# TRAK<sup>®</sup> EMX KNEE MILLS ProtoTRAK<sup>®</sup> EMX CNC

Safety, Installation, Maintenance, Service & Parts

Document: 26109 Version: 072211

**Covers Models:** 

- ProtoTRAK EMX Retrofits
- > TRAK KEMX Knee Mill
- > TRAK K3EMX Knee Mill



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## 1.0 Safety

The safe operation of the TRAK K Mills and the ProtoTRAK CNC depends on their proper use and the precautions taken by each operator.

- Read and study this manual and the ProtoTRAK EMX Programming, Operating, and Care Manual. Be certain every operator understands the operation and safety requirements of this machine *before* its use.
- Always wear safety glasses and safety shoes.
- Always stop the spindle and check to ensure the CNC control is in the stop mode before changing or adjusting the tool or workpiece.
- Never wear gloves, rings, watches, long sleeves, neckties, jewelry, or other loose items when operating or around the machine.
- Use adequate point of operation safeguarding. It is the responsibility of the employer to provide and ensure point of operation safeguarding per OSHA 1910.212 Milling Machine.

#### **1.1 Safety Publications**

Refer to and study the following publications for assistance in enhancing the safe use of this machine.

Safety Requirements for Manual Milling, Drilling and Boring Machines with or without Automatic Control (ANSI B11.8-2001). Available from The American National Standards Institute, 1819 L Street N.W., Washington D.C. 20036

**Concepts And Techniques Of Machine Safeguarding** (OSHA Publication Number 3067). Available from The Publication Office - O.S.H.A., U.S. Department of Labor, 200 Constitution Avenue, NW, Washington, DC 20210.

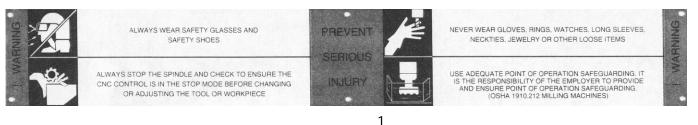
### 1.2 Danger, Warning, Caution, and Note Labels & Notices As Used In This Manual

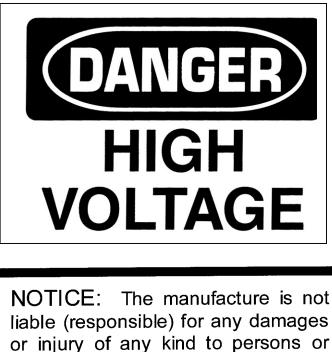
**DANGER** - Immediate hazards that **will** result in severe personal injury or death. Danger labels on the machine are red in color.

**WARNING** - Hazards or unsafe practices which *could* result in severe personal injury and/or damage to the equipment. Warning labels on the machine are orange in color.

**CAUTION** - Hazards or unsafe practices, which *could* result in minor personal injury or equipment/product damage. Caution labels on the machine are yellow in color.

**NOTE** - Call attention to specific issues requiring special attention or understanding.



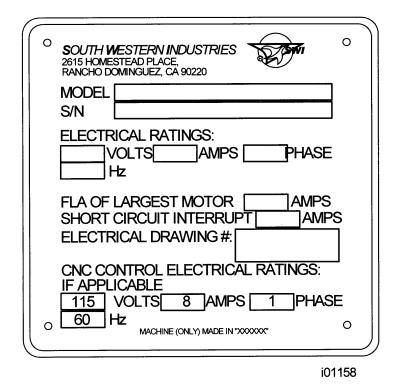


liable (responsible) for any damages or injury of any kind to persons or property caused by or resulting from the improper or unauthorized use, operation, maintenance, alteration, modification, change in configuration of this machine or any of its component parts, or the use of this unit with any third party accessories or parts.

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## Safety & Information Labels Used On The TRAK K Milling Machines

It is forbidden by OSHA regulations and by law to deface, destroy or remove any of these labels



Safety & Information Labels Used On TRAK Milling Machines It is forbidden by OSHA regulations and by law to deface, destroy or remove any of these labels

Power Requirements at 220 and 440 Volts, 3-phase 60 Hz		
	КЕМХ	
Overload Setting 220 V	8.5 A	
Overload Setting 440 V	4.25 A	
FLA of Largest Motor at 220 V	8.5 A	
FLA of Largest Motor at 440 V	4.25 A	
FLA of Machine at 220 V	8.5 A	
FLA of Machine at 440 V	4.25 A	

## **1.3 Safety Precautions**

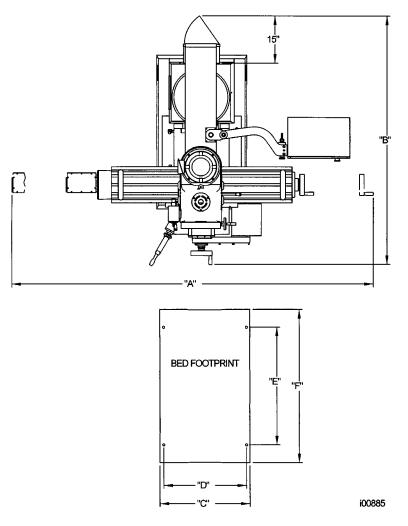
- 1. Do not operate this machine before the TRAK K Mill Installation, Maintenance, Service and Parts List Manual, and ProtoTRAK EMX Programming, Operating & Care Manual have been studied and understood.
- 2. Do not run this machine without knowing the function of every control key, button, knob, or handle. Ask your supervisor or a qualified instructor for help when needed.
- 3. Protect your eyes. Wear approved safety glasses (with side shields) at all times.
- 4. Don't get caught in moving parts. Before operating this machine remove all jewelry including watches and rings, neckties, and any loose-fitting clothing.
- 5. Keep your hair away from moving parts. Wear adequate safety headgear.
- 6. Protect your feet. Wear safety shoes with oil-resistant, anti-skid soles, and steel toes.
- 7. Take off gloves before you start the machine. Gloves are easily caught in moving parts.
- 8. Remove all tools (wrenches, chuck keys, etc.) from the machine before you start. Loose items can become dangerous flying projectiles.
- 9. Never operate a milling machine after consuming alcoholic beverages, or taking strong medication, or while using non-prescription drugs.
- 10. Protect your hands. Stop the machine spindle and ensure that the CNC control is in the stop mode:
  - Before changing tools
  - Before changing parts
  - Before you clear away the chips, oil or coolant. Always use a chip scraper or brush
  - Before you make an adjustment to the part, fixture, coolant nozzle or take measurements
  - Before you open safeguards (protective shields, etc.). Never reach for the part, tool, or fixture around a safeguard.
- 11. Protect your eyes and the machine as well. Don't use compressed air to remove the chips or clean the machine.
- 12. Disconnect power to the machine before you change belts, pulley, and gears.
- 13. Keep work areas well lighted. Ask for additional light if needed.
- 14. Do not lean on the machine while it is running.
- 15. Prevent slippage. Keep the work area dry and clean. Remove the chips, oil, coolant and obstacles of any kind around the machine.
- 16. Avoid getting pinched in places where the table, saddle or spindle head create "pinch points" while in motion.
- 17. Securely clamp and properly locate the workpiece in the vise, on the table, or in the fixture. Use stop blocks to prevent objects from flying loose. Use proper holding clamping attachments and position them clear of the tool path.

- 18. Use correct cutting parameters (speed, feed, depth, and width of cut) in order to prevent tool breakage.
- 19. Use proper cutting tools for the job. Pay attention to the rotation of the spindle: Left hand tool for counterclockwise rotation of spindle, and right hand tool for clockwise rotation of spindle.
- 20. After an emergency stop, always turn the FORWARD/REVERSE switch to "Off" (STOP) before releasing or resetting the E-Stop.
- 21. Prevent damage to the workpiece or the cutting tool. Never start the machine (including the rotation of the spindle) if the tool is in contact with the part.
- 22. Check the direction (+ or -) of movement of the table, saddle and ram when using the jog or power feed.
- 23. Don't use dull or damaged cutting tools. They break easily and become airborne. Inspect the sharpness of the edges, and the integrity of cutting tools and their holders. Use proper length for the tool.
- 24. Large overhang on cutting tools when not required result in accidents and damaged parts.
- 25. Handwheels must have the crank folded inside when using CNC programmed machining or rapid feeds, power feed or jog.
- 26. Prevent fires. When machining certain materials (magnesium, etc.) the chips and dust are highly flammable. Obtain special instruction from you supervisor before machining these materials. Keep flammable materials and fluids away from the machine and hot, flying chips.
- 27. Changing the speed of rotation of the spindle must be done while the rotation is on. It is recommended to stop and start the spindle at a low rate of speed.
- 28. Interlocked table guards may be purchased from Southwestern Industries, Inc., if deemed necessary by the user.

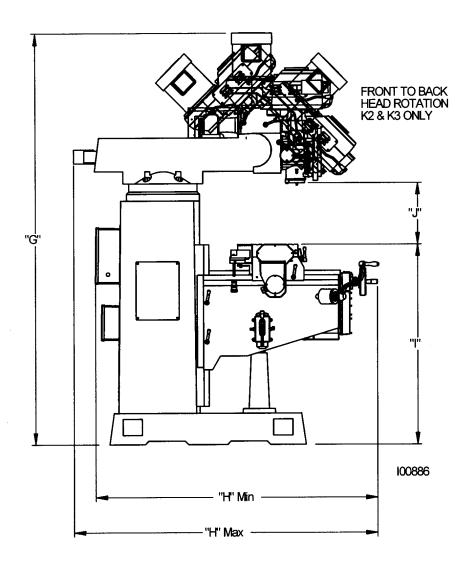
## 2.0 KEMX Machine Installation

Read and understand this entire installation section before beginning the installation procedure.

## 2.1 Floor Plan, Layout & Space Requirements



		KEMX
Weight (approximate) net		2800 lbs
Weight (approximate) shipping		3100 lbs
Palle	t Size	6' x 6'
Α	Overall width	103″
В	Overall length	70″
С	Base width	24.2″
D	Width between leveling screws	21.9″
Ε	Distance between leveling screws	29.7″
F	Base length	38.8″



## Figure 2 - Overall Dimensions

	КЕМХ
Table Size	10″ x 50″
Dimension G	87″
Dimension G Min	65″
Dimension H Min	64″
Dimension H Max	78″
Dimension I Min	38″
Dimension I Max	49′
Dimension J Max	17″

## 2.2 Uncrating

Carefully remove the wood crate and protective packaging, paying attention not to scratch, damage, or mar any parts of the machine.

Remove the cardboard box containing the TOOL BOX. The leveling pads and screws for the machine can be found in the toolbox. The Y way covers are shipped in a separate tube.

Loosen and remove 4 screws and nuts holding the machine to the wood pallet.

## 2.3 Shortages: Inventory Checklist

\_\_\_\_ Machine (check model and serial number)

- \_\_\_\_\_ Manual drawbar with washer
- \_\_\_\_\_ Leveling pads (B239) and screws (B240) (4 each)
- \_\_\_\_\_ Pendant Display (installed on machine)
- \_\_\_\_\_ Pendant Arm assembled to the column
- \_\_\_\_\_ Toolbox with various tools
- \_\_\_\_\_ ProtoTRAK EMX Safety, Operation & Programming Manual (P/N 26056)
- \_\_\_\_\_ TRAK KEMX & Retrofit Safety, Installation, Maintenance, Service & Parts List Manual (P/N 26109)
- \_\_\_\_\_ Way covers front & rear of saddle

## 2.4 Installation Instructions & Checklist

Installer: Use this checklist to assure a complete set-up of the Ki or EMX retrofit.

1. Shut off power to the machine.	
2. Visually inspect the 220 or 440V wiring going into the electrical panel. Visually verify the	
wiring is correct per our wiring diagram. Make sure a strain relief is being used where the	
wiring enters the cabinet.	
3. Clean the machine if needed and remove any remaining grease.	
<ol><li>Unlock the table, saddle, and knee gib locks.</li></ol>	
5. Make and check all the proper electrical connections from the pendant to the electric box.	
See the pendant and electric box wiring diagrams.	
6. Turn on the power to the machine and to the pendant.	
7. Lubricate all the way surfaces and the ball screws.	
8. Jog the table and saddle back and forth until the way surfaces are well lubricated. Oil should	
be visible on all the way surfaces.	
9. Check the level of the machine. The machine should be level to within 0.0005" front to back	
and 0.0005" side to side.	
10. Check to make sure that the E-Stop button is functioning correctly.	
11. Perform Service Code 12, Feed Forward Constant.	
12. Perform Service Code 123 to calibrate the X and Y-axis using a 150mm standard.	
13. Perform Service Code 127 and 128 to manually calculate the backlash for the X and Y-axis.	
Assure the Z-axis quill glass scale is working and the Z axis DRO is functioning. Use Service	
Code 15 to turn on the Z axis readout. (Z axis quill scale is optional.)	
15. Perform Service Code 123 and press QUILL softkey to calibrate the Z-axis quill using a 75mm	
 standard.	
16. Perform Service Code 100 in both directions for the X and Y-axes, to verify that the feed rate	
shown on the display is at least 120 ipm.	
17. Run the spindle at various speeds in both high and low gear for 15 minutes. Verify head	
shifts from high to low gear smoothly. Test quill feed and spindle brake. N/A to retrofits.	
18. Install the Y-axis front and rear way covers.	
19. If the machine has a power drawbar option, check to make sure that the tools load and	
unload properly. N/A to retrofits.	
20. Wipe down the machine.	

## 2.5 Machine Specifications

	KEMX
Movement and ranges (X, Y, Z axis)	32" x 16" x 16"
Quill Travel (maximum)	5″
Quill Diameter	86 mm
Spindle Taper	R8
Speed Range	60-4200 RPM
Spindle to Column	8" to 32"
Quill Feeds Per Revolution of Spindle	.0015/.003/.006"
Head Tilt	+/- 90°
Head Swivel	+/- 45°
Spindle Motor Power	3 HP
Voltage	220/440 V
Phase/Cycle	3 phase/60 Hz
Current	8.5/4.3 amps
Maximum Weight of Workpiece	850 lbs

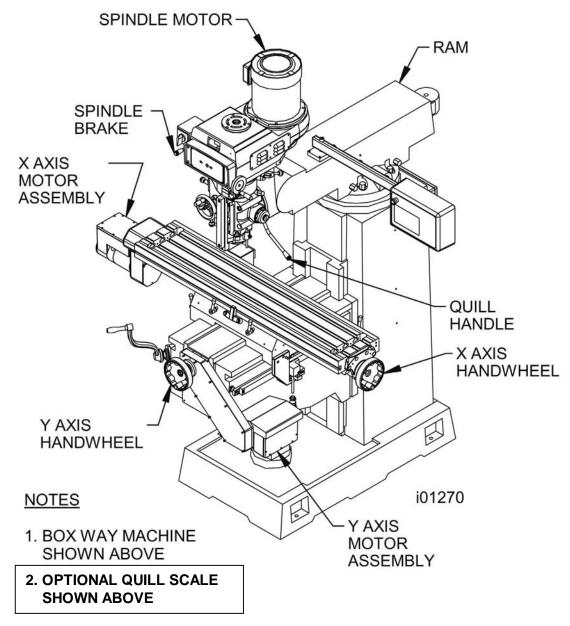
### 2.6 Maximum Work Capacities

Drilling Mild Steel (2-axis manual feed)	1 1⁄4″
Tapping Mild Steel	1″
Milling (metal removal rate/mild steel)	1 <sup>1</sup> ⁄ <sub>2</sub> inch <sup>3</sup> /min

Maximum work capacities are dependent on a lot of variables that cannot be controlled by the machine manufacturer. Each one of the following will have an impact on the above numbers: speeds, feeds, cutter, cutter sharpness, material, setup, coolant and machine adjustments. The numbers above assume all conditions are optimal and may be higher or lower depending on material composition.

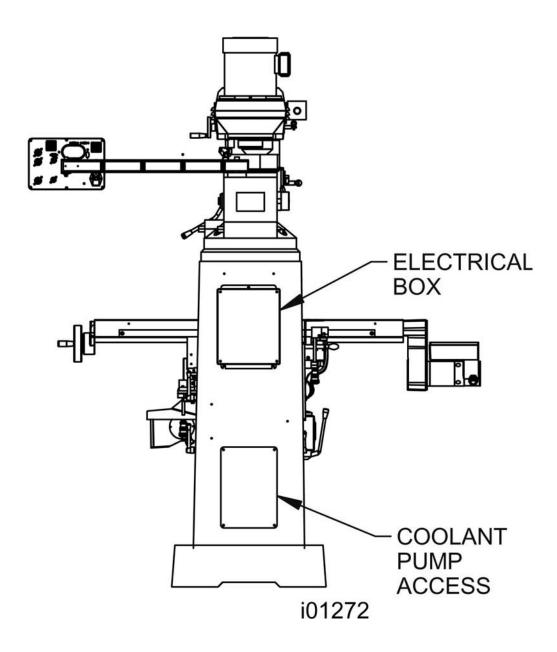
## 2.7 ProtoTRAK EMX Control Hardware

- Digital Servo Amplifiers custom designed for ProtoTRAK operation
- D.C. Servo Motors rated at 280 in-oz. continuous torque are twice that required
- Precision Ball Screws in the table and saddle
- Modular Design simplifies service and maximized uptime
- 115V/60HZ/10 amps
- Feedrate Override of programmed feedrate and rapid
- Polycarbonate Sealed Membrane Keypad to lock out contamination
- 7.0" Color LCD
- On board IDE flash memory storage for part programs
- USB port for interface with a storage device
- Rugged Industrial PC
- Glass Scale on quill for Z-axis readout (Optional)



## Figure 3 Knee Mill Component Identification

Item	Part Number	Description
1	20819	Spindle Motor
2	26015-1	EMX Pendant
3	15616	Y-Axis Handwheel (Saddle)
4	15616	X-Axis Handwheel (Table)
5	20296	X or Y Motor



## Figure 4 - Knee Mill Rear View

Part Number	Description
220V=20676	Electrical Box
440V=20676	
9001	Lube Pump

If the machine was sold with a table guard option, the electrical box part number is 20676-2.

## 2.8 Lifting and/or Moving the Machine

#### CAUTION!

The K machine weighs approximately 2800 lbs. Proper equipment of sufficient capacity must be used when lifting and/or moving the machine.

(See Figure 5 To Prepare the Mill before Lifting):

- 1. Using a steel cable with protective sleeving (min 3/4" diameter) or a 3-ton sling, position sling loops on machine as shown in Figure 5.
- 2. Use cardboard pieces or other suitable protective sheets on both sides of the machine to prevent scratching.
- 3. Remove the 4 nuts and screws holding the machine to the wood skid.
- 4. Lift the machine (the machine should lift approximately level).
- 5. Insert the 4 screws for leveling pads in their place in the bed.
- 6. Place the machine in its location (see floor plan and bed footprint drawing). Carefully positioning each leveling pad under each leveling screw.
- 7. Remove the lifting cable or sling and all protective cardboard.

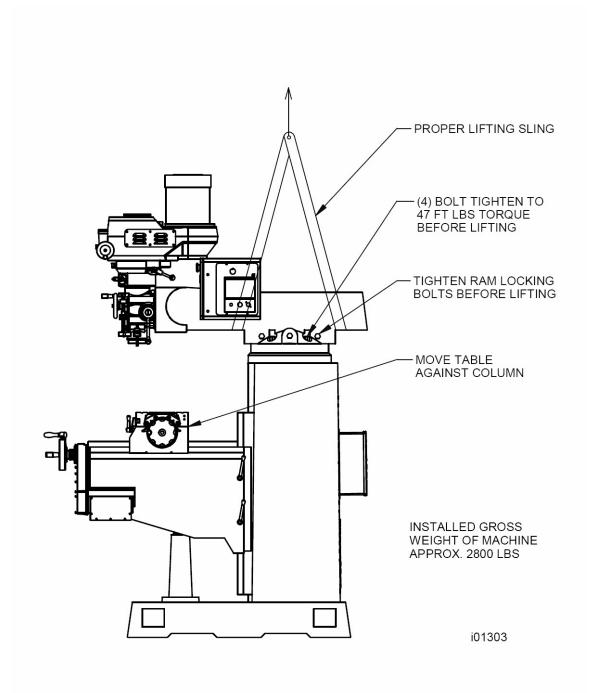


Figure 5 Lifting the Machine

## 2.9 Cleaning

- 1. Remove rust protective coating from the machine before moving any slideways (table, saddle, knee, etc.).
- 2. The coating is best removed with clean, dry shop towels. Do not use a cleaning solution that may damage the rubber way scrapers, plastic parts, or paint.

#### WARNING!

Do not use gasoline or other flammable cleaning agents for cleaning the machine.

3. It may be necessary to move back and forward, left and right, and up and down the table, saddle and the ram. Always release the clamp levers (two in front of the table, one underneath the saddle on each side, and two ram lockbolts on the right side of the column) before attempting to move the above parts.

#### CAUTION!

Never move any of the above parts over ways that were not previously cleaned. Serious damage to the TURCITE surface of slideways can occur.

4. Be certain the table, saddle and spindle move freely and smoothly over their entire length.

### 2.10 Leveling: Leveling Tolerance is .0005"/10"

- 1. Set the machine on its 4 leveling pads on a solid, level floor prepared in accordance with the state and local rules for machine tool installation.
- 2. Put one or two precision Spirit Levels or Electronic Levels in the center of the table in the positions illustrated in Figure 6.
- 3. Adjust the 4 corner leveling screws on their pads until the machine is level to .0005 in/10 in.
- 4. If the machine must be anchored to the floor, follow the general instruction for installing machine tools and use for leveling any well-known methods: shims, etc.).
- 5. If the machine must be installed on vibration mounts/pads (rubber, commercially available leveling and vibration mounts, etc.) follow the instructions delivered with the mounts/pads, ordering them to satisfy the load of the machine and the maximum weight of the workpiece.
- 6. When machine is correctly level, lock the adjusting screws in place with their hex nuts.

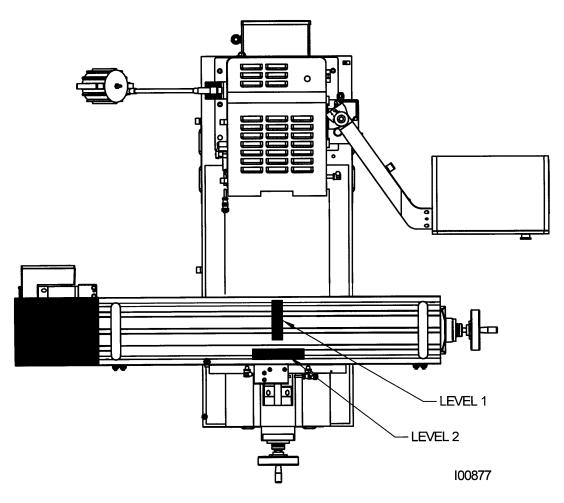


Figure 6 Placement of Levels

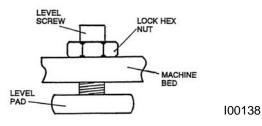


Figure 7 Leveling Screws

## 2.11 Electrical Connection

The TRAK Knee Mill can be configured for 220 or 440 volt 3 phase electricity. These machines also require a 110V power source to power the control..

#### DANGER!

Be certain that 200-volt electricity (typical range 208 – 240V) is used only with a machine labeled 220 volts at the motor and at the electrics box on the back of the column. Be certain that 400-volt electricity (typical range 415 - 460V) is used only with a machine labeled 440 volts at the motor and at the electrics box on the back of the column.

#### DANGER!

The 220 or 440-volt line must originate from a dedicated and independent fused box with a manual shut-off lever. It is the responsibility of the purchaser to supply a wired box that meets all local codes and regulations.

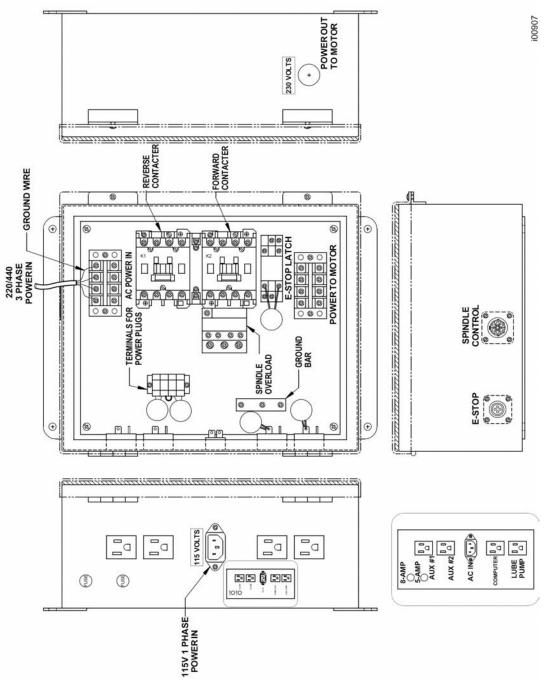
Incoming 220 or 440-volt power connects to the machine through the electrical box located on the back of the column. The power cable enters the black box through a hole on the top of the box.

DANGER!
Only a qualified electrician should wire the 220 or 440-volt 3-phase electricity.

To convert a machine from 220 to 440 volt power or vice versa 3 things must happen: spindle motor must be rewired, overload relay must be set to 8.5 amps for 220 V and 4.25 for 440 volts and the voltage stickers on the electric's box must be replaced.

See Section 5.1.12 for a diagram of how to rewire the spindle motor.

Southwestern Industries recommends the machine be earth grounded by driving a copper rod into the ground. It is the responsibility of the customer to install this rod.



## Figure 8 Wiring KEMX - Not for retrofit

Part Number	Description
220V = 20676	Electrical Box
440V = 20676	
220V = 23438-3	Overload
440V = 23438-3	
23436	Contactor (Qty = 2) (Reverse or Forward)
20676-2	Electrical Box Replacement if machine has
	table guard option.

## 2.12 Air Connection - Optional

The machine has an air hookup in the rear of the machine if the machine has a power drawbar

If the machine has a power drawbar option then the machine will include an air regulator, air manifold and an oiler. The air fitting is ¼" NPT. Within the manifold there is an additional air line port in case the user wants to hook up an air line to clean chips. Remove the plug to gain access to this port

## 2.13 Lubrication

#### CAUTION!

Failure to properly lubricate the mill will result in the premature failure of bearings, sliding surfaces & ballscrews

#### 2.13.1 Manual Lubrication

The TRAK mill X & Y way surfaces and ball screws need to be manually lubricated. The Manual Lube automatically discharges about 4ml of oil every plunge.

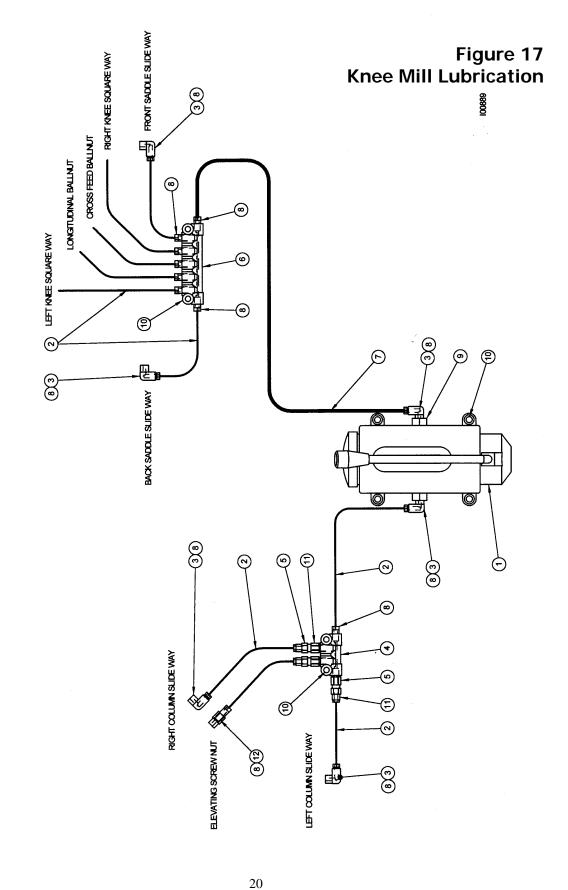
1. At the beginning of each day, manually pull the pump handle.

*Note:* If the machine has been sitting for a long while, run the machine through the full length of its travel to ensure lubrication reaches all surfaces.

2. At the beginning of each day, check the oil level in the system. If low, fill with Mobil Vactra Oil No. 2 or equivalent.

#### CAUTION!

Failure to manually activate the pump at the beginning of each day and allowing the pump to run dry may cause severe damage to the TRAK mill way surfaces and ball screws.



Item	P/N	Description	Qty
1	9001	FRU-K3-HAND OILER	1
2	9002	FRU-K3-ALUMINUM PIPE	6
3	9003	FRU-K3-ELBOW	6
4	9004	FRU-K3-T-JOINT - 4 HOLES- M8 X 1.0	1
5	9005	FRU-K3-CONNECTOR	3
6	9006	FRU-K3-REGULATING DISTRIBUTOR	1
7	9007	FRU-K3-FLEXIBLE TUBE	1
8	9008	FRU-K3-SCREW NUT - M8 X 1.0 MALE	15
9	9009	FRU-K3-SCREW NUT - PD 1/8- 19MM	2
10	9010	FRU-K3-SCREW - M5 X 20 mm LG	8
11	9011	FRU-K3-SCREW NUT - M8 X 1.0 FEMALE	3
12	9012	FRU-K3-ADAPTER	1
13	9013	FRU-K3-SLEEVE - 4.1 mm I.D.	18

### Parts List – Figure 17, Knee Mill Lubrication

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#### 2.13.2 Head Lubrication

#### Once Each Week:

- 1. Fill the oil cup on the front of the head with SAE 30 or 30 W oil. This oil lubricates the Hi/Lo range shifter.
- 2. Extend the quill fully and apply a coating of SAE 30 or 30W oil to the outside diameter of the quill.

#### **Every Four Months:**

- 1. Apply a good grade of general-purpose grease through the grease fitting on the back of the head. This grease lubricates the Low-range gear set and the feed-change gears.
- 2. Grease vari-disk on spindle motor through the grease fitting on the motor shaft.

## 3.0 ProtoTRAK EMX Retrofit Installation

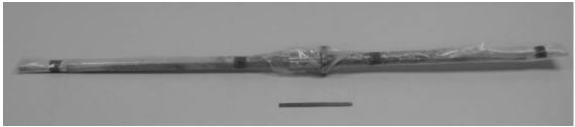
### 3.1 Recommended Tools

- Allen wrenches, set, inch and metric
- Drill motor
- Drills, set
- Taps, set, and tap handle
- Machinist square
- Bubble level
- Crescent wrench, 10"
- Torque wrench, up to 60 ft/lbs. Optional, better if you have it
- Crowfoot wrench, 1 1/4" open end to fit torque wrench
- Socket set with 3" and 6" extension and ratchet wrench
- Dial calipers
- Flat blade screwdriver set
- Phillips screwdriver set
- Gauge block, 6" or 150mm Calibrate X, Y
- Gauge block, 3" or 75mm Calibrate optional Z scale
- .0001" dial indicator and magnetic base
- Center punch
- Hammer, small
- Combination wrenches, set, 3/8" to 15/16"
- Counterbores or step drills set
- Combination wrench, 10mm
- Transfer punch set
- Transfer screw set
- Feeler gage Z glass scales option
- Pliers set
- File set
- Xacto knife with flat blade
- 3/4" 2 flute end mill For machining test
- Safety glasses

## 3.2 Kit parts

#### 3.2.1 Ballscrews

Warning: never unscrew a ballscrew from its ball nut. This will destroy the ballscrew. This is especially important with the Y-axis ballscrew. Before installing, be sure that the ballscrew is long enough for the saddle travel of your machine.



1 - BALLSCREW-XAXIS (P/N 26031-42), (P/N 26031-48), (P/N 15608-36) or (P/N 15608-54)

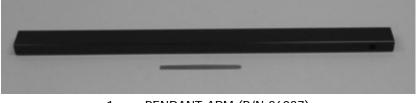
This item will have one of these part numbers based on the kit that is shipped.



1 - BALLSCREW-YAXIS (P/N 26032-12), (P/N 26032-16) or (P/N 15609-19)

This item will have one of these part numbers based on the kit that is shipped.

#### 3.2.2 Pendant Arm Assembly – P/N 26034-2, -3 or –4 This assembly will vary depending on the machine it is installed on.



1 ea - PENDANT ARM (P/N 26037)

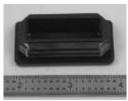


1 ea - NAMEPLATE-SYSTEM S/N (P/N 21934)

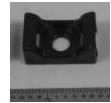


1 ea. – PLATE-LEVELING (P/N 16919)

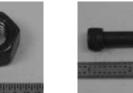




1 ea - CAP PLUG (P/N 26038)



4 ea- CABLE MOUNT (P/N 26050)



1 ea – SCREW-SHCS-STL-BO (P/N 3/8-16X2 3/4 25B)



2 ea - SCREW-

DRIVE-4-SS

(P/N 4X3/8 34J)

1 ea – BUSHING-THREADED M-20X2.5 METRIC (P/N 26016-2)



4 ea - BHCS (P/N 1/4-20 X 1/2 27B)



1 ea – BUSHING-THREADED 3/4-10 STANDARD (P/N 26016-1)



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4 ea - SCREW-SOC

SET-STL-BO-CUP

(P/N 1/4-20X3/4 40B)

1 ea – NUT-HEX-ST BO (P/N 3/8-16 50B)



1 ea – WASHER-EXT TOOTH-STL-ZINC (P/N 1/2 75Z)



1 ea – WASHER – BELLEVILLE SPRING LOCK (P/N 24009-2)



1 ea – SCREW-SHCS-STL-BO (P/N 1/2-13X3 1/2 25B) (P/N 5/8-11X3 1/2 25B)

#### 3.2.3 Motors



2 ea - MOTOR ASSY ENCODER/DRIVER 4020 (P/N 20296)

### 3.2.4 Options

#### Z Glass scale and glass scale mounting bracket

The Z Glass Scale and hardware are packaged in two separate boxes. One box contains the scale and the other contains all hardware. See the instructions that came with your glass scale kit for the listing of parts.







1 – Z GLASS SCALE (P/N 22800-4)

**Remote Stop-Go switch Option** 



1 – REMOTE STOP/GO SWITCH (P/N P-TRAK RSG)

**USB Thumb Drive Option** 



1 – USB-FLASH DRIVE-256MB (P/N 24671-256)

#### 3.2.5 Pendant and pendant hardware



1 ea - PENDANT ASSY – PROTOTRAK EMX (P/N 26015-2)

#### ProtoTRAK EMX Pendant Hardware – P/N 26035-2

55 ea – CABLE TIE-PLASTIC 8 IN LONG (TCA1)

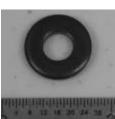
(P/N 21968)



2 ea – CABLE ASSY – AC POWER (P/N 22608)



4 ea – SCREW-SHCS-STL-BO (P/N 1/4-20X3/4 25B)



4 ea – WASHER-1/4 HARD BLK OX 1/8 THK (P/N 15759)

## ΝΟ ΡΗΟΤΟ

1 ea – MANUAL-EMX SERVICE AND INSTALLATION (P/N 26109)



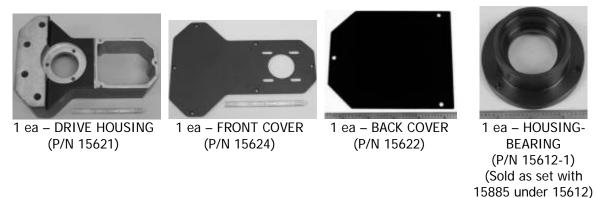
4 ea – CLAMP-CABLE (4160) (P/N 21967)

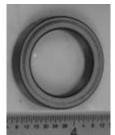
#### ΝΟ ΡΗΟΤΟ

1 ea – MANUAL-EMX PROGRAMMING (P/N 26056)

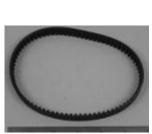
3.2.6 X-Axis Drive Kit - P/N 20255-1,-2,-3,-5 or -6

#### This assembly will vary depending on the machine it is installed on.

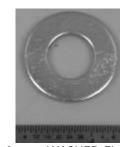




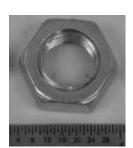
1 ea – RING-BEARING HOUSING (P/N 15885)



1 ea – BELT-TIMING 5MM POWERGRIP (P/N 400-5M-15)



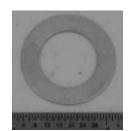
2 ea – WASHER-FLAT SAE-STL-ZINC (P/N 1/2 71Z)



2 ea – NUT-HEX JAM-STL-ZINC (P/N 1/2-20 51Z)



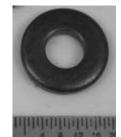
2 ea – WASHER-EXT TOOTH-STL-ZINC (P/N 1/2 75Z)



2 ea - SPACER - .020" THICK (P/N 14772-2)



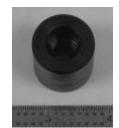
4 ea – WASHER-FLAT USS-STL-BO (P/N 3/8 70P)



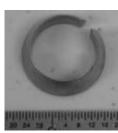
7 ea – WASHER-1/4 HARD BLK OX 1/8 THK (P/N 15759)



1 ea – SPACER- .100" THICK (P/N 14772)



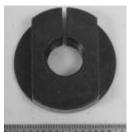
1 ea – STOP – X-AXIS (P/N 15638) Use if needed. Mount on saddle to prevent X motor bracket from pinching the oil manifold.



