

REVOLUTION

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1.3 Your Safety Is Important

Safety precautions are listed both here and throughout this manual. Operators and maintenance personnel must read and understand these warnings completely before setting up, operating, or maintaining this machine.

1.3.1 Conventions

This manual uses the following conventions:

DANGER Describes hazards or unsafe practices which WILL result in death or severe injury. Example:

DANGER

High voltage in the electrical enclosure will shock, burn, or kill. Unplug the machine before changing the fuses.

WARNING Describes hazards or unsafe practices which could cause severe personal injury. Example:

WARNING

Moving machine parts can seriously injure untrained operators. Understand all instructions before operating this machine.

CAUTION Describes hazards or unsafe practices which could cause mechanical damage or void the machine warranty. Example:

CAUTION

To avoid machine damage, use recommended lubricants.

NOTE Describes information that is useful but not safety-related. Example:

NOTE

The hand wheel turns clockwise only.

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1.3.2 General Safety Practices

This list includes general safety practices. Specific warnings are described throughout this manual.

1. Wear safety glasses, ear plugs, and safety shoes while operating the machine. Keep your safety equipment clean and in good condition for maximum protection. Follow company and OSHA safety rules.
2. Keep clear of the machine during operation. Never lean or reach into the machine to remove chips or to adjust the machine while it is running. Doing so can cause serious personal injury or death.
3. When setting up or servicing the machine, disconnect it from the power source and lock it out. Failure to do so could result in the machine accidentally being turned on, seriously injuring you or another operator.
4. Keep all cords and hoses away from moving machine parts during operation. If the cords become tangled in the machinery the operator could be seriously injured and the machine extensively damaged.
5. Properly ground all machines. Be sure the electric power source matches the requirements of the machine and complies with all electric codes.
6. This machine is not intended to be used in potentially explosive environments.
7. Do not operate this machine until all personnel have received adequate orientation and training to fully understand safe setup, operation, and maintenance procedures.
8. Use power hoists or other mechanical lifting devices to lift heavy equipment. Before lifting, be sure the hoist is securely holding the load. Do not exceed the rated load capacity of the hoist.
9. Because this machine is CNC controlled, it will not stop during operation. To avoid being seriously injured or killed by the machine, stay clear of the machine during automatic operation.

Minuteman III CNC Mill

2.0 SPECIFICATIONS & DIMENSIONS

Table	12" x 54" Hardened and ground surface. Coolant channels and dual return hoses to sump.
T Slots	Three 5/8" ground T slots on 2½" centers.
Coolant System	¼ hp pump with sump cast in machine base. 1 flex hose nozzle and control valve standard. Coolant pump is controlled either manually or by CNC control from program.
Castings	Stress relieved, Meehanite iron castings. Heavy sections with substantial ribbing for strength.
X Axis	39" travel. Hardened and ground dovetail way with Turcite lining and tapered gibs.
Y Axis	18" travel. Hardened and ground box type ways with Turcite and tapered gibs.
Z Axis	20" travel with full CNC control. Hardened and ground box type ways with tapered gibs. Turcite not used here to give extra rigidity under high loads. Head is fully counterweighted with counterweight inside column.
Leadscrews	Ground Grade 5, 1.24" (32 mm) diameter, .195" (5 mm) pitch with ABEC 7 bearings.
Lubrication	Automatic. Directly piped to all ways and leadscrew ball nuts. Automatic low oil shutdown of machine.
Spindle construction	40 NMTB taper standard, CAT 40 optional. Large size ABEC 7 angular contact bearings for excellent rigidity in heavy cuts.
Spindle power and range	5 hp with back gear for range from 60 to 4200 rpm. 5000 rpm optional with inverter.
Spindle drive	Standard with vari-speed pulley manually controlled. AC inverter with programmable control by CNC. Optional timing belt drive, 1:1 ratio
Quill	Hard chromed and ground with 5.80" travel. Manual quill may be power fed at rates of .0015", .003", or .006" ipr.
Quill diameter	4.13" hard chromed and ground with ground, close-fit quill housing bore.
CNC control	486 32-bit PC based control designed by Centroid of Harris, PA.

Minuteman III CNC Mill

2.0 SPECIFICATIONS & DIMENSIONS (cont'd)

Computer	8 Mb memory standard. 850 Mb hard disk, two RS-232 serial ports with DNC standard, printer port, CRT, and sealed membrane keyboard with tactile feedback (PC keyboard optional). 14" VGA color monitor standard. Servos and amplifiers: X and Y axes 29 in-lb motors, 1.5:1 drive. Z axis 40 in-lb 2:1 drive. 12 amp digital amplifier.
Electrical system	Industrial design with standard components and liquid-tight conduits for rugged environments.
Machine weight	Approximately 5800 lbs net, 6500 lbs ship. Crate 72" x 72" x 96" high.

Minuteman III CNC Mill

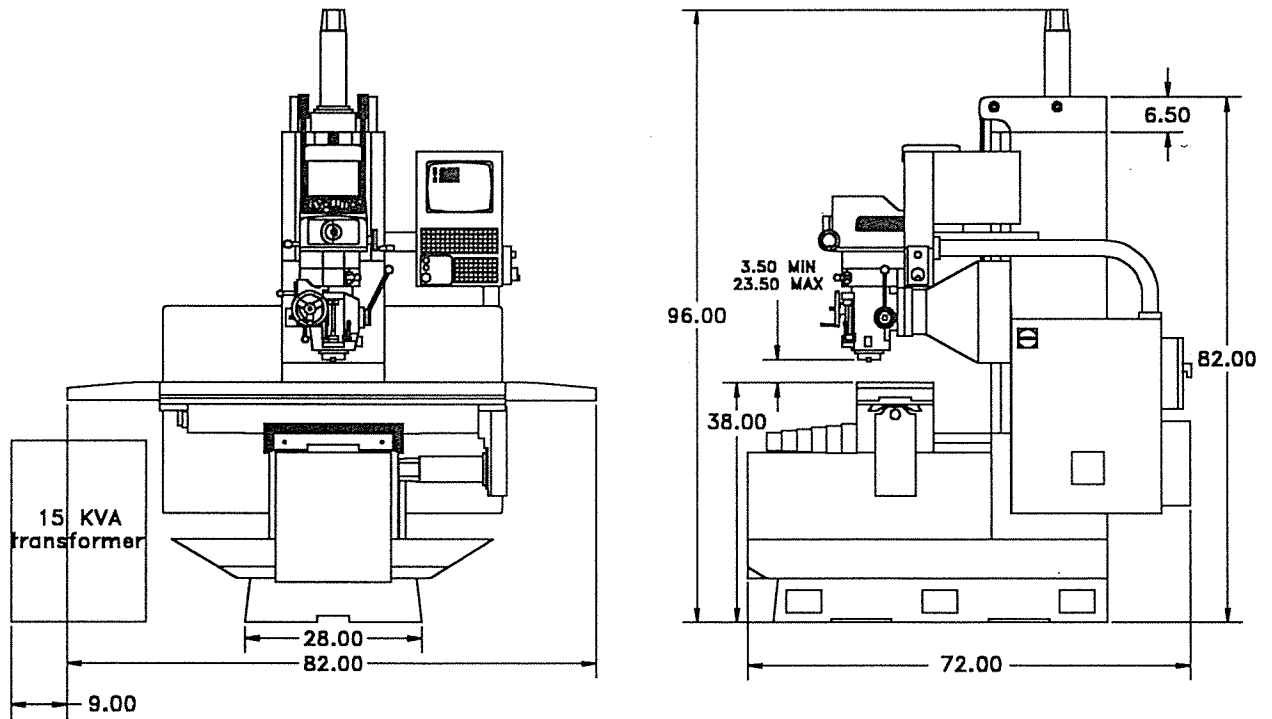


Fig. 2-1 Basic Dimensions

Minuteman III CNC Mill

	Head (Variable Speed)
Power	5 hp
Motor RPM	1800 RPM std 5000 RPM opt
Speed Ranges (rpm): Low High	60 - 500 RPM 500 - 4200 RPM
Quill Travel Quill Diameter	5.8" 4.13"
Spindle Taper	ISO #40
Quill Power Feed Rate	.0015"/Rev. .003"/Rev. .006"/Rev.
Drilling Capacity - Manual	1.00" diameter
Drilling Capacity - Power	.75" diameter
Boring Capacity	6.0" diameter
Milling Capacity	3.0 cu.in./min.
Spindle to Column:	18.0"

Fig. 2-2 Milling Head Specifications

Minuteman III CNC Mill

3.0 MACHINE CONTROLS

3.1 SPINDLE BRAKE

The Spindle Brake can be pulled down to stop the spindle. When locking the spindle, move the lever right or left and then raise it. The brake is not serviceable; it must be replaced when it wears out.

CAUTION

To avoid damaging the spindle, release the Spindle Brake before starting the spindle motor.

3.2 POWER FEED ENGAGEMENT KNOB

CAUTION

Do not use Power Feed at speeds above 3000 rpm.

The Power Feed Engagement Knob engages the power feed worm gear. When the arrow points backward, the power feed is engaged.

CAUTION

To avoid damaging the power feed worm gear, slowly engage the power feed while the spindle is turning. The gear can be disengaged at any time.

To disengage the feed, pull the knob out and turn the crank clockwise while moving it to the opposite position.

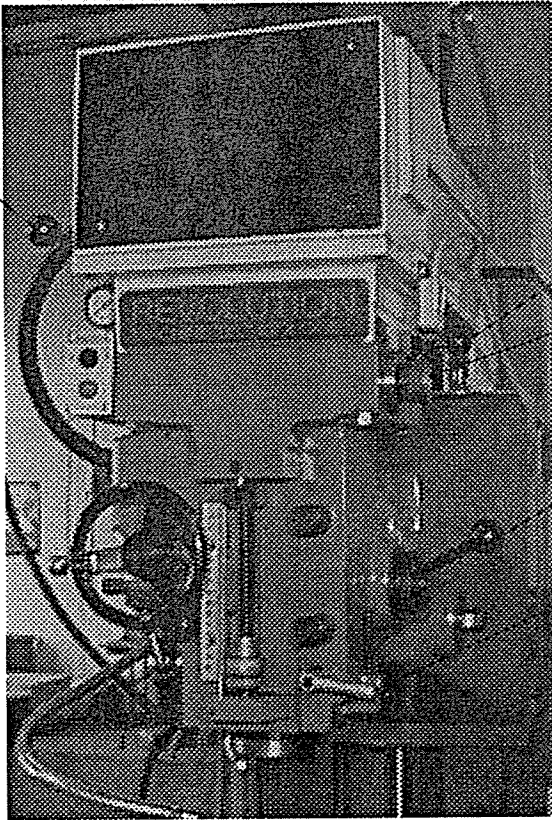
NOTE

To engage or disengage the Power Feed Crank, turn the handle clockwise while repositioning the crank.

To avoid excessive wear on the power feed worm gear, disengage the power feed when it is not in use.

Minuteman III CNC Mill

Spindle Brake



Quill Feed On/Off

Spindle HI/LOW Range Lever

Manual Quill Feed

Adjustable Quill Feed Stop

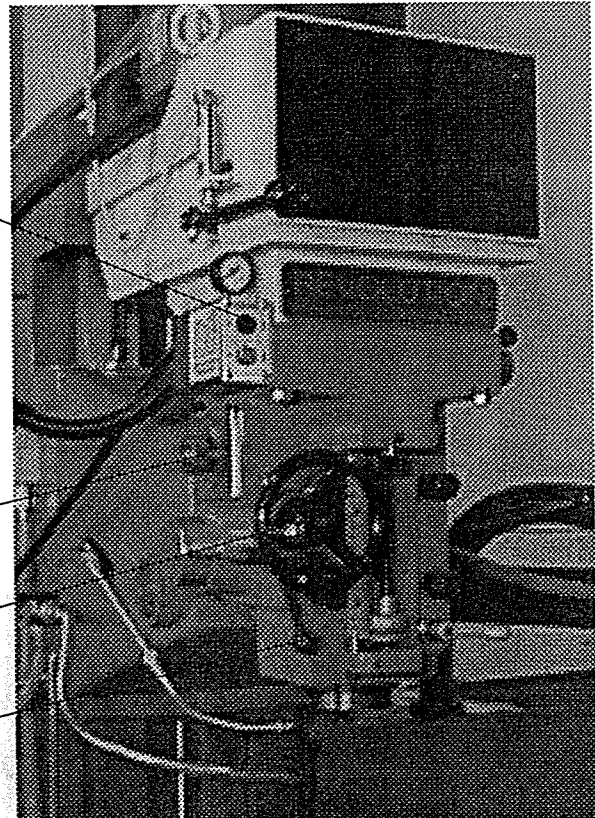
MINUTEMAN III MILLING HEAD

Power Drawbar

Quill Feed Adjusting Knob

Microfeed Handwheel

Quill Power Feed Engagement Knob



3.3 QUILL FEED SELECTOR

The Quill Feed Selector is used to select the desired quill feed speed. To select a feed speed, pull the knob out and move it to the desired position. Be sure the knob seats completely.

Feed speeds are stamped below each hole.

NOTE

It is easier to change the feed speed while the spindle is turning.

3.4 MANUAL FEED HAND WHEEL

CAUTION

Before using the Manual Feed Hand Wheel, the Feed Reversing Knob must be in NEUTRAL and the Feed Control Lever must be engaged.

The Manual Feed Hand Wheel feeds the quill up and down. To manually feed the quill:

1. Place the Feed Reversing Knob in NEUTRAL.
2. Engage the Feed Control Lever.
3. Turn the hand wheel clockwise to move the quill down or counterclockwise to move the quill up.
4. To disengage the hand wheel, pull it out approximately 1/8".

NOTE

The Manual Feed Hand Wheel can be taken off when not in use.

3.5 FEED REVERSING KNOB

The Feed Reversing Knob sets the direction the tool rotates. The position of this knob depends upon the direction that the spindle is rotating. When boring with right-hand cutting tools, pull the Feed Reversing Knob toward you until the clutch engages. NEUTRAL is located between FORWARD and REVERSE.

NOTE

Leave the Feed Reversing Knob in NEUTRAL when not in use.

3.6 FEED CONTROL LEVER

The Feed Control Lever engages the overload clutch on the pinion shaft when moved to the left. The clutch will stay engaged until:

1. The quill stop comes contacts the micrometer adjusting nut, automatically disengaging the Feed Control Lever

OR

2. The Feed Control Lever is moved to the right.

The Feed Control Lever is factory set to disengage automatically when the quill stop contacts the micrometer adjusting nut or the throw out pin at the top. If the lever goes out of adjustment, it may easily be reset by adjusting the socket set screw at bottom of trip rod.

NOTE

Lubricate the trip mechanism
with WD-40 to insure proper operation.

CAUTION

After adjusting the socket set screw, be sure
the Feed Control Lever will automatically
disengage in both directions (against the
feed trip lever and against the reversing trip ball lever).

3.7 MICROMETER ADJUSTING NUT AND LOCKNUT

The Micrometer Nut is used to set the depth of cut. Each graduation on the nut equals .001" and reads directly to the scale mounted along the side. The Micrometer Nut Quill Stop Knob can be used together to mill to a specified depth.

3.8 QUILL LOCK

The Quill Lock is a friction lock that holds the quill in position. Use the Quill Lock any time you want to mill without the quill moving.

3.9 QUILL FEED HANDLE

The Quill Feed Handle is used to manually feed the quill up and down. Turn the handle clockwise to raise the quill; turn the handle counterclockwise to lower the quill.

3.10 QUILL STOP KNOB

The Quill Stop Knob is used to disengage the power quill feed in either direction as well as act as a depth stop when milling to a specific depth.

3.11 HIGH-NEUTRAL- LOW MOTOR SPEED LEVER

CAUTION

To avoid damaging the motor,
do not shift the Motor Speed Lever
while the motor is running.

The Motor Speed Lever shifts the milling head into either High Range (Direct Drive), Neutral, or Low Range (Back Gear). When changing the direction of the milling head, rotate the spindle by hand to facilitate meshing of clutch or gears.

The machine has two feed ranges:
90 - 625 rpm (Low Range)
625 - 5000 rpm (High Range)

Low Range of 60 - 500 rpm is obtained through the back gear drive. To engage the back gears:

1. Hold the spindle gears so that they clear each other.
2. Manually rotate the spindle until the gears line up.
3. Shift the lever to LO.

High Range of 500 - 4200 rpm is obtained through direct drive. To engage the direct drive gears:

1. Hold the spindle gears so that they clear each other.
2. Manually rotate the spindle until the gears line up.
3. Shift the lever to HI.

NEUTRAL, at the midway position of the lever, permits free spindle rotation for indicating and setup.

After an extended period of use, the mill in Neutral may be noisy due to the clutch teeth rubbing against each other. To correct this:

1. Loosen the set screw.
2. Reverse the detent plate.

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3. Retighten the set screw.

In High Range (Direct Drive), the spindle is driven by tapered clutch teeth. If the clutch teeth do not mesh tightly, a clutch rattle will be heard. To correct this, move the detent plate upward as the clutch wears.

3.12 SPEED CHANGE HAND WHEEL

The Speed Hand Wheel is used to set the spindle rpm on the standard mill. Mills with timing belt options do not have this adjustment.

CAUTION

**To avoid damaging the machine,
do not change the spindle rpm
unless the spindle motor is running.**

The machine has two feed ranges:

60 - 500 rpm (Low Range)

500 -4200 rpm (High Range)

Dial speeds are approximate. Belt wear may cause a slight variation in speed from what is indicated on the dial.

3.13 DRAWBAR

The drawbar holds the tooling inside the spindle. It has a 5/8" right-hand thread and should be tightened with normal pressure using the wrench furnished with the machine.

The spindle must be locked before tightening or loosening the drawbar. To lock the spindle:

1. Raise the quill all the way.
2. Turn the Spindle Brake, located on the left side of the belt housing, either right or left until it binds.

To remove a collet and tool, back off the drawbar. If the collet does not come out of the spindle, lightly tap the top of the drawbar. Because the spindle has nonstick taper, the collet and tool should slide out.

