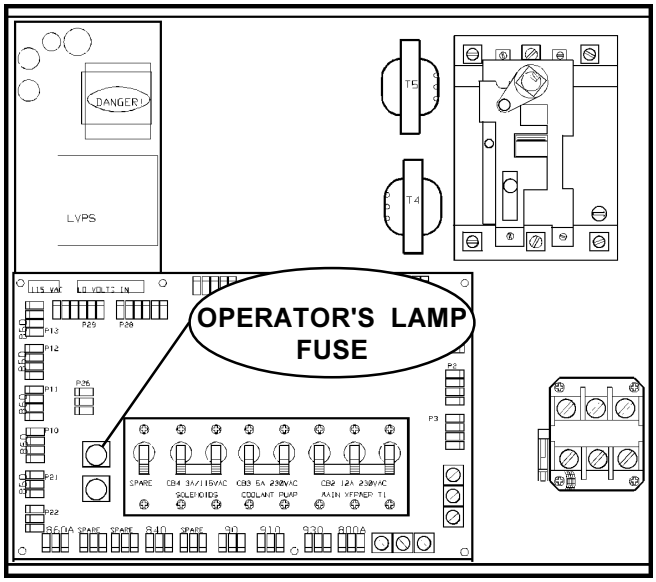


Fig. 2-3 Power supply board; fuse locations.

4. Using a flat tip screwdriver, turn the fuse(s) counterclockwise to remove and replace the blown fuse(s) with ones having the same type and rating (operator's lamp:½ amp, type AGC, 250V; tool changer: 5 amp, type ABC, 250V).

2.3 SERVO DRIVER & SDIST FUSES

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

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

3. On the SERVO DRIVE ASSEMBLY, there are three fuses on the SDIST panel, and three individual fuses on each of the SERVO DRIVE boards (See Fig. 2-4; the F3 fuses are not shown).

4. On the SDIST panel, use a flat tip screwdriver or a fuse puller to turn the fuse(s) counterclockwise and 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).

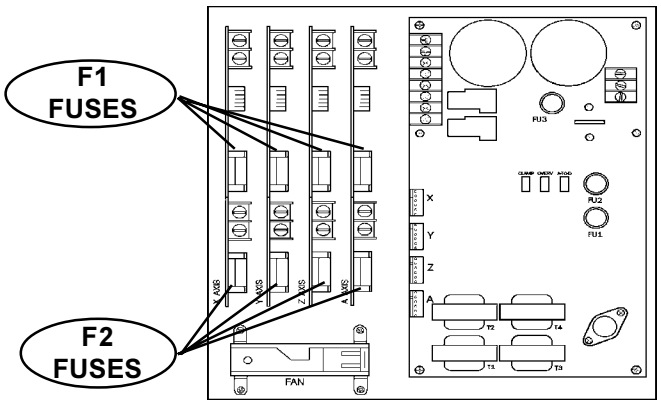


Fig 2-4 Servo Drive Assembly; fuse locations

3. PCB REPLACEMENT

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

TOOLS REQUIRED:
3 3/16" HEX WRENCHPHILLIPS SCREWDRIVER
3 3/16" HEX WRENCH FLAT-TIP SCREWDRIVER
3 3/16" HEX WRENCH ¼" HEX WRENCH

3.1 MICROPROCESSOR, VIDEO, & MOTIF

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

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

MOTIF BOARD -

1. Turn machine power off.

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

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

4. Disconnect all leads to the Motor Interface (MOTIF) board. Ensure all cables are properly labeled for reconnecting later. Fig. 3-1 shows all cable numbers and the locations on the MOTIF board.

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

NOTE: If the VIDEO 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.

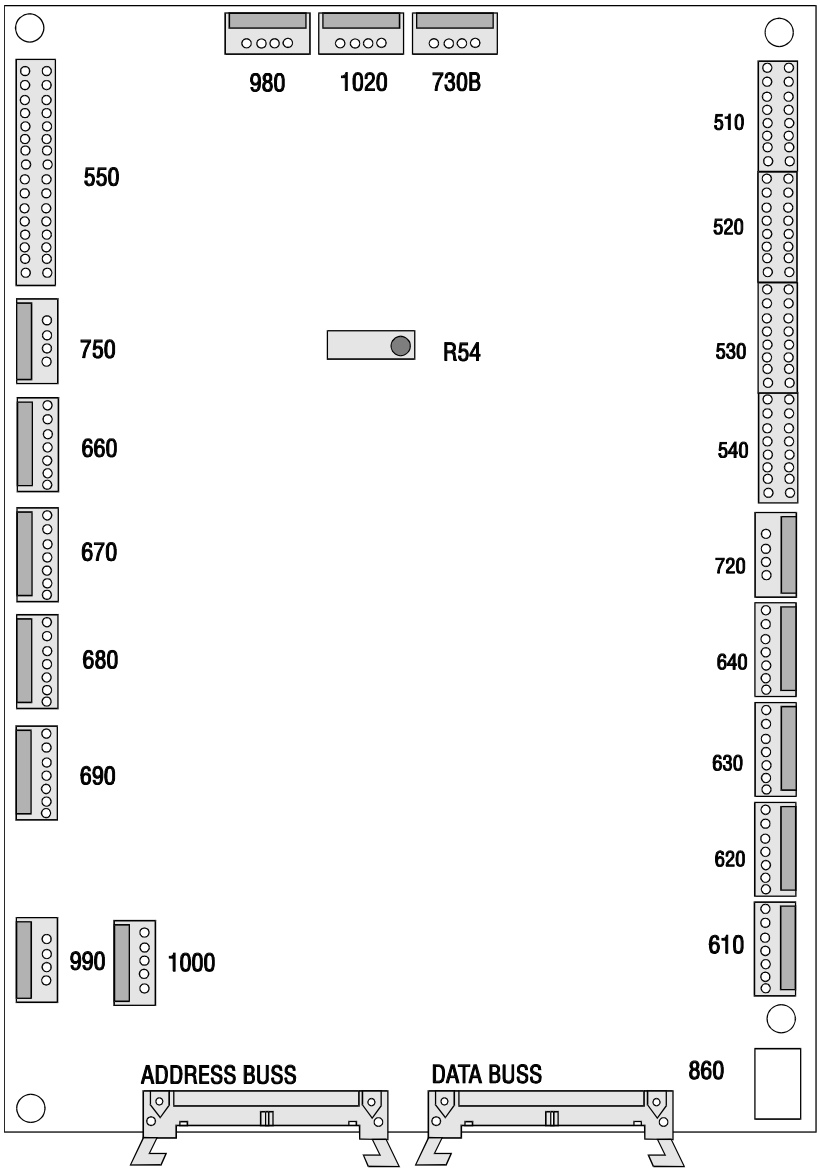


Fig. 3-1 Motor Interface board.

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. Fig. 3-2 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.

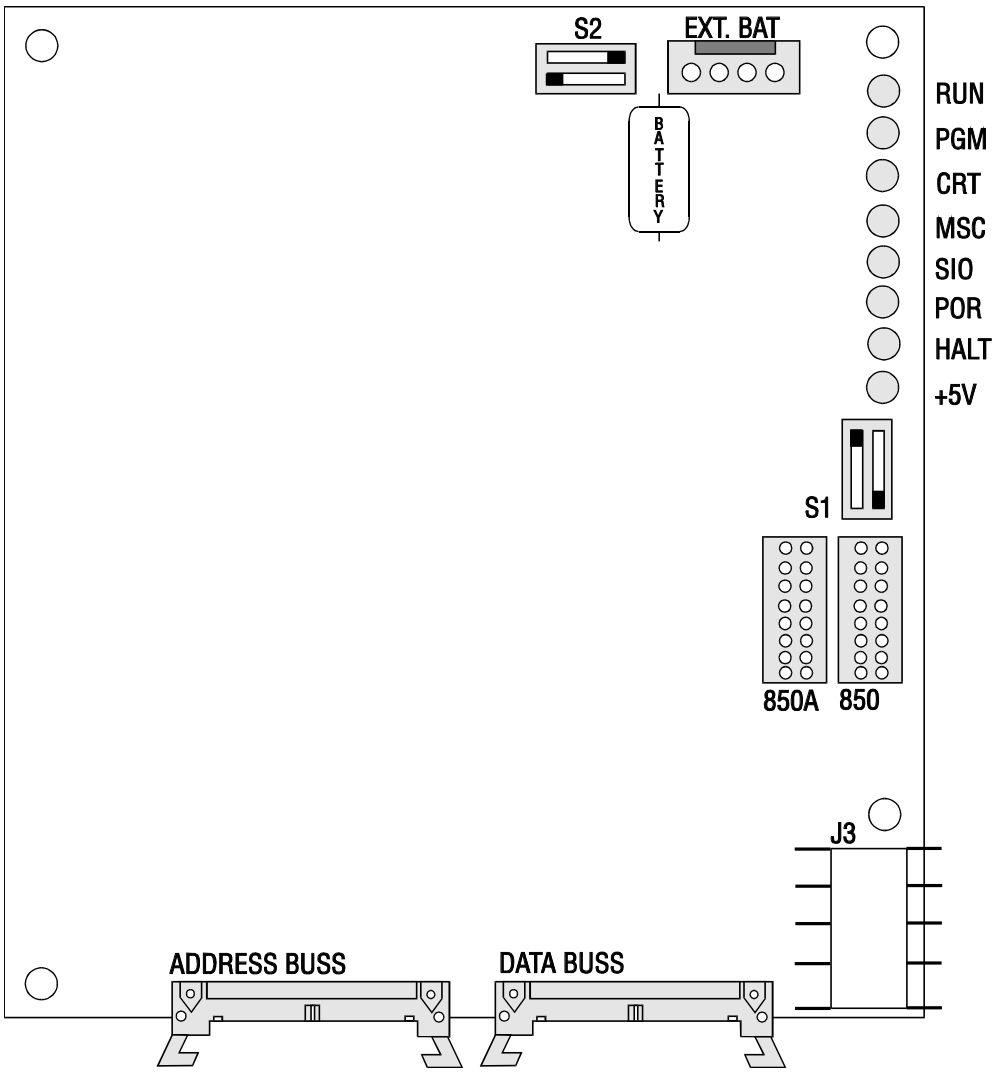


Fig. 3-2 Video board.

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.

PROCESSOR BOARD -

13. Remove the MOTIF board as described in steps 1-5, and the VIDEO2 board as described in steps 9-10.

14. Disconnect all leads to the Processor (68EC030) board. Ensure all cables are properly labeled for

reconnecting later. The following illustration shows all cable numbers and the locations on the 68EC030 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 (68EC030) board, attaching it to the electrical cabinet (beneath the 68EC030 board) with the standoffs.

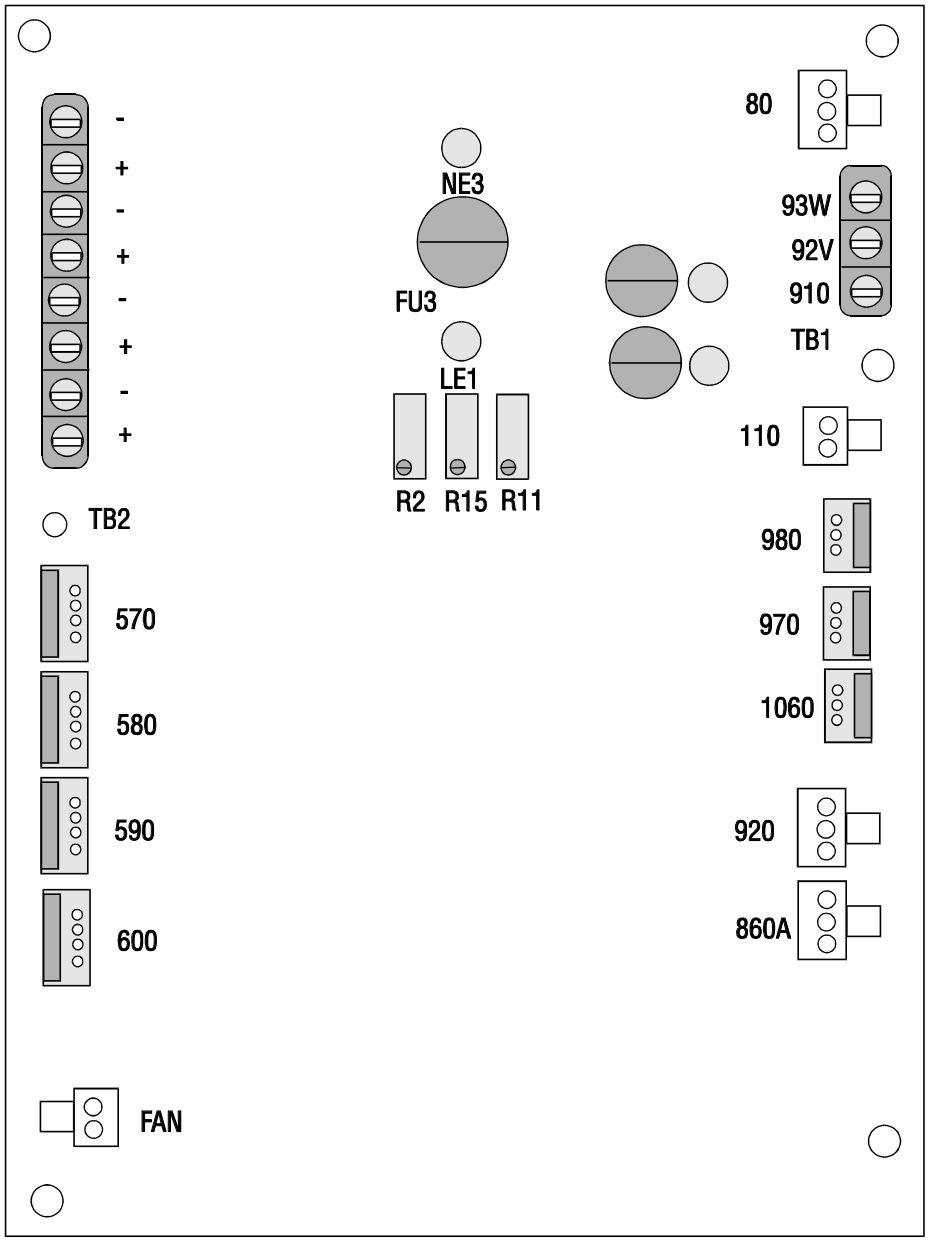


Fig. 3-4 SDIST board.

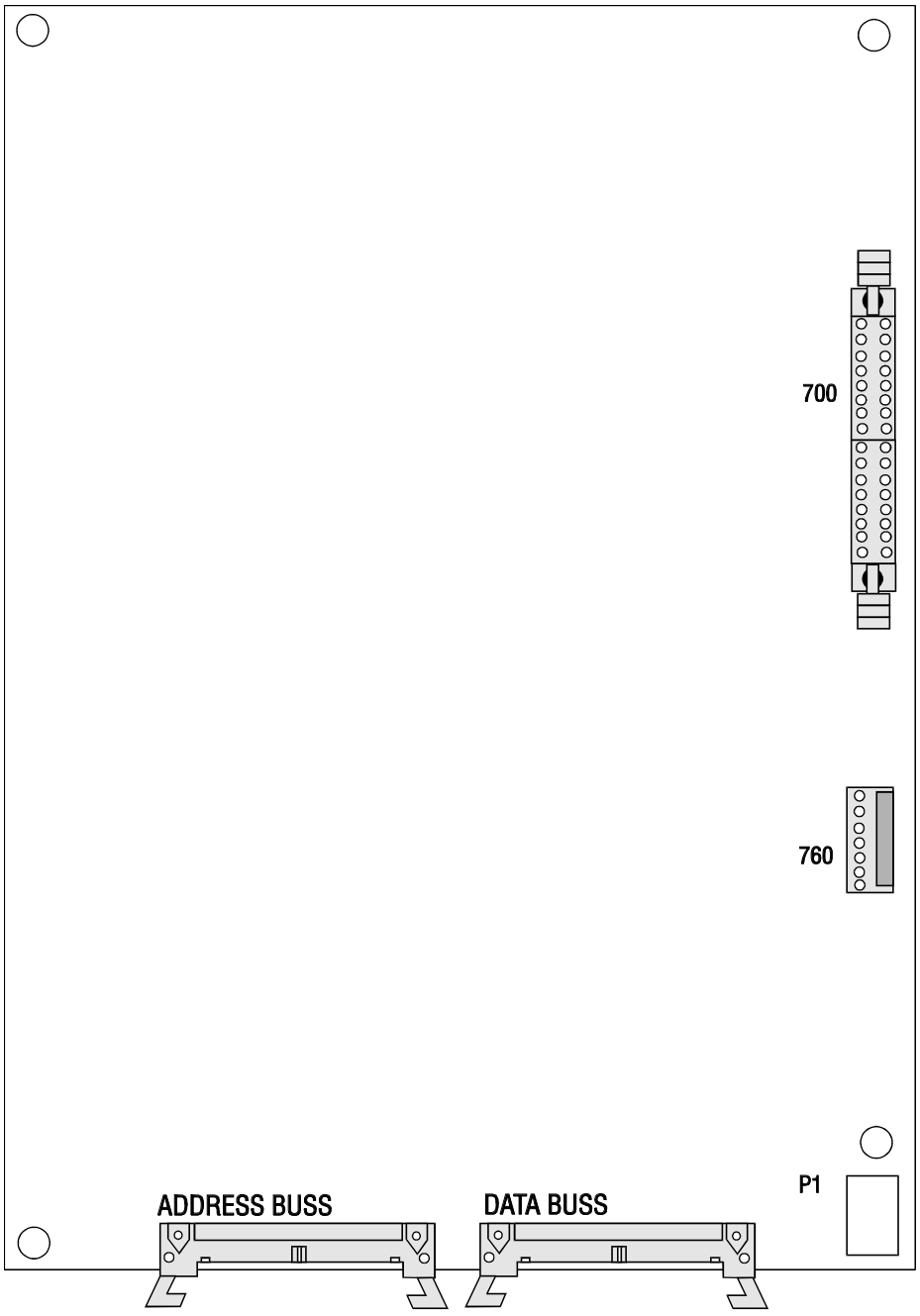


Fig. 3-3 Processor board.

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

3.2 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 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. 3-4) shows all cable numbers and the locations on the SDIST board.

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

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 -

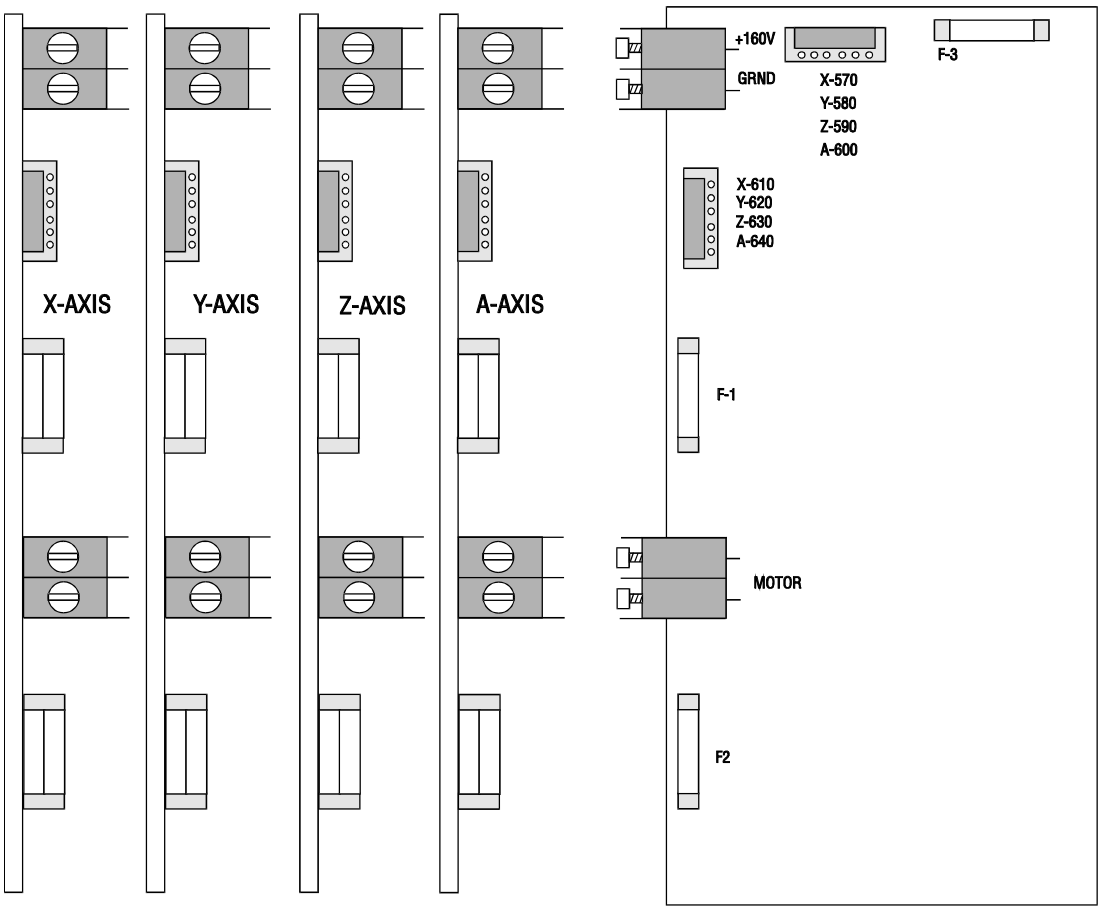


Fig. 3-5 Servo DRIVER boards.

