BRIDGEPORT
SERIES I EZTRAK

INSTALLATION, MAINTENANCE, AND PARTS BREAKDOWN MANUAL

Code No. 1104-2900

April 2000
Rev. E

IMPORTANT

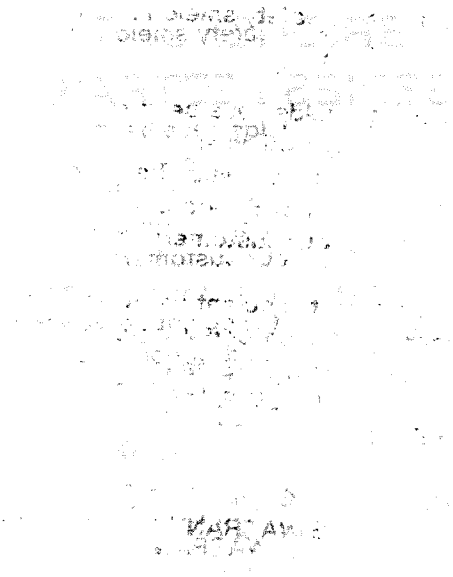
Before operation of this machine, the operator must read and complete the Operators Safety Test shipped with each machine.
Operator Safety Manual code no. 11041128.

IMPORTANT

Bridgeport Machines, Inc. does not guarentee any interchange of Bridgeport parts or accessories on any other than Bridgeport Machines, i.e. any interchange of Bridgeport look alike.

Changes from last issue:

- *Revised electrical information and drawings reflect new electrical cabinet and components.*
- *Chapter 6, Axis Drives, describes new Axis Motion Control.*



IMPORTANT SAFETY NOTICE

Bridgeport Machines Inc. supplies a safety shield for protection from chips and coolant with every machine we ship.

The Bridgeport chip and coolant shields have been designed with the highest clear impact materials commercially available: LEXAN (Polycarbonate) and KODAR PETG (Copolyester 6763). These shields have an impact strength 5 to 10 times greater than acrylic (plexiglass) or Butyrate (UVEX) materials, thereby offering the greatest protection for our customers.

Some of the new "easy to dispose of" coolant and/or cutting oils may contain chemicals harmful to Polycarbonate and Copolyester 6763. These chemicals are: Mono-Ethanolamine, Di-Ethanolamine, Tri-Ethanolamine and the combination thereof. OVER TIME, THESE CHEMICALS MAY SIGNIFICANTLY REDUCE THE IMPACT STRENGTH OF THE SHIELD.

USE OF COOLANTS AND/OR CUTTING OILS CONTAINING THESE CHEMICALS WILL VOID THE WARRANTY ON YOUR BRIDGEPORT SHIELD.

IMPORTANT SAFETY NOTICE
WARNING

It is the user's responsibility to be acquainted with the legal obligations and requirements in the use and application of the machine particularly as discussed in the American National Standards Institute Standard Entitled Safety Requirements for the Construction, Care, and Use of Drilling, Milling, and Boring Machines.

The Bridgeport Milling Machine

SAFEGUARD INSTALLATION

The Bridgeport Milling Machine is fitted with a chip and coolant shield spindle guard as standard. In certain cases and tooling applications additional guarding may have to be provided by the user.

The guards are made with clear plastic having high impact resistance to provide operator safety and a clear, unobstructed view of the operations in progress. The opening of any guard door provides access to potential hazard areas. Opening the guard doors will not stop the spindle. Extreme care must therefore be used at all times.

SOFTWARE

Any unauthorized changing of control parameters is not permitted. Bridgeport Machines will not accept any liability whatsoever for the alteration of any set parameters to those programmed at installation.

AUTHORIZED PERSONNEL AND TRAINING

Operating, service and maintenance engineers shall be authorized by the 'User Company' and properly trained in the use of the machine.

SAFE WORKING PRACTICES

Workholding devices, cranes, tooling and their use shall be the responsibility of the user. It is the user's reponsibility to protect against the hazards caused by chips, leaking oil or coolant and their use.

Use of proprietory oil or coolant is the reponsibility of the user. Special instructions from the suppliers concerning their use should be carefully read and understood before use.
To prevent bodily injury, safe working practices should be employed when operating or servicing the machine.

IMPORTANT

SAFETY INFORMATION

To prevent bodily injury, you should observe the following basic safety precautions when installing, operating or servicing you Bridgeport milling machine.

1. Follow all instructions in the manual.
2. Wear approved industrial safety glasses and safety shoes.
3. **DO NOT** wear gloves, long sleeves, long hair, rings, watches, jewelry or other items that could become caught in moving parts.
4. Keep all parts of your body away from moving parts (belts, cutters, gears, etc.).
5. Use proper point of operation safeguarding.

These and other safety precautions are discussed in the American National Standards Institute Standard entitled *Safety Requirements for the Construction, Care, and Use of Drilling, Milling, and Boring Machines* (ANSI B11.8-1983).

This publication is available from: The American National Standards Institute
1430 Broadway
New York, NY 10018

Safeguarding for protection at the point of operation can only be designed and constructed when the parameters of the particular operation have been determined. As a result, ANSI B11.8-1983, Section 5.1, states that *"it shall be the responsibility of the employer to provide, and ensure the use of, a guard, guarding device, awareness barrier, awareness device, or shield..."*

To assist machine users in designing point of operation safeguarding for their specific machine applications the Occupational Safety and Health Administration has published a booklet entitled *Concepts and Techniques of Machine Safeguarding* (O.S.H.A. Publication Number 3067).

This publication is available from: The Publication Office - O.S.H.A.
U.S. Department of Labor
200 Constitution Avenue, NW

The general purpose point of operation shield provided with this machine may not be appropriate and cannot be utilized for all possible applications of the machine. Use additional or alternate safeguarding where this shield is not appropriate or cannot be utilized. Note that for purposes of display, the shield has been removed in certain illustrations in this manual.

BRIDGEPORT SAFETY LIST
ALL COUNTRIES

1. **DON'T** run your machine until you have read and understood the Bridgeport Operator and Maintenance manuals.
2. **DON'T** run your machine until you have read and understood all machine and control key signs.
3. **DON'T** run your machine for the first time without a qualified instructor. **ASK** your supervisor for help when you need it.
4. **PROTECT** your eyes. Wear safety glasses with side shields at all times.
5. **DON'T** get caught in moving parts. Remove watches, rings, jewelry, neck-ties, and loose-fitting clothes.
6. **PROTECT** your head. Wear a safety helmet when working near overhead hazards.
7. **KEEP** your hair away from moving parts.
8. **PROTECT** your feet. Always wear safety shoes with steel toes and oil-resistant soles.
9. Gloves are easily caught in moving parts. **TAKE THEM OFF** before you turn on the machine.
10. **REMOVE** all loose items (wrenches, chuck keys, rags, etc.) from machine before starting. Loose objects can become flying particles.
11. **NEVER** operate a machine tool after taking strong medication, using non-prescription drugs or consuming alcoholic beverages.
12. **SAFEGUARD** the cutting zone ("point of operation"). Use standard, general purpose safeguard where possible. Use special safeguards when required.
13. Protect your hands. **STOP** the spindle completely **BEFORE** changing tools.
14. Protect your hands. **STOP** the spindle completely **BEFORE** you load or unload a workpiece.
15. Protect your hands. **STOP** the spindle completely **BEFORE** you clear away chips or oil. Use brush or chip scraper. **NEVER** use you hands.
16. Protect your hands. **STOP** the spindle completely **BEFORE** you adjust the workpiece, fixture, or coolant nozzle.
17. Protect your hands. **STOP** the spindle completely **BEFORE** you take measurements.
18. Protect your hands. **STOP** the spindle completely **BEFORE** you open safeguard or covers.
19. Never reach around a safeguard.
20. Protect your hands. **STOP** the machine **BEFORE** you change or adjust belts, pulleys or gears.
21. **PROTECT** your hands. Keep hands and arms clear of spindle start switch when changing tools.
22. **PROTECT** your eyes and the machine. **NEVER USE A COMPRESSED AIR HOSE TO REMOVE CHIPS.**
23. **KEEP** work area well-lighted. Ask for additional light if needed.
24. **DON'T** slip. Keep your work area clean and dry. Remove chips, oil and obstacles.
25. **NEVER** lean on your machine. Stand away when the machine is running.
26. **DON'T** get trapped. Avoid pinch points caused by motion of table and head.
27. **PREVENT** objects from flying loose. Securely clamp and locate workpiece. Use stop blocks where necessary. **KEEP** clamps clear of cutter path.

28. **PREVENT** cutter breakage. Use correct table feed and spindle speed for the job. Reduce feed and speed if you notice unusual noise or vibration.
29. **PREVENT** cutter breakage. Rotate spindle in clockwise direction for right-hand tools, counterclockwise for left-hand tools. Use the correct tool for the job.
30. **PREVENT** workpiece and cutter damage. Never start the machine when the cutter is in contact with the workpiece.
31. **KEEP** tools sharp. Dull and damaged tools break easily. Inspect tools and tool holders. Keep tool overhang short.
32. Keep rotating cranks and handwheels well-lubricated and maintained. Do not remove safety springs.
33. Certain materials, such as magnesium, are highly flammable in dust and chip form. See your supervisor before working with these materials.
34. **PREVENT** fire. Keep flammable liquids and materials away from work area and hot chips.
35. **PREVENT** machine table from moving unexpectedly. Disengage power feed when not being used (manual machines only).
36. **PREVENT** machine from moving unexpectedly. Always start machine in manual mode.

WARNING

ANY UNAUTHORIZED CHANGING OF CONTROL PARAMETERS IS NOT PERMITTED. BRIDGEPORT MACHINES WILL NOT ACCEPT ANY LIABILITY WHATSOEVER FOR THE ALTERATION OF ANY SET PARAMETERS TO THOSE PROGRAMMED AT INSTALLATION.

DANGER

Danger notices are used in this publication to emphasize that lethal electrical voltages are present which could cause serious personal injury or death.

WARNING

Warning notices are used in this publication to emphasize that hazardous mechanical conditions, voltages, currents, or temperatures exist in this equipment which could cause serious personal injury and/or damage to the equipment.

CAUTION

Caution notices are used where equipment might be damaged if care is not taken.
In situations where inattention could cause either personal injury or damage to the equipment, a WARNING notice is used.

NOTE

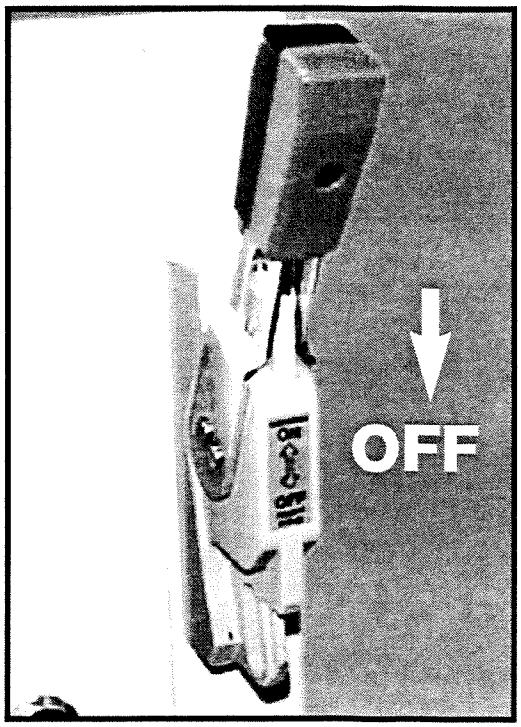
Notes merely call attention to information that is especially significant in understanding and operating the equipment.

IMPORTANT NOTICE

DO NOT ATTEMPT DISASSEMBLY OR REMOVAL OF MAJOR COMPONENTS WITHOUT FIRST CONTACTING THE BRIDGEPORT MACHINES SERVICE DEPARTMENT FOR PROPER PROCEDURES.

This document is intended for the use of those who install, operate, and maintain the Bridgeport Milling Machine. Although reasonable care has been exercised in the preparation of this manual to make it complete and accurate, this manual does not purport to cover all conceivable problems or applications pertaining to this machine.

ATTENTION
IMPORTANT SAFETY NOTICE



MAIN CIRCUIT BREAKER

DANGER

HIGH VOLTAGE is present in equipment control cabinet.

DO NOT SERVICE this cabinet before switching MAIN CIRCUIT BREAKER to OFF POSITION and DISCONNECTING POWER at bus source.

Table of Contents

Chapter | Page

Chapter Page

Chapter 1. Introduction

1.1 PURPOSE AND SCOPE

This manual contains the information needed to install, maintain, troubleshoot, and repair the Series I EZTRAK Milling, Drilling, and Boring machine. The information presented covers all tasks and levels of skills needed for the maintenance of a computer-controlled milling machine, including theory of operation, preventive maintenance, troubleshooting, adjustments, and parts replacement. Attendance at Bridgeport Service Training Schools is strongly recommended.

1.2 ORGANIZATION OF MATERIAL

This manual has been divided into the following chapters to make information easy to find:

Chapter 2: Specifications
Lists features of the EZTRAK Milling Machine.

Chapter 3: Installation
Provides information on lifting, foundation preparation, lubrication, and initial setting of machine.

Chapters 4, 5, and 6: Systems
Provides a description of the control and its theory of operation. Chapter 4 covers Power Distribution, Chapter 5 covers Logic Boards, and Chapter 6 covers Drive System. This is done so that all Maintenance personnel can fully understand the information needed for their level of maintenance.

Chapters 7, 9, and 10: Maintenance
Chapter 7 covers Preventative Maintenance for the complete system, Chapter 9 covers adjustments and parts replacements for the milling machine, and Chapter 10 covers procedures for troubleshooting and testing the control system.

Chapter 8: Manual Controls
Provides descriptions of all controls and their operations.

Chapter 11: Auxiliaries
Details the auxiliary systems used on the machine.

Chapter 12: Optional Equipment
Covers optional equipment available for the machine. Included are descriptions and installation instructions.

Chapter 13: Third Axis Option
Covers the option which automates the Z-Axis.

Chapter 14: Parts Breakdown
Lists part numbers for the machine and equipment.

Appendix A: Static Sensitive Materials
Contains information on the safe handling of static-sensitive materials.

Appendix B: Safeguard
Covers the General Purpose Safeguard Installation.

1.3 REFERENCE MANUALS

Other manuals that deal with the EZTRAK Milling Machine:

Code No. 1104-6148 — Programming Manual
Code No. 1104-2740 — 3rd Axis Operator's Manual

Chapter 2. Specifications

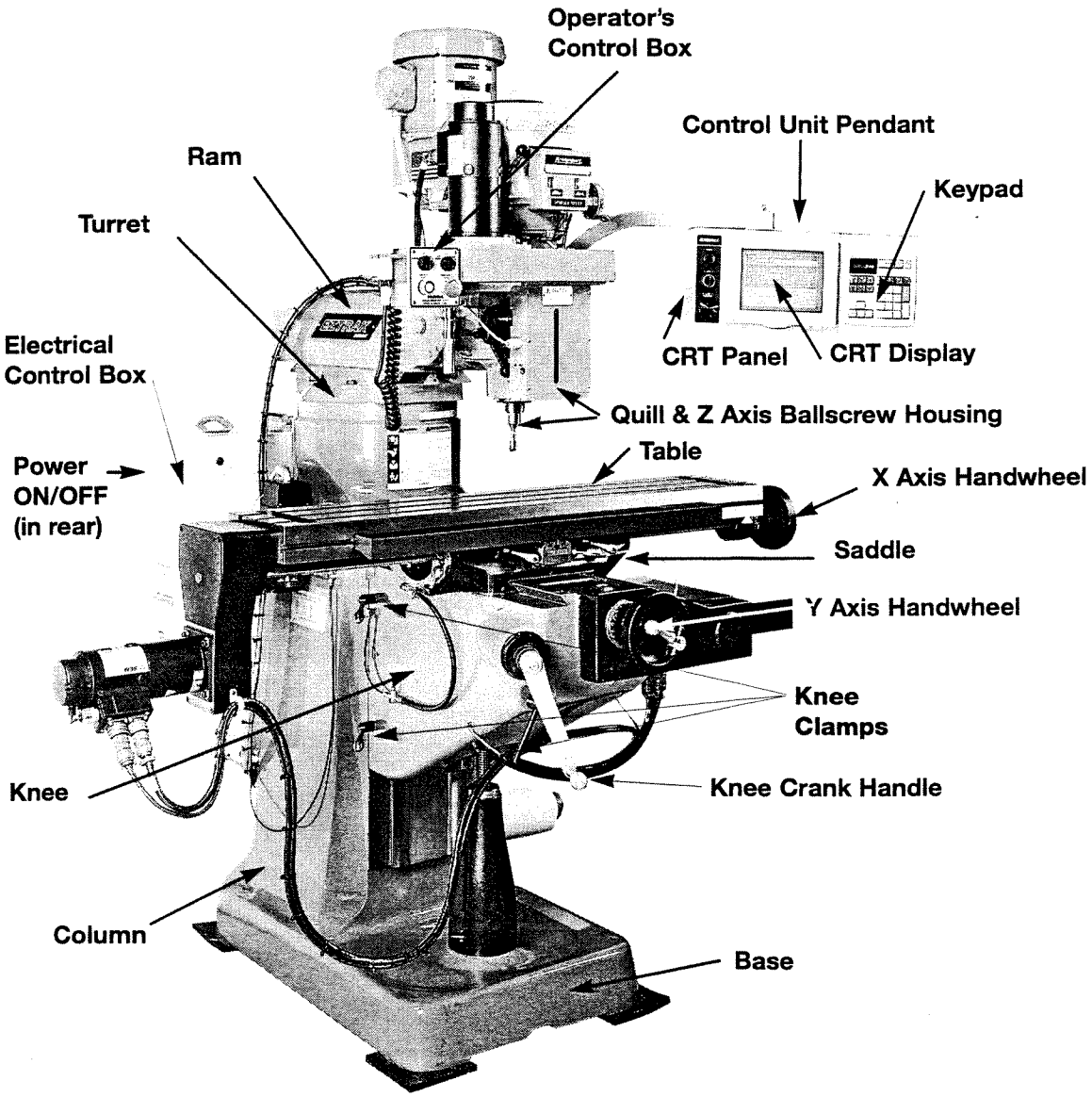


Figure 2-1. Basic components of a 3-Axis EZTRAK Milling Machine

EZTRAK®

2.1 SERIES I SPECIFICATIONS

Range

Table travel (X-axis)	30 in. (762 mm)
Saddle travel (Y-axis)	12 in. (305 mm)
Quill travel	5 in. (127 mm)
Quill travel w/3rd axis	4.5 in. (114 mm)
Knee travel* (Z-axis)	16 in. (406 mm)
Ram travel	12 in. (305 mm)
Throat distance (min.)	6.75 in. (171 mm)
Throat distance (max.)	18.75 in. (476 mm)
Table to spindle nose gage line (min.)	2.5 in. (64 mm)
Table to spindle nose gage line (max.)	18.25 in. (463 mm)

Table

Overall size	48 x 9 in. (1219 x 229 mm)
Working surface	48 x 9 in. (1219 x 229 mm)
Height above floor (max.)	47.4 in. (1204 mm)
Maximum uniform load	300 lbs. (136 kg)
T-slots	3 @ 2.5 in. (64 mm) centers
T-slot size	.625 in. (16 mm)

Space and Weight

Floor area (door open)	8.2 x 7.3 ft. (2.5 x 2.2 m)
Floor area (door closed)	8.2 x 5.3 ft. (2.5 x 1.6 m)
Height	6.8 ft. (2.1 m)
Net weight	2340 lbs. (1061 kg)
Shipping weight	2900 lbs. (1315 kg)

Spindle

AC spindle motor rating (continuous)	2 hp (1.5 kw)
Power rating	3 hp (2.2 kw)
(Duty cycle)	30 min. duty rated
Spindle speed Hi	500 – 4200 rpm
Spindle speed Low	60 – 500 rpm
Spindle diameter	1.875 in. (48 mm)
Quill diameter	3.375 in. (86 mm)
Standard Spindle Taper	
Spindle taper	R-8
Tooling	R-8 collets
Optional Spindle Taper	
Spindle Taper	#30 ISO
Tool Holder	Erickson Quickchange #30 ISO
Spindle Taper	#200 Universal
Tool Holder	Universal #200 Kwik switch

Ballscrews

Diameter	1.25 in. (32 mm)
Pitch	0.200 in. (5.08 mm)

Positioning

Auto (X,Y)	100 ipm	(2540 mm/min.)
Manual (X,Y)	100 ipm	(2540 mm/min.)
Feedrate range (X,Y)	0.1 – 100 ipm	(2 – 2540 mm/min.)
Minimum increment	0.0001 in.	(0.003 mm)

Machine and Control Performance

Positioning accuracy	± 0.001 in.	(0.025 mm) over saddle
Positioning repeatability	± 0.0008 in.	(0.02 mm) over saddle
Input resolution	0.0001 in.	(0.003 mm)
Servo resolution	0.0001 in.	(0.003 mm)
Display resolution	0.0001 in.	(0.003 mm)

BPC2M PC Control system manufactured by Bridgeport Machines

Full 3-axis DRO

Simultaneous 2-axis linear or 2-axis circular interpolation

9-inch monochrome conversational display

Absolute and incremental programming

Automatic corner rounding

Mathematical help modes

Powerful canned cycles for machining arcs, diagonals, circles, bolt hole patterns, pocket milling and more

Cutter diameter compensation

English/metric conversion

1000 block program storage

Disk storage: (standard) 3.5 in. diskette, HD 1.44 Mb (12,000 ft.)

8MB PC Flashdisk

Maintenance, diagnostic and program error message display

Part program loading: RS-232 bi-directional communication link

Input/Output: 1 RS-232 serial port

Maintenance: Diagnostic routines embedded in system

Power

Input power: 208/230/460 volts 3 phase, 50/60 cycles

Power capacity: 4kVA

Standard Features

Automatic centralized lubrication system

Chrome plated ways

Electrics: NFPA/NEMA-12 Standards, UL Listed.

Color: Machine Tool Gray

Optional Features

3rd Axis Control

Mist or flood coolant system

4 or 7 inch Riser block

Universal communication software

Power drawbar for R-8 or 30 QC Spindle

NOTE: Specifications Subject to Change Without Notice.

* Knee Travel Reduced by 1" with Flood Coolant.