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Material	Feet Per Minute		
	Rough Cuts	Rough and Finish Cuts	Light and Finish Cuts
Cast Iron - Soft (<200 Brinnell)	70 fpm	80 to 90 fpm	120 fpm
Cast Iron - Medium (200 to 300 Brinnell)	55 fpm	60 to 70 fpm	90 fpm
Cast Iron - Hard (>300 Brinnell)	40 fpm	50 to 60 fpm	70 fpm
Steel (Chrome Nickel 40 to 45 Shore)	30 fpm	40 fpm	50 fpm
Steel (Stainless)	60 fpm	80 fpm	90 fpm
Steel (Low Carbon)	80 fpm	90 fpm	140 fpm
Steel (High Carbon)	40 fpm	50 fpm	70 fpm
Bronze (Medium)	90 fpm	120 fpm	150 fpm
Bronze (Hard)	65 fpm	90 fpm	130 fpm
Brass (Hard)	100 fpm	150 fpm	200 fpm
Copper	150 fpm	200 fpm	300 fpm
Duraluminum	400 fpm	---	600 fpm
Aluminum	600 fpm	---	1000 fpm

**Fig. 4-1 Recommended General Speeds
for High-Speed Steel Cutters**

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Feet Per Minute	15	20	25	30	40	50	60	70	80	90	100
Diameter (Inches)	Revolutions Per Minute										
1/16"	917	1222	1528	1833	2445	3056	3667	4278	4889	5500	6112
1/8"	458	611	764	917	1222	1528	1833	2139	2445	2750	3056
3/16"	306	407	509	611	815	1019	1222	1426	1630	1833	2037
1/4"	229	306	382	458	611	764	917	1070	1375	1375	1528
5/16"	183	244	306	367	489	611	733	856	978	1100	1222
3/8"	153	204	255	306	407	509	611	713	815	917	1019
7/16"	131	175	218	262	349	437	524	611	698	786	873
1/2"	115	153	191	229	306	382	458	535	611	688	764
5/8"	91	122	153	183	244	306	367	428	489	550	611
3/4"	76	102	127	153	204	255	306	357	407	458	509
7/8"	65	87	109	131	175	218	262	306	349	393	437
1"	57	76	95	115	153	191	229	267	306	344	382
1-1/8"	50	67	84	102	136	170	204	238	272	306	340
1-1/4"	45	61	76	91	122	153	183	214	244	275	306
1-3/8"	41	55	69	83	111	139	167	194	222	250	278
1-1/2"	38	50	63	76	102	127	153	178	204	229	255
1-5/8"	35	47	58	70	94	118	141	165	188	212	235
1-3/4"	32	43	54	65	87	109	131	153	175	196	218
1-7/8"	30	40	50	61	81	102	122	143	163	183	204
2"	28	38	47	57	76	95	115	134	153	172	191

Fig. 4-2 Cutting Speeds & Feeds

5.0 OPTIONAL SETUPS

5.1 REMOVING THE TABLE

1. Remove the ball crank, all handles, dial holders, and bearing brackets.
2. Remove the bearing bracket from the left end of the table carriage.
3. Remove the X axis belt cover. Loosen the belt.
4. Remove the X axis servo motor pulley from the leadscrew.
5. Remove the oil line to the table.
6. Loosen both left and right table gibs.
7. Attach a hoist to the table.
8. Slide the table to the left to remove it from the saddle.

5.2 REMOVING THE SADDLE

1. Remove the cover from the front of the mill base.
2. Remove the Y axis servo motor belt
3. Loosen the saddle gibs and then remove them.
4. Support the saddle carriage with a hoist

WARNING

To avoid damaging the saddle and seriously injuring or killing a worker, be sure the hoist is securely holding the saddle when you remove it from the machine.

5. Remove the Y axis servo motor.
6. Reach up inside the mill base from the front and remove the four bolts holding the leadscrew nut to the saddle carriage.
7. Slide the saddle off the machine.

1.0 UNCRATING AND SETTING UP THE MACHINE

1.1 UNCRATING THE MACHINE

CAUTION

To avoid machine damage, do not move the table, knee, saddle, or ram until all ways have been well cleaned and lubricated.

To uncrate the machine:

1. Carefully remove the top and side plywood panels from the machine, being careful not to mar or damage the machine. In the event of damage in transit, IMMEDIATELY notify Revolution Machine Technologies as well as the transportation company making the delivery.
2. Unbolt the machine from the skid.
3. Using a forklift rated to lift at least 8000 lbs and having 48" long forks, lift the machine from the skid. Remove the 4x4 supports from the base.
4. Set the machine on pads and level it.
5. Mount the Z axis servo motor to the machine.
6. Have an electrician connect the power to the machine. Turn on the machine.
7. Jog the Z axis up. Remove the block under the head on the table.
8. Jog the Z axis down. Remove the counterweight shipping bar in the column.
9. The three ball crank handles may be turned to face the machine for shipping. If this is the case, reverse the handles before setting up, adjusting, or operating the machine.

1.2 CLEANING THE MACHINE

Thoroughly clean protective coating from machine with suitable cleaning solution such as WD-40.

WARNING

To avoid serious injury and machine damage, do not use gasoline or any other highly flammable solvent to clean the machine.

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I.3 LIFTING AND PLACING THE MACHINE ON A SOLID FOUNDATION

CAUTION

To avoid machine damage, do not move the table, knee, saddle, or ram until all ways have been well cleaned and lubricated.

Prepare the foundation:

CAUTION

To prevent machine movement or tipping due to off-center loading, secure the machine to a solid foundation.

1. Check that the foundation is large enough to fully support the entire base of the machine.
2. Be sure the foundation will hold the machine. Hold-down bolts are suggested.

CAUTION

Bolt down the machine to avoid machine damage or serious personal injury from the machine tipping over if a heavy part is shifted off-center on the table.

3. If setting the machine on a concrete foundation, use grout (or thin mortar) to provide complete contact between the machine base and the foundation.
4. If the foundation is uneven, have shims available to level the machine later.

Mount the machine to the foundation:

WARNING

To avoid serious personal injury and to prevent machine damage, do not lift or suspend the machine over people.

CAUTION

The machine should be hoisted only by a qualified rigger using the proper equipment.

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1. Using a suitable lifting device, lift the machine onto the foundation. Be sure the machine is centered and squared on the foundation.
2. Double check that all support jack bolts are in contact with the foundation (or shims). Tighten the hold-down bolts.

CAUTION

To avoid twisting the column and binding the ways, be sure the machine is centered and in full contact with the foundation.

2.0 PREPARING THE MACHINE

2.1 LEVELING THE MACHINE

To level the machine:

1. Set a precision level lengthwise on the table.
2. Using the leveling screws, level the machine in the lengthwise direction.
3. Set the level crosswise on the table.
4. Using the leveling screws, level the machine in the crosswise direction.
5. Repeat Steps #1 through #4 until the machine is level.

2.2 ALIGNING THE MILLING HEAD

For precision work the milling head must be square with the table.

To align the milling head along the X axis:

1. Loosen the four lock nuts located on the front of the milling head.
2. Mount a dial indicator to the quill as shown in Fig. 2-2.
3. Adjust the vertical adjusting worm shaft on the right side of the milling head until the dial reads consistently as you rotate the spindle one full turn.
4. Evenly tighten the locknuts first to 25 ft-lbs torque then to 50 ft-lbs torque.
5. Remove the dial indicator.

CAUTION

To avoid distorting the quill,
do not overtighten the locknuts.

2.3 GIB ADJUSTMENT

2.3.1 Saddle/Table Gib Adjustment

The table has two tapered gibs in the saddle and adjusting screws on the right and left sides. To adjust the gibs:

1. Crank the handle to move the saddle along the table.

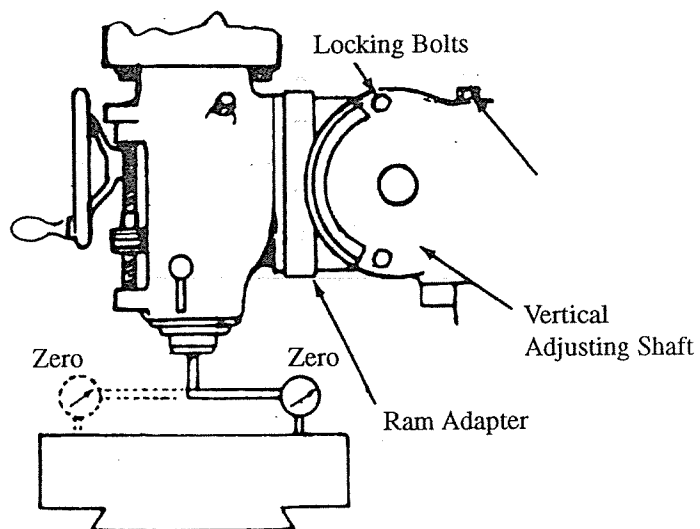


Fig. 2-1 Head Alignment (Y Axis)

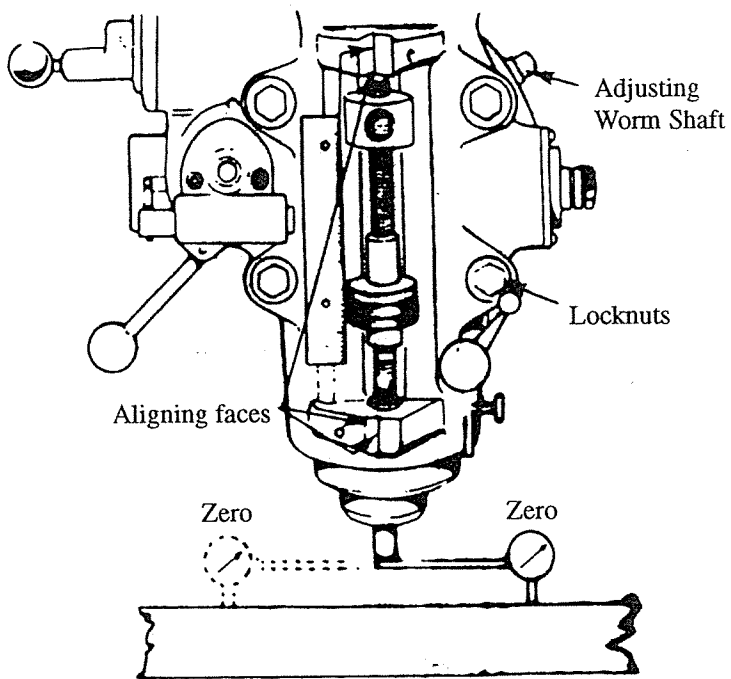


Fig. 2-2 Head Alignment (X Axis)

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2. Jog the table both left and right several times to lubricate the gibs. Jog the table to the left about 4" from center.
3. Loosen both gib adjusting screws on the left side of the table.
4. Using your fingers, push the left gib in until it stops. Bring the nuts up to the gib bracket and lock.
5. Jog the table to the right about 4" from center.
6. Loosen both gib adjusting screws on the right side of the table.
7. Using your fingers, push the right gib in until it stops. Bring the nuts up to the gib bracket and lock.
8. Fill the way oil reservoirs with way oil.

2.3.2 Saddle Bearing/Knee Gib Adjustment

Three tapered gibs are used for adjusting the saddle bearing on the knee. This forms a guide for the saddle. To tighten the gib:

1. Remove the Y axis way cover on the front.
2. Remove the chip wipers on the front and back of the Y axis slide.
3. Crank the handle to move the saddle along the knee.
4. When the saddle is fully engaged along the table, tighten the gib adjusting screw until there is a slight drag when the saddle is moved manually. Two screws are on each gib, one at each end. Loosen the screw at the back of the slide and tighten the screw at the front of the slide to tighten the gib.
5. Replace the chip wipers and way cover after gibs have been adjusted.
6. Fill the way oil reservoirs with way oil.

2.3.3 Knee/Column Gib Adjustment

1. Remove the chip wiper.
2. Adjust the three column gib screws until the knee moves smoothly.
3. Replace the chip wiper.

2.4 TOOLING RECOMMENDATIONS

1. Use 2-, 3-, or 4-flute end mills.
2. When using shell mills, face mills, or any other tooling, follow standard milling safety practices.

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3. Power feed can be used with drill bits up to $\frac{3}{4}$ " in diameter in mild tool steel. The overload clutch is preset to withstand 400 lbs of downward pressure on the quill. For drill bits over $\frac{3}{4}$ " in diameter use manual feed.

CAUTION

The overload clutch is
not field serviceable.

3.0 MAINTENANCE

3.1 RECOMMENDED LUBRICANTS

LUBRICANT	BRAND	WHERE USED
Way Oil	Sunoco Waylube #80	Way surfaces and leadscrews
Light Oil	SAE 10 or 10W light oil	Milling Heads and Spindle Bearings

3.2 WAY MAINTENANCE

Clean the ways frequently during operation. Lubricate them periodically with way oil to insure smooth travel.

3.3 LEADSCREW MAINTENANCE

Clean the leadscrew frequently during operation. Hand lubricate it with way oil periodically to insure smooth travel.

3.4 TABLE MAINTENANCE

Clean the table frequently during operation. Lubricate it periodically to insure smooth travel.

3.5 SADDLE MAINTENANCE

Clean the saddle frequently during operation. Lubricate it periodically to insure smooth travel.

3.6 MILLING HEAD MAINTENANCE

3.6.1 High-Neutral-Low Lever Maintenance

After an extended period of use, the clutch teeth of the High-Neutral-Low Lever may rub together, causing noise. To correct this

After an extended period of use, the mill in Neutral may be noisy due to the clutch teeth rubbing against each other. To correct this:

1. Loosen the set screw.
2. Reverse the detent plate.
3. Retighten the set screw.

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In High Range (Direct Drive), the spindle is driven by tapered clutch teeth. If the clutch teeth do not mesh tightly, a clutch rattle will be heard. To correct this, move the detent plate upward as the clutch wears.

3.6.2 Vari-Drive Belt Maintenance

Wear on the Vari-Drive belt will cause the machine speed to be different from the speed shown on the dial. To correct the problem:

1. Crank the Speed Change Hand Wheel snugly against the High Speed Stop (near the 4200 reading on the dial).
2. Set a tachometer to verify the spindle speed.
3. Loosen the jam nut.
4. Turn the pivot nut until the spindle registers 4200 on the tachometer.
5. Tighten the jam nut.
6. Reposition the speed dial plate to match the tachometer reading:
 - Loosen the hex nut until the spindle speed reads 4200 on the tachometer.
 - Tighten the jam nut.

For information about changing the drive belt or timing belt, see Section 3.7 VARI-DRIVE MOTOR MAINTENANCE

3.6.3 Quill Maintenance

Do not loosen the three hex nuts on the upper part of the Quill Housing. These are factory set and are used only for alignment.

3.7 VARI-DRIVE MOTOR MAINTENANCE

3.7.1 Removing the Motor

WARNING

To avoid serious injury from a live motor, turn off and lock out the electric power source.

1. Disconnect the power and lock out the power source.
2. Remove the switch from the side of the belt housing.
3. Remove the Motor Pulley Cover.

Minuteman III CNC Mill

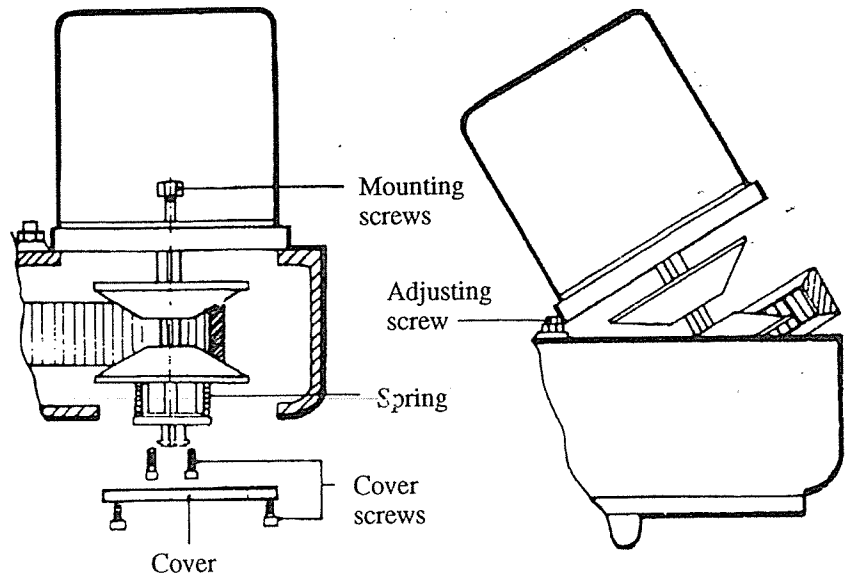


Fig. 3-1 Removing the Vari-Motor

WARNING

To avoid serious personal injury from the quick release of the Motor Shaft Spring, secure the spring to the lower drive pulley with two of the cover screws.

4. Use two of the cover screws to fasten the Motor Shaft Spring to the lower motor drive pulley.
5. Crank the speed change hand wheel to the top speed position.
6. Remove the two screws holding the Vari-Drive motor to the belt housing. This will pull the belt against the spindle pulley, making belt removal easier.
7. Lift the motor high enough to GENTLY rest the motor base on the adjusting screw.

CAUTION

To avoid damaging the adjusting screw, do not drop the motor onto the screw during disassembly.

8. Slip the belt from the lower pulley.
9. Remove the motor from the belt housing.

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3.7.2 Changing the Vari-Drive Belt

1. Remove the Vari-Drive motor as described in Section 3.8.1 "Removing the Motor."
2. Remove the three top bearing cap screws. Lift off the top bearing cap.
3. While looking down inside the housing, locate and remove the two socket-head cap screws and sleeves.
4. Remove the six set screws holding the belt housing base to the gear housing.
5. Remove and replace the belt. Use only Bando Variable Belt #875vs or equivalent.

CAUTION

To avoid vibration and heat, use only the recommended replacement belt.

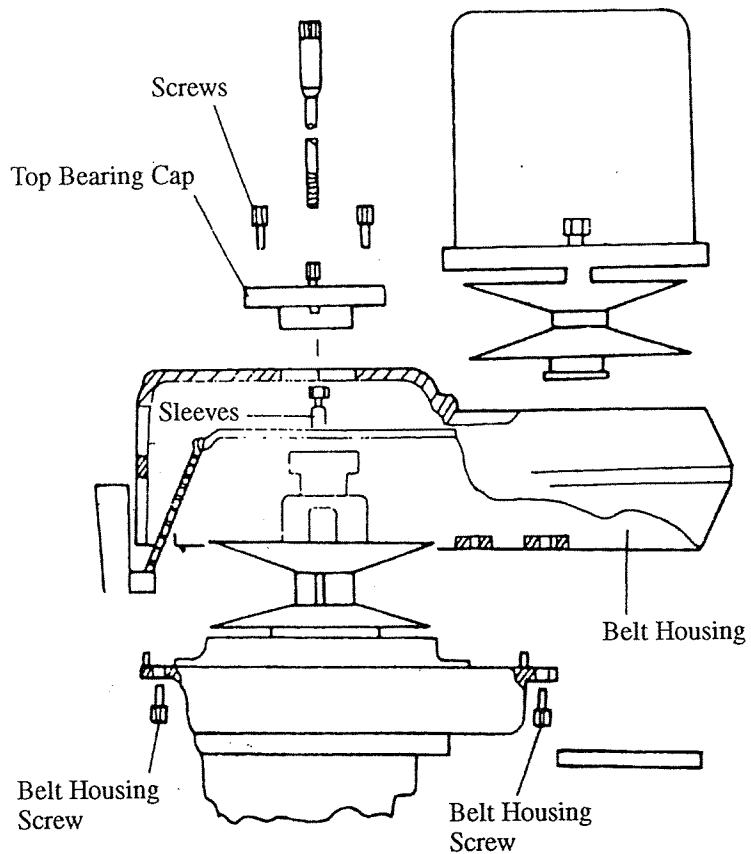


Fig. 3-2 Removing the Vari-Drive Belt

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3.7.3 Changing the Back Gear Timing Belt

1. Remove the Vari-Drive motor as described in Section 3.8.1 "Removing the Motor."
2. Put the High-Neutral-Low Lever in the Low position.
3. Remove the drawbar.
4. Lower the spindle.
5. Remove the screws holding the belt and gear housings together. Also remove the two lower screws in the speed changer bracket just below the speed dial. Lightly tap the speed changer bracket to separate the housings.
6. Gently push the belt off the large pulley as the upper housing is being raised.
7. Remove and replace the belt.