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

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

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

4. Disconnect all leads to the Servo Driver (DRIVER) board that you wish to replace. Ensure all cables are properly labeled for reconnecting later. 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. Ensure the red and black leads go to the appropriate connections.

3.3 I/O BOARD

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

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

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

4. Disconnect all leads to the Input/Output board and move aside for removal. Ensure all cables are properly labeled for reconnecting later. Fig. 3-6 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.

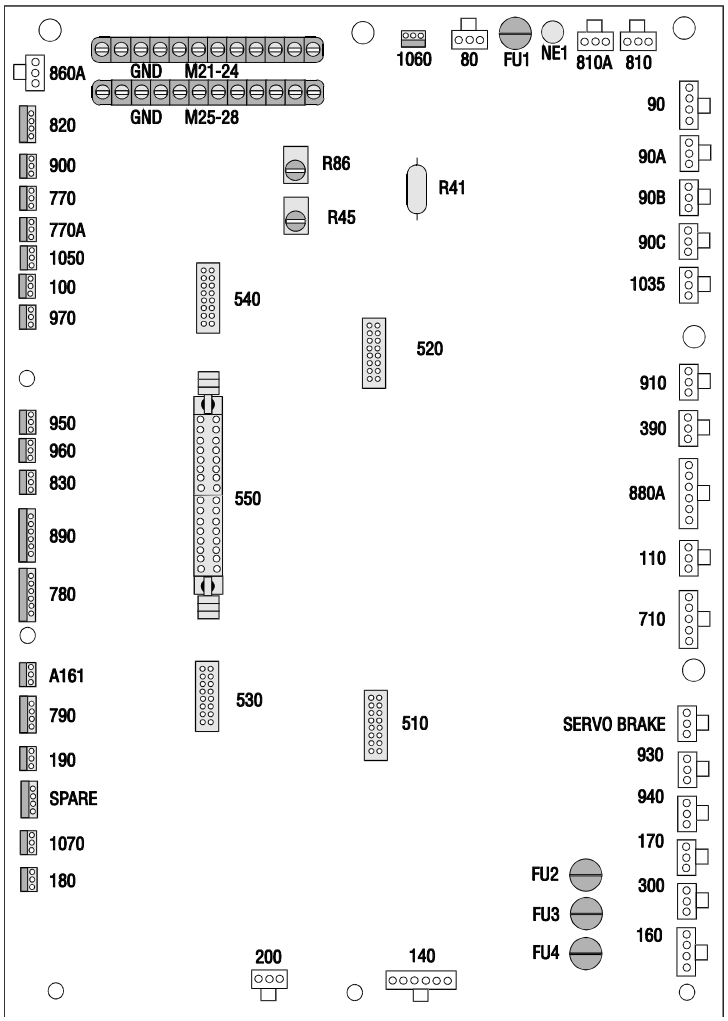


Fig. 3-6 I/O board.

3.4 POWER & LOW VOLTAGE SUPPLY

POWER 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 Power Distribution (POWER) board and move aside for removal. Ensure all cables are properly labeled for reconnecting later. Fig. 3-7 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.

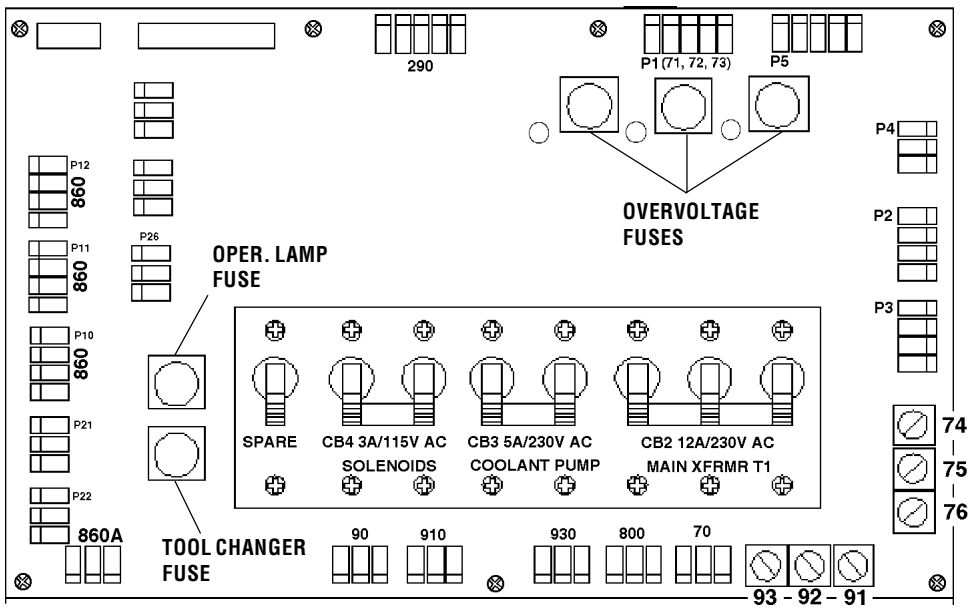


Fig. 3-7 Power Distribution (POWER) board.

LOW VOLTAGE POWER SUPPLY -

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

9. Disconnect all leads to the Low Voltage Power Supply (LVPS) board. Ensure all cables are properly labeled for reconnecting later. Fig. 3-8 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.

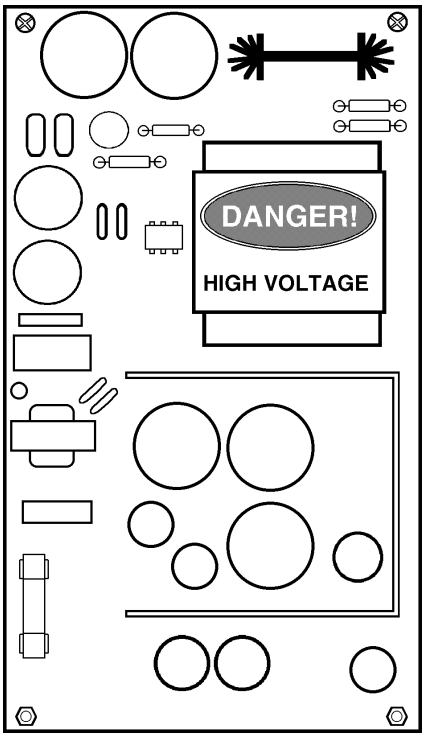


Fig. 3-8 Low Voltage Power Supply board.

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.

3.5 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.

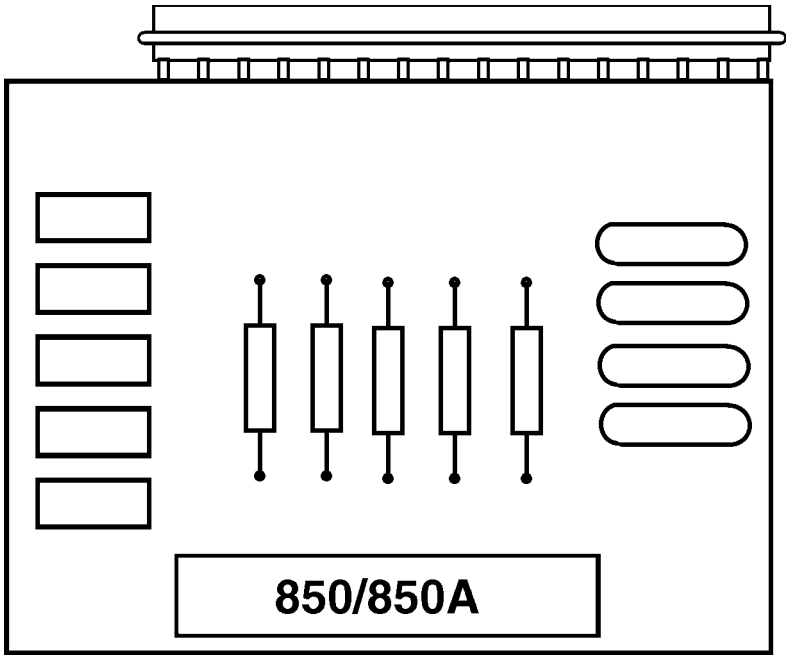


Fig. 3-9 RS-232 DB25 board.

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. 3-9 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.

3.6 KEYBOARD INTERFACE

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

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.

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.

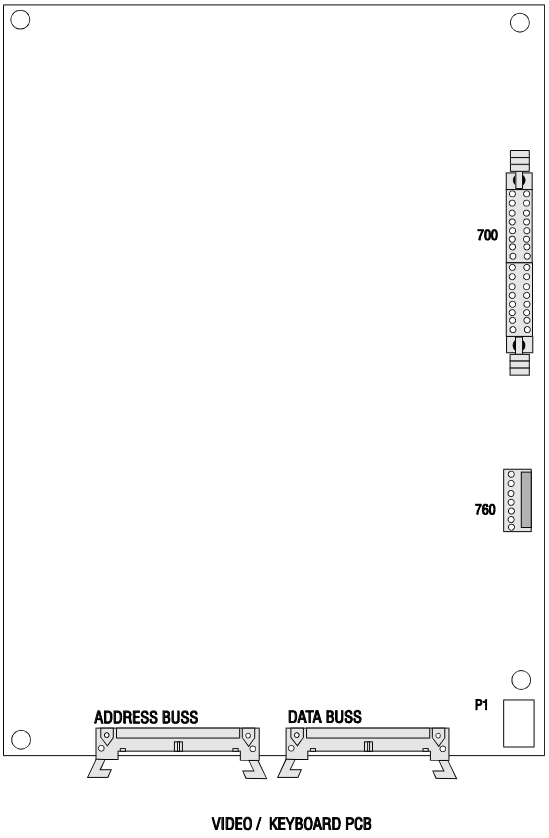


Fig. 3-10 Keyboard Interface board.

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

4. FRONT PANEL

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

TOOLS REQUIRED:

3 3/16" HEX WRENCH	**PHILLIPS SCREWDRIVER**
3 3/16" HEX WRENCH	**3/8" SOCKET WRENCH**
3 3/16" HEX WRENCH	**5/64" ALLEN WRENCH**
3 3/16" HEX WRENCH	**SMALL FLAT-TIP SCREWDRIVER**

4.1 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 connec tion inside, then unplug the black cable at the connection in the control panel. It may be neces- sary 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. 4-1 for the order of replacement.
   Once all washers have been attached and nuts have been hand-tightened, tighten down com pletely with the socket.

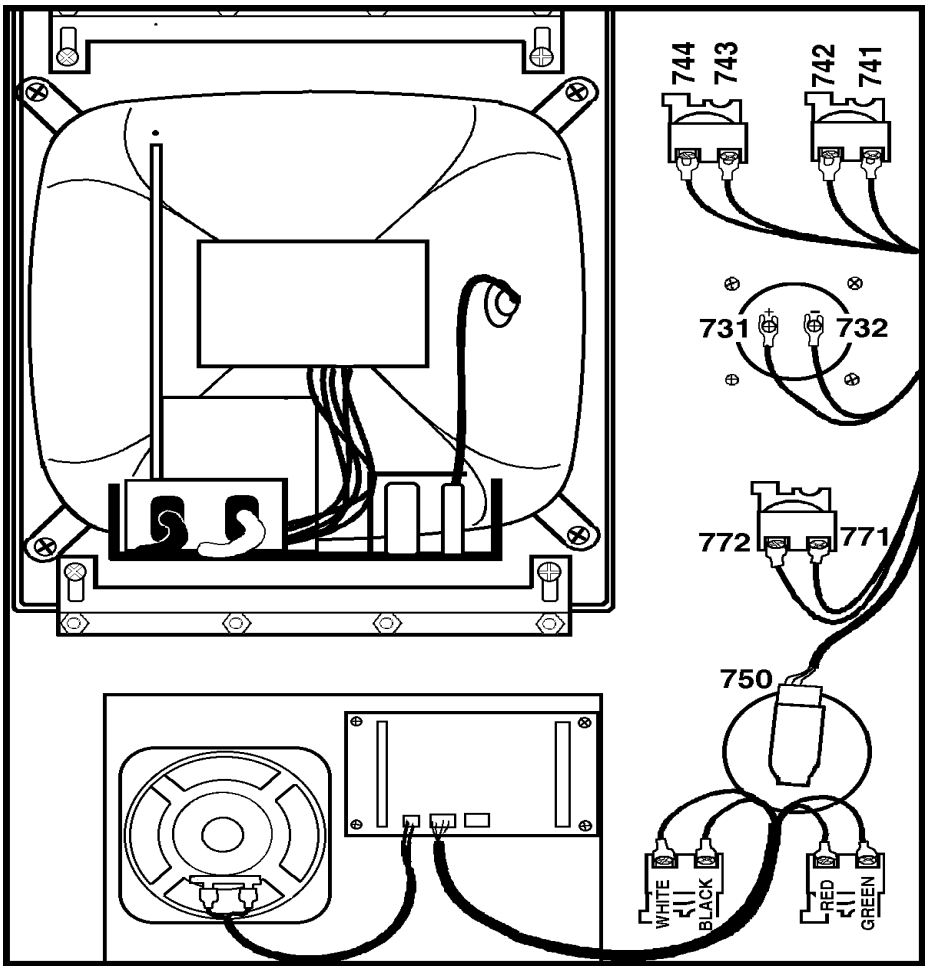


Fig. 4-1 Interior of control panel (rear).

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.

4.2 JOG HANDLE REPLACEMENT

The JOG handle is actually a 100-line-per-revolution encoder. We use 100 steps per revolution to move one of the servo axes. If no axis is selected for jogging, turning of the crank has no effect. When the axis being moved reaches its travel limits, the handle inputs will be ignored in the direction that would exceed the travel limits.

Parameter 57 can be used to reverse the direction of operation of the handle.

1. Turn the machine power off.

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

3. Unplug the cable leading to the jog handle encoder. IMPORTANT! The blank pin side of the connector must face as shown in Fig. 4-2 when reconnecting; otherwise, damage may occur to the machine.

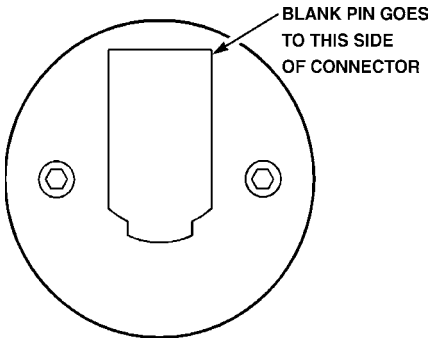


Fig. 4-2 Jog handle encoder.

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

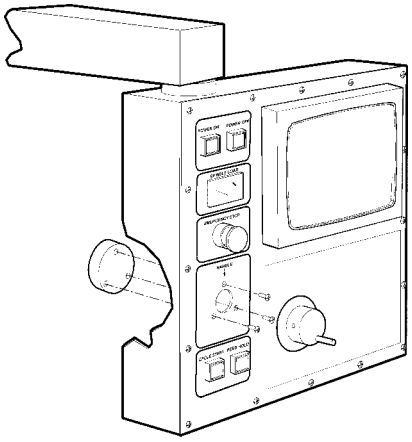


Fig. 4-3 Jog Handle removal.

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

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

4.3 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 recon necting 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.

4.4 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 to the correct location.

4.5 KEYPAD REPLACEMENT

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

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

3. Remove all switches, spindle load meter, and the jog handle as described in previous sections.

4. Unplug the keypad's 24-pin ribbon cable from the Keyboard Interface board.

5. Remove the screws from the front of the control panel. Take care to hold the front cover panel and bezel spacer in place until all screws have been removed. Remove the two pieces and set aside in a safe place.

6. Using a flat, blunt tool, such as putty knife, pry the keypad away from the control panel. Pull the ribbon cable through the opening in the control to remove.

7. To replace, first put the bezel spacer in place and fasten temporarily with screws in the top corners.

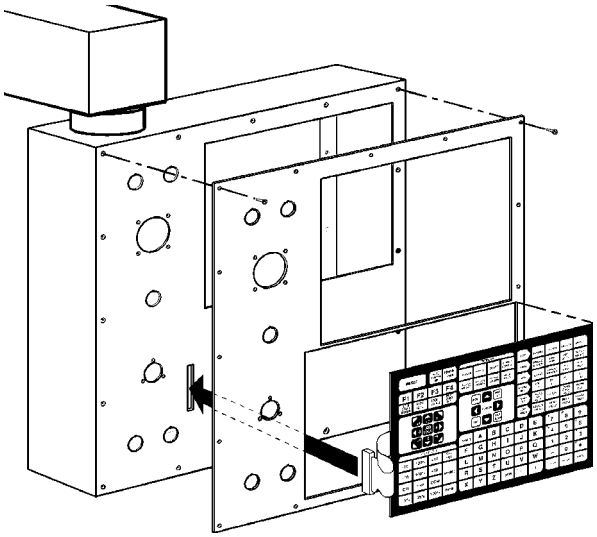


Fig. 4-4 Keypad installation.

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.

5. SPINDLE ENCODER REPLACEMENT

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

1. Loosen the (8) motor fan panel mounting bolts (on left end of machine), then remove the panel.

2. Loosen the two encoder mounting bolts and slide the encoder up until there is slack in the belt.

4. Remove the encoder.

5. Inspect the encoder belt for any damage. If replacement is necessary, refer to Spindle Section for removal.

6. Place the belt onto the pulley.

7. Mount the new encoder and tighten the bolts.

NOTE: When tightening the bolts, ensure the belt remains loose around the pulleys. If the belt is too tight it could damage the encoder.

8. Replace the motor fan panel.

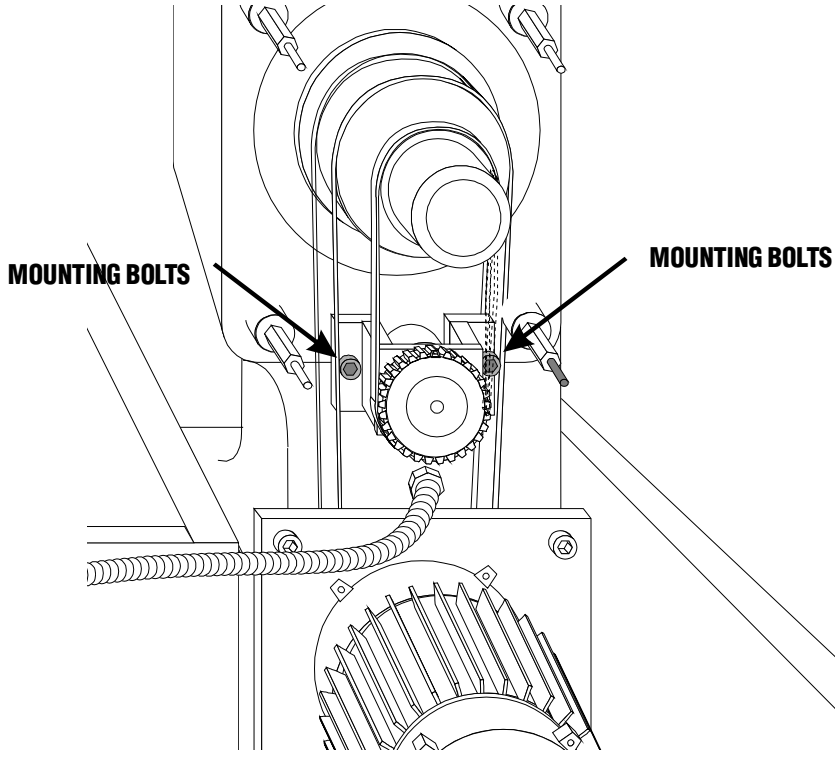


Fig. 5-1 Encoder bolt locations

6. LIMIT SWITCHES

TOOLS REQUIRED:
3 2.5 mm ALLEN WRENCH
3 1/8" ALLEN WRENCH
3 9/64" ALLEN WRENCH

NOTE: There are fourteen (8) limit switches located on the lathe, and some are difficult to reach. Ensure the problem is the switch before beginning removal procedures. The following is a list of all switches, their general location, and a functional description:

CLAMP/UNCLAMP SWITCHES
[Tool changer]

There are two switches used to sense the position of the turret 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.

The diagnostic display can be used to display the status of the relay outputs and the switch inputs.

DOOR HOLD SWITCH
[Top outer edge of door opening (1)]

The DOOR OPEN sense switch consists of a switch on each the enclosure. The switch is normally closed. When the door is open, the switch will open and the machine will stop with a “Door Hold” function. When the door is closed again, operation will continue normally.

If the door is 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.

TURRET HOME SWITCH
Located inside Turret housing

X, Z TRAVEL LIMIT SWITCHES
[X: Left side of wedge by X-axis motor]

[Z: Top near rear middle]

The machine zero position is defined by a limit switch for each of the X, B, Z and turret 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 look ahead 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 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 and Z axes will move towards the limit switch unless it is already active (open); then they will move away from the switch until it closes again; then they will continue to move until the encoder Z channel is found. This position is machine zero.

Auto search for zero in the Z-axis is followed by a rapid move from the limit switch position down to the tool change position. This makes the Z-axis a little different from the other axes. The position found with the limit switch is not machine zero but is the position used to pull tools out of the spindle. Machine zero for Z is below this by Parameter 64. Be careful during the Z zero search and stay clear of that rapid move.

What Can Go Wrong With Limit Switches?