2.2 PRINCIPAL DIMENSIONS

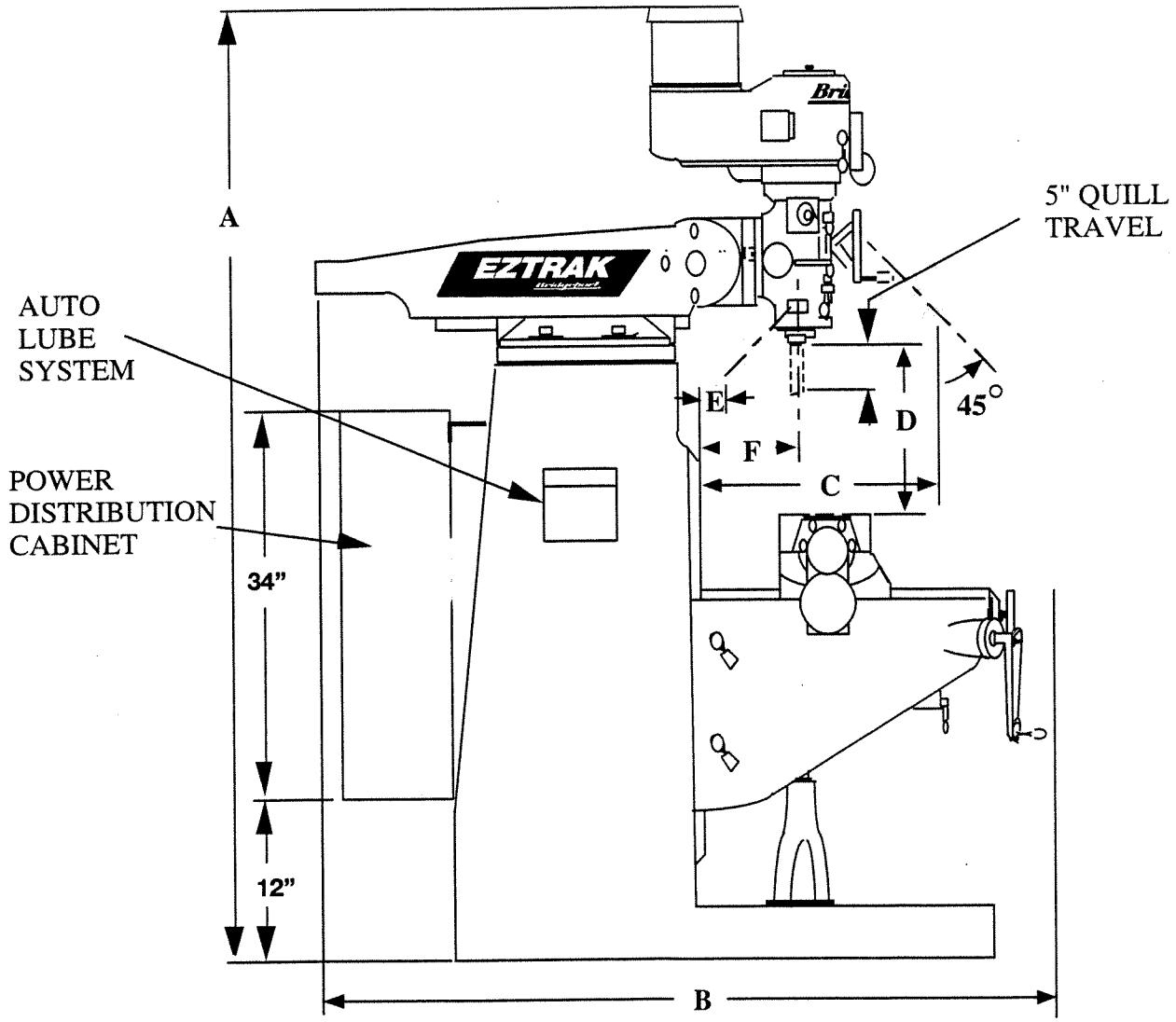
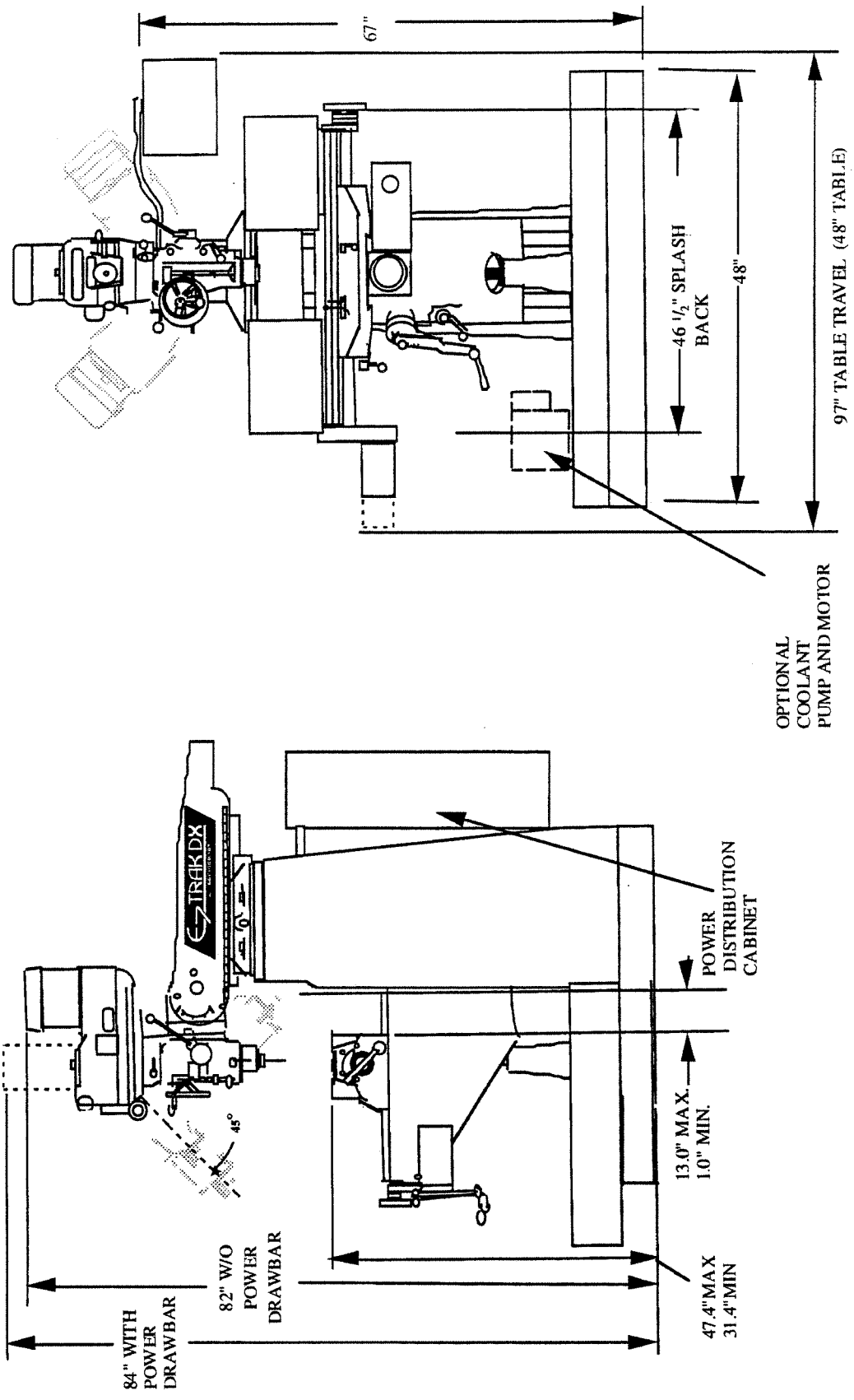


	TABLE TRAVEL 30.0 in. (762 mm)		TABLE LENGTH 48 in. (1219 mm)			
	A	**B**	**C**	**D**	**E**	**F**
MIN.	82" (2083)	51" (1295)	8.75" (222)	2.5" (64)	0	6.75" (171)
MAX.	84" (2140)	63" (1600)	20.75" (527)	18.25" (470)	12" (305)	18.75" (476)

Note: Metric specifications in parentheses

2.3 MACHINE


67"
46 ½" SPLASH BACK
48"
97" TABLE TRAVEL (48" TABLE)
OPTIONAL COOLANT PUMP AND MOTOR
POWER DISTRIBUTION CABINET
13.0" MAX.
1.0" MIN.
47.4" MAX
31.4" MIN
82" W/O POWER DRAWBAR
84" WITH POWER DRAW BAR
45°
TRAK DX

2.4 MILLING HEAD SPECIFICATIONS

MODEL	'2J'
Power	2.0 HP
Motor RPM	1800 RPM
Speed Ranges - RPM LOW HIGH	Stepless 60 - 500 500 - 4200
Quill Travel	5.0 in. (127 mm)
Quill Diameter	3.375 in. (86 mm)
Spindle Tapers	R-8 #30 Q.C.
Spindle diameter	1.875 in. (48 mm)
Spindle Feed Rate	0.0015/Rev (0.038 mm) 0.003/Rev (0.076 mm) 0.006/Rev (0.152 mm)
Drilling Capacity - Manual	0.87 in. (22 mm) dia.
Drilling Capacity - Power	0.37 in. (9.4 mm) dia.
Boring Capacity	6.75 in. (152.4 mm) dia.
Milling Capacity	2.0 cu. in./min. (32 cc/min.)
Spindle to Column - Minimum Maximum	6.75 in. (171 mm) 18.75 in. (476 mm)

RECOMMENDATIONS:
Use 2, 3, or 4 flute end mills. Eight flute end mills are usually not satisfactory for general milling. When using shell mills, face mills or any other tooling, proper machining practice should be observed.

Power Feed can be used for drills up to 0.375 in. diameter. Use manual feed for drills larger than 0.375 in.

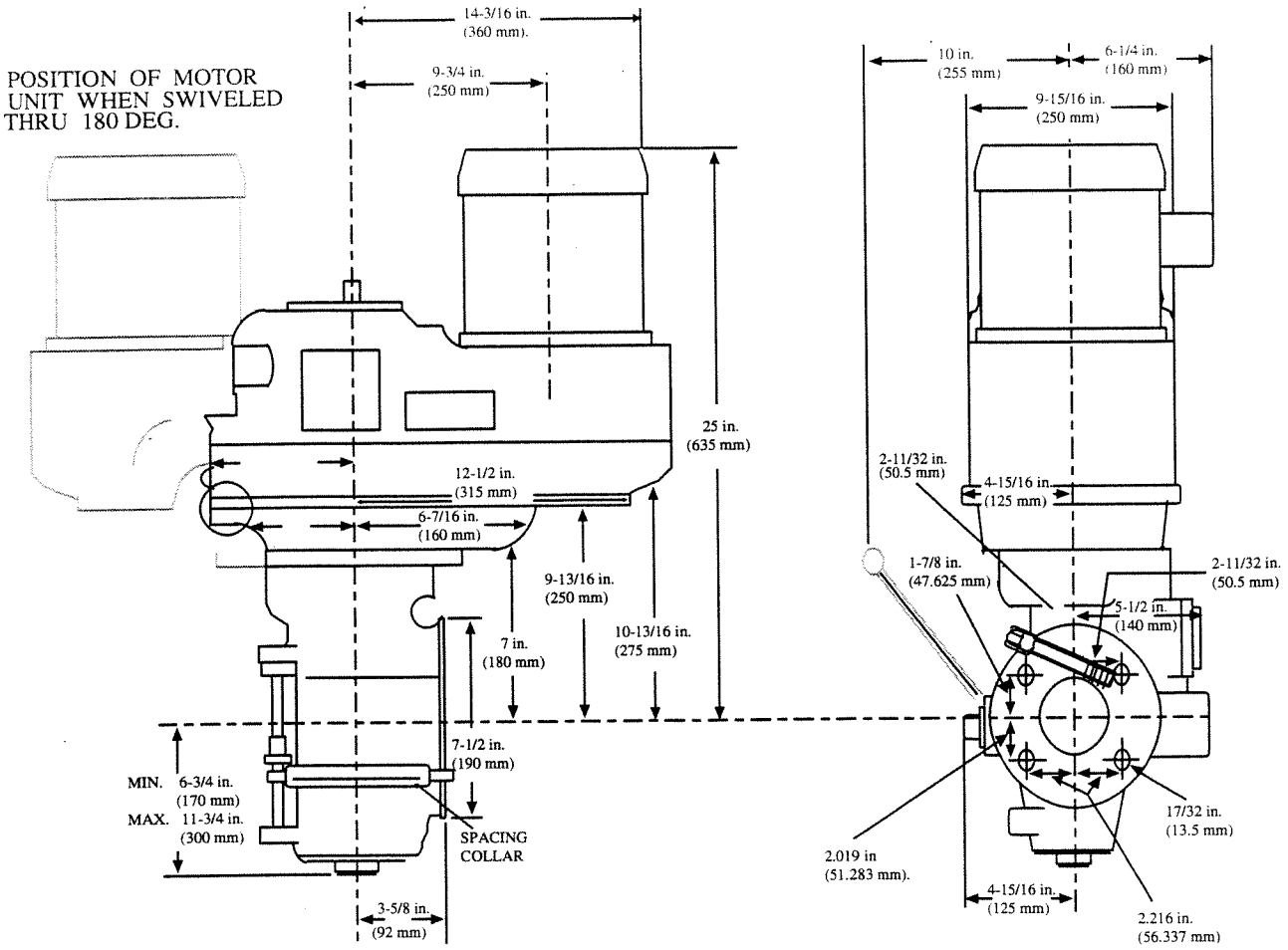
2.5 FEEDS AND SPEEDS

MATERIAL TO BE CUT	FEED PER MINUTE Rough Cut	Rough and Finish	Light and Finsh Cut
Cast Iron - Soft - (Under 150 Brinnell)	70	80-90	120
Cast Iron - Med - (150-200 Brinnell)	55	60-70	90
Cast Iron - Hard - (Over 200 Brinnell)	40	50-60	70
Steel (Chrome Nickel 40-45 Shore)	30	40	50
Steel (Stainless)	60	80	90
Steel (Low Carbon)	80	90	140
Steel (High Carbon)	40	50	70
Bronze (Medium)	90	120	150
Bronze (Hard)	65	90	130
Brass (Hard)	100	150	200
Copper	150	200	300
Duraluminum	400	-	600
Aluminum	600	-	1000

TABLE OF CUTTING SPEEDS AND FEEDS IN REVOLUTIONS PER MINUTE

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

2.6 2-J HEAD SPECIFICATIONS



Spindle taper	R8
Spindle speeds - RPM	60-4200
Motor	*2 HP (1.5 kw)
Quill travel	5 in (127 mm).
Power feed of Quill	0.0015 in. (0.04 mm)
per rev of Spindle (3 rates)	0.003 in. (0.08 mm)
	0.006 in. (0.15 mm)
Collet capacity	1/8 - 3/4 in. x 1/16 in. (3-9 mm x 1.5 mm)
Weight	196 lb. (89 kg)

*2 HP Continuous - 3 HP Intermittent

Chapter 3. Installation

3.1 UNCRATING

Carefully remove crating and skids so that the machine and parts are not marred, scratched or impaired. In the event of damage in transit, communicate AT ONCE with our representative and the transportation company making delivery.

3.2 SHORTAGES

Check shipment carefully against the itemized packing list which is included in the parts box. In the case of shortages, report them IMMEDIATELY to the representative from whom the machine was purchased, indicating parts not recieved which have been checked on the packing list.

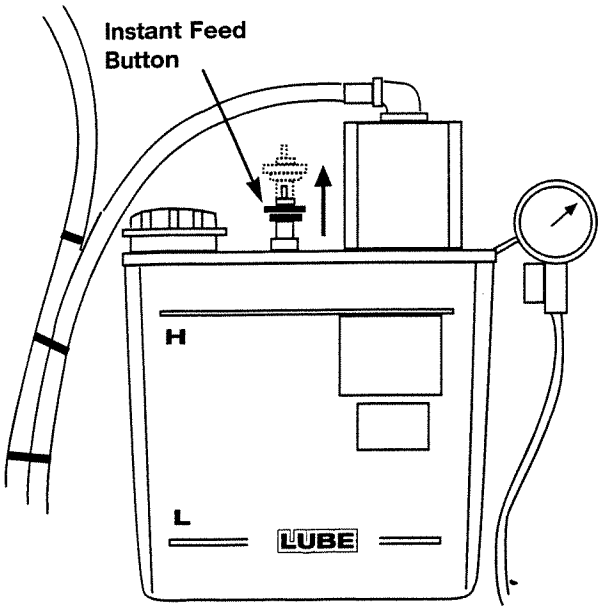


Figure 3-1. Way Lube Reservoir mounted on left side of machine column

3.3 CLEANING & LUBRICATING

1. Thoroughly clean protective coating from machine with suitable cleaning solution.

WARNING

Do not use gasoline or any other flammable cleaning agent for cleaning machine.

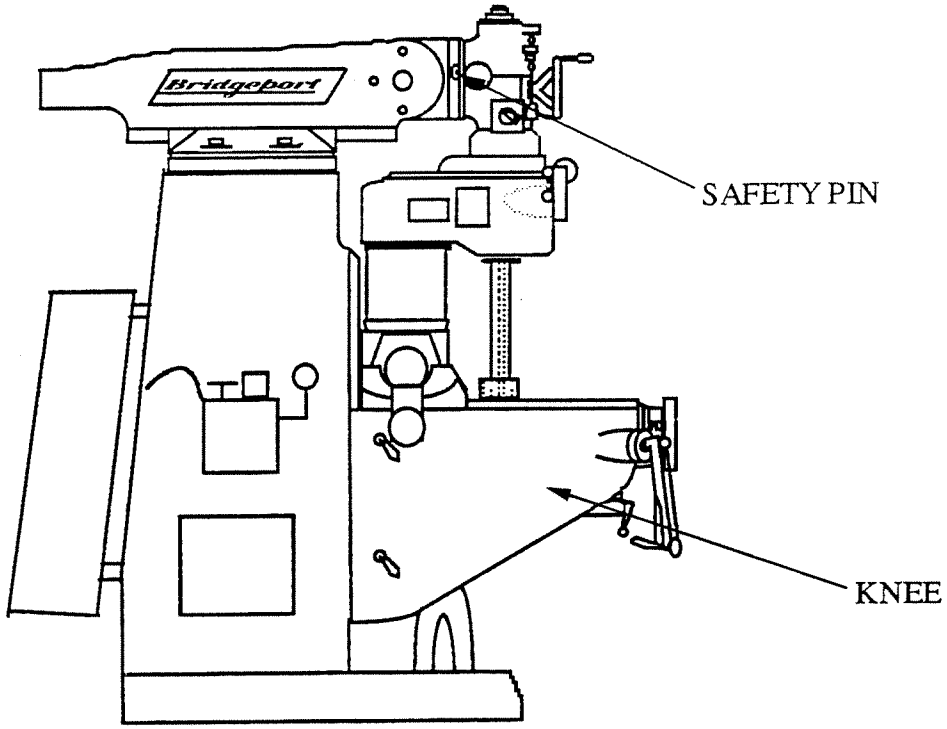
2. By hand, move table, saddle, and knee to limit stop in one direction.

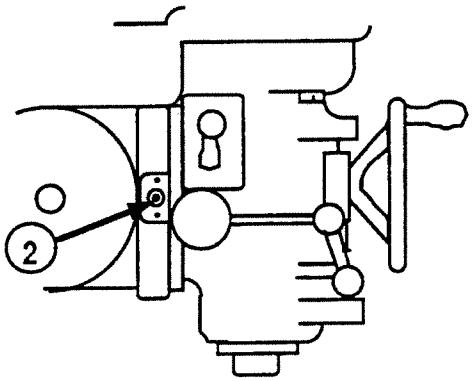
3. Clean and lubricate the exposed ways and then move each unit to the opposite limit stop and similarly clean and lubricate exposed ways.

4. Loosen bolts to unlock the ram, and move it forward and backward to the full length in order to clean and lubricate.

NOTE

Check Way Lube Reservoir and fill if necessary (Sunoco Way Lubricant 1180 or eqiuivalent --see Chapter 11, Auxiliaries for list of acceptable lubricants). Pull and release the Instant Feed button on the reservoir several times until oil flows freely on way surfaces and leadscrews (Figure 3-1).

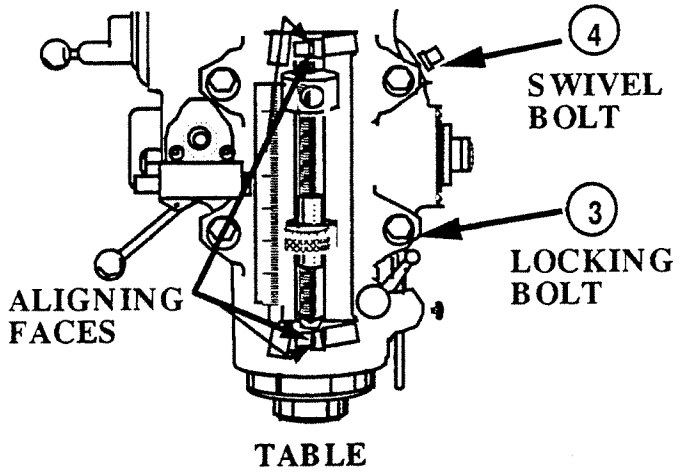




SWIVELING HEAD

To swivel the head more than 25°, the safety pin (2) must be pulled outwards.

POSITIONING HEAD
LEFT VIEW



POSITIONING HEAD
FRONT VIEW

Figure 3-2. Positioning Head Upright

3.4 POSITIONING THE HEAD UPRIGHT (Figure 3-2)

NOTE

If your Bridgeport machine was delivered with the milling head in an upside down position, do the following steps.

NOTE

Care should be taken to avoid excessive pressure since this will cause distortion in the quill.

1. Lower the knee approximately 6 in. (150 mm).
2. Loosen four locknuts (3) and pull stop pin (2) out to detent. Using the swivel bolt (4), rotate head attachment in either direction until it is within approximately 20% of vertical.
3. Support the head by hand to relieve the weight on the swivel bolt.
4. As a safety precaution, push the stop pin back in after passing the 25 degree mark.
5. Continue to raise the head attachment to vertical position.
6. Align the indicator on the head attachment with the ZERO line on the ram adapter scale.
7. Retighten all nuts first to 25 ft. lbs. torque in a diagonal sequence and then to 50 ft. lbs, (see Figure 3-3).

RETIGHTENING ORDER

TIGHTEN BOLTS IN THIS ORDER: **A B C D**

Tighten bolts first to 25 ft. lbs. torque in a diagonal sequence and then to 50 ft. lbs. Over-tightening could cause bind in the quill movement.

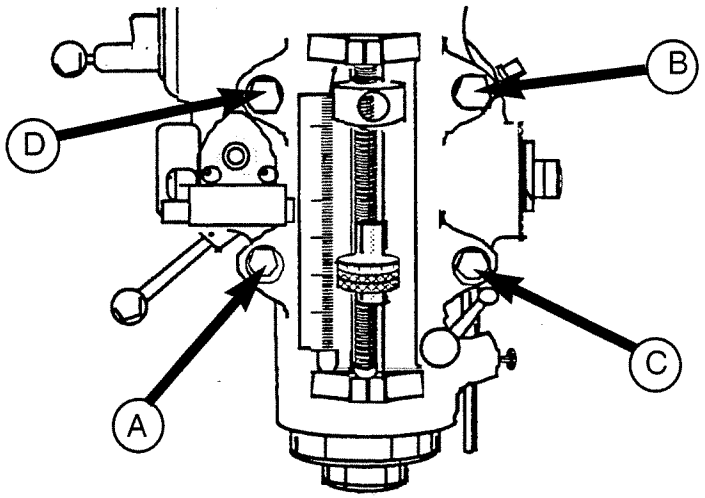


Figure 3-3. Tightening Head Bolts

3.5 LIFTING THE MACHINE (Figure 3-4)

Note position of ram and table when lifting with sling. Machine should be lifted by placing sling under the ram as illustrated. Be sure to use proper sling when lifting. Improper lifting could cause serious injury.