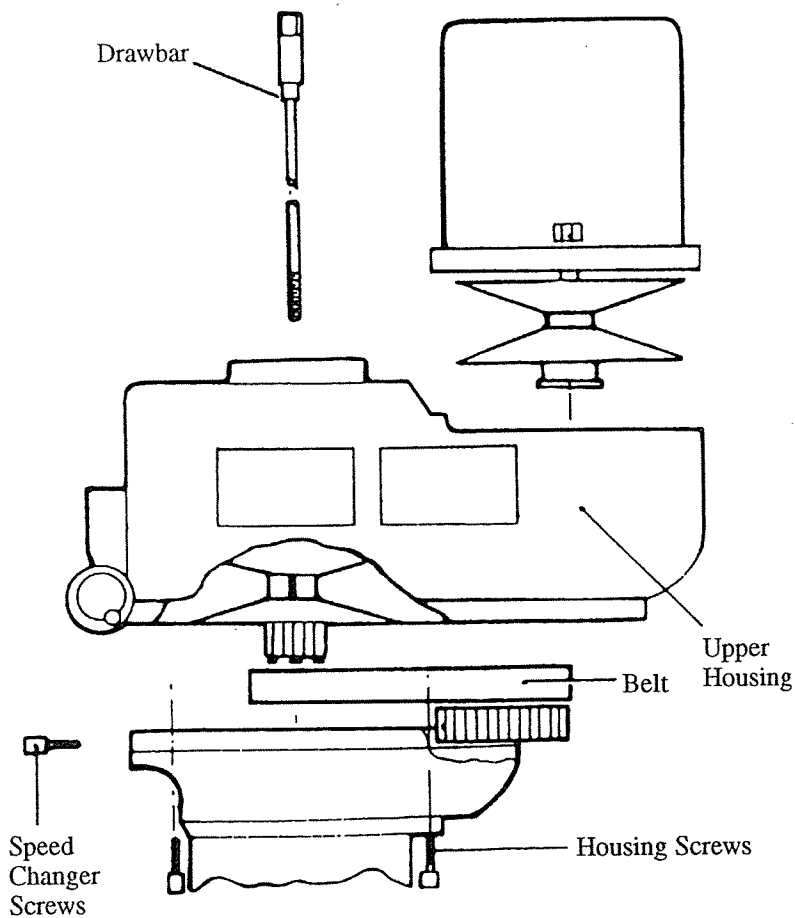


Fig. 3-3 Removing the Back Gear Timing Belt

3.7.4 Vari-Drive Motor Maintenance

The electric motors are greased for life.

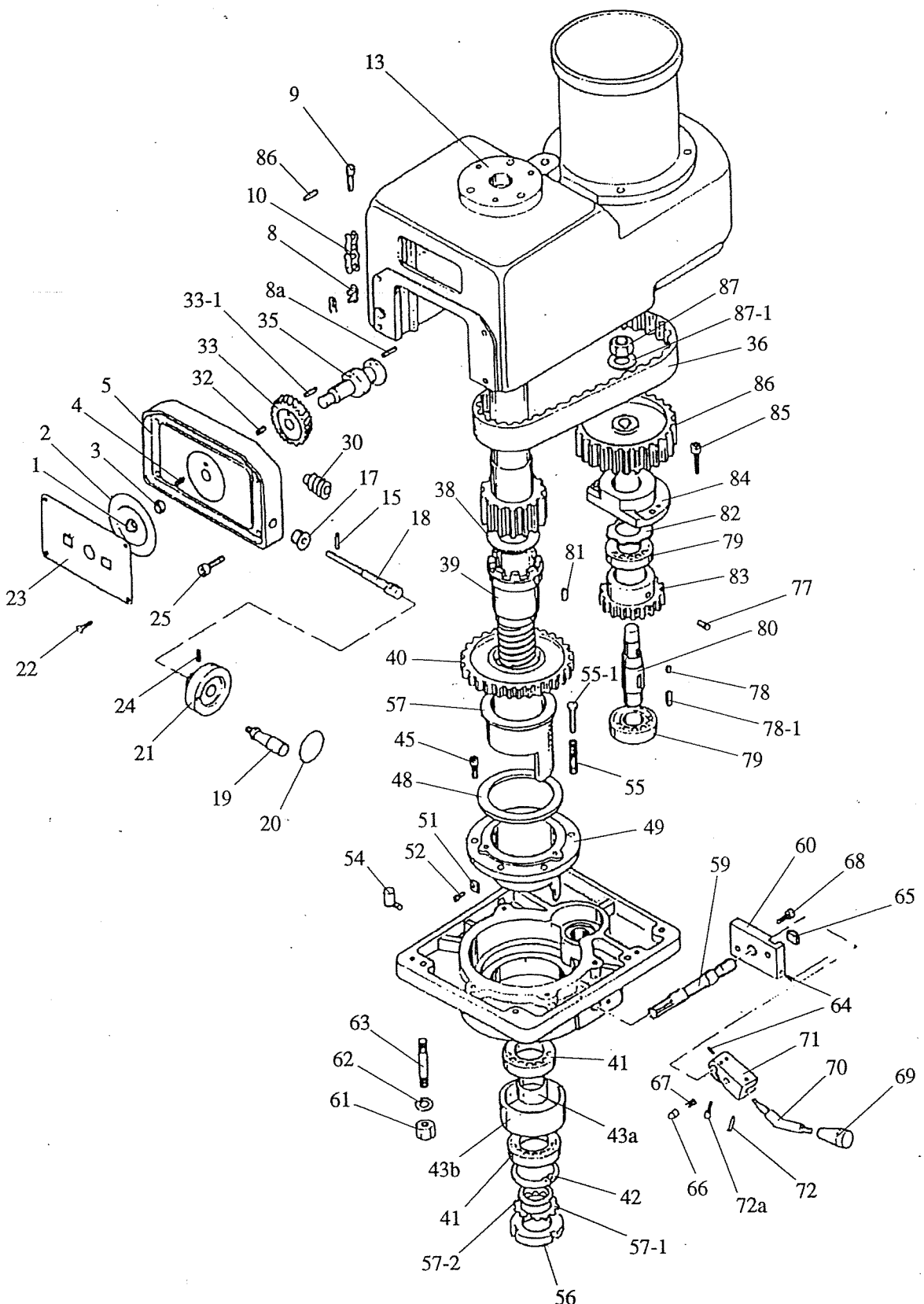
Minuteman III CNC Mill

4.0 SPARE PARTS

The spare parts listed below include parts most frequently purchased (due to wear, loss, or damage). To prevent unwanted down time you may want to purchase any or all of the parts listed.

PART NO.	DESCRIPTION	QTY
100308	Belt	1
100376	Belt	1
100214	Belt	1
100207	Belt	2
100208	Belt	1
100158	Key (to open elec. encl)	1
100602	Hand Wheel w/Hand Knob	1

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**VARI-SPEED HEAD
TOP HOUSING**

Minuteman III CNC Mill

TOP HOUSING PARTS LIST

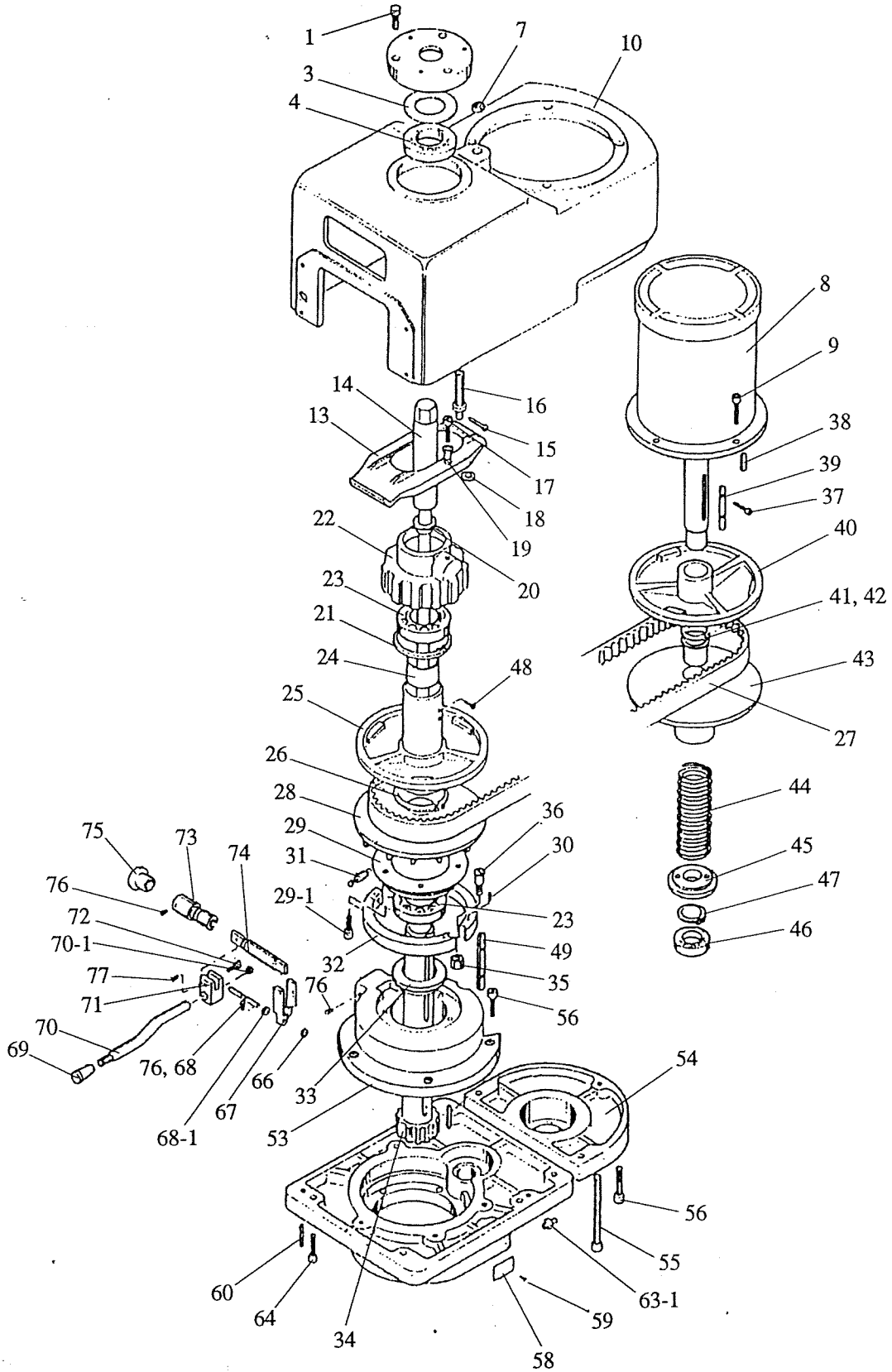
ITEM NO.	PART NO.	DESCRIPTION	ITEM NO.	PART NO.	DESCRIPTION
1	100282	Hex Cap Nut	57	100324	Bearing Sleeve
2	100283	Vari-Speed Dial	57-1	100325	Lock Washer
3	100284	Bronze Bearing	57-2	100326	Washer
4	100285	Full Dog Socket Set Screw	59	100327	Bull Gear Shift Pinion
5	100286	Speed Changer Housing	60	100328	High-Low Detent Plate
8	100287	Chain Joint	61	100329	Hex Nut (3 Req'd)
8a	100288	Roll Pin	62	100330	Lock Washer (3 Req'd)
8b	100289	Roll Pin	63	100331	Socket Head Cap Screw (3 Req'd)
9	100290	Speed Changer Stud			
10	100291	Speed Changer Chain	64	100332	Socket Set Screw (2 Req'd)
13	100292	Top Bearing Cap	65	100333	Adjustable Plate
15	100293	Roll Pin	66	100334	High-Low Detent Plunger
17	100294	Bronze Bearing	67	100335	Spring
18	100295	Speed Change Shaft	68	100336	Socket Cap Screw (2 Req'd)
19	100296	Handle	69	100337	Bakelite Ball Handle
20	100297	Caution Plate	70	100338	High-Low Shift Crank
21	100298	Speed Change Hand Wheel	71	100339	High-Low Pinion Block
22	100299	Flat Head Cap Screw (4 Req'd)	72	110340	Roll Pin
23	100300	Face Plate	72a	100341	Socket Head Cap Screw
24	100301	Set Screw	77	100342	Socket Set Screw
25	100302	Socket Head Cap Screw (4 Req'd)	78	100343	Key
			79	100344	Ball Bearing (2 Req'd)
30	100303	Worm Gear	80	100345	Gear Shaft
32	100304	Set Screw	81	100346	Key
33	100305	Speed Changer Spur Gear	82	100347	Wave Spring Washer
33-1	100306	Roll Pin	83	100348	Bull Gear Pinion
35	100307	Speed Changer Chain Drum	84	100349	Bull Gear Pinion Bearing
36	100308	Belt	85	100350	Socket Head Cap Screw (2 Req'd)
38	100309	Timing Pulley Clutch Sleeve			
39	100310	Splined Gear Hub	86	100351	Timing Belt Pulley (2 Req'd)
40	100311	Spindle Bull Gear Assembly	87	100352	Jam Nut
41	100312	Ball Bearing (2 Req'd)			
42	100313	Snap Ring			
43	100314	Bull Gear Bearing Spacer			
45	100315	Socket Head Cap Screw (6 Req'd)			
48	100316	Ball Bearing Gear Sleeve Washer			
49	100317	Fixed Clutch Bracket			
51	100318	Guide for Clutch Bracket (2 Req'd)			
52	100319	Flat Head Socket Cap Screw (2 Req'd)			
54	100320	Oil Cup			
55	100321	Compression Spring (3 Req'd)			
55-1	100322	Adjusting Pin (3 Req'd)			
56	100323	Bearing Lock Nut			

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**HEAD BACK GEAR
PARTS LIST**

ITEM NO.	PART NO.	DESCRIPTION	ITEM NO.	PART NO.	DESCRIPTION
1	100355	Socket Head Cap Screw	53	100400	Belt Housing Base
3	100356	Spring Washer	54	100401	Motor Pulley Cover
4	100357	Ball Bearing	55	100402	Socket Cap Screw (2 Req'd)
7	100358	Hex Jam Nut	56	100403	Socket Head Cap Screw (2 Req'd)
8	100359	Motor 5 hp	58	100404	High-Low Range Name Plate
9	100360	Hex Head Screw (4 Req'd)	59	100405	Drive Screw (2 Req'd)
10	100361	Belt Housing	60	100406	Taper Pin (2 Req'd)
13	100362	Speed Change Plate	63	100407	Gear Housing
14	100363	Drawbar	63-1	100408	Grease Nipple
15	100364	Cotter Pin	64	100409	Socket Cap Screw (6 Req'd)
16	100365	Speed Change Plate Pivot Stud	66	100410	Snap Ring
17	100366	Socket Head Screw (2 Req'd)	67	100411	Brake Finger Pivot Stud (2 Req'd)
18	100367	Washer	68	100412	Brake Operating Finger
19	100368	Pivot Sleeve (2 Req'd)	68-1	100413	Washer
20	100369	Drawbar Washer	69	100337	Bakelite Ball Handle
21	100370	Snap Ring	70	100415	Brake Lock Handle
22	100371	Spindle Pulley Bearing Spindle Housing	70-1	100416	Jam Nut
23	100372	Ball Bearing (2 Req'd)	71	100417	Brake Lock Handle
24	100373	Plastic Insert (2 Req'd)	72	100418	Socket Set Screw
25	100374	Adjustable-Drive Varidisc	73	100418	Sleeve for Brake Lock Shaft
26	100375	Snap Ring	74	100419	Brake Lock Shaft
27	100376	Belt	75	100421	Rubber Bushing
28	100377	Stationary Driven Varidrive	76	100422	Socket Set Screw (3 Req'd)
29	100378	Brake Bearing Cap	77	100423	Socket Set Screw
29-1	100379	Socket Head Cap Screw (5 Req'd)			
31	100380	Brake Spring (2 Req'd)			
32	100381	Brake Shoe Assembly			
33	100382	Spindle Pulley Spacer			
34	100383	Spindle Pulley Hub			
35	100384	Jam Nut			
36	100385	Brake Shoe Pivot Sleeve			
37	100386	Socket Head Cap Screw			
38	100387	Drive Key			
39	100388	Key			
40	100389	Stationary Motor Varidisc			
41	100390	RET Ring			
42	100391	Plastic Insert (2 Req'd)			
43	100392	Adjustable Motor Varidisc Assembly			
44	100393	Spring for Varidisc Motor Shaft			
45	100394	Adjustable Varidisc Spring Collar			
46	100395	Ball Bearing			
47	100396	RET Ring			
48	100397	Socket Cap Screw			
49	100398	Key			
51	100399	Key			