If the machine is operated without connector P5, a LOW LUBE and DOOR OPEN alarm will be generated. In addition, the Home search will not stop at the limit switch and will instead run into the physical stops on each axis.

If the switch is damaged and permanently open, the zero search for that axis will move in the negative direction at about 0.5 in/min until it reaches the physical travel stops at the opposite end of travel.

If the switch is damaged and permanently closed, the zero search for that axis will move at about 10 in/min in the positive direction until it reaches the physical stops.

If the switch opens or a wire breaks after the zero search completes, an alarm is generated, the servos are turned off, and all motion stops. The control will operate as though the zero search was never performed. The RESET can be used to turn servos on but you can only jog that axis slowly.

7. MICROPROCESSOR ASSEMBLY

The Microprocessor PCB contains the 68EC030 processor running at 40 MHz, one 128K EPROM; between 256K and 4MB of CMOS RAM and betwen 512K and 1MB of FAST STATIC RAM. It also contains a dual serial port, a five year battery to backup RAM, buffering to the system buss, and eight system status LED's.

Two ports on this board are used to set the point at which an NMI* is generated during power down and the point at which RESET* is generated during power down.

The eight LED's are used to diagnose internal processor problems. As the system completes power up testing, the lights are turned on sequentially to indicate the completion of a step. The lights and meanings are:

+5V +5V logic power supply is present.
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 the EPROM is 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 the EPROM is plugged in. Test the card with the buss connectors off.

SIO Serial I/O initialization complete.
If this light does not come on, there is a problem with the serial ports. Disconnect anything on the external RS-232 and test again.

MSG Power-on serial I/O message output complete.
If this light does not come on, there is a problem with serial I/O or interrupts. Disconnect anything on the external RS-232 and test again.

CRT CRT/VIDEO initialization complete.
If this light does not come on, there is a problem communicating with the VIDEO PCB. Check the buss connectors and ensure the VIDEO PCB is getting power.

PGM Program signature found in memory.
If this light does not come on, it means that the main CNC program package was not found in memory or that the auto-start switch was not set. Check that switch S1-1 is on and the EPROM is 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 (2) two-position DIP switches on the processor PCB labled S1 and S2. Switch S1-1 must be ON to auto-start the CNC operational program. If S1-1 is OFF, the PGM light will remain off. Switch 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.

Switch S2-1 is used to enable FLASH. If it is disabled it will not possible to write to FLASH. Switch S2-2 enables the processors CACHE memory.

The processor connectors are:
J1 Address buss
P2 Data buss
P4 Serial port #1 (for upload/download/DNC) (850)
P5 Serial port #2 (for auxiliary 5th axis) (850A)
P3 Power connector
P6 Battery

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.

VIDEO AND KEYBOARD PCB (VIDEO2)
The VIDEO and KB PCB generates the video data signals for the monitor and the scanning signals for the keyboard. In addition, the keyboard beeper is generated on this board. There is a single jumper on this board used to select inverse video. The video PCB connectors are:

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

MOTOR INTERFACE PCB (MOTIF)
The Motor Interface PCB provides all of the interfaces to motors and discrete inputs and outputs. It contains a single pot R54 to adjust the output of the D-A converter. The MOTIF PCB connectors are:

P1 Data buss
P2 X drive control and overcurrent sense (610)
P3 Y drive control and overcurrent sense (620)
P4 Z drive control and overcurrent sense (630)
P5 A drive control and overcurrent sense (640)
P6 X-axis encoder, Z, home, and overheat (660)
P7 Y-axis encoder, Z, home, and overheat (670)
P8 Z-axis encoder, Z, home, and overheat (680)
P9 A-axis encoder, Z, home, and overheat (690)

P10 32 discrete inputs (550)
P11 Relay drives 1 to 8 (510)
P12 Relay drives 9 to 16 (520)
P13 Relay drives 17 to 24 (530)
P14 Relay drives 25 to 32 (540)
P15 Power connector (+5,+12+)
P16 D-to-A output and -12V DC (720)
P17 A-to-D inputs for DC buss voltage (980)
P18 Jog Crank input and aux 1,2 (750)
P19 Address buss
P20 Spindle encoder inputs (1000)
P21 A-to-D input for spindle temperature (1020)
P22 A-to-D input for spindle load monitor (730B)
P23 A-to-D input spare
P24 Home switch inputs X, Y, Z (990)
P25 Spare inputs
P26 A-to-D input spare
P27 A-to-D inputs spare
P28 A-to-D inputs spare

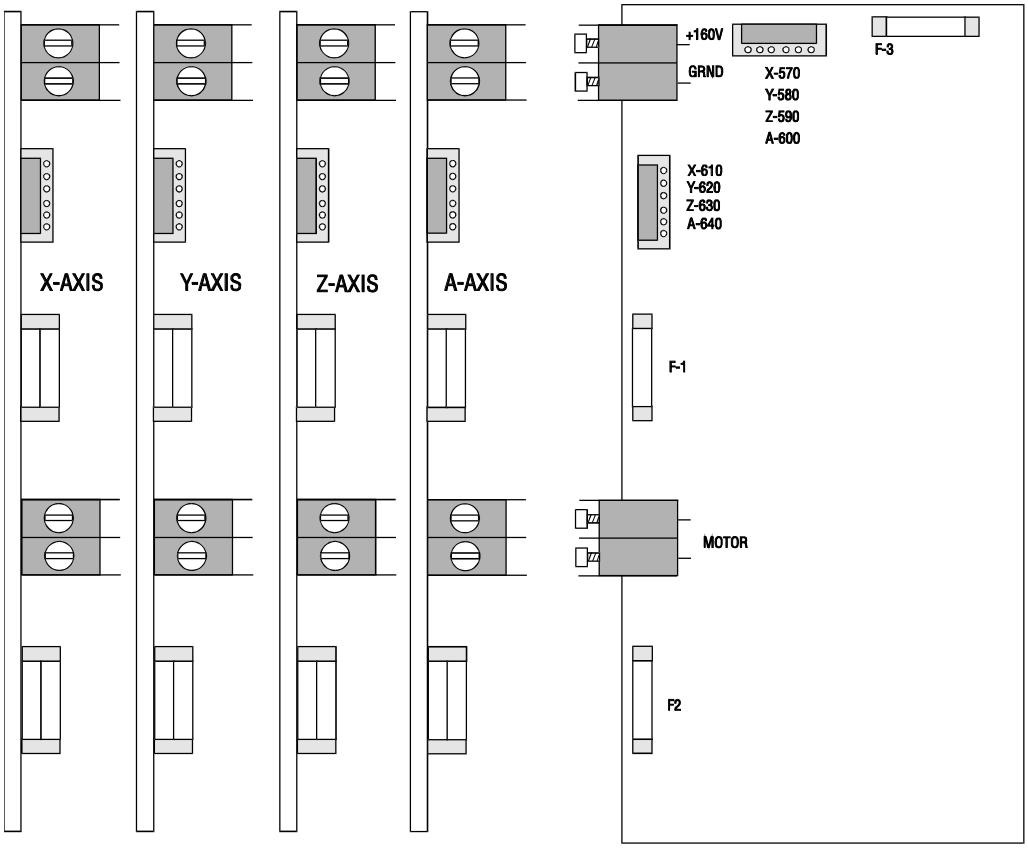


Fig. 7-1 Servo Drive Assembly.

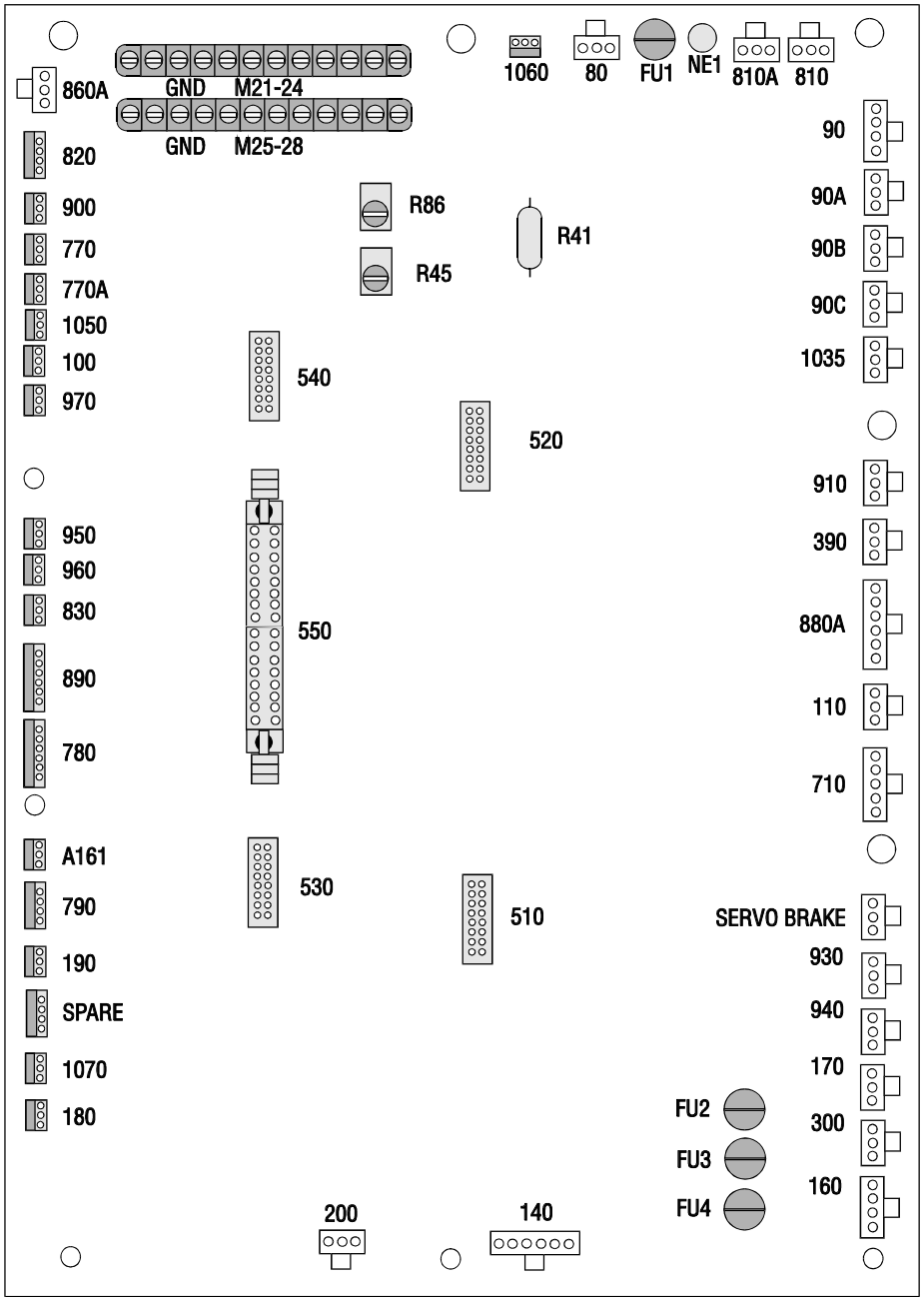


Fig. 7-1 Input/Output board.

8. POWER SUPPLY

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 corre spond to as much as 15 horsepower.

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.

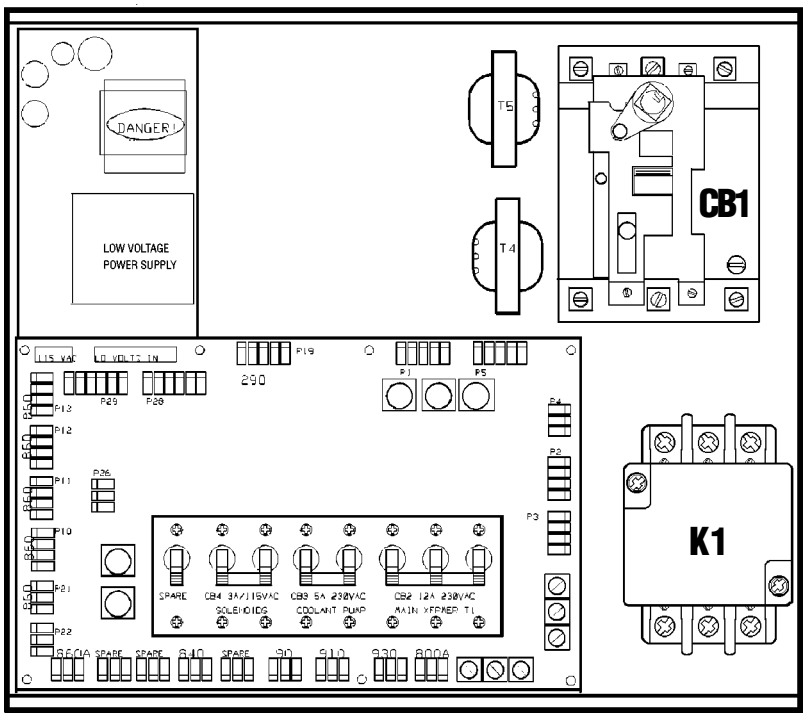


Fig. 8-1 Power Supply Assembly.

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, holding contacts 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.

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.

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

P1 Five-pin brings 230V AC three ph from main breaker
P2 On/Off connections to front panel (740)
P3 Coil and aux connections to contactor K1
P4 Auto-off connection to IOPCB (170)
P5 Low voltage control transformer to power K1
P6 230V AC from CB3 to coolant pump (930)
P7 115V AC from CB4 to IOPCB for solenoids
P8 115V AC from IOPCB for low voltage supply and solenoids (910)
P9 Tool changer fuse circuit from FU5 to IOPCB (840)
P10 +5/+12/Gnd form low volt supply to logic boards (860)
P11 +5/+12/Gnd form low volt supply to logic boards (860)
P12 +5/+12/Gnd form low volt supply to logic boards (860)
P13 +5/+12/Gnd form low volt supply to logic boards (860)
P14 12V AC to operator's lamp (800)
P15 230V AC from contactor K1 for coolant pump (70)
P16 Low voltage power from power supply
P17 +12V DC to IOPCB (860A)
P18 Not used
P19 Connector to operator's lamp transformer T4 (290)
P20 115V AC to low voltage supply
P21 -12V DC to processor PCB
P22 -12V DC to MOTIF PCB
P23 Spare circuit breaker CB5
P24 Spare fuse FU7
P25 Spare fuse FU8

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

For older internal transformer with 208/230 taps:

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

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

TB1 115V AC from T1 secondary
TB2 115V AC to servo assembly and I/OPCB

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.

Power-Up Low ,Voltage Control Transformer (T5)
The low voltage control transformer, T5, supplies power to the coil of the main contactor K1. It guarantees that the maximum voltage leaving the Power Supply assembly when power is off is 12V AC to earth ground. It is connected via P5 to the POWER PCB.

Secondary Circuit Breakers
Three 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.

OPERATOR'S LAMP TRANSFORMER
Transformer T4 supplies low voltage to the operator's lamp. The primary is 115V AC and the secondary is 10V AC. The primary is protected at ½ amp by F6. It is connected to the POWER PCB by connector P19.

9. 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.

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.

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.

10. UNDER/OVER VOLTAGE SENSORS

An overvoltage sensor monitors the DC servo motor buss. When this voltage exceeds 10% of the tap a load is applied to the servo buss. That load is called the regen load resistor. When this volt age exceeds 15%, 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:

190-260 on 4 tap transformers.
360-480 on 5 tap transformers.

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.

There is an undervoltage sensor that monitors the voltage of all three inputs’ power phases. If this voltage drops more than 15% below a selected tap, either a low voltage or a phase loss alarm will be generated. This phase sensor is built into the I/OPCB circuit board in the lower left hand corner of the control.

11. CABLE LIST

CNC WIRING OVERALL
16-May-95

WIRE/
TERMINAL NUMBER — FUNCTION NAME:

GND INCOMING EARTH GROUND #8
-FROM INCOMING POWER GROUND
-TO CHASSIS GROUND
-TO 160 VDC RETURN
-TO SHIELD OF ALL BULK CABLES
-TO LOGIC RETURN (D GROUND 65)

L1 INCOMING 230VAC, PHASE 1, TO CB1-1 #10
L2 INCOMING 230VAC, PHASE 2, TO CB1-2 #10
L3 INCOMING 230VAC, PHASE 3, TO CB1-3 #10

L4 230VAC, PHASE 1, CB1 TO K1-1 #10
L5 230VAC, PHASE 2, CB1 TO K1-2 #10
L6 230VAC, PHASE 3, CB1 TO K1-3 #10

R/L7 230VAC FROM K1 TO SPINDLE DRIVE, PHASE 1 #10
S/L8 230VAC FROM K1 TO SPINDLE DRIVE, PHASE 2 #10
T/L9 230VAC FROM K1 TO SPINDLE DRIVE, PHASE 3 #10

71/L4 FUSED 230 VAC (FROM MAIN CB1-4 TO K1-1) #10
72/L5 FUSED 230 VAC (FROM MAIN CB1-5 TO K1-2) #10
73/L6 FUSED 230 VAC (FROM MAIN CB1-6 TO K1-3) #10

74/R 230 VAC (FROM MAIN CONTACTOR K1-4) #12
75/S 230 VAC (FROM MAIN CONTACTOR K1-5) #12
76/T 230 VAC (FROM MAIN CONTACTOR K1-6) #12

77 230VAC FUSED 12A TO 3 PH XFORMER T1 #12
78 230VAC FUSED 12A TO 3 PH XFORMER T1 #12
79 230VAC FUSED 12A TO 3 PH XFORMER T1 #12

80 DISTRIBUTED 160 VDC - SHIELD +2
81 +160 VDC HIGH VOLTAGE SUPPLY #16
82 160 VDC RETURN #16

90 115 VAC FROM TRANSFORMER T1
91/U STEPPED-DOWN 115 VAC (FROM XFRMER T1) #12
92/V STEPPED-DOWN 115 VAC (FROM XFRMER T1) #12
93/W STEPPED-DOWN 115 VAC (FROM XFRMER T1) #12

90A 115 VAC TO CRT - SHIELD +2
92 LEG 1 #16
93 LEG 2 #16

90B 115 VAC TO HEAT EXCHANGER - SHIELD +2
91 LEG 1 #16
93 LEG 2 #16

90C 115 VAC TO CB4 - SHIELD +2
91 LEG 1 #16
92 LEG 2 #16

100 M-FIN (IOASM TO SIDE OF BOX)
101 LEG 1 #16
102 LEG 2 #16

110 SERVO POWER CONTROL - SHIELD +2
111 GROUND RETURN
112 RELAY DRIVER SINKS 12VDC TO GROUND

120 CHIP CONVEYOR COMMAND CABLE SHIELD +4 #20
(REMOVED IN REV J IOPCB)

130 OVERCURRENT SENSE FROM CHIP CONVEYOR
(REMOVED IN REV J IOPCB)

140 230VAC 3PH POWER TO CHIP CONVEYOR MOTOR (5 +SHIELD)
141 PHASE A 230VAC
142 PHASE B 230VAC
143 PHASE C 230VAC
144 STARTING WINDING 230VAC
145 STARTING WINDING 230VAC

140A 230VAC 3PH POWER IN CONDUIT TO CHIP CONVEYOR

150 12VDC TO CHIP CONVEYOR CONTROL PCB
(REMOVED IN REV J IOPCB)

160 3PH 230VAC TO CHIP CONVEYOR CONTROLLER
161 PHASE A 230VAC
162 PHASE B 230VAC
163 PHASE C 230VAC

170 AUTO OFF FUNCTION - SHIELD +2
172 RELAY 1-7 COMMON (C7) ; AUTO OFF
173 RELAY 1-7 N.O.

180 COOLANT SPIGOT DETENT SWITCH
181 SIGNAL
182 COMMON

190 UNCLAMP FROM SPINDLE HEAD TO IOASM
191 INPUT 25
192 DIGITAL RETURN

200 COOLANT SPIGOT MOTOR (12VDC)
201 MOTOR +
202 MOTOR -

210 DATA CABLE TO 3" FLOPPY DISK DRIVE (40 PINS)

220 SERVO BRAKE 115VAC - SHIELD +2
221 115VAC COMMON
222 115VAC SWITCHED

230 5'th AXIS BRAKE - SHIELD +2
231 115VAC COMMON
232 115VAC SWITCHED

240 SPARE INPUTS FROM IOPCB P25
241 COMMON
242 SPARE 3
243 SPARE 4

250 HORIZONTAL TOOL CHANGER SHUTTLE VALVE - SHIELD +2
251 COMMON 115VAC
252 SWITCHED 115VAC

260 K210 CABLING FOR EC

270 K111 CABLING FOR EC

280 RED/GREEN STATUS LIGHT WIRING
281 RED LAMP 115VAC
282 GREEN LAMP 115VAC
283 COMMON 115VAC

290 230VAC TO TRANSFORMER T2 (deleted 1-Aug-90)

300 115VAC TO SPINDLE MOTOR FAN/OIL PUMP/OILER
301 LEG 1 115VAC FUSED AT 3 A #18
302 LEG 2 115VAC FUSED AT 3 A #18

310 SOLENOIDS OUTPUT TO HORIZONTAL PALLET CHANGER
311 115VAC COMMON
312 UNSCREW
313 SCREW
314 DB DOWN
315 PALLET UP
316 PALLET CW
317 PALLET CCW