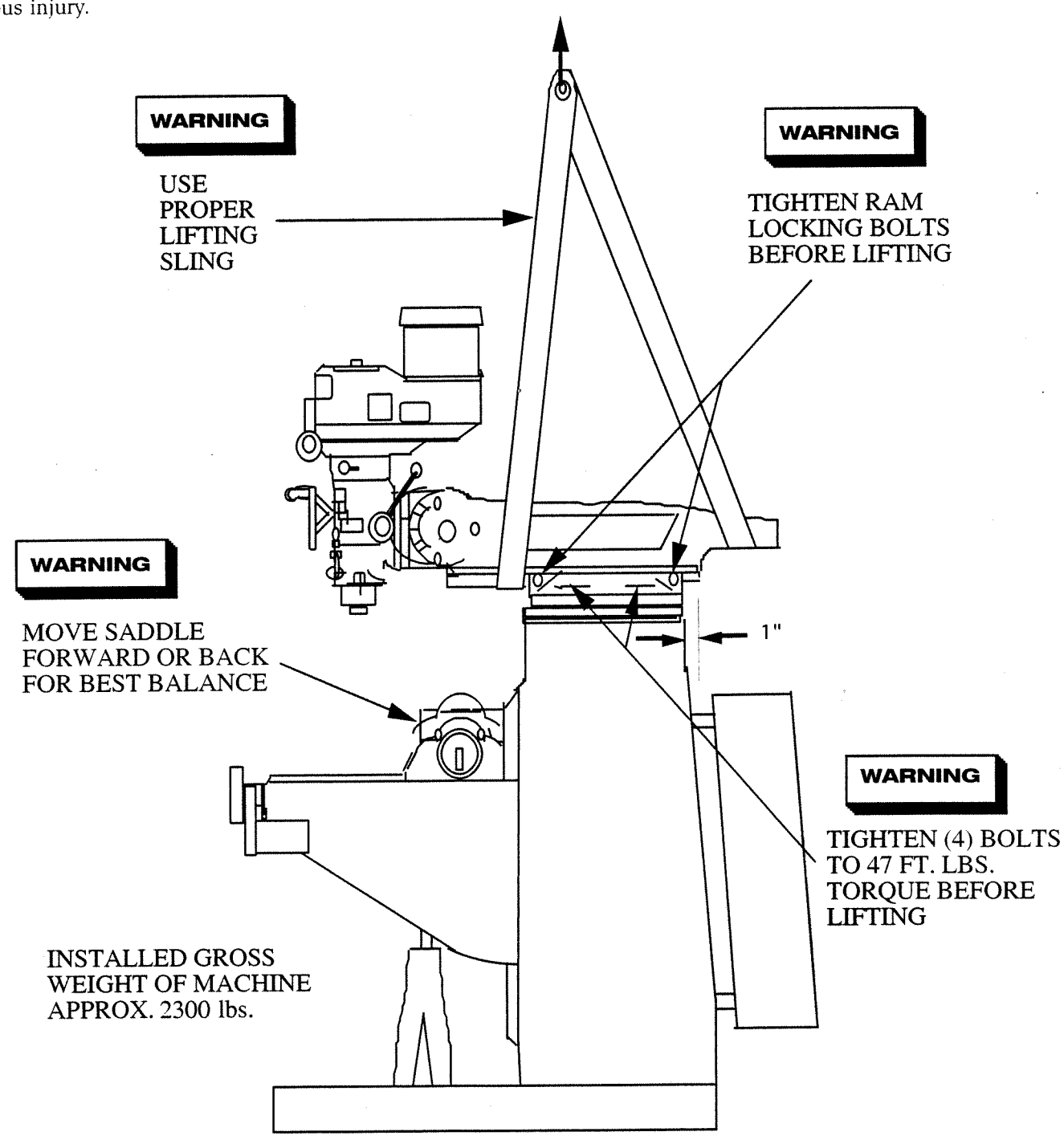


Figure 3-4. Lifting the Machine

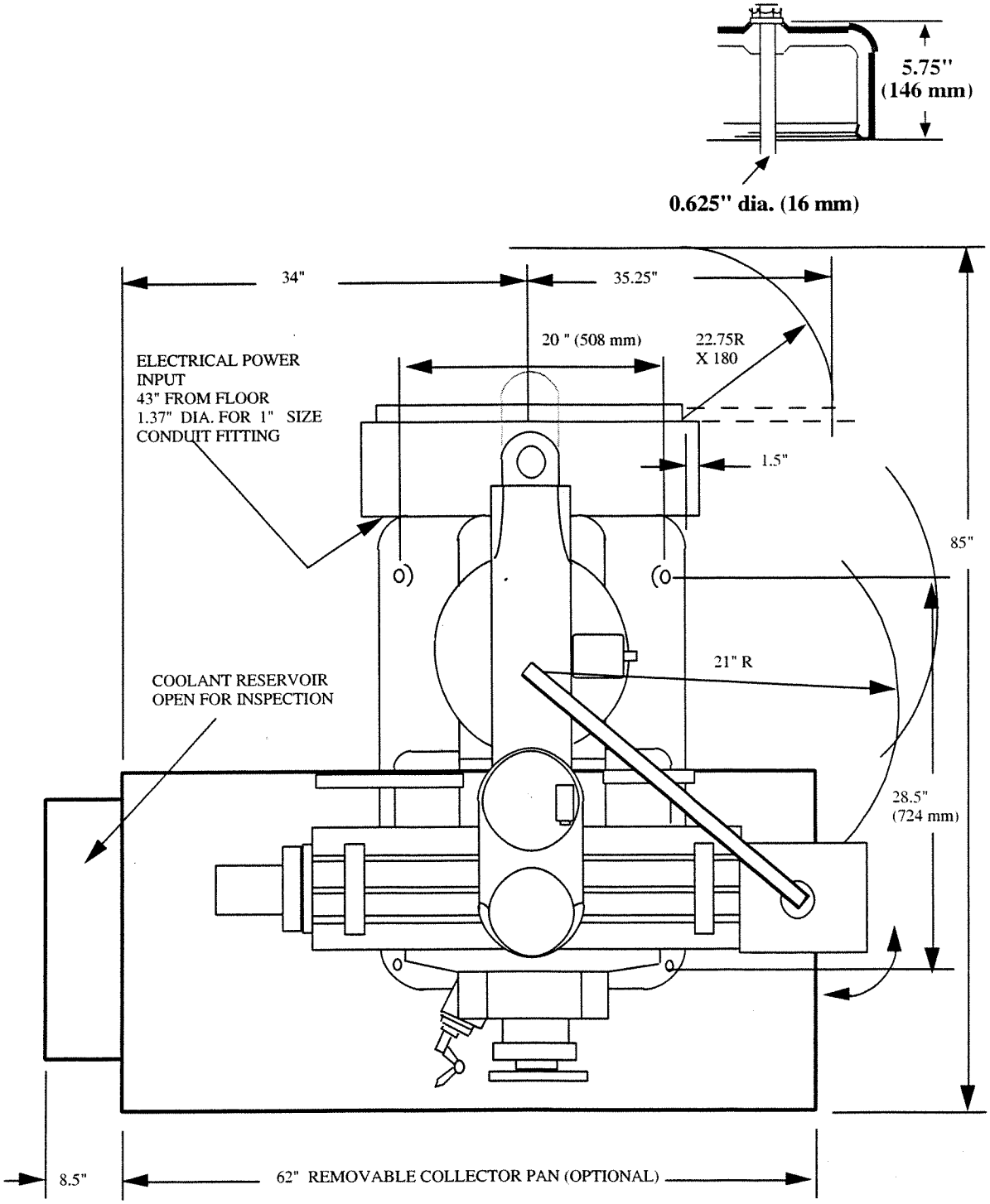


Figure 3-5. EZTRAK Floor Installation Layout

3.6 PLACING ON SOLID FOUNDATION (Figure 3-6)

NOTE

The Series I EZTRAK should be placed on a solid level floor with shims or anti-vibration pads to insure machine base is positioned evenly to prevent rocking.

1. When setting machine on a concrete foundation, use a little grout (thin mortar) to take care of any unevenness in the concrete as well as to provide a solid foundation at all points.

2. When setting machine on a floor that has any surface irregularities, use shims to correct this condition to the greatest extent possible.

3. Before securing machine to floor (i.e. tightening hold down bolts), make certain that all four corners are making contact with the floor after machine is leveled. If above condition is not met, it is possible to twist the column and put a bind into the ways.

NOTE

It is recommended that the machine be secured to the floor to prevent movement or tipping due to off-center loading.

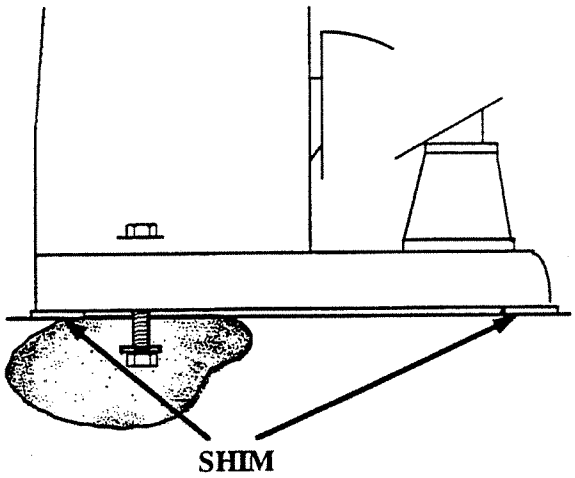


Figure 3-6. Foundation

3.7 LEVELING MACHINE (Figure 3-7)

Set machine by leveling the work table length-wise and crosswise with a precision instrument as shown.

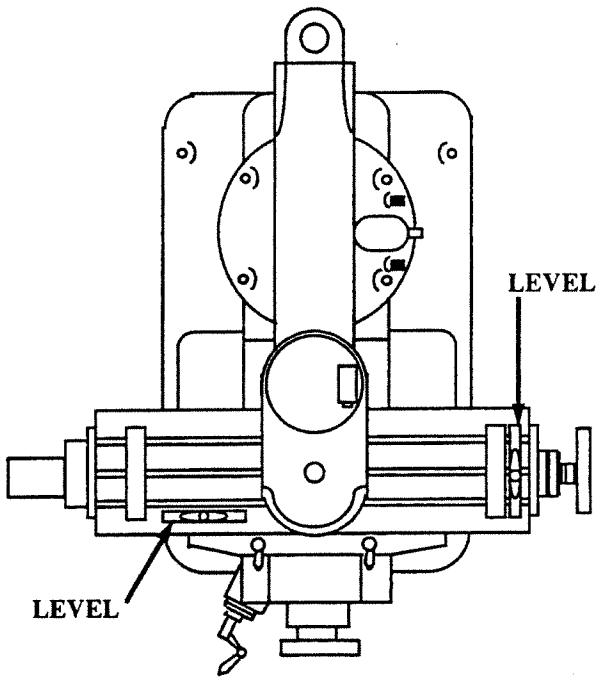


Figure 3-7 Leveling Machine

3.8. ELECTRONIC CABINET INSPECTION

The Electronic Control Cabinet requires careful inspection for shipping damage. The following is a list of the control elements that should be inspected **with power off.**

1. Ensure that the customer's electrical service is compatible with the machine's voltage, which is stamped on a plate mounted on the cabinet door.

   Also, ensure that incoming power is properly grounded. (See Section 3.14 for 4-wire ground procedures.)

2. Check all Control Box connections:

   - Plug connection on the LCU Unit.
   - Keypad interface plug of the LCU Unit.
   - LCU Axis I/O connections.
   - X & Y axis power amplifiers (AMC drives).
   - Check the seating of relays and wire termination points on the relay sockets for tightness.

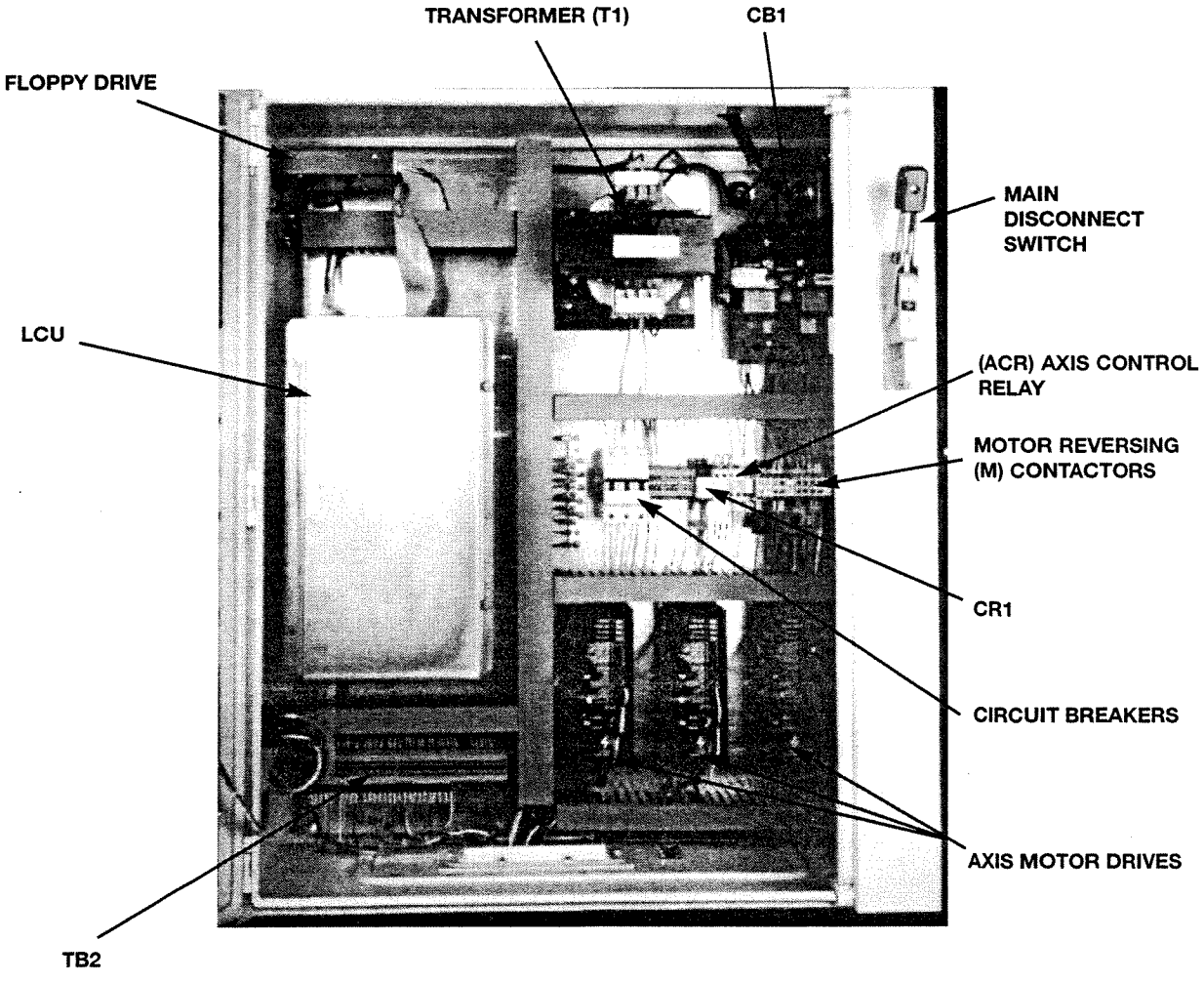


Figure 3-8. Electronic Control Cabinet

3.9 ATTACH CRT DISPLAY: OPERATOR CONTROL STATION

1. Check all contents for damage.

2. Remove the back cover and check for damage around neck of CRT and electronic area.

3. Attach CRT/operating station onto swivel arm. The CRT/operating station mounts to the arm with a long bolt and locking nut.

4. Mounting the CRT/Operator control requires two people, one to lift and hold while the other person attaches and locks the bolt to the swivel arm.

5. Connect existing wires from the swivel arm to the back of the CRT/operating station.

   Connectors are unique to each other, so there should be no confusion as to what plugs into what.

See also CRT & Arm Assembly drawings in Parts Breakdown chapter.

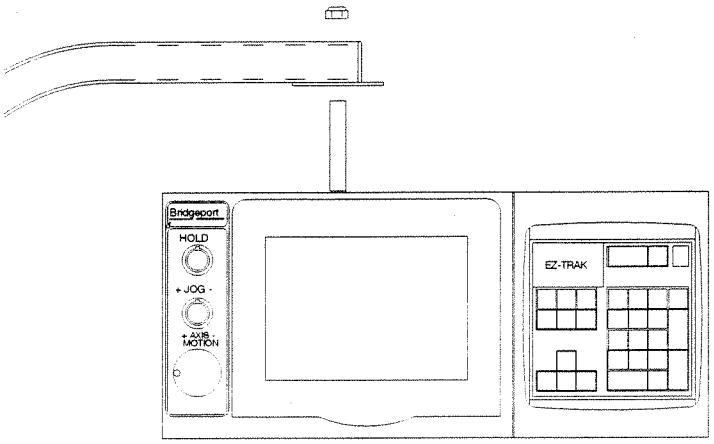


Figure 3-9. Pendant

Pendant mounts to swivel arm with a long bolt and locking nut.

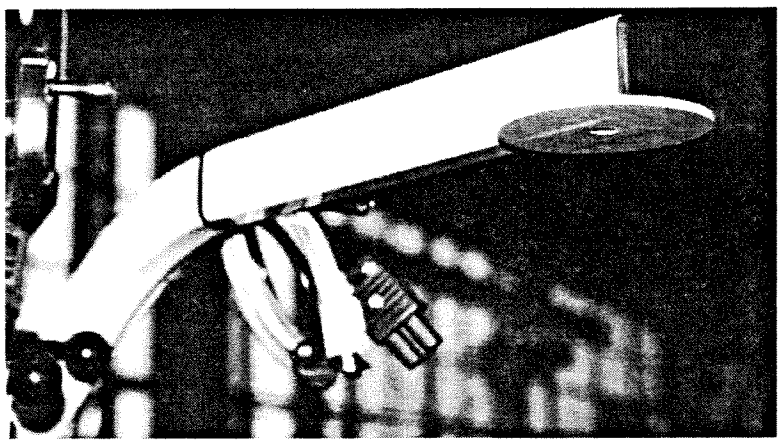


Figure 3-10. Pendant Arm

Connectors to CRT travel along swivel arm to plug in back of pendant.

3.10 CONNECTING POWER SUPPLY

To connect the machine to the plant supply, have a qualified electrician proceed as follows:

1. **Check required voltage against power supply to ensure that they are compatible.**

2. Connect machine wiring to power supply, making sure connection is in compliance with safety regulations.

3. Maximum earth loop impedance must not exceed 1.0 Ohm. See Section 3.11, Protective Ground (below).

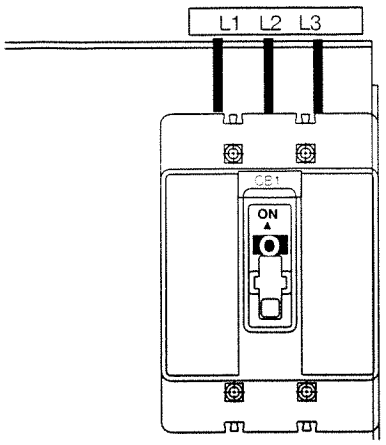


Figure 3-11. Main Circuit Breaker (behind the Disconnect Switch) with incoming power supply.

3.11 PROTECTIVE GROUND

Protective ground is required. It minimizes the exposure to personal shocks in the event of circuit shorts or other malfunctions. Failure to ensure protective ground may create electrical shock hazard, causing serious personal injury or death.

Protective Ground (Chassis or Safety Ground) establishes a low impedance path from the equipment enclosure and other mechanical parts of the system to earth ground. Protective Ground assures that all conductive parts of the enclosure are safe. If any circuit inadvertently touches the chassis, the voltage will be reduced to zero and the enclosure will be safe to touch. Because safety requirements vary in different localities, be sure to consult local governing codes. These codes take precedence over the practical guidelines presented which are based upon:

National Electrical Code;
California "Electrical Safety Orders"; and
Pennsylvania "Electrical Safety Regulations".
The four methods listed below are commonly used to establish earth ground:

Continuous Metal Water Pipe — When properly buried, length is installed below the permanent moisture level, impedance is typically 3 ohms.

Copper Stake (3/4 in. dia, 6-8 ft. long). — When properly driven into the ground below permanent moisture level, the impedance of this type is typically below 5 ohms.

Fourth Wire Ground — Although a copper ground stake is preferred, an alternative is a fourth wire for ground included with the power wires from the enclosure ground stud to the power company service panel ground bus. (See Note, below.)

Other Metal Electrodes (Well Castings or the Like) — Must be well chosen, since they generally exceed an impedance of 5 ohms but are well below 25 ohms.

NOTE

The resistance of the earth ground connection is measured from the enclosure ground stud, through the ground wire, to the earth ground connection; then through the earth ground to another earth ground connection (at least 20 feet away), and through its associated wire to another ground stud. The resistance should not exceed 5 ohms. The wire used between the ground stud and the earth ground should be AWG10 or larger and should be braided cable to minimize resistance at high frequencies (cable resistance less than 0.075 ohm). The ground wire should be inspected for mechanical abuse periodically.

3.12 PRESTART CHECKS

Make a careful check of the following conditions before applying power.

1. **Floor** is of sufficient quality to support machine and maintain machine level.
2. **Incoming power** is within +/- 10% of nameplate voltage.
3. **Machine is properly gounded** (1 ohm between ground rod and reference point.)
4. **Electrical Cabinet components inspected** for loose connections, etc.
5. **Level of lubricating oil —** refill if low. See Section 3.13 (below) for lubrication check points.
6. **Air pressure level —** adjust to nominal 80 psi (5.5 bar). Applicable only if power drawbar is installed.
7. **Way areas are cleared, cleaned and lubricated.**
8. **Fill Coolant Tank** with coolant to required level (if optional coolant system is installed).

   For Series I machines, the tank capacity is 50 litres.

   For Series II machines, the tank capacity is 25 litres.

   Do not use coolant containing the following chemicals: Mono-ethanolamide, Di-ethanolamide, Tri-ethanolamide,as these chemicals may degrade the polycarbonate spindle guard.
9. **Install Air Filter** on Electrical Cabinet Door.

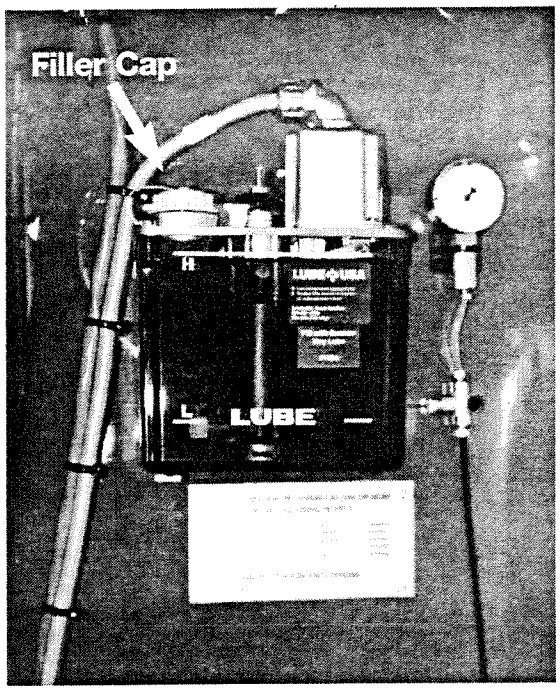
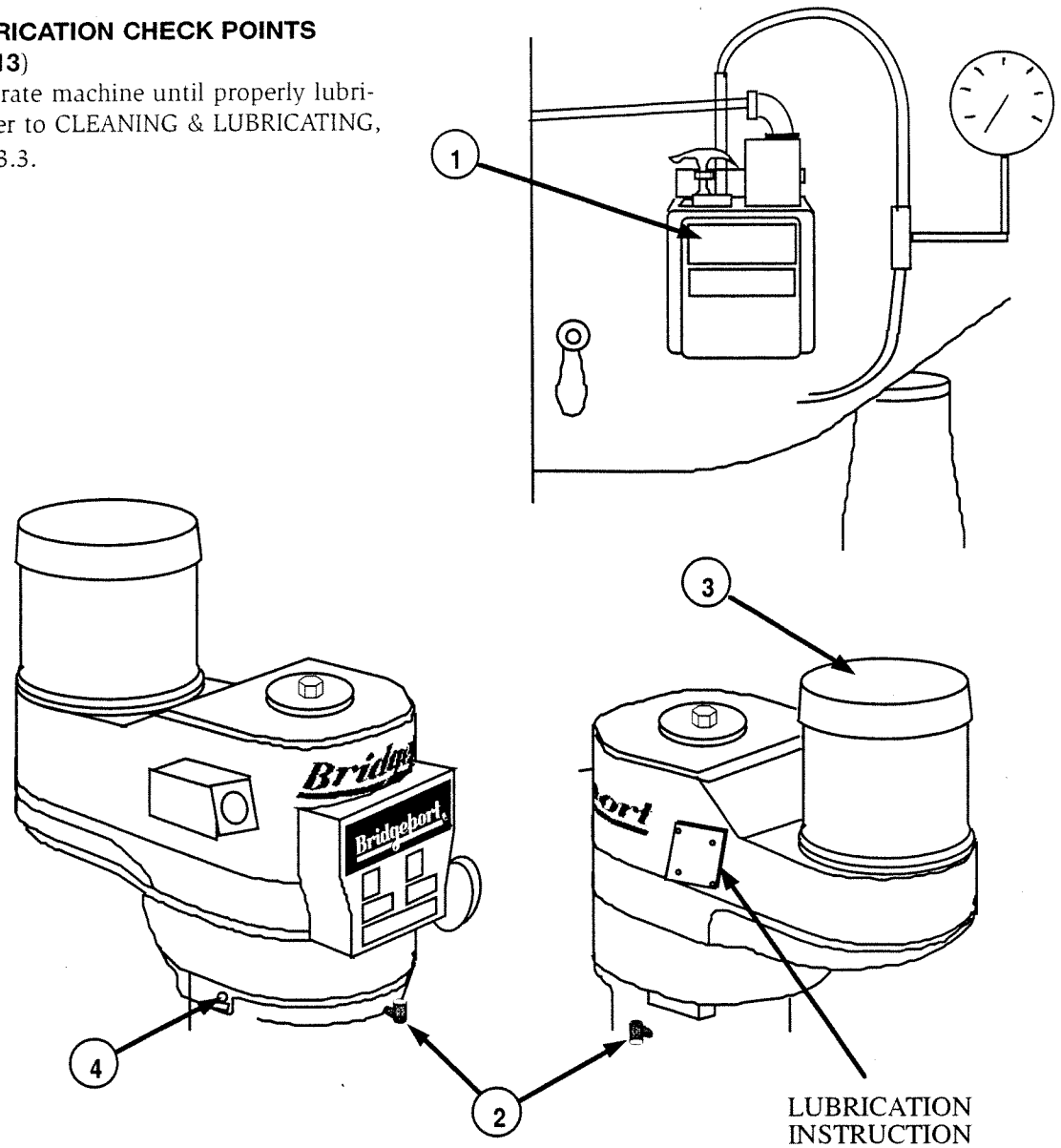


Figure 3-12. Way Lube Pump and Reservoir.

3.13 LUBRICATION CHECK POINTS (Figure 3-13)

Do not operate machine until properly lubricated. Refer to CLEANING & LUBRICATING, paragraph 3.3.