1 ea – FERRULE-SPROCKET (P/N 16350)



1 ea – SEAL-BEARING HOUSING (P/N 15626)



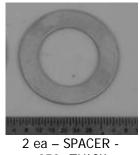
1 ea – NUT CLAMP-X,Y, & Z AXIS (P/N 16452)



1 ea – KEY WOODRUFF #404-1/8 X 1/2 (P/N 98481A090)



(P/N 23930)



.050" THICK (P/N 14772-5)

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ProtoTRAK® KEMX & Retrofit Safety, Installation, Maintenance, Service & Parts List Manual



4 ea - SCREW-SHCS-STL-BO

(P/N 3/8-16X2 1/2 25B), (P/N M8-1.25X65 25B)

or (P/N M10-1.5X65 25B)

Kits may contain one or all of these parts.



3 ea – SCREW-RH-PHIL-STL-BO (P/N 8-32X3/8 20B)



1 ea – PULLEY-SOLID 44 TEETH W/O GUIDES (P/N 16983-1)



7 ea – SCREW-HEX ND-STL-BO (P/N 1/4-20X1 24B)



1 ea – HANDWHEEL ASSY-MX (P/N 15616)



ea – SCREW-SHCS-STL-BC (P/N 8-32X3/8 25B)



1 ea – SCREW-SHCS-STL-BO (P/N 5/16-18X1 25B)



1 ea – SCREW-SHCS-STL-BO (P/N 10-32X3/4 25B)



3 ea – SCREW-SHCS-STL-BO (P/N 10-32X1 25B)

### 3.2.7 Y-Axis Drive Kit - P/N 23083-1,-2,-3 or -4

This assembly will vary depending on the machine it is installed on.



1 ea – MOTOR BRACKET-KNEE MILLS-40 DEGR (P/N 20623)



ea – COVER-SPORT 40 DEGRE (P/N 20621)



1 ea – BELT-TIMING 5MM POWERGRIP (Y AXIS) (P/N 890-5M-15)



1 ea – HANDWHEEL ASSY-MX (P/N 15616)



1 ea – PULLEY-SOLID 44 TEETH W/O GUIDES (P/N 16983-1)



1 ea – BEARING HOUSING (P/N 15980-1) (Sold as set with 15885 under 15980)



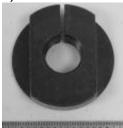
1 ea – SEAL-BEARING HOUSING (P/N 15626)



1 ea – WASHER-EXT TOOTH-STL-ZINC (P/N 1/2 75Z)



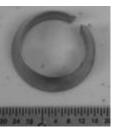
1 ea – RING-BEARING HOUSING (P/N 15885)



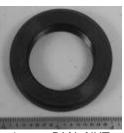
1 – ea NUT CLAMP-X,Y, & Z AXIS (P/N 16452)



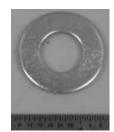
1 Set – BEARING-ANGULAR CONTACT (P/N 23930)



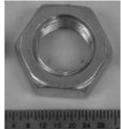
1 ea – FERRULE-SPROCKET (P/N 16350)



1 ea – DIAL NUT (P/N 15836)



1ea – WASHER-FLAT SAE-STL-ZINC (P/N 1/2 71Z)



1 ea – NUT-HEX JAM-STL-ZINC (P/N 1/2-20 51Z)



4 ea – SCREW-SHCS-STL-BO (P/N 3/8-16X2 1/2 25B), (P/N M8-1.25X65 25B) or (P/N M10-1.5X65 25B) *Kits may contain one or all of these parts.* 



4 ea – SCREW-HEX ND-STL-BO (P/N 1/4-20X1 24B)



4 ea – WASHER-1/4 HARD BLK OX 1/8 THK (P/N 15759)

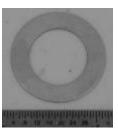


1 ea – SHEET METAL-PT4-COOLANT MOTOR COVER ASSY (P/N 23141)

This item is found in the Misc. Parts box.



1 ea – KEY WOODRUFF #404-1/8 X 1/2 (P/N 98481A090)



1 ea – SPACER – .020" THICK (P/N 14772-2)



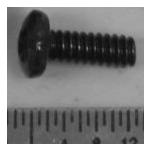
3 ea – WASHER-FLAT USS-STL-BO (P/N 3/8 70P)



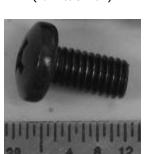
1 ea – TAB WASHER (P/N 15614)



1 ea – DIAL HOLDER (P/N 15627-2)



8 ea – SCREW-PH-PHIL-STL-BO (P/N 6-32X3/8 10B)



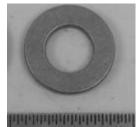
3 ea – SCREW-SHCS-STL-BO (P/N 10-32X3/8 10B)



2 ea – SCREW-PH-PHIL-STL-BO (P/N 1/4-20X3/8 10B)



3 ea – WASHER-SPLIT LOCK-STL-BO (P/N 10 73B)



4 ea – WASHER-.75X.394X.10-STL (P/N 23082)



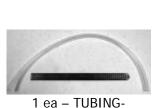
ea – SCREW-SHCS-STL BO (P/N 10-32X3/4 25B)

#### 3.2.8 Yoke Kit - P/N 15844-1,-2,-3,-5,-6 or -13

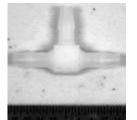
This assembly will vary depending on the machine it is installed on.



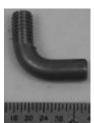
1 ea – YOKE-MACHINED (P/N 15546-x) Needed when the original machine yoke is not usable. This part may not be in every kit. It will be included in kit P/N 15844-2



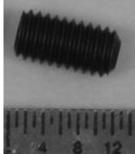
TYGOTHANE 1/4 OD. 1/8 ID 2FT (P/N 5549K11)



1 ea – FITTING (P/N P2 TUB-2) Needed when knee mill contains only 1 oil line that supplies both the X and Y ballscrews.



2 ea – ELBOW-RIGHT ANGLE-THREADED LEADLOY A (P/N 15187)



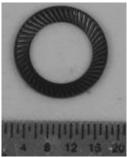
2 ea – SCREW-SCO SET-STL-BO-CUP (P/N 10-32X3/8 40B)



2 ea – SCREW-SHCS-STL-BO (P/N 5/16-18X1 1/4 25B)



2 ea - PIN-ROLLED-STL-PLAIN (P/N 3/16X1 1/4 81P)



2 ea – WASHER – BELLEVILLE SPRING LOCK (P/N 24009-1)



2 ea – oil line restrictor (P/N 15782)

#### 3.2.9 Other parts

The parts in this section are not needed for all machine models and do not appear in some kits. Even if they are in your kit, you may not need to use them. See the instructions.



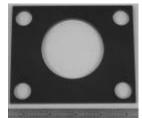
1 – YOKE SHIM (P/N 16568) Needed if the ballscrew bore is too small relative to the yoke bore.



1 – BEARING (P/N 22008) Needed when the original floating bearing is not usable.



1 – END CAP (P/N 22007) Needed when the original end cap is not usable.



1 – BACKING PLATE (P/N 16029) Needed to support the Y-axis bearing assembly when the hole in the machine casting is too large.



1 – BALLSCREW EXTENSION ASSEMBLY (P/N 15181) Needed for the X-axis ballscrew for tables that are 49" long.



1 – BALLSCREW EXTENSIVE SUB ASSEMBLY (P/N 14975) Needed the X-axis ballscrew for tables that are 50" long.

#### 3.3 Installation Steps

The following steps suggest the best way to install the ProtoTRAK EMX retrofit. We recommend you proceed with the installation by doing the following.

- Follow the order of the steps.
- Read the Warnings and Cautions to avoid injury and damage.
- Refer to the drawings for the order of assembly of parts.
- Use the photos and tips to save yourself some time.

#### Step 1. Remove the table and lead screws.

#### DANGER!

Crushing, slicing and pinching hazards are present with this step. Use extreme caution when removing the table. Ensure you have adequate working area and support before you remove the table. Don't work alone.

We suggest you remove the items in the following order:

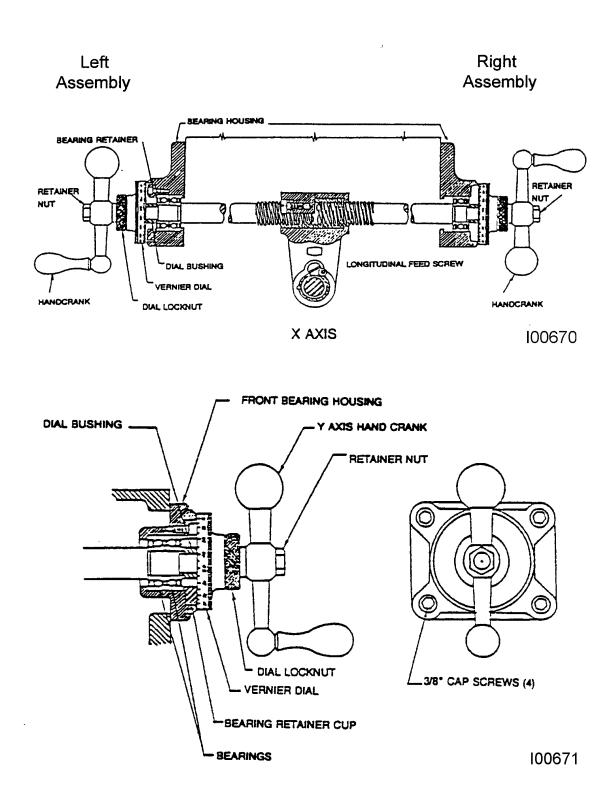
- 1. Left and right hand wheel and bearing assemblies from the table
- 2. Table gib (easiest with table centered)
- 3. Table
- 4. Saddle hand wheel and bearing assembly (with saddle cranked all the way forward)
- 5. Table and saddle lead screws
- 6. Yoke, or lead screw nut retainer
- 7. Nut, bushing, key and pins from the yoke (if a new yoke came with the kit, you don't have to do this)

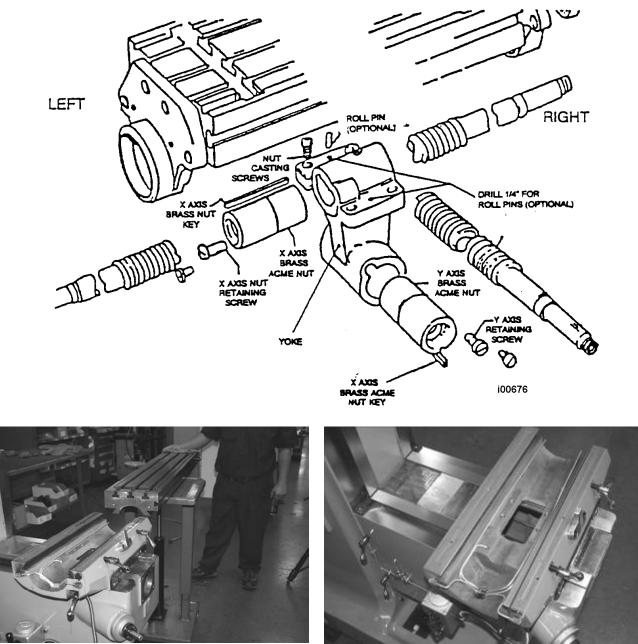
#### Tips:

- Keep the original machine hardware organized as you remove it. You will need some of it later.
- Before removing any of the hardware from the machine, crank the table all the way to the right or left in order to be able to position the lift table next to the machine.
- With the machine disassembled, do a good job of cleaning the gibs, oil grooves and slideways. This will help ensure smooth operation of your ProtoTRAK.
- Assure that the lubrication system is working properly.

Caution!

When removing the table, make sure it does not cock or it may break the dovetails as it slides out.

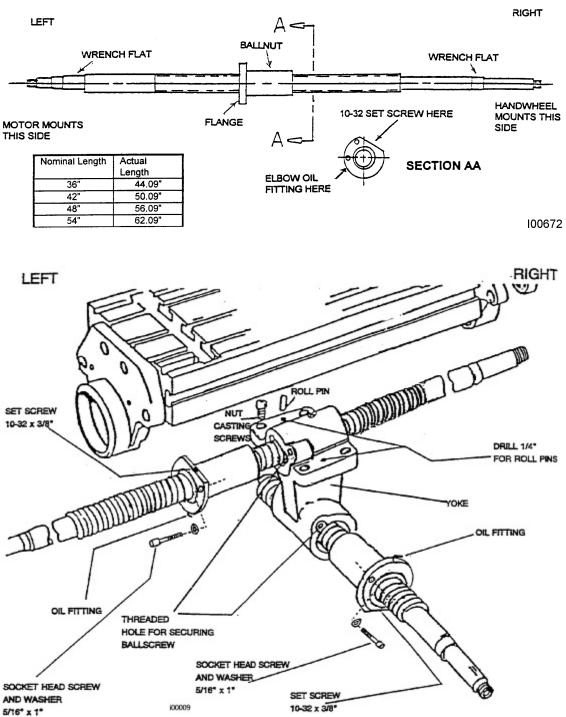




WARNING! Use proper support for the table

Ready for Step 2

This step is completed when: the table is removed, the casting is cleaned and the parts are organized for later.

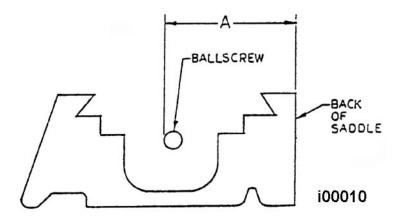


#### X Axis Ballscrew

#### Caution: Never unscrew the ballscrew from the nut. This will destroy the ballscrew.

#### Tips:

- Install the elbow oil fitting and 10-32 set screws on the ball nut. The set screw goes in flush to the surface to prevent oil from draining out of the hole. Don't tighten too much or it will damage the ballnut.
- First position the yoke in the saddle without the casting screws, then slide the ballscrew into the yoke. Once the ballscrew is in you can screw in the screws that go through the yoke and into the saddle casting, although you should not tighten them until the ballscrew is aligned.
- If you are using the original machine yoke and it was pinned to the casting, simply replace the pins. If not, it will be necessary to align the ballscrew.
- Align the X ballscrew either to the back of the saddle or to a piece of round stock you clamp into the back dovetail. The ballscrew should be aligned within +/- 0.005" end-to-end.



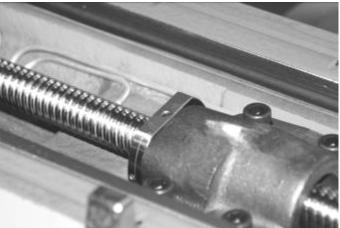
- Trim excess oil line tubing to get it out of your way.
- T-fittings are provided in case they are needed. Use provided restrictors in the oil lines to both the x and y ball nuts so that there will be enough pressure to force oil to the ways.

Caution! Ballscrews must be aligned. Damage to the ballscrew and drive assemblies will occur if the ballscrews are not aligned properly.

Caution!	
Assure that the oil line will provide for proper oil flow to the ball nut.	The ballscrew must have oil.



Position ballscrew with yoke still loose



Install set screw flush, not tight



Elbow fitting



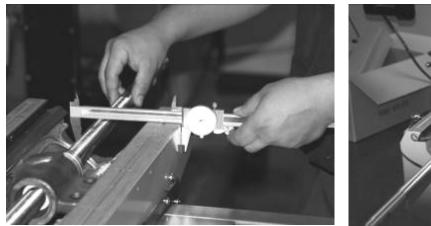
Oil line installed with restrictor



Tighten ball nut retaining screw



Install casting screws snugly, not tight yet





Align to back of the saddle...

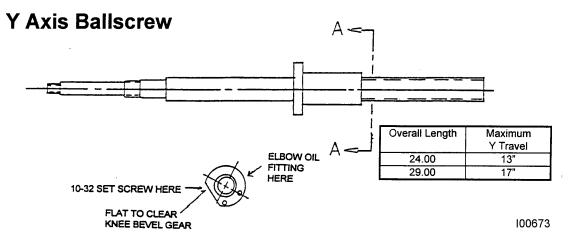
...within ± 0.005"



Now tighten. Check alignment again.

**This step is completed when:** the X ballscrew is tightly attached to the saddle casting and is aligned within +/- 0.005" from end-to-end.

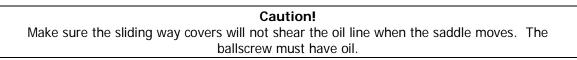
#### Step 3. Install the Y-axis (saddle) ballscrew.

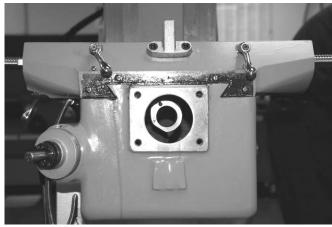


## Caution: never unscrew the ballscrew from its ball nut. This will destroy the ballscrew.

Tips:

- Note that the oil fitting and set screw for the Y-axis ballscrew are in different positions than for the X ballscrew.
- Make sure the oil fitting clears the machine casting at the front. If it doesn't, you will have to grind away some of the casting for it to clear.
- Pull the saddle all the way forward to make it easier to slide the ballscrew into the yoke.
- The flat of the ball nut should match the flat of the yoke. These flats are there in order to clear the beveled gear of the knee crank.
- If you are using a yoke provided in the kit (and not the original yoke), make sure the flat of the new yoke clears the beveled gear. If it does not, you will have to grind some of the yoke away.
- Run the oil line for the ballscrew to the right and rear of the yoke. Don't trim it too short having it longer will make maintenance easier in the future. Make sure to install an oil line restrictor.
- Leave the oil line to the ballscrew long for easier maintenance access

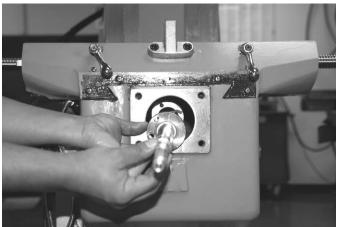




Note the flat on the yoke



Attach oil line and routed



Align ball nut flat with yoke flat



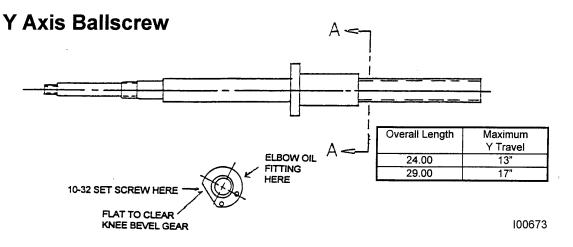
Ball nut and yoke must clear the bevel gear



**Oil lines routed** 

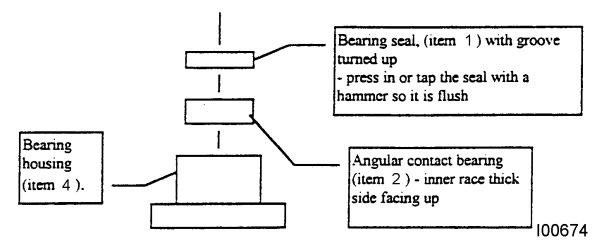
**This step is completed when:** The Y-axis ballscrew is installed and it clears the bevel gear inside the saddle casting when the saddle is pushed back. Both oil lines are attached to both ball nuts and oil is flowing to the ball nuts and all the ways.

#### Step 4. Install the Y-axis drive train.



Tips:

 Assemble bearing housing assembly on a flat surface before you assemble it onto the ballscrew.



- There are two sets of bearing housings and bearing rings (one for Y and one for X); they are matched sets, don't mix them.
- The bearing seal should fit flush into the bearing housing with the groove side out. Press or gently tap it in with a hammer.
- The angular contact bearings must be oriented properly. The thick part of the inner races should face away from each other and be separated by the bearing ring.

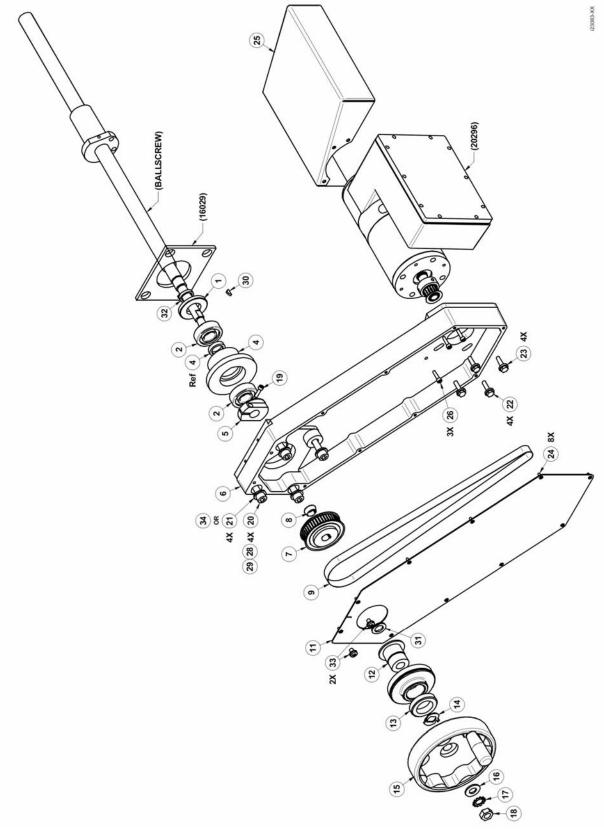


Figure 32 Y-Axis Drive Assembly 23083-3

Item	P/N	Title	Qty
1	15626	SEAL-BEARING HOUSING	1
2	23930	BEARING SET (2)-ANGULAR CONTACT- 7204 BECBP	1 Set
4	15980	BEARING HOUSING ASSY-LARGE FLANGE-Y AXIS	1
5	16452	NUT CLAMP-X ,Y, & Z AXIS	1
6	20623	MOTOR BRACKET-KNEE MILLS-40 DEGR	1
7	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
8	16350	FERRULE-SPROCKET	1
9	890-5M-15	BELT - TIMING 5MM POWERGRIP (Y AXIS)	1
11	20621	COVER-SPORT 40 DEGREE	1
12	15627-2	DIAL HOLDER	1
13	15836	DIAL NUT	1
14	15614	TAB WASHER	1
15	15616	HANDWHEEL ASSY-MX	1
16	1/2 71Z	WASHER-FLAT SAE-STL-ZINC	1
17	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	1
18	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	1
19	10-32X3/4 25B	SCREW-SHCS-STL-BO	4
20	M10-1.5X60 25B	SCREW-SHCS-STL-BO	4
21	23082	WASHER75X.394X.10-STL	4
22	1/4-20X1 24B	SCREW-HEX HD-STL-BO	4
23	15759	WASHER-1/4 HARD BLK OX 1/8 THK	4
24	6-32X3/8 10B	SCREW-PH-PHIL-STL-BO	8
25	23141	SHEET METAL-PT4-COOLANT MOTOR COVER ASSY	1
26	10-32X1 25B	SCREW-SHCS-STL-BO	3
27	10 73B	WASHER-SPLIT LOCK-STL-BO	3
30	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
31	14772-2	SPACER020" THICK	1
32	20322	SPACER Y-AXIS- BALLSCREW	1
33	1/4-20X3/8 10B	SCREW-PH-PHIL-STL-BO	2
	20296	MOTOR ASSY ENCODER/DRIVER 4020	1
	26032-12	BALLSCREW - Y AXIS	1
	26032-16	BALLSCREW - Y AXIS	1

i23083-3

The clamp nut is designed to trap the bearing against the ballscrew journal with the correct preload:

- Thread the clamp nut onto the ball screw and tighten the #10-32 clamp screw until you feel the clamp nut contact the ball screw threads. It should drag as you tighten the clamp nut.
- Tighten the clamp nut to 50 ft/lb.
- Tighten the 10-32 clamp screw.

The bearing housing is designed to float to find its own center. If it does not contact the saddle casting (because the hole is too large) use the backing plate (PN 16029) that is provided for the machine models that need them.

Once the clamp nut is installed, turn it until the bearing housing contacts the knee casting (or backing plate) and the saddle begins to move forward. Then install the motor mounting casting.

Bring the saddle forward until it is about an inch away from the front of its travel. Having the ball nut retainer (yoke) close to the mounting bracket will help to align it properly.

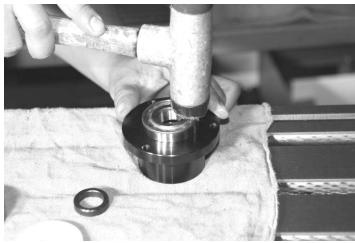
Put the Y axis drive belt on the pulley before installing the vernier dial. Install the motor next. Position the motor so the cable can be routed to the left and around the machine.

Use the machine's original vernier dial.

Install the top cover of the motor mounting bracket and check for clearance between the vernier dial and cover. Add shims to the vernier dial holder if needed.

Tighten the 1/2-20 hex head nut to 50 ft/lb.

Warning! Don't push down on the ballscrew as you are tightening – this may bend the ballscrew.



Bearing letters face in



**Bearing ring** 



Groove side out



Bearing housing complete assembly



Clamp nut pins bearings



Torque clamp nut to 50 ft/lb.



Bearing housing assembly next



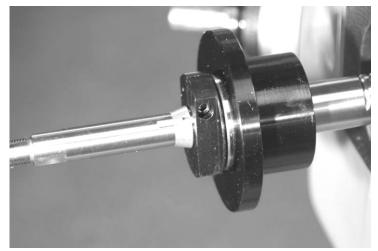
10-32 socket head cap screw, but not tight yet



Now tighten socket head cap screw



Woodruff key



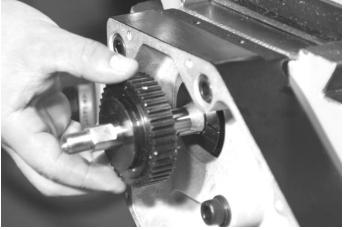
Brass ferrule



Flat against casting



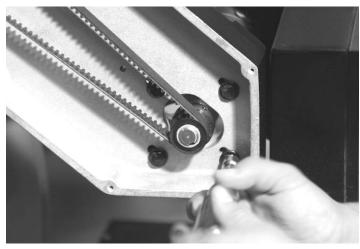
Motor bracket



Pulley

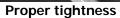


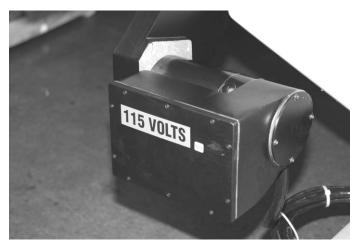
Belt





Motor

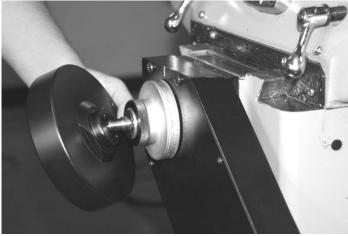




Motor, proper orientation



Vernier and spacer



Dial nut, tab washer and handwheel

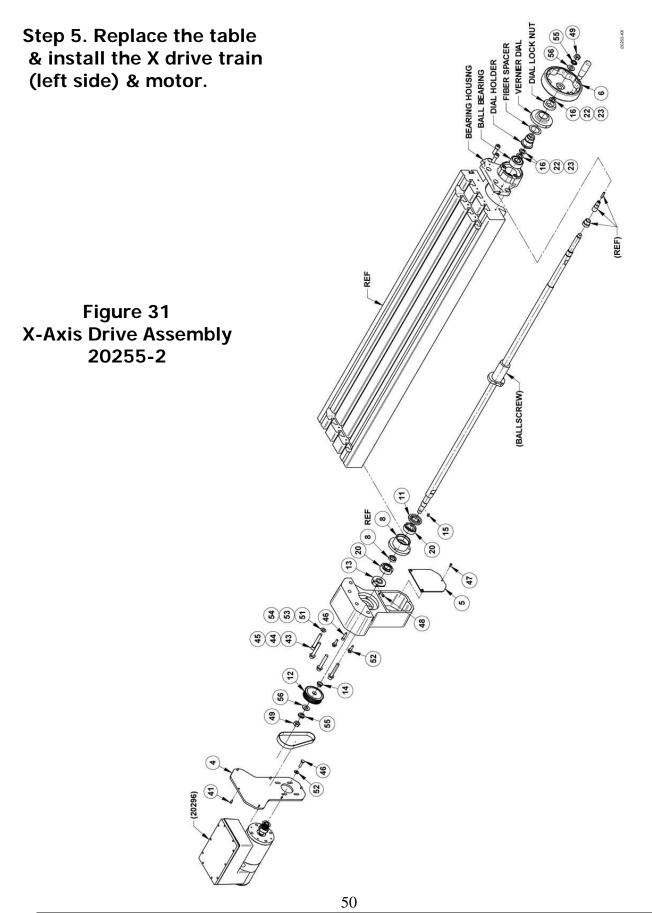


Tighten, don't push down



Y-axis drive completed

**This step is completed when:** The drive train feels smooth as you crank the Y-axis hand wheel through the entire travel. You will feel the belt cogs engage and the balls move through the ball nut, but it should be consistent and smooth.



#### X-Axis Drive Assembly Parts List

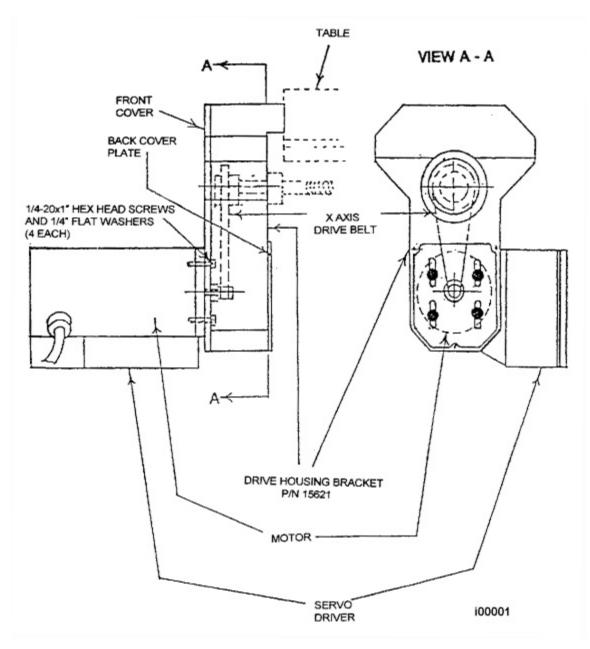
1			Qty
	15621	DRIVE HOUSING	1
4	15624	COVER - X-AXIS - DRIVE - HOUSING-MX	1
5	15622	BACK COVER	1
6	15616	HANDWHEEL ASSY-MX	1
8	15612	BEARING HOUSING ASSY-X AXIS	1
10	15638	STOP - X-AXIS	1
11	15626	SEAL-BEARING HOUSING	1
12	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
13	16452	NUT CLAMP-X ,Y, & Z AXIS	1
14	16350	FERRULE-SPROCKET	1
15	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
16	14772	SPACER100" THICK	5
19	400-5M-15	BELT - TIMING 5MM POWERGRIP	1
20	23930	BEARING SET (2)-ANGULAR CONTACT-7204 BECBP	1Set
22	14772-2	SPACER020" THICK	2
23	14772-5	SPACER050" THICK	2
41	8-32X3/8 25B	SCREW-SHCS-STL-BO	6
42	5/16-18X1 25B	SCREW-SHCS-STL-BO	1
45	M10-1.5X65 25B	SCREW-SHCS-STL-BO	4
46	1/4-20X1 24B	SCREW-HEX HD-STL-BO	7
47	8-32X3/8 20B	SCREW-RH-PHIL-STL-BO	3
48	10-32X3/4 25B	SCREW-SHCS-STL-BO	1
49	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	2
52	15759	WASHER-1/4 HARD BLK OX 1/8 THK	7
54	M10 70P	WASHER-FLAT USS-STL-PLAIN	4
55	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	2
56	1/2 71Z	WASHER-FLAT SAE-STL-ZINC	2
57	22008	BEARING-204KTT	1
	26031-42	BALLSCREW - X AXIS	1
	26031-48	BALLSCREW - X AXIS	1

Crushing, slicing and pinching hazard. Use extreme caution when replacing the table. Don't work alone.

#### Tips:

- Screw the X ballscrew to the opposite side to make it easier to slide the table back on.
- Temporarily install the 1/2-20 hex head nut on the ballscrew and use a wrench to turn it.
- Before you slide the table back on attach the oil lines and test the oil flow. Liberally lubricate the ways.
- Make sure the gib locks have not fallen out of their holes and into the saddle.
- Reinstall the table gib after the table is back on the machine.
- Unlike the Y-axis drive, the X-axis bearing housing attaches to the drive housing.
- See Step 4 for tips about the assembly of bearing housing and the clamp nut.

- Position the left end of the table almost flush with the left side of the saddle to install the left side drive train and motor.
- Make sure the belt is tight on the pulleys.
- Position the motor so the cable can be routed to the left (your left, facing the machine) and around the machine.
- When more than one fastener is called out in the drawing, use the ones that work for your machine.
- Item 10 in the list above may be installed on the saddle if needed to prevent the X motor casting from damaging the oil manifold. Use the 5/16-18 X 1 SHCS to fasten the stop.



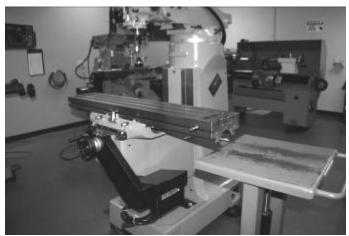
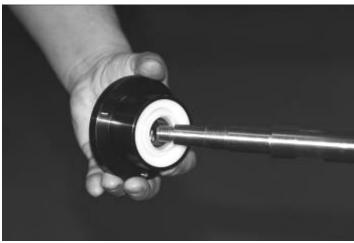


Table back on



X gib back in



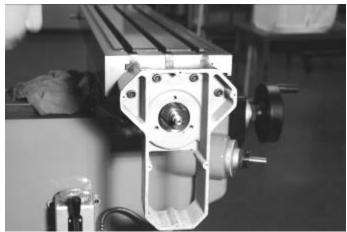
Bearing housing assembly



Tighten, don't push down, to 50 ft-lbs



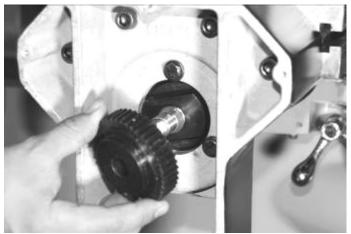
Ready for drive housing



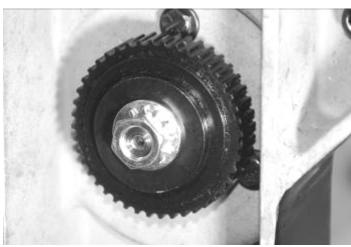
Drive housing installed on table



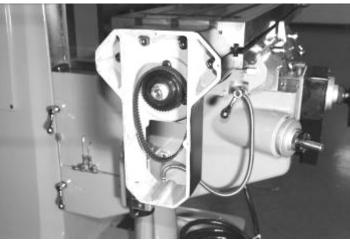
Securing the bearing housing assembly



Key, ferrule, pulley



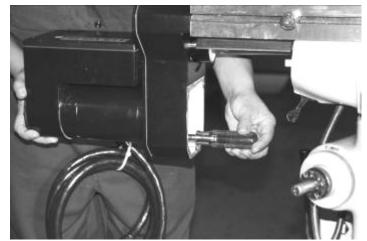
Washer, star washer, ½ hex nut Tighten to 50 ft-lbs



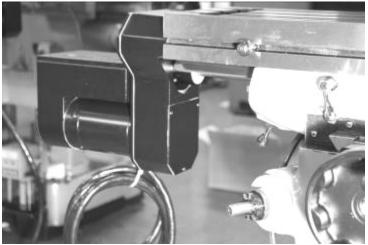
Belt



Front cover



Motor



Complete. Note motor orientation.