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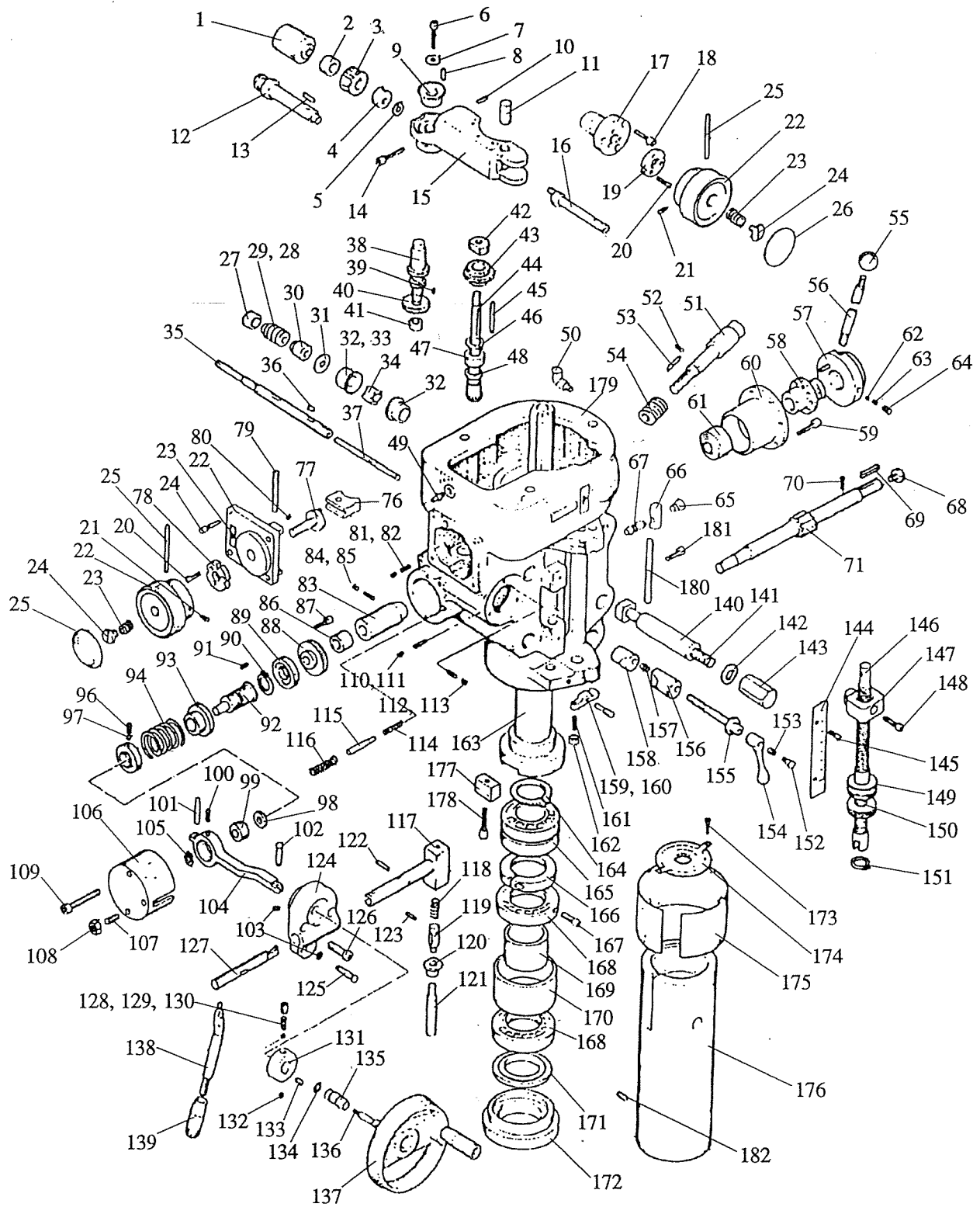
VARI-SPEED HEAD BACK GEAR

Minuteman III CNC Mill

MILLING HEAD PARTS LIST (cont'd)

ITEM NO.	PART NO.	DESCRIPTION	ITEM NO.	PART NO.	DESCRIPTION
98	100643	Overload Clutch Washer	145	100690	Blacked Round Head Screws
99	100644	Clutch Ring	146	100691	Quill Stop Microscrew
100	100645	Clutch Ring Pin	147	100692	Quill Stop Knob
101	100646	Pin	148	100693	Screw
102	100647	Dowel Pin	149	100694	Micrometer Nut
103	100648	Snap Ring	150	100695	Quill Microstop Nut
104	100649	Overload Clutch Trip Lever	151	100696	Snap Ring
105	100650	Snap Ring	152	100697	Spring Screw
106	100651	Clutch Arm Cover	153	100698	Spring
107	100652	Socket Set Screw	154	100699	Lock Handle
108	100653	Blacked Locknut	155	100700	Quill Lock Bolt
109	100654	Cap Screw	156	100701	Quill Lock Sleeve - Tapped
110	100655	Socket Set Screw	157	100702	Compression Spring
111	100656	Mock-It Lockscrew	158	100703	Quill Lock Sleeve
112	100657	Socket Set Screw	159	100704	Trip Lever Pin
113	100658	Lockscrew	160	100705	Feed Trip Lever
114	100659	Compression Spring	161	100706	Socket Set Screw
115	100660	Overload Clutch Lever Spring Plunger	162	100707	Blacked Locknut
116	100661	Compression Spring	163	100708	#40 Spindle
117	100662	Cam Rod Sleeve Assy	164	100709	Snap Ring
118	100663	Compression Spring	165	100710	Bearing
119	100664	Trip Plunger	166	100711	Nut
120	100665	Trip Plunger Bushing	167	100712	Cap Screw
121	100666	Feed Trip Plunger	168	100713	Bearing
122	100667	Roll Pin	169	100714	Bearing Spacer - Small
123	100668	Roll Pin	170	100715	Bearing Spacer - Large
124	100669	Feed Trip Bracket	171	100716	Spindle Dirt Shield
125	100670	Feed Trip Bracket	172	100717	Nosepiece
126	100671	Cap Screw	173	100718	Felt Washer Screw
127	100672	Cam Rod	174	100719	Felt Washer
128	100673	Handwheel Clutch Spring Screw	175	100720	Quill Skirt
129	100674	Compression Spring	176	100721	Quill
130	100675	Steel Ball	177	100722	Keeper Key
131	100676	Handwheel Clutch	178	100723	Cap Screw
132	100677	Socket Set Screw	179	100724	Quill Housing
133	100678	Key	180	100725	Set Bar
134	100679	Snap Ring	181	100726	Cap Screw
135	100680	Reverse Knob	182	100727	Set Screw
136	100681	Feed Reverse Knob Stud			
137	100682	Handwheel			
138	100683	Trip Handle			
139	100684	Plastic Handle			
140	100685	Lowering Clamp Bolt Spacer			
141	100686	T Bolt Assy			
142	100687	Spring Washer			
143	100688	Locknut			
144	100689	Micrometer Scale			

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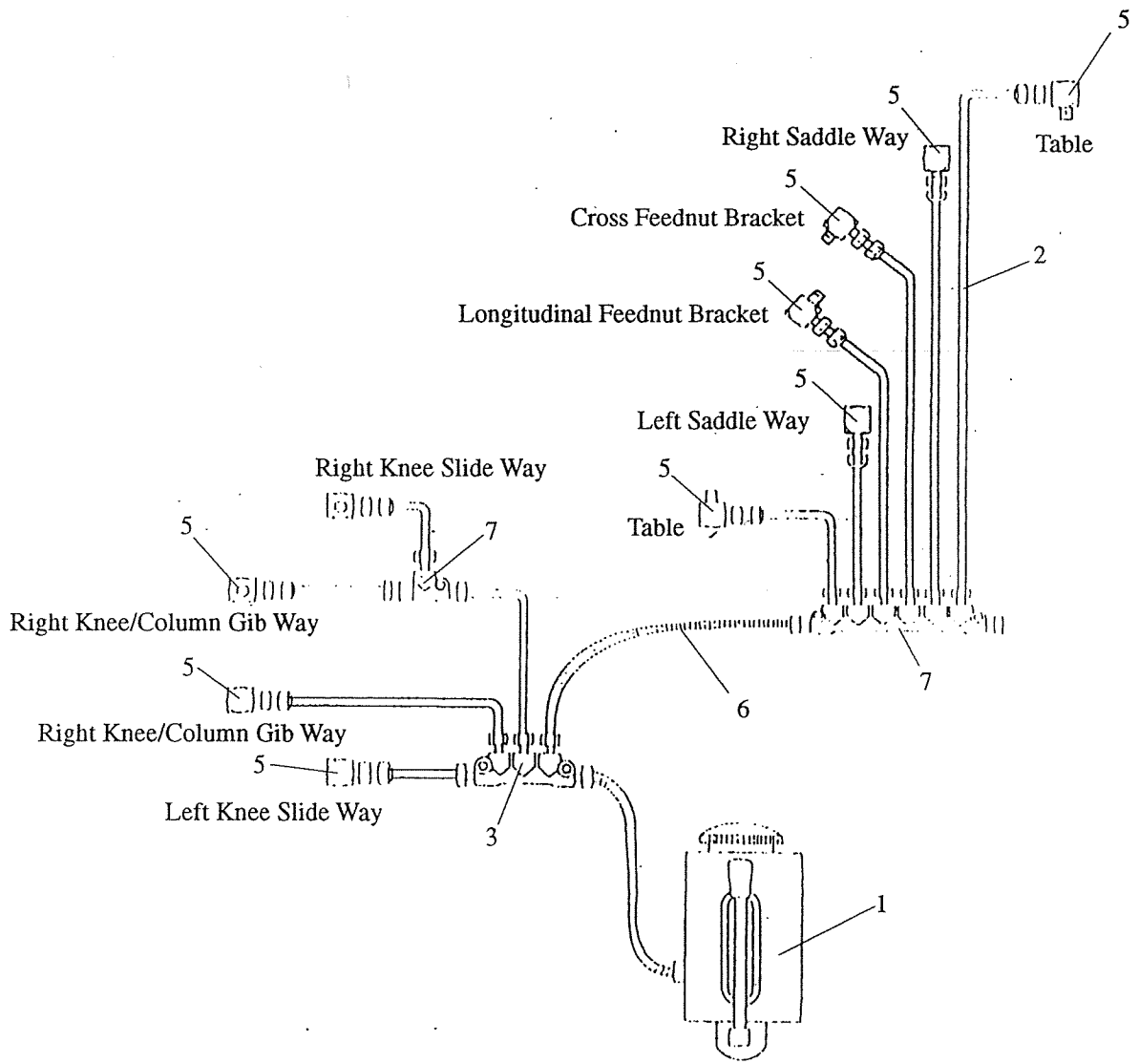
MILLING HEAD

Minuteman III CNC Mill

MILLING HEAD PARTS LIST

ITEM NO.	PART NO.	DESCRIPTION	ITEM NO.	PART NO.	DESCRIPTION
1	100425	Worm Cradle Bushing	49	100473	Grease Nipple
2	100426	Worm Gear Spacer	50	100474	Oil Cap
3	100427	Feed Drive Worm Gear	51	100475	Adjusting Worm Shaft
4	100428	Worm Gear Bushing	52	100476	Socket Head Cap Screw
5	100429	Snap Ring	53	100477	Key
6	100430	Cap Screw	54	100478	Worm Gear
7	100431	Washer	55	100479	Black Plastic Ball Handle
8	100432	Key	56	100480	Pinion Shaft Hub Handle
9	100433	Feed Reverse Bevel Gear	57	100481	Rack Feed Handle Hub
10	100434	Set Screw	58	100482	Pinion Shaft Hub Sleeve
11	100435	Feed Engage Pin	59	100483	Cap Screw (2 Req'd)
12	100436	Feed Bevel Pinion	60	100484	Spring Cover
13	100437	Key	61	100485	Clock Spring
14	100438	Cap Screw	62	100486	Steel Ball
15	100439	Worm Gear Cradle	63	100487	Compression Spring
16	100440	Worm Gear Cradle Throw-out	64	100488	Set Screw
17	100441	Shift Sleeve	65	100489	Reverse Trip Ball Lever Screw
18	100442	Cap Screw (3 Req'd)	66	100490	Feed Reverse Trip Plunger
19	100443	Adjusting Block	67	100491	Reverse Trip Ball Lever
20	100444	Cap Screw	68	100492	Pinion Shaft Hub Screw
21	100445	Set Screw	69	100614	Key
22	100446		70	100615	Cap Screw
23	100447	Compression Spring	71	100616	Quill Pinion Shaft
24	100448	Spring Screw	72	100617	Cluster Gear Cover
25	100449	Roll Pin	73	100618	Plate
26	100450	Quill Feed Name Plate	74	100619	Cap Screw
27	100451	Bushing	75	100620	Vari-Speed Dial
28	100452	Roll Pin	76	100621	Feed Gear Shift Fork
29	100453	Worm	77	100622	Cluster Gear Shift Crank
30	100454	Feed Worm Shaft Bushing	78	100623	Adjusting Block
31	100455	Feed Worm Shaft Thrust Washer	79	100624	Feed Shift Rod
32	100456	Feed Reverse Bevel Gear	80	100625	KP Set Screw
33	100457	Roll Pin	81	100626	Mock-It Screw
34	100458	Feed Reverse Clutch	82	100627	Socket Set Screw
35	100459	Feed Worm Shaft	83	100628	Quill Pinion Shaft Bushing
36	100460	Key	84	100629	Lockscrew
37	100461	Reverse Clutch Rod	85	100630	Socket Set Screw
38	100462	Feed Driving Gear	86	100631	Pinion Shaft Worm Gear Spacer
39	100463	Key	87	100632	Round Head Screw
40	100464	Feed Drive Gear	88	100633	Overload Clutch Worm Gear
41	100465	Needle Bearing	89	100634	Overload Clutch Ring
42	100466	Cluster Gear Shaft Upper Bearing	90	100635	Snap Ring
43	100467	Cluster Gear Assembly	91	100636	Key
44	100468	Cluster Gear Shaft	92	100637	Overload Clutch Sleeve
45	100469	Cluster Gear Key	93	100638	Overload Clutch
46	100470	Snap Ring	94	100639	Safety Clutch Spring
47	100471	Bevel Gear Bearing	95	100640	Overload Clutch Locknut
48	100472	Bevel Gear Thrust Bearing	96	100641	Socket Set Screw
			97	100642	Brass Plug

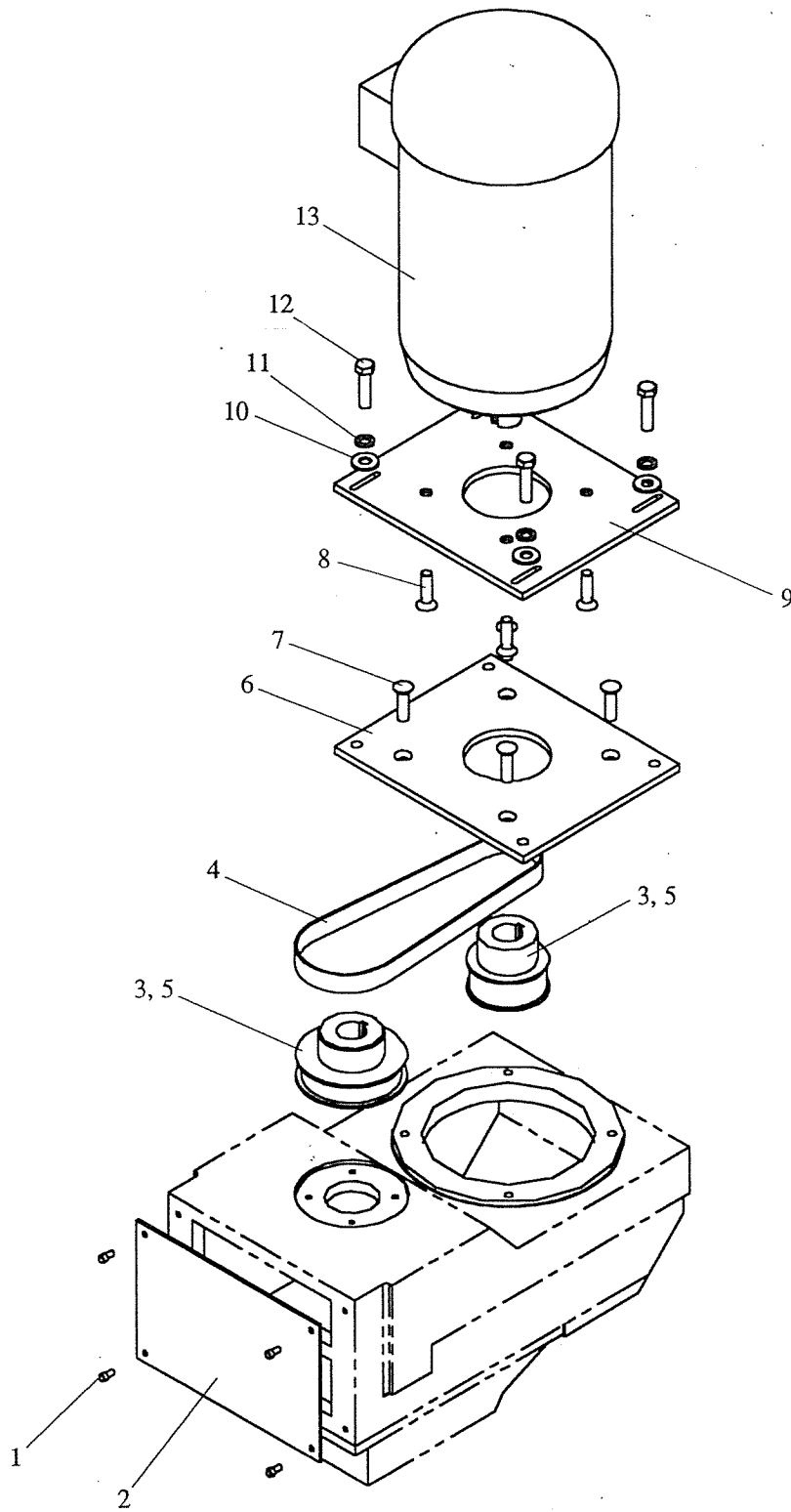
Minuteman III CNC Mill



OIL FEEDING SYSTEM PARTS LIST

ITEM NO.	PART NO.	DESCRIPTION
1	100555	Hand Oiler
2	100556	Aluminum Pipe
3	100557	Joint
4	100558	Joint
5	100559	Elbow Joint
6	100560	Oil Regulator
7	100561	Joint