1. **Way Surfaces - Lead Screws** "Sunoco" Waylube #1180 or equivalent
2. **Milling Heads (Spindle Bearings)** S.A.E. 10 or 10W Light Oil (none on grease packed heads)
3. **Motors are greased for life of bearings**
4. **Grease with lubriplate every 6 months as described on lubrication plate.**

Figure 3-13. Lubrication

3.14 APPLYING POWER:

WARNING

Before applying power, ensure that electrical service is compatible with the machine's voltage and that machine is properly grounded.

1. Verify that the correct Cam settings have been made for the machine voltage (see chart below).

2. Do the voltage checks as outlined on the Voltage Check Report (below).

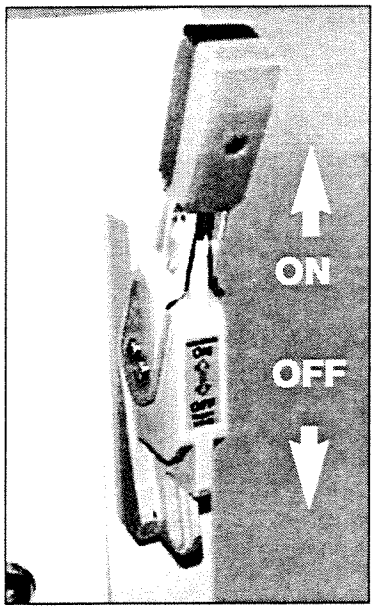


Figure 3-14. Main Circuit Breaker Switch on Electronic Control Cabinet.

TRANSFORMER CONNECTIONS

LINE VAC	INPUT	JUMPER	OVERLOAD CAM SETTING	OVERLOAD
208	1L1 TO 1 1L2 TO 4	1 TO 3 2 TO 4	7.8A	MTO3M
230	1L1 TO 1 1L2 TO 4	1 TO 3 2 TO 4	7.5A	MTO3M
245	1L1TO 1 1L2 TO 4	1 TO 3 2 TO 4	7.3A	MTO3M
380	1L1 TO 1 1L2 TO 2		4.5A	MTO3L
415	1L1 TO 1 1L2 TO 2		4.2A	MTO3L
460	1L1 TO 1 1L2 TO 4	2 TO 3	3.7A	MTO3K
490	1L1 TO 1 1L2 TO 4	2 TO 3	3.3A	MTO3K

VOLTAGE CHECKS

AC LINE INPUT VOLTS

PHASE TO PHASE		PHASE TO GROUND	
L1 TO L2	_____ VAC	L1 TO GND	_____ VAC
L2 TO L3	_____ VAC	L2 TO GND	_____ VAC
L3 TO L1	_____ VAC	L3 TO GND	_____ VAC

T1 TRANSFORMER

SECONDARY:

WIRE #1 TO #2 _____ **115 VAC +/- 10%**

WIRE #20 TO #2 _____ **115 VAC +/- 10%**

LCU UNIT VOLTAGE CHECK:

Voltage is checked at the Auxiliary Power Connector on the side of the LCU cabinet.

The Center conductors are GND.

The End conductors are + 5V and + 12 V and should be:

+ 5.00 +/- .25V

+ 12.00 +/- .6V

3.15 STARTUP CHECKLIST

1. Enable drives and reference machine.

2. Check Spindle Rotation.

   The spindle should rotate clockwise when viewed from the top of the machine.

WARNING

Drum switch and HI-NEUTRAL-LO lever must be in HI range when checking spindle rotation.

3. Install Air Filter on the Back Door.

4. Ensure that Door Fan is blowing air into the cabinet.

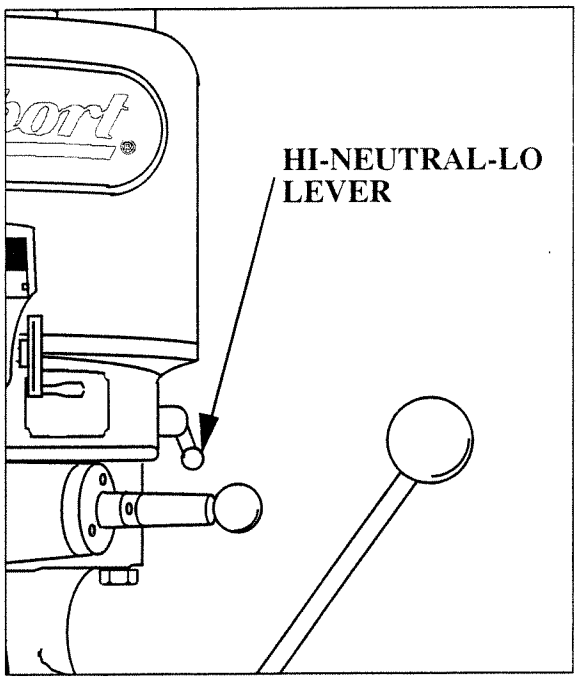


Figure 3-15. HI-NEUTRAL-LO lever located on right side of head.

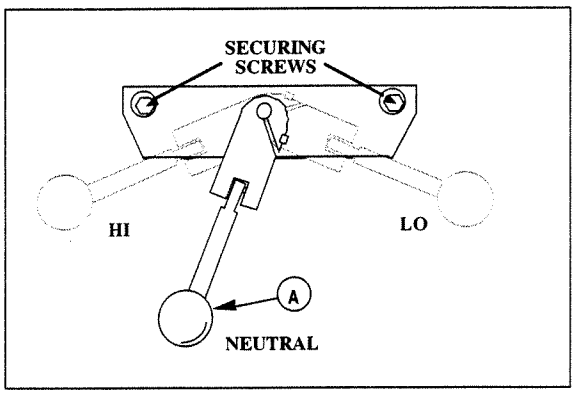


Figure 3-16. HI-NEUTRAL-LO lever settings.

CAUTION: DO NOT SHIFT WHILE MOTOR IS RUNNING.

3.16 ALIGNMENT OF HEAD FOR FINE WORK (Tramming the Spindle)

The spindle has been properly trammeled at the factory, but it is recommended that you check the setting of the head to ensure that it has not moved during shipment.

1. To set head perfectly square with table, adjust ram adapter through vertical adjusting worm shaft with ram adapter on ram.
2. Loosen four locking bolts but leave some drag for fine adjustment.
3. To square head to table in the longitudinal axis, mount indicator as shown (Figure A).
4. Retighten the four head locking bolts in a diagonal order asdescribed at right (Figure B).
5. Retighten the three Ram Locking Bolts to 50 ft. lbs.

Figure 3-17B. Retightening Order:

TIGHTEN BOLTS IN THIS ORDER: **A B C D**

Tighten bolts first to 25 ft. lbs. torque in a diagonal sequence and then to 50 ft. lbs. Over-tightening could cause bind in the quill movement.

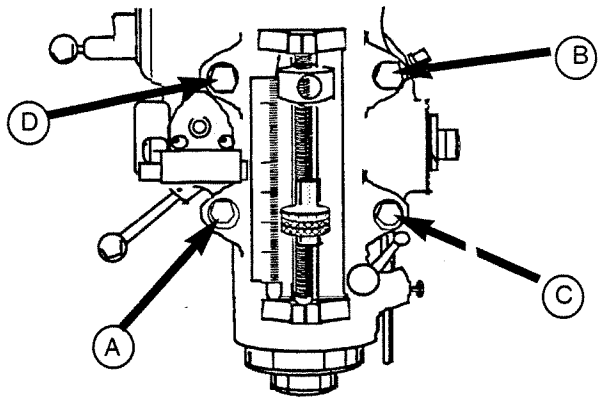
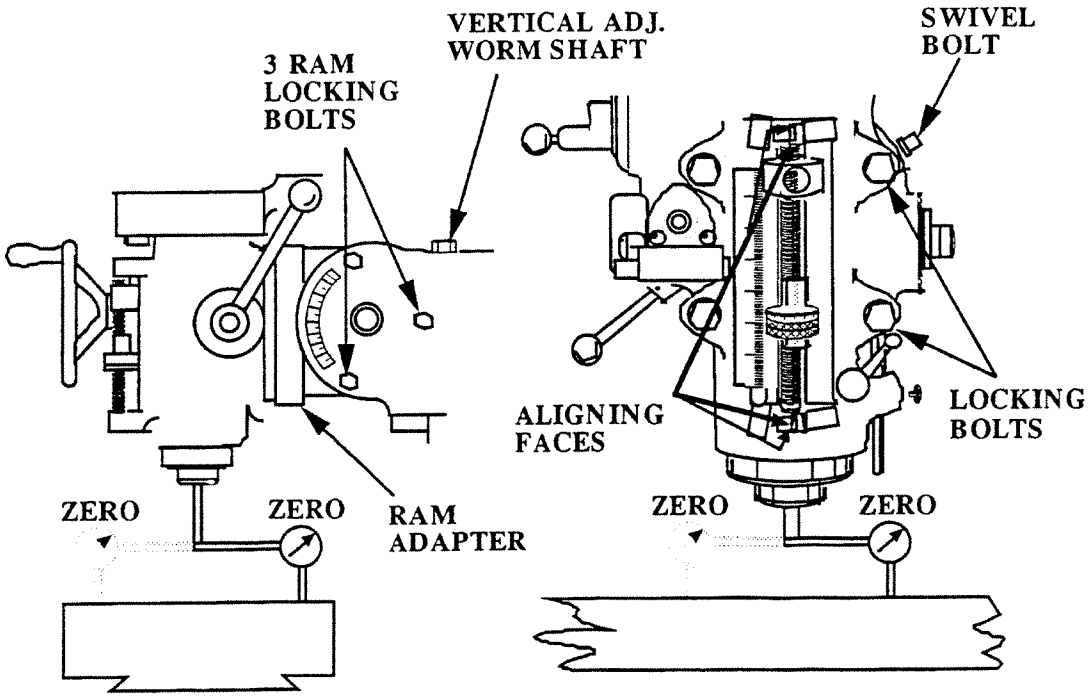


Figure 3-17A. Tightening Head Bolts



Chapter 4. Power Distribution

4.1 POWER DISTRIBUTION SYSTEM OVERVIEW

The EZTRAK system consists of an electrical cabinet attached to the back of the column, a CRT display and key pad, an operator station, and two motors, one on the X-axis and one on the Y-axis. The CRT display shows the operator the control and machine status, and the position of each axis. The key pad permits the operator to input and modify part programs. The operator's station permits direct control of the spindle, coolant, and emergency stop. The electrical cabinet contains all apparatus to control the spindle, coolants, and motors.

4.2 CRT DISPLAY AND FRONT PANEL

The front panel contains the CRT (cathode ray tube), the jog +/- knob, the axis motion knob, and the Hold switch. The CRT is a 9 inch monochrome display which is used to interact with the operator to prompt him for the information to complete an instruction. The screen will change to a new display with each mode as it is selected; input, setup, or edit. All axis positions will be displayed as an offset from the last established zero position.

The **JOG +/-** button gives the operator the capability to move the axis in a continuous move.

The **AXIS MOTION** permits the operator to position the table to within 0.0001 inch of the final position.

The **HOLD** switch, when activated, will cease all motion of the axis. The axis will stay stopped until a start command is issued to the control.

CAUTION

The HOLD switch will not shut off the spindle or coolant. It is not the Emergency Stop.

4.3 KEY PAD FUNCTIONS

The key pad contains 29 keys that in conjunction with the selected mode permit the operator to input part program information or to initiate a start. Once the part program has been established, it can be edited through the use of the key pad.

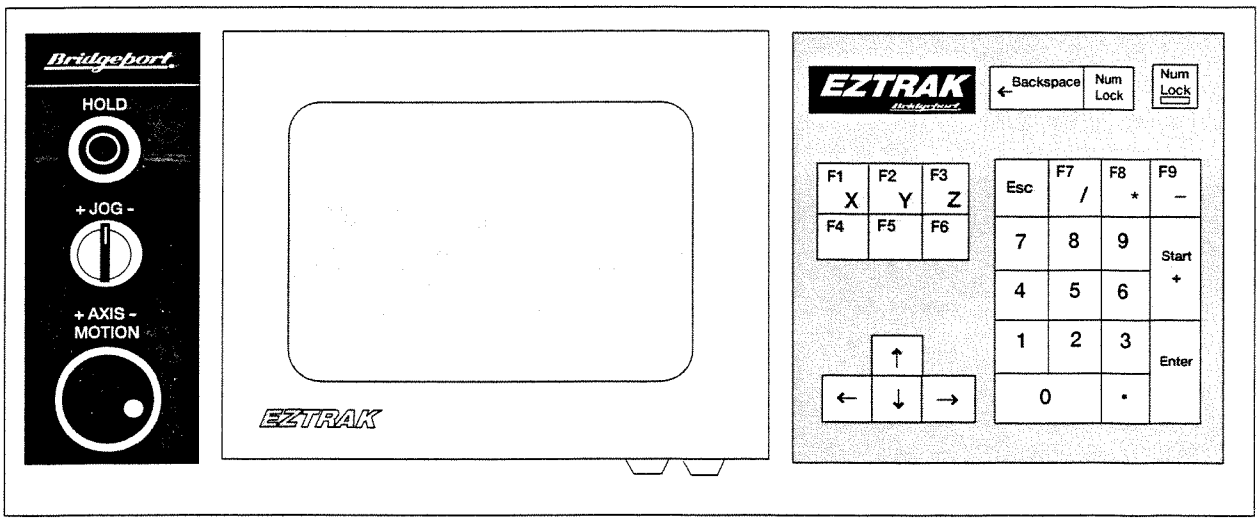


Figure 4-1. CRT Display and Front Panel

4.4 OPERATOR'S CONTROL STATION (Figure 4-2)

The operator's control station is mounted up on the left hand side of the spindle. The box contains four separate switches. They are the emergency stop, the spindle start, the spindle off/ high gear/ low gear selector, and the flood/off/mist coolant selector. These switches bypass the control and operate directly on the function for which they are named.

The **EMERGENCY STOP (A)** switch will remove power from the spindle, coolant, and the axis motors. This switch is maintained on when activated by pushing it in toward the panel and will not release until it is manually pulled out.

The **SPINDLE LOW GEAR/OFF/HIGH GEAR (B)** switch permits the operator to select clockwise direction of the spindle by having the gear selection agree with this switch selection. The off position shuts the spindle off.

The **SPINDLE START (D)** switch will start the spindle when the lighted portion of this switch is pressed. The light will go out after the spindle is started.

CAUTION

Never put hands near the spindle unless the spindle light is ON.

CAUTION

Pressing the Emergency Stop button or Spindle Off selector removes power from the spindle motor but does NOT apply the spindle brake. The brake must be activated manually.

The **COOLANT FLOOD/OFF/MIST (C)** selector switch will select the desired coolant. The coolant will turn on and off with the spindle.

On the left side of the operator's control station is a hanger for the remote start switch. This switch is portable and is intended to be held in the left hand when in use. The control will move in auto until a Z cycle is called for by the program and then the control will stop. After the operator has completed the Z cycle, pressing this switch will restart the machine.

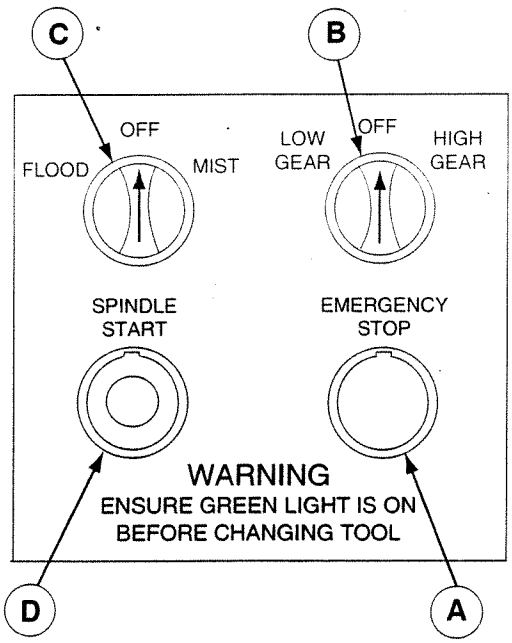


Figure 4-2. Operator's Control Station

4.5 CONTROL CABINET

The control cabinet is a large metal box mounted on the back of the column. It contains the following devices:

a. **The incoming power disconnect,** which is mounted on the equipment panel with the handle protruding through the flange. This disconnect is used as the Power On/Off switch. The circuit breaker is rated at 15 amps.

b. **An interface transformer** that receives the incoming line voltage and outputs 115 vac to the CRT monitor, LCU,the 115 vac control circuits, and 115 vac to supply power for the axis drives.

c. **A forward/reversing starter** to control the three horsepower spindle motor. The starter is equipped with a motor overload for motor protection.

d. **Within the LCU are the following components**

Pentium processor board to interface with the CRT, the BMDC board, the key pad, the floppy disk reader, and all external communications.

BMDC board that controls all motion on the X and Y-axis when the control is in auto/run.

Axis I/O Card.

Disk-On-Module which emulates an IDE hard disk.

e. **Two motor driver amplifiers** to control the speed and torque required by the axis motors.

f. **A floppy disk reader** placed in the cabinet that is used at start up to load the machine software and to load part programs.

4.6 POWER DISTRIBUTION SYSTEM (Figure 4-3)

The power input to these machines is four conductor wires carrying three phase 60 cycle alternating current. The machine wiring can be adjusted to accommodate 208, 230, 240, 380, 416, 460, or 495 vac. The following are the connections required for each voltage.

4.6.1 The 208 VAC Configuration

Secondary supplementary protection is provided. The spindle motor overload is 5.5 to 8.0 amps (adjustable) part number MT03M. The transformer connections are 1L1 to terminal H1, 1L2 to terminal H4, a jumper from H1 to H3, and a jumper from H2 to H4. The spindle motor must be wired according to the instructions in the manufacturer's manual or the motor name plate. The voltage plate should read 208 vac part number 31943395.

4.6.2 The 230 VAC Configuration

Secondary supplementary protection is provided. The spindle motor overload is 5.5 to 8.0 amps (adjustable) part number MT03M. The transformer connections are 1L1 to terminal H1, 1L2 to terminal H4, a jumper from H1 to H3, and a jumper from H2 to H4. The spindle motor must be wired to the instructions in the manufacturer's manual or the motor name plate. The voltage plate should read 230 vac part number 31943394.

4.6.3 The 240 VAC Configuration

Secondary supplementary protection is provided. The spindle motor overload is 4.55 to 7.4 amps (adjustable) part number C306DN3B. The transformer connections are 1L1 to terminal H1, 1L2 to terminal H10, a jumper from H1 to H6, and a jumper from H5 to H10.

4.6.4 The 380 VAC Configuration

Secondary supplementary protection is provided. The spindle motor overload is 4.55 to 7.4 amps (adjustable) part number C306DN3B. The transformer connections are 1L1 to terminal H1, 1L2 to terminal H7, with a jumper from H2 to H6. The voltage plate should read 380 vac part number 12598103.

4.6.5 The 416 VAC Configuration

Secondary supplementary protection is provided. The spindle motor overload is 3.23 to 5.23 amps (adjustable) part number C306DN3B. The transformer connections are 1L1 to terminal H1, 1L2 to terminal H6, and a jumper from H3 to H6. The spindle motor must be wired to the instructions in the manufacturer's manual or the motor name plate. The voltage plate should read 416 vac part number 31943706.

4.6.6 The 460 VAC Configuration

Secondary supplementary protection is provided.The spindle motor overload is 2.15 to 3.49 amps (adjustable) part number C306DN3B. The transformer connections are 1L1 to terminal H1, 1L2 to terminal H9, and a jumper from H4 to H6. The spindle motor

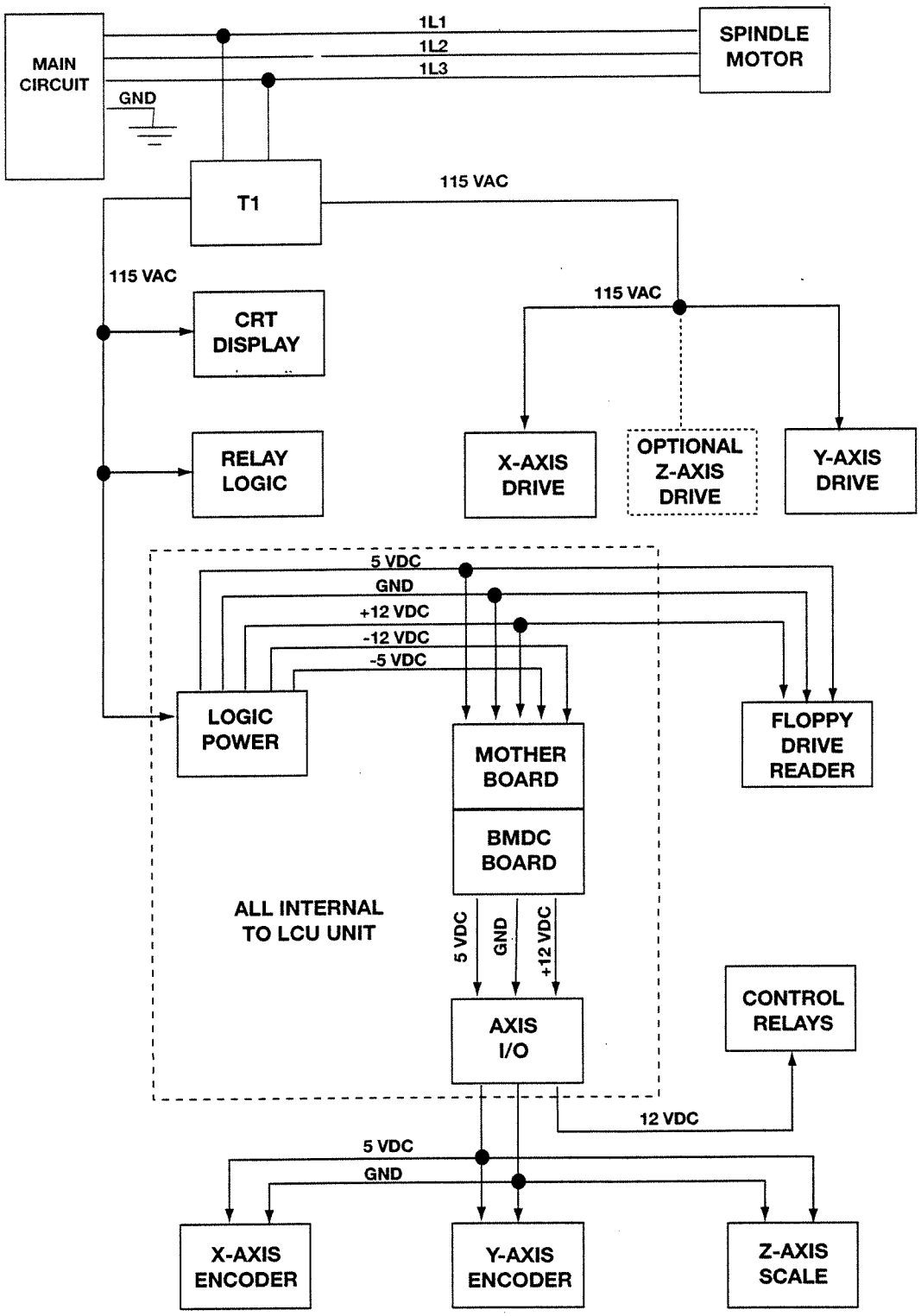


Figure 4-3. Power Distribution Block Diagram

must be wired to the instructions in the manufacturer's manual or the motor name plate. The voltage plate should read 460 vac part number 31943391.

4.6.7 The 480 VAC Configuration

Secondary supplementary protection is provided. The spindle motor overload is 2.15 to 3.49 amps (adjustable) part number C306DN3B. The transformer connections are 1L1 to terminal H1, 1L2 to terminal H10, and a jumper from H5 to H6.

The four wire connections are L1 to the top left connection on the Main Circuit Breaker, L2 to the top middle connection, and L3 to the top right connection; the green wire must be connected to the chassis ground terminal.

CAUTION

The green wire is a personnel safety device. The green wire must be connected directly to the chassis.

NOTE

To determine the correct phasing, put the transmission in high. Select the high gear position on the spindle switch and press the spindle start switch. If the spindle direction is clockwise, the phasing is correct. If the spindle direction is counterclockwise, reverse any two incoming wires.

The incoming three phases are switched off and on by the Main Circuit Breaker. The output from the circuit breaker energizes the spindle motor through the reversing starter and the motor overload. Phases L1 and L2 are used to energize transformer T1.

The output of transformer T1 supplies the power for the complete control.