320 SWITCH INPUTS FROM HORIZONTAL PALLET CHANGER
321 SWITCHES COMMON
322 DB DOWN
323 PALLET UP
324 PALLET DOWN
325 PALLET CW
326 PALLET CCW
327 SCREW IN *
328 FIXTURE CLAMPED *

330 230V 3PH FROM CB6 TO K2 (LATHE HYDRAULICS)
331
332
333

340 230V 3PH FROM K2 TO HYDRAULIC PUMP (LATHE)
341
342
343

350-389 RESERVED

390 115VAC TO 4'TH AXIS BRAKE (LATHE PART DOOR) - SHIELD +2
391 LEG 1 #18
392 LEG 2 SWITCHED #18

400 SPINDLE DRIVE COAST COMMAND - SHIELD +2
401 LOGIC COMMON #20
402 SPINDLE COAST COMMAND #20

410-483 reserved

490 ALL WIRES CARRYING SERVO MOTOR DRIVE POWER (all #14)
491 X-AXIS FUSED MOTOR POWER + (P1-E)
492 X-AXIS FUSED MOTOR POWER - (P1-F)
493 Y-AXIS FUSED MOTOR POWER + (P2-E) (LATHE T.S)
494 Y-AXIS FUSED MOTOR POWER - (P2-F) (LATHE T.S)
495 Z-AXIS FUSED MOTOR POWER + (P3-E)
496 Z-AXIS FUSED MOTOR POWER - (P3-F)
497 A-AXIS FUSED MOTOR POWER + (P4-E)
498 A-AXIS FUSED MOTOR POWER - (P4-F)

500 OVERTEMP SENSOR FROM SPINDLE MOTOR - SHIELD +2
501 OVERTEMP WIRE 1 #20 (N.C.)
502 OVERTEMP WIRE 2 #20

510 RELAY CARD 1 DRIVE CABLE - 16 WIRE RIBBON #24

520 RELAY CARD 2 DRIVE CABLE - 16 WIRE RIBBON #24

530 RELAY CARD 3 DRIVE CABLE - 16 WIRE RIBBON #24

540 RELAY CARD 4 DRIVE CABLE - 16 WIRE RIBBON #24

550 INPUTS CARD CABLE (MOTIF-P10) 34 WIRE RIBBON #24

560 TO MICROPROCESSOR P8 (REMOVED NOV-94)
561 -12V FROM 862 AT SUPPLY TO P8-1 #24
562 Gnd FROM 865 AT SUPPLY TO P8-4 #24

570 X AXIS DRIVER LOW VOLTAGE POWER - 6 WIRE RIBBON
571 14 VAC LEG 1 (DRIVER P2-1 #24
572 14 VAC LEG 2 (DRIVER P2-2 #24
573 16 VAC LEG 1 (DRIVER P2-3 #24
574 16 VAC LEG 2 (DRIVER P2-4 #24
575 CHASSIS GROUND (DRIVER P2-5 #24
576 CHASSIS GROUND (DRIVER P2-6 #24

580 Y AXIS DRIVER LOW VOLTAGE POWER (LATHE T.S)
(SAME AS 571 to 576)

590 Z AXIS DRIVER LOW VOLTAGE POWER
(SAME AS 571 to 576)

600 A AXIS DRIVER LOW VOLTAGE POWER
(SAME AS 571 to 576)

610 X AXIS DRIVER CONTROL CABLE - SHIELD +6
611 LOW ENABLE* (MOTIF P2-1) #24
612 HIGH ENABLE* (MOTIF P2-2) #24
613 DRIVE DIRECTION (MOTIF P2-3) #24
614 +5 VDC (MOTIF P2-4) #24
615 OVERCURRENT SIGNAL (MOTIF P2-5) #24
616 LOGIC RETURN (MOTIF P2-6) #24

620 Y AXIS DRIVER CONTROL CABLE - SHIELD +6 (LATHE T.S)
(SAME AS 611-616)

630 Z AXIS DRIVER CONTROL CABLE - SHIELD +6
(SAME AS 611-616)

640 A AXIS DRIVER CONTROL CABLE - SHIELD +6
(SAME AS 611-616)

650 THREE PHASE POWER TO SPINDLE MOTOR - SHIELD +3
651 LEG 1 OF 230VAC #14
652 LEG 2 #14
653 LEG 3 #14

660 X-ENCODER CABLE - SHIELD +7
661 LOGIC RETURN (D GROUND) #24
662 ENCODER A CHANNEL #24
663 ENCODER B CHANNEL #24
664 +5 VDC #24
665 ENCODER Z CHANNEL #24
666 HOME/LIMIT SW #24
667 OVERHEAT SWITCH #24
668 ENCODER A*
669 ENCODER B*
66T ENCODER Z*

670 Y-ENCODER CABLE - SHIELD +7 (LATHE SPINDLE ENCODER)
(SAME AS 661-66T)

680 Z-ENCODER CABLE - SHIELD +7
(SAME AS 661-66T)

690 A-ENCODER CABLE - SHIELD +7
(SAME AS 661-66T)

700 KEYBOARD CABLE - 34 WIRE RIBBON WITH IDC
(FROM VIDEO P4 TO KBIF P1)

710 FORWARD/REVERSE/RESET TO SPINDLE - SHIELD +4
711 FORWARD COMMAND (SP DR CN1-18 TO IO P9-4) #24
712 REVERSE COMMAND (CN1-19 TO IO P9-3) #24
713 RESET COMMAND (CN1-21 TO IO P9-2) #24
714 COMMON (CN1-14 TO IO P9-1) #24

720 ANALOG SPEED COMMAND TO SPINDLE - SHIELD +2
721 0 TO +10 VOLTS SPEED COMMAND (SPINDLE DRIVE CN1-1) #24
722 SPEED COMMAND REFERENCE (A GROUND) (CN1-17) #24

730 POWER METER FROM SPINDLE DRIVE TO KBIF - SHIELD +2
731 METER + (SPINDLE DRIVE CN1-5 TO KBIF) #24
732 METER - (CN1-6 TO KBIF) #24

730A POWER METER FROM KBIF TO METER - SHIELD +2
733 METER + AFTER TRIM POT (KBIF TO METER) #24
734 METER - AFTER TRIM POT (KBIF TO METER) #24

730B ANALOG SIGNAL FROM SPINDLE DRIVE LOAD MONITOR
731 SIGNAL 0..5V
732 GROUND

740 POWER ON/OFF CABLE TO FRONT PANEL - SHIELD +4
741 POWER ON SWITCH LEG 1 (24 VAC) #24
742 POWER ON SWITCH LEG 2 #24 N.O.
743 POWER OFF SWITCH LEG 1 (24 VAC) #24

744 POWER OFF SWITCH LEG 2 #24 N.C.

750 JOG-CRANK DATA CABLE - SHIELD +4
751 LOGIC RETURN (D GROUND) (65) #24
752 ENCODER A CHANNEL #24
753 ENCODER B CHANNEL #24
754 +5 VDC #24

760 MONITOR VIDEO DATA CABLE - SHIELD +9 (all #24)
(FROM VIDEO P3 TO CRT)

770 EMERGENCY STOP INPUT CABLE - SHIELD +2
771 SIGNAL (INPUT 8) #20
772 RETURN (D GROUND) (65) #20

770A SECOND E-STOP INPUT FOR HORIZONTAL

780 STATUS CABLE FROM SPINDLE DRIVE - SHIELD +4
781 +12 VDC (SPINDLE DRIVE CN1-25) #24
782 FAULT (INPUT 18 TO CN1-24) #24
783 AT SPEED (INPUT 20 TO CN1-23) #24
784 STOPPED (INPUT 19 TO CN1-22) #24

790 SPARE INPUTS FROM IOPCB P24
791 SPARE 1
792 SPARE 2
793 COMMON

800 12VAC TO LAMP - SHIELD +2
801 UNSWITCHED LEG 1 #20
802 SWITCHED LEG 2 #20

800A CABLE FOR LAMP SWITCH - SHIELD +2

800B CABLE WITH 10VAC FROM TRANSFORMER T2 - SHIELD +2

810 TOOL CHANGER MOTORS - SHIELD +2 #20
811 TURRET MOTOR + (IO P30-2 TO P6-J) #14
812 TURRET MOTOR - (IO P30-1 TO P6-I) #14

810A TOOL CHANGER MOTORS - SHIELD +2 #20
813 SHUTTLE MOTOR - (IO P30-4 TO P6-A) #14
814 SHUTTLE MOTOR + (IO P30-3 TO P6-B) #14

820 TOOL CHANGER STATUS - SHIELD +7
821 LOGIC RETURN (D GROUND) (P6-F/H/L/M) #24
822 GENEVA MARK (INPUT 5 TO P6-G) #24 (LATHE PART DOOR)
823 TOOL #1 (INPUT 3 TO P6-E) #24
824 SHUTTLE IN (INPUT 1 TO P6-C) #24 (LATHE TURRET CLAMPED)
825 SHUTTLE OUT (INPUT 2 TO P6-D) #24 (LATHE TURRET UNCLAMPED)

830 OVERHEAT THERMOSTAT - SHIELD +2
831 OVERHEAT SIGNAL (INPUT 14) #20
832 OVERHEAT RETURN (D GROUND) (65) #20

840 CIRCUIT BREAKER FOR 160 VDC - SHIELD +2
841 LEG 1 (TO 81) #14
842 LEG 2 #14

850 SERIAL PORT #1 INTERFACE CABLE (16 WIRE RIBBON #24)

850A SERIAL PORT #2 INTERFACE CABLE (16 WIRE RIBBON #24)

860 +12V/+5V/Gnd POWER CABLES - 4 WIRE (all #18)
861 +12 VOLTS
862 -12 VOLTS FROM LOW V SUPPLY TO 68020 PCB
863 +5 VOLTS
864 -5 VOLTS
865 LOGIC POWER RETURN (D GROUND)
866 POWER GOOD SIGNAL FROM SUPPLY

860A 12 VOLT POWER TO IOPCB - SHIELD +2
861 +12 VOLTS
865 LOGIC POWER RETURN (D GROUND)

860B +5 POWER TO 3" FLOPPY DRIVE

860C +5,+12,-12 POWER TO 68030

870 115VAC TO OILER - SHIELD +2
871 115VAC LEG 1 #18
872 115VAC LEG 2 #18

880A HIGH/LOW GEAR UNCLAMP/LOCK SOLENOID POWER - SHIELD +6
881 115 VAC SOLENOID COMMON (IO P12-5) #18
882 HIGH GEAR SOLENOID (IO P12-4) #18
883 LOW GEAR SOLENOID (IO P12-3) #18
884 TOOL UNCLAMP SOLENOID (IO P12-2) #18
885 SPINDLE LOCK SOLENOID (IO P12-1) #18
886 PRE-CHARGE SOLENOID #18 (IO P12-7)

880B TRANSMISSION HIGH/LOW GEAR SOLENOIDS FOR LATHE
881 115 VAC SOLENOID COMMON (IO P12-5) #18
882 HIGH GEAR SOLENOID (IO P12-4) #18
883 LOW GEAR SOLENOID (IO P12-3) #18

890 SPINDLE STATUS SWITCHES SHIELD +6
891 SIGNAL RETURN (D GROUND) (65) #24
892 HIGH GEAR (INPUT 6) #24
893 LOW GEAR (INPUT 7) #24
894 TOOL UNCLAMPED (INPUT 15) #24

895 TOOL CLAMPED (INPUT 16) #24
896 SPINDLE LOCKED (INPUT 17) #24

900 LOW COOLANT STATUS - SHIELD +2
901 LOW COOLANT SIGNAL (INPUT 4 TO P7-C) #20
902 LOW COOLANT RETURN (D GROUND) (65 TO P7-D) #20

910 115 VAC CIRCUIT BREAKER TO SOLENOIDS - SHIELD +2
911 LEG 1 #18
912 LEG 2 #18

920 REGENERATIVE LOAD RESISTOR FOR SERVO - SHIELD +2
921 LEG 1 #18
922 LEG 2 #18

930 FUSED 230 VAC FOR COOLANT PUMP - SHIELD +2
931 LEG 1 #14
932 LEG 2 #14

940 230 VAC TO COOLANT PUMP - SHIELD +2
941 LEG 1 (P7-A) #14
942 LEG 2 (P7-F) #14

950 LOW AIR PRESSURE SENSOR - SHIELD +3
951 LOW AIR SIGNAL (INPUT 12) #20
952 LOW AIR/OIL RETURN (D GROUND) (65) #20
953 LOW OIL PRESSURE SWITCH FOR VERTICAL TRANSMISSION #20

950A LOW HYDRAULIC PRESSURE SWITCH FOR LATHE - SHIELD +2
952 LOW HYDRAULIC RETURN (D GROUND) (65) #20
953 LOW HYD PRESSURE SWITCH FOR VERTICAL TRANSMISSION #20

960 LOW LUB/DOOR OPEN SENSORS - SHIELD +4
961 LOW LUB SIGNAL (INPUT 13) #24
962 LOW LUB RETURN (D GROUND) (65) #24
963 DOOR OPEN SIGNAL (INPUT 9) #24 (OBSOLETE OPTION)
964 DOOR OPEN RETURN (D GROUND) (65) #24 (OBSOLETE OPTION)

970 LOW VOLTAGE SENSOR - SHIELD +2
971 LOW VOL SIGNAL (INPUT 11 FROM PMON P9-3) #24
972 LOW VOL RETURN (D GROUND) (PMON P9-4) #24

980 VOLTAGE MONITOR - SHIELD +2
981 VOLTAGE MONITOR 0 TO +5 (PMON P9-1 / MOTIF P17-1) #24
982 VOLTAGE MON RET (A GND) (PMON P9-2 / MOTIF P17-2) #24

990 HOME SENSORS - SHIELD +4
991 X HOME SWITCH (MOTIF P24-2 TO P5-B) #24
992 Y HOME SWITCH (MOTIF P24-3 TO P5-D) #24 (LATHE TAIL STOCK)
993 Z HOME SWITCH (MOTIF P24-4 TO P5-L) #24

994 HOME SWITCH RETURN (MOTIF P24-1 TO P5-C) #24

1000 SPINDLE ENCODER CABLE - SHIELD +5 (LATHE TAIL STOCK)
1001 LOGIC RETURN (D GROUND) (TO MOTIF P20-1) #24
1002 ENCODER A CHANNEL (TO MOTIF P20-2) #24
1003 ENCODER B CHANNEL (TO MOTIF P20-3) #24
1004 +5 VDC (TO MOTIF P20-4) #24
1005 ENCODER Z CHANNEL (TO MOTIF P20-5) #24

1010 KEYBOARD INPUTS FROM HORIZONTAL OPERATOR PANEL
1011 CYCLE START
1012 CYCLE START
1013 FEED HOLD
1014 FEED HOLD
1015 PART READY
1016 FIXTURE ROTATE
1017 PART RDY/FIX ROT COMMON

1020 SPINDLE TEMPERATURE SENSOR CABLE - SHIELD +3
1021 SIGNAL
1022 ANALOG RETURN
1023 +5 VOLTS TO SENSOR
1024 SHIELD GROUND

1030 SPINDLE LOAD RESISTOR - SHIELD +2
1031 REGEN LOAD RESISTOR FOR SPINDLE DRIVE (B1) #18
1032 REGEN LOAD RESISTOR FOR SPINDLE DRIVE (B2) #18

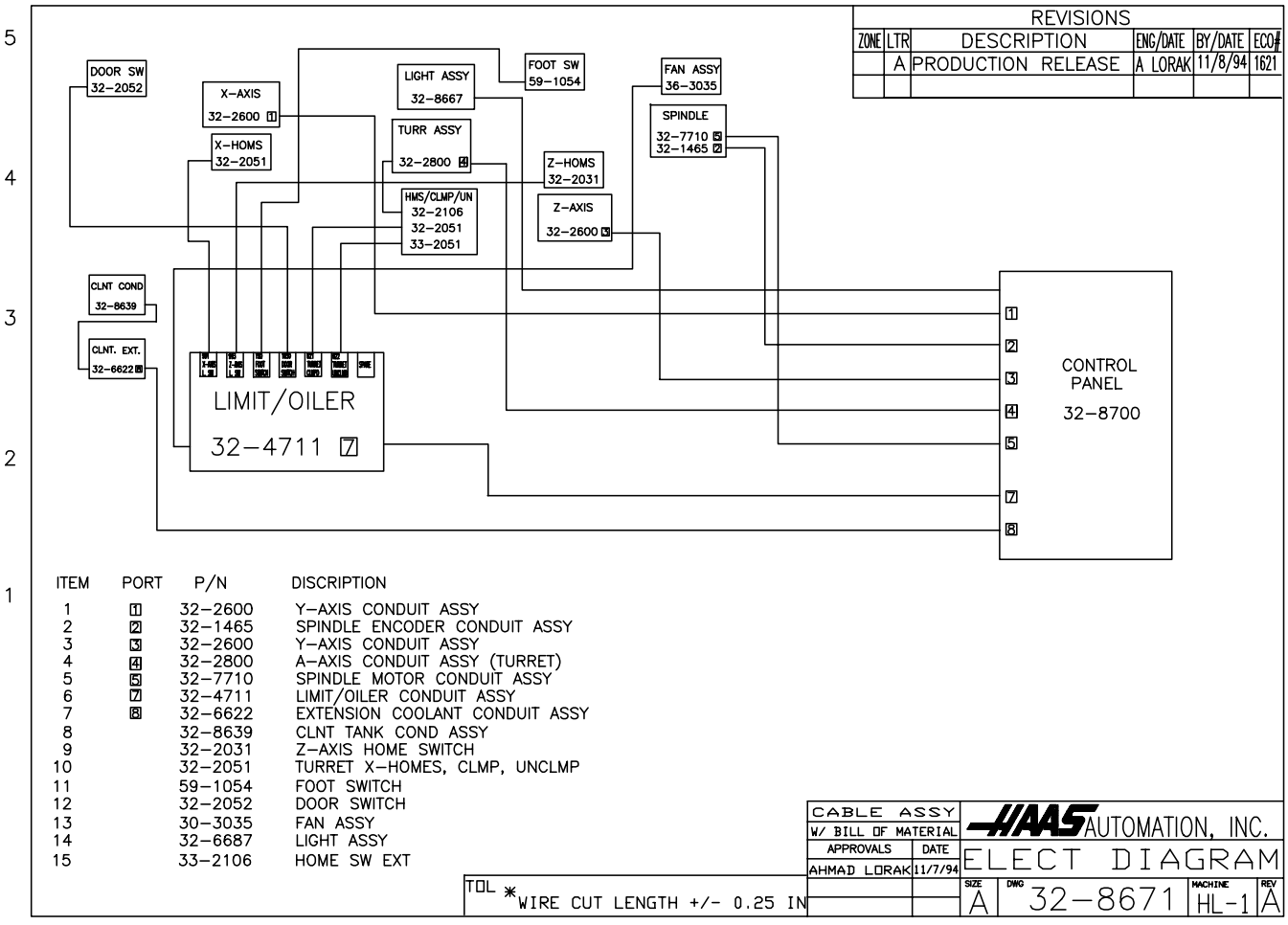
1040 Y160 (MIKRON DOOR LOCK OR HORIZONTAL PART READY LAMP)
1041 SWITCHED RELAY CONTACT
1042 SWITCHED RELAY CONTACT

1050 DOOR SWITCH WIRING THRU SUPPORT ARM - SHIELD +2
1051 DOOR OPEN SIGNAL (INPUT 9) #24
1052 DOOR OPEN RETURN (D GROUND) (65) #24

1060 GROUND FAULT DETECTION SENSE INPUT
1061 + INPUT FROM SENSE RESISTOR
1062 - INPUT FROM SENSE RESISTOR

1070 SKIP INPUT FROM SENSOR - SHIELD +2
1071 LOGIC COMMON
1072 SKIP SIGNAL

12 . CABLE LOCATION DIAGRAM



ITEM	PORT	P/N	DISCRIPTION
1	1	32-2600	Y-AXIS CONDUIT ASSY
2	2	32-1465	SPINDLE ENCODER CONDUIT ASSY
3	3	32-2600	Y-AXIS CONDUIT ASSY
4	4	32-2800	A-AXIS CONDUIT ASSY (TURRET)
5	5	32-7710	SPINDLE MOTOR CONDUIT ASSY
6	7	32-4711	LIMIT/OILER CONDUIT ASSY
7	8	32-6622	EXTENSION COOLANT CONDUIT ASSY
8		32-8639	CLNT TANK COND ASSY
9		32-2031	Z-AXIS HOME SWITCH
10		32-2051	TURRET X-HOMES, CLMP, UNCLMP
11		59-1054	FOOT SWITCH
12		32-2052	DOOR SWITCH
13		30-3035	FAN ASSY
14		32-6687	LIGHT ASSY
15		33-2106	HOME SW EXT

TOL * WIRE CUT LENGTH +/- 0.25 IN

CABLE ASSY
W/ BILL OF MATERIAL
APPROVALS DATE
AHMAD LORAK 11/7/94

HAAS AUTOMATION, INC.
ELECT DIAGRAM
SIZE A DWG 32-8671 MACHINE HL-1 REV A

TECHNICAL REFERENCE

SECTION

1. SPINDLE

- Spindle speed is selectable from 50 to 3750 RPM on the lathe.
- The spindle is hardened and ground with a A2-6 spindle nose.

2. SERVO MOTOR ENCODERS

Attached to each DC servo motor, there is an incremental encoder that is either 1000 or 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.