This step is completed when: The motor is installed with the cable pointing down and toward the rear of the machine.

# Step 6. Install the right side end cap and hand wheel assembly.

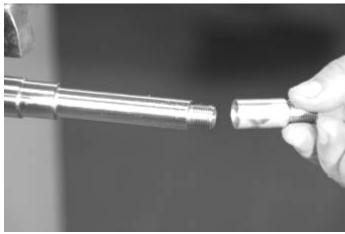
See the figure from Step 5 above.

Tips:

- Use the original right or left side hardware from the machine.
- Position the table (by screwing the ballscrew) so that the right end is almost flush with the right side of the saddle to install the hardware.
- Some installations require a ballscrew extension (included in the kit). If you use the ballscrew extension, note that there is a setscrew inside the extension. First install the extension; use two wrenches to tighten it securely. Then install and tighten the setscrew (lock tight is recommended). Use the bushing to seat the floating bearing (that came with the machine.
- Once the handwheels are installed on both sides, crank the table back and forth. It should move smoothly throughout the entire travel with no binding.
- Adjust the table and saddle gibs to be snug but allow smooth motion.

Warning!
•
Don't push down on the ballscrew as you are tightening – this may bend the ballscrew.

**This step is completed when:** The drive train feels smooth as you crank the X-axis hand wheel through the entire travel. You will feel the belt cogs engage and the balls move through the ball nut, but it should be consistent and smooth.



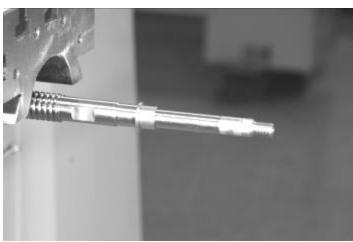
Extension, only if needed



**Tighten extension** 



Set screw to tighten extension



Bushing



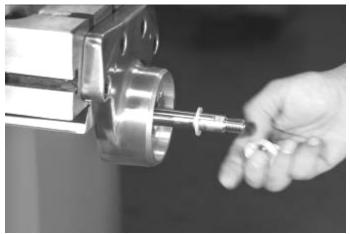
Original bearing in original housing



Housing on table

- Use cable ties to secure the cables to the pendant-mounting arm. You may want to do this after the system check out in step 10. Just don't forget to come back to it because the machine will look a lot nicer with the cables all tied up.
- **Note:** The tableguard port is not used for retrofits.

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Spacers as needed



Vernier dial, lock nut, spacers as needed

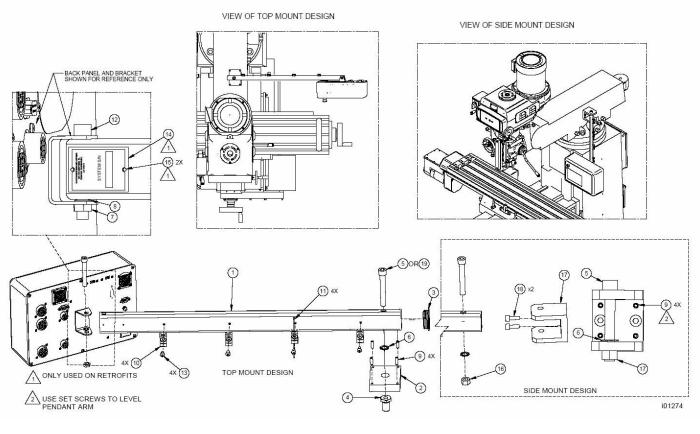


Handwheel, washer, star washer, nut



Tighten, don't push down, to 50 ft-lbs

### Step 7. Install the display pendant.



Item	P/N	Title	UseAs	Qty
1	26037	PENDANT ARM	EA	1
2	16919	PLATE-LEVELING	EA	1
3	26038	CAP PLUG	EA	1
4	26016-1 26026-2	BUSHING - THREADED - 3/4-10 BUSHING - THREADED - M20X2.5	EA	1
5	1/2-13X3 1/2 25B	SCREW-SHCS-STL-BO	EA	1
6	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	EA	1
7	3/8-16 50B	NUT-HEX-STL-BO	EA	1
8	24009-2	WASHER - BELLEVILLE SPRING LOCK	EA	1
9	1/4-20X3/4 40B	SCREW-SOC SET-STL-BO-CUP	EA	4
10	26050	CABLE MOUNT	EA	4
11	22475	TIE WRAP – 4 IN. PLASTIC	EA	4
12	3/8-16X2 3/4 25B	SCREW-SHCS-STL-BO	EA	1
13	1/4-20 X 1/2 27B	SCREW-BHCS-STL-BO	EA	4
14	21934	NAME PLATE - SYSTEM S/N	EA	1
15	4X3/8 34J	SCREW - DRIVE 4SS	EA	2
16	1/2-13 50Z	NUT - HEX - STL - ZINC	EA	1
17	26066	BRACKET - PENDANT ARM	EA	1
18	5/16-18X1 25B	SCREW-SHCS-STL-BO	EA	2
19	5/8-11X3 1/2 25B	SCREW-SHCS-STL-BO	EA	1
				i01274

The drawing illustrates the two ways of mounting the pendant arm to the machine. Your kit will include one of the two sets of hardware depending on the model of your machine. For Bridgeport models, if it is necessary to use the 5/8" bolt supplied, you will have to open up the through-hole in the pendant arm.

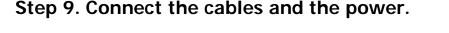
Attach the nameplate serial number plate (21934) on the pendant arm. This serial number plate is the serial number that you will need to reference for service parts and other support in the future. The Service Department will not be able to help you efficiently without the serial number.

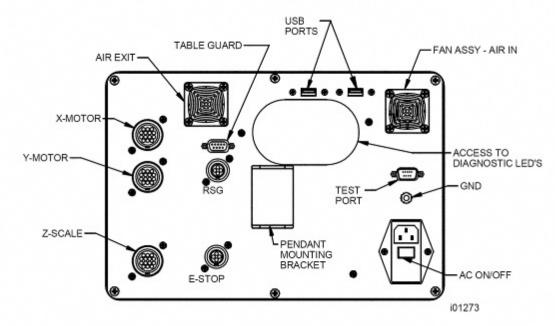
This step is completed when: The display pendant is mounted securely to the machine ram and the serial number name plate is attached to the pendant arm.

#### Step 8. Install the Z glass Scale

There are several different brackets that come with the Z-axis glass scale kit, depending on the machine model. Illustrated instructions will come with the scale kit.

This step is completed when: the glass scale is mounted securely to the machine quill and moves smoothly with quill travel.





### Caution: do not turn the power on to the pendant until all cables are plugged in properly. Plugging or unplugging with power on will destroy the computer.

Tips:

• Loosely route the cables and check that there will be enough slack to accommodate full table and saddle traverse.

- Use cable ties to secure the cables to the pendant-mounting arm. You may want to do this after the system check out in step 10. Just don't forget to come back to it because the machine will look a lot nicer with the cables all tied up.
- Note: The tableguard port is not used for retrofits.

This step is completed when: The cables are plugged into the display.



Pendant arm and cables

Z cables - plug in all cables with system off

#### Step 10. Check out.

Do the following:

- 1. Plug the ProtoTRAK EMX into a 110 volt outlet.
- 2. Turn the ProtoTRAK EMX on.
- 3. Go into DRO mode, press Jog.
- 4. Push the X, the table should move under power. Press the +/- key and press the X again. It should move the opposite direction.
- 5. Note: The table should move to the left for positive X counting and the saddle should move towards the operator for positive Y counting. Moving the quill up should result in positive Z counting. Use Service Code 97 to change if needed.
- 6. Do the same with the Y key and observe the saddle.
- 7. Press Return to get out of Jog.
- 8. Move the quill handle. There should be a readout on the Z. If the Z isn't activated, see section 5.9 for instructions on how to do service code 15.

If the system is jogging we recommend that you calibrate and set backlash constants now. See section 6.2.2. Also run service code 12, see Section 5.7.2.1.

If you have any problems, see the troubleshooting section in this manual for what to do. Don't worry, there isn't anything too tough. You may just have to reinstall something.

Congratulations! See your ProtoTRAK EMX Safety, Programming, Operating and Care Manual for instructions for using the ProtoTRAK EMX, a tutorial and some sample programs.

Now you can machine!

## 4.0 Troubleshooting by Symptom

Use this section to begin the process of resolving a service problem. Each symptom type is described in a few words and then more fully described in an explanatory paragraph. Following this is a chart that directs in the most logical steps

### 4.1 Problems Relating to Machining Results

#### 4.1.1 Poor Finish

The part finish is marred with scallops or is very rough.

Do the following Service Codes and document values:

- Code 33 Software Identification. This is needed if you call SWI Customer Service.
- Code 12 Feed Forward Constant
- Code 127 Measures backlash in the system
- Code 128 Enter backlash compensation

Possible Cause	Check This
Too much backlash entered for code 128	Verify nothing is mechanically loose and the backlash values are not higher than what physically is in the system.
Machine Tool & Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). Check the condition and type of cutter being used, type of material, RPM and Feedrate, etc. See Machine Tool & Setup Section 5.1
Table, Saddle, or Knee Locks are locked	Make sure the Table and Saddle Locks are unlocked. Never use gib locks with a CNC machine.
Inadequate or no Lubrication to Ballscrews and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication Section 5.1.3
X, Y, and knee Gibs are not adjusted properly	Check the adjustment of the X and Y gibs. See X and Y Gib Adjustments in Section 6.2.1.
X & Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 5.2
Way surfaces are pocked, scarred, or excessively worn	Visually check the condition of all the Way surfaces. For machines that may have excessively worn Way surfaces you may need to adjust the Gibs in this area. This will affect performance when using the machine outside of this area. Check lubrication to affected areas.

#### 4.1.2 Circles Out of Round

Circles are not round within 0.002" TIR over 3.0" DIA. This is best measured by placing a dial indicator in the quill and sweeping around the part.

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Note: The typical slideway-milling machine is not capable of achieving more precise results although careful adjustments to a new milling machine may produce better results. If more precise circles are required, then it is recommended to use a precision boring head/boring bar.

Do the following Service Codes and document values:

- Code 33 Software Identification. This is needed if you call SWI Customer Service.
- Code 12 Feed Forward Constant.
- Code 127 Measures backlash in the system
- Code 128 Enter backlash compensation.

Possible Cause	Check This
Torque values on X and Y-axis are too high.	Make sure torque is lower than 20 in-lbs. Normal values for a machine that is aligned and adjusted properly should be between 10 and 15 in-lbs. Make sure torque is consistent across axis travel.
Machine Tool and Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). See Machine Tool & Setup - Section 5.1
Machine not level	Verify that the machine is level to specification.
Head is not Trammed	Verify that the Head is Trammed to specification. See Tramming the Head Sec 6.2.3
X and Y Gibs are not adjusted properly	Check the adjustment of the X and Y Gibs using the X and Y Gib adjustment procedures.
Calibration or Backlash problem	Recalibrate the machine. Reset the Backlash. Check Repeatability and Positional Accuracy. See Calibration & Backlash Constants Section 6.2.2
X & Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 5.2
Head Bolts are loose	Verify that all the head bolts are tight.

#### 4.1.3 Taper Cut on a Programmed Straight Line Move

An unwanted tapered cut occurs, when the machine is programmed to move in a straight line along either the X or Y-axis. The DRO shows motion of a few thousandths of an inch in the axis that is not supposed to be moving.

Explanation: For straight line cuts along the X or Y-axis, the control is designed to lock the motor of the axis that is not moving. A taper is created when there is play in the system. The force of the tool shoves the table or saddle out of position.

The system will respond to being pushed out of position by making an adjustment at the end of the move.

An unwanted tapered cut is the result of looseness in the system.

Do the following Service Codes and document values:

• Code 33 Software Identification. This is needed if you call SWI Customer Service.

- Code 12 Feed Forward Constant.
- Code 127 Measures the backlash in the system. •
- Code 128 Enter backlash compensation.

Possible Cause	Check This
Machine Tool & Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). See Machine Tool & Setup Section 5.1
X and Y Gibs are loose	Check the adjustment of the X and Y Gibs using the X and Y Gib adjustment procedures. See Section 6.2.1
X and Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 5.2

#### 4.1.4 Parts Have Incorrect Dimensions

Parts are being machined with dimensions that are different than those programmed. Typical accuracy expectations should be:

- Circles: 0.002" TIR over 3.00" DIA •
- Positional Accuracy: +/- 0.0005" •
- Repeatability: 0.0005" •

Note: The typical slideway-milling machine is not capable of achieving more precise results. Although careful adjustments to a new milling machine have produced better results, you should not expect the same level of accuracy from an older or worn machine.

Furthermore, the system should be expected to repeat within the resolution of the displayed DRO numbers of 0.0005".

Do the following Service Code:

- Code 33 Software Identification. This is needed if you call SWI Customer Service. •
- Code 123 Calibration using a measurement standard, or •
- Code 122 Calibration using work piece measurements. •
- Code 12 Feed Forward Constant. •
- Code 127 Measures the backlash in the system. •
- Code 128 Enter backlash compensation. .

Possible Cause	Check This
Machine Tool & Setup problem	See Machine Tool & Setup Section 5.1
Programming Error	In the program, look for common errors in programming such as transposing numbers, tool diameters, and pressing INC SET when ABS SET is meant. This is especially suspected if the dimensional errors are larger than a few thousandths. See the Controls Programming, Operations and Care manual.
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#### 4.1.4.1 Every Part Has the Same Error

4.1.4.2 The Dimensional Errors Are Random or Accumulate in Size Over the Part Program Run

Possible Cause	Check This
Machine Tool & Setup problem	See Machine Tool & Setup Section 5.1
X and Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 5.2

#### 4.2 Problems Regarding the Motion of the Machine

#### 4.2.1 Run Away Axis

The axis makes an unwanted move at rapid speed in one direction and faults out. This is usually caused by an encoder signal being interrupted.

Do the following Service Codes:

- Code 33 Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting properly.
- Code 131 Motor encoder operation test.

Possible Cause	Check This
The home positions or tools are not set	See the Controls Programming, Operations and Care
correctly	manual.
Bad Motor Encoder	See Motor diagnostics Section 5.4

#### 4.2.2 Slow Down Axis

The axis slows down and moves at a feedrate that is lower than rapid or than the programmed feedrate.

Do the following Service Codes:

- Code 33 Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.
- Code 129 Sets the maximum allowable arc accuracy error. This applies to arcs only.

Possible Cause	Check This
The maximum allowable Arc Accuracy is set too low.	This value will only slow down the machine during arc moves. The factory default is set at 0.001". Perform Code 129 to check or change this value. See Service Codes section
Incoming AC voltage is inadequate	Perform Code 100. See Service Codes - Section 5.9 and Electrical Section 5.8
Table and Saddle Locks are locked	Make sure the Table and Saddle Locks are unlocked.
Inadequate or no Lubrication to Ballscrews and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication Section 5.1.3
X and Y Gibs are not adjusted properly	Check the adjustment of the X and Y Gibs using the X and Y Gib adjustment procedures.
Binding in the Drive Train	Check Repeatability using the Repeatability and Positional Accuracy procedure. Check the torque reading of the Drive Train. Step by step, carefully inspect the Drive Train for any binding. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 5.2
Servo Drive failure	See Servo Drive Section 5.5
Motor failure	See Motor Section 5.4

#### 4.2.3 Axis Will Not Jog

The system powers up but will not respond to the jog command.

Do the following Service Codes and procedures:

- Code 33 Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.

Possible Cause	Check This
Improper Boot-up	Shut down the system and wait 10 seconds before rebooting
E-Stop is pressed in	Check E-Stop. Especially if both axes will not jog
Servo Drive failure	Especially, if only one axis will not jog;
	See Servo Driver Section 5.5
Shorted motor	See Motor Section 5.4
Poor cable or wiring connections	See Electrical Connection Section 5.8
Computer/Pendant failed	See Computer/Pendant diagnostics Section 5.3

#### 4.2.4 Axis Motor Motion Is Not Smooth

While under motor power, the motion is not smooth. The motion appears to be "rough" or jerky".

Do the following Service Codes and procedures:

- Code 33 Software Identification. This is needed if you call SWI Customer Service.
- **Code 12** Feed Forward Constant. High feed forward constants will cause an unstable servo system.
- Code 127 Measures the backlash in the system.
- Code 128 Enter backlash compensation.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.

Possible Cause	Check This
X and Y Gibs are not adjusted properly	Check the adjustment of the X and Y Gibs using the X
	and Y Gib adjustment procedures.
Calibration or Backlash problem	Recalibrate the machine. Reset the Backlash. Check
	Repeatability and Positional Accuracy. See Calibration &
	Backlash Constants section.
Binding in the Drive Train	Check Repeatability using the Repeatability and Positional Accuracy procedure. Check the torque reading of the
	Drive Train. Step by step, carefully inspect the Drive
	Train for any binding. It may be necessary to
	disassemble and then reassemble the Drive Train. See
	Mechanical Drive Train (X, Y) Section 5.2

#### 4.2.5 Searching Axis

The handwheels are slowly turning back and forth when the servos are engaged. Several thousandths of motion are observed on the vernier dial and the frequency is one cycle every couple of seconds.

Do the following Service Code and procedures:

- Code 12 Sets a feed forward power constant to drive axis motors.
- Code 128 Backlash compensation.

Possible Cause	Check This
Most often causes by excess backlash compensation	Use code 127. Check physical backlash in system and re-enter in code 128.
High feed forward values	Check ball screw torque. Typical values should be between 10 to 15 in-lbs.
Excessive friction in the sliding ways	Lubrication, gib adjustments, gib locks. See Machine Tool & Setup - Section 5.1
Looseness in the drive train	Especially the tightness of the drive assembly. See Mechanical Drive Train (X, Y) - Section 5.2

#### 4.3 Problems Relating to the Operation of the Control

#### 4.3.1 Display Blanks

The display is completely blank.

Possible Cause	Check This
Screen saver has been activated	Press any key to turn back on.
The system has shut down	Turn the power switch off, check the computer/ pendant fuses and cable connections. See Electrical Section 5.8
Poor cable connection from Computer Module to LCD (Liquid Crystal Display)	Double-check the connection from the computer module to the LCD.
Computer/Pendant failed	See Computer/Pendant Section 5.3

#### 4.3.2 Bad Picture on the Display

The display has strange characters, horizontal bars or other unfamiliar images, or the display continually rolls.

Possible Cause	Check This
Computer/Pendant failed	See Computer/Pendant Section 5.3
Poor cable connection from Computer	Double-check the connection from the computer
Module to LCD (Liquid Crystal Display)	module to the LCD.

#### 4.3.3 Keyboard Lockup

The screen display is normal, but the system will not respond to key presses.

Do the following Service Codes and procedures:

• **Code 81** To check if the pendant keys are working properly, press each key. If a key is working properly, the corresponding key on the screen will light. The pendant will also beep.

Possible Cause	Check This
Voltage drop/spike has occurred	Shut down the system and wait 10 seconds to reboot the system.
Remote Stop-Go (RSG) switch has a short (if connected)	Remove the RSG. Turn the system off and then on again. If the problem goes away and then re-appears when the RSG is plugged-in, replace the RSG.
Computer/Pendant failed	See Computer/Pendant Section 5.3

#### 4.3.4 Fault X or Y

The program run or jogging operation is interrupted with a Fault Message on the display.

Do the following Service Codes and procedures:

- Code 33 Software Identification. This is needed if you call SWI Customer Service.
- **Code 12** Feed Forward Constant.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.

Possible Cause	Check This
Table and Saddle Locks are locked	Make sure the Table and Saddle Locks are unlocked.
	High torque on any axis may cause faulting problems during alignment routine.
X and Y Gibs are adjusted extremely tight	Check the adjustment of the X and Y Gibs using the X and Y Gib adjustment procedures. See X and Y Gib Adjustments Section 6.2.1
Excessive friction in the slideways	See Machine Tool & Setup Section 5.1
Binding or looseness in the Drive Train	See Mechanical Drive Train (X, Y) Section 5.2
Incoming electrical power	Incoming voltage. See Electrical Section 5.8
Servo Drive failure	See Servo Driver - Section 5.5
Motor failure	See Motor diagnostics, Section 5.4
Computer/Pendant failure	See Computer/Pendant diagnostics, Section 5.3

#### 4.3.5 System Will Not Turn On

Nothing happens when the switch is turned on or the system does not boot-up.

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Possible Cause	Check This
110 V line is not plugged in	Check incoming 110 V power source to black electrical cabinet
Pendant On/Off switch is Off.	Check the Pendant On/Off switch
Fuse blown in pendant or electrical cabinet	Remove fuses and check continuity.
IDE Flash Drive	If Boot Failure message appears, then check that the IDE Flash is properly installed. See section 5.3.
Computer/Pendant has failed	See Computer/Pendant diagnostics Section 5.3

#### 4.3.6 System Reboots by Itself

During operation, the screen suddenly blanks and then shows that the system has begun the boot-up sequence.

Possible Cause	Check This
Interruption of 110 V power to pendant	Using a Voltmeter, check the incoming 110VAC to the pendant.
Poor wiring and cable connections	Check for any loose wiring or cables
Computer/Pendant failed	See Computer/Pendant diagnostics Section 5.3

#### 4.3.7 System Shuts Off

During operation, the system shuts off and will not turn back on.

Possible Cause	Check This
Fuse blown in pendant	Remove fuse and check continuity
Poor wiring and cable connections	Check for any loose wiring. Also, check the 110VAC
	Power Cable connection from the electrical box to the
	Pendant. See Electrical Section 5.8
Computer/Pendant has failed	See Computer/Pendant diagnostics Section 5.3

#### 4.3.8 Will Not Hold Calibration

The control will not hold calibration. Go to the "Configuration Values" screen and write down the calibration values for the motor encoders (Encoder) Recalibrate the system and see if the values change. Turn the system off and on and see if the values are held.

Do the following service codes and procedures:

- Code 33 Software Identification. This is needed if you call SWI Customer Service.
- Code 313 Configuration Values
- Code 123 Calibration using a measurement standard, or
- **Code 122** Calibration using work piece measurements.

Possible Cause	Check This
Configuration file corrupt	Load default configuration by going to code 313

Not saving Calibration values	Replace Computer/Pendant module.
	See Computer/Pendant

If calibration factors are being saved, but the measurements are not repeating or are not accurate:

- See Measurements Are Not Repeating
- See Measurements Are Not Accurate

# 4.3.9 E-Stop Error

For TRAK Knee mills, the E-Stop turns the power off to the axis and spindle motors (for retrofits, the e-stop does not cut power to the spindle motor). For the machine this is done by stopping 110V power from reaching the electrical box through the use of a relay in the pendant.

110V Power reaches the electrical box through the AC E-stop cable. It is used to energize the spindle motor contactor. If this contactor is not energized the spindle will not turn on. See Figure 19.

If the E-Stop button is depressed, and no message is displayed on the screen, then either the E-Stop button or the Computer Module is at fault.

Possible Cause	Check This
Faulty E-Stop switch	Check the cable connections from the computer module to the E-Stop switch. Check the E-Stop switch for functionality.
Bad Computer Module	Does 110 V power come out of the pendant through the e-stop connector? If yes, and the screen has an E-stop message, replace the computer module.

# 4.4 **Problem with the Measurements**

#### 4.4.1 X, Y and Z-Axis Measurements Do Not Repeat

With a dial indicator mounted to the bottom of the spindle, touch off a fixed surface either in the X or Y-axis direction and then set the DRO equal to 0. Crank away several inches and then touch off again at the same place. If the reading has not returned to 0 on the DRO, zero the display and repeat the procedure. If the measurement does not repeat, you have a repeatability problem that must be resolved.

Test for accumulative error by moving the axis a number of times to see if the error gradually grows by a small amount or if the error abruptly changes by a large amount, it may be caused by a bad encoder.

Possible CauseCheck ThisMachine Tool & Setup problemCheck for any looseness in the setup (Tool, Tool<br/>holder, Part, Vise, or Fixture). Make sure there is<br/>sufficient contact between the tool holder and the<br/>spindle. See Machine Tool & Setup Section 5.1X and Y Gibs are looseCheck the adjustment of the X and Y Gibs using the X<br/>and Y Gib adjustment procedures.

Expected repeatability numbers should be 0.0005" or less

Possible Cause	Check This
X and Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 5.2
Spindle and/or Quill are loose	Use a Dial Indicator and check for side-to-side movement between the Spindle and the Head. Next, check for side-to-side movement between the Quill and the Head. There should be no more than 0.0003" of side-to-side movement. Make sure that there is a few thousandths gap between the Spindle Collar and the Quill after tightening.
Head bolts are loose	Tighten Ram bolts

# 4.4.2 X, Y, and Z-Axis Measurements Are Not Accurate

Measurements repeat, but with a dial indicator mounted to the bottom the spindle, traversing the length of a gage block or some other measurement standard, the measurement is not accurate.

Possible Cause	Do This
The Calibration is incorrect	Recalibrate the machine. See Calibration & Backlash Constants
Incorrect backlash values	If the machine does not repeat bi-directionally check the backlash on the axis in question. See Section 5.2.2.

# 4.4.3 The DRO Is Not Counting

The DRO for one axis is not counting when an axis is moved. Often times if this is the case the axis will fault. See section on faulting.

Do the following Service Codes:

- Code 33 Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.
- Code 131 Motor encoder operation test.

Possible Cause	Check This
Motor Encoder not counting	See Motor diagnostics section 5.4
Computer/Pendant failure	See Computer/Pendant diagnostics 5.3

# 4.4.4 X, Y, and Z-Axis DRO Counting in Wrong Direction

The DRO is counting in the wrong direction.

The positive directions for each axis are:

- **X-axis** Table moves to the left.
- **Y-axis** Saddle moves toward the front of the machine.
- **Z-axis** Quill moves up.

Do the following service code and procedures:

- Code 33 Software Identification. This is needed if you call SWI Customer Service.
- Code 97 set positive motor encoder direction.
- Code 313 Check the line that specifies the product.

# 4.5 **Problems with the Machine Tool**

## 4.5.1 Spindle Stalls or Turns Off During Machining

During machining, the spindle turns off and loses power. First check incoming voltage and connections.

Possible Cause	Check This
Machine Tool and Setup problem	Check the type of material being cut, type and size of cutting tool, RPM, and Feed rate. Also check the condition of the cutter to verify that the cutter is not dull. See Machine Tool & Setup Section 5.1
Drive Belt in the head is slipping	Check the alignment, condition, and tension of the Drive Belt.
Cut more than the machine is capable	Check width and depth of cut
Insufficient voltage, excessive amp load	Check incoming power. Check overload setting.

# 4.5.2 Spindle Motor Hums or Will Not Run

**If the spindle will not run**, you must ensure that 110V power is reaching the spindle motor contactors in the electrics box. Check your 110V power across terminals wire 3 and ground. If power has reached the electrical box, use the schematic in Section 5.8 to see how the power is routed.

If the spindle motor makes a constant humming noise during operation, check the 3-phase power to the machine by checking line to line.

Possible Cause	Check This
Wrong voltage	Check the 220V/440V voltage to the machine
Poor wiring connections	Check all the wiring connections to the electric's box.
Defective cables or poor cable connections	Check all cable connections
Spindle Motor is bad	Check the resistance of the Spindle Motor windings on the Spindle Motor between L1 & L2, L2 & L3, and L1 & L3, using an Ohmmeter. The resistance should range from ".7 to 1.2 Ohm". If the Ohmmeter reads "0 Ohms" or "OL", then replace Spindle Motor. Next, check the resistance between L1 & Ground, L2 & Ground, and L3 & Ground, using an Ohmmeter. The resistance should read "OL". If not then replace Spindle Motor.
Spindle will not run because 110 V power is not reaching the spindle contactor	Check 110 V coming out of the AC e-stop port on the pendant. If no voltage replace or repair the pendant.

# 4.5.3 Spindle Runs Backwards

The spindle motor runs in the opposite direction. The spindle will run in opposite directions from high to low gear.

Possible Cause	Check This
3-Phase wires backwards	Need to switch any 2 of the 3 wires either coming into the machine or motor. Warning: Be sure to shut off all power to the machine before attempting to switch any wires.

#### 4.5.4 Head Noise

Head noise pertains to any unusual noises coming from the head under load and no load situations. Most often head noise will only be noticeable under load situations. It is important to try to distinguish between problems with components in the head versus problems caused by the setup or tooling being used on a particular job. Use the table below to try to pinpoint the possible cause. Also try to pinpoint the noise by seeing if it exists in high, low or neutral. For example, if the noise is evident in neutral then this eliminates the spindle bearings.

Possible Cause	Check This
Machine setup or tooling problem	If the noise is most evident under load (cutting situations) then it is important to look at setup and tooling being used. Ask the following questions. Is the cutter dull? Is the tool loose in the holder? Am I taking a bigger cut then is possible on the machine? Is the part moving in the vice? Am I using realistic speeds and feeds? Any one of these can have a significant impact.
Upper spindle bearing is worn out.	Remove the upper bearing plate above the spindle. This will unload the bearing. If the noise goes away then this bearing should be replaced.
Verify nosepiece is tight on bottom of spindle.	To check if the nosepiece is bottomed out try to insert a piece of paper in between the nosepiece and the quill. If a piece of paper does fit then this may be the problem. Before tightening or loosening the nosepiece make sure to loosen the setscrew that holds it in place.
Spindle bearings are worn out	This is categorized by a high pitch sound and is most evident at high RPM's. It should also cause chatter under load. Replace the spindle if this is the case. See spindle replacement in Section 5.

# 5.0 Diagnostics

This section explains the diagnostic procedures used to isolate service problems.

# 5.1 The Machine Tool & Set-Up

# 5.1.1 The Milling Machine Checklist

The following is a quick reference for the types of problems that may arise if problems are noticed in these areas.

Problems With:	Can Contribute To:	Most Suspect When (and why):
Spindle bearings See Spindle Replacement	Noisy head Parts incorrect Circles out of round	Older machines, machines that are pushed hard
Lubrication system	Premature wear of ball screws, wear surfaces. Faulting Poor finish	New installations (may not be hooked up or line sheared)
Inadequate lubrication habits	Premature wear of ball screws, wear surfaces Poor finish Faulting	New installations (more motion than the machinist is used to with a manual mill) Lubricate machine every morning before use.
Gib locks - on X and Y axis	If locked can lead to axis faults.	Note: when using the CNC to machine, never tighten the gib locks!
X and Y gibs loose See Gib Adjustment - Section 5.2.1	Taper on straight Y moves Poor finish Circle out of round	When machine hasn't been serviced in a long while.
Gibs too tight	Not getting to position, does not repeat, axis faults Poor finish	N/A
Gibs floating	Not getting to position, does not repeat, axis faults Poor finish	Contact area of gibs. May need to be scraped. Very old machines may not have any more adjustments on gib. A new gib will need to be fit on the machine.
Gibs defective - bowed, scarred	Excess play when gib is checked side to side	Inadequate gib contact
Way surfaces pocked, scarred, or excessively worn	Poor finish Out of round circles Faulting	Inadequate lubrication
Machine not level Weight not distributed evenly on all four screws See Leveling procedures	Parts incorrect Machine geometry off, i.e. tram.	New installation or heavy crash. Relocation of mill.
Head out of tram See Tramming Head - Section 5.2.3	Leaves uneven surfaces on bottom of pockets.	Machine not level

# 5.1.2 A Special Word About X & Y Gibs

The slideway surfaces are vital to the performance of the bed mill.

Gibs should be:

- flat
- free of twist
- free of burrs

• free of blockages in the oil passages and channels

Defective or scarred gibs must be replaced. Shimming of gibs may not yield acceptable results.

It is good machining practice to avoid the use of shop air to clean the chips off a machine. This risks blowing chips into the sliding way surfaces and compromising the performance of the machine.

Gibs that are not adjusted correctly will affect the performance of the machine. It will lead to positioning and repeatability problems. The gibs should be adjusted at least twice a year.

See Gib Adjustments Section 5.2.1.

## 5.1.3 Lubrication

Lubrication is one of the single, most important maintenance issues and plays a key role in assuring the performance and durability of the Knee mill. At the beginning of each day manually supply oil to the way surfaces.

Lack of lubrication can lead to a variety of problems with your machine motion due to increased friction in the sliding ways. This increased friction may lead to part inaccuracies and decreased life expectancies of your ball screws and way surfaces.

# 5.1.4 Machining Set-Up

The machining set-up itself is always something that can greatly influence the performance of the your mill. The following are some things to keep in mind.

Problems With	Can Contribute To:
Feed and Speeds (spindle rpm)	Poor finish
See below	Machine chatter
	Excessive speeds and feeds can break cutting
	tools or wear tools prematurely.
Tooling	Poor finish
Using the wrong cutter for an application	
Entering the wrong size diameter and	Parts incorrect size
programming with tool compensation.	
Cutting too deep	Part dimensions incorrect
	Driving and cutting forces cause deflections,
	since no material is totally rigid
	Machine chatter
No coolant	Poor finish, decrease the life of the cutter

## 5.1.4.1 Spindle Speeds

Spindle speeds are influenced by a number of variables:

- Material
- Rigidity of the Machine Setup
- Coolant
- Cutter type, material and diameter
- Cutting Depth

As a general rule:

- Lower spindle speeds are used to machine hard or tough material or where heavy cuts are taken.
- Higher spindle speeds are used to machine softer materials in order to achieve better surface finishes. Higher speeds also apply when using small diameter cutters for light cuts on frail work pieces and delicate setups.

*Note: Cutter diameter greatly affects spindle speeds. The larger the diameter, the lower the spindle speed.* 

## 5.1.4.2 Feedrates

Factors that affect feedrates:

- Depth and width of cut
- Design or type of cutter
- Sharpness of the cutter
- Workpiece material
- Type of finish or accuracy required
- Climb or conventional milling

If a fine finish is required, reduce the feed rather than increase the spindle speed. Cutters are dulled by higher spindle speeds rather than high feedrates.

# 5.2 The Mechanical Drive Train (X, Y)

Indications:

- Troubleshooting instructions indicate that the drive train is potentially the problem and other (more easily checked variables) have been exhausted.
- Roughness, looseness, tightness or jamming movement in the table or saddle.
- 1. Check for machine considerations, especially gib locks and gib adjustments. See Gib Adjustments section
- 2. Check the torque of the axis in three places (both ends and center of ball screw) along the length of the ball screw. The torque should be within 2 or 3 in-lbs across the length of the ball screw. If it is not, chances are the ball screw is misaligned. A misaligned ball screw can lead to parts being out of round and servo problems at low feedrates. A bad ball screw can also cause high torque, although this is highly unlikely. See Sections

5.2.1 and 5.2.2 for more information.

The following steps take you in logical sequence through the assemblies for the knee mills. For drawings of these assemblies see figures. These instructions break the machine down from fully assembled and point out the areas to look at specifically.

- 3. Check that the belt is properly tightened. A loose belt can lead to excessive backlash compensation values on motor encoder only machines.
- 4. Check that the nut that tightens up against the ball screw pulley is tight. If this is loose the pulley may not run true on the ball screw.
- 5. Check that the tapered sleeve that seats the pulley has not clamped to the ball screw prematurely. It should be seated firmly against the pulley. Tightening the nut may not have ensured this. Also make sure the pulley is keyed to the ball screw.
- 6. Ensure that the screws that hold the bearing housing in place to the bracket are not loose.
- 7. Ensure that the Clamp Nut is secured. The following applies to the clamp nut:
  - When loosening, make sure to back out the 10-32 screw from the clamp nut.
  - When tightening, snug the 10-32 screw so the clamp goes onto the ball screw thread with some drag. Thread it onto the ball screw and torque the clamp nut to 50 ft/lbs and then tighten the screw down.
- 8. Take out the angular contact bearings and inspect them. They should roll smoothly and be lightly greased. If not, replace them. When putting the bearings back into the housing make sure to put them in correctly. Failure to do this will cause problems. The thin race of each bearing should be facing inward toward the spacer ring.

Note: the bearing housing and spacer ring are matched sets - keep them together.

- 9. Check the ball screw mounting to the yoke. Make sure the SHCS are tight.
- 10. Inspect the ball screw, ball nut and yoke for the potential problems shown in the chart on the next page.