The 115 vac output from ground and terminal X1 is used to supply power to the IPC, the CRT Monitor, the Duplex Outlet, Axis Drives, and the cabinet fan through wire 1.

4.7 RELAY LOGIC

The output of CB3 on wire 5 delivers 115 vac to three circuits. The first is to a normally closed contact on the MR relay. On the other side of this relay contact, wire 17 is connected to a normally closed contact on the MF relay. Wire 18 connects the output on the MF contact to the light on the spindle start switch. Wire 2 completes the circuit. This circuit insures that the spindle safe light is only lit when the spindle is off. The second circuit, wire 5 is connected to the Lube Level Switch. Wire 19 from Lube Level connects to CR1. The third circuit is to a normally closed contact on MOL1. Wire 11 on the other side of MOL1 connects to the emergency stop switch. Wire 6 on the output of the emergency stop switch feeds this to several circuits. MOL1 opens if the spindle motor is shut down for an over current condition. The Emergency Stop circuit opens when the operator depresses the switch activator. This series connection insures that if either the MOL1 or Emergency Stop switch opens, the spindle motor stops, the coolant shuts off, and the axis motors are brought to a halt.

Wire 6 connects to SW2, the spindle start switch. The output of SW2 connects to a normally open CR1 through wire 7. The other side of the low lube switch wire 8 connects to SW3, the spindle select switch. One output (low gear) from SW3 is connected to a normally closed contact on MF through wire 9. On the other side of MF contact wire 10 connects to the MR coil. The other side of MR coil is connected to wire 2 to complete this circuit. The second output of SW3 is connected to a normally closed contact on MR through wire 12. The other side of MR contact is connected to the coil of the MF relay through wire 13. Wire 2 connected to the other side the MF coil completes the circuit. Wire 6 connects to a normally open contact on the MR and MF relay, and to the ACR relay. The other sides of these contacts are connected to wire 8. This circuit will energize the MR relay when the lubricator is full, low gear is selected on the

spindle switch, and the spindle start switch is depressed. The MR contact between wire 6 and 8 holds the circuit on. Note that the MR contacts between wire 12 and 13 will open and MF cannot be energized until MR is turned off. A mechanical fail-safe mechanism between contacts also prevents both coils from being picked. Turning the spindle selector switch to off will stop the spindle. The other leg of this circuit will operate if high gear is selected.

Wire 6 also is connected to ACR. The other side of the coil on ACR is connected to wire 2 to complete the circuit. ACR applies power to the axis motors.

Wire 8 also supplies power to SW4, the lube pump motor, and power drawbar switch. The output of SW4 is connected to the flood coolant pump motor through wire 14. Wire 2 completes the flood coolant circuit. The output of SW4 is connected to the coolant solenoid through wire 15. Wire 2 completes the circuit to the coolant solenoid. Wire 8 is energized when the spindle is on. The lube pump will be on and the power drawbar pneumatics will be on.

NOTE

If the lube reservoir is close to empty the spindle will not start. If the spindle is running when the pump runs dry, the machine will run until the spindle is shut off but will not start again until oil is added to the reservoir.

The fourth set of contacts on the MR and MF reversing starter is used to signal the control logic that the spindle is running. They are connected to the IPC and Axis I/O through wires 33 and 34. Wire 34 at J9 pin 16 supplies 12 vdc to a normally open contact on the MR and MF relay. On the other side of the MR and MF relay, contact wire 33 connects the contacts to J9 pin 3. When either one of the relays is energized, J9 pin 3 goes to 12 vdc. Wire 34 also supplies 12 vdc to a normally open contact on the emergency stop switch and a normally open contact on MOL relay. Wire 35 connects J9 pin 4 to the other side of the normally open contact on the emergency stop switch and the normally open contact on the MOL relay. When either the emergency switch or the MOL relay is energized, J9 pin 4 goes to 12 vdc. This signal informs the control that the machine is in the Emergency Stop mode.

4.8 FRONT PANEL SWITCHES

The front panel contains three switches for the operator's use. They are Jog Continuous, Axis Motion, and Hold.

The Jog Continuous Switch (SW6) is connected to the IPC and Axis I/O board at J9. Pin 1 is connected to SW6 at pin 4 through wire 53. Pin 2 is connected to SW6 at pin 3 through wire 52. When jog + is selected J9 pin 1 goes to 12 vdc. When jog - is selected J9 pin 2 goes to 12 vdc. The jog function will continue as

Table 4-1. Control Circuit

FUSE #	USE	P/N	DESC.	
FU1	LCU Logic Unit	1542110	5 amp GDA	Internal
FU2	CRT Monitor	1508813	1 amp GDA	Internal
FU3, 4, 5	Motor Drives		16 amp MDA	Internal

long as the switch is held in that position.

The Axis Motion Encoder (P4) is connected to the Axis I/O board at connector J11. Pin 9 is connected to P4 at pin 4 through wire 54. Pin 10 is connected to P4 at pin 5 through wire 51. Pin 8 is connected to P4 at pin 3 through wire 50. Pin 7 is connected to P4 at pin 1 through wire 48. The axis motion encoder is a rotary encoder that produces a quadrature signal with 5 vdc amplitude. This signal is decoded to determine direction, speed, and distance of the axis selected to jog.

The Hold Switch (SW7) is connected to the Axis I/O board at connector J9. Pin 6 is connected to SW7 at pin 3 through wire 55. Pin 14 is connected to SW7 at pin 4 through wire 56. Pin 14 supplies 12 vdc to the switch. When the switch is pressed, pin 6 is raised to 12 vdc. This signal will halt the axis motion only.

The Remote Start Switch (SW8) is connected to the Axis I/O board at connector J9. J9 Pin 4 is connected to SW8 at pin 2 through wire 44. J9 Pin 21 is connected to SW8 at pin 1 through wire 45. Pin 21 supplies 12 vdc to the switch. When the switch is pressed, pin 8 goes to 12 vdc and stops the machine.

4.9 SYSTEM PROTECTION

4.9.1 Signal Ground

Each module, separated device, or separate circuit, is referenced to the System Ground as close as practical to the System Ground Stud. Because these circuits branch out independently from the ground stud, they will not carry current from other modules. The Signal Ground (a zero-volt reference) is connected to the protective ground at only one point.

4.9.2 Shielding

Certain shielded cables for signal purposes are continuous shields grounded at one end only (the point closest to the System Ground Stud).

4.9.3 Noise Suppression

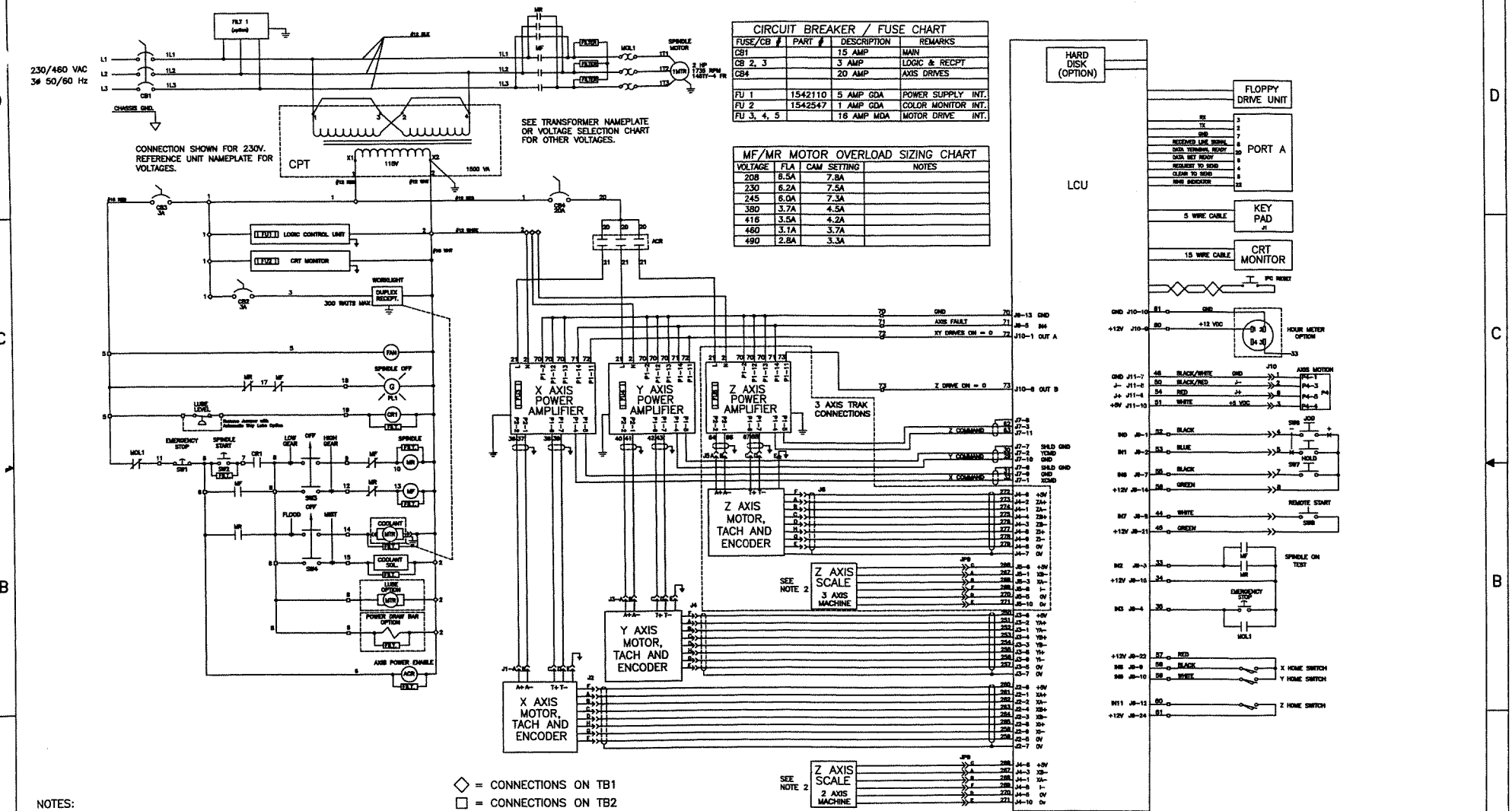
Suitable RC circuits are applied across AC relays and starters as well as at the main 3 phase AC induction motor for the spindle.

4.10 PROTECTIVE GROUND

See Installation Chapter, Section 3.11.

CAUTION

This power supply is equipped with a crowbar circuit that will shut down the output power if the output current exceeds its preset level. When trouble shooting this supply, unload the outputs one at a time to determine if one of the loads are shorted. Shut down the control to disconnect each load. The power supply will not reset with power on. It may take several minutes for the power supply to reset.



CIRCUIT BREAKER / FUSE CHART			
FUSE/CB #	PART #	DESCRIPTION	REMARKS
CB1		15 AMP	MAIN
CB 2, 3		3 AMP	LOGIC & RECPT
CB4		20 AMP	AXIS DRIVES
FU 1	1542110	5 AMP GDA	POWER SUPPLY INT.
FU 2	1542547	1 AMP GDA	COLOR MONITOR INT.
FU 3, 4, 5		16 AMP MDA	MOTOR DRIVE INT.

MF/MR MOTOR OVERLOAD SIZING CHART			
VOLTAGE	FLA	CAM SETTING	NOTES
208	8.5A	7.8A	
230	6.2A	7.5A	
245	6.0A	7.3A	
380	3.7A	4.5A	
416	3.5A	4.2A	
460	3.1A	3.7A	
490	2.8A	3.3A	

◇ = CONNECTIONS ON TB1

□ = CONNECTIONS ON TB2

NOTES:

1. WHEN CHANGING TRANSFORMER TAPS, REWIRE SPINDLE MOTOR PER VOLTAGE SPECIFICATIONS.
2. WHEN INSTALLING 12598992 FACTORY 3RD AXIS OPTION OR 12598993 FIELD RETROFIT 3RD AXIS OPTION: DISCONNECT J4 CONNECTOR FROM AXIS I/O CARD, SWAP CONNECTOR WIRES ON PINS 1 & 3, INSTALL NEW AXIS I/O CARD, RECONNECT J4 CONNECTOR TO J5 ON NEW AXIS I/O CARD.

Axis Drive Mode Selection Table										
	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
CURRENT MODE	OFF	OFF	ON	OFF	OFF	ON	OFF	ON	OFF	OFF
VOLTAGE MODE	ON	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF
IR COMPENSATION	ON	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF
* TACHOMETER MODE	OFF	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF	OFF

Bridgeport. BRIDGEPORT MACHINES, INC.

TITLE: SYSTEM WIRING DIAGRAM BMI TRAK SERIES

SIZE	FSCM NO.	DWG. NO.	REV.
D	05807	59-7917	01

SCALE: NONE | SHEET 1 OF 1

Chapter 5. Logic Boards

5.1 INTRODUCTION

This chapter deals with the logic boards in the EZTRAK system and describes what they do and how they interact with the whole system. Refer to the system block diagram (below).

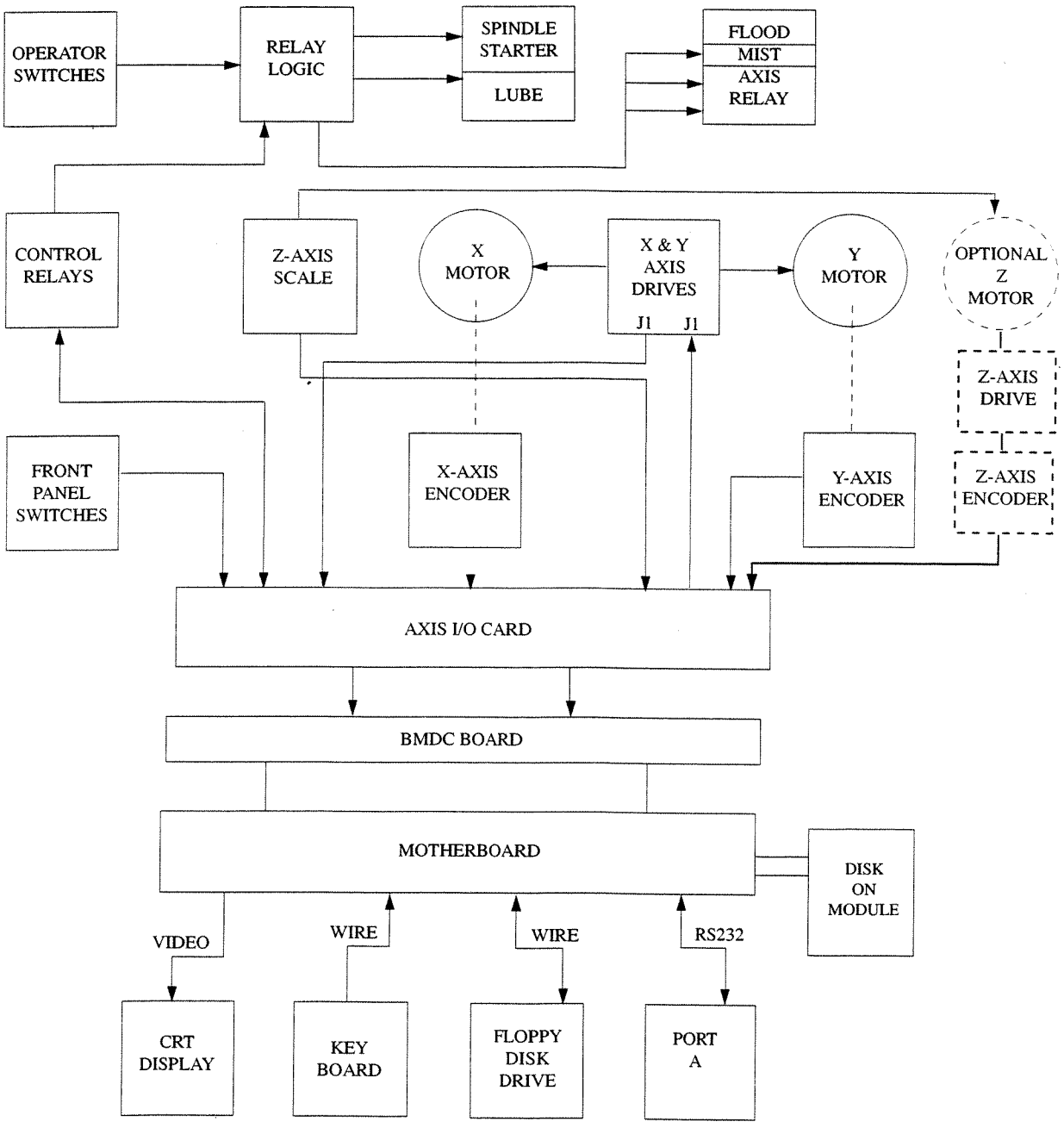


Figure 5-1. System Block Diagram

5.2 CRT FRONT PANEL

Three controls are on the front panel that are not part of the key pad. These controls are:

AXIS MOTION - This control is an encoder that generates 100 pulses per revolution. The axis will move in direction and speed proportional to the number of pulses per second.

JOG +/- SWITCH - This switch is a select and operate switch. It causes the selected axis to move in the selected direction at 100 IPM for the period of time that the switch is held.

HOLD SWITCH - This switch is a normally open momentary push button that causes the axis motion to come to a stop when it is depressed.

CAUTION

The HOLD switch will not stop the spindle rotation or turn off the coolant.

5.3 MOTHER BOARD

Description-This board is a general purpose Pentium digital processor operating at 100 megahertz with 8 megabytes of RAM. This board contains all computer functions necessary to meet the functional requirements of this control. One back plane slot is occupied by the BMDC machine controller board.

Function-The mother board handles all communications related to the part program. It receives information directly from the keyboard. All information to or from the Floppy Disk, Disk on Chip (or Hard Disk), and the external Port A is handled by the motherboard. All information displayed on the CRT is ported through the VGA port.

5.4.Mother Board I/O Features and Specifications:

a. Serial Port

- Two RS-232C serial ports
- Supports COM1, COM2, COM3 and COM4 ports addressed at 3F8-3FF, 2F8-2FF, 3E8-3EF and 2E8-2E
- Supports IRQ2 to IRQ5 Interrupt Request Lines
- Supports DTE/DCE operation
- Equipped with enable/disable function
- Includes a 9-pin to 25-pin connector with cable

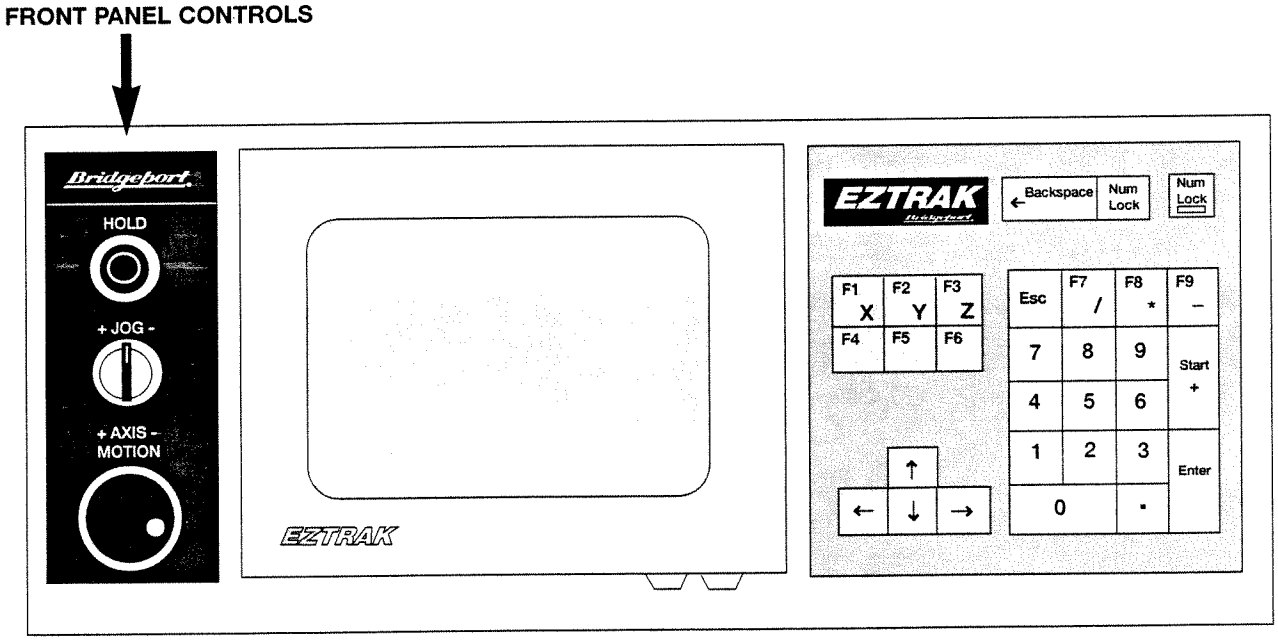


Figure 5-2. CRT Display and Front Panel

b. Parallel Printer Port

- One parallel printer port (25-pin female connector)
- Supports two port addresses, 378-37F and 278-27F HEX
- Supports IRQ5 and IRQ7 Interrupt Request Lines
- Equipped with enable/disable function

c. Floppy Disk Controller

- Supports up to two standard floppy disk drives
- Supports 360KB, 720KB, 1.3MB and 1.44MB 5.25/3.5-inch floppy disk drives
- Equipped with enable/disable function

d. IDE Hard Disk Interface

- Interfaces up to 4 IDE hard disk drives
- Equipped with enable/disable function

e. Disk On Module

- Flash memory array that emulates hard disk
- Memory capacity: 8 meg.

f. PS2 Mouse Port

5.5 DISK ON MODULE

Description - Disk On Module is a computer chip which emulates a hard disk. The card is a memory array of 8 megabyte flash memory components. Disk On Module can read faster, and withstand vibrations better than an ordinary hard drive.

5.6 BMDC CARD

Description- The Bridgeport Machines Drive Controller (BMDC) board is a low cost, high performance general purpose machine tool controller that is IBM AT bus compatible. The board and its companion software are designed to be a general purpose, five-axes control with the following features:

1. 25 Mhz 32 bit microprocessor (MC68EC030) provides a powerful platform with sufficient computational "horsepower" to allow additional features to be added.

2. 25 Mhz Floating Point Coprocessor (MC68882) provides fast and accurate (80 bit) arithmetic.

3. 512K bytes of High Speed Static memory for Control software, User data, and/or programs.

4. 4096 bytes of Dual Port Memory to facilitate communication between the Host processor (286/386/486) and the 68EC030.

5. Five Axis Position Encoder inputs. The encoder inputs may be either single ended TTL/HCMOS compatible, or RS-422 differential. Inputs for each channel include Phase A, Phase B, and Index.

6. One Quadrature encoder input for Operator Input such as a "Jog Knob". The Phase A, Phase B inputs must be single ended TTL/HCMOS compatible.

7. Four 12 bit DACs for outputting +-10 Volt commands to the four axes amplifiers.

8. One 16 bit DAC for outputting +/-10 Volt commands to a fifth axis, typically a spindle.

9. Eight channel 8 bit Analog to Digital converter. Four channels are used to perform diagnostics, four channels are available for operator controls such as joy sticks or feedrate override pots.

10. Two Serial I/O communication Ports for auxiliary I/O through optional AUF and/or TLAUF boards, or to control "digital axis drive systems".

11. Twelve bits of general purpose input, typically used for operator switch inputs.

12. Two relay driver outputs rated for 60 VDC and 1 amp.

The BMDC board is plugged into a standard IBM AT compatible back plane. The Bridgeport Operating System Software (BOSS) is divided into two parts. The BOSS software that runs on the DOS (286/386/486) is responsible for providing the interface to the machine operator (through the VGA screens and the keyboard), as well as communication capability with other computer based systems. The BOSS software for BMDC is

responsible for interpreting the user's part program, controlling the machine's axes servos, and other auxiliary functions such as coolant, lube, spindle, etc.

The BOSS software resides on a floppy or hard disk drive on the DOS machine. On power-up, the BOSS software on the DOS machine loads the main memory of the 68EC030 with BMDC BOSS software. The DOS BOSS software then enables the 68030 to run. The BMDC software then performs its power-up diagnostics and the begins its normal operation. Once the BMDC board is running, all communication between the DOS BOSS software and the BMDC BOSS software is performed through the dual port memory on the BMDC board.

The BMDC board is compatible with most IBM AT compatible systems. There are two requirements:

1. The I/O addresses 1A0 through 1B6 (hex) are reserved for use by the BMDC board !!!

2. The Memory addresses D4000 through D4FFF (hex) are reserved for use by the BMDC board.

In some PC systems, these addresses may be in use for other boards and/or features. Often, conflicts may be fixed by changing addresses on the other boards and/or changing the system configuration information in the battery backed ram on the AT mother board.