2.1 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).

2.2 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.

2.3 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.

2.4 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 ofdecelerating 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.

2.5 SERVO DRIVE PCB'S (DRIVER)

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, Z, B axes and to the turret 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.

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.

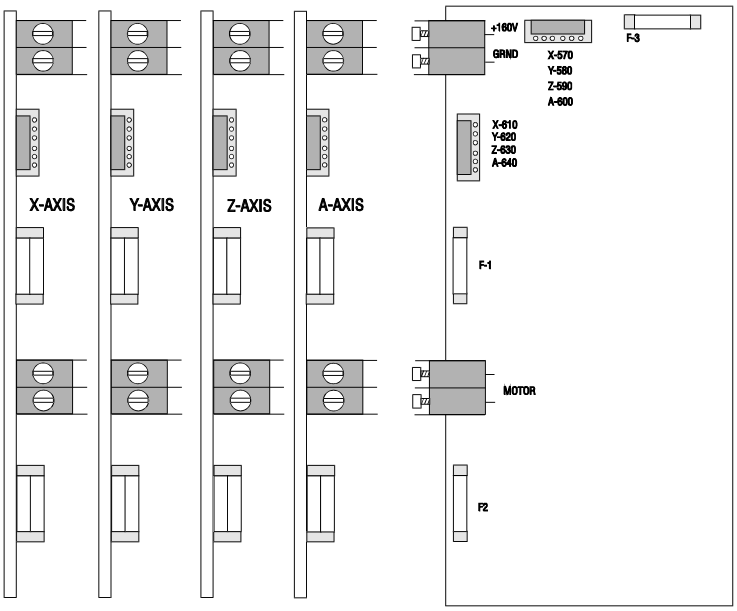


Fig. 2-1 Servo Drive Assembly.

3. INPUT/OUTPUT ASSEMBLY

The Input/Output Assembly consists of a single printed circuit board called the IOPCB.

The I/OPCB 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)
P41 Operator lamp switch connection (800A)
P43 Ground fault sense signal input (1060) Axis Brake
P44 5TH AXIS BRAKE
P45 HTC Shuttle
P46 Chip Conveyor
P47 Skip input signal (1070)
P48 Kill
P49 k210
P50 Spigot Motor (200)
P51 16 PIN Relay drivers 25-32 (540)
P52 A1 B1 Input
P53 Spigot Sense
P54 Servo Brake

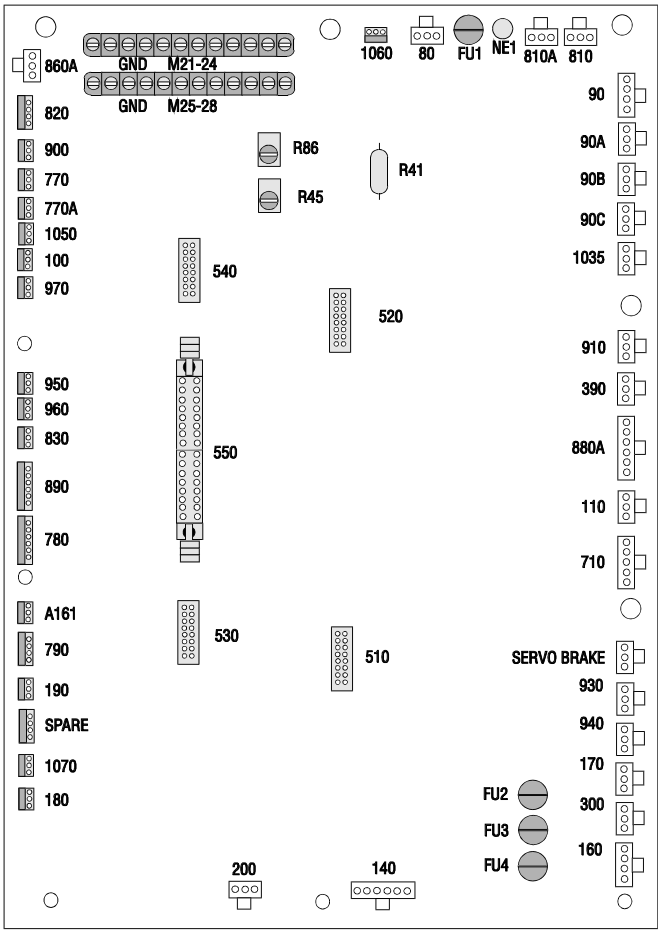


FIG. 3-1 Input/Output Board

4. CONTROL PANEL

4.1 JOG HANDLE

The JOG handle is actually a 100-line-per-revolution encoder. We use 100 steps per revolution to move one of the servo axes. If no axis is selected for jogging, turning of the crank has no effect. When the axis being moved reaches its travel limits, the handle inputs will be ignored in the direction that would exceed the travel limits.

Parameter 57 can be used to reverse the direction of operation of the handle.

4.2 POWER ON/OFF SWITCHES

The POWER ON switch engages the main contactor. The on switch applies power to the contactor coil and the contactor thereafter maintains power to its coil. The POWER OFF switch interrupts power to the contactor coil and will always turn power off. POWER ON is a normally open switch and POWER OFF is normally closed. The maximum voltage on the POWER ON and POWER OFF switches is 24V AC but this voltage is present any time the main circuit breaker is on.

4.3 SPINDLE LOAD METER

The Load meter measures the load on the spindle motor as a percentage of the rated continuous power of the motor. There is a slight delay between a load and the actual reflection of the meter. The eighth A-to-D input also provides a measure of the spindle load for cutter wear detection. The second page of diagnostic data will display % of spindle load. The meter should agree with this display within 5%. The spindle drive display #7 should also agree with the load meter within 5%.

4.4 EMERGENCY STOP SWITCH

The EMERGENCY STOP switch is normally closed. If the switch opens or is broken, power to the servos will be removed instantly. This will also shut off the tool changer, spindle drive, and coolant pump. The EMERGENCY STOP switch will shut down motion even if the switch opens for as little 0.005 seconds.

Be careful of the fact that Parameter 57 contains a status switch that, if set, will cause the control to be powered down when EMERGENCY STOP is pressed.

You should not normally stop a tool change with EMERGENCY STOP as this will leave the tool changer in an abnormal position that takes special action to correct.

Note that tool changer alarms can be easily corrected by first correcting any mechanical problem, pressing RESET until the alarms are clear, selecting ZERO RETURN mode, and selecting “AUTO ALL AXES”.

4.5 KEYBOARD BEEPER

There is a speaker inside the control panel that is used as an audible response to pressing keyboard buttons and as a warning beeper. The beeper is a one kHz signal that sounds for about 0.1 seconds when any keypad key, CYCLE START, or FEED HOLD is pressed. The beeper also sounds for longer periods when an auto-shutdown is about to occur and when the "BEEP AT M30" setting is selected.The volume of this beeper can be adjusted from pot R2 on the Keyboard Interface PCB inside the control panel. Controls built after January 1991 have this volume adjustment permanently set to high.

If the beeper is not audible when buttons are pressed, the problem could be in either the keypad or in the speaker. Check that the problem occurs with more than one button and check that the speaker volume is not turned down.

5. MICROPROCESSOR ASSEMBLY

The microprocessor assembly is in the rear cabinet at the top left position. It contains three large boards. They are: 68EC030, VIDEO, and MOTIF. All three boards of the processor assembly receive power from the low voltage power supply. The three PCB's are interconnected by a local buss on dual 50-pin connectors. At power-on of the control, some diagnostic tests are performed on the processor assembly and any problems found will generate alarms 157 or 158. In addition, while the control is operating, it continually tests itself and a self test failure will generate Alarm 152.

5.1 MICROPROCESSOR PCB (68EC030)

The Microprocessor PCB contains the 68EC030 processor running at 40 MHz, one 128K EPROM; between 256K and 4MB of CMOS RAM and betwen 512K and 1MB of FAST STATIC RAM. It also contains a dual serial port, a five year battery to backup RAM, buffering to the system buss, and eight system status LED's.

Two ports on this board are used to set the point at which an NMI* is generated during power down and the point at which RESET* is generated during power down.

The eight LED's are used to diagnose internal processor problems. As the system completes power up testing, the lights are turned on sequentially to indicate the completion of a step. The lights and meanings are:

+5V +5V logic power supply is present.
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 the EPROM is 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 the EPROM is plugged in. Test the card with the buss connectors off.

SIO Serial I/O initialization complete.
If this light does not come on, there is a problem with the serial ports. Disconnect anything on the external RS-232 and test again.

MSG Power-on serial I/O message output complete.
If this light does not come on, there is a problem with serial I/O or interupts. 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 the EPROM is 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 are (2) two-position DIP switches on the processor PCB labled S1 and S2. Switch S1-1 must be ON to auto-start the CNC operational program. If S1-1 is OFF, the PGM light will remain off. Switch 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.

Switch S2-1 is used to enable FLASH. If it is disabled it will not possible to write to FLASH.
Switch S2-2 enables the processors CACHE memory.

The processor connectors are:

J1 Address buss
P2 Data buss
P4 Serial port #1 (for upload/download/DNC) (850)
P5 Serial port #2 (for auxiliary 5th axis) (850A)
P3 Power connector
P6 Battery

5.2 MEMORY RETENTION BATTERY

The memory retention battery is initially soldered into the processor PCB. This is a 3.3V Lithium battery that maintains the contents of CMOS RAM during power off periods. Prior to this battery being unusable, an alarm will be generated indicating low battery. If the battery is replaced within 30 days, no data will be lost. The battery is not needed when the machine is powered on. Connector J6 on the processor PCB can be used to connect an external battery.

5.3 VIDEO AND KEYBOARD PCB (VIDEO2)

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

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

5.4 MOTOR INTERFACE PCB (MOTIF)

The Motor Interface PCB provides all of the interfaces to motors and discrete inputs and outputs. It contains a single pot R54 to adjust the output of the D-A converter. The MOTIF PCB connectors are:

P1 Data buss
P2 X drive control and overcurrent sense (610)
P3 Y drive control and overcurrent sense (620)
P4 Z drive control and overcurrent sense (630)
P5 A drive control and overcurrent sense (640)
P6 X-axis encoder, Z, home, and overheat (660)
P7 Y-axis encoder, Z, home, and overheat (670)
P8 Z-axis encoder, Z, home, and overheat (680)
P9 A-axis encoder, Z, home, and overheat (690)
P10 32 discrete inputs (550)
P11 Relay drives 1 to 8 (510)
P12 Relay drives 9 to 16 (520)
P13 Relay drives 17 to 24 (530)
P14 Relay drives 25 to 32 (540)
P15 Power connector (+5,+12+)
P16 D-to-A output and -12V DC (720)
P17 A-to-D inputs for DC buss voltage (980)
P18 Jog Crank input and aux 1,2 (750)
P19 Address buss
P20 Spindle encoder inputs (1000)
P21 A-to-D input for spindle temperature (1020)
P22 A-to-D input for spindle load monitor (730B)
P23 A-to-D input spare
P24 Home switch inputs X, Y, Z (990)
P25 Spare inputs
P26 A-to-D input spare
P27 A-to-D inputs spare
P28 A-to-D inputs spareP29 A-to-D inputs spare

The spindle drive is located in the main cabinet on the right side and halfway down. It operates from three-phase 200 to 240V AC. It has a 10 H.P. continuous rating, a 15 H.P. one-minute rating, and a 18 H.P. 30-sec. rating. The spindle drive is protected by CB1 at 30 amps. Never work on the spindle drive until the small red *CHARGE* light goes out. Until this light goes out, there are dangerous voltages inside the drive, even when power is shut off.

For all other data on the spindle drives, refer to the supplied documentation for your drive.

6. RESISTOR ASSEMBLY

The Resistor Assembly is located near the center of the control cabinet. It contains the servo and spindle drive regen load resistors.

6.1 SPINDLE DRIVE REGEN RESISTOR

A 20- or 30-ohm, 600-watt resistor assembly is used by the spindle drive to dissipate excess power caused by the regenerative effects of decelerating the spindle motor. If the spindle motor is accelerated and decelerated again in rapid succession repeatedly, this resistor will get hot. In addition, if the line voltage into the control is above 255V, this resistor will begin to heat. This resistor is overtemp protected at 100° C. At that temperature, an alarm is generated and the control will begin an automatic shutdown. If the resistor is removed from the circuit, an alarm may subsequently occur because of an overvoltage condition inside the spindle drive.

6.2 SERVO DRIVE REGEN RESISTOR

A 500-ohm, 100-watt resistor is used by the servo drives to dissipate excess power caused by the regenerative effects of decelerating the servo motors. If the servo motors are accelerated and decelerated again in rapid succession repeatedly, this resistor will get hot. In addition, if the line voltage into the control is above 255V, this resistor will begin to heat. This resistor is overtemp protected at 100° C. At that temperature, an automatic control shutdown is begun. If that resistor is removed from the circuit, an alarm may subsequently occur because of an overvoltage condition for the servo buss.

6.3 OVERHEAT SENSE SWITCH

There is an overtemperature sense switch mounted near the above-mentioned regen resistors. This sensor is a normally-open switch that opens at about 100°C. It will generate an alarm and all motion will stop. After four minutes of an overheat condition, an automatic shutdown will occur in the control.

7. 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.

7.1 MAIN CIRCUIT BREAKER CB1

Circuit breaker CB1 is rated at 30 amps and is used to protect the spindle drive and to shut off all power to the control. The locking On/Off handle on the outside of the control cabinet will shut this breaker off when it is unlocked. A trip of this breaker indicates a SERIOUS overload problem and should not be reset without investigating the cause of the trip. These 30 amps could correspond to as much as 15 horsepower.

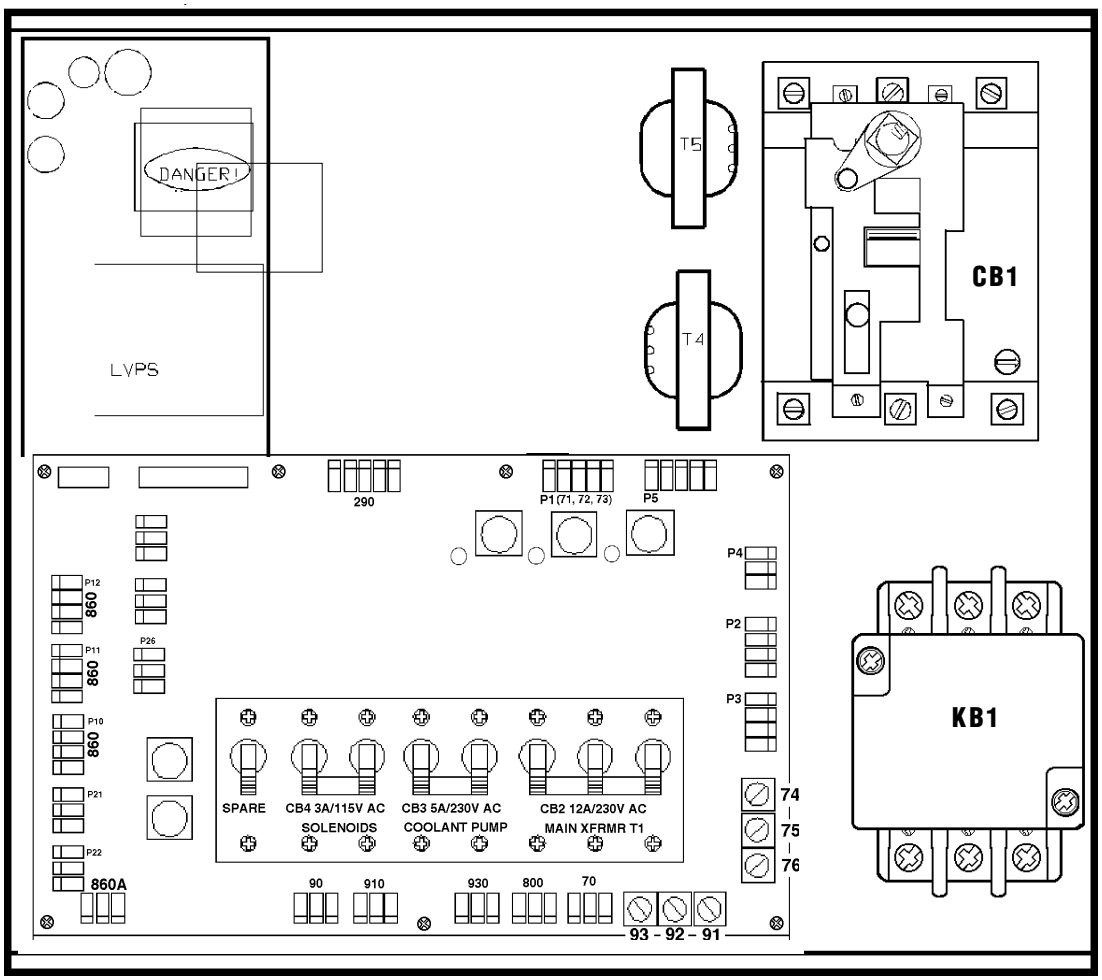


Fig. 7-1 Power Supply Assembly.

7.2 MAIN CONTACTOR K1

Main contactor K1 is used to turn the control on and off. The POWER ON switch applies power to the coil of K1 and after it is energized, an auxiliary switch on K1 continues to apply power to the coil. The POWER OFF switch on the front panel will always remove power from this contactor.

When the main contactor is off, the only power used by the control is supplied through two ½ amp fuses to the circuit that activates the contactor. An overvoltage or lightning strike will blow these fuses and shut off the main contactor.

The power to operate the main contactor is supplied from a 24V AC control transformer that is primary fused at ½ amp. This ensures that the only circuit powered when the machine is turned off is this transformer and only low voltage is present at the front panel on/off switches.

7.3 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.

7.4 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.

7.5 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.

7.6 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.

7.7 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.

7.8 POWER PCB (POWER)

The low voltage power distribution and high voltage fuses and circuit breakers are mounted on a circuit board called the POWER PCB. The following connectors are on it:

P1 Five-pin brings 230V AC three ph from main breaker
P2 On/Off connections to front panel (740)
P3 Coil and aux connections to contactor K1
P4 Auto-off connection to IOPCB (170)
P5 Low voltage control transformer to power K1
P6 230V AC from CB3 to coolant pump (930)
P7 115V AC from CB4 to IOPCB for solenoids
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 op. 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

7.9 POWER-UP LOW VOLTAGE CONTROL TRANSFORMER (T5)

The low voltage control transformer, T5, supplies power to the coil of the main contactor K1. It guarantees that the maximum voltage leaving the Power Supply assembly when power is off is 12V AC to earth ground. It is connected via P5 to the POWER PCB.

7.10 SECONDARY CIRCUIT BREAKERS

Three more circuit breakers are on the Power supply assembly.

CB2 controls the power to the servo transformers and, if tripped, will turn off the servo motors and air solenoids. CB2 also controls the 115V AC from the T1 secondary and could be blown by a severe servo overload.

CB3 controls the power to coolant pump only. It can be blown by an overload of the coolant pump motor or a short in the wiring to the motor.

CB4 controls the 115V AC to the air solenoids, 4th axis brake, and the oiler. It is never expected to trip. If it does trip, it is likely caused by a short circuit in the wiring on the I/O assembly or the wiring to the solenoids on the spindle head.

7.11 OPERATOR'S LAMP TRANSFORMER

Transformer T4 supplies low voltage to the operator's lamp. The primary is 115V AC and the secondary is 10V AC. The primary is protected at ½ amp by F6. It is connected to the POWER PCB by connector P19.

8. POWER TRANSFORMER ASSEMBLY (T1)

The power transformer assembly is used to convert three-phase 230/208V to three-phase 115V. The 115V is used primarily by the servo drives. The video monitor, solenoids, fans, and oiler also use 115V AC. This transformer's maximum input voltage is 260V @ 60 Hertz, and 240V @ 50 Hertz. It is located in the main cabinet in the lower right corner. It is a polyphase bank transformer. It is rated at 3750 VA and its primary is protected at 12 amp.

This transformer is replaced by one that is much larger and can adjust the primary voltage applied to the spindle drive. The new transformer has four voltage connections that allow for a range of inputs from 195V to 260V.

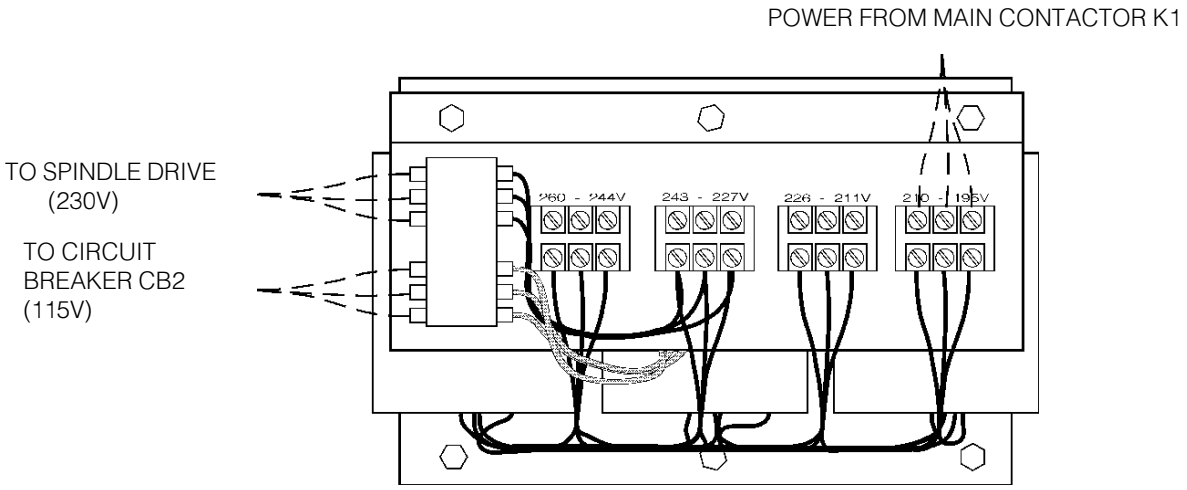


FIG. 8-1 POLYPHASE BANK TRANSFORMER ASSEMBLY.