CAUTION! Unlike a lead screw, do not unscrew the ball screw from its nut. This will destroy the ball screw!	
Potential Problem:	Check By:
Bad ball screw	<ul> <li>Visually inspecting the ball nut - if the nylon seal is broken or deformed, if contamination has visibly entered the ball nut or if balls are out of the ball nut, replace the ball screw.</li> <li>Cranking the ball screw through a significant part of its travel. If it jams, feels loose or has rough spots, replace the ball screw.</li> <li>Using the dial indicator on a vertical flat of the ball screw to check for backlash between the ball screw and ball nut.</li> </ul>

Potential Problem:	Check By:
Ball nut not tightened to the yoke	• Inspection for space between the head of the bolt and the ball nut i.e. the retaining bolt has bottomed out in its thread and is not securing the ball nut to the yoke properly.
Yoke loose in the saddle	<ul> <li>Inspection for any motion of the yoke or looseness in the Yoke mounting screws.</li> </ul>
Oil lines sheared	Visual inspection.
Oil line blockage	<ul> <li>Pump the oil and ensure that it flows evenly to the ways and ball screw.</li> </ul>
Ball screws not aligned properly	• Measure from the ball screw to the back of the saddle on both sides of the yoke (the table must be removed). The measurements must be within ±.005" end to end. See above explanations.

Note: Ball screws are inspected throughout their entire travel for backlash and consistent torque. A ball screw should be good for millions of inches of travel if installed properly. Do not be too quick to replace a ball screw if there is insufficient indication that it is bad; this will just be a costly delay to resolving the real problem.

# 5.2.1 Keys to Ball Screw Alignment

- X-axis there are 3 components that can cause misalignment: the yoke, the left side bearing housing bracket, and the right side bearing housing.
- Yoke the yoke is aligned at the factory and pinned in place. It is aligned to within +/-0.0005" with a precise alignment tool. The yoke most likely is not causing the problem. If this were the problem you would need to remove the pins and align the X ball screw with the back of the saddle. Drill new holes and pin the yoke in place. The Y-axis ball screw bore is machined perpendicular to the X bore. If the X-axis is aligned the Y-axis will also be aligned.
- Left side table bearing housing this is most likely the cause of the misalignment. To align the bracket and bearing housing, move them as close to the yoke as possible. Loosen the bracket bolts and bearing housing bolts and then retighten. This should allow the bearing housing to align itself up with the yoke.
- **Right side table bearing housing** once again move the bearing housing as close to the yoke as possible. Loosen the bearing housing and retighten. This should allow the bracket to align itself. If you do not move the table toward the yoke the ball screw will tend to bend down slightly and cause misalignment.
- **Y-axis** the only component that can cause a misalignment problem is the motor mounting bracket. To align this bracket, move the saddle as close to the front of the machine as possible. Loosen the bracket and then retighten it. Once again moving the saddle forward allows the yoke to be as close to the bearing housing as possible.

# 5.3 Computer/Pendant Diagnostics

The pendant consists of 2 separate modules: the computer module, and LCD screen/enclosure.

In general, the pendant/computer module is best diagnosed by eliminating all other possible alternatives. The following table lists some problems and what these problems can lead to.

Possible problems	Can lead to
Poor cable connections	There are 4 cable connections to the rear of the pendant. Make sure all cables are properly fastened. Warning: do not unplug and plug cables with the control on. This will destroy the computer.
Pendant locks up	Press the E-stop button and see if lock up clears if not then do the following: Turn the pendant off, wait at least 30 seconds, and turn it back on and check to see if the malfunction has been reset.
No voltage to RSG port	RSG will not work – should be 5 DC volts present Check with a voltmeter.
IDE flash drive failure	If the IDE flash drive fails, the system will not boot up or operate. It will need to be replaced. All programs and machine configurations will be lost. Make sure to back up your flash disk from time to time.
LCD backlight burns out	Check all cable connections to LCD, distribution board and computer module. Make sure the power is turned off before doing so.
Faulty E-stop switch	It can be stuck open or closed (pressed). If it is stuck closed the pendant will need to be replaced because the user will have no way to get rid of the message. If it is open it will allow the machine to still operate but it will be unsafe for the user. The pendant will still need to be replaced.
Overlay failure (keys on pendant)	Certain buttons on overlay do not work. Do code 81 to verify each key beeps.
Low voltage to pendant or current spikes	10 or 8 amp fuse in pendant blows. Pendant will not turn on if the 10 amp fuse in the on/off switch is blown.

The following is the list of diagnostic LED's found on the back of the applications board. Remove the black cover on the rear of the pendant to access them.

See figure 23.

LED lights – the applications board has 10 LED lights with LED 1 found on the left of the LED segment.

- 1. 5 volt power LED signifies that 5 volts is present on the applications board which is being supplied from the power supply.
- 2. Overlay Key LED this LED will flash each time a key is pressed on our overlay.
- 3. Watchdog timer not used
- 4. Not used
- 5. Z absolute zero LED this LED will be lit when the Z axis counter is set to zero. This light should come on when you are + or 0.001" from your zero.
- 6. Not used will be used on future products with more axes.
- 7. Y absolute zero LED this LED will be lit when the Y axis counter is set to zero. This light should come on when you are + or 0.001" from your zero.

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- 8. X absolute zero LED this LED will be lit when the X axis counter is set to zero. This light should come on when you are + or 0.001" from your zero.
- 110 volt power LED this light will be on when the applications board is seeing 110 volts. Check the 8 amp fuse on the applications board if this light is not on.
- 10. Not used.

# 5.4 Motor Diagnostics

The Motor subsystem is comprised of 3 parts: The Motor Encoder and the Motor and Servo Driver. The motors are powered by 110 VAC voltage. The servo driver is also an integral part of servo system, which is discussed in detail in the next section.

#### WARNING!

Do not work with the motors unless the power is disconnected from the machine. The motors are run by 110 VAC. There is possibility of death by electrocution!

Rarely do both the X and Y motor/servo systems fail at the same time and in the same way. So, if your problem is occurring on both axes, its source is probably somewhere else.

#### 5.4.1 Cable Connections

Check the motor cable connections on the cable breakout box. Verify there are no pushed in pins on the connector.

## 5.4.2 To Check the Motor Encoders

If the motor encoder inside the motor has failed or is not reading the machine will fault out on that axis. Do the following to verify this problem:

Run Service Codes 100 or 131. This will display on the DRO if the motor encoder is counting. If the axis does not count, the encoder is not counting. This means either the encoder or the cable is the problem. Visually check the cable for any problems. If the encoder has failed the motor must be replaced.

#### 5.4.3 Diagnosing a Brush Problem

Each of the axis motors on the machine contains 4 brushes. These are a wear item and may need to be replaced during the life of the control system. When the brushes begin to wear out, you may start to see intermittent faulting of an axis. Please note your brushes will last for a number of years before they need replacement so if you are seeing this symptom in the 1<sup>st</sup> year of 2 of your product, this is probably not the cause.

#### **Motor Identification**

Before ordering your brush replacement kit, you  $1^{st}$  will need to identify the type of motor you have on your machine. This can be done by identifying the diameter of the cap that holds the brushes in place. Each motor has 4 caps spaced 90° apart. They are found at the end of the motor furthest away from the motor pulley. If the diameter of the cap holding the brush in place is  $\frac{3}{4}$ " in diameter then the motor is a Hathaway motor. If the diameter of the cap is  $\frac{1}{2}$ " in diameter then the motor is an AO Smith motor. You can also identify the type of motor by removing the brush and measuring its cross sectional size. If the brush measures  $\frac{3}{8}$ " x  $\frac{1}{8}$ " then it is a Hathaway motor and if it measures  $\frac{3}{8}$ " x  $\frac{1}{4}$ " it is an AO Smith motor.

On Hathaway motors it will be time to replace the brushes when the brush reaches a length of approximately <sup>1</sup>/<sub>4</sub>". 79

On AO Smith motors it will be time to replace the brushes when the brush reaches a length of approximately 3/16".

See Section 6.1.2 for the procedure for replacing motor brushes.

# 5.4.4 Moving Problem from One Axis to Another

Another way to troubleshoot a problem with a particular axis is to swap parts from 1 axis to another to see if the problem moves. If the problem moves then that component is faulty. See the example below.

#### Symptom – X Axis will not move and faults

This particular problem can happen because of any of following reasons: bad motor, servo driver, or computer module. In some cases it is not obvious which component is causing the problem. This example will help us pinpoint the problem through a trial and error process.

Let's assume we have narrowed it down to the servo or electrical systems and the Y-axis has no problems. Lets also assume it is not an obvious problem like a loose connection.

Swap these components	Results
Physically switch the X and Y motors	Has problem moved to Y-axis? If yes, replace motor. If no, the motor is not the problem.
Warning – turn off the power before plugging or unplugging motors or you will destroy the computer.	

# 5.5 Servo Driver

Note: the Servo Driver is located in the black box on the side of each motor.

#### Indications:

• Problems moving just one axis, including hard turning in one or both directions.

#### Servo Types:

• X and Y servos are identical

#### **Objective:**

• Isolate the problem to the particular Servo Driver

#### Steps:

1. Turn off and unplug the system.

#### WARNING!

Do not work with the Servo Driver unless the power is disconnected from the machine. There is possibility of death by electrocution!

2. Physically swap the servo module from the axis that is not working to one that is.

Note: To avoid pulling the wires out of the connector, use the loop to pull the connector from the Servo Driver.

If the problem moves to the other axis and clears up from the original axis, replace the Servo Driver.

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# 5.6 Electrical

# 5.6.1 Checking A/C Voltage

This procedure tests for the 110V power for the control.

- Use a Voltmeter, reading A/C volts.
- Acceptable range is 100V to 130V.

*Note: systems running consistently close to the low values may have problems when normal voltage fluctuations push the voltage out of the acceptable range.* Test the following in the order presented:

	Problems Here:		May Indicate:
1.	The wall outlet.	•	Fuse blown in the shop electrical panel. Incoming service from local utility is bad. Call the electric company.
2.	The control power cord from the wall. For TRAK Knee mills, check the end that goes to the electrics box.	•	Power cord defective.
3.	Check the top fuse on the electrical cabinet. It should be a 10-amp fuse.	•	If this is blown then power will not reach the 4 outlets on the electrical box.
4.	Check the 110-power cord to the pendant.	•	Power cord defective

# 5.6.2 Checking Fuses

#### CAUTION! Turn off power before removing and replacing

There are 4 fuses to check in the system. There are 2 in the pendant and, for TRAK Knee mills, 2 in the electrical cabinet. The top fuse in the electrical cabinet is 10 amps and fuses power to the pendant. The bottom fuse is 5 amps and fuses power to the lube pump outlets. The 2 fuses in the pendant are 10 amp and 8 amps. The 10-amp fuse in the pendant is found in the on/off switch. The 8-amp fuse is found on the applications board inside the pendant.

To check fuses:

- 1. Use a Volt/Ohmmeter; select "OHM".
- 2. Remove the fuses completely from the pendant or electrics box for TRAK Knee mills.
- 3. Place a lead of the meter on each end of the fuse.
  - A good fuse reads 0 (zero) or close to it.
  - A bad fuse reads Open or Infinity.

# 5.6.3 Cable Connections

The TRAK knee mill machines use 5+ cables to communicate between systems. It is often the case that what appears to be the failure of an electrical component is actually attributable to a poor connection.

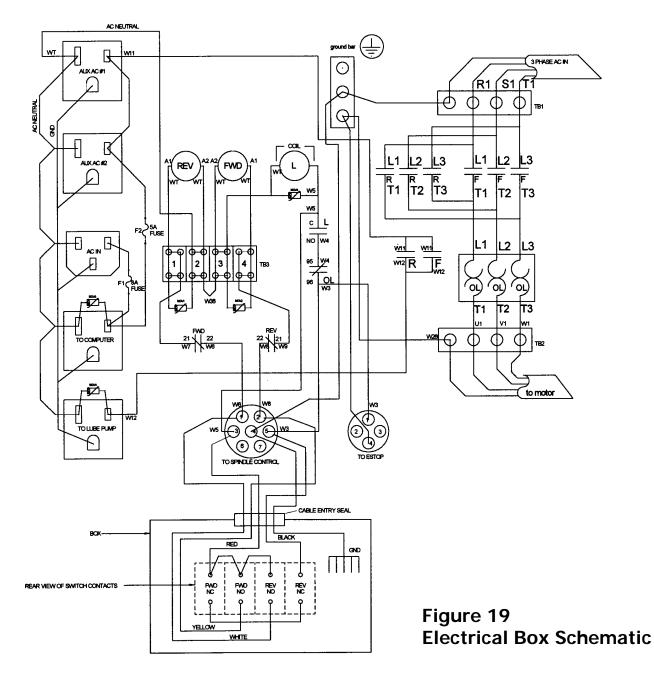
Indications:

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- Control problems, chronic or intermittent.
- Motor problems
- Measurement problems. Explanation:
- 1. Turn off and *unplug* the system from the wall.

# **CAUTION!** Do not plug and unplug connectors with the system power on. This may cause damage to the connector board and harm to the technician.

- 2. Visually inspect the connections for excessive debris, moisture, or obvious damage.
- 3. Carefully clean any chips away from the connectors.
- 4. One-by-one, take out each connector and then plug them back in.
- 5. Make sure to tighten up the screws on each of the connectors.



#### 5.7 Service Codes

Service codes are broken down into the 4 following categories: software, machine setup, diagnostics and user options/defaults.

All Service Codes are accessed in the DRO Mode by pressing the soft key for "SERV CODES". The service codes can be found under one of the headings listed on the main screen. Press the heading you want to access the code in question. Press CODE #, enter the number you want, press SET.

# 5.7.1 Software Codes

The following codes pertain to software functions in the control. To get to any of these codes go to Service Codes, press "A" and press the code you wish to view.

Note: If you are working with the SWI Customer Service Group, write the values down for Code 33 or Code 313. These values will be valuable for troubleshooting.

# 5.7.1.1 CODE 33: Software ID

The Code 33 is the software identification procedure. The software ID will display the various software modules. The two that are important for resolving problems are:

- User Interface/Tool Path write down the numbers if service support is needed.
- Motion Control write down the numbers if service support is needed.

Other software information displayed on this screen is rarely needed. You should provide it on request of a service technician.

# 5.7.1.2 CODE 141: Load Configuration file from USB thumb drive

This code allows you to load your configuration file from the USB thumb drive to the ProtoTRAK's internal IDE Flash drive. The configuration file consists of items such as calibration and backlash constants. This code is used when a computer module or IDE Flash Drive has been replaced and you already loaded the information on the thumb drive using code 142.

# 5.7.1.3 CODE 142: Save Configuration file to USB thumb drive

This code allows you to save your configuration file to a USB thumb drive. The configuration file consists of items such as calibration and backlash constants. Use this process before a computer module or IDE Flash Drive needs to be replaced. It stores the configuration file from the ProtoTRAK's internal IDE Flash Drive to the USB thumb drive. It is a good idea to do this code after the machine is initially setup so these values can be saved and used in the future. If the computer or IDE flash drive fails, then you will not have the ability to save the configuration file and the machine will need to be re-setup when the computer or IDE flash drive is replaced.

# 5.7.1.4 CODE 313: Display Configuration File

This code displays the configuration file. This file contains pertinent information about the machine. Some of the common service code values are displayed on this page as well, such as code 12, 100, 128, and 129. Press the Load Default if you wish to load factory defaults for all of the control's settings and configurations.

# 5.7.1.5 CODE 316: Update Software

Load in USB thumb drive and enter this service code. New software will automatically download and control will reboot.

# 5.7.1.6 CODE 340: copy part programs to USB Thumb drive

Load in USB thumb drive and enter this service code. All the part programs that are stored in the ProtoTRAK's internal storage will be copied to the USB Thumb Drive.

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# 5.7.1.7 CODE 341: copy part programs from the USB Thumb drive

Load in USB thumb drive and enter this service code. All the part programs that are stored on the USB Thumb Drive will be copied to the ProtoTRAK's internal storage.

# 5.7.2 Machine Set-up Codes

The following codes are used primarily when setting up a new machine. To get to any of these codes go to Service Codes, press "B" and press the code you wish to view.

## 5.7.2.1 CODE 12: Feed Forward Constant

The Code 12 procedure helps the control "learn" the friction characteristics of the machine by sending a graduated series of motor signals and observing the results. The process takes less than 30 seconds to run. It is both a diagnostic routine that displays values, and a routine that sets the parameters of the control for the particular machine.

The Code 12 is used for diagnosing and resolving:

- Problems with machine motion.
- Machined parts come out bad especially poor finish.

Note: Code 12 routine will set the parameters for the particular machine and its particular situation. If the machine changes its friction characteristic, the Feed Forward Constant should change too, or the system will not servo properly. Whenever gibs are adjusted or a heavy workpiece has been added to the table, you should run a Code 12. When the heavy workpiece is removed, Code 12 should be run again.

- 1. Position the table and addle in the center of travel. *Note: You will lose your DRO position reference.*
- 2. Go into the Service Codes and input the Code 12.
- 3. Press Auto
- 4. The system will run the routine automatically and then display values on the position readout.

#### Explanation

Typical values should be between 4.04 and 11.11 are considered normal for each axis. Higher values indicate excessive friction in the system. Lower values indicate a loose system and may mean a gib adjustment is necessary. Value 4.04 means the friction is a factor of 4 in one direction, and 4 in the other direction. The values should be within 3 or 4 of each other in both directions. A value of 6.08 would still be considered normal.

The feed forward gain can be adjusted manually by pressing the manual button. Choose the axis you would like to change and then enter values in the positive and negative direction to adjust. Adjusting the gain can help solve circularity problems. Default values can be set by pressing the Reset button. The manual feature should only be used in extreme cases where the AUTO routine did not solve the problem. Manual adjusts above 12 may lead to servo related problems.

#### 5.7.2.2 Code 97 set positive motor encoder direction.

This procedure sets the Plus and Minus motion for the Motor encoders.

It may be necessary to perform this procedure after a new installation or after installing a new Computer Module.

#### STEPS:

- 1. Center the table and saddle and position the quill about halfway down.
- 2. Go into Service Codes and input Code 97.
- 3. Very carefully, move the table, the saddle and the quill in the positive direction, less than 2 inches for each axis. Positive motion is:
  - X table moves to the left (so the tool moves to the right relative to the workpiece)
  - Y saddle moves toward the front (so the tool moves up relative to the workpiece).
  - Z the quill moves up.

If you do not move correctly from the beginning, repeat the procedure.

4. Press INC SET to signal the procedure is complete.

## 5.7.2.3 CODE 100: Axis Open Loop Test

Code 100 procedure is used to diagnose problems with the configuration of the system, the encoders and incoming A/C voltage.

#### CAUTION!

During this procedure, the designated axis will be given a command to move at maximum speed for 1 second in the direction you choose. Avoid crashes by making sure the quill is out of the way and by starting with the table and saddle centered. MAKE SURE THAT NO ONE IS STANDING IN THE WAY OF THE TABLE OR SADDLE!

Note: You will lose the DRO reference position.

This procedure is to be run for each axis that is servo-driven, and for both the plus and minus direction for each axis.

- 1. Center the table and saddle and raise the head. Make sure the gib locks are released.
- 2. On the Pendant display, go into the Service Codes and input the Code 100.
- 3. The conversation line will say: "SELECT AXIS". Input the axis. Either X or Y.
- 4. In the conversation line it will say "WHICH DIRECTION? PLUS".
  - If you want to run in the plus direction, press INC SET.
  - If you want to run in the minus direction, press +/-, then INC SET
- 5. In the conversation line it will say "PRESS GO". Press Go after you are sure that the machine will not crash in the direction and axis that you have specified.

6. Afterward the screen will display values next to the DRO position axes. The table below assumes machine has secondary feedback. Machines with motor encoders only will display the reading next to the axis in question.

Your input	Display	Data displayed.
Χ +	Х	Motor encoder reading
	Y	nothing (should be 0)
	Z	nothing (should be 0)
	Feedrate	the maximum feedrate attained
Vourinput	v	Motor opender reading
Your input	X	Motor encoder reading
Х-	Y	nothing (should be 0)
	Z	nothing (should be 0)
	Feedrate	the maximum feedrate attained
Your input	Х	nothing (should be 0)
Y +	Y	Motor encoder reading
	Z	nothing (should be 0)
	Feedrate	the maximum feedrate attained
Your input	Х	nothing (should be 0)
Υ -	Y	Motor encoder reading
	Z	nothing (should be 0)

Interpretation of the resulting values displayed:

Feedrate

The values for the encoder displays should be in the range of 3.0000" to 5.0000".

• If the motor encoder is not within this value, then the one that is out of specification may be the problem.

the maximum feedrate attained

- The feedrate should be a minimum of 120 ipm.
- If the feedrate is less than 120 ipm and inconsistent in both directions, check the incoming AC voltage and mechanics of the drive train.

#### 5.7.2.4 Code 122: Calibration using part measurements

See Section 6.2.2.2 for a further explanation of this code.

#### 5.7.2.5 CODE 123: Calibration

See Section 6.2.2.1 for a further explanation of this code.

# 5.7.2.6 CODE 127 - Set X or Y Backlash Constant

See Section 6.2.2.3 for a further explanation of this code.

#### 5.7.2.7 CODE 128: Input Backlash Constant

Code 128 allows you to enter the backlash values for each axis. It displays the value after it enters.

# 5.7.3 Diagnostic Codes

The following codes are used primarily when diagnosing a problem with the machine. To get to any of these codes go to Service Codes, press "C" and press the code you wish to view.

# 5.7.3.1 Code 54: Program Continuous Run

This Code runs a program continuously without stopping for SET Z or CHECK Z commands. It is helpful in running a long period to identify an intermittent problem.

- 1. Prepare a program as you normally would.
- 2. Press MODE, SET UP, "C", Code 54, INC SET. The program run will start automatically.
- 3. Press **STOP** to stop, and **GO** to continue.

# 5.7.3.2 Code 81: Keyboard Test

This code is used to check if the keyboard is functioning correctly. It allows you to test each key on the pendant individually. When you press the keys, the corresponding box for that key will highlight on the screen. The pendant will also beep, indicating that the key is working correctly. If one of the keys does not work the pendant assembly may need to be replaced. If none of the keys are working chances are that the computer module will need to be replaced.

# 5.7.3.3 Code 131: Manual DRO

A manual diagnostic routine to check the motor encoder and table encoders. Turn the X hand wheel to display the encoder readings. This code will display the actual DRO counts and the raw encoder counts.

## 5.7.3.4 Code 319: Error Log

This service code keeps track of all commands being sent to the servo system. This may be asked for when troubleshooting a problem specific to motion of the ProtoTRAK.

# 5.7.3.5 CODE 320: History Log

This code keeps track of incidents such as servo faults and software updates, and allows for it to be saved onto a USB drive. This is useful for keeping track how often an error occurs. You may be asked by a customer service representative to send in for evaluation.

# 5.7.3.6 CODE 327: Check Available Memory

This code monitors how much memory (RAM) is available within the system, as well as much space is available within our internal storage device.

# 5.7.3.7 CODE 342: Toggle test lights on or off

Use this service code to toggle a set of test lights visible on screen. The top green light will blink indicating that our operating system and User Interface software is responding properly. The middle orange light is to indicate that commands are being sent to our servo system. The bottom turns red when our servos are in position, and green when they are not.

# 5.7.4 Operator Defaults/Options Codes

The following codes allow the user to set programming defaults or turn features on or off. To get to any of these codes go to Service Codes, press "D" and press the code you wish to view.

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## 5.7.4.1 CODE 22: Turn on Simulation Mode

This code allows the ProtoTRAK to emulate RUN, POWER FEED, and JOG modes without having to move the servos.

#### 5.7.4.2 Code 66: Metric Mode

This code gives you the choice of switching to Metric Measurements for temporary use or setting Metric as the default, which means it will not change unless you change it with code 67.

#### 5.7.4.3 Code 67: English Mode

This code gives you the choice of switching to English (inch) Measurements for temporary use or setting English as the default, which means it will not change unless you change it with code 66.

#### 5.7.4.4 Code 79: Beeper On

This turns on the beeper to the control keys.

#### 5.7.4.5 Code 80: Beeper Off

This turns off the beeper to the control keys.

#### 5.7.4.6 Code 89: Turn off Simulation Mode

Use this code to turn off the simulation mode and return to normal operation.

#### 5.7.4.7 Code 129: Arc Accuracy

When the EMX control operates at high feedrates it may create small part machining errors as it goes around sharp corners. This exists on all CNC's and is commonly called a "following error." The control is factory preset to allow a maximum following error of 0.001 inch. The feedrate will automatically be adjusted around sharp corners so as to not violate this limit. This code only applies to arcs that are programmed and ones that are created in the tool path to generate the shape you want. This code will not make a difference on mill moves.

You may adjust the maximum following error to a value as small as .0001 inch. However, the smaller the value, the slower the feedrate around corners.

To input a new Following Error use the following procedure:

Follow the instructions on the screen and input the Following Error value (from .0001 to .0100) and press **INC SET**.

# 6.0 Procedures for Replacements & Maintenance

# 6.1 Replacements

# 6.1.1 Servo Motor Replacement

#### WARNING!

Do not work with the Servo Motors unless the power is disconnected from the machine. The servomotors are run by 110 VAC. There is possibility of death by electrocution!

- 1. Turn off power to the machine.
- 2. Each motor is mounted by the use of (4)  $\frac{1}{4}$  20 screws. Be careful not to over tighten these bolts and strip the threads.

## 6.1.2 Motor brush replacement

- 1. This procedure assumes the motor assembly has either been removed from the machine and/or no power is applied to the machine.
- 2. When the motor is mounted to the casting that holds the Servo Driver, it is necessary to remove the four Phillips head bolts at the shaft end of the motor which hold the motor to the housing to access all four brush assemblies. DO NOT Remove/Disconnect any wires, it is not necessary.
- 3. Before removing caps, please note they are made of plastic and care must be taken when removing them to not damage the screw slots. To this end, apply firm downward force while gently turning the caps counter clockwise.
- 4. Note there are four (4) caps to be removed to access and replace all of the brush assemblies. When the caps is loose and before removing it, hold your finger over the top of the cap/hole to contain the parts
- 5. Remove the O-ring, Keeper and brush assembly.
- 6. Insert new brush assembly, re-insert keeper (Note: No Keeper is used on the Hathaway/EmoteQ Motor) and install new O-Ring taking care to use the edge of a small screw driver to gently force the O-Ring into the hole down onto the Washer/Keeper. If the O-ring is installed properly, it will hold the brush assembly in place while you install the cap.
- 7. Install Cap to complete installation and repeat this process for the remaining three (3) brush assemblies.
- 8. Re-assemble motor to housing while pushing wiring back into housing taking care to not pinch it.
- 9. Re-install the assembly to the machine.

# 6.1.3 Servo Driver Replacement (figure 22)

#### DANGER!

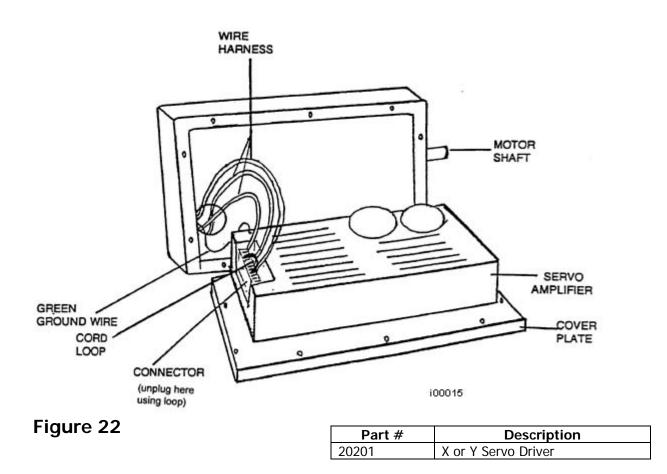
Do not work with the Servo Drivers unless the power is disconnected from the machine. The servo drivers are run by 110 VAC. There is possibility of death by electrocution!

The Servo Driver for each axis is integrated into the servo motor casting.

#### WARNING!

Always engage (push in) the Emergency Stop switch, turn the ProtoTRAK SM Control off, and disconnect the servo motor/driver cable at the cable breakout box.

- 1. Press in the Emergency Stop.
- 2. Remove the servo motor/driver assembly from its mounting bracket.
- 3. Remove the 10 cap screws that hold the servo driver and its heat sink plate to the motor casting.
- 4. Disconnect the cable connector. Do not pull on the wires.
- 5. Reinstall the new servo driver with its heat sink plate. Be certain the gasket properly seals the assembly.
- 6. Reinstall the motor/driver assembly. Make certain the belt is tight so that there is little play if pinched in the middle.



# 6.1.4 Computer Module and LCD/Enclosure Replacement (figure 23).

- 1. Turn off power to the machine and control.
- 2. Unplug all the connectors from the rear of pendant.
- 3. Remove the pendant from the pendant arm by removing the 3/8 16 bolt and nut that secures it in place.
- 4. Place the pendant assembly on a clean and secured table with the display pointing away from you.
- 5. Remove the (6) 8-32 x 3/8" Pan Phillips Head Screws securing the computer module to the LCD/enclosure.
- 6. Pull the computer module a few inches and stop. Pulling the computer module too far will damage the ribbon cables.
- 7. Now reach from the top and remove the overlay cable and LCD cable from the computer module. The LCD cable will have some RTU holding it in place.
- 8. Remove the two e-stop wires, LCD inverter cable and the ground wire from the LCD/enclosure side.
- 9. Replace computer module or LCD/enclosure.
- 10. Follow the instructions in reverse order when reinstalling the new computer module or LCD/enclosure. Make sure that all connectors are properly seated before fastening the unit back in place.

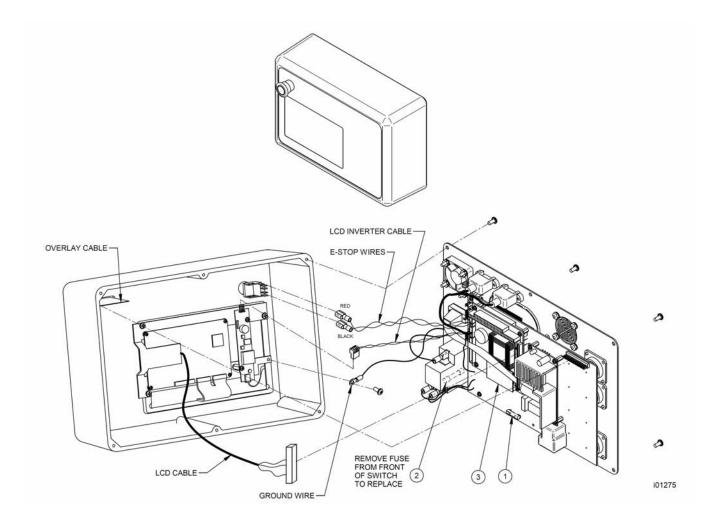


Figure 23 Computer Module and LCD/Enclosure Replacement

Item	P/N	Title	Use As	Qty
1	21824-8	FUSE-8 AMP SLOW BLOW	EA	1
2	21824-10	FUSE-10 AMP SLOW BLOW	EA	1
3	26027-32	Memory – Ide Flash	EA	1

# 6.1.5 IDE Flash Disk Replacement

- 1. From the control, go to SETUP, SERV CODES, SECTION A, and then code 142 and save your Configuration file (calibration values, etc.) to a USB Thumb Drive. Run code 340 to save your parts programs.
- 2. Turn off power to the machine and control.
- 3. Unplug all the connectors from the rear of pendant.
- 4. Remove the pendant from the pendant arm by removing the 3/8 16 bolt and nut that secures it in place.
- 5. Place the pendant assembly on a clean and secured table with the display pointing away from you.
- 6. Remove the (6) 8-32 x 3/8" Pan Phillips Head Screws securing the computer module to the LCD/enclosure.
- 7. Pull the computer module a few inches and stop. Pulling the computer module too far will damage the ribbon cables.
- 8. Now reach from the top and remove the overlay cable.
- 9. Remove the IDE flash drive from the motherboard. Remove the extra adhesive from the motherboard.
- 10. Firmly insert the replacement IDE Flash Drive into the motherboard. While pressing the replacement in, by sure the pins line up correctly. Secure the connector with RTV adhesive such as REP Fast Gasket Adhesive, Product #1430.
- 11. Secure the computer module back to the LCD/enclosure by following the instructions in reverse order.
- 12. Make sure that the overlay cable is properly seated before fastening the unit back in place.
- 13. Turn power on to the machine and control.
- 14. Update the System Software by inserting a Thumb Drive that contains updated system software from our website <www.prototrak.com>. Use service codes 316 found in section A to update the software.
- 15. Use Service Code 141 to restore the Configuration file saved on your USB Thumb Drive if you were able to save it using Code 142. Otherwise do the calibration and backlash procedures described in section 6.2.2.

#### CAUTION!

It is a good idea to back up your flash disk from time to time Service Code 340. If your IDE Flash Drive needs to be replaced you will loose all of your programs. See your programming manual for instructions on backing up programs.

# 6.1.6 Cable Routing on Machine

Whenever you replace a cable or reroute a cable it is very important to keep the high voltage power cables and glass scale cable separated from each other. The power cables consist of the (2) 110-volt motor cables and (1) 110-volt power cable for the pendant, and the 220 or 440 Volt power cables for the spindle motor. The glass scale cable should not be tied to the 220 or 440 volt cable. Mixing of the power and scale cables may cause noise from the power cable to interrupt the signals in the scale cable. This can lead to measurement repeatability problems.

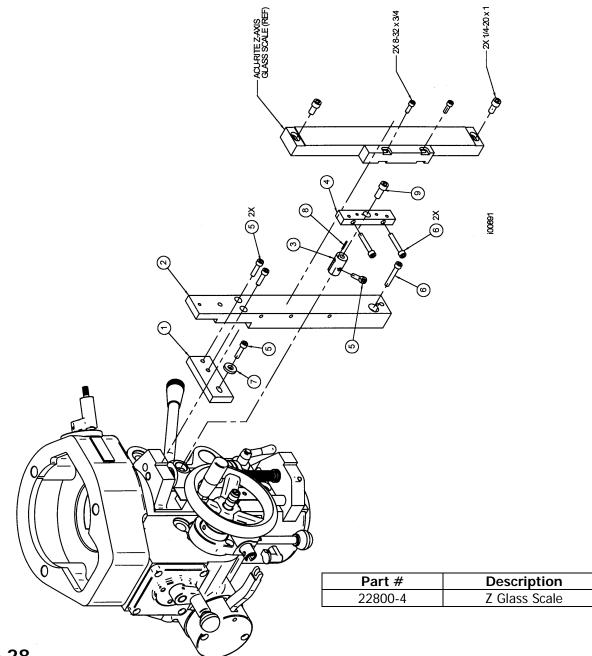
# 6.1.7 Replacement of the Optional Z-Axis Glass Scale (KEMX mill only, not retrofit)

See Figure 28.

- 1. Check the tram of the head in the X direction. If it is within a few thousands then continue on. If not tram.
- 2. Assemble Z-axis glass scale mounting bracket and mount to head. Items 1, 2, 3 and 4. Tap items 3 and 4 together and tap item 3 into the quill stop knob. Leave the bolt loose. Use 2 screws (item 6) and mount item 4 to the side of item 2 using a spacer between both items to provide a gap of approximately 0.040" between Items 2 and 4. This is to make sure item 2 does not rub against item 4.
- 3. Align the glass scale bracket (Item 2) with an indicator and tighten the mounting screws. Leave the quill stop knob screws loose. Remove the spacer and bolts from Item 4.
- 4. Unscrew the shipping protection screw from the scale.
- 5. Mount the glass scale to the mounting bracket and align it with an indicator. It needs to be aligned within 0.008" with respect to the quill. Tighten the screws down.
- 6. Fasten the readerhead to the readerhead bracket.
- 7. Move the readerhead up and down the glass scale and make sure the gap is consistent between the readerhead and the glass scale. Tighten the screw to the quill stop knob.
- 8. Remove the red head securing plate.
- 9. If the gap is not consistent between the readerhead and the glass scale when moving the quill up and down then adjust the angle of the scale to make the gap consistent.

#### CAUTION!

The gap must be no larger than 0.060" between the readerhead and glass scale.