The I/O for the BMDC board is through two 50-pin connector.

BMDC Application Notes

The BMDC board requires +5 Volts DC at 3 amps. If the axes encoders are plugged into the encoder I/O board and obtain their power from the BMDC board, then the current requirement for +5VDC will increase. Typically, four axes of encoders requires an additional 1.0 amp of current. The BMDC does not need any positive or negative 12VDC from the AT bus connection, but if an external device such as a "joy stick" is connected, then sufficient +/-12VDC current must be supplied.

The axis encoder line rate (line count times the encoder rotational speed) is limited to a rate of 127,000 lines per second. This limits the axis position counters to 508,000 counts per second.

An example:

A 1,000 line encoder at 3,000 RPM (50 revs/second) will generate a line rate of 50,000 lines per second or 200,000 counts per second.

Diagnostic Software Features

There are four types of diagnostics that are available for the BMDC board:

1. There are software routines that run on the DOS machine that can check the basic functionality of the BMDC by directly accessing the 68030's bus and its devices.

2. The 68030 has its own software routines within BMDC BOSS that also check the BMDC board. The 68030's routines run faster and are more extensive than the DOS based diagnostics.

3. There are checks performed by the BMDC software during normal operation that monitor the behavior of the system. If a run time check detects a problem, a note of the problem and the time and date are placed into the Event Queue. The Event Queue may be read with a program running on the DOS machine. The event queue is VOLATILE! If the system is powered down, the information in the queue is LOST.

4. The fourth type of diagnostic software is called the Window Monitor. The window monitor allows a technician to read and write memory and I/O on the BMDC while normal system operation continues. The Window Monitor consists of software that runs on the DOS machine and software that runs on the 68030. The two parts of the window monitor software communicate with each other through the dual port memory.

A Quick Check for Proper BMDC Operation

At Power-Up, the LED D1 should be ON and LED D10 should be OFF. When the BMDC is loaded with BOSS software and started, the LED D1 will turn off and D10 will Blink on and off. At the successful completion of the power up tests, LED D10 will begin to blink! LED D11 (if installed) will glow dimly during normal operation. If D11 is glowing brightly, then the 68EC030 has suffered a DOUBLE BUS FAULT or the board was reset.

Status LEDs

The BMDC boards have three status LEDs, a "RESET" LED, a "HALT" LED, and a "STATUS" LED. The Reset LED is on when the BMDC board is powered up or when the Host computer issues "RESET" command. The HALT LED is on if the BMDC is in a reset state or if the 68030 has detected a severe fault. Under normal conditions, the HALT LED will glow dimly. The STATUS LED is off at power up or after a RESET command. The 68030 power test software will blink this LED as it begins its BMDC tests. If the tests are successful, the status LED will blink on and off as the 68030 runs its normal system software.

BMDC3

Reset Led = D1 (next to U2, MC68882)
Halt Led = D2 (next to U2, MC68882)
Status Led = D3 (next to U21, 2681)

5.6.1 Function In The System

The BMDC has the basic function of controlling the position of the motors at all times. It does this by commanding the velocity of the axis motors through the AXSBOB card and receiving the output of the motor encoders and the Z-axis scale through the AXSBOB card. This board computes the new commanded position each 500 micro seconds and corrects the velocity of the motors to get there. This board also monitors the front panel switches and issues commands the control relay through the Encoder-I/O card.

5.8 ENCODER I/O CARD

The purpose of this board is to break out all the BMDC board connections. The Encoder-I/O board handles the general purpose low current inputs and outputs, Jog Knob, Axis Commands and encoder inputs.

The assigned use of these connectors is as follows.

JP2 returns the encoder signals from the X-axis.
JP3 returns the encoder signals from the Y-axis.
JP4 returns the encoder signals from the Z axis.
JP7 outputs the velocity command to the X, Y, and optional Z axis.
JP9 returns BMDC inputs.
JP10 BMDC outputs A and B. to X, Y and optional Z axis drive enable inputs.
JP11 Jog Knob input from Front Panel.

Function- The Encoder-I/O board delivers to the BMDC board the status of all the main interface switches. Over and above the front panel switches connected to it, as described above, the following signals are also connected to it.

Encoder I/O Outputs - The Encoder-I/O has two outputs called Output A and Output B. They are capable of sinking .5 amp of current up to 30 VDC. The power transistor for these outputs is located on the BMDC board.

Encoder Inputs - Each axis has an encoder to enable the BMDC to maintain the position on each axis.

Chapter 6. Axis Drive System

6.1 EZTRAK DRIVE SYSTEM

6.1.1 System Overview

The X axis and the Y axis on the EZTRAK are driven by two DC servo motors. These motors are equipped with an encoder and tachometer for position and speed control. The power to these motors is controlled by the X and Y axis power amplifier. The DC voltage for the motors is supplied by the amplifier. The control of the motor position, speed, and direction is done in the BMDC card through the Encoder I/O Board.

6.1.2 DC Servo Motors

The servo motors on the EZTRAK, when combined with the amplifiers in this design, are capable of producing 19 in.-lbs. of torque continuous, 30 in.-lbs. intermittent, and a peak of 50 in. lb. for 2.5 seconds. The tachometer output is 7 vdc at 1000 rpm. The encoder output is 250 lines of quadrature output with one index mark per revolution. The motors are geared to the lead screws by a 2 revolution of the motor to 1 revolution of the 5 pitch lead screw timing belt. The output of the encoder will be 500 lines for every revolution of the lead screw. The control will decode the quadrature input and multiply it by 4. This will yield a pulse count of 2000 pulses for each revolution of the lead screw, which will be 0.2 inches of linear motion. This enables the control resolution to be 0.0001 inches.

The index mark is used for homing the machine to X0.0 and Y0.0 in machine coordinates. This point is the reference for the software limits. When the machine is requested to home, first the Y axis and the X axis will travel in the positive direction until the home trip dog causes the home switch to close. The axis will continue to move until the control finds the next marker pulse on the encoder. At that time the control sets the move dimension to 0.2000 and continues to the home position. In the event that one or both of the axes has already tripped the home switch, that axis will travel in the negative direction until the trip dog clears the home switch. The axis will then return to home by the normal sequence described above.

6.1.3 Axis Power Amplifier

The axis power amplifier is rated at 160 vdc with a continuous output current of +/- 8 amps and a peak current of +/- 16 amps for 2.0 seconds. They are located on the bottom right side of the equipment panel. These amplifiers have 4 potentiometers to adjust their performance. Refer to the following information on AMC drive amplifiers. To adjust these pots in this control:

1. The current limit pot (Pot 2 if it is present) should be adjusted fully clockwise. Some models may not have this pot. In this case, the pot has been replaced by a fixed resistor and no ad justment is necessary.

2. The reference in gain pot must be adjusted before the current gain pot is adjusted. To adjust this pot, request the control to run the axis at 100 IPM. In the System Terminal adjust the the AT for 0 following error on the screen.

3. The current gain pot must be adjusted for minimum overshoot on the axis. Many times, this pot can be turned clockwise until the motor hums and backed off 2 turns.

4. The balance pot is adjusted with the axis at rest. Go to the system terminal and adjust the DAC offset number for 0. Refer to the section of this manual that deals with tests.

5. After the above settings have been completed, the following error must be set. To accomplish this,

input the FERROR program following the instructions on the screen to set up the axis. Set the machine in motion in the automatic mode. Go to system terminal and select the screen that displays the following error on both axis. Determine which axis has the least following error. Adjust that axis with the velocity gain pot to make the following error the same for each axis.

NOTE

To complete this section, review the following ADVANCED MOTION CONTROL USER GUIDE.

ADVANCED MOTION CONTROLS
Servo Amplifiers

USER'S GUIDE

WARNING

AVOID HUMAN CONTACT WITH THE POWER CONNECTOR (J2) AND THE HIGH VOLTAGE AREA OF THE AMPLIFIER, P.C. BOARD ANY TIME POWER IS APPLIED. ELECTRICAL SHOCK CAN RESULT!

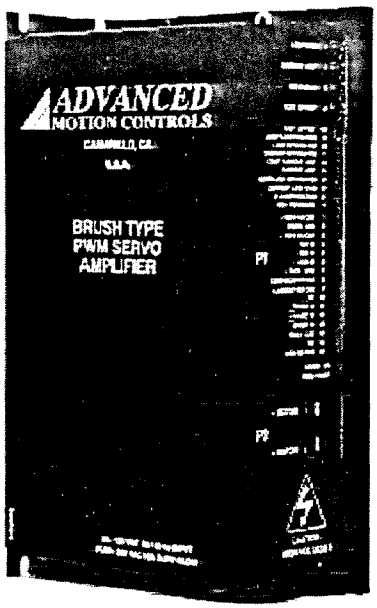
WAIT AT LEAST 3 MINUTES AFTER POWER HAS BEEN TURNED OFF BEFORE CONTACTING THE MOTOR OUTPUT LEADS.

DO NOT APPLY POWER WITH UNTERMINATED LEADS ATTACHED TO THE MOTOR OUTPUT TERMINALS ON J2.

AMPLIFIERS MUST BE OPERATED IN ENCLOSURES WHERE ACCESS BY PERSONNEL UNFAMILIAR WITH THE WARNINGS CONTAINED IN THIS MANUAL IS RESTRICTED.

INCORRECT SERVO PHASING CAN RESULT IN ERRATIC MOTOR MOTION. SERVO PHASING SHOULD BE ESTABLISHED BEFORE MOUNTING THE MOTOR IN THE MECHANISM.

SERIES 30A-AC SERVO AMPLIFIERS
Models: 30A20AC, 16A20AC
120VAC, 50-60 Hz Single Supply Operation

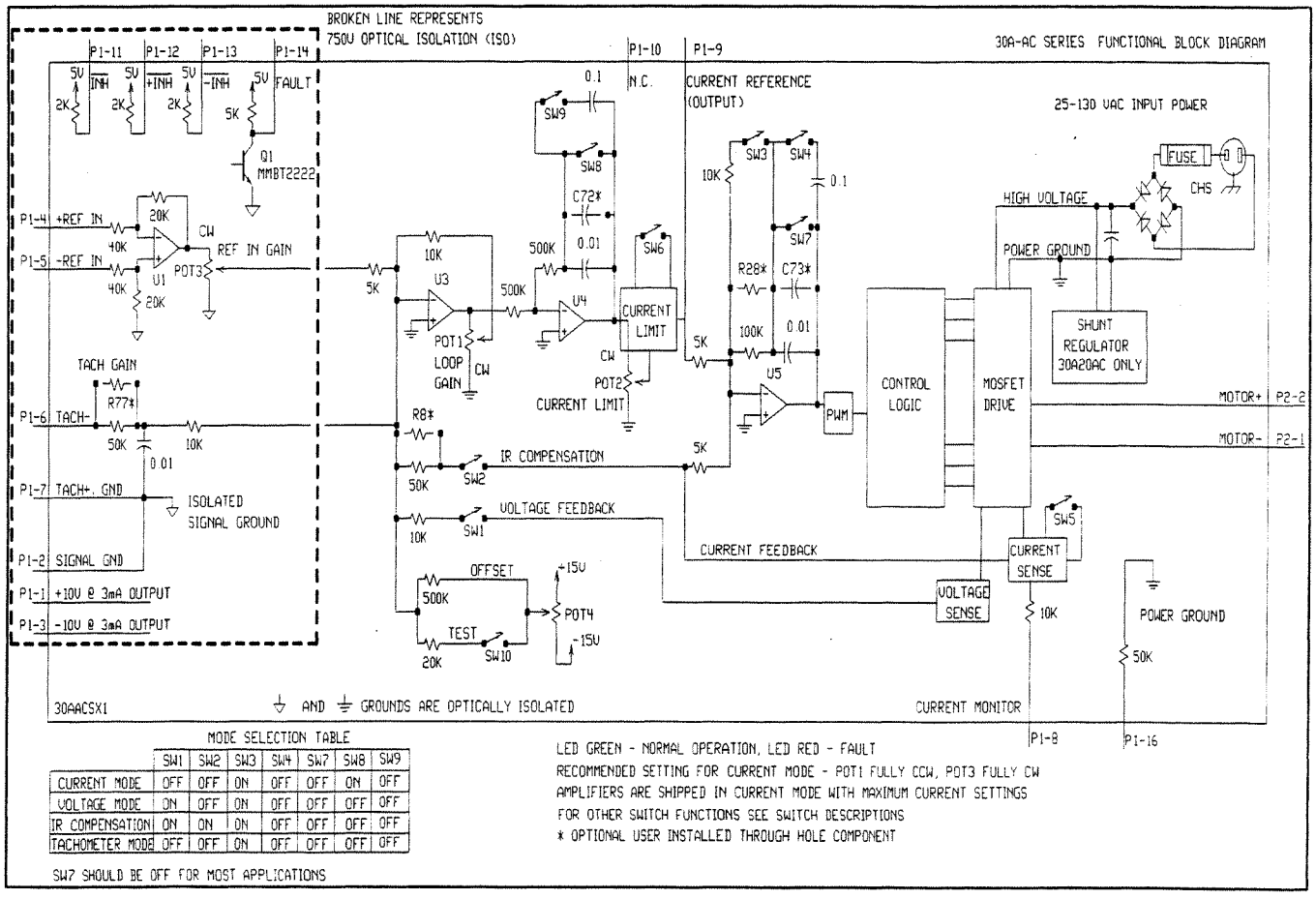


FEATURES:

- Surface-mount technology
- Small size, low cost, ease of use
- Built-in optical isolation, see block diagram
- Shunt regulator (30A20AC only)
- DIP switch selectable: current, voltage, velocity, IR compensation, analog position loop
- Four quadrant regenerative operation
- Agency Approvals:

c UL us CE

BLOCK DIAGRAM:



MODE SELECTION TABLE

	SW1	SW2	SW3	SW4	SW7	SW8	SW9
CURRENT MODE	OFF	OFF	ON	OFF	OFF	ON	OFF
VOLTAGE MODE	ON	OFF	ON	OFF	OFF	OFF	OFF
IR COMPENSATION	ON	ON	ON	OFF	OFF	OFF	OFF
TACHOMETER MODE	OFF	OFF	ON	OFF	OFF	OFF	OFF

SW7 SHOULD BE OFF FOR MOST APPLICATIONS

LED GREEN - NORMAL OPERATION, LED RED - FAULT
RECOMMENDED SETTING FOR CURRENT MODE - POT1 FULLY CCW, POT3 FULLY CW
AMPLIFIERS ARE SHIPPED IN CURRENT MODE WITH MAXIMUM CURRENT SETTINGS
FOR OTHER SWITCH FUNCTIONS SEE SWITCH DESCRIPTIONS
* OPTIONAL USER INSTALLED THROUGH HOLE COMPONENT

ADVANCED MOTION CONTROLS
3629 Vista Mercado, Camarillo, CA 93012 Tel: (805) 389-1935, Fax: (805) 389-1165

DESCRIPTION: The 30A-AC Series PWM servo amplifiers are designed to drive brush type DC motors at a high switching frequency. Single red/green LED indicates operating status. All models are fully protected against over-voltage, over-current, over-heating and short-circuits across motor, ground and power leads. These models interface with digital controllers or can be used as a stand-alone system. They require only a single AC power supply. Loop gain, current limit, input gain and offset can be adjusted using 14-turn potentiometers. The offset adjusting potentiometer can also be used as an on-board input signal for testing purposes when SW10 (DIP switch) is ON.

	MODELS	
POWER STAGE SPECIFICATIONS	**30A20AC**	**16A20AC**
SINGLE PHASE AC SUPPLY VOLTAGE *	30 – 125 VAC @ 50 - 60 Hz	
PEAK CURRENT (2 sec. Max., internally limited)	± 30 A	± 16 A
MAXIMUM CONTINUOUS CURRENT (internally limited)	± 15 A	± 8 A
MINIMUM LOAD INDUCTANCE**	250 µH	250 µH
SWITCHING FREQUENCY	22 kHz ± 15%	
HEATSINK (BASE) TEMPERATURE RANGE	-25° to +65° C, disables if > 65° C	
POWER DISSIPATION AT CONTINUOUS CURRENT	150 W	80 W
OVER-VOLTAGE SHUT-DOWN (self-reset)	195 VDC	
BANDWIDTH (load dependent)	2.5 kHz	
SHUNT REGULATOR TRIP VOLTAGE (30A20AC)	185 V = On, 180 V = Off	N/A
SHUNT RESISTOR	10 Ω @ 50 W	N/A
BUS CAPACITANCE	3600 µF	
BUS FUSE	15 A slow-blow rated @ 250 VAC	

MECHANICAL SPECIFICATIONS	
POWER CONNECTOR	Screw terminals
SIGNAL CONNECTOR	Molex connector
SIZE	7.35 x 4.23 x 2.45 inches 186.7 x 107.4 x 62.2 mm
WEIGHT	2.5 lb. 1.14 kg

* Do not exceed 125 VAC input.
**Low inductance motors ("pancake" and "basket-wound") require external inductors.

These amplifiers contain a rectifier bridge and filter capacitors to generate the DC bus internally from the AC input power. The DC bus voltage is 1.4 times AC voltage (RMS), e.g. 170 VDC from 120 VAC. During braking much of the stored mechanical energy is fed back into the power supply and charges the output capacitor to a higher voltage. If the charge reaches the amplifier's over-voltage shutdown point, output current and braking will cease. To ensure smooth braking of large inertial loads a built-in shunt regulator is provided in model 30A20AC. The shunt regulator will switch on the internal power resistor when the bus voltage reaches 185 VDC. This resistor then dissipates the extra energy of the DC bus.

PIN FUNCTIONS:

CONNECTOR	PIN	NAME	DESCRIPTION / NOTES	I/O
P1	1	+10V OUT	Outputs regulated voltages of ±10 V @ 3 mA for customer use. Short circuit protected. Pin P1-2 is signal ground.	O
	2	SIGNAL GND		SGND
	3	-10V OUT		O
	4	+REF IN	Differential analog input, maximum ±15 V, 40K input resistance.	I
	5	-REF IN		
	6	-TACH IN	Maximum ±60 VDC, 60K input resistance.	I
	7	+TACH (SGND)		
	8	CURRENT MONITOR OUT	This signal is proportional to the actual current in the motor leads. Scaling is 4A/V (2A/V when SW5 = OFF) for 16A20AC; and 8A/V (4A/V when SW5 = OFF) for 30A20AC. See current limit adjustment information below.	O
	9	CURRENT REFERENCE OUT	Command signal to the internal current-loop. The maximum peak current rating of the amplifier always equals 7.25V. See current limit adjustment information below.	O
	10	NC	Not connected	
	11	$\overline{\text{INHIBIT}}$	Inhibit. TTL, turns off all four power devices of the "H" bridge drive when pulled to ground. Will cause high FAULT and red LED. For inverted inhibit inputs; see section "G".	I
	12	$\overline{\text{+INHIBIT}}$	Inhibits the motor for "+" direction only. This function can be useful to remove power to the motor using a "limit switch". Will not cause high FAULT or red LED.	I
	13	$\overline{\text{-INHIBIT}}$	Inhibits the motor for "-" direction only. This function can be useful to remove power to the motor using a "limit switch". Will not cause high FAULT or red LED.	I
	14	FAULT OUT (red LED)	TTL compatible output. It becomes high during output short-circuit, over-voltage, over-heating, inhibit, and during "power-on reset". Fault condition indicated by a red LED.	O
	15	NC	Not connected	N/A
	16	NON-ISO GND	Connected to power ground and can be used as ground with P1-8 and P1-9.	PGND

SWITCH FUNCTIONS:

SWITCH	FUNCTION DESCRIPTION	SETTING	
		ON	OFF
1	Internal voltage feedback	On	Off
2	Internal current feedback for IR compensation	On	Off
3	Current loop gain	Decrease	Increase
4	Current loop integration	Increase	Decrease
5	Current scaling. When OFF, increases sensitivity of current sense thus reducing both peak and continuous current limit by 50%.	Full-current	Half-current
6	Can be used to reduce factory-preset maximum current limit.	Cont./Peak Ratio 25%	Cont./Peak Ratio 50%
7	It is recommended to leave SW7 in the OFF position.	Shorts out the current loop integrator capacitor	Current loop integrator operating
8	This capacitor normally ensures "error-free" operation by reducing the error-signal (output of summing amplifier) to zero.	Shorts out the outer velocity / voltage loop integrator capacitor.	Velocity/ Voltage integrator operating.
9	Adjusts the value of the integrator capacitor. It is recommended to leave SW9 in the OFF position for most applications.	Increase	Decrease
10	Offset / test. Controls sensitivity of the "offset" pot. Used as an on-board reference signal in test mode.	Test	Offset

POTENTIOMETER FUNCTIONS:

POTENTIOMETER	DESCRIPTION	TURNING CW
Pot 1	Loop gain adjustment in voltage & velocity modes.	Increases loop gain
Pot 2	Current limit. It adjusts both continuous and peak current limit by maintaining their ratio (50%).	Increases current limit
Pot 3	Reference gain. It adjusts the ratio between input signal and output variables (voltage, current, velocity).	Increases reference input gain
Pot 4	Offset / test. Used to adjust any imbalance in the input signal or in the amplifier. When SW10 (DIP switch) is ON, the sensitivity of this pot is greatly increased thus it can be used as an on-board signal source for testing purposes. See section "G".	N/A

TEST POINTS FOR POTENTIOMETERS: See section "G"

SET-UP: See section "G" for engineering and installation notes.

STANDARD INPUT SIGNAL ISOLATION:

These amplifiers feature an internally installed analog isolation amplifier, which optically isolates the inputs from the rest of the amplifier circuitry. See functional block diagram above.

OPERATING MODE SELECTION:

These modes can be selected by the DIP switches according to the chart in the functional block diagram:

- Current Mode
- Voltage Mode
- IR Compensation Mode
- Tachometer Mode

See section "G" for more information.

APPLICATION NOTE:

See section "G" for more information on analog position loop mode.

CURRENT LIMIT ADJUSTMENTS:

These amplifiers feature separate peak and continuous current limit adjustments.

The current limit adjusting Pot 2 adjusts both peak and continuous current limit at the same time. It has 12 active turns plus 1 inactive turn at each end and is approximately linear. Thus, to adjust the current limit, turn the potentiometer counter-clockwise to zero, then turn clockwise to the appropriate value. If the desired limit is, for example, 15 amperes, and the servo amplifier peak current is 30 amperes, turn the potentiometer 7 turns clockwise from zero.

Pin P1-9 is the input to the internal current amplifier stage. Since the output current is proportional to P1-9, the adjusted current limit can easily be observed at this pin. Note that a command signal must be applied to the reference inputs to obtain a reading on P1-9. The maximum peak current value equals 7.25V at this pin and the maximum continuous current value equals 3.625 at this pin. If SW5=ON, peak rated amplifier current=7.25 V. if SW5=OFF, 1/2 peak rated amplifier current =7.25 V. Example: using the 30A20AC with SW5=ON, 30A=7.25 V and with SW5=OFF, 15A=7.25 V.

The actual current can be monitored at pin P1-8.

SW6 (DIP switch) will reduce the continuous current limit to 50% of the maximum value, when switched ON. SW5 (DIP switch) will reduce the current feedback (monitor) scaling by 50% thereby reducing both the peak and the continuous current limit by 50%, when switched OFF.

TYPICAL SYSTEM WIRING: See section "G".

ORDERING INFORMATION:

Models: 16A20ACX, 30A20ACX

X indicates the current revision letter.

MOUNTING DIMENSIONS: See page F-11.

Engineering Reference

Part 1 Engineering Notes

INDEX

CAUTION: Exercise caution during maintenance and troubleshooting! Potentially lethal voltages exist within the amplifier and auxiliary assemblies. Only qualified technically trained personnel should service this equipment.

1. INTRODUCTION

1.1 Motion Control Systems

Motion control technology (sometimes also referred to as "robotics") is used in industrial processes to move a certain load in a controlled fashion. These systems can use either pneumatic, hydraulic, or electromechanical actuation technology. The choice of the actuator type (i.e. the device that provides the power to move the load) is based on power, speed, precision, and cost requirements. Electromechanical systems are typically used in high precision, low power, and high-speed applications. Such systems are flexible (e.g. programmable), efficient, and very cost-effective. The actuators used in electromechanical systems generate power through the interaction of electromagnetic fields and create either rotary or linear motion. Typically a complete system consists of the following components:

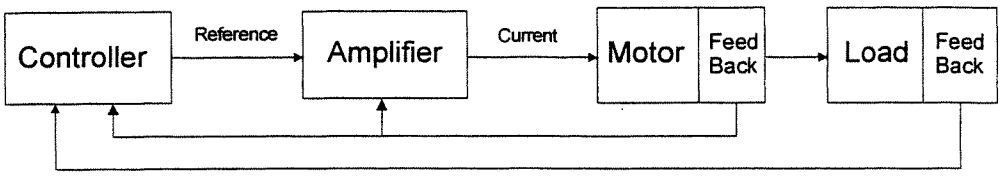


Figure 1 – Typical motion control system

The above figure shows the components typically used in a servo system (i.e. a feedback system used to control position, velocity, and/or acceleration). The controller contains the algorithms to close the desired servo loop and also handles machine interfacing (inputs/outputs, terminals, etc.). The amplifier represents the electronic power converter that drives the motor according to the controller reference signals. The motor (which can be of the brushed or brushless type, rotary or linear) is the actual electromagnetic actuator, which generates the forces required to move the load. Feedback elements are mounted on the motor and/or load in order to close the servo loop.