8.1 PRIMARY CONNECTION TO T1

Input power to T1 is supplied from the power assembly through CB2; a 12 amp, three leg magnetic circuit breaker. Three-phase 230 to T1 is connected to the first three terminals of TB10. With the newer transformer, CB2 protects the secondary of transformer T1 and is rated at 25 amps.

The newer transformer acts as an auto-transformer and thus has an output connection on its primary side. This connection supplies 230V AC power to the spindle drive and coolant pump.

8.2 VOLTAGE SELECTION TAPS

With the older main transformer, terminal block TB11 is used to select the 208 or 230V taps of transformer T1. To select between 208 and 230, three terminals must be moved. The two positions for each of these terminals are marked 208 and 230.

With the newer transformer, there are four labeled plastic terminal blocks. Each block has three connections for wires labeled 74, 75, and 76. Follow the instructions printed on the transformer.

8.3 SECONDARY CONNECTION TO T1

The secondary output from T1 is 115V AC three-phase. It is available on the last three terminals of TB10.

9. FUSES

The servo drive (DRIVER) cards have three fuses on each of the X, Z, A and Y PCB's (F1, F2, F3). If these fuses are ever blown, the associated motor will stop. This will only happen if there is a failure of the drive card and the user should never attempt to replace these fuses.

The POWER PCB contains three ½-amp fuses located at the top right (FU1, FU2, FU3). If the machine is subject to a severe overvoltage or a lightning strike, these fuses will blow and turn off all of the power. Replace these fuses only with the same type and ratings. The other two fuses protect the tool changer (FU5) and the operator's lamp (FU6).

On the servo drive assembly, there is a printed circuit board (SDIST) containing three one-amp fuses (FU1, FU2, FU3). Two of these fuses protect the contactor and small transformers. They are never expected to blow. The third fuse protects the regen load circuit load from shorts.

FUSE NAME	TYPE	RATING	VOLTAGE (amps)	LOCATION	
FU1	AGC	½	250V	POWER pcb,	upper right
FU2	AGC	½	250V	"	"
FU3	AGC	½	250V	"	"
LAMP	AGC	½	250V	"	lower left
TOOL CH	ABC	5	250V	"	"
FU1	AGC	½	250V	SDIST pcb,	right center
FU2	AGC	½	250V	"	"
FU3	AGC	5	250V	"	top center
F1	ABC	20	250V	SDRIVER pcb's (X, Y, Z, A)	
F2	ABC	20	250V	"	
F3	ABC	10	250V	"	

10. SPARE USER M CODE INTERFACE

The M code interface uses outputs 21 to 24 and one discrete input circuit. M codes M21 through M24 will activate relays 25 through 28. These relay contacts are isolated from all other circuits and may switch up to 120V AC at one amp. The relays are SPDT.

The M-FIN circuit is a normally open circuit that is made active by bringing it to ground. The one M-FIN applies to all four of the user M codes.

The timing of a user M function must begin with all circuits inactive, that is, all circuits open.

The Diagnostic Data display page may be used to observe the state of these signals.

10.1 M FUNCTION RELAYS

As of January 1991, there is no longer a requirement for a separate M function relay board. The IOPCB contains position for four relays (M21-M28) and six of these are installed. In addition, M21 is already wired out to P12 at the side of the control cabinet. This is a four-pin DIN connector and includes the M-FIN signal.

10.2 M-FIN DISCRETE INPUT

The M-FIN discrete input is a low voltage circuit. When the circuit is open, there is +12V DC at this signal. When this line is brought to ground, there will be about 10 milliamps of current. M-FIN is discrete input #10 and is wired from input #10 on the Inputs PCB on the Input/Output Assembly. The return line for grounding the circuit should also be picked up from that PCB. For reliability, these two wires should be routed in a shielded cable where the shield is grounded at one end only. The diagnostic display will show this signal a “1” when the circuit is open and a “0” when this circuit is grounded.

10.3 TURNING M FUNCTIONS ON AND OFF

The four optional M code relays can also be separately turned on and off using M codes M51-M54 and M61-M64. M51 to M54 will turn on one of the eight relays and M61 to M68 will turn the relays off. M51 and M61 correspond to M21, etc.

11. LUBRICATION PUMP

The lubrication pump is powered whenever the spindle is on or any axes are in motion. It operates from 115V AC On a cyclic basis, it will pump oil to the screws and guides. It cycles at least once every 30 minutes.

11.1 LOW LUBRICATION AND LOW PRESSURE SENSE SWITCHES

There is a low lube sense switch in the oil tank. When the oil is low, an alarm will be generated. This alarm will not occur until the end of a program is reached. There is also an lube pressure switch that senses the lube pressure. Parameter 117 controls the lube pressure check. If Parameter 117 is not zero, the lube pressure is checked for cycling high within that period. Parameter 117 has units of1/50 seconds; so 30 minutes gives a value of 90000. Parameter 57, bit "Oiler on/off", indicates the lube pump is only powered when the spindle fan is powered. The lube pressure is only checked when the pump is on.

12. DOOR OPEN SENSE SWITCH

The DOOR OPEN sense switch is normally closed and wired in series. When the door is open, the switche will open and the machine will stop with a "Door Hold" function. When the door is closed again, operation will continue normally.

If the door is 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.

13. X, Z, B LIMIT SWITCHES

The machine zero position is defined by a limit switch for each of the X, Z and B 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 look-ahead 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 switche.

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, Z and B. 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.

14. 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 the alarm section 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 as described in Section 24.1.

If the machine powers up but has a fault in one of its power supplies, it may not be possible to flag an alarm condition. If this happens, all motors will be kept off and the top left corner of the CRT will have the message:

POWER FAILURE ALARM

and all other functions of the control will be locked out.

When the machine is operating normally, a second push of the PARAM/DGNOS key will select the diagnostics display page. The PAGE UP and PAGE DOWN keys are then used to select one of two different displays. These are for diagnostic purposes only and the user will not normally need them. The diagnostic data consists of 32 discrete input signals, 32 discrete output relays and several internal control signals. Each can have the value of 0 or 1. In addition, there are up to three analog data displays and an optional spindle RPM display. Their number and functions are:

DISCRETE INPUTS

#	Name	Description	#	Name	Description
1	TT UNL	TOOL TURRET UNLOCK	17	SP LOK	SPINDLE LOCKED
2	TT LOK	TOOL TURRET LOCK	18	SP FLT	SPINDLE DRIVE FAULT
3	SPARE		19	SP ST*	SPINDLE NOT STOPPED
4	LO CNT	LOW COOLANT	20	SP AT*	SPINDLE NOT AT SPEED
5	SPARE		21	LO OIL	SPINDLE/GB COOLANT LOW
6	SP HIG	SPINDLE IN HIGH	22	SPARE	
7	SP LOW	SPINDLE IN LOW	23	SPARE	
8	EM STP	EMERGENCY STOP	24	SPARE	
9	DOOR S	DOOR OPEN SWITCH	25	UNCLA*	REMOTE TOOL UNCLAMP
10	M-FIN*	NOT M FUNC FINISH	26	LO PH A	LOW VOLTAGE IN PHASE 1
11	OVERT*	OVER VOLTAGE	27	SPARE	
12	LO AIR	LOW AIR PRESSURE	28	SPARE	
13	LO LUB	LOW LUBE OIL	29	GR FLT	GROUND FAULT
14	OVRHT	REGEN OVERHEAT	30	SKIP	SKIP SIGNAL
15	SPARE		31	SPARE	
16	SPARE		32	CNVYR*	CONVEYOR OVERLOAD

DISCRETE OUTPUTS

#	Name	Description	#	Name	Description
1	SRV PO	SERVO POWER ON	17	SPARE	
2	SP FOR	SPINDLE FORWARD	18	SPARE	
3	SP REV	SPINDLE REVERSE	19	SPARE	
4	SP RST	SPINDLE RESET	20	SPARE	
5	4TH BK	4TH AXIS BRK REL	21	TT OUT	TOOL TURRET OUT
6	COOLNT	COOLANT PUMP	22	SPARE	
7	AUT OF	AUTO TURN OFF	23	SPARE	
8	SP FAN	SPIND MOTOR FAN	24	SPARE	
9	SPARE		25	M21	
10	SPARE		26	M22	
11	SPARE		27	M23	
12	SPARE		28	M24	
13	SP HIG	SPINDLE HIGH GEAR	29	M25	
14	SP LOW	SPINDLE LOW GEAR	30	M26	
15	SP UNC	SPINDLE UNCLAMPED	31	M27	
16	SP LOK	SPINDLE LOCKED	32	M28	

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
B Z CH	B-Axis Z Channel	B ZIRQ	B-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
B HOME	B-axis Home	Z IRQ	Z channel interrupt
Z HOME	Z-axis Home	SPZIRQ	Spindle Z interrupt
A HOME	A-axis Home	SELF T	Self-Test Input
X OVRH	X Motor OverTemp	X CABL	Broken cable to X encoder
B OVRH	B Motor OverTemp	B CABL	Broken cable to B 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 B	B 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	TEMPERATURE OF SPINDLE HEAD
SP LOAD	LOAD % OF SPINDLE MOTOR
SP SPEED	SPINDLE RPM/DIRECTION

15. PARAMETERS

Parameters are seldom modified-values that change the operation of the machine. These include: servo motor types, gear ratios, speeds, stored stroke limits, lead screw compensations, motor control delays and macro call selections. These are all rarely changed by the user and should be protected from being changed by the parameter lock setting.

The settings page lists some parameters that the user may need to change during normal operation and these are simply called Settings. Under normal conditions, the parameter displays should not be modified. If you need to change parameters, contact your dealer. An explanation of each of the parameters is provided here.

There are 230 parameters in this control. The first 56 apply to the individual servo axes, 14 each. The first 14 of these will be described. The other axes' parameters (15 through 56) are identical in function.

Parameter 1 X SWITCHES
Parameter 1 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

REV ENCODER	Used to reverse the direction of encoder data.
REV POWER	Used to reverse direction of power to motor.
DISABLED	Used to disable any axis.
Z CH ONLY	With A only, indicates that no home switch.
AIR BRAKE	With A only, indicates that air brake isused.
DISABLE Z T	Disables encoder Z test (for testingonly).
SERVO HIST	Graph of servo error (fordiagnostics only).
INV HOME SW	Inverted home switch (N.C. switch).
INV Z CH	Inverted Z channel (normally high).
CIRC. WRAP.	With rotary axis only, causes 360 degree wrap to return to 0.
NO I IN BRAK	With rotary axis only, removes I feedback when brake is active.
LOW PASS +1X	Adds 1 term to low pass filter.
LOW PASS +2X	Adds two terms to low pass filter.
OVER TEMP NC	Selects a normally closed overheat sensor in motor.
CABLE TEST	Enables test of encoder signals and cabling.
Z TEST HIST	History plot of Z channel test data.
SCALE FACT/3	Scale ratio is interpreted as divided by 3.

Parameter 2 X P GAIN
Proportional gain in servo loop.

Parameter 3 X D GAIN
Derivative gain in servo loop.

Parameter 4 X I GAIN
Integral gain in servo loop.

Parameter 5 X RATIO (STEPS/INCH)
The number of steps of the encoder per inchof travel. Encoder steps supply four times their line count per revolution.Thus a 2000 line encoder and a 6mm pitch screw give:
2000 x 4 x 25.4 / 6 = 33867

Parameter 6 X MAX TRAVEL (STEPS)
Max negative direction of travel from machine zero in encoder steps. Does not apply to A-axis. Thus a 20 inch travel and 2000 line encoder and 6 mm pitch screw give:
20.0 x 33867 = 677340

Parameter 7 X ACCELERATION
Maximum acceleration of axis in steps per second per second.

Parameter 8 X MAX SPEED
Max speed for this axis in steps per second.

Parameter 9 X MAX ERROR
Max error allowed in servo loop before alarm is generated. Units are encoder steps.

Parameter 10 X FUSE LEVEL
Fuse level in % of max power to motor. ,Applies only when motor in motion.

Parameter 11 X BACK EMF
Back EMF of motor in volts per 1000 RPM times 10. Thus a 63 volt/KRPM motor gives 630.

Parameter 12 X STEPS/REVOLUTION
Encoder steps per revolution of motor. Thus a 2000 line encoder gives:
2000 x 4 = 8000.

Parameter 13 X BACKLASH
Backlash correction in encoder steps.

Parameter 14 X DEAD ZONE
Dead zone correction for driver electronics.
Units are 0.0000001 seconds.

Parameter 15 Y SWITCHES
See Parameter 1 for description.

Parameter 16 Y P GAIN
See Parameter 2 for description.

Parameter 17 Y D GAIN
See Parameter 3 for description.

Parameter 18 Y I GAIN
See Parameter 4 for description.

Parameter 19 Y RATIO (STEPS/INCH
See Parameter 5 for description.

Parameter 20 Y MAX TRAVEL (STEPS)
See Parameter 6 for description.

Parameter 21 Y ACCELERATION
See Parameter 7 for description.

Parameter 22 Y MAX SPEED
See Parameter 8 for description.

Parameter 23 Y MAX ERROR
See Parameter 9 for description.

Parameter 24 Y FUSE LEVEL
See Parameter 10 for description.

Parameter 25 Y BACK EMF
See Parameter 11 for description.

Parameter 26 Y STEPS/REVOLUTION
See Parameter 12 for description.

Parameter 27 Y BACKLASH
See Parameter 13 for description.

Parameter 28 Y DEAD ZONE
See Parameter 14 for description.

Parameter 29 Z SWITCHES
See Parameter 1 for description.

Parameter 30 Z P GAIN
See Parameter 2 for description.

Parameter 31 Z D GAIN
See Parameter 3 for description.

Parameter 32 Z I GAIN
See Parameter 4 for description.

Parameter 33 Z RATIO (STEPS/INCH)
See Parameter 5 for description.

Parameter 34 Z MAX TRAVEL (STEPS)
See Parameter 6 for description.

Parameter 35 Z , ACCELERATION
See Parameter 7 for description.

Parameter 36 Z MAX SPEED
See Parameter 8 for description.

Parameter 37 Z MAX ERROR
See Parameter 9 for description.

Parameter 38 Z FUSE LEVEL
See Parameter 10 for description.

Parameter 39 Z BACK EMF
See Parameter 11 for description.

Parameter 40 Z STEPS/REVOLUTION
See Parameter 12 for description.

Parameter 41 Z BACKLASH
See Parameter 13 for description.

Parameter 42 Z DEAD ZONE
See Parameter 14 for description.

Parameter 43 TURRET SWITCHES
See Parameter 1 for description. Turret parameters take effect if setting 30 (TURRET ENABLE) is ON.

Parameter 44 TURRET P GAIN
See Parameter 2 for description

Parameter 45 TURRET D GAIN
See Parameter 3 for description

Parameter 46 TURRET I GAIN
See Parameter 4 for description

Parameter 47 TURRET RATIO (STEPS/INCH)
See Parameter 5 for description

Parameter 48 TURRET MAX TRAVEL (STEPS)
See Parameter 6 for description

Parameter 49 TURRET ACCELERATION
See Parameter 7 for description

Parameter 50 TURRET MAX SPEED
See Parameter 8 for description

Parameter 51 TURRET MAX ERROR
See Parameter 9 for description

Parameter 52 TURRET FUSE LEVEL
See Parameter 10 for description

Parameter 53 TURRET BACK EMF
See Parameter 11 for description

Parameter 54 TURRET STEPS/REVOLUTION
See Parameter 12 for description

Parameter 55 TURRET BACKLASH
See Parameter 13 for description

Parameter 56 TURRET DEAD ZONE
See Parameter 14 for description

Parameters 57 through 128 are used to control other machine ,dependent functions. They are:

Parameter 57 COMMON SWITCH 1

Parameter 57 is a collection of general purpose single bit flags used to turn some functions on and off. The left and right cursor arrows are used to select the function being changed. All values are or 1 only.

Function names are:

REV CRANK	Reverses direction of jog handle.
DISABLE T.C.	Disables tool changer operations.
DISABLE G.B.	Disables gear box functions.
POF AT E-STP	Causes power off at EMERGENCY STOP.
RIGID TAP	Indicates hardware option for rigid tap.
REV SPIN ENC	Reverses sense direction of spindle encoder.
SYNC THREADS	Threads will repeat between passes.
EX ST MD CHG	Selects exact stop in moves when mode changes.
UNDEFINED	Not presently used.
SP DR LIN AC	Enables display of Z channel test plot.
PH LOSS DET	When enabled, will detect a phase l loss.
UNDEFINED	Not presently used.
OVER T IS NC	Selects control over temp sensor as N.C.
SKIP OVERSHT	Causes Skip (G31) to act like Fanuc and overshoot sense point.
NONINV SP ST	Non-inverted spindle stopped status.
SP LOAD MONI	Spindle load monitor option is enabled.
SP TEMP MONI	Spindle temperature monitor option is enabled.
UNDEFINED	Not presently used.
ENABLE DNC	Enables DNC selection from MDI.
ENABLE BGEDT	Enables BACKGROUND EDIT mode.

ENA GRND FLT	Enables ground fault detector.
KEYBD SHIFT	Enables use of keyboard with shift functions.
ENABLE MACRO	Enables macro functions.
INVERT SKIP	Invert sense of skip to active low=closed.
HANDLE CURSR	Enable use of jog handle to move cursor.
NEG WORK OFS	Selects use of work offsets in negative direction.
UNDEFINED	Not presently used.
ENA CONVERSE	Enables Conversational programming.
OILER ON/OFF	Enables oiler power when servos or spindle is in motion.
NC OVER VOLT	Inverts sense of over voltage signal.
ALT CHAR SET	Enables alternate character set on CRT.
DOOR STOP SP	Enables functions to stop spindle and manual ops at door switch.

Parameter 58 LEAD COMPENS SHIFT
Shift factor when applying lead screw compensation. Lead screw compensation is based on a table of 256 offsets; each +\-127 encoder steps. A single entry in the table applies over a distance equal to two raised to this parameter power encoder steps.

Parameter 59 MAX FEED RATE (INCH)
Maximum feed rate in inches per minute.

Parameter 60 UNDEFINED
Not presently used.

Parameter 61 UNDEFINED
Not presently used.

Parameter 62 TURRET UNLK ERRTIME
Maximum delay allowed for tool turret to unlock. Units are milliseconds. After this time, an alarm is generated.

Parameter 63 TURRET LOCK ERRTIME
Maximum delay allowed for tool turret to lock. Units are milliseconds. After this time, an alarm is generated.

Parameter 64 TOOL CHANGE OFFSET
For turret; displacement from home switch to tool 0.

Parameter 65 NUMBER OF TOOLS
Number of tool positions in tool changer. This number must be 20 for the present VMC configuration.

Parameter 66 SPINDLE ORI DELAY
Maximum delay allowed when orienting spindle. Units are milliseconds. After this time, an alarm is generated.

Parameter 67 GEAR CHANGE DELAY
Maximum delay allowed when changing gears. Units are milliseconds. After this time, an alarm is generated.

Parameter 68 UNDEFINED
Not presently used.

Parameter 69 AIR BRAKE DELAY
Delay provided for air to release from brake on A-axis prior to moving. Units are milliseconds.

Parameter 70 MIN SPIN DELAY TIME
Minimum delay time in program after commanding new spindle speed and before proceeding. Units are miliseconds.

Parameter 71 SPIN STALL DET DLAY
Time to delay after spindle is started before spindle stall checking is started. Each unit represents 1/50 of a second.

Parameter 72 UNDEFINED
Not presently used.

Parameter 73 SP HIGH G/MIN SPEED
Command speed used to rotate spindle motor when orient ing spindle in high gear. Units are 5000/256 RPM.

Parameter 74 SP LOW G/MIN SPEED
Command speed used to rotate spindle motor when orient ing spindle in low gear. Units are 5000/256 RPM.

Parameter 75 GEAR CHANGE SPEED
Command speed used to rotate spindle motor when changing gears. Units are 5000/256RPM.

Parameter 76 LOW AIR DELAY
Delay allowed after sensing low air pressure before alarm is generated. Alarm skipped if air pressure returns before delay. Units are 1/50 seconds.

Parameter 77 SP LOCK SETTLE TIME
Required time in milliseconds that the spindle lock must be in place and stable before spindle orientation is considered complete.

Parameter 78 GEAR CHANGE REVERSE TIME
Time in milliseconds before motor direction ,is reversed while in a gear change.

Parameter 79 SPINDLE STEPS/REV
Sets the number of encoder steps per revolution of the spindle. Applies only to hard tapping option.

Parameter 80 MAX SPIN DELAY TIME
The maximum delay time control will wait for spindle to get to commanded speed or to get to zero speed. Units are milliseconds. After this time, operation will continue anyway.