# Figure 28 K Mill Z-Axis Glass Scale Assembly

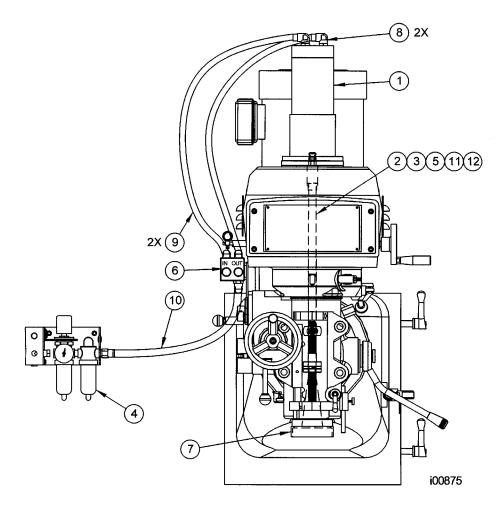
	20550	ARM- Z-AXIS MOUNTING PLATE	
<u>ງ</u> ງ		ARIVI- Z-AATS IVIOUNTTING PLATE	1
Z Z	20551	MOUNTING PLATE-Z-AXIS GLASS SCALE	1
3 2	20548	ADAPTER-Z-AXIS GLASS SCALE	1
4 2	20549	ADAPTER PLATE- Z-AXIS GLASS SCALE	1
5 1	10-32X3/4 25B	SCREW-SHCS-STL-BO	4
6 1	10-32X1 1/4 25B	SCREW-SHCS-STL-BO	3
7 1	15759	WASHER-1/4 HARD BLK OX 1/8 THK	1
8 1	1/16X1/2 81B	SPRING PIN	1
9 1	1/4-28X3/8 25B	SCREW-SHCS-STL-BO	1

i00891

#### 6.1.8 Power Drawbar

A power drawbar is an optional item on a TRAK Knee mill machine. It is bolted to the top of the head by the use of 3 SHCS. Some machines may require a washer to space the unit up to the proper height to allow the drawbar to engage properly.

Air Regulator and Oiler -\_This unit requires between 80 and 100 psi to operate properly. Some units work fine at 80 psi while others may need 90 or 100 psi. It is also important to make sure the oiler for this unit is kept filled with oil. Fill the reservoir about 2/3 full using AIR TOOL OIL ONLY. Failure to do this will not allow oil to lubricate the internal components of the unit and it may wear out prematurely. It is also important to make sure the oiler is set properly. To set the oiler, first close the adjustment screw (CW) on top of the oiler completely making sure to not over tighten. Then open the screw (CCW) between  $\frac{1}{2}$  to  $\frac{3}{4}$  of a turn. Any more than this will cause too much oil to get into the unit and oil may come out of the exhaust port of the unit.



# Figure 30 Power Drawbar Assembly

Item	P/N	Title
1	22581-1	AIR GUN ASSY ONLY- TORQUE RITE
2	22605	DRAWBAR-R8 SPINDLE
3	20893	SPACER - DRAWBAR - R8 SPINDLE
4	22380-1 or -2	AIR REGULATOR ASSY (-2 with solenoid)
5	23888	SPACER - DRAWBAR - 40 TAPER SPINDLE
6	22581-2	SWITCH - CONTROL HEAD - TORQUE RITE
7	22581-4	NOSEPIECE FOR SPINDLE (40 taper heads only)
8		1/4" NPT AIR FITTING 90°
9		3/8 O.D. TUBING 132" LG.
10		3/8 O.D. TUBING 27" LG.
11	22641-NMTB	DRAWBAR - NMTB -40 TAPER
12	22641-CAT	DRAWBAR - CAT - 40 TAPER
13	TR220	SOCKET - AIR GUN REPLACEMENT (not shown on drawing)

i00875-1

# 6.1.9 Ball Screw Replacement, X-Axis (Table)

#### CAUTION!

Never screw a ball screw partially or totally out of its nut. They cannot be reassembled.

- 1. Y-axis motor mounting bracket and hardware must be removed to remove X yoke.
- 2. Position the table in the center of travel.
- 3. Remove the left side table tray by pulling it up, and remove the X motor (If machine has tray).
- 4. Remove the motor mounting bracket and bearing housing.
- 5. Remove the right side bearing housing.
- 6. Loosen the table gibs. Slide the table to the right and on to a lift that will support the table's weight. Slide the table until the yoke is exposed.

#### CAUTION!

The weight of the table must be supported by the lift to prevent damage or breakage to the dovetails.

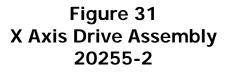
- 7. Remove the 5/16 x 1" screws holding the ball nut to the yoke and loosen the 4 screws that mount the yoke to the saddle. Remove the oil line.
- 8. Tilt the yoke (it is pinned) to remove the ball screw.
- 9. Remove the elbow and setscrew from the old ball screw flange and fit them similarly in the new ball screw.
- 10. Pump oil to be certain it flows through the oil line and then attach the oil line to the elbow.
- 11. Reassemble all assemblies.

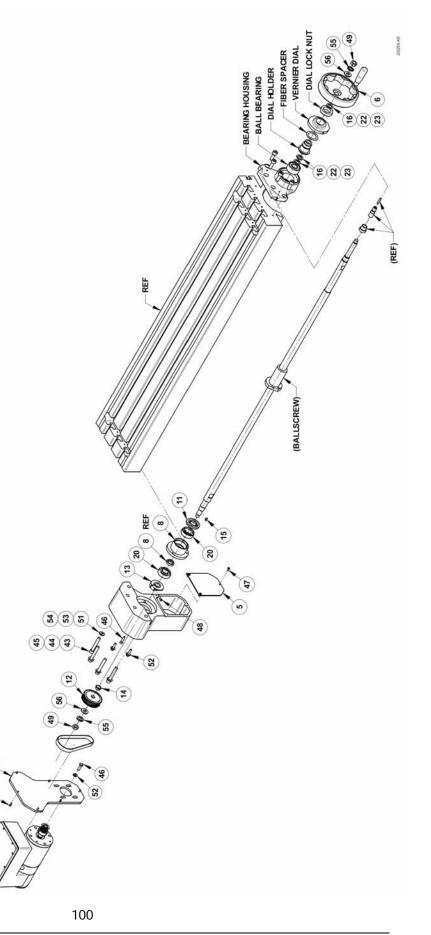
**Important**: The clamp nut must be reassembled as follows:

- Install rear bearing and seal into bearing housing and slide housing onto the ball screw. (Note: Letters on bearings must face each other in the housing.).
- Thread the split nut onto the ball screw and tighten the #10-32 clamp screw until you feel the split nut contact the ball screw threads. It should drag as you tighten the clamp nut.
- Torque the split nut to 50 ft. lb.
- Firmly tighten the #10-32 clamp screw to lock the clamp nut in place.

See the diagnostics section under Mechanical Drive Train for an explanation of how to align the ball screw.

See Figure 31 for an illustration of the X-axis drive train.





20296)

# X Axis Drive Assembly Parts List

Item	P/N	Title	Qty
1	15621	DRIVE HOUSING	1
4	15624	COVER - X-AXIS - DRIVE - HOUSING-MX	1
5	15622	BACK COVER	1
6	15616	HANDWHEEL ASSY-MX	1
8	15612	BEARING HOUSING ASSY-X AXIS	1
10	15638	STOP - X-AXIS	1
11	15626	SEAL-BEARING HOUSING	1
12	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
13	16452	NUT CLAMP-X ,Y, & Z AXIS	1
14	16350	FERRULE-SPROCKET	1
15	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
16	14772	SPACER100" THICK	5
19	400-5M-15	BELT - TIMING 5MM POWERGRIP	1
20	23930	BEARING SET (2)-ANGULAR CONTACT-7204 BECBP	1Set
22	14772-2	SPACER020" THICK	2
23	14772-5	SPACER050" THICK	2
41	8-32X3/8 25B	SCREW-SHCS-STL-BO	6
42	5/16-18X1 25B	SCREW-SHCS-STL-BO	1
45	M10-1.5X65 25B	SCREW-SHCS-STL-BO	4
46	1/4-20X1 24B	SCREW-HEX HD-STL-BO	7
47	8-32X3/8 20B	SCREW-RH-PHIL-STL-BO	3
48	10-32X3/4 25B	SCREW-SHCS-STL-BO	1
49	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	2
52	15759	WASHER-1/4 HARD BLK OX 1/8 THK	7
54	M10 70P	WASHER-FLAT USS-STL-PLAIN	4
55	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	2
56	1/2 71Z	WASHER-FLAT SAE-STL-ZINC	2
57	22008	BEARING-204KTT	1
	26031-42	BALLSCREW - X AXIS	1
	26031-48	BALLSCREW - X AXIS	1

i20255-2

# 6.1.10 Ball Screw Replacement, Y-Axis (Saddle)

#### CAUTION!

Never screw a ball screw partially or totally out of its nut. They cannot be reassembled.

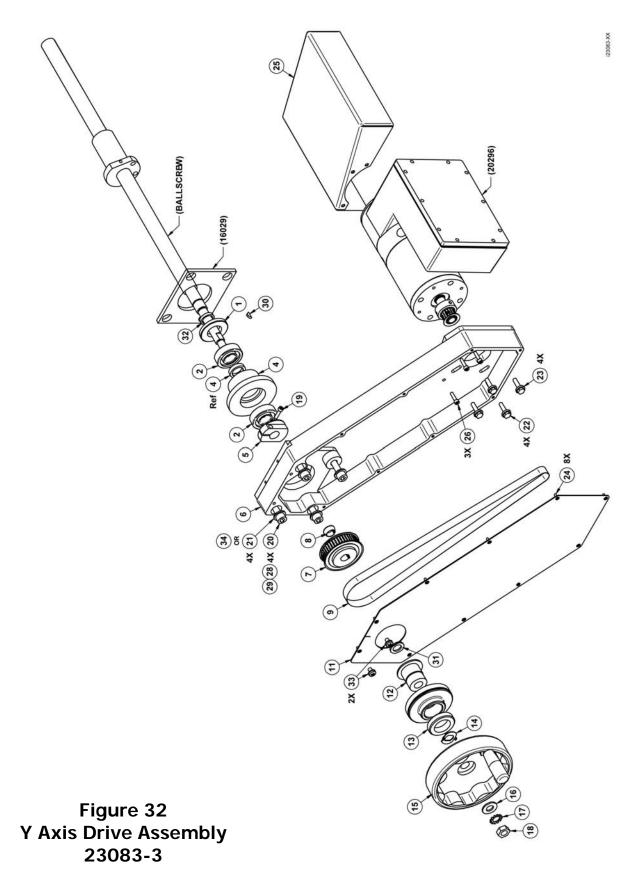
- 1. Position the saddle all the way forward.
- 2. Remove the hand wheel assembly and bracket.
- 3. Remove the sheet metal covers on the front of the machine bed and on the motor mounting bracket.
- 4. Remove the motor, then remove the motor mounting bracket.
- 5. Remove the rest of the parts on the ball screw journal. Note the orientation of the bearings for reassembly.
- 6. Remove the 5/16 x 1 inch screws that attach the ball nut to the yoke.
- 7. Remove the ball screw and oil line attached to the elbow fitting on the ball nut.
- 8. Remove the elbow and setscrew from the old ball screw flange and fit them similarly in the new ball screw.
- 9. Pump oil to be certain it flows through the oil line, and then attach the oil line to the elbow.
- 10. Reassemble all assemblies.

**Important**: The clamp nut must be reassembled as follows:

- Install rear bearing and seal into bearing housing and slide housing onto the ball screw. (Note: Letters on bearings must face each other in the housing.)
- Thread the split nut onto the ball screw and tighten the #10-32 clamp screw until you feel the split nut contact the ball screw threads. It should drag as you tighten the clamp nut.
- Torque the split nut to 50 ft. lb.
- Firmly tighten the #10-32 clamp screw to lock the clamp nut in place.

See the diagnostics section under Mechanical Drive Train for an explanation of how to align the ball screw.

See Figure 32 for an illustration of the Y-axis drive train.



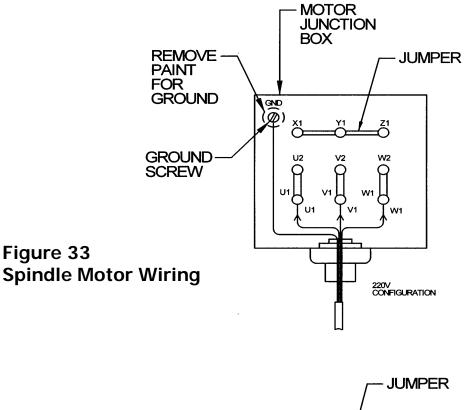
# Y-Axis Drive Assembly Parts List

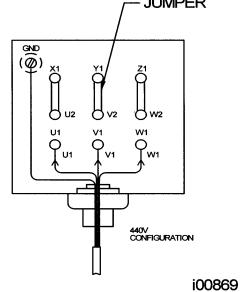
Item	P/N	Title	Qty
1	15626	SEAL-BEARING HOUSING	1
2	23930	BEARING SET (2)-ANGULAR CONTACT-7204 BECBP	1Set
4	15980	BEARING HOUSING ASSY-LARGE FLANGE-Y AXIS	1
5	16452	NUT CLAMP-X ,Y, & Z AXIS	1
6	20623	MOTOR BRACKET-KNEE MILLS-40 DEGR	1
7	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
8	16350	FERRULE-SPROCKET	1
9	890-5M-15	BELT - TIMING 5MM POWERGRIP (Y AXIS)	1
11	20621	COVER-SPORT 40 DEGREE	1
12	15627-2	DIAL HOLDER	1
13	15836	DIAL NUT	1
14	15614	TAB WASHER	1
15	15616	HANDWHEEL ASSY-MX	1
16	1/2 71Z	WASHER-FLAT SAE-STL-ZINC	1
17	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	1
18	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	1
19	10-32X3/4 25B	SCREW-SHCS-STL-BO	4
20	M10-1.5X60 25B	SCREW-SHCS-STL-BO	4
21	23082	WASHER75X.394X.10-STL	4
22	1/4-20X1 24B	SCREW-HEX HD-STL-BO	4
23	15759	WASHER-1/4 HARD BLK OX 1/8 THK	4
24	6-32X3/8 10B	SCREW-PH-PHIL-STL-BO	8
25	23141	SHEET METAL-PT4-COOLANT MOTOR COVER ASSY	1
26	10-32X1 25B	SCREW-SHCS-STL-BO	3
27	10 73B	WASHER-SPLIT LOCK-STL-BO	3
30	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
31	14772-2	SPACER020" THICK	1
32	20322	SPACER Y-AXIS- BALLSCREW	1
33	1/4-20X3/8 10B	SCREW-PH-PHIL-STL-BO	2
	20296	MOTOR ASSY ENCODER/DRIVER 4020	1
	15609-12	BALLSCREW - Y AXIS	1
	15609-16	BALLSCREW - Y AXIS	1

i23083-3

## 6.1.11 Spindle Motor Wiring

The spindle motor is wired for 220 or 440 volts. See Figure 33 for how to wire the motor.

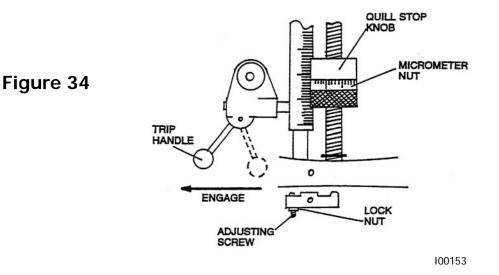




## 6.1.12 Feed Trip Adjustment

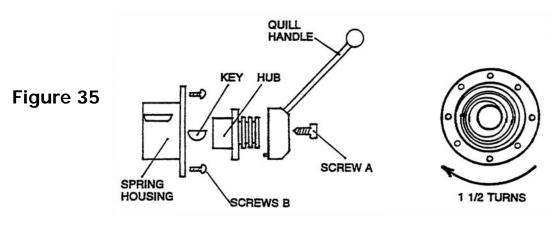
If the feed trip is adjusted too light it will inadvertently trip when drilling. If too heavy, it will not trip accurately and stress the mechanism. The correct adjustment depends on the operation to be performed. To adjust:

- 1. Release the lock nut.
- 2. Engage the trip handle--move it left.
- 3. Adjust the micrometer nut against the quill stop knob.
- 4. Slowly turn the adjusting screw until the handle trips.
- 5. Tighten the lock nut.
- 6. Check the reaction. If too sensitive, lower the adjusting screw slightly. If too heavy, raise it.



### 6.1.13 Quill Clock Spring Replacement and Adjustment

The quill Clock Spring counterbalances the weight of the quill and tool.



- 1. Move the quill to its top position and lock it in place.
- 2. Remove the quill handle, hub (by removing Screw A) and key.
- 3. Remove Screws B and allow the spring housing to unwind.
- 4. Remove the spring. It is held by a pin on the shaft and slot in the housing.
- 5. Replace the spring. Rotate the housing clockwise until the spring catches the shaft pin.
- 6. Rotate (wind up) the housing 1 1/2 turns, replace Screws B, key hub, Screw A, and handle.

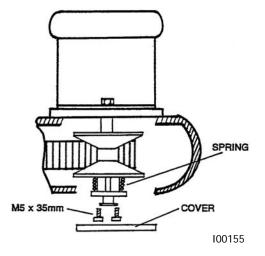
### 6.1.14 Spindle Motor Removal and Replacement

- 1. While the spindle is running, change the RPM to its lowest value.
- 2. Disconnect the power to the motor. It is recommended that the power disconnect be made from the shop feeder box.
- 3. Disconnect the electrical connection in the conduit box attached to the motor.
- 4. Crank the speed changer to the highest RPM value.
- 5. Remove the two screws that fasten the motor to the top of the housing.

#### **CAUTION!** The motor is heavy--about 60 pounds. Be certain you have the proper equipment or assistance.

- 6. Tilt the motor toward ram and remove the belt from the motor pulley. Remove motor.
- 7. If the motor is to be replaced, remove the M8 socket head cap screw at the end of the motor shaft. Slide the pulley assembly off the motor shaft and onto the new motor.

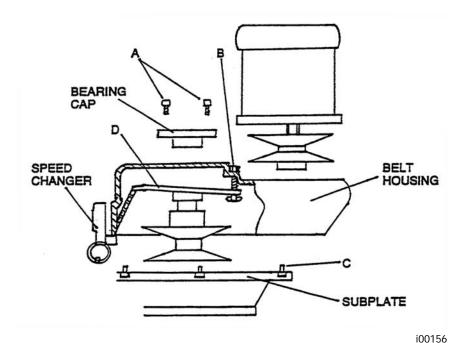
Figure 36



### 6.1.15 Drive Belt Replacement

- 1. Remove the motor.
- 2. Remove the draw bar and its bushing.
- 3. Remove the three Screws A and use M6 x 35mm screws in the adjacent tapped holes to remove the Bearing Cap.
- 4. Remove the nut from the fine speed adjustment Screw B and turn the screw all the way down through the casting. Catch it from the motor hole.
- 5. Remove six Screws C holding the belt housing to the subplate.
- 6. Remove the four screws holding the speed changer.
- 7. Remove the belt housing.
- 8. Replace the belt by sliding it over the speed changer.
- 9. In reassembly be certain the fine speed adjustment Screw B goes into the slot of the Speed Change Plate D in the area in which the screw is not threaded.

## Figure 37



6.1.16 Timing Belt Replacement

- 1. Remove the motor and drive belt.
- 2. Slide the top or adjustable vari-disc pulley assembly off the shaft.
- 3. Remove the three M8 screws holding the belt housing base to the gear housing.
- 4. Lower the quill about 4 inches.
- 5. Remove the belt housing base and lower or stationary vari-disc pulley assembly.
- 6. Replace the timing belt.

### 6.1.17 Brake Shoe Replacement

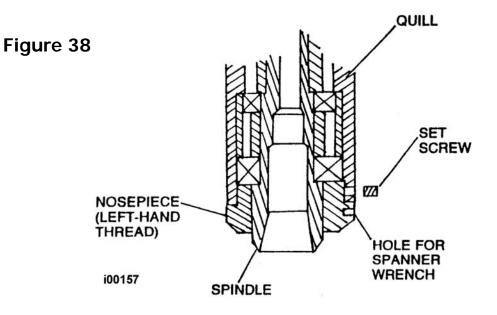
- 1. Remove the motor, drive belt and complete Steps 1-5 of the timing belt replacement procedure.
- 2. Remove the two M6 cap screws from the bottom of the belt housing base.
- 3. Separate the belt housing base from the lower or stationary vari-disc pulley. This is a slight press fit.
- 4. Remove the 2 springs.
- 5. Replace the brake shoes.

### 6.1.18 Spindle Replacement

- 1. Remove the draw bar and its bushing.
- 2. Lower the quill about 1 inch and lock.
- 3. Remove the setscrew from the back of the spindle.
- 4. Loosen (unscrew) the large black ring (nosepiece) with a spanner wrench.

#### Note: The nosepiece has a left hand thread-- rotate counterclockwise to loosen.

- 5. Using a soft bar about 12 inches long, alternately tap on the top of the spindle and loosen a few threads on the nosepiece until fully unscrewed (the nosepiece will remain attached to the spindle).
- 6. Continue to tap the spindle out of the quill. The spindle bearings will come out with the spindle.



## 6.2 Maintenance

### 6.2.1 Gib Adjustments

The objective of adjusting the gibs is to eliminate as much play in the table, saddle and ram sliding surfaces as possible without having the tightness of the gib interfere with their free movement and cause a decrease in the accuracy and/or performance of the machine due to excessive friction.

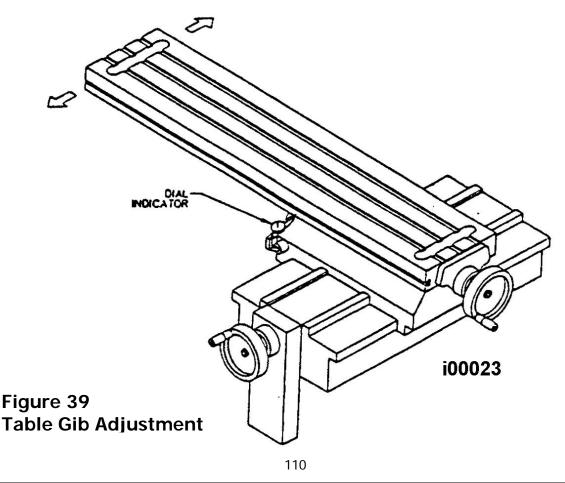
### 6.2.1.1 Table Gib Adjustment, X-Axis

See Figure 39.

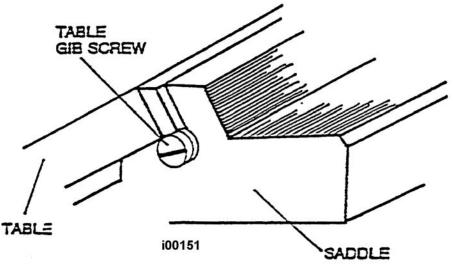
- 1. Clean all chips, dirt and excess oil from the table and saddle.
- 2. Center the saddle on the bed ways.
- 3. Move the table fully to the left side of the saddle.

Note: For machines that have excessive wear in the center of the table way, it will be necessary to center the table on the saddle. The resulting adjustment of the gib will be compromised to account for the varying clearance from the center to the ends of the table.

4. Attach a .0001 dial indicator with a magnetic base to the left front of the saddle. Place the indicator stylus on the front surface of the table as close to the indicator base as possible.



- 5. Move the left end of the table back and forth and note the amount of movement on the dial indicator. Adjust the X-axis gib until the registered movement is .0010-.0015.
  - To adjust the gib for excessive clearance: Loosen the gib lock screw on the right end of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the left end of the saddle. Tighten the gib lock screw on the right end of the saddle to lock the give in place, and recheck. Repeat as necessary.
  - To adjust the gib for too small of a clearance: Loosen the gib lock screw on the left end of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the right end of the saddle. Tighten the gib lock screw on the left end of the saddle to lock the gib in place, and recheck. Repeat as necessary.

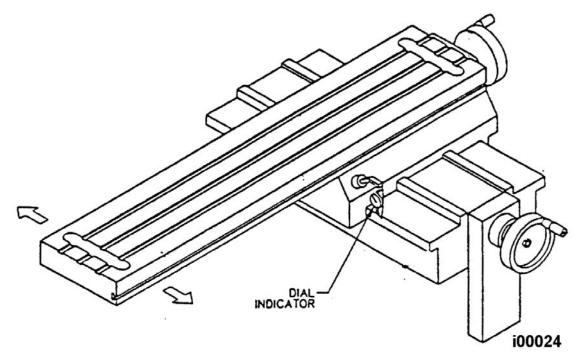


## Figure 40 Table Gib Screw

### 6.2.1.2 Saddle Side Gib Adjustment, Y-Axis

See Figure 41.

- 1. Clean all chips, dirt and excess oil from the table and saddle.
- 2. Center the saddle on the bed ways.
- 3. Move the table fully to the left side of the saddle.
- 4. Remove the chip wiper guard and chip wiper from the front and rear of the left side box way.



## Figure 41 Saddle Side Gib Adjustment

- 5. Attach a .0001 dial indicator with a magnetic base to the left front of the saddle. Place the indicator stylus on the edge of the large box way.
- 6. Move the left end of the table back and forth and note the amount of movement on the dial indicator. Adjust the Y-axis side gib until the registered movement is .0010-.0015.
  - To adjust the gib for excessive clearance:
     Loosen the gib lock screw on the back of the saddle. Estimate

Loosen the gib lock screw on the back of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the front of the saddle. Tighten the gib lock screw on the back end of the saddle to lock the gib in place, and recheck. Repeat as necessary

To adjust the gib for too small of a clearance:

Loosen the gib lock screw on the front of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the back of the saddle. Tighten the gib lock screw on the front of the saddle to lock the gib in place, and recheck. Repeat as necessary.

7. Replace the front and rear chip wiper, and chip wiper guard.

## 6.2.2 Calibration & Backlash Constants

Calibration and backlash constants were set as part of the installation and set-up of your system. They should be re-set when indicated in the Troubleshooting section or after the replacement of the Computer module, or any parts of the drive train.

### 6.2.2.1 X, Y, Z and Quill Calibration using a standard.

Calibration is used teach the machine a known distance. We typically calibrate our machines over a 150 mm distance. There is no limit to how far you can calibrate the machine.

1. Set-up a gauge block or standard and indicate it parallel to the axis you are calibrating.

*Note: Put the display in Inch or mm to match your gage block. Recommended gage blocks are:* 

- X and Y -- 150mm or 6"
- Z -- 75 mm or 3"
- 3. Set a 0.0001" indicator in the spindle and move it up to one side of the gage block or standard.
- 4. Go to setup mode, go to section "B" and press CODE 123.
- 5. Select the axis you want to calibrate X, Y or Z. For the quill press the F1 key labeled QUILL. The Z key is used to calibrate 3 axis machines only.
- 6. Follow the instructions on the screen to complete calibration.

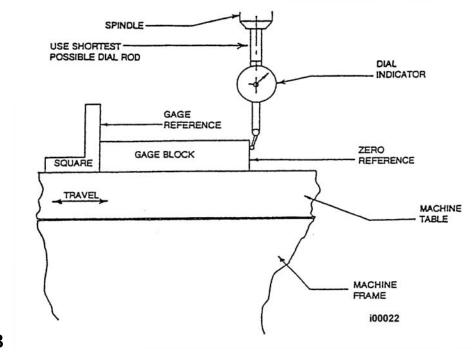


Figure 43 Calibration Set-Up

### 6.2.2.2 X, Y, Z Calibration using part measurements.

Measure your part and compare the actual measurement to the dimension desired. For example, say you squared a block using a 3" by 3" rectangular frame. When you measure the parts you find the actual measurements are the following:

X dimension = 3.003Y dimension = 2.995

To calculate your offset, do the following: X calibration offset = programmed  $\div$  actual = 3.000  $\div$  3.003 = 0.9990 Y calibration offset = programmed  $\div$  actual = 3.000  $\div$  2.995 = 1.0017

For your quill scale calibration, machine a reference plane and set your DRO Z readout to 0. Use the DRO to position the quill down some number, for example 1.00". Machine some material away from a corner so it will be easy to measure the difference between your reference plane and your new plane.

To calculate your offset with a 1.000" difference in position, measure the actual amount machined and compare it with 1.000".

For example, if your measurement showed the difference between the reference plane and the machined plane is 0.985", calculate the offset:

Z calibration offset = DRO  $\div$  actual = 1.000  $\div$  0.985 = 1.0152

Once you have calculated your values, use Service Code 122 to enter them.

#### 6.2.2.3 Backlash Compensation

#### Code 127: Set X or Y Backlash Constant

Every mechanical system has at least a little backlash or lost motion. It is produced by the small amount of play between the gibs and ways, and mostly by the accumulative bending or elasticity of all the parts of the drive train under load. The backlash constant is factory set, but may need to be adjusted periodically.

- 1. Set a .0001-inch dial indicator in the spindle, and touch off on a block or the vise along the direction (X or Y) you wish to check, or set the backlash constant.
- 2. Turn on the ProtoTRAK and at the Main Menu and follow the procedure below precisely. It is recommended to have zero values in code 128 before proceeding.

Conversation Says	You Do		
a	a. Press MODE		
b. Select Mode	b. Press DRO		
c. DRO	c. Press SERV CODES		
d. Service Code #	d. Press 127 and then ABS SET		
e. Select Axis	e. Press X or Y		

f. Travel =	<ul> <li>f. This shows the amount of travel for oscillation. Follow the instructions on the screen, press GO, and then press the appropriate soft keys (INC or DEC) to increase or decrease the amount of travel. Wait a few seconds for the amount to take effect. The value can also be manually input by pressing the TRAVEL button. To change the speed of oscillation, use the up</li> </ul>
	and down arrow keys.
g. The following is an example of what you	For example, if we were running this code for
might see when running this code.	the X axis, and the "Oscillation Value" shown in
	the conversation line is .00278 inch, and the
	dial indicator is moving back and forth .0012,
	then the true backlash value is .002780012
	= .00158 inch. Input this by pressing MODE,
	DRO, SERV CODE, 128, SET, OK, and then X,
	.00158, SET, RETURN.

3. The X backlash identified and stored in Step 2 should be less than 0.003" on a new machine. If it is appreciably larger, inspect the drive train for loose bolts, brackets, bearings, etc.

The backlash can also be found manually with a 0.0001" indicator with the following method (assuming once again that code 128 has zero value):

- Load the indicator to zero from one direction and zero out the DRO.
- Move the indicator to 0.002" and then back to zero. Do not over shoot 0, otherwise start over.
- Whatever number appears on the screen is the backlash value.
- Enter this value into service code 128.
- After entering this number redo the process. The DRO and indicator should now both read 0.

#### CODE 128: Input Backlash Constant

Code 128 allows you to enter the backlash values for each axis. It displays the value after it enters. This code is only used on machines with single feedback.

### 6.2.3 Head Rotation and Tramming

The TRAK knee head is free to rotate up to 90 degrees to the right or left. The K2 and K3 can also rotate 45° front to back. The K4 machine cannot rotate front to back.

#### 6.2.3.1 To Rotate the Head Side to Side:

- 1. Loosen the four locknuts.
- 2. Rotate the head with the adjusting worm shaft. When rotating to greater than a  $45^{\circ}$  angle, support head by hand.
- 3. Tighten the locknuts. Snug each locknut, then lightly tighten each locknut, then fully tighten each locknut in a crisscross pattern.
- 4. Use the method shown in the figure below and a parallel bar to square the head to the table.

#### 6.2.3.2 Tramming the Head

The purpose of tramming the head is make sure the head is perpendicular to the top of the table from both side to side and back to front.

Side to side tolerance - 0.001"

#### Side-to-Side Alignment

- 1. Make sure the machine is level.
- 2. Make sure the table has been clean and the Z gibs are adjusted properly. Mount a dial indicator in a tool holder and mount in the quill.
- 3. Adjust the Y-axis so that the spindle is in the center of the table.
- 4. Adjust the Knee so that the dial indicator will reach the table.
- 5. Move the dial indicator to 6 o'clock position and adjust the face so the needle is zero.
- 6. Do a series of sweeps from 9 o'clock to 3 o'clock and check for the repeatability of the setup. The head should be trammed within  $\pm$  0.001"
- 7. If the head is out of tram from side to side then loosen the 4 head bolts and rotate the head with the worm shaft.
- 8. Once the head has been trammed, tighten the 4 heads bolts. Be careful not to move the head while tightening. Tighten the bolts in a criss-cross pattern.

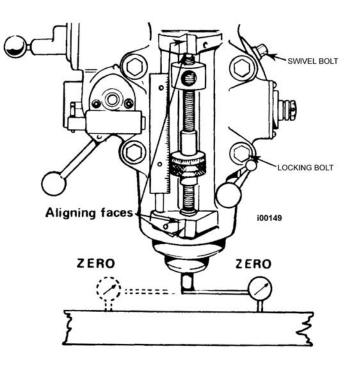


Figure 44

## **Tramming of Head**

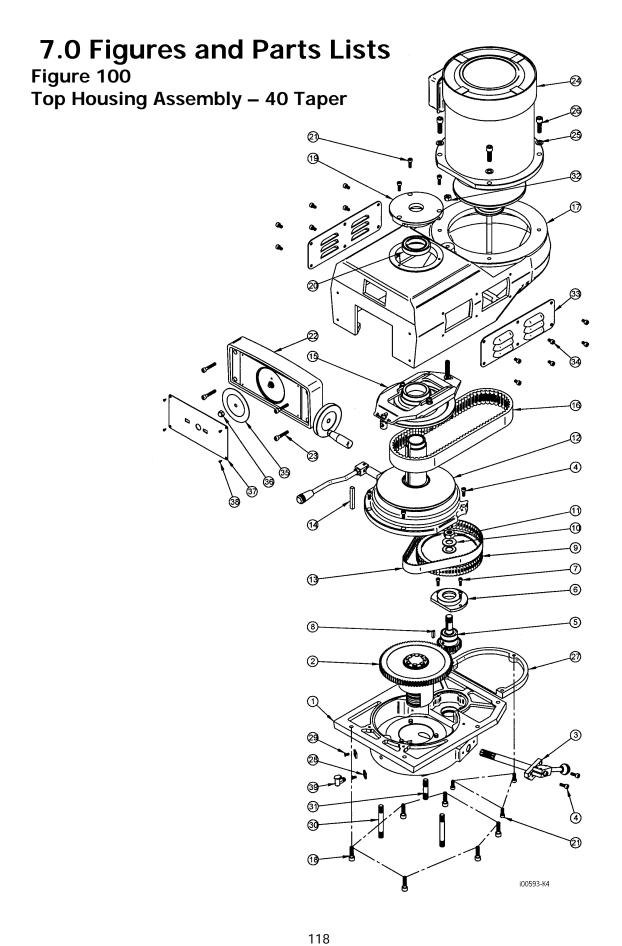
#### Back to Front Adjustment

With the dial indicator sweep the table from 6 o'clock to 12 o'clock. The head should be trammed within  $\pm$  0.0005" from front to back.

### 6.2.3.3 Back to Front Adjustment

- 1. Make sure the table has been clean and the gibs are adjusted properly.
- 2. Mount a dial indicator in a tool holder and mount in the quill.
- 3. Adjust the Y-axis so that the spindle is in the center of the table.
- 4. Adjust the knee so that the dial indicator will reach the table and lock the 2 clamps on the knee.
- 5. Move the dial indicator to 6 o'clock position and adjust the face so the needle is zero.
- 6. Do a series of sweeps from 6 o'clock to 12 o'clock and check for the repeatability of the setup. The head should be trammed as close as possibility to 0.0005."
- 7. Loosen the three bolts and adjust the tram with the bolt mounted on the top of the ram.

Once the head has been trammed tighten the three bolts. Be careful not to move the head while tightening. Tighten the bolts a little at a time. (Note: the head must droop down rather than up because tool pressure will take care of the extra 0.0005".)