1.2 Servo Amplifiers

Servo amplifiers are used extensively in motion control systems where precise control of position and/or velocity is required. The amplifier basically translates the low-energy reference signals from the controller into high-energy signals (motor voltage and current). These reference signals can be either of an analog or digital nature. An analog +/-10 VDC signal is the most common. This signal can represent either a motor torque or velocity demand (see Amplifier Modes below).

1.2.1 Pulse Width Modulation (PWM)

Although there exist many ways to "amplify" electrical signals, pulse width modulation (or PWM) is by far the most efficient and cost-effective approach. At the basis of a PWM amplifier is a current control circuit that controls the output current by varying the duty cycle of the output power stage (fixed frequency, variable duty cycle). A typical setup is as follows (here for a single phase load):

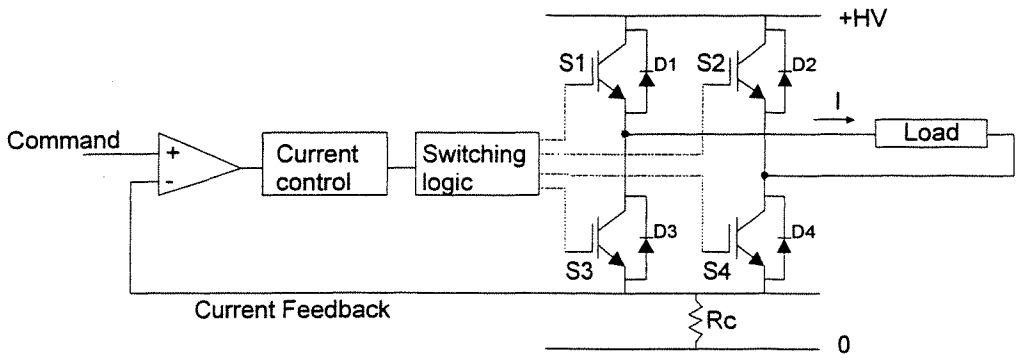


Figure 2 – PWM current control circuit

S1, S2, S3 and S4 are power devices (MOSFET or IGBT) that can be switched on or off. D1, D2, D3, and D4 are diodes, which guarantee current continuity. The bus voltage is depicted by +HV. The resistor Rc is used to measure the actual output current. For electric motors, the load is typically inductive (due to the windings used to generate electromagnetic fields). The current can be regulated in both directions (+ and -) by activating the appropriate switches. When switch S1 and S4 (or S2 and S3) are activated, current will flow in the positive (or negative) direction and increase. When switch S1 is off and switch S4 is on, (or S2 off and S3 on) current will flow in the positive (or negative) direction and decrease (via one of the diodes). The switch "ON"-time is determined by the difference between the current demand and the actual current. The current control circuit will compare both signals every time interval (typically 50 μsec or less) and activate the switches accordingly (this is done by the switching logic circuit, which also performs basic protection functions). The picture below shows the relationship between the pulse width (ON-time) and the current pattern. Note that the current rise time depends on the bus voltage (+HV) and the load inductance. Therefore, certain minimum load inductance requirements are necessary depending on the bus voltage.

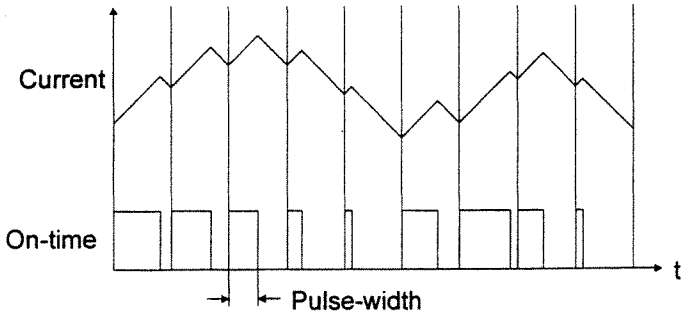


Figure 3 – Output current and duty cycle relationship

1.2.2 DC Brush Type Amplifiers

DC brush type amplifiers are designed for use with permanent magnet brushed DC motors (PMDC motors). The amplifier construction is basically as shown in figure 2 (single phase H-bridge). PMDC motors have a single winding (often called the armature) on the rotor, and permanent magnets on the stator (no field winding). Brushes and commutators maintain the optimum torque angle. The torque generated by a PMDC motor is proportional to the current, giving it excellent dynamic control capabilities in motion control systems.

Brushed DC amplifiers can also be used to control current in other inductive loads such as voice coil actuators, magnetic bearings, etc.

1.2.3 Brushless Amplifiers

Brushless amplifiers are used with brushless servo motors. These motors typically have a three-phase winding on the stator and permanent magnets on the rotor. Brushless motors require commutation feedback for proper operation (the commutators and brushes perform this "commutation" function in brush type motors). This feedback consists of rotor magnetic field orientation information, which can be supplied either by magnetic field sensors (Hall Effect sensors) or position sensors (encoder or resolver). Brushless motors have better power density ratings than brushed motors because heat is generated in the stator (shorter thermal path to the outside environment), not on the rotor. Also, the absence of brushes allows them be used in any environment. A typical system configuration is as follows:

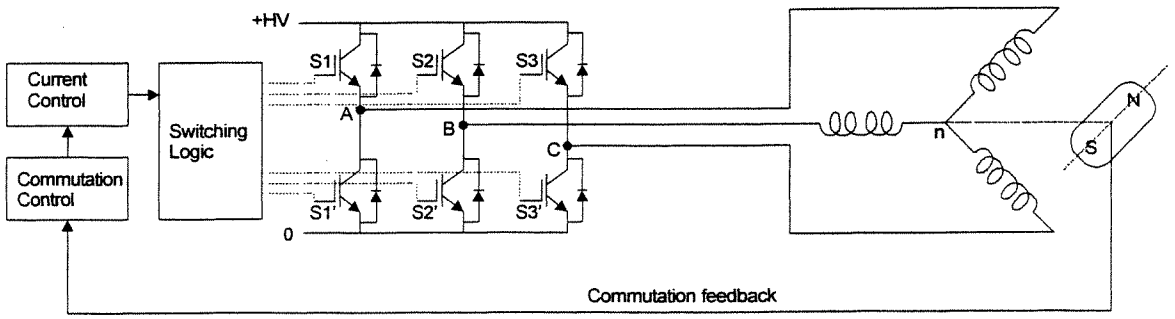


Figure 4 – Brushless servo system

DC Brushless Amplifiers (a.k.a. trapezoidal, 6-step)

DC brushless amplifiers use Hall Effect sensor signals for commutation feedback. The Hall Effect sensors (typically three) are built into the motor to detect the position of the rotor magnetic field. These sensors are mounted such that they each generate a square wave with 120-degree phase difference, over one electrical cycle of the motor. The amplifier drives two of the three motor phases with DC current during each specific Hall sensor state:

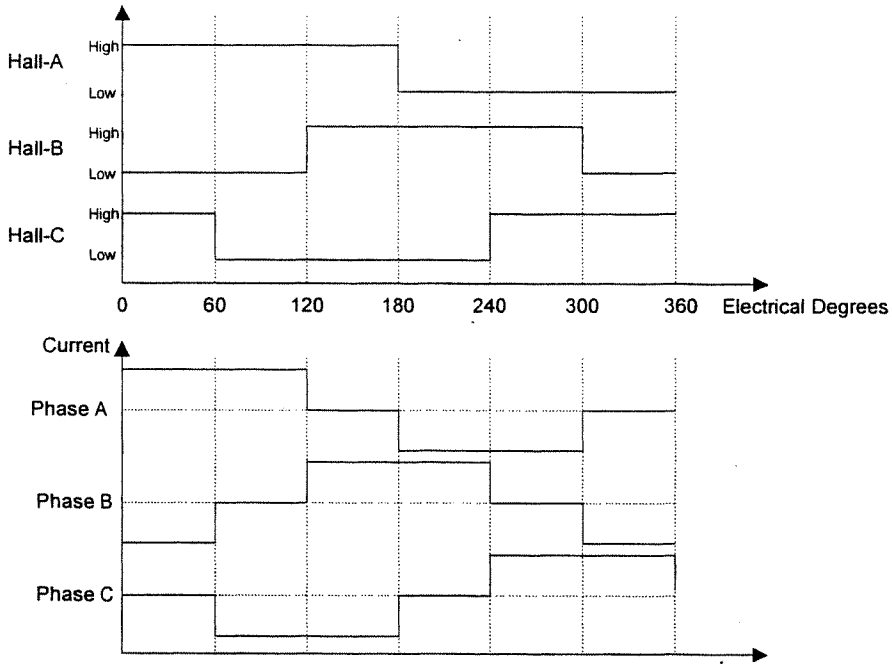


Figure 5 – Hall sensor based commutation

This commutation technique results in a very cost-effective amplifier. When used with motors with sinusoidal back-EMF, the torque ripple is about 13.4%. The average torque is 5% lower compared to a sinusoidal (or AC brushless) system, the peak torque however is 10% higher.

AC Brushless Amplifiers (a.k.a. sinusoidal, sine wave)

AC brushless amplifiers use encoder or resolver signals for commutation feedback. The amplifier drives the motor with sinusoidal currents, resulting in smooth motion (no torque ripple). The amplifier is more complex since it needs to accept high-resolution position feedback. Such amplifiers use a micro-controller implementation for the sinusoidal commutation.

When encoder feedback information is used for commutation, Hall Effect sensors are still needed for startup since the encoder provides only incremental position information. Resolvers provide absolute position information and therefore no additional sensors are required.

The commutation function can also be implemented in the motion controller. In such case, the amplifier merely amplifies the controller signals (2 analog sinusoidal signals that represent 2 of the 3 motor phase currents). The amplifier creates the third motor phase current (sum of the three currents must be zero). No position feedback needs to be wired into the amplifier. The motor current amplitude (Amperes) is proportional to the reference signal amplitude (Volts). The reference signal frequency depends on the motor velocity and the motor pole count. The phase angle is adjusted to obtain maximum torque. Amplifiers accepting 2 sinusoidal reference signals are sometimes also referred to as "non-commutating" or U-V amplifiers.

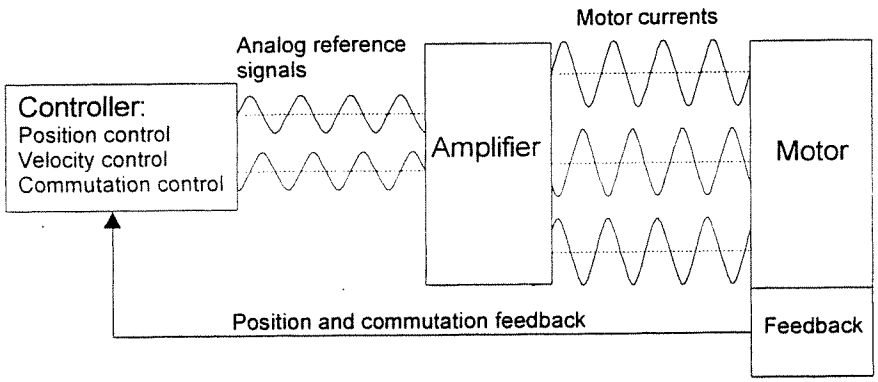


Figure 6 – Controller-based commutation

1.3 Amplifier Modes

Servo amplifiers can operate in most of the following modes:

AMPLIFIER MODE	CONTROLLED VARIABLE	FEEDBACK SOURCE
Open-loop Mode	Motor voltage	Duty cycle (internal)
Voltage Mode	Motor voltage	Voltage (internal)
IR Compensation Mode	Motor voltage	Voltage and current (internal)
Tachometer Velocity Mode	Motor speed	Tachometer
Hall Velocity Mode		Hall Sensors
Encoder Velocity Mode		Encoder
Current (torque) Mode	Motor current	Current (internal)
Analog Position Mode	Motor position	Potentiometer

The "controlled variable" means the physical parameter controlled by the input reference signal (+/-10 VDC).

- *Open-Loop Mode*

In this mode the input reference signal commands a proportional motor voltage (by changing the duty cycle of the output power stage). This mode is not a closed loop configuration (unlike the other modes described); therefore the average output voltage is also a function of the power-supply voltage.

- *Voltage Mode*

In voltage mode, the input reference signal commands a proportional motor voltage regardless of power supply voltage variations. This mode is recommended for velocity control when velocity feedback is unavailable and load variances are small.

- *IR Compensation Mode*

If in voltage mode there is a load torque variation, the motor current will vary, as torque is proportional to motor current. Hence, the motor terminal voltage will be reduced by the voltage drop over the motor winding resistance (IR), resulting in a speed reduction. Thus, motor speed - which is proportional to motor voltage (terminal voltage minus IR drop) - varies with the load torque.

In order to compensate for the internal motor voltage drop, a voltage proportional to motor current can be added to the output voltage. An internal resistor adjusts the amount of compensation. Use caution when adjusting the IR compensation level. If the feedback voltage is high enough to cause a rise in motor voltage with increased motor

current, instability occurs. Such result is due to the fact that increased voltage increases motor speed and thus load current which, in turn, increases motor voltage. If a great deal of motor torque change is anticipated, it may be wise to consider the addition of a speed sensor to the motor (e.g. tachometer, encoder, etc.).

- *Tachometer Velocity Mode*

The addition of a DC tachometer to the motor shaft produces a voltage proportional to speed. With this addition, the tachometer output voltage replaces the motor terminal voltage as the controlled variable. Since this voltage is proportional to the motor speed, this operating mode truly controls motor speed in a closed loop fashion.

- *Hall Velocity Mode*

The frequency of Hall sensors is proportional to the motor speed. In most brushless amplifier series, an internal circuit decodes velocity information from the motor mounted Hall sensors. This analog signal is available for closed loop velocity control. This mode does not provide good velocity control at low speeds (below 300 rpm for a 6-pole motor, 600 rpm for a 4-pole motor, or 900 rpm for a 2-pole motor) since the resolution of Hall sensor signals is not very high.

- *Encoder Velocity Mode*

The frequency of a motor mounted encoder is proportional to the motor speed. An internal circuit can decode velocity information from such encoder feedback. This analog signal is available for closed loop velocity control. Since the resolution of an encoder is much higher than of Hall Effect sensors, much better low speed regulation can be obtained.

- *Current (or Torque) Mode*

The current mode produces a torque output from the motor proportional to the input reference signal. Motor output torque is proportional to the motor current. Torque mode is recommended if the servo amplifier is used with a digital position controller (under this condition, a movement of the motor shaft from the desired position causes a large correcting torque, or "stiffness"). Therefore, this mode may produce a "run away" condition if operated without a digital position controller.

- *Analog Position Loop Mode*

In this mode the feedback device is an analog potentiometer mechanically tied to the positioned object, thus providing position feedback. The wiper of the potentiometer is connected to one of the differential input terminals (-REF). The command is an analog signal, which is connected to the other differential input terminal. It is recommended to use a tachometer to close the velocity loop. The input reference gain can be increased for the analog position mode by ordering the -ANP extension. Example: 12A8X-ANP. The following figure is a typical wiring diagram of the analog position mode:

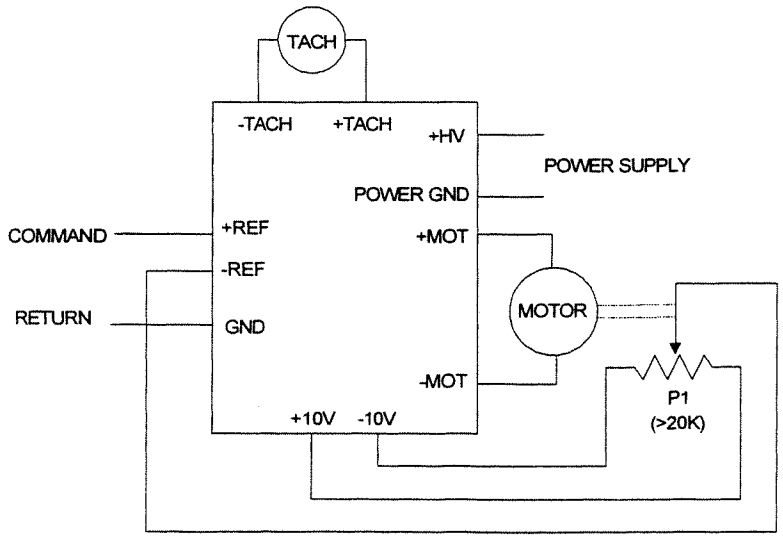


Figure 7 – Analog Position Loop Mode

2. COMPONENT SELECTION

2.1 Motor Type

The type of motor used depends on the application characteristics. Brushed DC motors are cost-effective, simple to use and install, and provide high power density. Drawbacks are brush wear and arcing (explosive environments). Brushless motors provide the same advantages as brushed DC motors. The absence of brushes reduces maintenance and allows them to be used in any type of environment. Brushless motors may require more wiring due to the commutation feedback requirements.

Determine motor voltage and current requirements, based on the maximum velocity and torque. Torque and velocity can be derived from the application move profiles. Both maximum torque and RMS (Root Mean Square) torque need to be calculated. RMS torque can be calculated by plotting torque versus time for one move cycle.

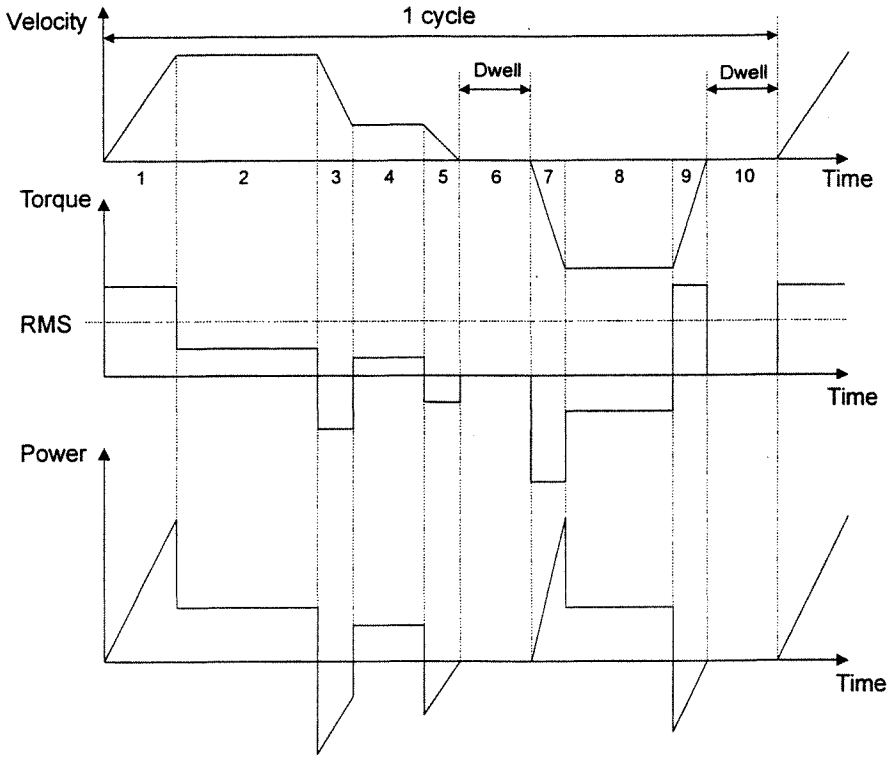


Figure 8 – Torque, velocity and power curves

RMS torque is calculated as follows:

$$T_{RMS} = \sqrt{\frac{\sum_i T_i^2 * t_i}{\sum_i t_i}}$$

Here T_i is the torque and t_i the time during segment i. In the case of a vertical application, make sure to include the torque required to overcome gravity.

In general, the motor voltage is proportional to the motor speed and the motor current is proportional to the motor shaft torque. Linear motors exhibit the same behavior, except that in their case force is proportional to current. These relationships are described by the following equations:

$V_t = I_m * R_m + E$
$E = K_e * S_m$

$T = K_t * I_m$ for rotary motors or
$F = K_f * I_m$ for linear motors

With:

V_t	Terminal Voltage [V]
I_m	Motor Current [A]
R_m	Motor Winding Resistance [Ω]
E	Back-EMF Voltage [V]
T	Motor Torque [Nm or lb.-in]
F	Motor Force [N or lb.]
K_t	Motor Torque Constant [Nm/A or lb.-in/A]
K_f	Motor Force Constant [N/A or lb./A]
K_e	Voltage Constant [V/Krpm or V/m/s]
S_m	Motor Speed [rpm or m/s]

The motor manufacturer's data sheets contain K_t (or K_f) and K_e constants. Pay special attention to the units used (metric vs. English) and the amplitude specifications (peak-to-peak vs. RMS, phase-to-phase vs. phase-to-neutral).

The maximum motor terminal voltage and current can be calculated from the above equations. For example, a motor with a K_e = 10V/Krpm and required speed of 3000 rpm would require 30V to operate. In this calculation the IR term (voltage drop across motor winding resistance) is disregarded.

Maximum current is maximum torque divided by K_t. For example, a motor with a K_t = 0.5 Nm/A and maximum torque of 5 Nm would require 10 Amps of current. Continuous current is RMS torque divided by K_t.

In the above equations, the motor inductance is neglected. In brushless systems, the voltage drop caused by the motor inductance can be significant. This is the case in high-speed applications, if motors with high inductance and high pole count are used. Please use the following equation to determine motor terminal voltage (must be interpreted as a vector):

$$V_t = (R_m + j * \omega * L) * I_m + E$$

Where:

L	phase-to-phase motor inductance [Henry]
ω	maximum motor current frequency [rad/s]

2.2 Amplifier

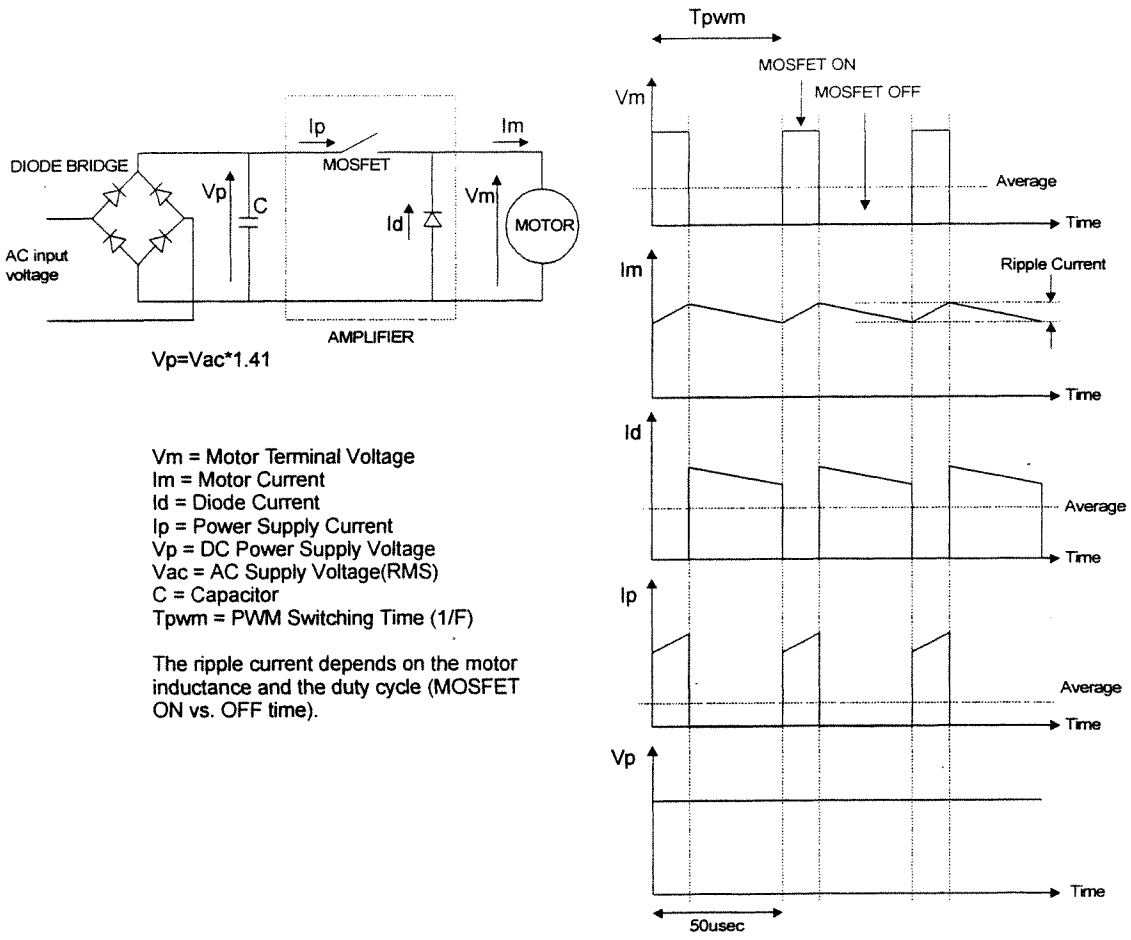
The amplifier voltage and current ratings are determined from the maximum voltage and the maximum and continuous motor current. It is recommended to select an amplifier with a voltage rating of at least 20% higher than the maximum voltage to allow for regenerative operation and power supply variations. The amplifier peak (and continuous) current rating should exceed the maximum (and continuous) motor current requirements.