Parameter 81 M MACRO CALL O9000
M code that will call O9000. Zero causes no call.

Parameter 82 M MACRO CALL O9001 same as 81
Parameter 83 M MACRO CALL O9002 same as 81
Parameter 84 M MACRO CALL O9003 same as 81
Parameter 85 M MACRO CALL O9004 same as 81
Parameter 86 M MACRO CALL O9005 same as 81
Parameter 87 M MACRO CALL O9006 same as 81
Parameter 88 M MACRO CALL O9007 same as 81
Parameter 89 M MACRO CALL O9008 same as 81
Parameter 90 M MACRO CALL O9009 same as 81
Parameter 91 G MACRO CALL O9010
G code that will call O9010. Zero causes nocall.

Parameter 92 G MACRO CALL O9011 same as 91
Parameter 93 G MACRO CALL O9012 same as 91
Parameter 94 G MACRO CALL O9013 same as 91
Parameter 95 G MACRO CALL O9014 same as 91
Parameter 96 G MACRO CALL O9015 same as 91
Parameter 97 G MACRO CALL O9016 same as 91
Parameter 98 G MACRO CALL O9017 same as 91
Parameter 99 G MACRO CALL O9018 same as 91
Parameter 100 G MACRO CALL O9019 same as 91

Parameter 101 IN POSITION LIMIT X
considered complete when not in exact stop (G09 or G61). Units are encoder steps.

Parameter 102 IN POSITION LIMIT Y
Same definition as Parameter 101.

Parameter 103 IN POSITION LIMIT Z
Same definition as Parameter 101.

Parameter 104 IN POSITION LIMIT A
Same definition as Parameter 101. Applied to the turret.

Parameter 105 HOLDING LIMIT X
Fuse level in % of max power to motor. Applies only when motor is stopped.

Parameter 106 HOLDING LIMIT Y
Same definition as Parameter 105.

Parameter 107 HOLDING LIMIT Z
Same definition as Parameter 105.

Parameter 108 HOLDING LIMIT A
Same definition as Parameter 105. Applied to the turret.

Parameter 109 D*D GAIN FOR X
Second derivative gain in servo loop.

Parameter 110 D*D GAIN FOR Y
Second derivative gain in servo loop.

Parameter 111 D*D GAIN FOR Z
Second derivative gain in servo loop.

Parameter 112 D* D GAIN FOR A
Second derivative gain in servo loop. Applied to the turret.

Parameter 113 X ACC/DEC T CONST
Exponential acceleration time constant. Units are 1/10000 seconds. This parameter provides for a constant ratio between profiling lag and servo velocity. It is also the ratio between velocity and acceleration. In conjunction with Parameter 7, it defines the speed above which exponential accel/decel is not provided.
Thus if Parameter 7 is 1200000 steps/sec/sec and this parameter is 750 (0.075 seconds); the maximum velocity for accurate interpolation should be:

1200000 x 0.075 = 90000 steps/second
For a 2000 line encoder and 6 mm screw, this would be
60 x 90000 / 33867 = 159 inches min

Parameter 114 Y ACC/DEC T CONST
Same definition as Parameter 113

Parameter 115 Z ACC/DEC T CONST
Same definition as Parameter 113

Parameter 116 A ACC/DEC T CONST
Same definition as Parameter 113. Applied to the turret.

Parameter 117 LUB CYCLE TIME
If this is set nonzero, it is the cycle time for the lube pump and the Lube pressure switch option is checked for cycling in this time. It is in units of 1/50 seconds.

Parameter 118 SPINDLE REV TIME
Time in milliseconds to reverse spindle motor.

Parameter 119 SPINDLE DECEL DELAY
Time in milliseconds to decelerate spindle motor.

Parameter 120 SPINDLE ACC/DECEL
Accel/decel time constant in steps/ms/ms for spindle motor.

Parameter 121 X BEMF BIAS
Back EMF bias for X motor. This is arbitrary units.

Parameter 122 Y BEMF BIAS
See Parameter 121 for description.

Parameter 123 Z BEMF BIAS
See Parameter 121 for description.

Parameter 124 A BEMF BIAS
See Parameter 121 for description. Applied to the turret.

Parameter 125 X GRID OFFSET
This parameter shifts the effective position of the encoder Z pulse.
It can correct for a positioning error of the motor or home switch.

Parameter 126 Y GRID OFFSET
See Parameter 125 for description.

Parameter 127 Z GRID OFFSET
See Parameter 125 for description.

Parameter 128 A GRID OFFSET
See Parameter 125 for description. Applied to the turret.

Parameter 129 GEAR CH SETTLE TIME
Gear change settle time. This is the number of one millisecond
samples that the gear status must be stable before considered in gear.

Parameter 130 GEAR STROKE DELAY
This parameter controls the delay time to the gear change soleoids when performing
a gear change.

Parameter 131 MAX SPINDLE RPM
This is the maximum RPM available to the spindle. When this speed is programmed,
the D-to-A output will be +10V and the spindle drive must be calibrated to provide
this.

Parameter 132 SPIN. X TEMP. COEF.
This parameter controls the amount of correction to the X-axis in response to heating of the spindle head. It is 10 times the number of encoder steps per degree F.

Parameter 133 SPIN. Z TEMP. COEF.
This parameter controls the amount of correction to the Z-axis in response to heating of the spindle head. It is 10 times the number of encoder steps per degree F.

Parameter 134 X EXACT STOP DIST.
Parameter 135 Y EXACT STOP DIST.
Parameter 136 Z EXACT STOP DIST.
Parameter 137 A EXACT STOP DIST.
These parameters control how close each axis must be to its end point when exact stop is programmed. They apply only in G09 and G64. They are in units of encoder steps. A value of 34 would give 34/33867 = 0.001 inch. A exact stop is applied to turret.

Parameter 138 X FRICTION FACTOR
Parameter 139 Y FRICTION FACTOR
Parameter 140 Z FRICTION FACTOR
Parameter 141 A FRICTION FACTOR
These parameters compensate for friction on each of the four axes. The units are in 0.004V. A friction factor is applied to turret.

Parameter 142 HIGH/LOW GEAR CHANG
This parameter sets the spindle speed at which an automatic gear change is performed. Below this parameter, low gear is the default; above this, high gear is the default.

Parameter 143 UNDEFINED
Not presently used.

Parameter 144 RIG TAP FINISH DIST
This parameter sets the finish tolerance for determining the end point of a rigid tapping operation.

Parameter 145 X ACCEL FEED FORWARD
This parameter sets the feed forward gain for the X-axis servo. It has no units.

Parameter 146 Y Same as Parameter 145.
Parameter 147 Z Same as Parameter 145.
Parameter 148 A Same as Parameter 145. Applied to turret.

Parameter 149 UNDEFINED
This parameter sets the delay time from pre-charge to tool release. Units are milliseconds.

Parameter 150 MAX SP RPM LOW GEAR
Max spindle RPM in low gear.

Parameter 151 UNDEFINED
Not presently used.

Parameter 152 UNDEFINED
Not presently used.

Parameter 153 SPIN FAN OFF DELAY
Delay for turning the spindle fan off after the spindle has been turned off.

Parameter 209 COMMON SWITCH 2
Parameter 209 is a collection of general purpose single bit flags used to turn some functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

LATHE T.C.	Designates control as a lathe.
RST STOPS T.C.	Tool changer can be stopped with RESET button.
M21-28 @ 540	When enabled (1), M21-M28 is installed at cable 540.
ENA CONVEYOR	Enables chip conveyor, if machine is so equipped.
50% RPD KBD	When (1) the control will support the new style keyboards with the 50% rapid traverse key. For controls without a 50% rapid keypad set this bit to (0).
FRONT DOOR	When enabled the control will look for an additional door switch and will generate an operator message.
RESERVED	
RESERVED	
RESERVED	
UNDEFINED	Not presently used.
T SUBROUTINE	When set to a 1, all references to T codes, that are not macro parameters, are replaced by a subroutine call to program O9000. The value following the T code is place in macro variable 149.
M27-M28 CONVYR	Usually the chip conveyor motor and direction relays are attached to the user relays M21
M22.	When this bit is set, the control expects to see the conveyor hooked up to M27 and M28.

LOPH A ONLY	When (0) three discrete inputs are used to detect power phase loss. When (1)only LOPH A is to detect phase loss.
GREEN BEACON	When (1) user relay M25 is used to flash a beacon. If the control is in a reset state, the beacon will be off. If the control is running normally, the beacon will be steadily on. If the control is in a M00, M01, M02, M30 feedhold, or single block state, then the beacon will flash.
RED BEACON	When (1) user relay M26 is used to flash a beacon. The beacon flashes if the control is experiencing an alarm or emergency stop condition.
CONVY DR OVRD	When (1) the conveyor will continue to run with the door open. When (0) the conveyor will stop when the door is open, but will resume when the door is closed. For safety it is recommended that the bit be set to (0).
RESERVED	
RESERVED	
RESERVED	
FLOPPY ENBL	Enables an installed floppy disk drive.
UNDEFINED	
UNDEFINED	
UNDEFINED	
UNDEFINED	
UNDEFINED	
UNDEFINED	
UNDEFINED	
UNDEFINED	
STALL DETECT	Enables detection of spindle stall. If spindle stalls, the spindle motor is stopped and an alarm is generated.
CNCR SPINDLE	When set to 0, spindle start occurs at the end of a block, as in normal M code operation. When set to 1, spindle start occurs at the beginning of a block and concurrent with axis motion.

Parameter 210 RESERVED
Parameter 211 RESERVED
Parameter 212 RESERVED
Parameter 213 RESERVED
Parameter 214 RESERVED

Parameter 215 CAROUSEL OFFSET
Parameter used to align tool 1 of tool changing carousel precisely. Units are encoder steps.

Parameter 216 CNVYR RELAY DELAY
Delay time in 1/50 seconds required on conveyor relays before another action can be commanded. Default is 5.

Parameter 217 CNVYR IGNORE OC TIM
Amount of time in 1/50 seconds before overcurrent is checked after conveyor motor is turned on. Default is 50.

Parameter 218 CONVYR RETRY REV TIM
Amount of time that the conveyor is reversed in 1/50 seconds after overcurrent is sensed. Default is 200.

Parameter 219 CONVYR RETRY LIMIT
Number of times tha the conveyor will cycle through the reverse/forward sequencing when an overcurrent is sensed before the conveyor will shut down. An overcurrent is sensed when chips jam the conveyor. By reversing and then forwarding the conveyor, the chip jam may be broken. Default is 3.

Parameter 220 CONVYR RETRY TIMEOUT
Amount of time in 1/50 seconds between consectutive overcurrents in which the overcurrents is considered another retry. If this amount of time passes between overcurrents then the retry count is set to (0). Default is 1500, 30 minutes.

Parameter 221 MAX TIME NO DISPLAY
The maximum time allowed for no update of the display. When executing short blocks at a high feed rate, the control will use the resources available for interpreting G-code and generation of motion blocks. The display may not update until this time is exceeded.
Time units are in 1/50 of a second. For high speed operation, updating of the display may cause the motion queue to become exhausted. This will manifest itself as a pause in motion. See M76 and M77 to disable the display completely.

Parameter 222 Reserved
Parameter 223 Reserved
Parameter 224 Reserved
Parameter 225 Reserved

Parameter 226 CIRC MAX FEED CNTRL
This parameter is used to limit the feed rate for circles with a small radius. This parameter limits following error to 1/4 the dimension of the radius of the circular arc. The larger the value of this parameter, the more the control will limit feed during circular interpolation.

Parameter 227 CHUCK UNCLAMP RPM
The RPM at which the chuck will not operate. If the spindle is spinning faster than this value the chuck will not open, if the spindle is spinning slower than this value the chuck will open. The default is 0 for safety.

Parameter 228 CHUCK CLAMP DELAY
The dwell time that is allowed after clamping the chuck (an M10 command). Program execution will not continue until this time has expired. Units are in milliseconds.

Parameter 229 CHUCK UNCLAMP DELAY
The dwell time that is allowed after unclamping the chuck (an M11 command). Program execution will not continue until this time has expired. Units are in milliseconds.

Parameter 230 FLOPPY DIR NAME
When the floppy drive is enabled and a floppy directory is read. The directory listing is placed into a program as comments. That program is then made the current program so that the user can read the contents of the floppy drive. This parameter designates what program is used to write the directory listing to. Program O8999 is the default value.

Parameter 231 TAILSTOCK RAPID JOG.
This value determines the maximum speed for travel allowed on the tailstock when in rapid jog mode. It is based on scaled encoder units used at low level. This affects the the tailstock rapid travel when a tail stock key and TS RAPID key is pressed simultaneously.

Parameter 232 TAILSTOCK OVERLOAD -
Determines the overload limit when the tailstock is traveling in the minus direction, toward the spindle. This is an arbitrary value based on the effective voltage being sent to the tail stock servo motor. If this valus is too low you may be unable to move the tail stock. The value for parameter 232 should be approximately 1/2 the valueof parameter 233. The default is 4000.

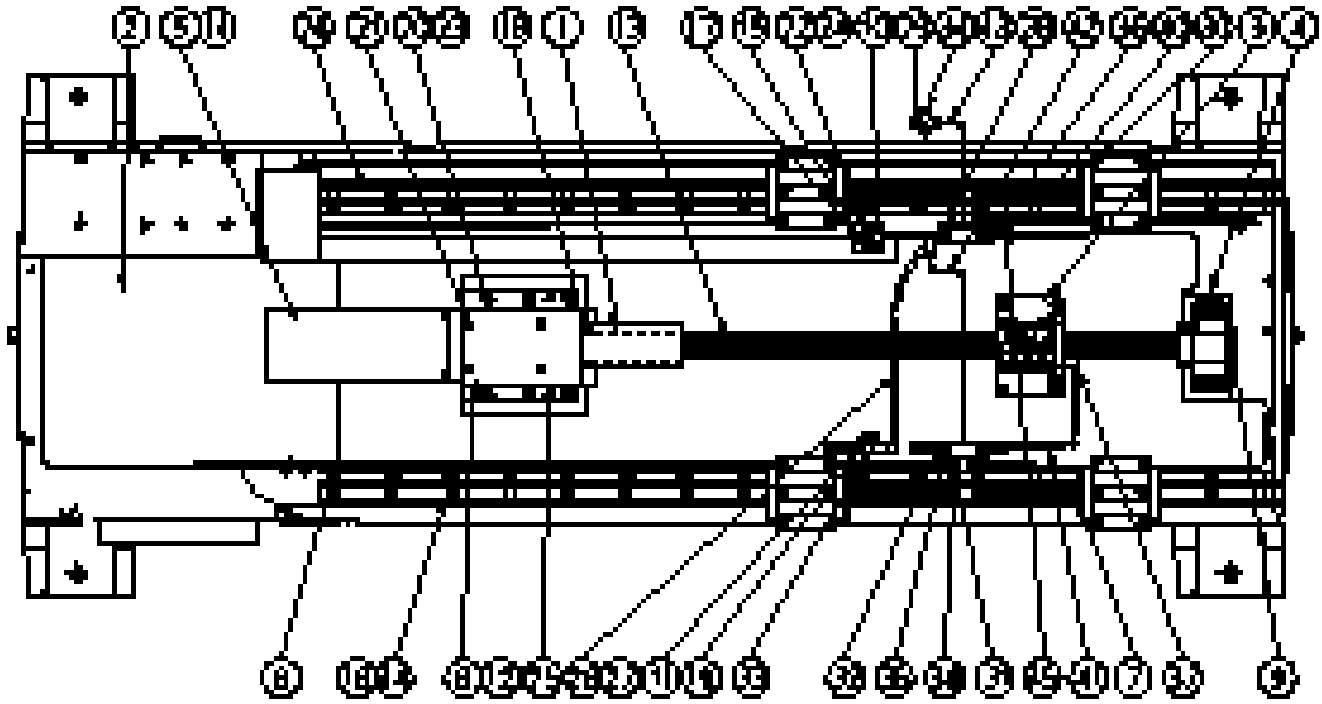
Parameter 233 TAILSTOCK OVERLOAD +
Determines the overload limit when the tailstock is traveling in the plus direction, away from teh spindle. The value of parameter 233 should be twice that of parameter 232. The default is 8000.

Parameter 234 SPINDLE CENTER
Reserved for future use.

ASSEMBLY DRAWINGS

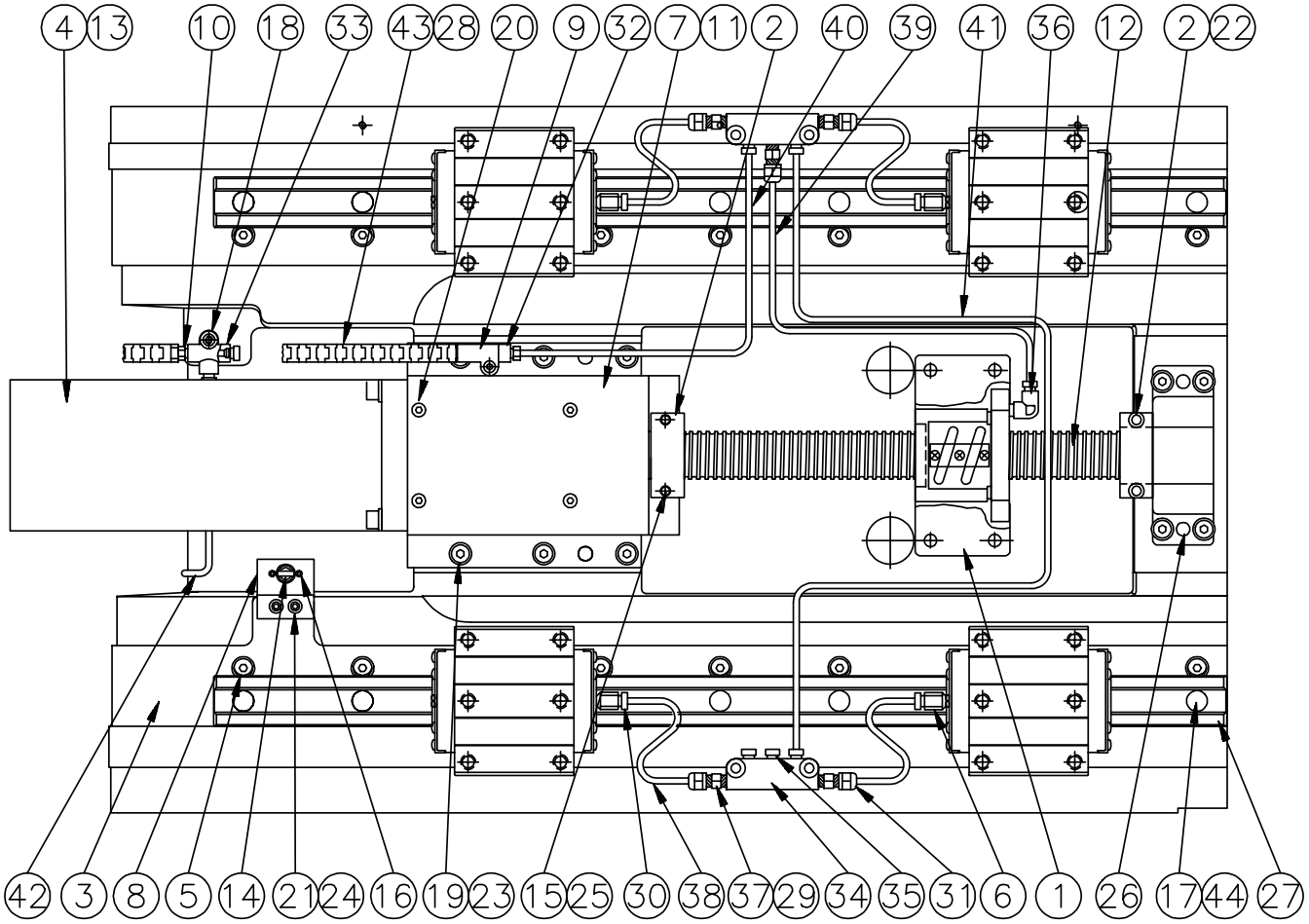
AND

PARTS LIST



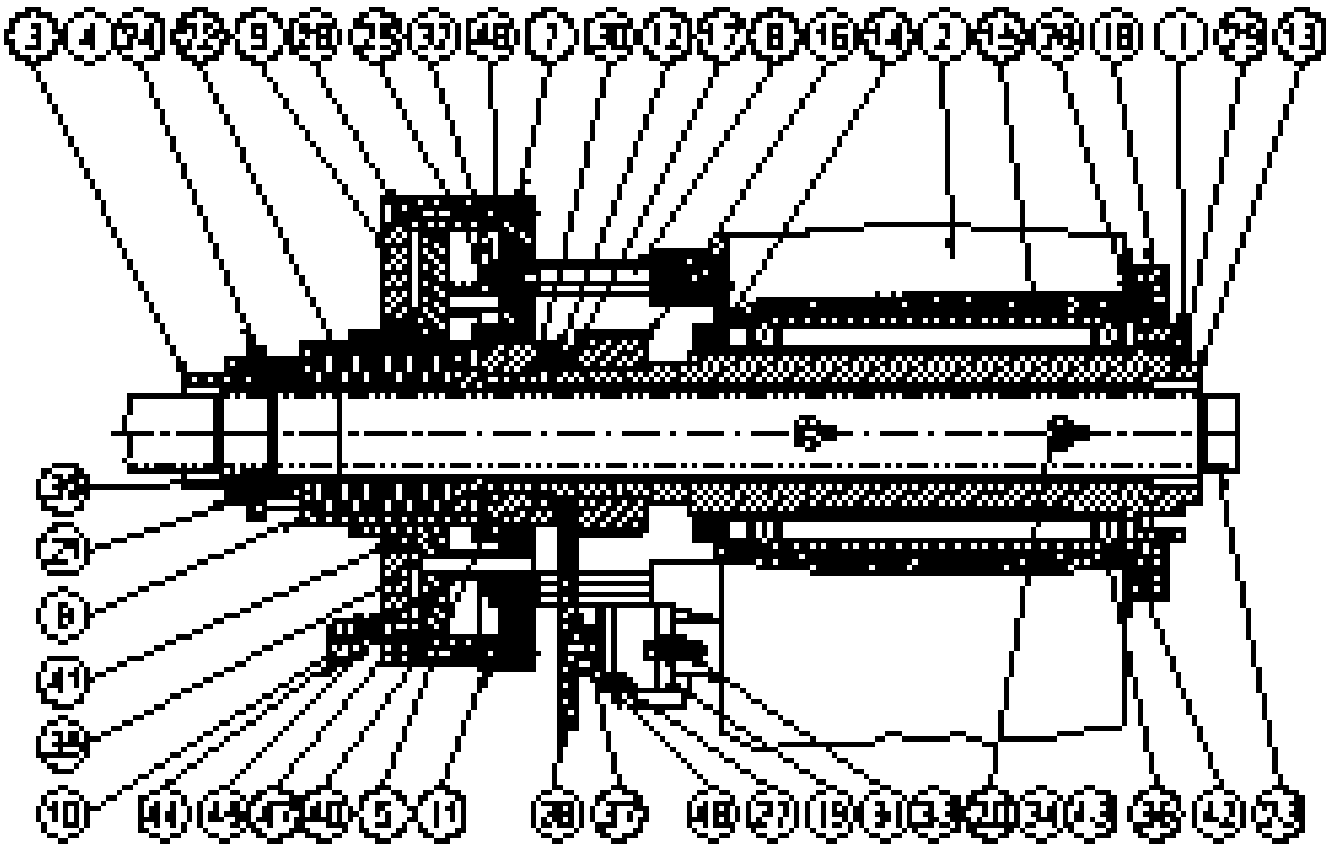
30-2600 BASIC MACHINE ASSEMBLY (BASE)