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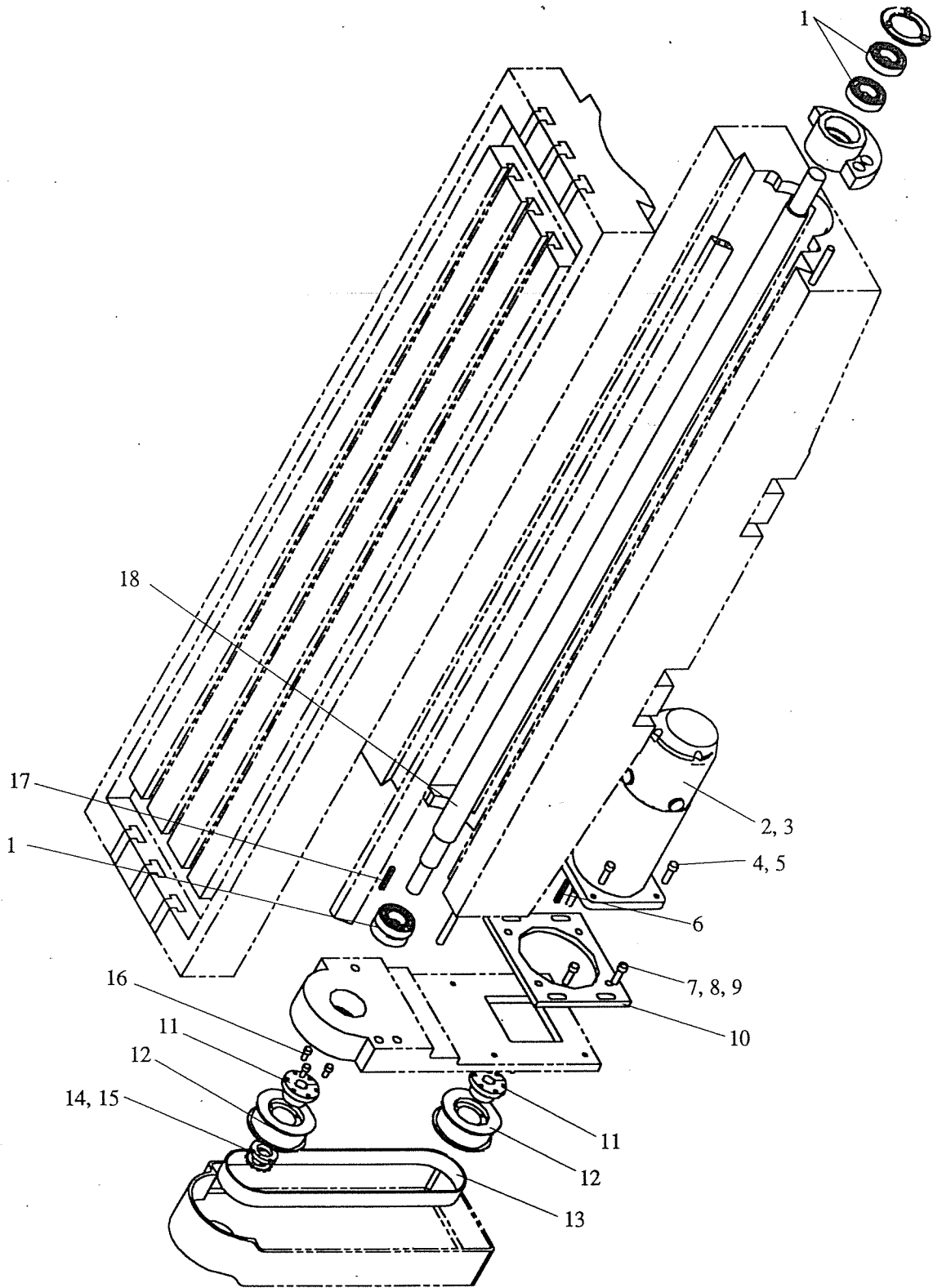


SPINDLE MOTOR ASSEMBLY

Minuteman III CNC Mill**SPINDLE MOTOR ASSEMBLY
PARTS LIST**

ITEM NO.	PART NO.	DESCRIPTION	MFG	MFG NO.
1	100523	Screw 1/4-20 x 5/8 SHCS		
2	100300	Plate Face		
3	100591	Bushing Taperlock		
4	100214	Belt 8 mm x 21 mm x 896 mm Polychain	Gates	8M-896-21 Polychain
5	100210	Pulley 8 mm x 21 mm x 45 Tooth HTD	Gates	8M-45S-21
6	100592	Plate Spindle Motor Mounting Lower		
7	100590	Screw 3/8-16 x 5/8 FHSCS		
8	100511	Screw 1/2-13 x 1 FHSCS		
9	100241	Plate Spindle Motor Mounting Upper		
10	100589	Washer 1/2 SAE		
11	100588	Washer 1/2-13 Lock		
12	100587	Screw 1/2-13 x 1-1/8" SHCS		
13	100121	Motor 7 1/2 hp C Face TEFC 230/460V	Baldor	VM3701T

Minuteman III CNC Mill

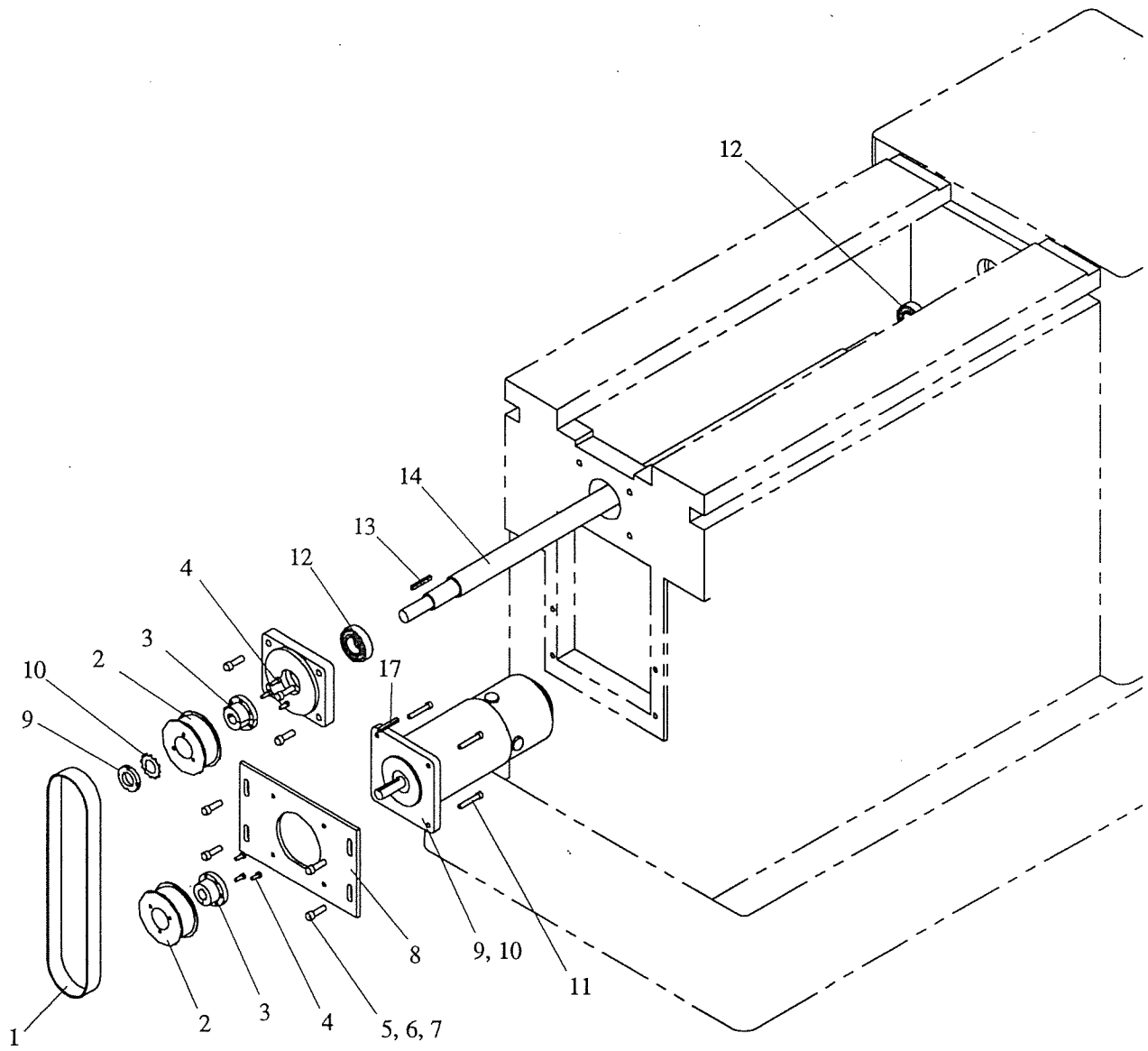


X-AXIS SERVO ASSEMBLY

Minuteman III CNC Mill**X-AXIS SERVO ASSEMBLY
PARTS LIST**

ITEM NO.	PART NO.	DESCRIPTION	MFG	MFG NO.
1	100530	Bearing Angular Contact Set	Global Bearing	205HDC (Class 7)
2	100049	Motor Servo 29 in-lb w/o Encoder	Servo Dynamics	6900-0430
3	100011	Encoder 2000 Line Butterfly	Encoder Products	755A-01-2000-LD
4	100512	Screw 1/4-20 x 7/8 SHCS		
5	100522	Washer 1/4 Lock		
6	100594	Key		
7	100593	Screw 5/16-18 x 3/4 SHCS		
8	100518	Washer 5/16 Lock		
9	100515	Washer 5/16 SAE		
10	100254	X-Axis Motor Mounting Plate		
11	100027	Bushing Taperlock for HTD Pulley	Woods	JA-5/8"
12	100026	Pulley 48T 5 mm x 25 mm HTD Taperlock	Woods	P48-5M-25
13	100207	Belt 5 mm x 25 mm x 710 mm HTD	Gates	710-5M-25
14	100595	Bearing Retainer		
15	100596	Nut Spanner		
16	100598	Screw 10-24 x 1 SHCS		
17	100597	Key		
18	100610	Leadscrew		

Minuteman III CNC Mill

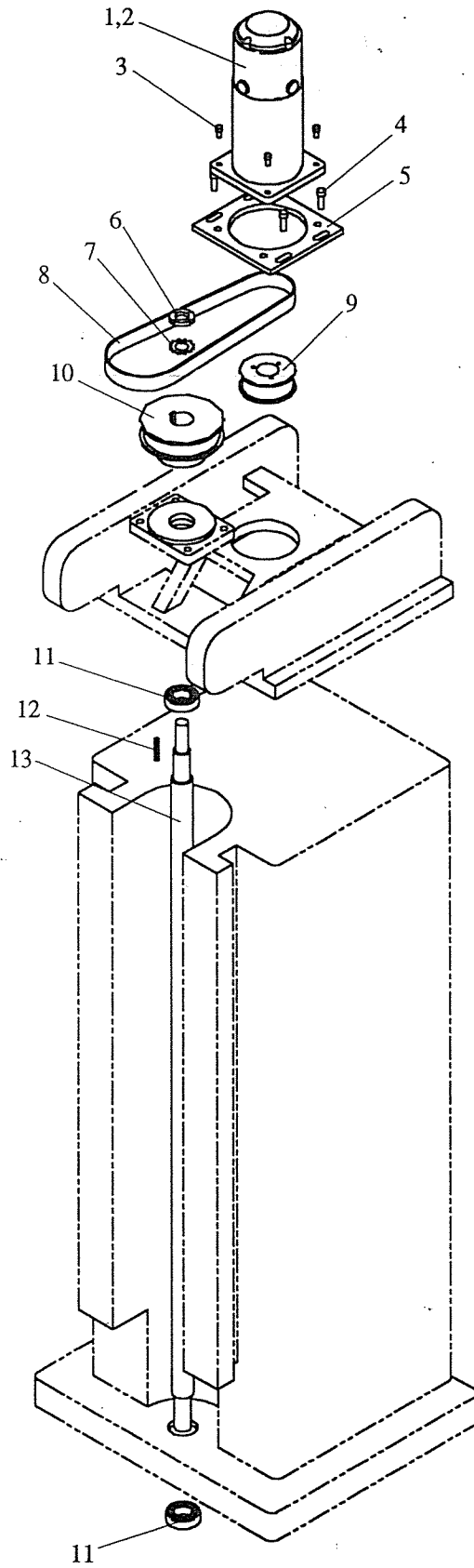


Y-AXIS SERVO ASSEMBLY

Minuteman III CNC Mill**Y-AXIS SERVO ASSEMBLY
PARTS LIST**

ITEM NO.	PART NO.	DESCRIPTION	MFG	MFG NO.
1	100207	Belt 5 mm x 25 mm x 710 mm HTD	Gates	710-5M-25
2	100026	Pulley 48T 5 mm x 25 mm HTD Taperlock	Woods	P48-5M-25
3	100027	Bushing Taperlock for HTD Pulley	Woods	JA-5/8"
4	100598	Screw 10-24 x 1 SHCS		
5	100593	Screw 5/16-18 x 3/4 SHCS		
6	100518	Washer 5/16 Lock		
7	100515	Washer 5/16 SAE		
8	100255	Y-Axis Motor Mounting Plate		
9	100049	Motor Servo 29 in-lb w/o Encoder	Servo Dynamics	6900-0430
10	100011	Encoder 2000 Line Butterfly	Encoder Products	755A-01-2000-LD
11	100512	Screw 1/4-20 x 7/8 SHCS		
12	100530	Bearing Angular Contact Set	Global Bearing	205HDC (Class 7)
13	100597	Key		
14	100611	Leadscrew		

Minuteman III CNC Mill

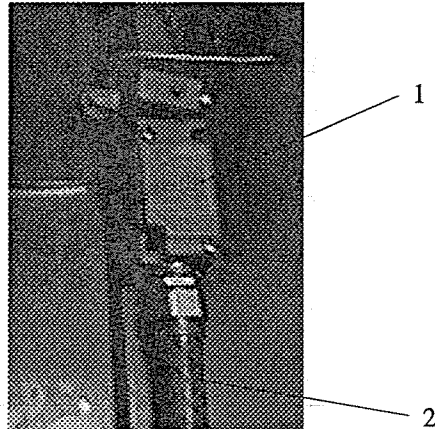


Z-AXIS SERVO ASSEMBLY

Minuteman III CNC Mill**Z-AXIS SERVO ASSEMBLY
PARTS LIST**

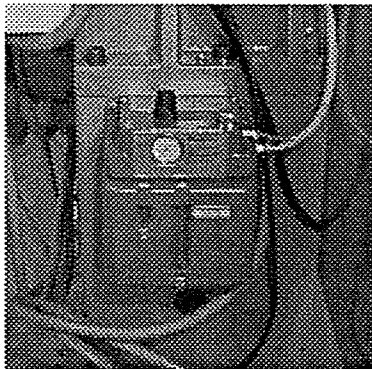
ITEM NO.	PART NO.	DESCRIPTION	MFG	MFG NO.
1	100050	Motor Servo w/Brake 40 in-lb	Servo Dynamics	6900-0440
2	100011	Encoder 2000 Line Butterfly	Encoder Products	755A-01-2000-LD
3	100516	Screw 3/8-16 x 7/8 FHSCS		
4	100517	Screw 5/16-18 x 1 SHCS		
5	100256	Z-Axis Motor Mounting Plate		
6	100596	Nut Spanner		
7	100595	Bearing Retainer		
8	100208	Belt 5 mm x 25 mm x 635 mm HTD	Gates	635-5M-25
9	100028	Pulley 32T 5 mm x 25 mm HTD 1/2" Bore	Woods	P32-5M-25-1/2"
10	100026	Pulley 48T 5 mm x 25 mm HTD Taperlock	Woods	P48-5M-25
11	100530	Bearing Angular Contact Set	Global Bearing	205HDC (Class 7)
12	100613	Key		
13	100612	Leadscrew		

Minuteman III CNC Mill

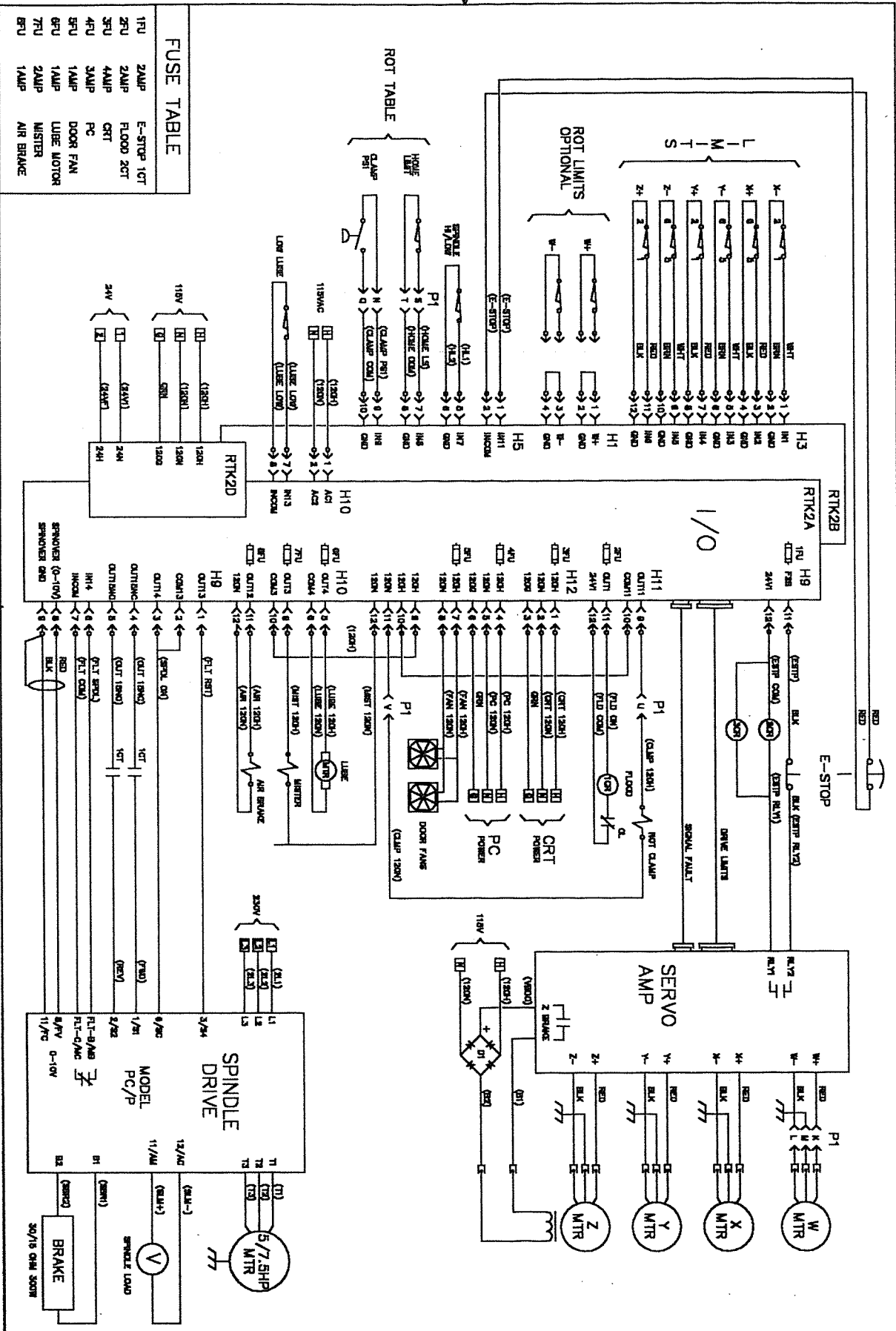


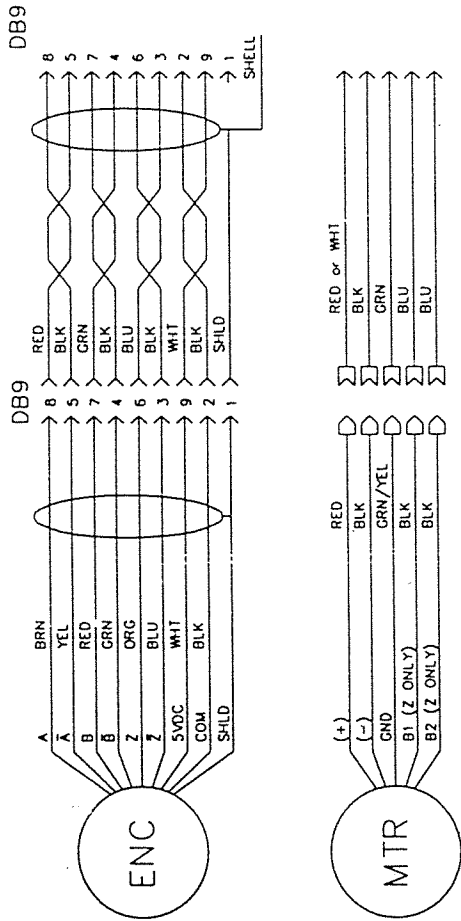
**LIMIT SWITCH ASSEMBLY
PARTS LIST**

ITEM NO.	PART NO.	DESCRIPTION	MFG.	MFG. NO.
	100564	Limit Switch Assembly - X Axis:		
1	100249	Limit Switch	Omron	D4A-2918N
2	100057	Conduit 1/2" LT Flex (74")		
	100565	Limit Switch Assembly - Y Axis:		
1	100249	Limit Switch	Omron	D4A-2918N
2	100057	Conduit 1/2" LT Flex (87")		
	100566	Limit Switch Assembly - Z Axis:		
1	100249	Limit Switch	Omron	D4A-2918N
2	100057	Conduit 1/2" LT Flex (118")		