Item	P/N	DESCRIPTION	Qty
1	20697-1	GEAR HOUSING SUB-ASSY (4VK-A1)	1
2	20697-2	HI-LOW SHIFT CLUTCH SUB-ASSY (4VK-A2)	1
3	20697-3	HI-LOW SHIFT SUB-ASSY (4VK-A3)	1
4	FVS12	SOCKET CAP SCREW M6-P1.0x15L	2
5	20697-4	PULLY PINION SUB-ASSY (4VK-A4)	1
6	FVS64	BULL GEAR PINION BEARING CAP	1
7	FVS93	SCREW SOC HD M5-P0.8x15L	1
8	FVS117	KEY 5x520L	1
9	FVS62	TIMING BELT PULLEY	1
10	FVS126	WASHER Ø 5/8	1
11	FVS61	JAM NUT 5/8-11NC	1
12	20697-5	LOWER VARI-DISC DRIVE SUB-ASSY (4VK-A5)	1
13	FVS63	BELT 8YU-600L	1
14	FVS135	KEY 8x7x60L	1
15	20697-6	UPPER VARI-DISC DRIVE SUB-ASSY (4VK-A6) (Shown for reference only - See figure 106)	1
16	FVS4	BELT	1
17	FVS1	BELT HOUSING	1
18	FVS17	SOCKET CAP SCREW M6-P1.0x35L	1
19	FVS13	TOP BEARING CAP	1
20	FVS15	BALL BEARING (6909VV)	1
21	FVS129	SCREW- SOC HD CAP M6-P1.0x18L	1
22		SPEED CHANGE HANDWHEEL SUB-ASSY (4VK-A7)	1
23	FVS10	SCREW- SOC HD CAP M8-P1.25x30L	1
24	20820	MOTOR ASSY-DPM5-5HP-GREEN (shown for reference only, not part of upper head housing assembly)	1
25	FVS130	WASHER- FLAT Ø 10.2	4
26	FVS111	SOC HD SCREW- 3/8-16NCx32L	4
27	FVS11	MOTOR PULLEY COVER	1
28	FVS104	COPPER CHIP(2REQ.)	2
29	FVS131	SCREW- FLAT HD PHILIP M5-P0.8x10L	1
30	FVS132	STUD Ø 7/16-92L	2
31	FVS133	STUD Ø 7/16-56L	1
32	FVS96	JAM NUT 3/8-16NC	1
33	FVS101	VENTILATOR(2REQ.)	2
34	FVS136	SCREW- SOC HD CAP M6-P1.0x10L	12
35	FVS16-1	VARI-SPEED DIAL	1
36		HEX CAP NUT 5/16-18NC	1
37		NAME PLATE	1
38	FVS19	DRIVE SCREW	1
39	OIL-1	FRU-K3-OIL CUP	1

# Parts List - Top Housing Assembly - 24688-1

i00593-K4

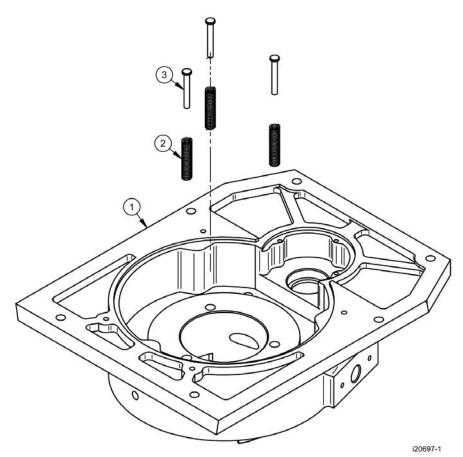
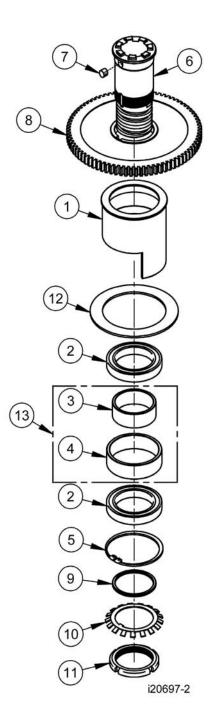


Figure 101 Gear Housing Sub-Assembly P/N: 20697-1

Item	P/N	Description	Qty
1	FVS82	GEAR HOUSING	1
2	FV112	GUIDE SPRING	3
3	FV113	SPRING GUIDE PIN	3

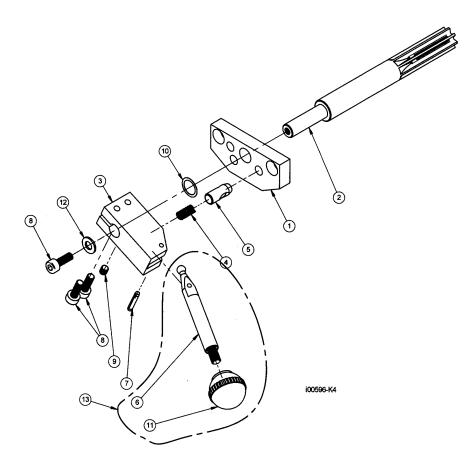
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ltem	P/N	DESCRIPTION	Qty
1	FVS75	BEARING SLIDING HOUSING	
2	23943	BEARING-DEEP GROVE U/SET (2)- 6910ZZ	1 SET
3	FVS78	BEARING SPACER	1
4	FVS79	BEARING SPACER	1
5	FVS80	SNAP RING R-75	1
6	FVS73	SPLINED GEAR HUB	1
7	FVS72	KEY 8x7x10L	
8	FVS74	SPINDLE BULL GEAR	1
9	FVS114	WASHER	1
10	FVS115	EXTERNAL TOOTH WASHER Ø 50	1
11	FVS81	LOCK WASHER Ø 50-18NC	1
12	FVS76	RING	1
13	20818	SPACER, BEARING	1
		100505 KA	

i00595-K4

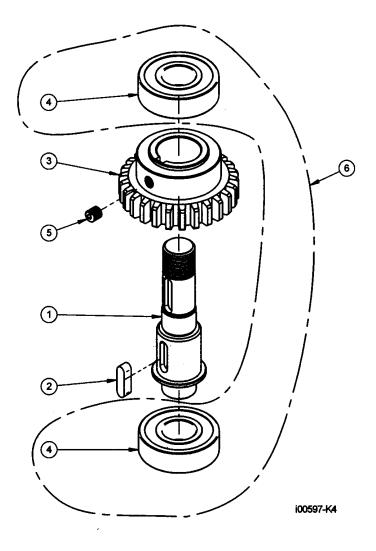
## Figure 102 Hi-Low Slip Clutch Sub-Assembly P/N: 20697-2



Item	P/N	DESCRIPTION	Qty
1	FVS89	HI-LOW DETENT PLATE	1
2	FVS87	CLUTCH GEAR SHAFT	1
3	FVS92	HI-LOW PINION BLOCK	1
4	FVS91	SPRING	1
5	FVS90	HI-LOW DETENT PLUNGER	1
6	FVS94	HI-LOW SHAFT CRANK	1
7	FVS88	PIN Ø 319L	1
8	FVS93	SCREW SOC HD M5-P0.8x15L	3
9	FVS92-1	SET SCREW M5-P0.8x5L	1
10	FVS92-2	WASHER- FLAT Ø 11	1
11	FVS57	BAKELITE BALL HANDLE	1
12	FVS116	WASHER- FLAT Ø 6	1
13	24083	SHAFT HI/LOW SHAFT ASSY	1

i00596-K4

## Figure 103 Hi-Low Shift Sub-Assembly P/N: 20697-3



ltem	P/N	DESCRIPTION	Qty
1	FVS67	BULL GEAR PINION COUNTER SHAFT	1
2	FVS69	KEY 5518L	1
3	FVS66	BULL GEAR PINION	1
4	AK118	BEARING-DEEP GROOVE-6203ZZ 2	
5	FVS3	SOCKET SET SCREW M6-P1.0x6L	1
6	23954	BEARING-DEEP GROOVE-SET (2)-6203ZZ	1
		i00597-K4	

Figure 104 Pulley Pinion Sub-Assembly P/N: 20697-4

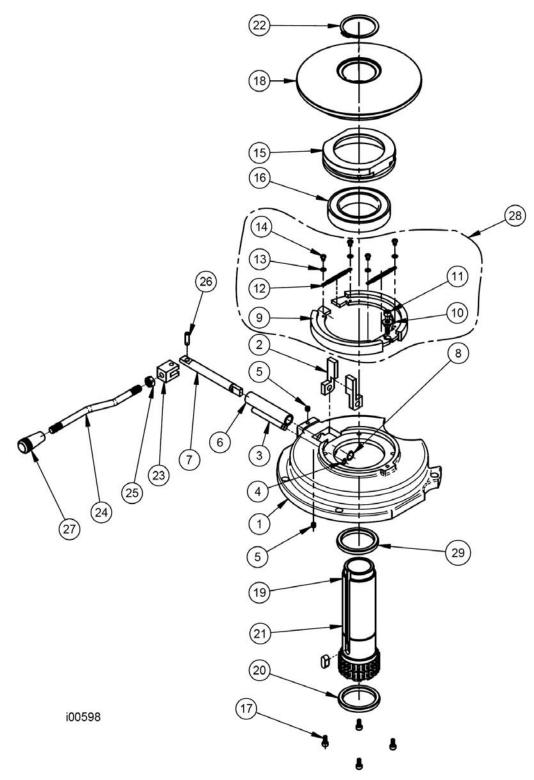


Figure 105 Lower Vari-Disc Sub-Assembly P/N: 20697-5 (assembly not available, order parts separately)

Item	P/N	DESCRIPTION	Qty
1	FVS50	BELT HOUSING BASE	1
2	FVS59	BRAKE BLOCK 2	
3	FVS58	TURNING BLOCK SHAFT 1	
4	FVS103	RETAINING RING Ø 7	1
5	FVS51	SET SCREW M6-P1.06L	2
6	FVS53	BRAKE LOCK BUSHING	1
7	FVS52	BRAKE LOCK SHAFT	1
8	FSV119	RETAINING RING Ø 11	1
9	FVS47	BRAKE SHOE	2
10	FVS48	BRAKE SHOE PIVOT SLEEVE	1
11	FVS17	SOCKET CAP SCREW M6-P1.0x35L	1
12	FVS49	BRAKE SPRING	2
13	FVS122	WASHER Ø 6	4
14	FVS120	SCREW- PHILLIP PAN HD 3/16-24NC6L	
15	FVS46	BRAKE BEARING CAP	1
16	AK048	BALL BEARING 6012ZZ	1
17	FVS14	SOCKET CAP SCREW M 5-PO.8x12L 4	
18	FVS45	STATIONARY DRIVEN VARIDISC	1
19	FVS70	SPINDLE PULLEY ASSY	1
20	FVS100	SPINDLE PULLEY SPACER	1
21	FVS71	KEY 8x8x20L	1
22	FVS97	SNAP RING Ø 50	1
23	FVS52-1	BRAKE LOCK SHAFT SWIVEL	1
24	FVS56	BRAKE LOCK HANDLE	1
25	FVS54	HANDLE FIX BLOCK 3/8-16NC 1	
26	FVS55	SPRING PIN Ø 6x20L 1	
27	FVS57-1	BAKELITE BALL HANDLE 3/8-16NC 1	
28	24055	BRAKE SHOE ASSY 1	
29	FVS98	CLUTCH WASHER	1

# Parts List - Lower Vari-Disc Sub-Assembly

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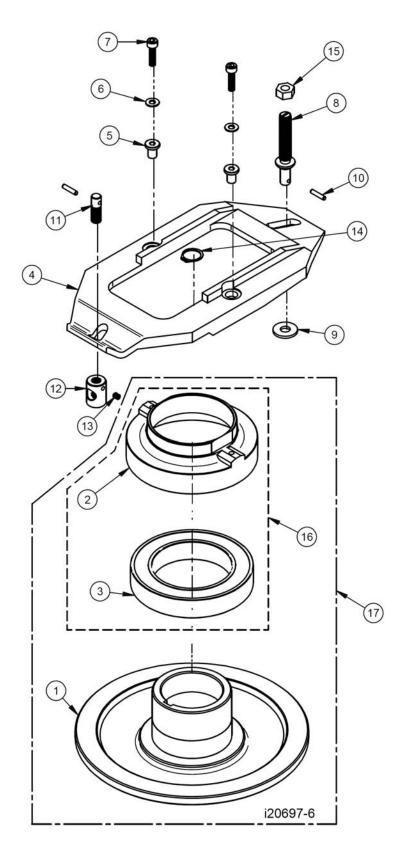
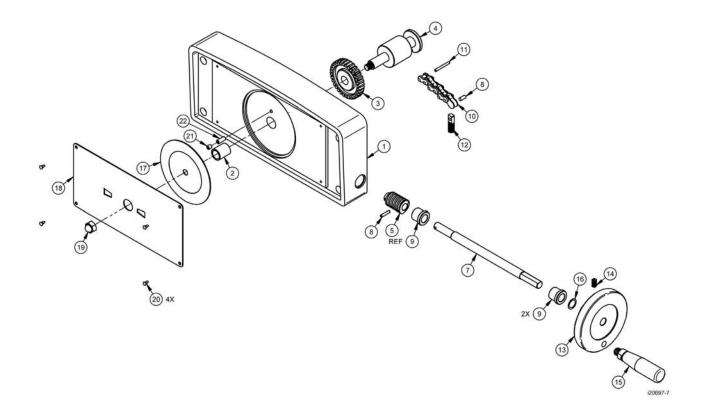


Figure 106 Upper Vari-Disc Sub-Assembly P/N: 20697-6

Item	P/N	DESCRIPTION	Qty
1	FVS44	ADJUSTABLE-DRIVEN VARIDISC	1
2	FVS42	SPINDLE PULLEY BEARING HOUSING	1
3	FVS43	BEARING-DEEP GROVE-6013ZZ	1
4	FVS36	SPEED CHANGE PLATE	1
5	FVS38	PIVOT SLEEVE Ø 5	2
6	FVS37	WASHER M5-P0.8x20L	2
7	FVS3123	SOCKET CAP SCREW	2
8	FVS39	SPEED CHANGE PLATE PIVOT STUD	1
9	FVS41	WASHER Ø 8.2	1
10	FVS40	ROLL PIN Ø3x15L	2
11	FVS35	CHAIN END STUD	1
12	FVS34	ADJUSTMENT NUT	1
13	FVS33	CHAIN FRONT SCREW M4-P0.7x5L	1
14	FVS97	SNAP RING Ø 50	1
15	FVS96	JAM NUT 3/8-16NC	1
16	24599	BEARING HOUSING ASSY-K4	1
17	24603	VARIDISC ASSY-ADJUSTABLE	1

# Parts List - Upper Vari-Disc Sub-Assembly

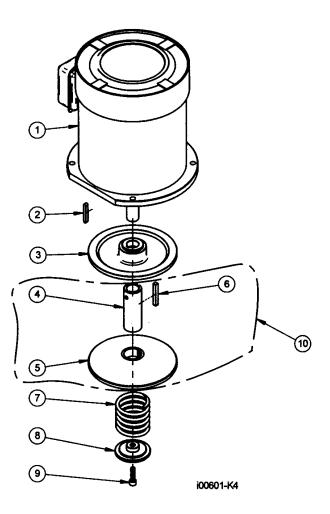
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Item	P/N	Title	Qty
1	FVS16	SPEED CHANGE HOUSING	1
2	FVS20	BEARING SELF LUBRICATING	1
3	FVS22	SPEED CHANGER GEAR	1
4	FVS31	SPEED CHANGE CHAIN DRUM	1
5	FVS21	WORM	1
7	FVS25	SPEED CHANGE SHAFT	1
8	FVS40	ROLL PIN Ø3x15L	2
9	FVS24	COPPER BUSHING	2
10	FVS32	CHAIN #3109.525	1
11	FVS31-1	DOWEL PIN Ø3x25L	1
12	FVS30	SPEED CHANGE STUD	1
13	FVS27	SPEED CHANGE HANDWHEEL	1
14	FVS18	FULL DOG SOCKET SET SCREW M6-P1.0x10L	1
15	FVS28	HANDLE 3/8-16NC	1
16	VS24-1	WASHER-WAVE	1

i20697-7

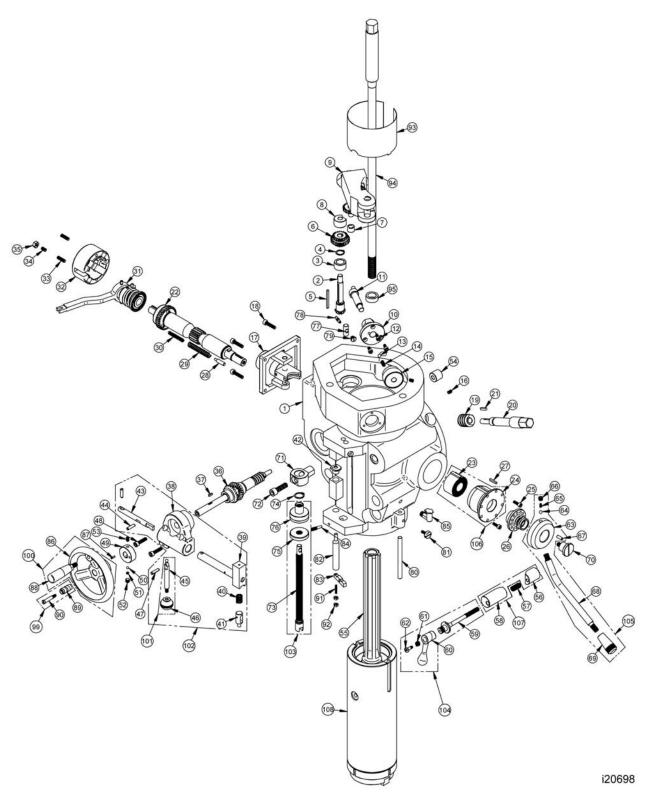
## Figure 107 Speed Change Handwheel Sub-Assembly, P/N: 20697-7



Item	P/N	Title	Qty	Notes
1	FVS110	MOTOR 5 HP	1	only available as 20820
2	FVS3-1	KEY 6x6x45L	1	only available as 20820
3	FVS2	STATIONARY MOTOR VARIDISC	1	only available as 20820
4	FVS6	BUSHING	1	available as 24054 or 20820
5	FVS5	ADJUSTABLE MOTOR VARIDISC	1	available as 24054 or 20820
6	FVS6-1	KEY 7x7x50L	1	available as 24054 or 20820
7	FVS8	SPRING FOR VARIDISC MOTOR SHAFT	1	only available as 20820
8	FVS9	ADJUSTABLE VARIDISC SPRING COLLAR	1	only available as 20820
9	FVS10	SCREW- SOC HD CAP M8-P1.25x30L	1	only available as 20820
10	24054	VARIDISC ASSY	1	

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## Figure 108 Spindle Motor Sub-Assembly P/N: 20820



## Figure 109 Bottom Housing Assembly

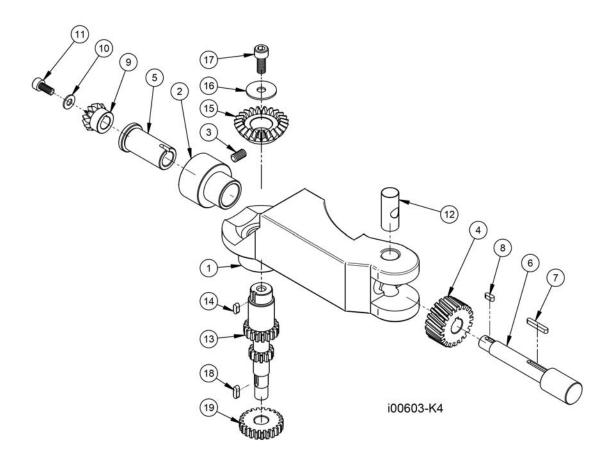
Item	P/N	Title	Qty
1	FB192	QUILL HOUSING	1
2	FB31	CLUSTER GEAR SHAFT	1
3	FB33	BEVEL GEAR BEARING	1
4	FB94	SNAP RING 95 DOWEL PIN Ø 14	1
5	FB29	CLUSTER GEAR KEY 3x3x45L	1
6	FB28	CLUSTER GEARS ASSEMBLY	1
7	FB41	NEEDLE BEARING KO-BA66Z	1
8	FB27	CLUSTER GEAR SHAFT UPPER BEARING	1
9	20698-1	WORM GEAR CRADLE SUB-ASSY (4VK-H1)	1
10	FB19	SHIFT SLEEVE	1
11	FB18	WORM GEAR CRADLE THROW-OUT	1
12	FB20	CAP SCREW M5-P0.8x12L	1
13	FB24	STEEL BALL	1
14	FB25-A	SPRING	1
14	FB23	SHIFT CRANK	1
			-
16 17	FB68	SET SCREW M6-P1.0x8L QUILL FEED SELECTOR SUB ASSY (4VK-H2)	1
17	20698-2 FB67	CAP SCREW M6-P1.0x18L	4
19	FB186	WORM GEAR	4
20	FB189	ADJ WORM SHAFT	1
20	FB187	KEY 4x4x18L	1
21	20698-3	SUB-ASSY-QUILL PINION SHAFT-40 TAPER	1
23	FB178	CLOCK SPRING (CLOCK SPRING ASSY.)	1
24	FB177		1
26	FB176	PINION SHAFT HUB SLEEVE	1
27	FB171		1
28	FB89	OVERLOAD CLUTCH LEVER SPRING PLUNGER	1
29	FB88	COMPRESSION SPRING	1
30	FB88-1	INTERNAL COMPRESSION SPRING	1
31	20698-4	OVERLOAD CLUTCH TRIP SUB-ASSY (4VK-H4)	1
32	FB99	CLUTCH ARM COVER	1
33	FB73	CAP SCREW M5-P0.8x40L	2
35	FB101	CHEM BLACKED LOCKNUT M6-P1.0	1
36	20698-5	FEED REVERSE CLUTCH SUB-ASSY (4VK-H5)	1
37	FB109	KEY 3x3x20L	1
38	FB106	FEED TRIP BRACKET	0
39	FB118	CAM ROD SLEEVE ASSY.	1
40	FB120	COMPRESSION SPRING	1
41	FB121	TRIP PLUNGER	1
42	FB123	TRIP PLUNGER BUSHING	1
43	FB103	CAM ROD	1
44	FB117	ROLL PIN Ø 3x15L	1
45	FB104	TRIP HANDLE	1
46	FB105	BLACK PLASTIC BALL	1
47	FB119-1	ROLL PIN Ø 3x20L	1
48	FB107	CAP SCREW M6-P1.0x25L	2
49	FB113	HAND WHEEL CLUTCH	1

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51	FB115	COMPRESSION SPRING	1
53	FB108	SET SCREW M6-P1.0x8L	1
54	FB42	BUSHING	1
55	20836-1	SPINDLE ASSY-40 TAPER	1
56	FB148	QUILL LOCK SLEEVE TAPPED	1
57	FB148-1A	COMPRESSION SPRING	1
58	FB153	QUILL LOCK SLEEVE	1
59	FB152	QUILL LOCK BOLT	1
60	FB149	LOCK HANDLE	1
61	FB149-1	CONICAL COMPRESSIONAL SPRING	1
62	FB149-2	SCREW- PHILLIP HD	1
63	FB175	RACK FEED HANDLE HUB	1
64	FB114	STEEL BALL	2
65	FB175-2A	COMPRESSION SPRING	1
66	FB116	HANDWHEEL CLUTCH SPRING SCREW M8-P1.25x6L	2
67	FB175-3	DOWEL PIN	1
68	FB190	PINION SHAFT HUB HANDLE	1
69	FB190	PLASTIC BALL HANDLES	1
70	FB169	SOC HEAD SCREW M5-P0.8x15L	4
70	FB163	QUILL STOP KNOB	1
71	FB200	SCREW- SOC HD 3/8-24NF x 1 1/4	1
72	FB200 FB164	QUILL STOP MICRO-SCREW	1
74	FB160	SNAP RING Ø16	1
75	FB161		1
76	FB162		1
77	FB184		1
78	FB183		1
79	FB185	REVERSE TRIP BALL LEVER SCREW	1
80	FB202		1
81	FB201		1
82	FB124		1
83	FB145	FEED TRIP LEVER	1
84	FB144	SOCKET SET SCREW	1
85	OIL-1	FRU-K3-OIL CUP	1
86	FB125	HANDWHEEL	1
87	FB125-1	HANDWHEEL SPRING PIN - Ø 3x3x10L	1
88	FB125-2	HANDWHEEL HANDLE	1
89	FB111	REVERSE KNOB	1
90	FB100	SOCKET SET SCREW M6-P1.0x20L	2
91	FB124-1	FEED TRIP PLUNGER SOC SET SCREW M4-P0.7x20L	1
92	FB124-2	FEED TRIP PLUNGER NUT M4-P0.7x20L	2
93	FB128	QUILL SKIRT	1
94	FVS109	DRAWBAR 5/8-11NC	1
95	FVS109-1	SPACER	1
96	25041	SCALE-HEAD ROTATION-NT40	1
97	25043	POINTER SCALE	1
98	25044	DRIVE SCREW-SCALE	4
99	20834	FEED REVERSE KNOB ASSY	1
100	20835	HANDWHEEL ASSY	1

101	24099	TRIP HANDLE ASS'Y (INCLUDES PLASTIC BALL)	1
102	20833	FRU-K4-FEED TRIP ASSY	1
103	20847	QUILL MICRO NUT & SCREW ASSY	1
104	20846	QUILL LOCK HANDLE ASSY	1
105	20850	FEED HANDLE ASSY	1
106	24095	CLOCK SPRING ASSEMBLY (SPRING & COVER)	1
107	20844	QUILL LOCK SLEVE ASSY	1
108	FB142	QUILL	1
109	A071	T BOLT ASSY (includes A070, A071, A069) (not shown on drawing)	4

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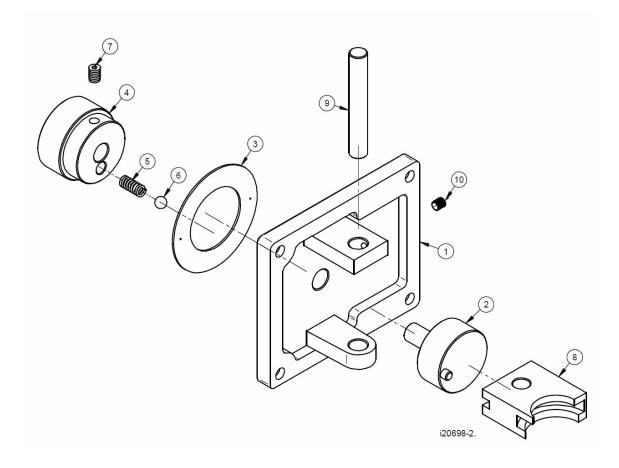


Item	P/N	Title	Qty
1	FB17	WORM GEAR CRADLE	1
2	FB5	WORM CRADLE BUSHING	1
3	FB6	SETSCREW M6-PP1.0x10L	1
4	FB8	FEED DRIVEWORM GEAR	1
5	FB4	FEED WORM GEAR SHAFT SLEEVE	1
6	FB9	FEED DRIVE WORM GEAR SHAFT	1
7	FB11	KEY 3x3x20L	1
8	FB10	WORM SHAFT KEY 3x3x8L	1
9	FB3	FEED BEVEL PINION	1
10	FB2	BEVEL PINION WASHER Ø 5	1
11	FB1	SOC.HD.SCREW M5-P0.8x10L	1
12	FB16	FEED ENGAGE PIN	1
13	FB36	FEED DRIVING GEAR	1
14	FB36-1	KEY 3x3x8L	1
15	FB15	FEED REVERSE BEVEL GEAR	1
16	FB13	WASHER Ø 6 Ø 22	1
17	FB14	SOC HD SCREW M6-P1.0x15L	1
18	FB37	KEY 3x3x10L	1
19	FB40	FEED DRIVE GEAR	1

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## Figure 110 Worm Gear Cradle Sub-Assembly P/N: 20698-1

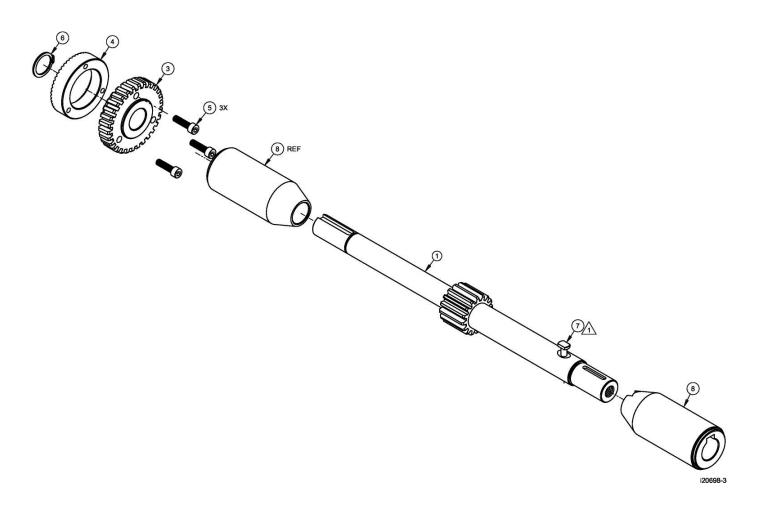
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Item	P/N	DESCRIPTION	Qty
1	FB66	CLUSTER GEAR COVER	1
2	FB64	CLUSTER GEAR SHIFT CRANK	1
3	FB69-1	DIAL	1
4	FB69	SHIFT KNOB	1
5	FB71	SPRING	1
6	FB70	STEEL BALL	1
7	FB68	SET SCREW M6-P1.0x8L	1
8	FB63	FEED GEAR SHIFT FORK	1
9	FB60	FEED SHIFT ROD	1
10	FB61	KP.SET SCREW M5-P0.8x6L	1
-		100604 KA	

#### i00604-K4

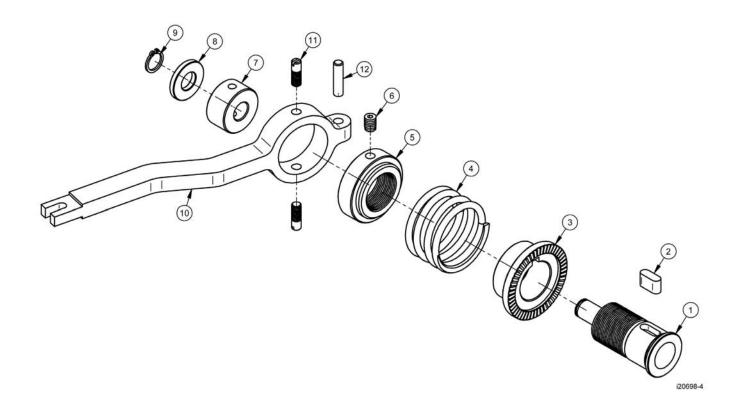
Figure 111 Quill Feed Selector Sub-Assembly P/N: 20698-2



Item	P/N	Title	UseAs	Qty
1	FB166	QUILL PINION SHAFT	EA	1
3	K-B92	OVERLOAD CLUTCH WORM GEAR	EA	1
4	K-B93	OVERLOAD CLUTCH RING	EA	1
5	K-B92-1	SCREW SOC HD CAP M4-P0.7x15L	EA	3
6	K-B94	SNAP RING 95 DOWEL PIN Ø 14	EA	1
7	K-B168	SCREW PIN	EA	(1)
8	25707	BUSHING KIT-PINION SHAFT-40 TAPER	EA	1

i20698-3

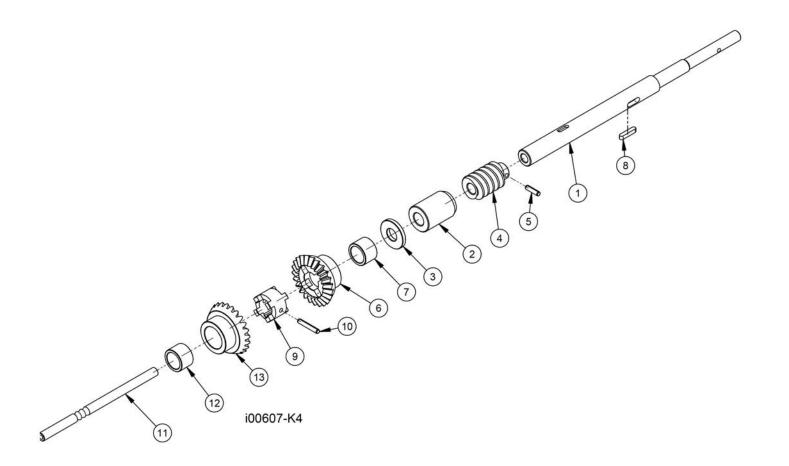
Figure 112 Quill Pinion Shaft Sub-Assembly P/N: 20698-3



Item	P/N	Title	Qty
1	FB81	OVERLOAD CLUTCH SLEEVE	1
2	FB81-1	KEY 5x8x13L	1
3	FB80	OVERLOAD CLUTCH	1
4	FB79	SAFETY CLUTCH SPRING	1
5	FB78	OVERLOAD CLUTCH LOCKNUT	1
6	FB76	SOCKET SET SCREW M6-P1.0x8L	1
7	FB75	CLUTCH RING	1
8	FB97	OVERLOAD CLUTCH WASHER	1
9	FB98	SNAP RING Ø 10	1
10	FB96	OVERLOAD CLUTCH TRIP LEVER	1
11	FB74	CLUTCH RING PIN (2REQ.)	2
12	FB77	BRASS PLUG	1

i00606-K4

## Figure 113 Overload Clutch Trip Sub-Assembly P/N: 20698-4



Item	P/N	Title	Qty
1	FB57	FEED WORM SHAFT	1
2	FB44	FEED WORM SHAFT BUSHING	1
3	FB47	FEED WORM SHAFT THRUST WASHER	1
4	FB43	WORM	1
5	FB59	PIN Ø 3x12L	1
6	FB49	FEED REVERSE BEVEL GEAR	1
7	FB48	BUSHING	1
8	FB62	KEY 3x3x15L	1
9	FB50	FEED REVERSE CLUTCH	1
10	FB50-1	PIN Ø 3x19L	1
11	FB55	REVERSE CLUTCH ROD	1
12	FB52	BUSHING	1
13	FB51	FEED REVERSE BEVEL GEAR	1

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## Figure 114 Feed Reverse Clutch Sub-Assembly P/N: 20698-5

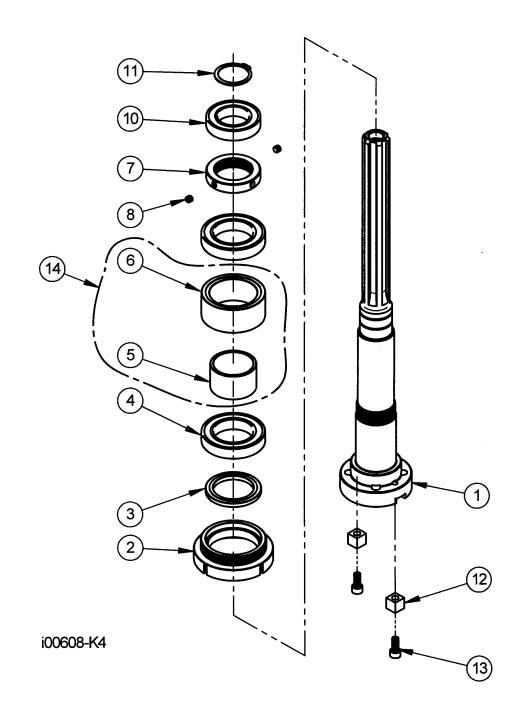
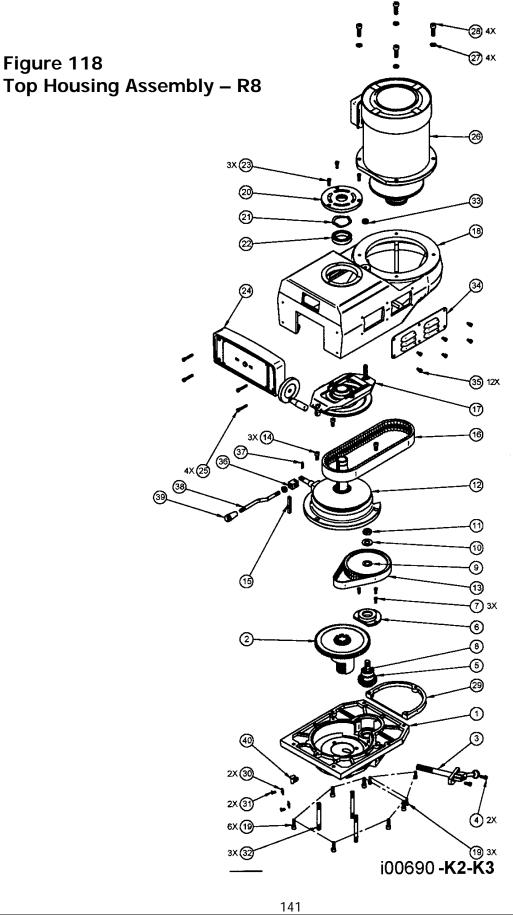


Figure 115 Quill Spindle Sub-Assembly P/N: 20836-1

# Parts List - Spindle Sub-Assembly

Item	P/N	DESCRIPTION	Qty
1	FB127	SPINDLE BT-40	1
2	FB133	NOSE-PIECE	1
3	FB134	SPINDLE DIRT SHIELD	1
4	20839	BEARING-ANGULAR CONTACT U/ SET (2)-7010 P4	1 Set
5	FB136	BEARING SPACER-LARGE	1
6	FB137	BEARING SPACER-SMALL	1
7	FB139	SPINDLE BEARING KNOCK NUT	1
8	FB139-1	SET SCREW M8-P1.25x6L	2
10	A112H	BEARING 6008ZZ	1
11	FB143	LOCK RING Ø 40	1
12	FB140	SPINDLE FIXED NUT	2
13	FB141	COLLET ALIGNMENT SCREW M8-P1.25x20L	2
14	20841	BEARING SPACER SET	1