ITEM	QTY	DWG_NUM	TITLE
1	1	20-7185	BUMPER, Z AXIS, MTR END
2	1	20-8500	BASE
3	1	20-9007	NUT HOUSING
4	1	20-9096	BUMPER, Y AXIS, MTR END
5	1	22-2629	KEY, 0.1875/0.1870 SQ.
6	32	22-7458	CAM SCREW, LINEAR GUIDE
7	4	24-7325	STR FIT METRIC LINEAR GUIDE
8	1	25-7042	COVER PLATE, LEAD SCREW
9	1	25-7080	BUMPER BRACKET, BRG HSG
10	1	25-7266	X AXIS MOUNT BRACKET
11	2	25-7485	BRACKET, OIL LINE CARRIER
12	1	26-7233	GASKET
13	1	30-1210	LEAD SCREW ASSY
14	1	32-1600	Y AXIS MOTOR ASSEMBLY
15	1	32-2031	TELEMECHANIQUE 75 IN Y AXIS ASSY
16	4	40-1632	SHCS, 1/4-20 x 1/2"
17	2	40-16413	MSHCS, M3 x 5
18	34	40-1667	SHCS, 5/16-18 x 1 1/4"
19	1	40-1705	FHCS, 10-32 x 1"
20	10	40-1715	SHCS, 5/16-18 X 1 1/2"
21	4	40-1750	BHCS, 10-32 x 3/8"
22	2	40-1850	SHCS, 10-32 x 3/8"
23	10	45-1600	WASHER, SPLIT LOCK, 5/16 MED.
24	2	45-1620	WASHER, SPLIT LOCK #10
25	4	48-0045	PIN, PULL 3/8 x 1 1/2"
26	2	50-3400	LINEAR GUIDE
27	6 FT	58-2000	NYLON TUBING, 1/4 IN
28	8 FT	58-2010	NYLON TUBING, 5/32 IN
29	14	58-2100	SLEEVE, LUBE ASSY
30	13	58-2110	SLEEVE NUT
31	5	58-2111	COMPRESSION NUTS
32	4	58-2130	SLEEVE, COMP NYLON TUBING
33	1	58-2760	FITTING MANIFOLD, 2 WAY
34	1	58-2763	3 WAY JUNCTION
35	2	58-3005	FITTING MANIFOLD, 5 WAY
36	2	58-3015	CLOSURE PLUG
37	1	58-3030	ELBOW, M6-1M x 5/16-24F
38	3	58-3045	ELBOW, 5/16-24 TO 5/15-24
39	5	58-4000	FLOWMETER, FJB-3/0
40	4	58-8648	TUBE - Z AXIS TRUCKS LUBE
41	1	58-8649	TUBE, Z AXIS BALL SCREW LUBE
42	1	58-8651	TUBE, Z AXIS MANIFOLD CONN
43	1	58-8652	TUBE, Z AXIS MANIFOLD OUT
44	32	59-6600	PLUG, GUIDE RAIL
45	2	63-1031	CABLE CLAMP, 1/4"


4 13 10 18 33 43 28 20 9 32 7 11 2 40 39 41 36 12 2 22
42 3 8 5 14 21 24 16 19 23 15 25 30 38 37 29 34 35 31 6 1 26 17 44 27

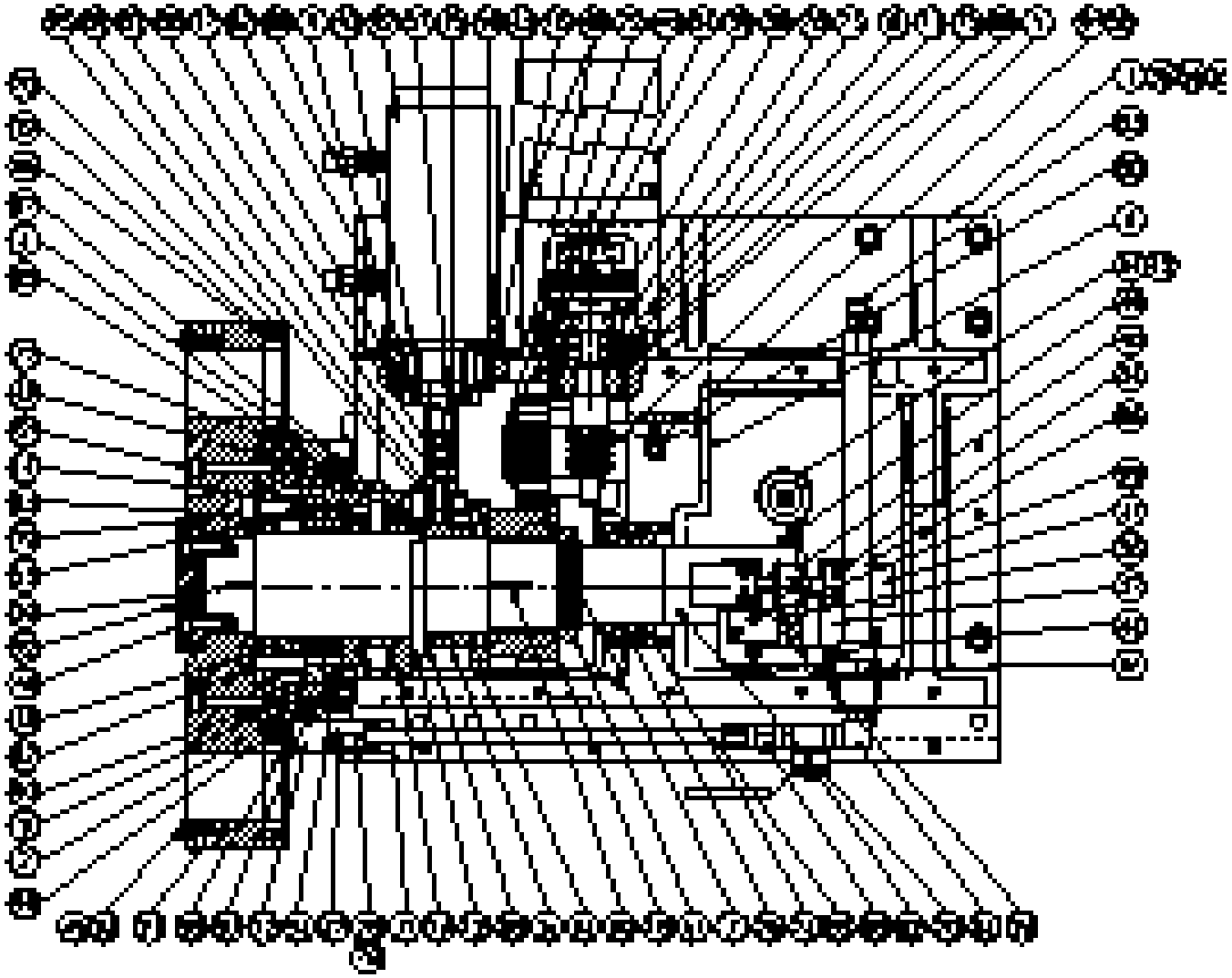
30-2610 WEDGE ASSEMBLY

ITEM	QTY	DWG_NUM	TITLE
1	1	20-7008F	NUT HOUSING, LD SCREW ASSY
2	3	20-7185	BUMPER, Z AXIS, MTR END
3	1	20-8502	CARRIAGE
4	1	22-2629	KEY, 0.1875/0.1870 SQ.
5	18	22-7458	CAM SCREW, LINEAR GUIDE
6	4	24-7352	STR FIT METRIC, LINEAR GUIDE
7	1	25-7042	COVER PLATE/LD SCREW
8	1	25-7266	X AXIS MOUNT BRACKET
9	1	25-7485	BRACKET, OIL LINE CARRIER, LEFT
10	1	25-7486	BRACKET, OIL LINE CARRIER, RIGHT
11	1	26-7233	GASKET
12	1	30-1290P	LEAD SCREW ASSY
13	1	32-1600	Y AXIS MOTOR ASSY
14	1	32-2051	TELEMECHANIQUE 168 IN CABLE ASSY
15	4	40-1632	SHCS, 1/4-20 x 1/2"
16	2	40-16413	MSHCS, M3 x 5
17	22	40-1667	SHCS, 5/16-18 x 1 1/4"
18	1	40-1705	FHCS, 10-32 x 1"
19	10	40-1715	SHCS, 5/16-18 x 1 1/2"
20	4	40-1750	BHCS, 10-32 x 3/8"
21	4	40-1850	SHCS, 10-32 x 3/8"
22	2	40-1976	BHCS, 1/4-20 x 3/4"
23	14	45-1600	WASHER, SPLIT LOCK, 5/16 MED
24	4	45-1620	WASHER, SPLIT LOCK #10 MED
25	2	45-1800	WASHER, SPLIT LOCK, 1/4" MED
26	4	48-0045	PIN PULL, 3/8 x 1 1/2"
27	2	50-8549	LINEAR GUIDE
28	1.2FT	58-2010	NYLON TUBING, 5/32 IN
29	16	58-2100	SLEEVE, LUBE ASSY
30	11	58-2110	SLEEVE NUT, LUBE ASSY
31	5	58-2111	COMPRESSION NUT
32	1	58-2760	FITTING MANIFOLD, 2 WAY
33	1	58-2763	3-WAY JUNCTION
34	2	58-3005	FITTING MANIFOLD, 5 WAY
35	3	58-3015	CLOSURE PLUG
36	1	58-3030	ELBOW, M6-1M.x 5/16-24 F
37	5	58-4000	FLOWMETER, FJB-3/0
38	4	58-8644	TUBE, X AXIS TRUCS LUBE
39	1	58-8645	TUBE, X AXIS BALL SCREW LUBE
40	1	58-8646	TUBE, X AXIS LUBE SUPPLY
41	1	58-8647	TUBE, X AXIS MANIFOLD CONN
42	1	58-8663	TUBING, TRANS Z- X
43	0.8FT	59-6150	PLASTIC CARRIER 0130.06
44	18	59-6600	PLUG, GUIDE RAIL



30-3600 SPINDLE ASSEMBLY

ITEM	QTY	DWG_NUM	TITLE
1	1	20-2717	LOCATING PIN, SRT
2	1	20-8501	SPINDLE HOUSING
3	1	20-8552	NUT, ADJ., DRAWTUBE
4	1	20-8533	NUT, LOCK, DRAWTUBE
5	1	20-8554A	HOUSING, ID, SPRING
6	1	20-8555	HOUSING, OD, SPRING
7	1	20-8556	PLATE, FLOAT, CLAMP
8	4	20-8558	STANDOFF, CLAMP, CYLINDER
9	1	20-8559	CYLINDER, DRAWTUBE
10	1	20-8560	PISTON, DRAW TUBE
11	4	20-8561	SPACER, CYLINDER
12	1	20-8562A	FLANGE, PULLEY
13	1	20-8563A	SHAFT, SPINDLE
14	1	20-8564A	RING, CLAMP
15	1	20-8565A	SPACER, BEARING
16	1	20-8566A	SHEAVE, DRIVE
17	1	20-8567A	PULLEY
18	1	20-8568	RING, RETAINER
19	2	20-8569	BLOCK, ENCODER
20	2	20-8572	NOZZLE, OIL MIST
21	1	20-8643	NUT, STOP
22	14	20-8670	BELLEVILLE, MOD
23	1	22-8551	TUBE, DRAW
24	1	40-1610	SHCS, 1/4-20 x 1"
25	4	40-1632	SHCS, 1/4-20 x 1/2"
26	6	40-1636	SHCS, 3/8-16 x 1 1/4"
27	4	40-1640	SHCS, 10-32 x 1/2"
28	4	40-16436	SHCS, 3/8-16 x 3 3/4"
29	1	40-1712	SHCS, 5/16-18 x 1/2"
30	1	44-1638	SSS, BRAS TIP 3/8-16 x 1/2"
31	2	40-16385	SHCS, 5/16-18 x 3/4"
32	4	45-0040	WASHER, HARD 1/4 “ID
33	2	45-1599	WASHER, FLAT, 5/16"
34	2	46-1720	NUT, HEX 1/2-13
35	4	48-1667	PIN, DOWEL 1/2 x 3 1/2"
36	1	51-7000	BALL BEARING
37	1	54-7129	TIMING BELT, 3/8 WIDE
38	1	54-7130	TIMING PULLEY, 3/8 BORE
39	1	56-2095	RETAIN RING, #VS-275
40	1	57-2986	0-RING, 2-452N674-70
41	1	57-2987	O-RING, 2-438E540-80
42	1	57-2989	0-RING, #265 N 70
43	1	58-3050	ELBOW, 1/4 NYLON TUBING
44	1	58-3665	1/4 NPT FEMALE TO 3/8 MALE
45	1	59-2230	1/4 NPT M-3/8 TUBE ELBOW
46	4	59-3014	SPRING
47	4	59-3018	COMP. SPRING, #C0975-105-3500
48	1	60-1810	ENCODER, 2000 LINE



30-9700 TOOL CHANGER ASSY, HL-1

ITEM	QTY	DWG_NUMBER	TITLE
1	1	20-8503	TOOL CHANGER HOUSING, MACHINED
2	1	20-8505	COUPLING, TURRET FEMALE
3	1	20-8506	COUPLING, TURRET MALE
4	1	20-8507	MOUNT, COUPLING TURRET
5	1	20-8509	WORM, TOOL CHANGER
6	1	20-8510	SHAFT, TRANSFER T/C
7	1	20-8511A	GEAR, CLUSTER, T/C
8	1	20-8512	WORM HOUSING, T/C
9	1	20-8513	NUT, AIR CYLINDER
10	1	20-8514	RING, AIR CYLINDER
11	1	20-8515	CLAMP, BEARING, WORM, T/C
12	1	20-8516	LEVER CAM
13	2	20-8517	CAM, TURRET, T/C
14	1	20-8518	RETAINER, SPRINGS, T/C
15	1	20-8519	COUPLING, AIR CYLINDER
16	1	20-8520	HOUSING, AIR CYLINDER, T/C
17	1	20-8521	RING, CLAMP, AIR CYLINDER
18	1	20-8522A	GEAR, SPUR, T/C
19	10	20-8523	NUT, TOOL HOLDER
20	1	20-8530	SHAFT, TURRET, T/C
21	1	20-8531	TURRET, T/C
22	1	20-8532	RETAINER TURRET, T/C
23	1	20-8533	RING, SWITCH, T/C
24	1	20-8537	RETAINER, SPRING, T/C
25	1	20-8538	SPACER, ROD END, T/C
26	1	20-8539	BEARING, REAR, T/C
27	1	20-8541	SHAFT, XFER, COOLANT, T/C
28	1	20-8542	HOUSING, XFER, COOLANT, T/C
29	1	20-8543	KEY, TURRET, T/C
30	1	20-8544	KEY, GEAR SPUR, T/C
31	1	20-8550	SPACER BELLEVILLE
32	1	20-8557	BUSHING FRONT, TURRET
33	10	22-2065	LOCATING PIN
34	2	24-4010	BELLEVILLE WASHER
35	1	25-7459	TRIP BRACKET, TABLE
36	1	25-8534	BRACKET, HOME SWITCH
37	1	25-8536	BRACKET, LIMIT SWITCH, T/C
38	1	30-1220P	COUPLING ASSEMBLY
39	1	32-1308	TURRET MOTOR ASSEMBLY
40	1	32-2010	TELEMECH. 24 IN CABLE ASSY
41	2	32-2051	TELEMECH. 168 IN CABLE ASSY
42	14	40-1500	SHCS, 5/16-18 x 1
43	8	40-1610	SHCS, 1/4-20 x 1"
44	2	40-1631	SHCS, 1/4-20 x 3/8"
45	13	40-1632	SHCS, 1/4-20 x 1/2"
46	8	40-1636	SHCS, 3/8-16 x 1 1/4"
47	2	40-16385	SHCS, 5/16-18 x 3/4"
48	8	40-1639	SHCS, 3/8-16 x 1"
49	2	40-16403	SSS, CUP PT 10-32 x 1/4"
50	1	40-1643	SHCS, 3/8-16 x 2 1/2"
51	10	40-1675	SHCS, 5/16-18 x 2 1/4"

ITEM	QTY	DWG_NUMBER	TITLE
52	5	40-1715	SHCS, 5/16-18 x 1 1/2"
53	3	40-1716	SHCS, 5/16-18 x 1 3/4"
54	6	40-1800	SHCS, 8-32 x 3/4"
55	2	40-1801	SHCS, 8-32 x 3/8"
56	4	40-1850	SHCS, 10-32 x 3/8"
57	1	43-1614	HHB, 1/2-20 x 1 1/2"
58	2	43-7006	HHB, 5/16-18 x 1"
59	2	45-1620	WASHER, SPLIT LOCK #10 MEDIUM
60	1	46-1805	JAM NUT, HEX 1/2-20
61	1	46-7016	BEARING NUT, N-13
62	4	49-1010	SHOULDER BOLT, 3/8 x 1 1/2"
63	1	49-1011	ROD-END, AIR CYLINDER
64	1	49-4115	WASHER, STEEL
65	4	51-2983	THRUST WASHER
66	10	51-2984	THRUST WASHER
67	2	51-3001	BEARING, THRUST NEEDLE ASSY
68	1	51-7001	BALL BEARING
69	1	51-9056	SPHERICAL BEARING
70	10	56-2090	RETAIN RING, RR-300
71	1	56-2091	RETAIN RING, #500-56
72	1	56-9057	RETAIN RING, N5100-150
73	1	56-9058	RETAIN RING, N5100-78
74	1	57-1045	SEAL, TURRET SHAFT
75	1	57-2022	O-RING, 2-150 BUNA
76	1	57-2129	SEAL, WORM SHAFT
77	1	57-2150	O-RING, 2-172 PARKER
78	2	57-2151	O-RING, #013 ALL SEALS
79	1	57-2154	O-RING, #240 ALL SEALS
80	1	57-2831	O-RING, 2-130 BUNA
81	1	58-1680	ANCHOR CONNECTOR
82	1	58-3053	3/8 NPT FEM x FEM BALL VALVE
83	1	58-3083	HOSE BARB 1/2 OD x 1/2 FPT
84	1	58-3086	MALE ELBOW 1/2 MPTX 3/8 MPT
85	2	58-3087	COMP STR FIT 1/2 x 3/8 MPT
86	1	58-3505	NIPPLE, 1/2-14 NPT x 10"
87	2	58-3665	1/4 NPT FEMALE TO 3/8 MALE
88	2	58-3680	1/4 NPT M-3/8 STR TUBE
89	1	58-8657	TUBING, COOLANT FRONT
90	3	59-2056	3/4 STEEL BALLS
91	1	59-2057	5/16 STEEL BALL
92	1	59-2743	AIR CYLINDER, T/C
93	4	59-3011	SPRING, TURRET COUPLING
94	1	59-3013	SPRING, COOLANT SHAFT
95	1	59-7226	RUBBER WASHER
96	1	57-2104	O-RING