**BIJUR MIST COOLANT ASSEMBLY
PART NO. 100089
(Sold ONLY as an assembly)**





MTR	CONDUIT LENGTH	ENCODER CABLE	MOTOR CABLE	BRAKE WIRES
X	88"	176"	148"	
Y	88"	176"	148"	
Z	88"	176"	148"	148" X2

MINUTEMAN III SERVO MOTOR CABLE ASSEMBLY

	CONDUCTOR COLORS			CONDUIT LENGTH	CABLE LENGTH	LS FTG	BOX FTG
 X-	YEL	WHT	WHT	74"	112"	STRT	90 DEG
	BLU	ORG	BLK				
 X+	RED	RED	RED				
	BLK	BLK	BLK				
 Y-	YEL	WHT	WHT	87"	125"	90 DEG	90 DEG
	BLU	ORG	BLK				
 Y+	RED	RED	RED				
	BLK	BLK	BLK				
 Z-	YEL	WHT	WHT	118"	156"	STRT	90 DEG
	BLU	ORG	BLK				
 Z+	RED	RED	RED				
	BLK	BLK	BLK				
NOT USED:			GRN				
	ORG		BLK				

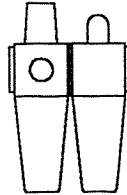
MINUTEMAN III LIMIT SWITCH CABLE ASSEMBLY

BACK VIEW OF MACHINE

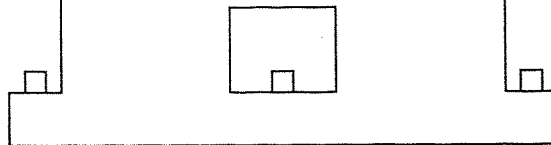
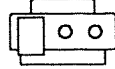
SPINDLE BRAKE
SOLENOID

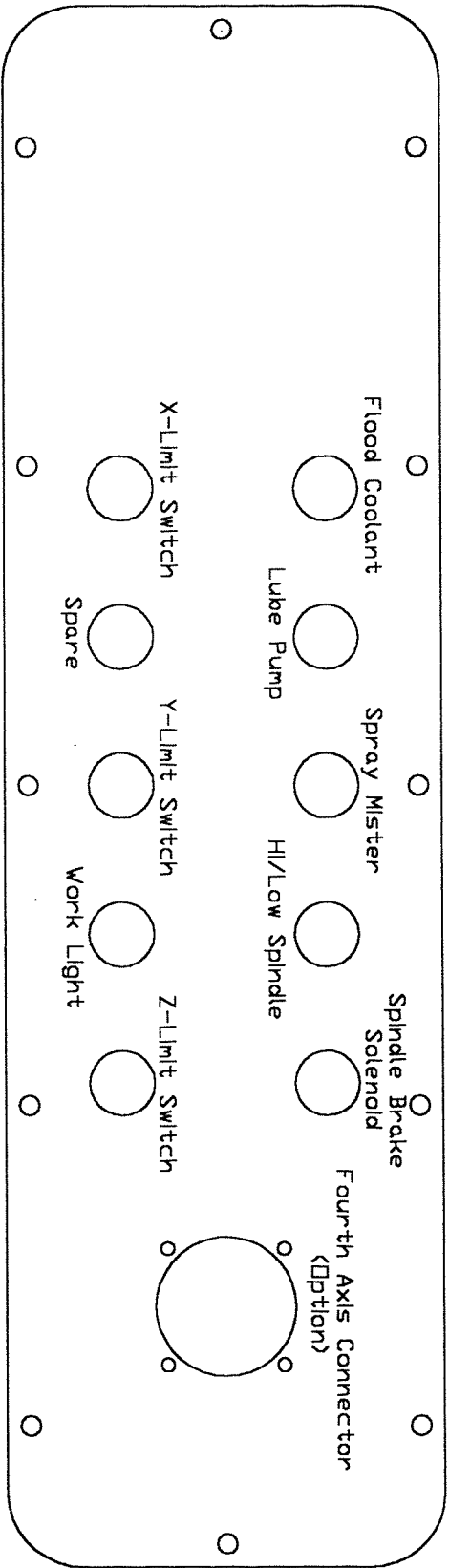


PNEUMATIC
FILTER/REGULATOR

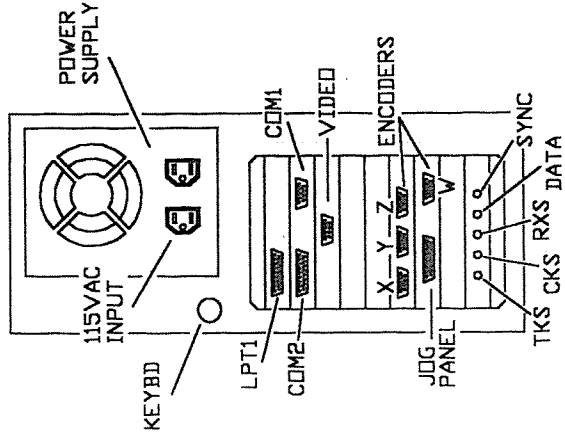
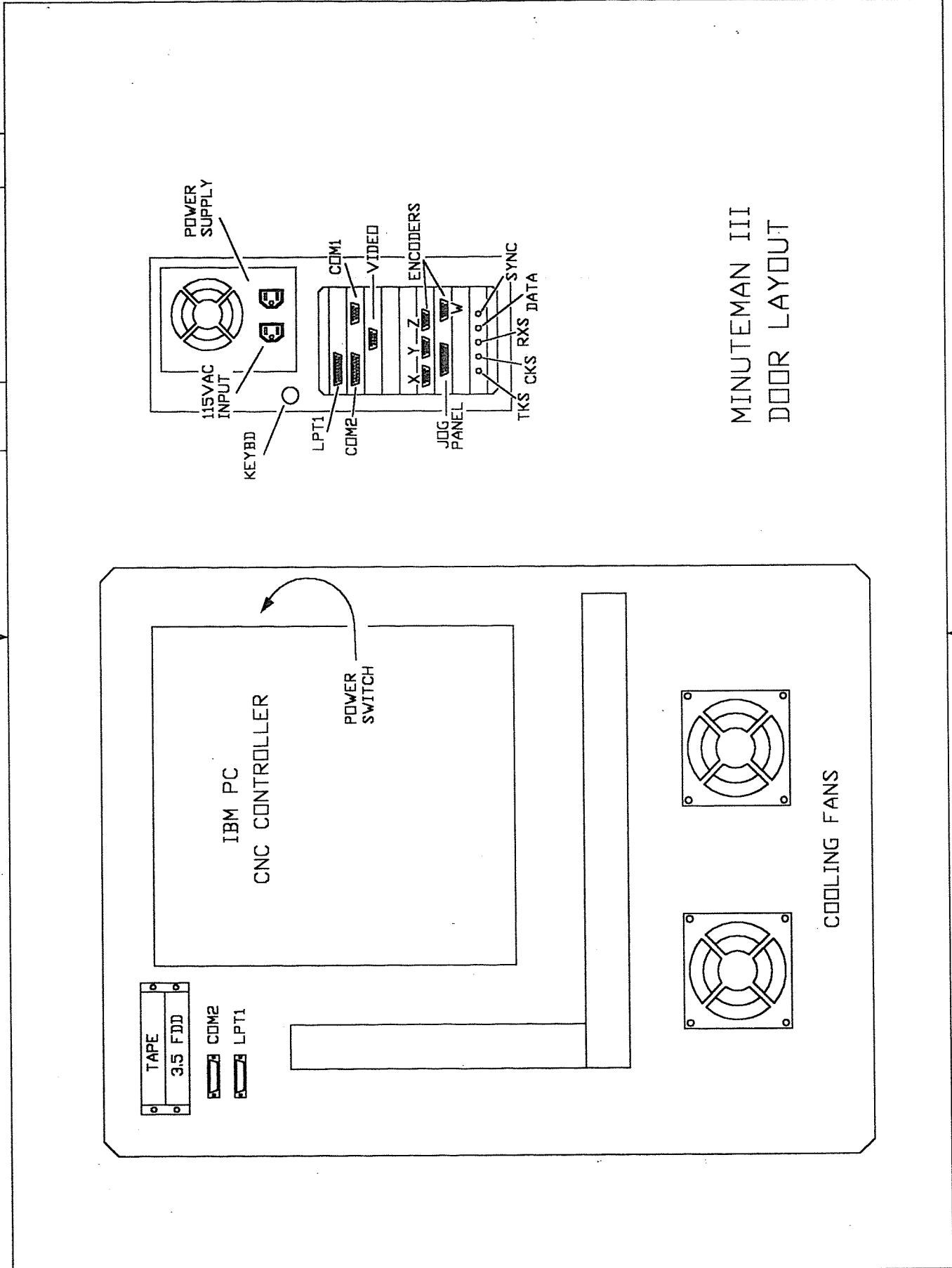


SPRAY MISTER
SOLENOID
(OPTION)

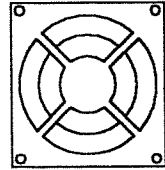
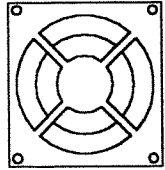
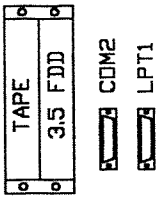