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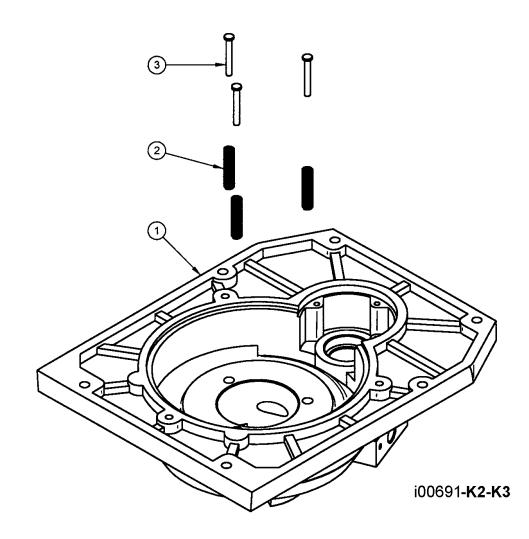


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## Parts List Head Top Assembly - 24692

ltem	P/N	Title	Qty
1	20778-1	GEAR HOUSING SUB-ASSY (3VK-A1)	1
2	20778-2	HI-LOW SHIFT CLUTCH SUB-ASSY (3VK-A2)	1
3	20778-3	HI-LOW SHIFT SUB-ASSY (3VK-A3)	1
4	VS12	SOCKET CAP SCREW M6-P1.0x15L	2
5	20778-4	PULLY PINION SUB-ASSY (3VK-A4)	1
6	VS64	BULL GEAR PINION BEARING CAP	1
7	VS93	SCREW M5-P0.8x15L	1
8	VS117	KEY 5x525L	1
9	VS62	TIMING BELT PULLEY	1
10	VS126	WASHER Ø 5/8	1
11	VS61	JAM NUT 5/8-11NC	1
12	20778-5	LOWER VARI-DISC DRIVE SUB-ASSY (3VK-A5)	1
13	VS63	BELT 3/8"-#225	1
14	VS14-1	SCREW M8-P1.25x18L	3
15	VS135	KEY 8x7x60L	1
16	VS4	BELT	1
17	20778-6	UPPER VARI-DISC DRIVE SUB-ASSY (3VK-A6)	1
18	VS1	BELT HOUSING	1
19	VS137	SOCKET CAP SCREW M8-P1.25x25L	1
20	VS13	TOP BEARING CAP	1
21	VS13-1	WAVE WASHER	1
22	VS15	BEARING-DEEP GROVE-6007V	1
23	VS129	SCREW- SOC HD CAP M6-P1.0x18L	1
24	20778-7	SPEED CHANGE HANDWHEEL SUB-ASSY (3VK-A7)	1
25	VS07	SCREW- SOC HD CAP M6-P1.0x35L	1
		MOTOR ASSY- K2 & K3- 3HP (reference only, not part of upper	
26	20819	head housing assembly)	1
27	VS130	WASHER- FLAT Ø 10.2	4
28	VS111	SOC HD SCREW- 3/8-16NCx32L	4
29	VS11	MOTOR PULLEY COVER	1
30	VS104	COPPER CHIP(2REQ.)	2
31	VS131	SCREW- FLAT HD PHILIP M5-P0.8x10L	1
32	VS132	STUD Ø 7/16-100L	2
33	VS96	JAM NUT 3/8"-16NC	1
34	VS101	VENTILATOR(2REQ.)	2
35	VS136	SCREW- SOC HD CAP M6-P1.0x10L	12
36	VS54	HANDLE FIX BLOCK	1
37	VS55	SET SCREW	1
38	VS56	BRAKE LOCK HANDLE	1
39	VS57	BAKELITE BALL HANDLE	1
40	OIL-1	OIL CUP	1

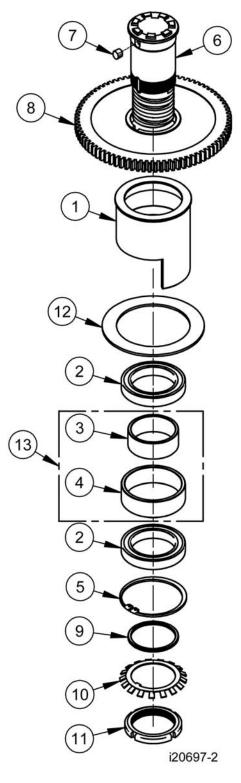
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Item	P/N	Title		Qty
1	VS82	GEAR HOUSING		1
2	VS112	GUIDE SPRING		3
3	VS113	SPRING GUIDE PIN		3
			100601 K2 K2	

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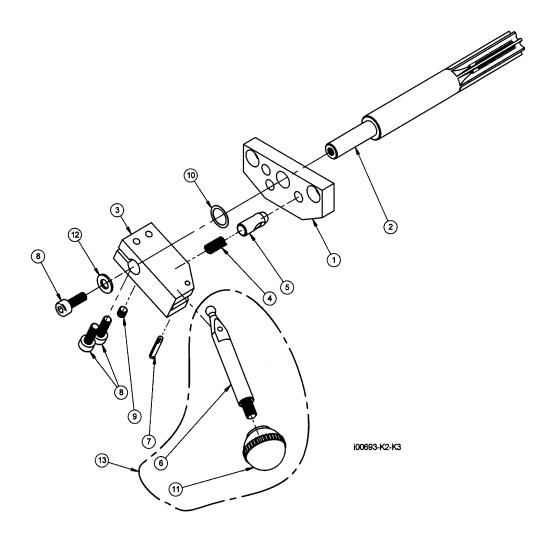
Figure 119 Gear Housing P/N: 20778-1 Figure 120 Hi-Low Shift Clutch Sub-Assembly P/N: 20778-2



# Parts List – High-Low Shift Clutch

Item	P/N	DESCRIPTION	Qty
1	VS75	BEARING SLIDING HOUSING	1
2	23970	BALL BEARING SET 6908ZZ	1 SET
3	VS78	BEARING SPACER	1
4	VS79	BEARING SPACER	1
5	VS80	SNAP RING R-65	1
6	VS73	SPLINED GEAR HUB	1
7	VS72	KEY 8x7x10L	1
8	VS74	SPINDLE BULL GEAR	1
9	VS114	WASHER	1
10	VS115	EXTERNAL TOOTH WASHER Ø 40	1
11	VS81	LOCK WASHER Ø 9/16-18NC	1
12	VS76	RING	1
13	20817	SPACER-BEARING	1

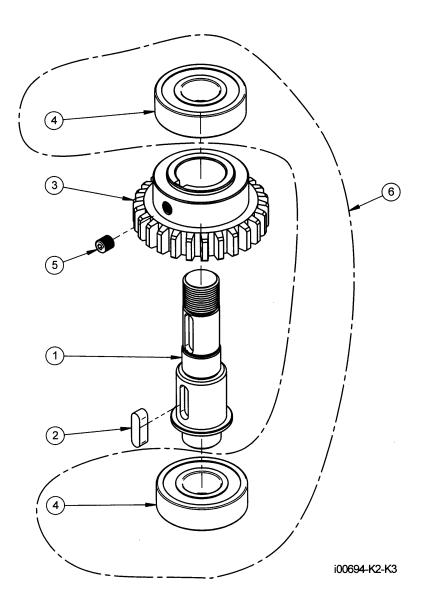
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## Figure 121 Hi-Low Shift P/N: 20778-3

Item	P/N	DESCRIPTION	Qty
1	VS89	HI-LOW DETENT PLATE	1
2	VS87	CLUTCH GEAR SHAFT	1
3	VS92	HI-LOW PINION BLOCK	1
4	VS91	SPRING	1
5	VS90	HI-LOW DETENT PLUNGER	1
7	VS88	PIN Ø 3X19L	1
8	VS93	SCREW M5-P0.8x15L	2
9	VS92-1	SET SCREW M5-P0.8x5L	1
10	VS92-2	WASHER- FLAT Ø 11	1
12	VS116	WASHER- FLAT Ø M5	1
13	24083	SHAFT-HI/LOW SHAFT ASSY	1
		i00693-K2-K3	

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Item P/N DESCRIPTION		Qty	
1	1 VS67 BULL GEAR PINION COUNTER SHAFT		1
2	VS69	KEY 5X5X18L	1
3	VS66	BULL GEAR PINION	1
4	AK118	BEARING-DEEP GROOVE-6203ZZ	2
5	VS3	SOCKET SET SCREW M6-P1.0x6L	1
6	23954	BEARING-DEEP GROOVE-SET (2)-6203ZZ	1 Set

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Figure 122 Pulley Pinion P/N: 20778-4

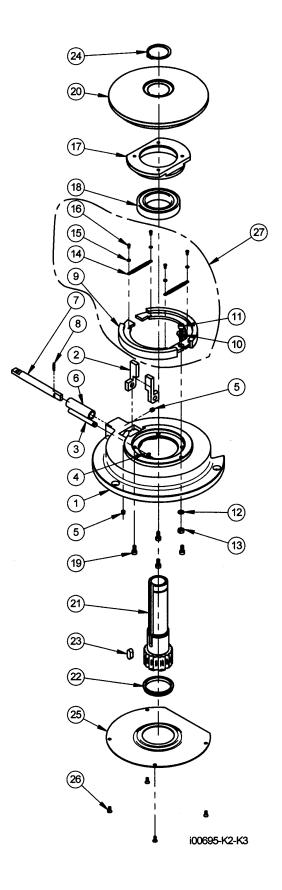


Figure 123 Lower Vari-Disc Drive P/N: 20778-5

### (assembly not available, order parts separately)

Item	P/N	DESCRIPTION	Qty
1	VS50	BELT HOUSING BASE	1
2	VS59	BRAKE BLOCK	2
3	VS58	TURNING BLOCK SHAFT	1
4	VS103	RETAINING RING Ø 7	1
5	VS51	SET SCREW M6-1.0X6L	2
6	VS53	BRAKE LOCK BUSHING	1
7	VS52	BRAKE LOCK SHAFT	1
8	VS52-2	BRAKE LOCK PIN DIA 3 X 5/8"L	1
9	VS47	BRAKE SHOE	2
10	VS48	BRAKE SHOE PIVOT SLEEVE	1
11	VS17	SOCKET CAP SCREW M6-P1.0x35L	1
12	VS17-1	WASHER Ø 6	1
13	VS17-2	NUT M6-P1.0	1
14	VS49	BRAKE SPRING	2
15	VS122	WASHER DIA 3.3	4
16	VS120	SCREW-PAN HEAD PHILIP 5-40NC	4
17	VS46	BRAKE BEARING CAP	1
18	VS43-1	BALL BEARING 6010ZZ	1
19	VS14	SOCKET CAP SCREW M5-0.8x12L	4
20	VS45	STATIONARY DRIVEN VARIDISC	1
21	VS70	SPINDLE PULLY ASSY	1
22	VS100	SPINDLE PULLY SPACER	1
23	VS71	KEY 8x7x20L	1
24	VS97	SNAP RING Ø 40	1
25	VS50-1	DUST COVER	1
26	VS50-2	SCREW-FH-PH-STL-BO M6-1.0X6L	4
27	24055	BRAKE SHOE ASSY	1

Parts List – Lower Vari-Disc Drive

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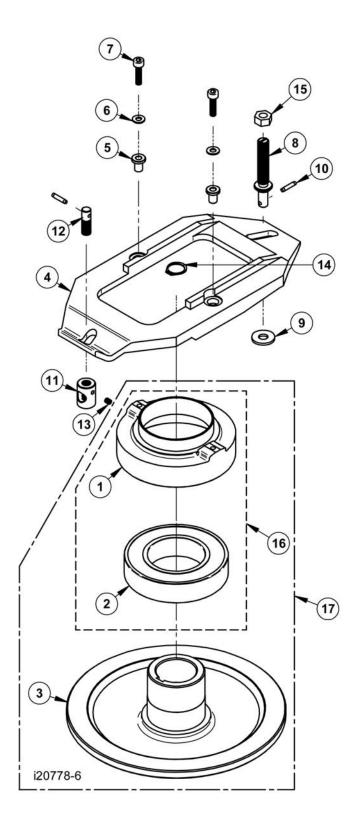
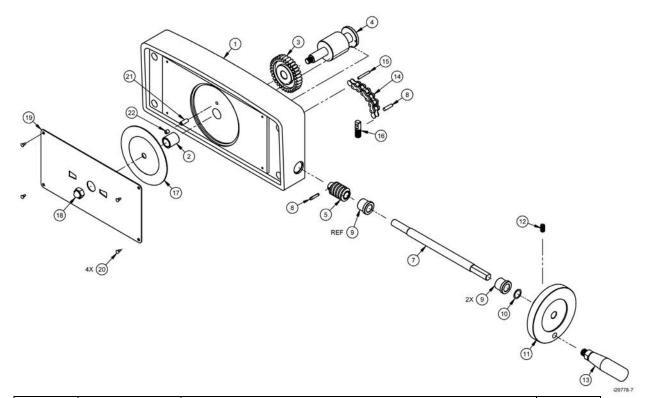


Figure 124 Upper Vari-Disc Drive Sub-Assy P/N: 20778-6

Item	P/N	DESCRIPTION	Qty
1	VS42	SPINDLE PULLEY BEARING HOUSING	1
2	VS43	BEARING-DEEP GROVE-6210ZZ	1
3	VS44	ADJUSTABLE-DRIVEN VARIDISC	1
4	VS36	SPEED CHANGE PLATE	1
5	VS38	PIVOT SLEEVE Ø 5	2
6	VS37	WASHER M5-P0.8x20L	2
7	VS123	SCREW-SHCS M5-0.8X20L	2
8	VS39	SPEED CHANGE PLATE PIVOT STUD	1
9	VS41	WASHER Ø 8.2	1
10	VS40	ROLL PIN Ø3x15L	2
11	VS35	ADJUSTMENT NUT	1
12	VS34	CHAIN END STUD	1
13	VS33	CHAIN FRONT SCREW M4-P0.7x5L	1
14	VS7	SNAP RING Ø 35	1
15	FVS96	JAM NUT 3/8-16NC	1
16	24564	BEARING HOUSING ASSY	1
17	24631	VARI DISC ADJUSTABLE ASSY	1

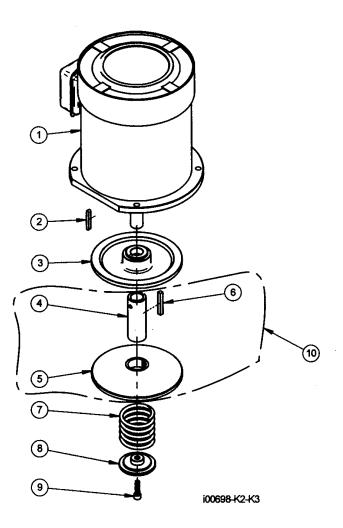
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Item	P/N	DESCRIPTION	Qty
1	VS16	SPEED CHANGE HOUSING	1
2	VS20	BEARING SELF LUBRICATING	1
3	VS22	SPEED CHANGER GEAR	1
4	VS31	SPEED CHANGE CHAIN DRUM	1
5	VS21	WORM	1
7	VS25	SPEED CHANGE SHAFT	1
8	VS40	ROLL PIN Ø3x15L	2
9	VS24	COPPER BUSHING	2
10	VS24-1	WASHER-WAVE	1
11	VS27	SPEED CHANGE HANDWHEEL	1
12	VS18	FULL DOG SOCKET SET SCREW M6-P1.0x10L	1
13	VS28	HANDLE 3/8-16NC	1
14	VS32	CHAIN #310X9.525	1
15	VS31-1	DOWEL PIN Ø3x25L	1
16	VS30	SPEED CHANGE STUD	1
17	VS16-1	SPEED DIAL	1
18	VS95	NUT-ACORN 5/16-18 NC	1
19	VS16-2	NAME PLATE	1
20	VS19	SCREW-DRIVE	4
21	M5-0.8X14 40B	SCREW-SOC SET-STL-BO-CUP	1
22	M5-0.8X5 40B	SCREW-SOC SET-STL-BO-CUP	1

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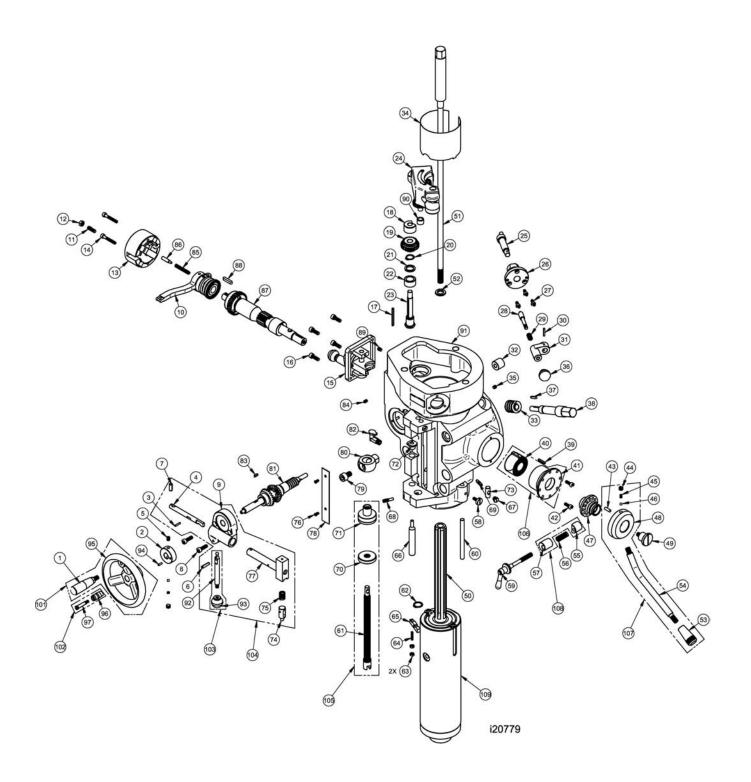
## Figure 125 Speed Change Handwheel P/N: 20778-7



## Figure 126 Spindle Motor P/N: 20819

ltem	P/N	DESCRIPTION	Qty	Notes
1	VS110	MOTOR 3 HP	1	only available as 20819
2	VS3-1	KEY 6x6x45L	1	only available as 20819
3	VS2	STATIONARY MOTOR VARIDISC	1	only available as 20819
4	VS6	BUSHING	1	available as 23953 or 20819
5	VS5	ADJUSTABLE MOTOR VARIDISC	1	available as 23953 or 20819
6	VS6-1	KEY 7x7x50L	1	available as 23953 or 20819
7	VS8	SPRING FOR VARIDISC MOTOR SHAFT	1	only available as 20819
8	VS9	ADJUSTABLE VARIDISC SPRING COLLAR	1	only available as 20819
9	VS10	SCREW- SOC HD CAP M8-P1.25x30L	1	only available as 20819
10	23953	VARIDISC ASSY-ADJUSTABLE MOTOR	1	
		100600 K2 K2		

i00698-K2-K3



# Figure 127 Lower Head Assembly

Item	P/N	Title	Qty
1	K-B125-2	HANDWHEEL HANDLE (AVAILABLE ONLY IN ASSY. 20835)	1
2	K-B123-2	HAND WHEEL CLUTCH	1
2	K-B113 K-B117	ROLL PIN Ø3x15L	1
4	K-B103	CAM ROD	1
4 5	K-B103	SOCKET SET SCREW M6-P1.0x8L	1
6	K-B100	ROLL PIN Ø3x20L	1
7	K-B113-1 K-B103-1	CAM ROD PIN Ø6x15L	1
8	K-B103-1	CAP SCREW M6-P1.0x25L	2
9	K-B107	FEED TRIP BRACKET	1
10	20779-4	OVERLOAD CLUTCH TRIP SUB-ASSY (3VK-B4)	1
11	K-B73	SOCKET SET SCREW M6-P1.0x20L	1
12	K-B101	CHEM BLACKED LOCKNUT M6-P1.0	1
13	K-B99	CLUTCH ARM COVER	1
15	20779-2	QUILL FEED SELECTOR SUB-ASSY (3VK-B2)	1
16	K-B67	CAP SCREW M6-P1.0x18L	4
17	K-B29	CLUSTER GEAR KEY 3x3x45L	1
18	K-B27	CLUSTER GEAR SHAFT UPPER BEARING	1
19	K-B28	CLUSTER GEARS ASSEMBLY	1
20	K-B94	SNAP RING 95 DOWEL PIN Ø 14	1
21	K-B32	BEVEL GEAR THRUST SPACER	1
22	K-B33	BEVEL GEAR BEARING	1
23	K-B31	CLUSTER GEAR SHAFT 6602BB	1
24	20779-1	WORM GEAR CRADLE SUB-ASSY (3VK-B1)	1
25	K-B18	WORM GEAR CRADLE THROW-OUT	1
26	K-B19	SHIFT SLEEVE	1
27	K-B25	CAP SCREW(3REQ.) M5-P0.8x12L	3
28	K-B20	GEAR SHIFT PLUNGER	1
29	K-B21	COMPRESSION SPRING	1
30	K-B22	ROLL PIN Ø3x20L	1
31	K-B23	SHIFT CRANK	1
33	K-B186	WORM GEAR	1
34	K-B128	QUILL SKIRT	1
35	K-B189-1	ADJ WORM SHAFT SET SCREW M6-P1.0x6L	1
36	K-B42	BUSHING	2
37	K-B187	KEY 4x4x18L	1
38	K-B189	ADJ WORM SHAFT	1
39	K-B171	KEY 3x3x20L	1
40	K-B178	CLOCK SPRING(CLOCK SPRING ASSY.)	1
41	K-B177	SPRING COVER	1
42	K-B169	RD.HEAD SCREW(2REQ.) M5-P0.8x15L	2
43	K-B170	ROLL PIN	1
44	K-B175-3	SET SCREW M8-P1.25x6L	2
45	K-B175-2	COMPRESSION SPRING	2
46	K-B175-1	STEEL BALL	2
47	K-B176	PINION SHAFT HUB SLEEVE	1
48	K-B175	RACK FEED HANDLE HUB	1

Parts List – Lower Head Assembly

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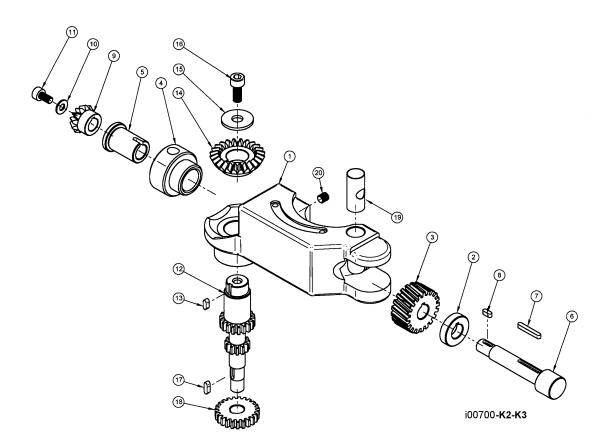
49	K-B172	PINION SHAFT HUB SEREW	1
50	20836	SPINDLE ASSY-R8	0
51	VS109	DRAWBAR 7/16-20UNF	1
52	VS109-1	SPACER	1
53	K-B191	BLACK PLASTIC BALL HANDLES (sold as assy 20849 only)	1
54	K-B190	PINION SHAFT HUB HANDLE (sold as assy 20849 only)	1
55	K-B148	QUILL LOCK SLEEVE	1
56	K-B148-1	COMPRESSION SPRING	1
57	K-B153	QUILL LOCK SLEEVE TAPPED	1
58	KB-201	INDICATOR ROD SCREW	1
59	K-B149	LOCK HANDLE	1
60	KB-202	INDICATOR ROD	1
61	K-B164	QUILL STOP MICRO-SCREW	1
62	K-B160	SNAP RING Ø16	1
63	K-B124-2	FEED TRIP PLUNGER NUT M40-P0.7	2
64	K-B124-1	FEED TRIP PLUNGER SOC SET SCREW M4-P0.7x20L	1
65	K-B145	FEED TRIP LEVER	1
66	K-B124	FEED TRIP PLUNGER	1
67	K-B185	REVERSE TRIP BALL LEVER SCREW	1
68	K-B144	SOCKET SET SCREW	1
69	K-B183	REVERSE TRIP BALL LEVER	1
70	K-B161		1
71	K-B162		1
72	K-B123	TRIP PLUNGER BUSHING	1
73	K-B184	FEED REVERSE TRIP PLUNGER	1
74	K-B121		1
75	K-B120		1
76	K-B158	CHEM BLACKED RD.HD.SCREWS(2 REQ.) M5-P0.8x8L	2
77	K-B118	CAM ROD SLEEVE ASSY MICROMETER SCALE	1
78 79	K-B159 KB-200	SCREW- SOC HD 3/8-24NFx15L	1
79 80	К-В163	QUILL STOP KNOB	1
81	20779-5	FEED REVERSE CLUTCH SUB-ASSY (3VK-B5)	1
82	OIL-1	OIL CUP	1
83	K-B109	KEY 3x3x20L	1
84	K-B17-1	WORM GEAR SET SCREW M6-P1.0x8L	1
85	K-B88-1	COMPRESSION SPRING	1
86	K-B89	OVERLOAD CLUTCH LEVER SPRING PLUNGER	1
87	20779-3	SUB - ASSY - QUILL PINION SHAFT - R8	1
88	K-B167	KEY 5x5x25L	1
89	K-B27-1	SET SCREW M6-P1.0x8L	1
90	K-B41	NEEDLE BEARING BA66 BEARING SIZE KO-BA66Z	1
91	K-B192	QUILL HOUSING	1
92	K-B104	TRIP HANDLE	1
93	K-B105	BLACK PLASTIC BALL	1
94	K-B125-1	HANDWHEEL SPRING PIN Ø3x3x10L	1
95	K-B125	HANDWHEEL	1
96	K-B111	REVERSE KNOB	1
97	K-B100	CAP SET SCREW M5-P0.8x35L	3

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98	25042	SCALE-HEAD ROTATION-R8	1
99	25043	POINTER SCALE	1
100	25044	DRIVE SCREW-SCALE	4
101	20835	HANDWHEEL ASSY	1
102	20834	FEED REVERSE KNOB ASSY	1
103	24052	TRIP HANDLE ASSEMBLY (INCLUDES PLASTIC BALL)	1
104	20832	FEED TRIP ASSY	1
105	20847	QUILL MICRO NUT & SCREW ASSY	1
106	24051	CLOCK SPRING ASSEMBLY (SPRING & COVER)	1
107	20849	FEED HANDLE ASSY (QUILL HANDLE)	1
108	20843	QUILL LOCK SLEVE ASSY	1
109	K-B142	QUILL	1
110	K-B155	T BOLT ASSY (not shown on drawing)	1
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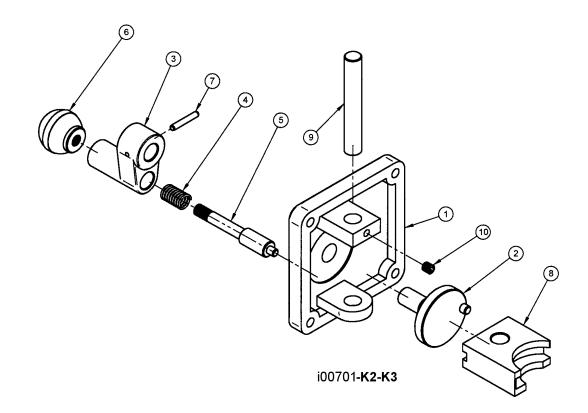
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Item	P/N	Title	Qty
1	K-B17	WORM GEAR CRADLE	1
2	K-B07	WORM GEAR SPACER	1
3	K-B08	FEED DRIVEWORM GEAR	1
4	K-B05	WORM CRADLE BUSHING	1
5	K-B04	FEED WORM GEAR SHAFT SLEEVE	1
6	K-B09	FEED DRIVE WORM GEAR SHAFT	1
7	K-B11	KEY 3x3x25L	1
8	K-B10	WORM SHAFT KEY 3x3x8L	1
9	K-B03	FEED BEVEL PINION	1
10	K-B02	BEVEL PINION WASHER Ø 5	1
11	K-B01	SOC.HD.SCREW M5-P0.8x10L	1
12	K-B36	FEED DRIVING GEAR	1
13	K-B36-1	KEY 3x3x8L	1
14	K-B15	FEED REVERSE BEVEL GEAR	1
15	K-B13	WASHER Ø 6, 22 OD	1
16	K-B14	SOC HD SCREW M6-P1.0x15L	1
17	K-B37	KEY 3x3x10L	1
18	K-B40	FEED DRIVE GEAR	1
19	K-B16	FEED ENGAGE PIN	1
20	K-B06	SETSCREW M6-P1.0x6L	1

Figure 128 Worm Gear Cradle P/N: 20779-1 i00700-K2-K3

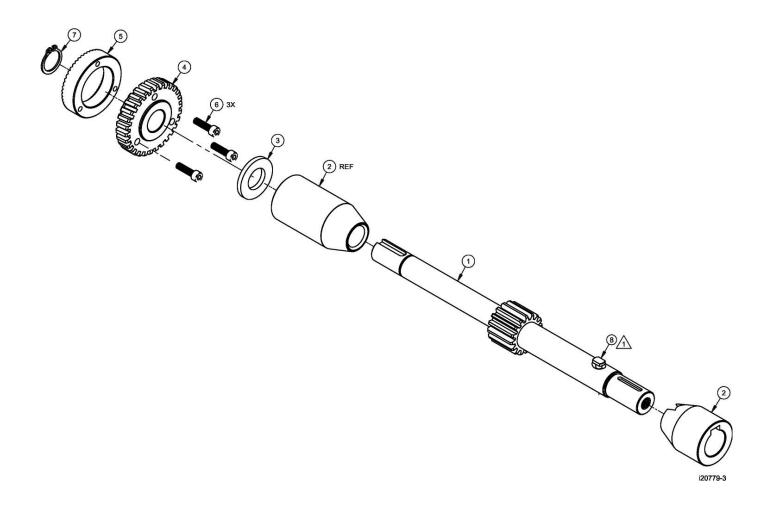
Southwestern Industries, Inc. ProtoTRAK KEMX Retrofit Safety, Installation, Maintenance, Service & Parts List Manual



Item	P/N	Title	Qty
1	K-B66	CLUSTER GEAR COVER	1
2	K-B64	CLUSTER GEAR SHAFT CRANK	1
3	K-B70	SHIFT CRANK	1
4	K-B69	SPRING Ø 3 x 20L	1
5	K-B68	GEAR SHIFT PLUNGER	1
6	K-B72	SHIFT KNOB-5/16-18NC	1
7	K-B71	ROLL PIN Ø 3 x 20L	1
8	K-B63	FEED GEAR SHIFT FORK	1
9	K-B65	SHAFT	1
10	K-B61	CAP SET SCREW M5-P0.8x5L	1
		i00701_K2_K	(2

i00701-K2-K3

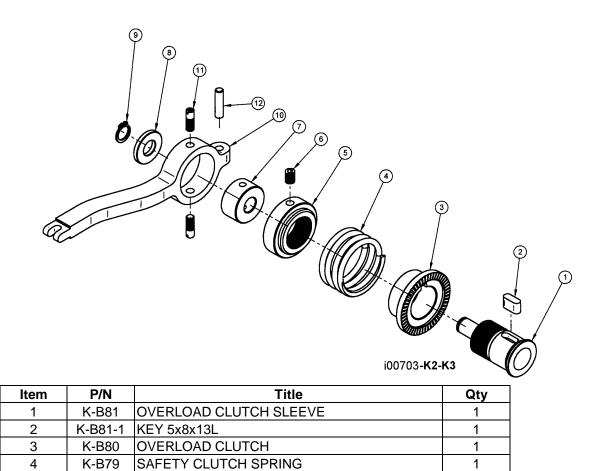
Figure 129 Quill Feed Selector P/N: 20779-2



Item	P/N	Title	UseAs	Qty
1	K-B166	QUILL PINION SHAFT	EA	1
2	25706	BUSHING KIT-PINION SHAFT-R8	EA	1
3	K-B91	WASHER	EA	1
4	K-B92	OVERLOAD CLUTCH WORM GEAR	EA	1
5	K-B93	OVERLOAD CLUTCH RING	EA	1
6	K-B92-1	SCREW SOC HD CAP M4-P0.7x15L	EA	3
7	K-B94	SNAP RING 95 DOWEL PIN Ø 14	EA	1
8	K-B168	SCREW PIN	EA	(1)

i20779-3

Figure 130 Quill Pinion Shaft P/N: 20779-3



1

1

7	K-B75	CLUTCH RING	1
8	K-B97	OVERLOAD CLUTCH WASHER	1
9	K-B98	SNAP RING Ø 10	1
10	K-B96	OVERLOAD CLUTCH TRIP LEVER	1
11	K-B74	CLUTCH RING PIN (2REQ.)	2
12	K-B77	BRASS PLUG	1
		i00703-K2-K3	

OVERLOAD CLUTCH LOCKNUT

SOCKET SET SCREW M6-P1.0x8L

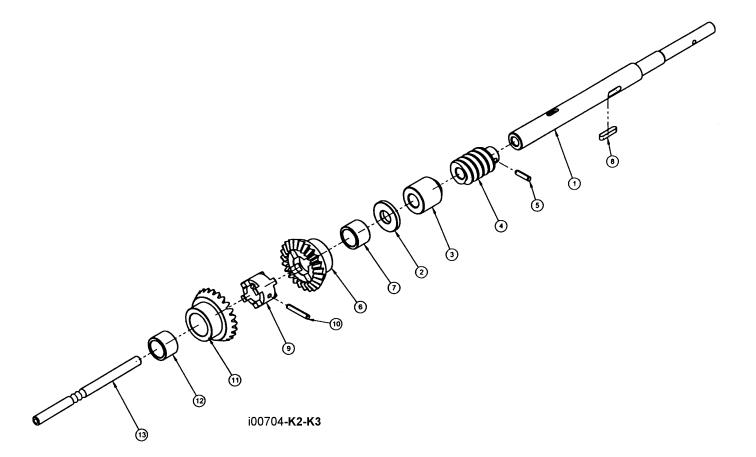
Figure 131 Overload Clutch Trip P/N: 20779-4