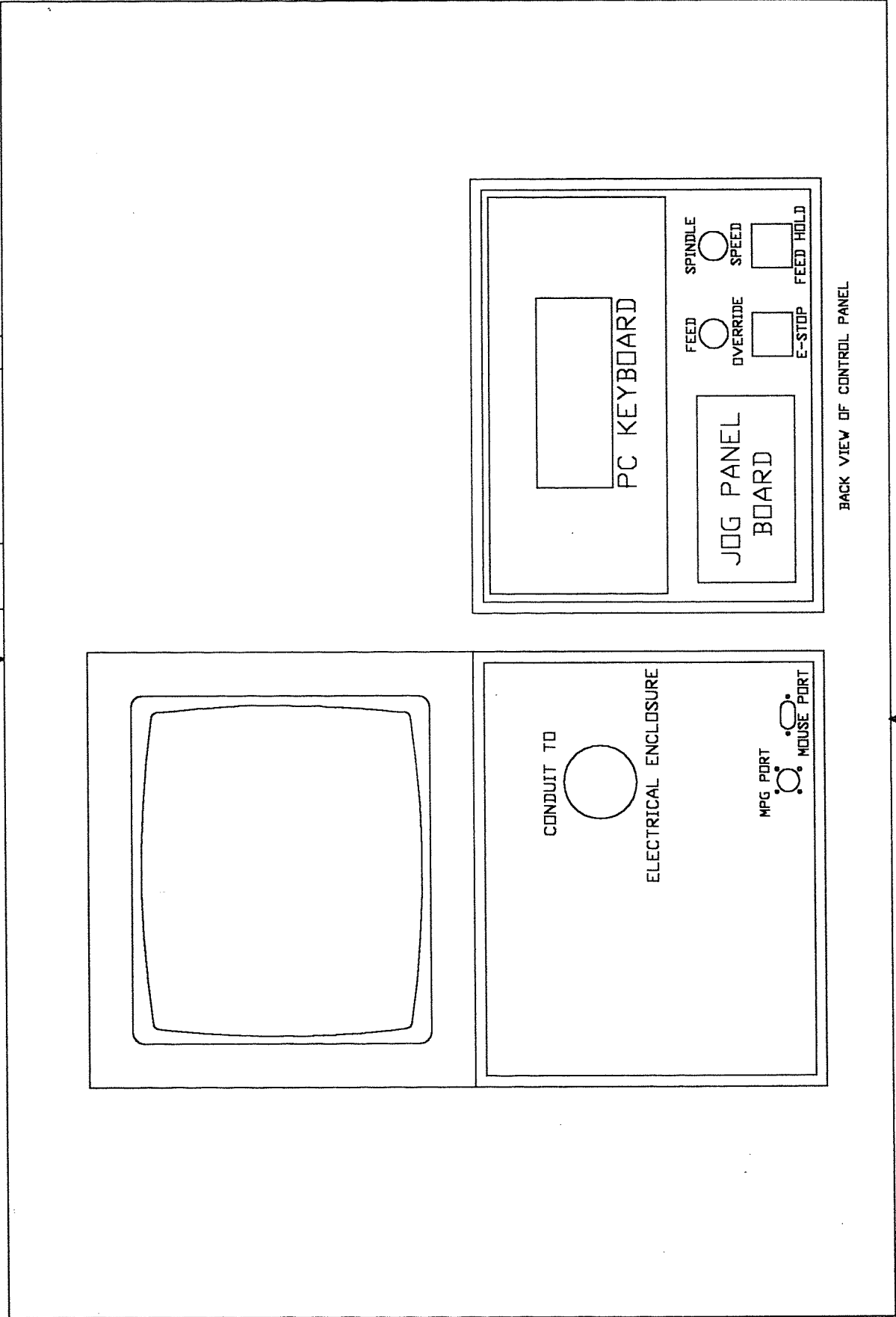
Gland Panel



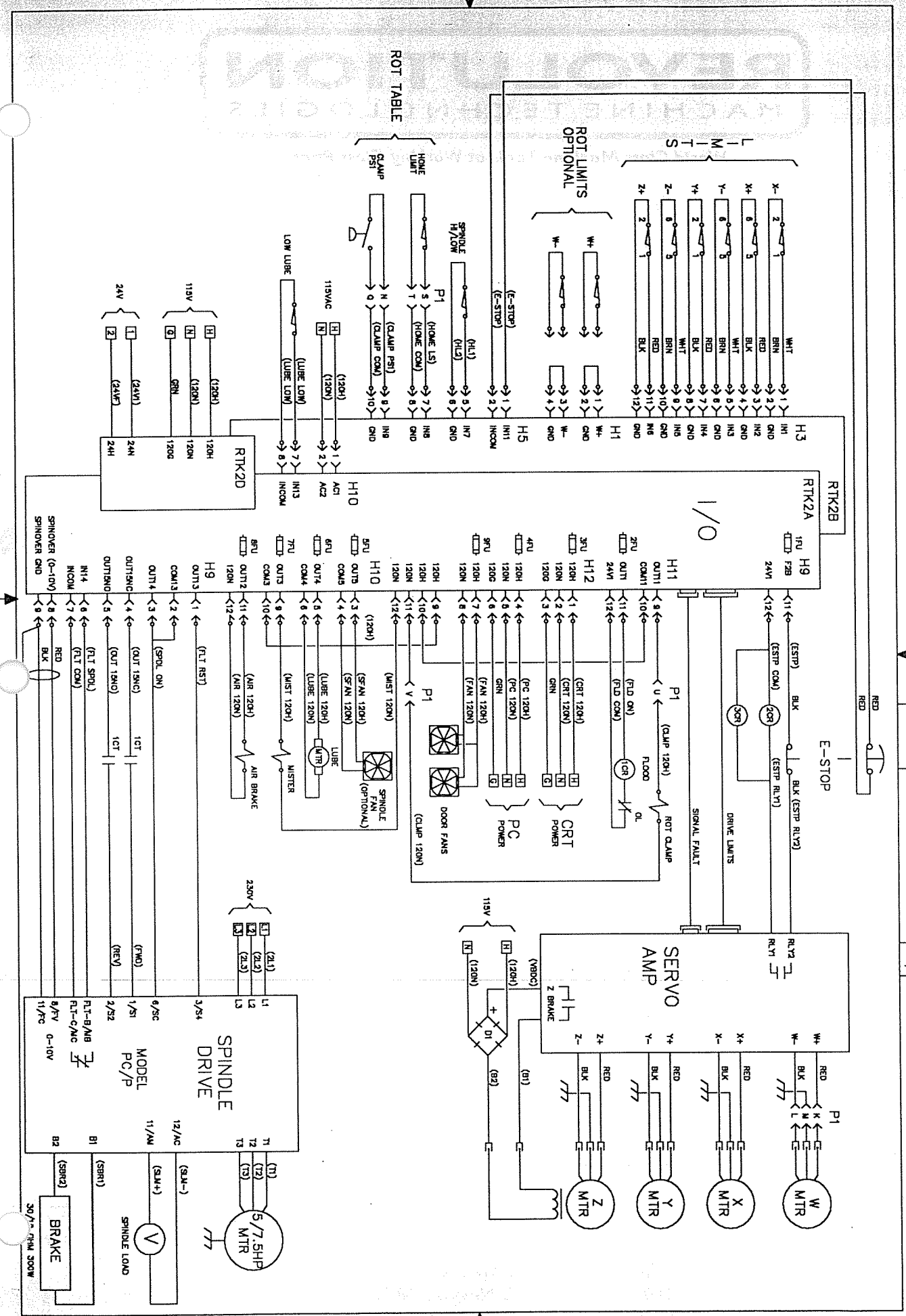
MINUTEMAN III
DOOR LAYOUT



COOLING FANS

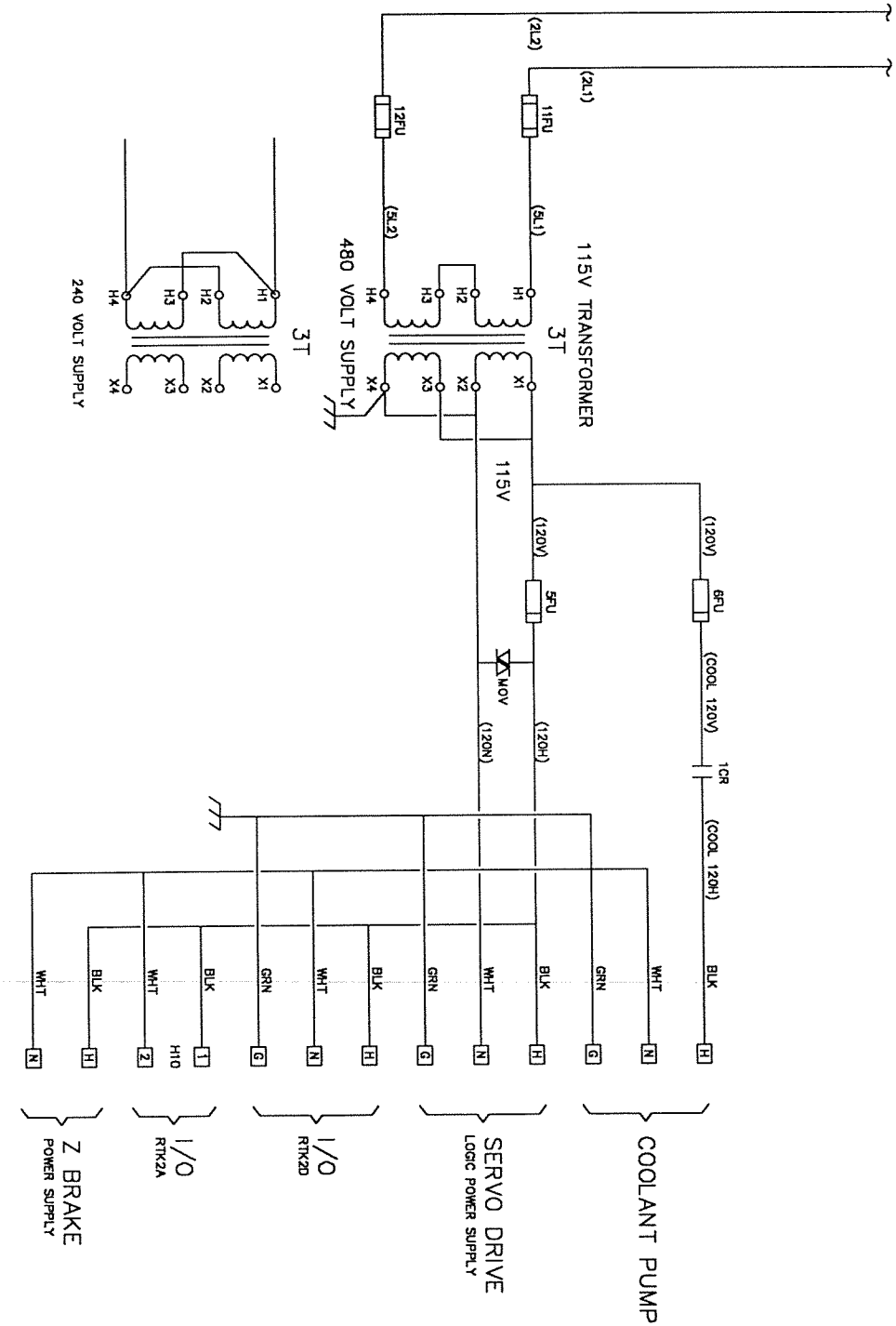


BACK VIEW OF CONTROL PANEL



SH 1

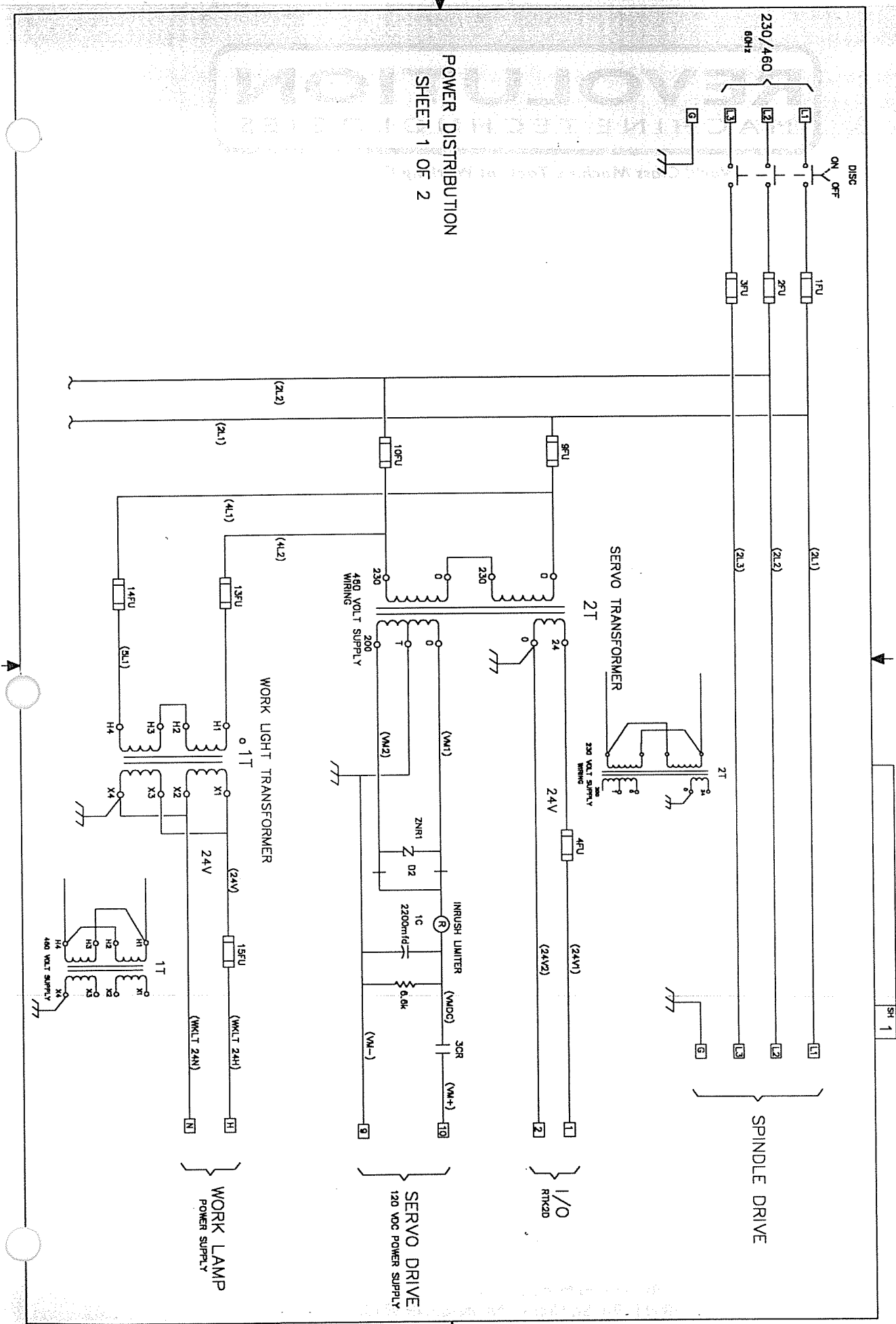
REVOLUTION
 MACHINES TECHNOLOGIES
 "Work Your Way" or "Let Us Work Your Way"



RTK I/O FUSES

FUSE TABLE	
5AMP	PRI WORK LAMP X-FORMER
5AMP	PRI WORK LAMP X-FORMER
5AMP	SEC WORK LAMP X-FORMER
3AMP	PRI 115V X-FORMER
3AMP	PRI 115V X-FORMER
10AMP	SEC 115V X-FORMER
1AMP	COOLANT PUMP 115V

POWER DISTRIBUTION
SHEET 1 OF 2



SPINDLE DRIVE

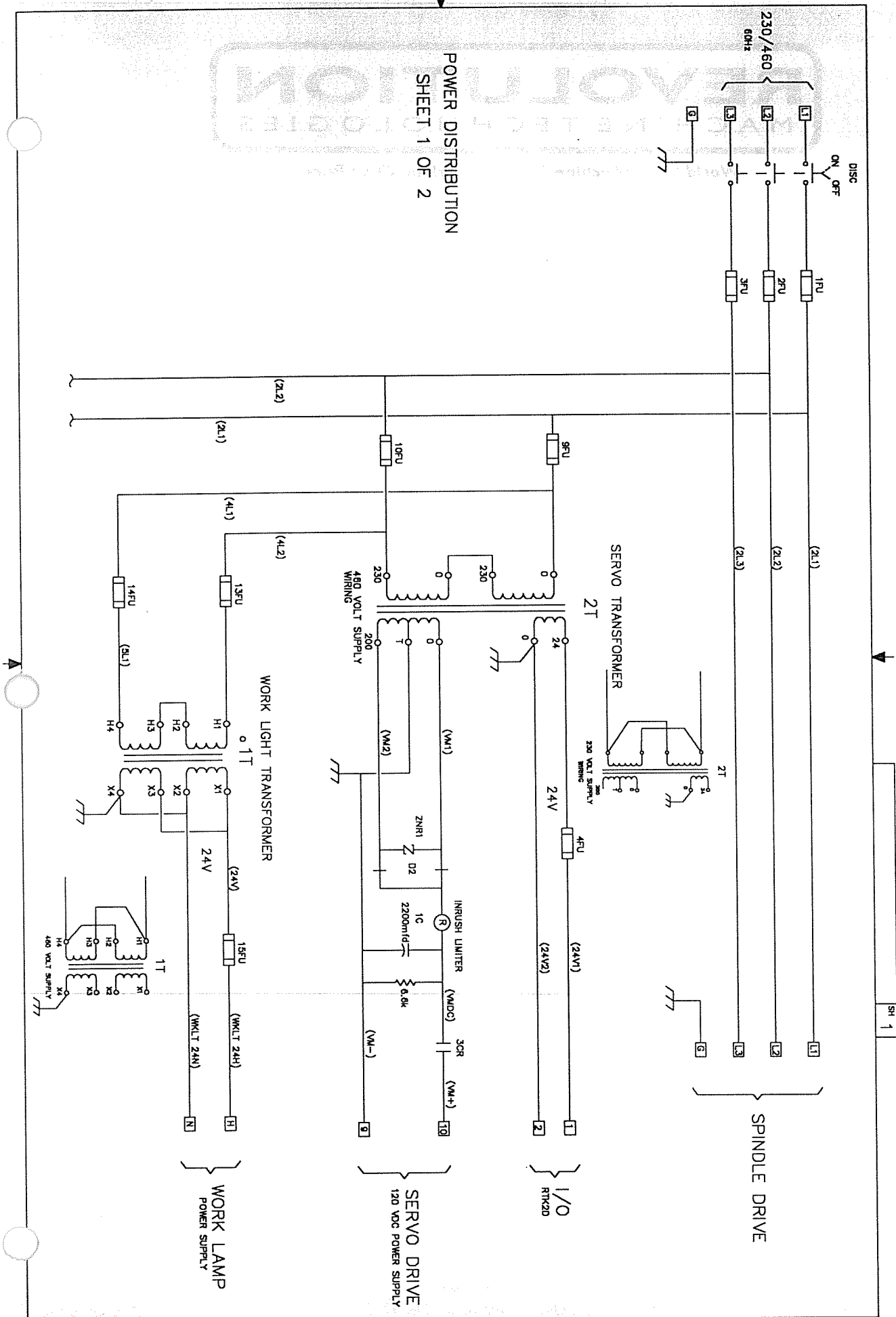
I/O
RTH2D

SERVO DRIVE
120 VAC POWER SUPPLY

WORK LAMP
POWER SUPPLY

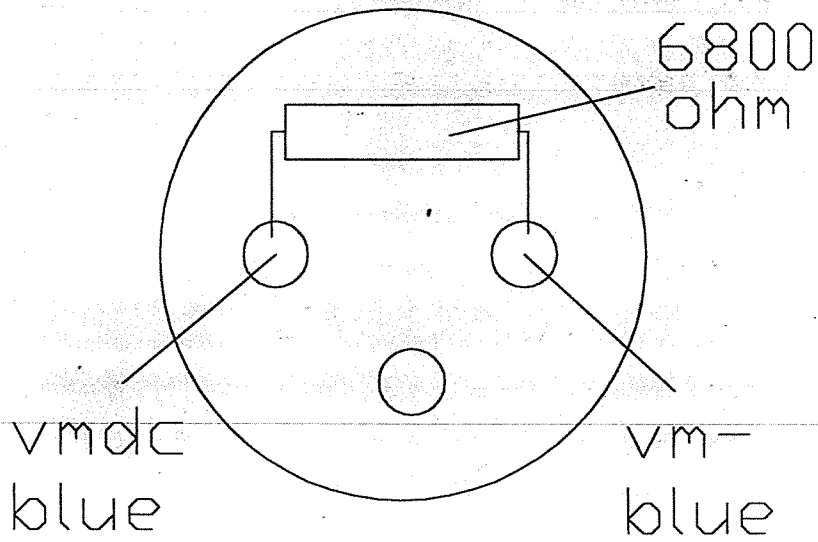
SH 1

POWER DISTRIBUTION
SHEET 1 OF 2

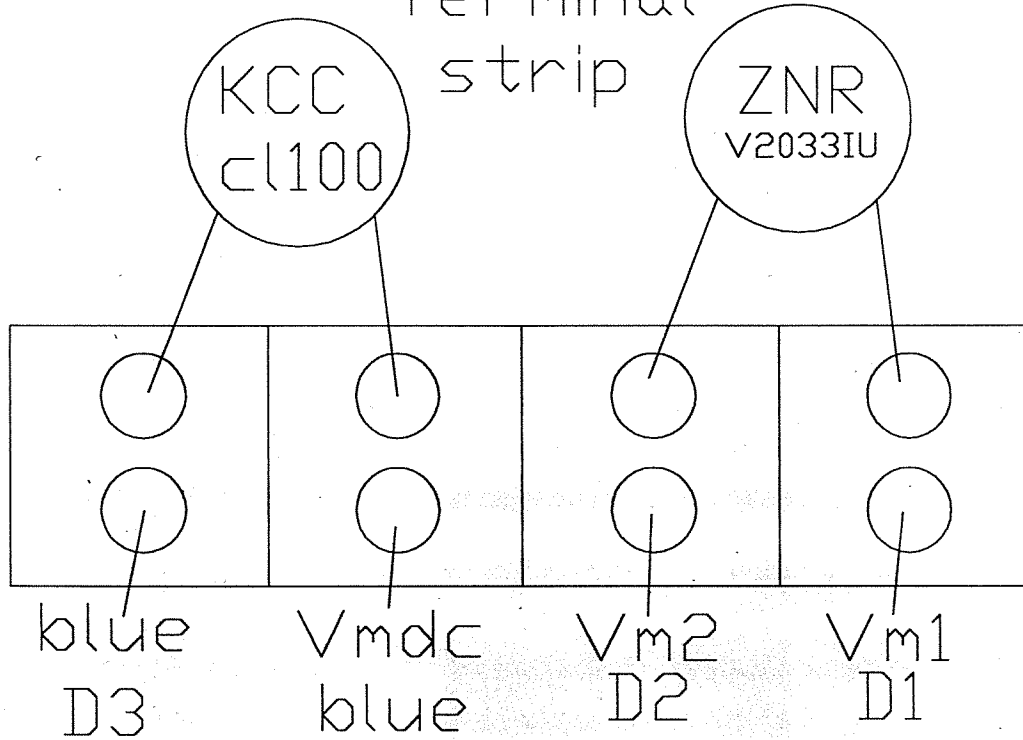


SH 1

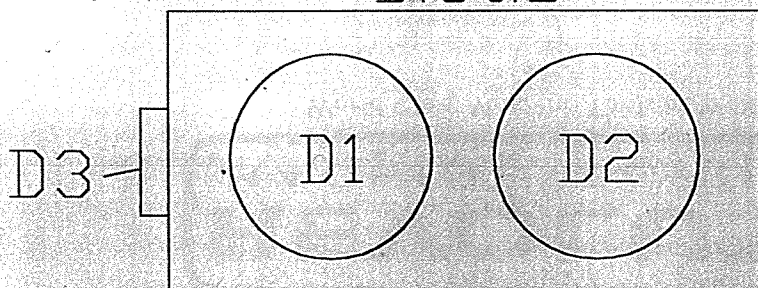
Capacitor



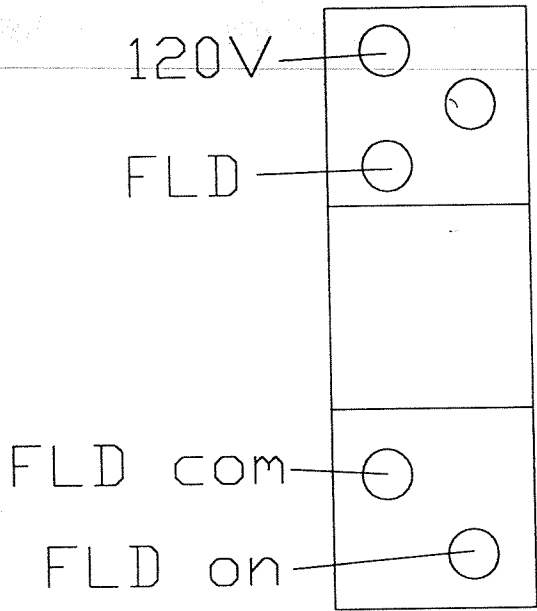
Terminal strip



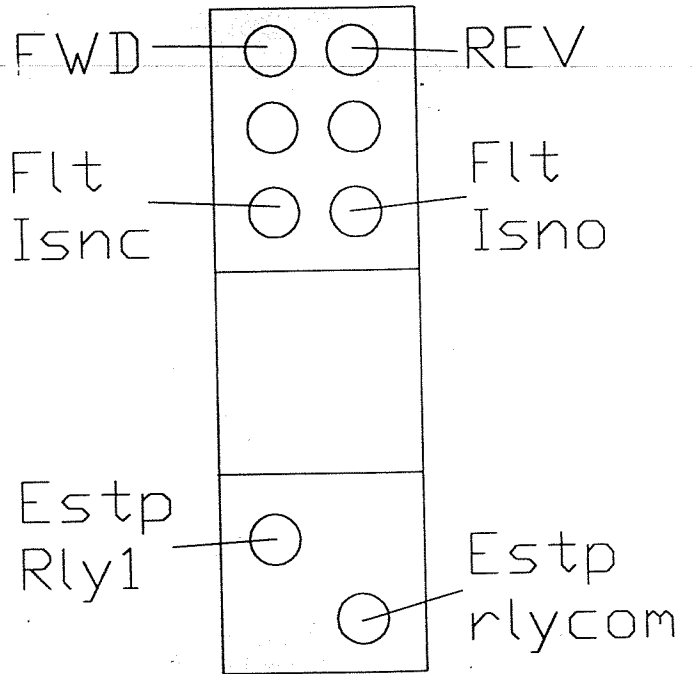
Diodes



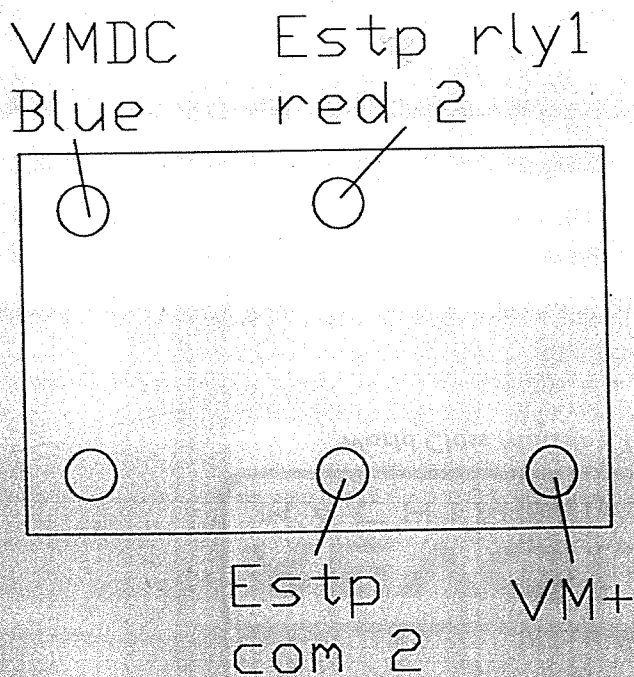
1CR



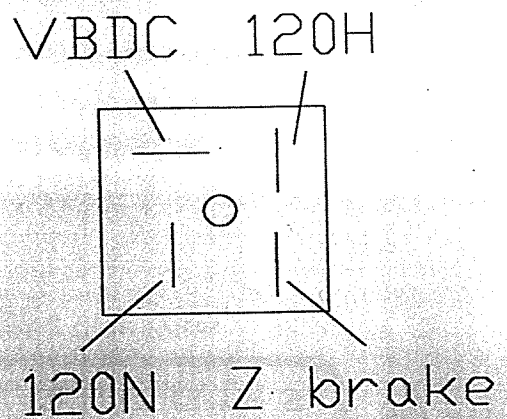
2CR

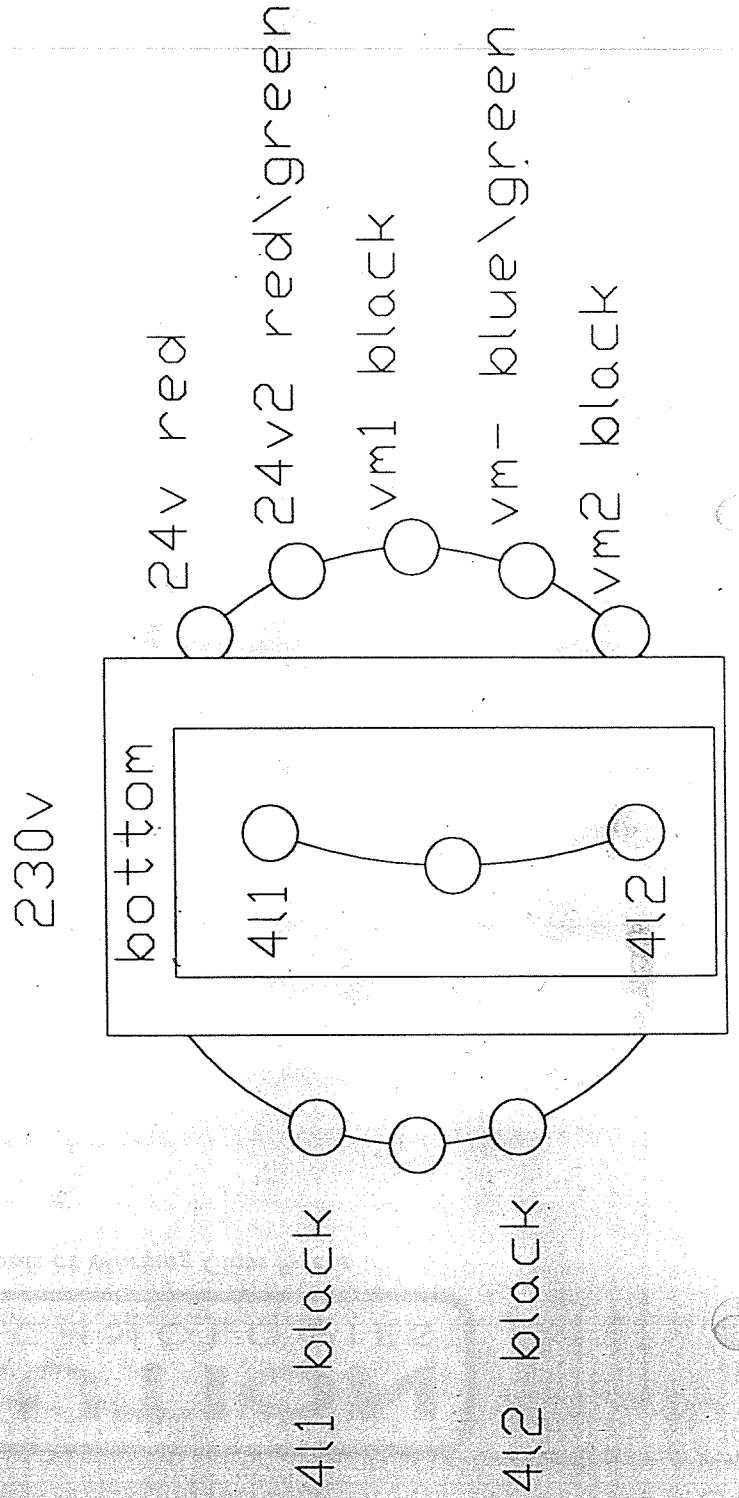
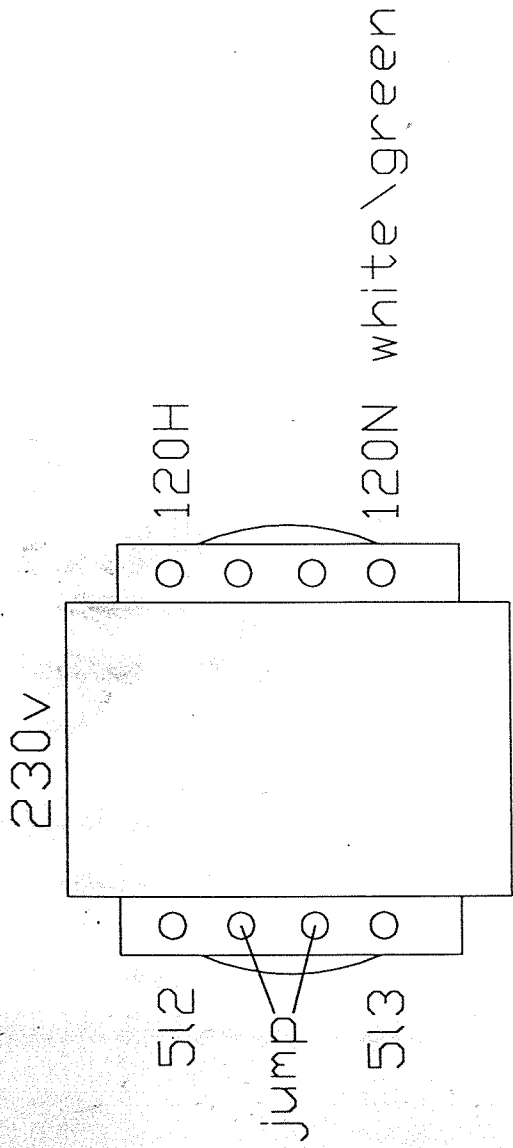


3CR



1D





WAY LUBE SYSTEM CHECK OUT AND REPAIR

The ways are hardened and ground cast iron with the saddles lined with Turcite, a special high tech plastic to reduce friction and increase way life. The ways are lubricated by a pressurized lubrication system which maintains a film of oil over the ways during operation.

Depending on the vintage of you mill two basic lubrication systems are used.

The older system uses a column mounted electric pump mounted on the left side of the column. The pump output goes into two hoses either at the pump or at the lower left of the front corner of the column. One hose goes up to the Z axis saddle and a hard line connects to a manifold up on top the Z axis saddle without orifices. The other hose goes down to a manifold under the left end of the saddle on the Y axis. **The manifold has adjustment screws** for the various way surfaces and the ball screw on the Y and X axes. The tubes go from the manifold to various locations on the saddle and the ballscrews on both the Y axis saddle and the Z axis saddle. By removing the left side table extension and moving the table all the way to the right you can see the oil lines inside of the Y axis saddle. The oil lines go directly into the casting and are **held in place by clamps or epoxy**. Oil flow to the Z axis manifold is determined by the flow set on the Y axis saddle manifold. If it is opened up too much, pressure will flow to the Y axis carriage and little to the Z axis.

The newer system uses a column mounted electric pump mounted on the left side of the column. The pump output goes into two hoses either at the pump or at the lower left of the front corner of the column. **One hose goes up to a manifold with fixed orifices on the top of the Z axis saddle**, the other goes down to a manifold under the left end of the saddle on the Y axis. The manifold has **fixed orifices with no adjustments** for the various way surfaces and the ball screw on the Y and X axes. The tubes go from the manifold to various locations on the saddle and the ballscrews on both the Y axis saddle and the Z axis saddle. By removing the left side table extension and moving the table all the way to the right you can see the oil lines inside of the Y axis saddle. The oil lines go directly into the casting and are **held in place by threaded tube ends**.

In both of the above systems often (but not always) a restrictor orifice has been installed in the outlet of the tee fitting located on the pump or on the column. The orifices balance the oil flow to the Z axis saddle and the Y axis Saddle. The orifices are brass hex shaped stock threaded into the tee on one end and have the hose attached to the other end.

The hex has numbers on it between 0 and 5. 0 is a small oil flow and 5 is a big oil flow. Most of the times a #3 is used. The orifices are available from us or Bijur at 802-447-2174

A #1 is a Bijur part number B2495, a #3 is a B2498, a #5 is a B2500

Over time these problems occur:

Dirty oil and/or wrong kind of oil. Empty reservoir by removing from pump and filling with Mobil Vactra #2 or equivalent. Type oil makes a difference on CNC ways.

Someone opens up the adjustment screws on the Y axis saddle causing oil flow to flood the saddle and leave the Z axis dry. Close the adjustment screws down to 1/8 of a turn from closed.

The restrictor orifice become clogged in the tee feeding the two saddle manifolds. Oil flow stops and slide is dry. Remove the hoses one at a time at the tee, after the orifice and hand stroke the pump to see oil flow, no flow the orifice is clogged. Replace the orifice to be sure. You can try to clean them out with solvent and block them out. Try the flow test to determine if they are still flowing.

Line is crimped from a crash. Replace the line, test for flow.

Plugged up oil passages in Y axis carriage for the X axis Table dovetail. Remove the table extensions from the table ends, jog the table to the ends of travel, clean out the oil grooves in the way surface. Hand pump the oils system to make sure oil is flowing. You may want to open the manifold valves to aid flow if so equipped. Close down to 1/8 open when oil flow is established.

Hose is cut. Replace hose.

Lube Pump is dead. To test, put control in MDI and put an ear to the pump, you can hear the pump motor running. Note the pump piston position in the left rear position of the pump. Leave control in MD for ½ hour. Go back and look at pump piston, it should be in different position. Motor lifts it up and spring pulls it down to pump oil.

GIB SETTING PROCEDURE

The gibs on the mill will require adjusting from time to time as the machine wears. Typically, the gibs need adjustment about 90 days after initial machine set up, then fairly rarely unless the ways are really dirty causing accelerated wear.

The most common problem in gib adjusting is to over tighten the gibs. The ways run on a film of oil, if the gibs are too tight, no oil can fit in the gap making the axis stick/slip. If the gibs are too loose, cutting with two flute end mills or drilling will reveal excessive way clearance by slopping around under cutting load.

The other problem is to not lock the gib locking screws down to keep the gib from moving back and forth with the slide movement causing the gib to get tight one direction and bind and then get sloppy the other direction.

Before you start the process do a back up of the machine configuration to floppy disk from the utility screen for the machine configuration.

- 1) Before adjusting the gibs wipe off the ways with a rag and verify that the ways are lubricating adequately. The best way to check for lubrication is to clean the ways and run the machine for a couple of hours. The ways should have a oil film on them at all times. The way system is an oil bearing system, without the oil the ways wear rapidly and positioning accuracy will be affected.
- 2) The way lube system operates only when the machine is MDI or running a program. The pump may be stroked manually by lifting the plunger on the pump located in the left rear corner of the pump mounted on the left side of the machine column. Many strokes by hand may be required to get oil flowing. The correct way Lube to use is Mobil Vactra #2 or equivalent. The type of oil makes a difference in how the system works, so stick with Vactra.
- 3) After getting the oil going and stroking the machine around move the axes to approximately the center of their travels.
- 4) The machine has 8 gibs: 3 on Z, 3 on Y and 2 on X. Adjust X first the X axis gibs are located on either end of the saddle on the front side of the table way. Each end of the saddle has a gib which tightens as it is moved toward the center of the machine.

- 5) The adjustment of the gibs is simple: without moving the slide, back of the two hex nuts on either side of the gib plate. To tighten the gib, push it toward the center of the machine BY HAND (not with the nuts) with 10 pounds force. Bring the locking nuts up to either side of the gib plate and lock down being careful not to jack the gib in tighter. Do not jog the axis while adjusting or you will have to start all over.
- 6) The remaining gibs all adjust in the same manner. The gib is tapered on it's back side and rides in a tapered seat in the saddle. When the gib is move one way axially, it get tighter (pushing on the big end of the gib), the other direction it gets looser (pushing on the small end of the gib) . The gib is head in place from moving back and forth while the slide moves by a locking screw at either end of the gib. The screws are meant to lock the gib, not to jack it in tighter.
- 7) The Y axis gib all get tighter when pushing from the front of the Y axis saddle. The Z axis gib all get tighter pushing down on the gibs.
- 8) To adjust the Y axis gibs remove the front metal way cover and the left side way wipers both front and rear. Adjust the side play gib, the one you see in the inside of the left Y axis way, using the same procedure outlined above. Adjust the two bottom guides on the Y axis way in the same manner.
- 9) To adjust the Z axis gibs a different method must be used. The side play gib is on the left side of the Z axis saddle. Push it down to make it tighter. Lock the lock screws to hold the gib.
- 10) The Z retainer gibs can only be adjusted on one side at a time. If you loosen them both at the same time, you will have the weight of the head on the gib and make adjusting difficult. The Z axis gibs are the toughest to adjust. It make take several iteration to get then adjusted up snug.
- 11) Once all the ways are adjusted, and oil is well covering the ways the machine should be auto tuned to allow the control to adjust to the new friction characteristics of the ways and enable the control to position accurately under various feed rates. Press setup, configuration , 137 for the password, then machine, then PID. Select autotune option. **DO NOT CHANGE ANY OTHER PARAMETERS IN THIS SCREEN OR YOU CAN CAUSE SERVO PROBLEMS.**

ALIGNMENT OF SPINDLE DRIVE SYSTEM

110798

Hunt

The spindle drive assembly consists of several housings which are coaxial but do not have alignment dowels or pilot diameters to ensure their concentricity to the spindle centerline. All of the housings, splines and bearing need to be aligned to the spindle centerline, the controlling centerline.

It is absolutely essential that you follow the steps below in order or you will damage the bearings, have a noisy spindle, a rough quill or all of the above.

1. The first section to align is the spindle spline to the female drive spline all. loosen the 4, 17 mm hex nuts on the lowest housing toward the spindle nose. Loosen the nuts so they still retain the load of the head, but may be jockeyed around easily to align to the spline. Turn the spindle by hand several revolutions allowing the hi/low casting to "float" on the spindle spline and seek center. Once you feel that it is centered, carefully tighten the 17mm bolts down evenly. Now turn the spindle by hand and note any binding in the spindle as you rotate it. If it binds do procedure again . Now loosen the quill clamp and extend the spindle with the manual quill handle. Note the noise in the spindle spline and feel the smoothness of the quill handle movement as you extend and retract the quill. If the it feels tight or if it pulses as you extend the quill in and out, the spline is mis-aligned.

Do not shim between the housing to achieve a smother running head. It has been our experience that shimming actually causes problems since the machining of the faces is perpendicular to the spindle centerline.

- 2) Install the Brake bearing housing assembly onto the head with the mounting screws loose enough to have about .02 under the screw heads, this will allow the housing to float on the spindle dog clutch.

Hold the high gear lever in toward the head so the lock pin on the lever is disengaged from the plate which locks the gear lever in hi-neutral-low positions. Now press the lever upwards further into high gear. This causes the Hi-Low drive dogs to engage each other fully and will center up the lower end of the Hi-Lo drive clutch. The whole brake housing assembly will rise up when you do this Sitting on the dog clutch fingers.

The brake housing will move around the spindle center to align these teeth to the spindle centerline. Rotate the spindle by hand while holding pressure upward on the Hi-Lo shift lever. Once aligned, snug down the housing bolts while turning the spindle by hand to make sure the alignment is maintained. After snugged down check the spindle and check Hi-Lo lever action again for smoothness.

3) Install the upper aluminum housing with 6 hold down bolts loosely holding the housing and the spindle motor and drive belt. Insert upper bearing and housing onto the upper drive shaft using a dead blow hammer and evenly tapping down until the bearing is seated against the aluminum housing. Insert the 3 socket head screws retaining the bearing housing loosely.

4) Adjust the belt tension to be very loose so it will turn the spindle but not pull it sideways. With the spindle running at 1000 RPM the upper bearing housing should not be vibrating greatly when there is no clamping force from the 3 socket head screws. If you feel a vibration, the brake housing bearing is not aligned to the shaft it is running on. Stop the spindle and put an indicator on the upper face of the inner race of the bearing. Rotate the housing while the spindle is not turning. The housing should not run out more than .002 inches during rotation. If it does use a soft hammer to tap on the housing to align it or pry under the bearing flange to lift it to align it. Do not tighten it down until it is running true or the bearing will fail.

Start the spindle at 1000 RPM and snug down the upper bearing mount while it is running. Tighten the 6 aluminum housing bolts.

5) Now the whole assembly is aligned. The spindle drive belt may be tightened back to normal belt tension.

6) Recheck quill movement, clutch engagement and sound levels during operation.

7) Replace all access cover plates.