K-B78

K-B76

5

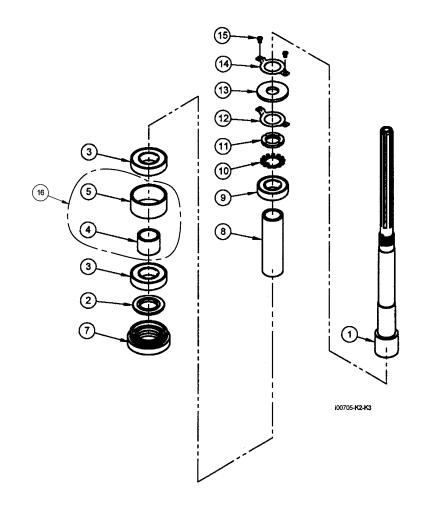
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Item	P/N	Title	Qty
1	K-B57	FEED WORM SHAFT	1
2	K-B47	FEED WORM SHAFT THRUST WASHER	1
3	K-B44	FEED WORM SHAFT BUSHING	1
4	K-B43	WORM	1
5	K-B59	PIN Ø 3x12L	1
6	K-B49	FEED REVERSE BEVEL GEAR	1
7	K-B48	BUSHING	1
8	K-B62	KEY 3x3x15L	1
9	K-B50	FEED REVERSE CLUTCH	1
10	K-B56	PIN Ø 3x19L	1
11	K-B51	FEED REVERSE BEVEL GEAR	1
12	K-B52	BUSHING	1
13	K-B55	REVERSE CLUTCH ROD	1

i00704-K2-K3

Figure 132 Feed Reverse Clutch P/N: 20779-5



Item	P/N	DESCRIPTION	Qty
1	K-B127	SPINDLE R8	1
2	K-B134	SPINDLE DIRT SHIELD	1
3	20838	BEARING-ANGULAR CONTACT-U/SET(2)-7207 P4	1 SET
4	K-B136	BEARING SPACER-SMALL	1
5	K-B137	BEARING SPACER-LARGE	1
7	K-B133	NOSE-PIECE	1
8	K-B132	SLEEVE	1
9	K-B131	BEARING-DEEP GROVE-6206ZZ	1
10	K-B130	BEARING LOCKWASHERØ 30	1
11	K-B129	SPINDLE BEARING LOCK NUT- Ø30-20N	1
12	K-B150-1	STRAIGHT LOWER CLAMP	1
13	K-B151	FELT OIL STRAINER	1
14	K-B150-2	STRAINER UPPER CLAMP	1
15	K-B139	SCREW-PH-HD-M5-0.8X8L	2
16	20840	BEARING SPACER SET	1

i00705-K2-K3

Figure 133 Spindle Assembly P/N: 20836

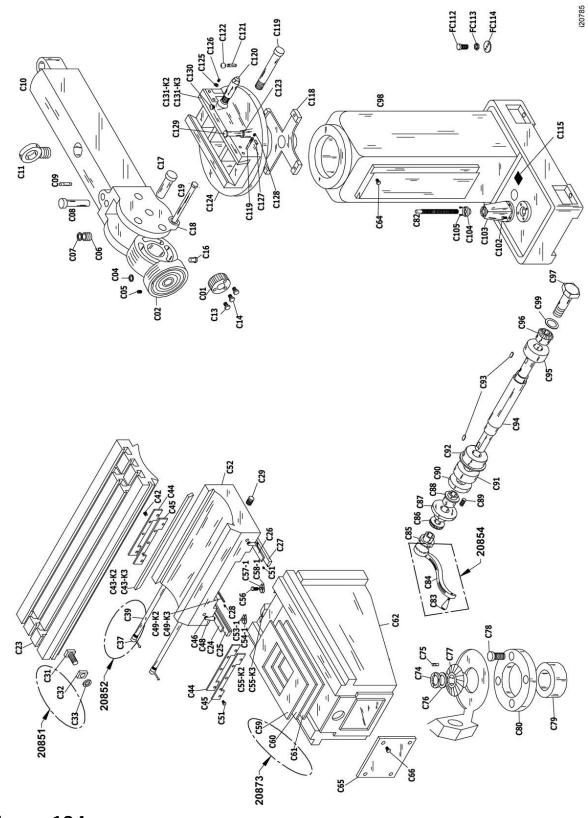


Figure 134 K2/K3 Base Machine P/N 20785 Parts List – K2 & K3 Base Machine (reference only)

ltem	P/N	Title	Comments
1	C01	QUILL HOUSING ADJ.GEAR	
2	C02	RAM ADAPTER	
3	C04	NUT	
4	C06	VERTICAL ADJUSTING WORM	
5	C07	WORM THRUST WASHER(2REQ.)	
6	C08	VERTICAL ADJUSTING WORM SHAFT	
7	C09	WORM KEY	
8	C10	RAM	
9	C13	SOCKET CAP SCREW(2REQ.)	
10	C14	ROLL DOWEL PIN	
11	C15	ANGLE PLATE	
12	C16	ROUND HD DRIVE SCREW(5REQ.)	
13	C17	ADAPTER PIVOT PIN	
14	C18	CHAMFERED & HARDENED WASHER(7REQ.)	
15	C19	ADAPTER LOCKING BOLT(3REQ.)	
16	C23	TABLE 42" OR 48"	
17	C31	STOP PIECE T-BOLT(3REQ.)	Available only in 20851
18	C32	TABLE STOP PIECE(2REQ.)	Available only in 20851
19	C33	HEX NUT(3REQ.)	Available only in 20851
20	C37	TABLE LOCK BOLT HANDLE	Available only in 20852
21	C38	SADDLE LOCK BOLT	
22	C39	SADDLE LOCK PLUNGER	Available only in 20852
23	C40	SOCKET HD CAP SCREW(2REQ.)	
24	C41	GIB ADJUSTING SCREW(3REQ.)	
25	C42	TABLE STOP BRACKET (not shown on drawing)	
26	C43-K2 C43-K3	SADDLE/TABLE GIB	
27	C44	FELT WIPERS(4REQ.)	
28	C46	TABLE LOCK PLUNGER	
29	C47	TABLE LOCK BOLT	
30	C48	TABLE LOCK BOLT HANDLE	
31	C49-K2 C49-K3	SADDLE/KNEE GIB	
32	C50	SADDLE KNEE WIPER PLATE(4REQ.)	
33	C51	OVAL HEAD SCREW(8REQ.)	
34	C53-1	LEFT HAND COLUMN WIPER HOLDER	
35	C52	SADDLE	
36	C54-1	KNEE WIPER FELT	
37	C55-K2 C55-K3	KNEE/COLUMN GIB	
38	C56	ALLEN CAP SCREW(2REQ.)	
39	C57-1	RIGHT HAND COLUMN WIPER HOLDER	
40	C58-1	KNEE WIPER FELT	
41	C59	CHIP GUARDS-UPPER	Available only in 20873
42	C60	CHIP GUARDS-MIDDLE	Available only in 20873
43	C61	CHIP GUARDS-LOWER	Available only in 20873
	C62	KNEE	

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46         C65         KNEE LOCK SHAFT ASSEMBLY           47         C69         KNEE LOCK PLUNGER           48         C71         KNEE BINDER PLUG(PLASTIC)           49         C72         DOG POINT SET SCREW           50         C73         SET SCREW           51         C74         JAM NUT           52         C75         KEY           53         C76         WASHER           54         C77         BEVEL GEAR           55         C79         SEALED BALL BEARING           56         C80         BEARING RETAINER RING           57         C81         SOCKET HEAD CAP SCREW           58         C82         ELEVATING CRANK           61         C85         GEARSHAFT CLUTCH INSERT           62         C84         ELEVATING CRANK           61         C85         GEARSHAFT CLUTCH INSERT           62         C84         DIAL LOCK NUT           63         C87         DIAL LOCK NUT           64         C88         DIAL HOLDER           65         C89         SOCKET HEAD CAP SCREW           66         C90         BEARING CAP           69         C33         KEY				
47         C69         KNEE LOCK PLUNGER           48         C71         KNEE BINDER PLUG(PLASTIC)           49         C72         DCG POINT SET SCREW           50         C73         SET SCREW           51         C74         JAM NUT           52         C75         KEY           53         C76         WASHER           54         C77         BEVEL GEAR           55         C79         SEALED BALL BEARING           56         C80         BEARING RETAINER RING           57         C81         SOCKET HEAD CAP SCREW           58         C82         ELEVATING SCREW ASSEMBLY         Available only in 2085           50         C83         HANDLE         Available only in 2085           60         C84         ELEVATING SCREW ASSEMBLY         Available only in 2085           61         C85         DIAL LOCK NUT         C           62         C86         DIAL HOLDER         Available only in 2085           63         C37         DIAL WITH 100 GRADUATIONS         C           64         C38         DIAL HOLDER         C           65         C89         SOCKET HEAD CAP SCREW         C           70	45	C64	STOP SCREW	
48         C71         KNEE BINDER PLUG(PLASTIC)           49         C72         DOG POINT SET SCREW           50         C73         SET SCREW           51         C74         JAM NUT           52         C75         KEY           53         C76         WASHER           54         C77         BEVEL GEAR           56         C80         BEARING RETAINER RING           57         C81         SOCKET HEAD CAP SCREW           58         C82         ELEVATING SCREW ASSEMBLY         Available only in 2085           59         C83         HANDLE         Available only in 2085           60         C64         ELEVATING CRANK         Available only in 2085           61         C85         GEARSHAFT CLUTCH INSERT         G           62         C86         DIAL HOLD K         Available only in 2085           64         C88         DIAL HOLD R         G           65         C89         SOCKET HEAD CAP SCREW         G           66         C80         BEARING CAP         G           67         C91         GREASE SEALED BEARING         G           68         C92         BEARING CAP         G	46	C65		
49         C72         DOG POINT SET SCREW           50         C73         SET SCREW           51         C74         JAM NUT           52         C75         KEY           53         C76         WASHER           54         C77         BEVEL GEAR           55         C79         SEALED BALL BEARING           56         C79         SEALED BALL BEARING           57         C81         SOCKET HEAD CAP SCREW           58         C82         ELEVATING SCREW ASSEMBLY           Available only in 2085         Available only in 2085           59         C83         HANDLE           61         C64         GEARSHAFT CLUTCH INSERT           62         C86         DIAL HOLDER           64         C89         DIAL HOLDER           65         C69         BEARING RETAINING RING           66         C90         BEARING CAP           67         C91         GREASE SEALED BEARING           68         C92         BEARING CAP           69         C93         KEY           70         C94         ELEVATING SHAFT FOR 12" KNEE           71         C95         GREASE SEALED BEARING				
50         C73         SET SCREW           51         C74         JAM NUT           52         C75         KEY           53         C76         WASHER           54         C77         BEVEL GEAR           55         C79         SEALED BALL BEARING           56         C80         BEARING RETAINER RING           57         C81         SOCKET HEAD CAP SCREW           58         C82         ELEVATINC SCREW ASSEMBLY         Available only in 2085           59         C83         HANDLE         Available only in 2085           60         C84         ELEVATING CRANK         Available only in 2085           61         C85         GEARSHAFT CLUTCH INSERT         GEARSHAFT CLUTCH INSERT           62         C86         DIAL LOCK NUT         GEARSHAFT CLUTCH INSERT           63         C87         DIAL HOLDER         Available only in 2085           64         C88         DIAL HOLDER         GEARSHAFT CLUTCH INSERT           65         C80         BEARING RETAINING RING         GEARS           66         C90         BEARING RETAINING RING         GEARS           67         C91         GREASE SEALED BEARING         GEARS           70<				
51       C74       JAM NUT         52       C75       KEY         53       C76       WASHER         54       C77       BEVEL GEAR         56       C79       SEALED BALL BEARING         56       C79       SECKET HEAD CAP SCREW         58       C82       ELEVATING SCREW ASSEMBLY       Available only in 2085         59       C83       HANDLE       Available only in 2085         60       C84       ELEVATING CRANK       Available only in 2085         61       C85       GEARSHAFT CLUTCH INSERT       Available only in 2085         62       C86       DIAL LOCK NUT       Available only in 2085         63       C87       DIAL HOLDER       Available only in 2085         64       C80       DIAL HOLDER       Available only in 2085         65       C89       SOCKET HEAD CAP SCREW       Gottal         66       C90       BEARING RETAINING RING       Gottal         67       C91       GREASE SEALED BEARING       Gottal         68       C92       BEARING CAP       Gottal       Gottal         69       C93       KEY       MEY       Available only in 2085         71       C96       BE	49	C72	DOG POINT SET SCREW	
52         C75         KEY           53         C76         WASHER           54         C77         BEVEL GEAR           55         C79         SEALED BALL BEARING           56         C80         BEARING RETAINER RING           57         C81         SOCKET HEAD CAP SCREW           58         C82         ELEVATING SCREW ASSEMBLY         Available only in 2085           59         C83         HANDLE         Available only in 2085           60         C84         ELEVATING CRANK         Available only in 2085           61         C85         GEARSHAFT CLUTCH INSERT         6           62         C86         DIAL LOCK NUT         6           63         C87         DIAL WITH 100 GRADUATIONS         6           64         C88         DIAL HOLDER         6           65         C89         SOCKET HEAD CAP SCREW         6           66         C90         BEARING RETAINING RING         6           67         C91         GREASE SEALED BEARING         6           68         C92         BEARING CAP         6           69         C93         KEY         7           70         C94         ELEVATING SH	50	C73	SET SCREW	
53         C76         WASHER           54         C77         BEVEL GEAR           55         C79         SEALED BALL BEARING           56         C80         BEARING RETAINER RING           57         C81         SOCKET HEAD CAP SCREW           58         C82         ELEVATING SCREW ASSEMBLY         Available only in 2085           59         C83         HANDLE         Available only in 2085           60         C84         ELEVATING CRANK         Available only in 2085           61         C85         GEARSHAFT CLUTCH INSERT         Available only in 2085           62         C86         DIAL LOCK NUT         Edited State S	51	C74	JAM NUT	
54         C77         BEVEL GEAR           55         C79         SEALED BALL BEARING           56         C80         BEARING RETAINER RING           57         C81         SOCKET HEAD CAP SCREW           58         C82         ELEVATING SCREW ASSEMBLY         Available only in 2085           60         C83         HANDLE         Available only in 2085           60         C84         ELEVATING CRANK         Available only in 2085           61         C85         GEARSHAFT CLUTCH INSERT         Available only in 2085           62         C86         DIAL WITH 100 GRADUATIONS         Available only in 2085           64         C80         DEAL HOLDER         Available only in 2085           65         C89         SOCKET HEAD CAP SCREW         Available only in 2085           66         C90         BEARING RETAINING RING         BEARING CAP           67         C91         GREASE SEALED BEARING         Available only in 2085           68         C92         BEARING CAP         BeARING CAP           69         C93         KEY         Available CAP           70         C94         ELEVATING SHAFT FOR 12" KNEE         Available COLUMN           72         C96         BEVEL PINI	52	C75	KEY	
55         C79         SEALED BALL BEARING           56         C80         BEARING RETAINER RING           57         C81         SOCKET HEAD CAP SCREW           58         C82         ELEVATING SCREW ASSEMBLY         Available only in 2085           59         C83         HANDLE         Available only in 2085           60         C84         ELEVATING CRANK         Available only in 2085           61         C85         GEARSHAFT CLUTCH INSERT         Available only in 2085           62         C86         DIAL LOCK NUT         C86           63         C87         DIAL WITH 100 GRADUATIONS         C87           64         C88         DIAL HOLDER         C9         BEARING RETAINING RING           65         C89         SOCKET HEAD CAP SCREW         C9         BEARING REAINING RING           66         C90         BEARING REATING REAINING         C9         BEARING REATING REAINING           68         C92         BEARING CAP         E         C9           69         C93         KEY         C9         E           70         C94         ELEVATING SHAFT FOR 12" KNEE         C9         C9           71         C95         GREASE SEALED BEARING         C9	53	C76	WASHER	
56         C80         BEARING RETAINER RING           57         C81         SOCKET HEAD CAP SCREW         Available only in 2085           59         C82         ELEVATING SCREW ASSEMBLY         Available only in 2085           59         C83         HANDLE         Available only in 2085           60         C84         ELEVATING CRANK         Available only in 2085           61         C85         GEARSHAFT CLUTCH INSERT         Available only in 2085           62         C86         DIAL LOCK NUT         DIAL           63         C87         DIAL WITH 100 GRADUATIONS         66           64         C88         DIAL HOLDER         66         C90         BEARING RETAINING RING           66         C90         BEARING CAP         66         C90         BEARING CAP           68         C92         BEARING CAP         66         67         C91         GREASE SEALED BEARING           70         C94         ELEVATING SHAFT FOR 12" KNEE         71         C95         GREASE SEALED BEARING           71         C95         GREASE SEALED BEARING         74         C98         COLUMN         75           72         C96         BEVEL PINION         77         C103         PEDESTAL	54	C77	BEVEL GEAR	
57         C81         SOCKET HEAD CAP SCREW           58         C82         ELEVATING SCREW ASSEMBLY         Available only in 2085           59         C83         HANDLE         Available only in 2085           60         C84         ELEVATING CRANK         Available only in 2085           61         C85         GEARSHAFT CLUTCH INSERT         Image: Comparison of Carbon of Ca	55	C79	SEALED BALL BEARING	
58         C82         ELEVATING SCREW ASSEMBLY         Available only in 2085           59         C83         HANDLE         Available only in 2085           60         C84         ELEVATING CRANK         Available only in 2085           61         C85         GEARSHAFT CLUTCH INSERT         6           62         C86         DIAL LOCK NUT         6           63         C87         DIAL HOLDER         6           64         C88         DIAL HOLDER         6           65         C90         BEARING RETAINING RING         6           66         C90         BEARING CAP         6           68         C92         BEARING CAP         6           68         C92         BEARING SHAFT FOR 12" KNEE         7           70         C94         ELEVATING SHAFT FOR 12" KNEE         7           71         C95         GREASE SEALED BEARING         7           72         C96         BEVEL PINION         7         7           73         C97         SET SCREW         7         7           74         C98         COLUMN         7         7           75         C99         WASHER         7         7	56	C80	BEARING RETAINER RING	
59         C83         HANDLE         Available only in 2085           60         C84         ELEVATING CRANK            61         C85         GEARSHAFT CLUTCH INSERT            62         C86         DIAL LOCK NUT            63         C87         DIAL WITH 100 GRADUATIONS            64         C88         DIAL HOLDER            65         C89         SOCKET HEAD CAP SCREW            66         C90         BEARING RETAINING RING            67         C91         GREASE SEALED BEARING            68         C92         BEARING CAP             69         C93         KEY             70         C94         ELEVATING SHAFT FOR 12" KNEE             71         C95         GREASE SEALED BEARING             72         C96         BEVEL PINION             73         C97         SET SCREW             74         C98         COLUMN             75         C99         WASHER	57	C81	SOCKET HEAD CAP SCREW	
60         C84         ELEVATING CRANK           61         C85         GEARSHAFT CLUTCH INSERT           62         C86         DIAL LOCK NUT           63         C87         DIAL WITH 100 GRADUATIONS           64         C88         DIAL HOLDER           65         C89         SOCKET HEAD CAP SCREW           66         C90         BEARING RETAINING RING           67         C91         GREASE SEALED BEARING           68         C92         BEARING CAP           69         C93         KEY           70         C94         ELEVATING SHAFT FOR 12" KNEE           71         C95         GREASE SEALED BEARING           72         C96         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD <td>58</td> <td>C82</td> <td>ELEVATING SCREW ASSEMBLY</td> <td>Available only in 20854</td>	58	C82	ELEVATING SCREW ASSEMBLY	Available only in 20854
61         C85         GEARSHAFT CLUTCH INSERT           62         C86         DIAL LOCK NUT           63         C87         DIAL WITH 100 GRADUATIONS           64         C88         DIAL HOLDER           65         C89         SOCKET HEAD CAP SCREW           66         C30         BEARING RETAINING RING           67         C91         GREASE SEALED BEARING           68         C92         BEARING CAP           69         C33         KEY           70         C94         ELEVATING SHAFT FOR 12" KNEE           71         C95         GREASE SEALED BEARING           72         C36         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION	59	C83	HANDLE	Available only in 20854
62         C86         DIAL LOCK NUT           63         C87         DIAL WITH 100 GRADUATIONS           64         C88         DIAL HOLDER           65         C89         SOCKET HEAD CAP SCREW           66         C90         BEARING RETAINING RING           67         C31         GREASE SEALED BEARING           68         C92         BEARING CAP           69         C93         KEY           70         C34         ELEVATING SHAFT FOR 12" KNEE           71         C95         GREASE SEALED BEARING           72         C96         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE </td <td>60</td> <td>C84</td> <td>ELEVATING CRANK</td> <td></td>	60	C84	ELEVATING CRANK	
63         C87         DIAL WITH 100 GRADUATIONS           64         C88         DIAL HOLDER           65         C89         SOCKET HEAD CAP SCREW           66         C90         BEARING RETAINING RING           67         C91         GREASE SEALED BEARING           68         C92         BEARING CAP           69         C93         KEY           70         C94         ELEVATING SHAFT FOR 12' KNEE           71         C95         GREASE SEALED BEARING           72         C96         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION           84         C122         PLASTIC BALL	61	C85	GEARSHAFT CLUTCH INSERT	
64         C88         DIAL HOLDER           65         C89         SOCKET HEAD CAP SCREW           66         C90         BEARING RETAINING RING           67         C91         GREASE SEALED BEARING           68         C92         BEARING CAP           69         C93         KEY           70         C94         ELEVATING SHAFT FOR 12" KNEE           71         C95         GREASE SEALED BEARING           72         C96         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER	62	C86	DIAL LOCK NUT	
65         C89         SOCKET HEAD CAP SCREW           66         C90         BEARING RETAINING RING           67         C91         GREASE SEALED BEARING           68         C92         BEARING CAP           69         C93         KEY           70         C94         ELEVATING SHAFT FOR 12" KNEE           71         C95         GREASE SEALED BEARING           72         C96         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET	63	C87	DIAL WITH 100 GRADUATIONS	
66         C90         BEARING RETAINING RING           67         C91         GREASE SEALED BEARING           68         C92         BEARING CAP           69         C93         KEY           70         C94         ELEVATING SHAFT FOR 12" KNEE           71         C95         GREASE SEALED BEARING           72         C96         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT <t< td=""><td>64</td><td>C88</td><td>DIAL HOLDER</td><td></td></t<>	64	C88	DIAL HOLDER	
67         C91         GREASE SEALED BEARING           68         C92         BEARING CAP           69         C93         KEY           70         C94         ELEVATING SHAFT FOR 12" KNEE           71         C95         GREASE SEALED BEARING           72         C96         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           <	65	C89	SOCKET HEAD CAP SCREW	
68         C92         BEARING CAP           69         C93         KEY           70         C94         ELEVATING SHAFT FOR 12" KNEE           71         C95         GREASE SEALED BEARING           72         C96         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90	66	C90	BEARING RETAINING RING	
69         C93         KEY           70         C94         ELEVATING SHAFT FOR 12" KNEE           71         C95         GREASE SEALED BEARING           72         C96         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129<	67	C91	GREASE SEALED BEARING	
70         C94         ELEVATING SHAFT FOR 12" KNEE           71         C95         GREASE SEALED BEARING           72         C96         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	68	C92	BEARING CAP	
71         C95         GREASE SEALED BEARING           72         C96         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	69	C93	KEY	
72         C96         BEVEL PINION           73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	70	C94	ELEVATING SHAFT FOR 12" KNEE	
73         C97         SET SCREW           74         C98         COLUMN           75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	71	C95	GREASE SEALED BEARING	
74       C98       COLUMN         75       C99       WASHER         76       C102       SOCKET HEAD CAP SCREW         77       C103       PEDESTAL         78       C104       ELEVATING SCREW NUT         79       C105       SOCKET HEAD CAP SCREW         80       C118       SPIDER         81       C119       RAM LOCK STUD         82       C120       RAM PINION         83       C121       RAM PINION HANDLE         84       C122       PLASTIC BALL         85       C123       CHAMFERED HARDENED WASHER         86       C124       TURRET         87       C125       GIB SCREW NUT         88       C126       GIB SCREW         89       C127       LOCK BAR         90       C128       SCREW         91       C129       LOCKING BOLT	72	C96	BEVEL PINION	
75         C99         WASHER           76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	73	C97	SET SCREW	
76         C102         SOCKET HEAD CAP SCREW           77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	74	C98	COLUMN	
77         C103         PEDESTAL           78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	75	C99	WASHER	
78         C104         ELEVATING SCREW NUT           79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	76	C102	SOCKET HEAD CAP SCREW	
79         C105         SOCKET HEAD CAP SCREW           80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	77	C103	PEDESTAL	
80         C118         SPIDER           81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	78	C104	ELEVATING SCREW NUT	
81         C119         RAM LOCK STUD           82         C120         RAM PINION           83         C121         RAM PINION HANDLE           84         C122         PLASTIC BALL           85         C123         CHAMFERED HARDENED WASHER           86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	79	C105	SOCKET HEAD CAP SCREW	
82C120RAM PINION83C121RAM PINION HANDLE84C122PLASTIC BALL85C123CHAMFERED HARDENED WASHER86C124TURRET87C125GIB SCREW NUT88C126GIB SCREW89C127LOCK BAR90C128SCREW91C129LOCKING BOLT	80	C118	SPIDER	
83C121RAM PINION HANDLE84C122PLASTIC BALL85C123CHAMFERED HARDENED WASHER86C124TURRET87C125GIB SCREW NUT88C126GIB SCREW89C127LOCK BAR90C128SCREW91C129LOCKING BOLT	81	C119	RAM LOCK STUD	
84C122PLASTIC BALL85C123CHAMFERED HARDENED WASHER86C124TURRET87C125GIB SCREW NUT88C126GIB SCREW89C127LOCK BAR90C128SCREW91C129LOCKING BOLT	82	C120	RAM PINION	
85C123CHAMFERED HARDENED WASHER86C124TURRET87C125GIB SCREW NUT88C126GIB SCREW89C127LOCK BAR90C128SCREW91C129LOCKING BOLT	83	C121	RAM PINION HANDLE	
86         C124         TURRET           87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	84	C122	PLASTIC BALL	
87         C125         GIB SCREW NUT           88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	85	C123	CHAMFERED HARDENED WASHER	
88         C126         GIB SCREW           89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	86	C124	TURRET	
89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	87	C125	GIB SCREW NUT	
89         C127         LOCK BAR           90         C128         SCREW           91         C129         LOCKING BOLT	88		GIB SCREW	
90         C128         SCREW           91         C129         LOCKING BOLT	89		LOCK BAR	
91 C129 LOCKING BOLT				
	92	C130	RAM PINION SCREW	

93	C131-K2 C131-K3	RAM/TURRET GIB	
94	20851	STOP PIECE T-BOLT ASSY	
95	20852	TABLE LOCK HANDLE	
96	20853	KNEE LOCK HANDLE & SHAFT	
97	20854	KNEE CRANK HANDLE ASSY	
98	20873	CHIP GUARD SET K2/K3	
99	FC112	LEVELING SCREW	
100	FC113	LEVELING NUT	
101	FC114	LEVELING PAD	

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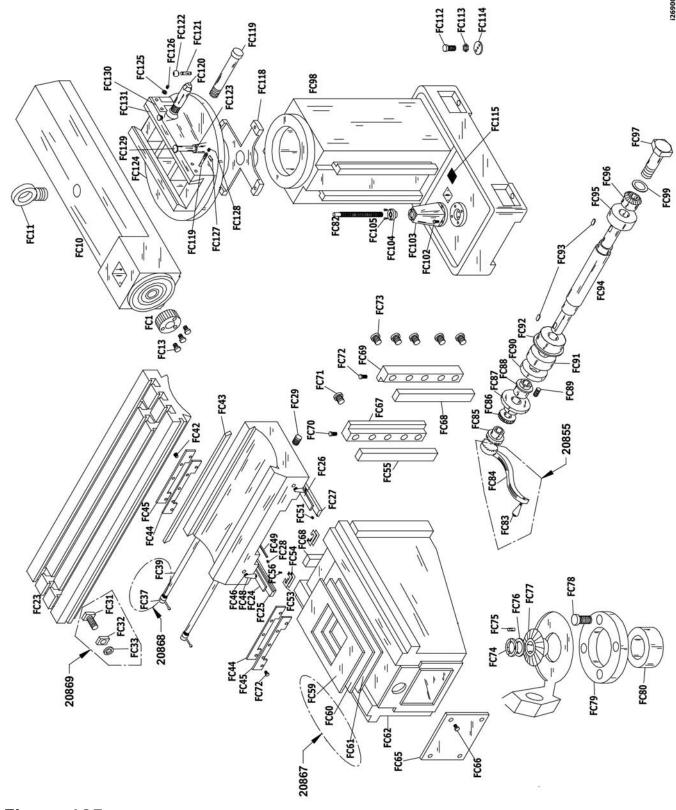


Figure 135 K4 Base Machine P/N 26900

Turts			
Item	P/N	Title	Comments
1	FC1	QUILL HOUSING GEAR	
2	FC10	RAM	
3	FC11	LIFTING EYE BOLT	
4	FC23	TABLE 50"	
5	FC24	SADDLE BOTTOM GIB	
6	FC25	GIB BLOCK	
7	FC26	GIB	
8		GIB BLOCK	
9	FC28	SET SCREW	
10		SET SCREW	
11		STOP PIECE T-BOLT	Available only in 20869
12		TABLE STOP PIECE	Available only in 20869
13		HEX NUT	Available only in 20869
14		TABLE LOCK HANDLE	Available only in 20868
15		SADDLE LOCK PLUNGER	Available only in 20868
16		TABLE STOP BRACKET (not shown on dwg)	
17		SADDLE/TABLE GIB	
18		SADDLE CHIP WIPER	
19		SADDLE CHIP WIPER PLATE	
20		TABLE LOCK PLUNGER	
21		TABLE LOCK BOLT HANDLE	
22		SADDLE GIB	
23		CAP SCREW	
24		SADDLE	
25		LEFT HAND COLUMN WIPER HOLDER	
26		KNEE WIPER FELT	
27		KNEE/COLUMN GIB	
28		ALLEN CAP SCREW	
29		RIGHT HAN COLUMN WIPER HOLDER	
30			
31		CHIP GUARDS - UPPER	Available only in 20867
32		CHIP GUARDS - MIDDLE	Available only in 20867
33			Available only in 20867
34			
35			
36			
37			
38			
39			
40			
41			
42			
43			
44			
45	FC75		
46		WASHER	
47	FC77	BEVEL GEAR	

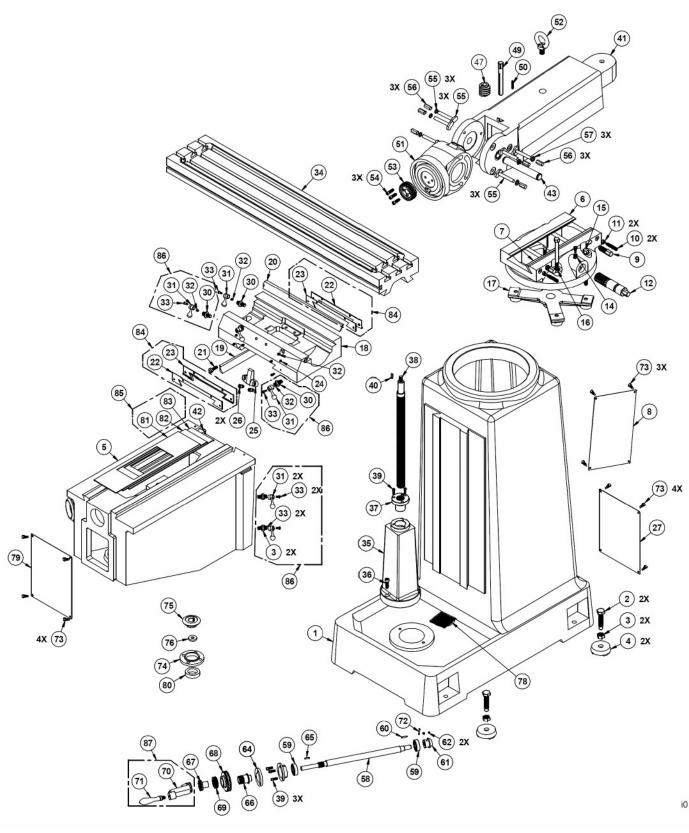
Parts List - K4 Base Machine

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ProtoTRAK KEMX Retrofit Safety, Installation, Maintenance, Service & Parts List Manual

40	FC70	SCDEW/	
48			
49		SEALED BALL BEARING	
50			
51		ELEVATING SCREW ASSY	
52		HANDLE	Available only in 20855
53		GEARSHAFT CLUTCH INSERT	
54		DIAL LOCK NUT	
55		DIAL WITH GRADUATIONS	
56		DIAL HOLDER	
57		SOCKET HEAD CAP SCREW	
58	FC90	BEARING RETAINING RING	
59	FC91	GREASE SEALED BEARING	
60	FC92	BEARING CAP	
61	FC93	KEY	
62	FC94	ELAVATING SHAFT	
63	FC95	GREASE SEALED BEARING	
64	FC96	BEVEL PINION	
65	FC97	SET SCREW	
66	FC98	COLUMN & BASE- K4	
67	FC102	SOCKET HEAD CAP SCREW	
68	FC103	PEDESTAL	
69	FC104	ELEVATING SCREW NUT	
70	FC105	SOCKET HEAD CAP SCREW	
71	FC112	CAP SCREW	
72	FC113	NUT	
73	FC114	MACHINE MAT	
74	FC115	OIL FILTER	
75	FC118	SPIDER	
76	FC119	RAM LOCK STUD	
77	FC120	RAM PINION	
78	FC121	RAM PINION HANDLE	
79	FC122	PLASTIC BALL	
80	FC123	CHABERED HARDENED WASHER	
81		TURRET	
82		GIB SCREW NUT	
83		GIB SCREW	
84		LOCK BAR	
85		SCREW	
86		LOCKING BOLT	
87		RAM PINION SCREW	
88		RAM/TURRET GIB	
89		FRU-SK4-KNEE CRANK HANDLE ASSY	
90		FRU-SK4-CHIP COVER ASSY	
91		FRU-SK4-HANDLE & BAR LOCK ASSY	
92		FRU-SK4 FC31,FC32,FC333	
			i20699

i20699



## Figure 136 Base Machine - KE

i01305

# Parts List - KE Base Machine

#	P/N	DESCRIPTION	QTY	_ #	P/N	DESCRIPTION	QTY
1	CC001	Column	1	47	CC047	worm - vertical adjusting	1
2	CC002	screw - set	4	49	CC049	worm-shaft-vertical adjusting	1
3	CC003	Nut	4	50	CC050	Key	1
4	CC004	pad - machine	4	51	CC051	Adapter - ram	1
5	CC005	Knee	1	52	CC052	bolt - lifting eye	1
6	CC006	Turret	1	53	CC053	Gear - quill housing adjusting	1
7	CC007	Gib - ram/turret	1	54	CC054	Socket cap screw	3
8	CC008	plate - filter	1	55	CC055	screw - T	6
9	CC009	screw - gib adjusting	1	56	CC056	screw - cap - T	6
10	CC010	screw - gib	2	57	CC057	Washer	6
11	CC011	nut - gib screw	2	58	CC058	Shaft - elevating knee shaft	1
12	CC012	pinion - ram	1	59	CC059	Bearing	2
13	CC013	screw - ram pinion	1	60	CC060	Key	1
14	CC014	Washer	2	61	FC96	pinion - bevel	1
15	CC015	bolt - locking	4	62	2 CC062	Screw	2
16	CC016	washer - screw	1	63	CC063	cap - bearing	1
17	CC017	Spider	1	64	CC064	ring - bearing retaining	1
18	CC018	Saddle	1	65	CC065	Key	1
19	CC019	gib - saddle	1	66	FC88	Dial holder	1
20	CC020	gib - table	1	67	FC85	shaft - gear - clutch insert	1
21	CC021	screw - oval head	1	68	FC86	Dial - 100 graduation	1
22	CC022	wiper - iron felt	2	69	CC069	nut - dial lock	1
23	CC023	wiper - rubber felt	2	70	CC070	crank - elevating	1
24	CC024	Screw	1	71	CC071	Handle	1
25	CC025	bracket - table stop	1	72	CC072	Pin	1
26	CC026	Screw	2	73	CC073	screw - socket cap	12
27	CC027	plate - column	1	74	CC074	ring - bearing retainer	1
30	CC030	Bolt - table lock	6	75	FC77	gear - bevel	1
31	CC031	Handle - table lock bolt	6	76	CC076	nut - jam	1
32	CC032	Spring	6	78	CC078	net - oil	1
33	CC033	screw - cap	6	79	CC079	cover - knee	1
34	CC034	Table	1	80	CC080	bearing - ball	1
35	CC035	Pedestal	1	81	CC081	Chip guard - upper	1
36	CC036	screw - socket head cap	2	82	CC082	Chip guard - middle	1
37	CC037	nut - elevating screw	1	83	CC083	Chip guard - lower	1
38	CC038	screw assembly - elevating	1	84	24962	wiper set - chip	1
39	CC039	screw - cap	3	85	24973	chip guard set	1
40	CC040	Кеу	1	86	24963	lock - gib	4
41	CC041	Ram	1	87	24974	crank - knee	1
42	CC042	gib - knee	1				

# Southwestern Industries, Inc TRAK Warranty Policy

# Warranty

TRAK products are warranted to the original purchaser to be free from defects in work-manship and materials for the following periods:

Product	Warranty Period				
FIUUUCI	Materials	Factory Labor			
New TRAK	1 Year	1 Year			
Any EXCHANGE Unit	90 Days	90 Days			

The warranty period starts on the date of the invoice to the original purchaser from Southwestern Industries, Inc. (SWI) or their authorized distributor.

If a unit under warranty fails, it will be repaired or exchanged at our option for a properly functioning unit in similar or better condition. Such repairs or exchanges will be made FOB Factory/Los Angeles or the location of our nearest factory representative or authorized distributor.

#### **Disclaimers of Warranties**

- This warranty is expressly in lieu of any other warranties, express or implied, including any implied warranty of merchantability or fitness for a particular purpose, and of any other obligations or liability on the part of SWI (or any producing entity, if different).
- Warranty repairs/exchanges do not cover incidental costs such as installation, labor, freight, etc.
- SWI is not responsible for consequential damages from use or misuse of any of its products.
- TRAK products are precision mechanical/electromechanical measurement systems and must be given the reasonable care that these types of instruments require:
- Replacement of chip scrapers and wipers is the responsibility of the customer. Consequently, the warranty does not apply if chips have been allowed to enter the mechanism.
- Accidental damage, beyond the control of SWI, is not covered by the warranty. Thus, the warranty does not apply if an instrument has been abused, dropped, hit, disassembled or opened.
- Improper installation by or at the direction of the customer in such a way that the product consequently fails, is considered to be beyond the control of the manufacturer and outside the scope of the warranty.