2.3 Power Supply

It is recommended to select a power supply voltage that is about 10 to 50% higher than the maximum required voltage for the application. This percentage is to account for the variances in K_t, K_e and losses in the system external to the amplifier. The selected margin depends on the system parameter variations. Sometimes a power supply is not available with the required voltage. In these cases it is necessary to choose a higher value. Make sure not to select a supply voltage that could cause a mechanical over-speed in the event of an amplifier malfunction or a runaway condition. Caution: brushed motors may have voltage limitations due to the mechanical commutators. Consult the motor manufacturer's data sheets.

The average DC power supply current is not the same as the motor current! See figure 9 below.

The power supply current is a pulsed DC current: when the MOSFET switch is on, it equals the motor current; when the MOSFET is off it is zero. Therefore, the power supply current is a function of the PWM duty-cycle and the motor current, e.g. 30% duty cycle and 12 Amps motor current will result in 4 amps power supply current. 30% duty cycle also means that the average motor voltage is 30% of the DC bus voltage. Power supply power is approximately equal to amplifier output power plus 3 to 5%.



Vp=Vac*1.41

Vm = Motor Terminal Voltage
Im = Motor Current
Id = Diode Current
Ip = Power Supply Current
Vp = DC Power Supply Voltage
Vac = AC Supply Voltage(RMS)
C = Capacitor
Tpwm = PWM Switching Time (1/F)

The ripple current depends on the motor inductance and the duty cycle (MOSFET ON vs. OFF time).

Figure 9 – Unregulated power supply current

2.4 Regenerative Operation

During braking (deceleration or a downward vertical move), the amplifier returns the system's kinetic and potential energy (motor + load) to the power supply capacitor and in the process can charge the capacitor to potentially dangerous voltages or voltages that may cause an amplifier over-voltage shutdown condition. Consequently, power supplies should have sufficient capacitance to absorb this energy without causing an over-voltage fault. For applications with extremely large inertial loads, use of a "shunt regulator" may be necessary to dissipate the kinetic and potential energy of the load. The shunt regulator is connected to the DC bus to monitor the voltage. When a preset trip voltage is reached, a power resistor R is connected across the DC bus by the shunt regulator circuit to discharge the bus capacitor. The electric energy, stored in the capacitor, is thereby transformed into heat (I^2R).

The kinetic energy of a rotating system is $1/2J\omega^2$ (Joule) where J is the total system inertia (motor + load, kg-m^2) and ω is the motor speed (rad/s). The potential energy is m*g*h, where m is the mass (kg), g is the gravity constant (9.81 m/s^2), and h is the vertical displacement (m). During regeneration this energy will be stored in the power supply's capacitor. The voltage increase caused by this regeneration can be calculated as follows (worst-case calculation, not accounting for system losses):

At the nominal bus voltage the energy stored in the capacitor is $1/2CV^2_{nom}$ (C is the capacitance in Farad). Regeneration will increase this energy level by $1/2J\omega^2$ + m*g*h. The new bus voltage V can be calculated from this new energy level:

$$\frac{1}{2}CV^2 = \frac{1}{2}CV_{nom}^2 + \frac{1}{2}J\omega^2 + m*g*h$$

$$V = \sqrt{V_{nom}^2 + J\frac{\omega^2}{C} + \frac{2*m*g*h}{C}}$$

This new bus voltage must be below the power supply capacitance voltage rating and the over-voltage limit. If this is not the case, a shunt regulator is necessary. A shunt regulator is sized in the same way as a motor or amplifier i.e. continuous and RMS power dissipation must be determined. The power dissipation requirements can be calculated from the application move profile (see figure 8).

Engineering Reference

Part 2 Installation Notes

INDEX

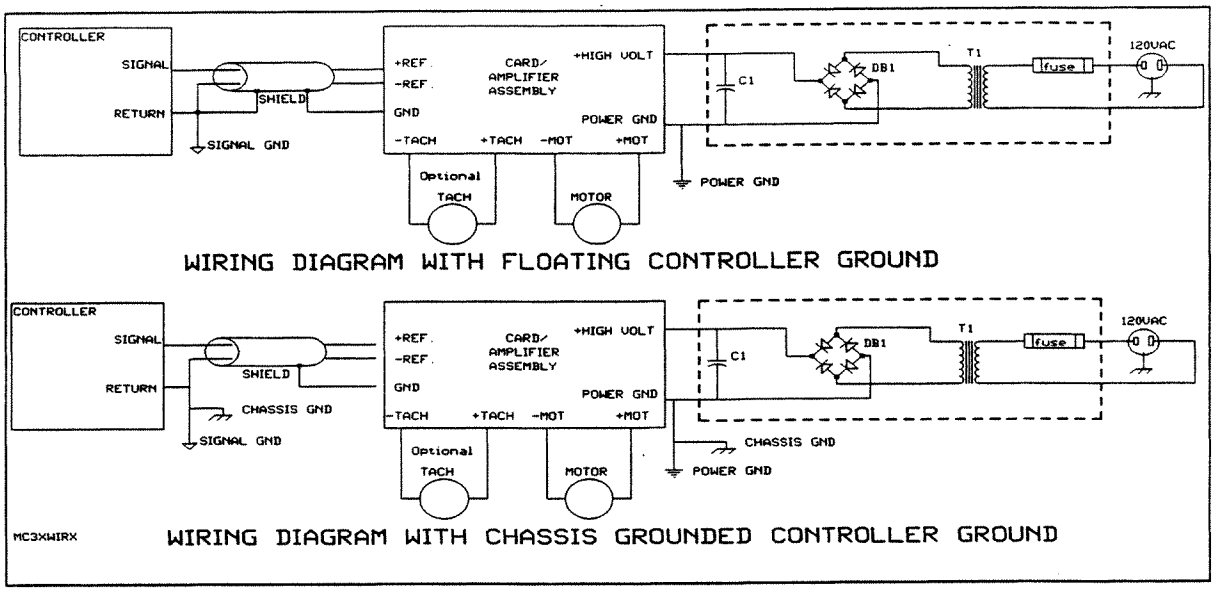
CAUTION: Exercise caution during maintenance and troubleshooting! Potentially lethal voltages exist within the amplifier and auxiliary assemblies. Only qualified technically trained personnel should service this equipment.

3. WIRING INSTRUCTIONS

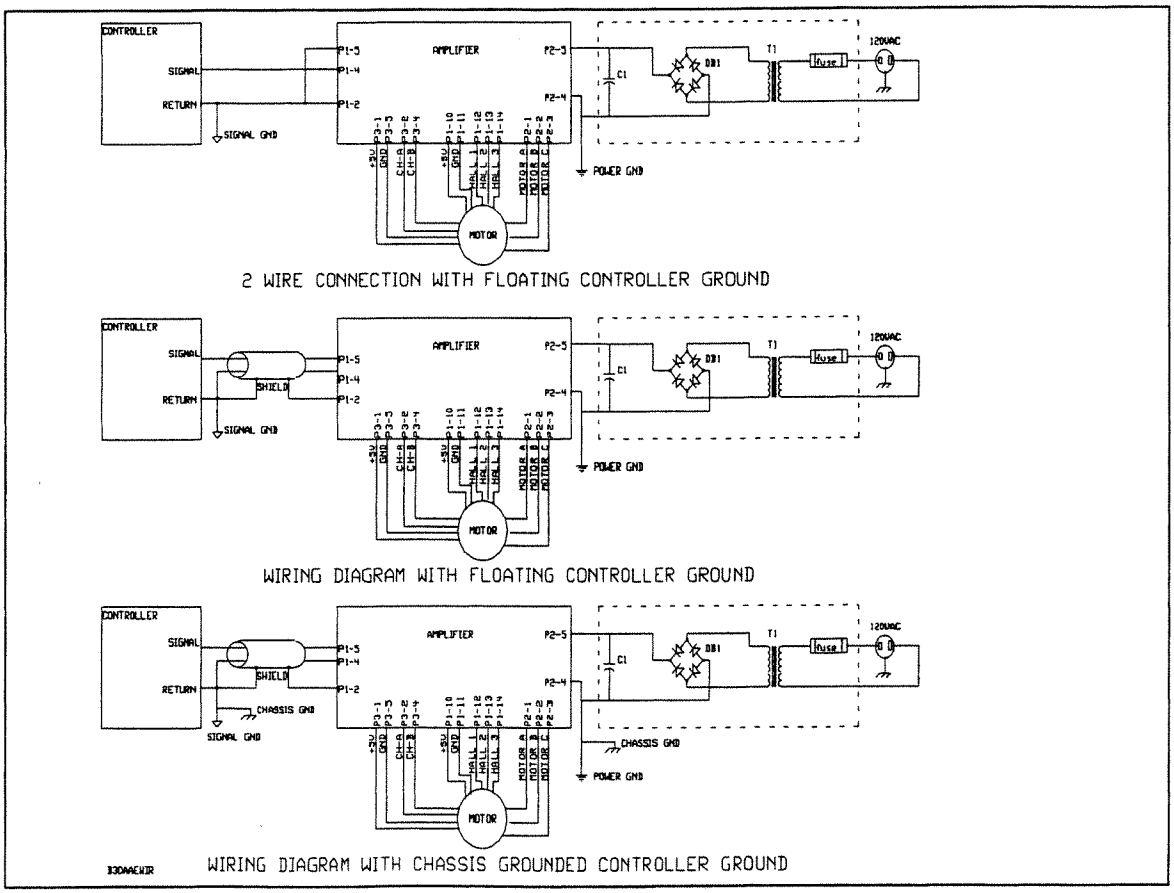
3.1 Typical Wiring Diagrams

The following schematics show typical amplifier wiring configurations:

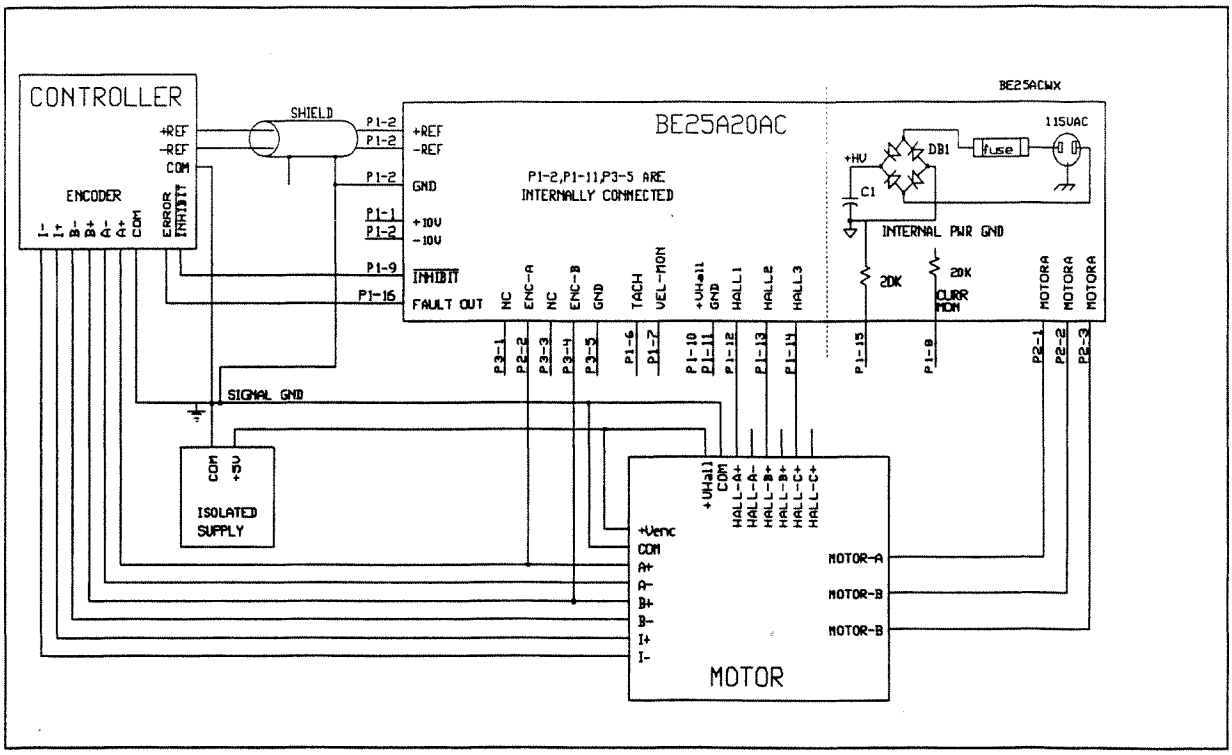
BRUSH TYPE AMPLIFIERS:



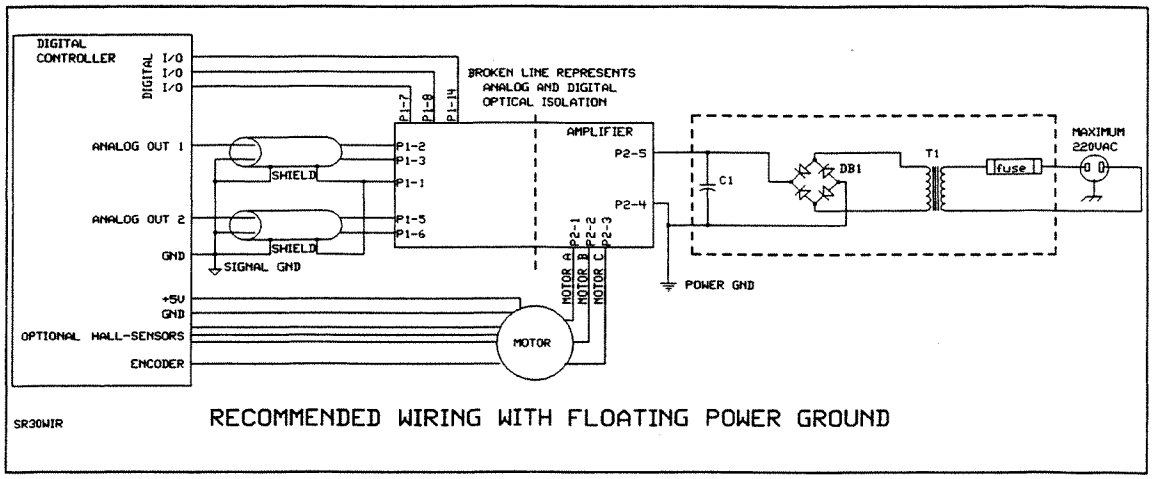
BRUSHLESS AMPLIFIERS:



BRUSHLESS AMPLIFIERS WITH ENCODER:



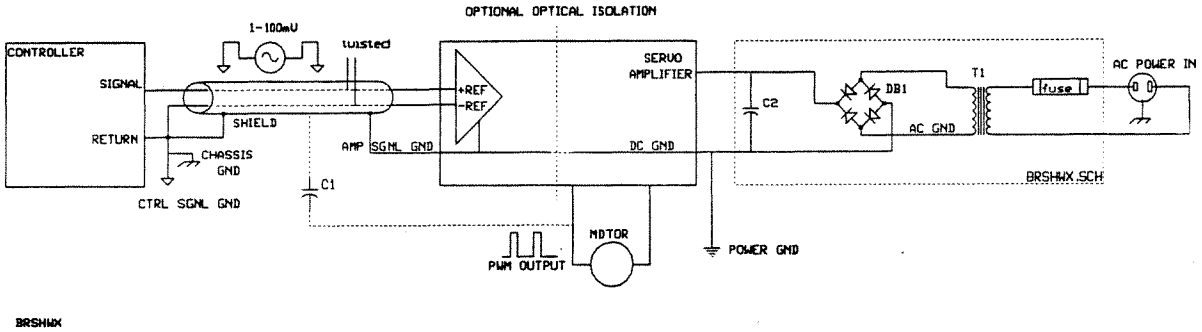
S SERIES BRUSHLESS AMPLIFIERS:



3.2 Noise considerations and system grounding

"Noise" in the form of interfering signals can be coupled:

- Capacitively (electrostatic coupling) onto signal wires in the circuit (the effect is more serious for high impedance points).
- Magnetically to closed loops in the signal circuit (independent of impedance levels).
- Electromagnetically to signal wires acting as small antennas for electromagnetic radiation.
- From one part of the circuit to other parts through voltage drops on ground lines.



WIRING DIAGRAM

The preceding wiring diagrams show a typical servo system using an *ADVANCED* MOTION CONTROLS servo amplifier.

Experience shows that the main source of noise is the high DV/DT (typically about 1V/nanosecond) of the amplifier's output power stage. This PWM output can couple back to the signal lines through straight capacitance "C1" between output and input wires. The best methods are to reduce capacitance between the offending points (move signal and motor leads apart), add shielding and use differential inputs at the amplifier. For extreme cases use of a filter card is recommended (see section E).

Unfortunately low-frequency magnetic fields are not significantly reduced by metal enclosures. Typical sources are 50 or 60 Hz power transformers and low frequency current changes in the motor leads. Avoid large loop areas in signal, power-supply and motor wires. Twisted pairs of wires are quite effective in reducing magnetic pick-up because the enclosed area is small, and the signals induced in successive twist cancel.

Aside from overall shielding the best way to reduce radio frequency coupling is to keep leads short.

The voltage source shown between the amplifier and controller grounds typically consists of some 60Hz voltage, harmonics of the line frequency, some radio-frequency signals, IR drops and other "ground noise". The differential inputs of the servo amp will ignore the small amount of "ground signal".

Long signal wires (10-15 feet and up) can also be a source of noise when driven from a typical OPAMP output. Due to the inductance and capacitance of the wire the OPAMP output can oscillate. It is always recommended to set a fixed voltage at the controller and then check the signal at the amplifier with an oscilloscope to make sure that the signal is noise free.

Servo system wiring typically involves wiring a controller (digital or analog), a servo amplifier, a power supply, and a motor. Wiring these servo system components is fairly easy when a few simple rules are observed.

The signal ground of the controller (CTRL SGNL GND) must be connected to the signal ground of the servo amplifier (AMP SGNL GND) either directly or through chassis ground, to avoid noise pick up due to the "floating" differential servo amplifier input.

It is recommended that the signal and power wires are routed in a separate cable harness.

In most servo systems all the grounds are connected to a single chassis ground (normally the same as Earth ground). In the power section there are two grounds "DC GND" and "AC GND" (see wiring diagram). Either of these grounds can be connected to "CHASSIS GND". If the system design requires that "AC GND" is connected to "CHASSIS GND" then the servo amp must have internal optical isolation in order to connect "CTRL SGNL GND" or "AMP SGNL GND" to "CHASSIS GND". This optical isolation is required to avoid a short across the diode-bridge "DB1", through "DC GND".

For servo amplifiers without optical isolation, if "DC GND" and "AMP SGNL GND" are connected to "CHASSIS GND" then it is not necessary to connect the signal wire shield to "AMP SGNL GND" because these grounds are then connected through the chassis.

⚠ **The grounding design is ultimately the responsibility of the user.**

3.3 DC Power Supply Wiring

All *ADVANCED* MOTION CONTROLS servo amplifiers operate from a single polarity unregulated DC power supply. Reservoir capacitance of 2,000 µF/ampere of maximum output current will reduce ripple to 4Vp-p at 120 Hz (single phase AC input).

The PWM current spikes generated by the power output-stage are supplied by the internal power supply capacitors. In order to keep the current ripple on these capacitors to an acceptable level it is necessary to use heavy power supply leads and keep them as short as possible. If the power supply leads exceed 3 feet then the amplifier must be "by passed" by a capacitor of at least 1000 µF within one foot of the servo amp. Reduce the inductance of the power leads by twisting them.

When multiple amplifiers are installed in a single application, precaution regarding ground loops must be taken. Whenever there are two or more possible current paths to a ground connection, damage can occur or noise can be introduced in the system. The following rules apply to all multiple axis installations, regardless of the number of power supplies used:

1. Run separate power supply leads to each amplifier directly from the power supply filter capacitor.
2. Use the differential input to the amplifier to avoid common mode noise.
3. Never "daisy-chain" any power or DC common connections. Use a "star"-connection instead.

3.4 Motor Wiring

Use of a twisted, shielded pair for the motor power cables is recommended. Ground the shields to the amplifier's chassis ground and to the motor's frame. The motor power input leads are connected to the amplifier's output.

⚠ **CAUTION: DO NOT use wire shield to carry motor current or power!**

3.5 Tachometer Wiring

Use of a twisted, shielded pair for the tachometer wires is recommended. Ground the shield at one end only to the amplifier's +tach input (tachometer ground).

3.6 Input Reference Wiring

Use of a twisted, shielded pair for the input reference wires is recommended. If the reference source can float (remain ungrounded), connect the cable shield to both the reference source common and the amplifier's signal ground. It is recommended that the input be connected directly to the amplifier's differential input (if applicable). Connect the reference source "+" to "+ref input", and the reference source "-" (or common) to "-ref input". If the reference source ground and the amplifier power ground are connected to the master chassis ground, leave the source end of the shield unconnected. The servo amplifier's reference input circuit will attenuate the common mode voltage between signal source and amplifier power grounds. In case of a single ended reference signal, connect the command signal to "+ref" and connect the command return and "-ref" to the signal ground

3.7 Reference Potentiometer Wiring

An external potentiometer can be used in conjunction with the amplifier's onboard signal voltage (±10 V @ 3 mA or ± 5 mA @ 3 mA) to supply a command signal to the amplifier. A 50 KΩ potentiometer is recommended. The potentiometer used should not be less than 20 KΩ. This potentiometer should be wired between the +10V (or +5V) and the -10V (or 5V) output with the wiper wired to the "+ ref" or "- ref" input. The other reference input can remain floating or can be tied to the signal ground. To have a single polarity command source use only the +10V (or +5V) or the -10V (-5V) output and wire the other lead of the potentiometer to the signal ground.

3.8 *Mating Signal Connectors*

The mating connector part number for the 16 pin I/O "Molex" connector part number 22-12-2164 is:

- Molex plastic body : 22-01-3167 Insert terminals : 08-50-0114

The mating connector part number for the 5 pin I/O encoder Connector part number is 22-12-2054 is:

- Molex plastic body: 22-01-3057 Insert terminals: 08-50-0114

Standard crimping hand tool "Molex" part number 11-01-0185.

See amplifier data sheets for appropriate D-shell connectors.

3.9 CE-EMC Wiring Requirements

Additional Installation Instructions Necessary for Meeting EMC Requirements:

General

1. Shielded cables must be used for all interconnect cables to the amplifier and the shield of the cable must be grounded at the closest ground point with the least amount of resistance.

2. The amplifier's metal enclosure must be grounded to the closest ground point with the least amount of resistance.

3. The amplifier must be mounted in such a manner that the connectors and exposed printed circuit board are not accessible to be touched by personnel when the product is in operation. If this is unavoidable there must be clear instructions that the amplifier is not to be touched during operation. This is to avoid possible malfunction due to electrostatic discharge from personnel.

Analog Input Amplifiers

4. A Fair Rite model 0443167251 round suppression core must be fitted to the low-level signal interconnect cables to prevent pickup from external RF fields.

PWM Input Amplifiers

5. A Fair Rite model 0443167251 round suppression core must be fitted to the PWM input cable to reduce electromagnetic emissions.

MOSFET Switching Amplifiers

6. A Fair Rite model 0443167251 round suppression core must be fitted to the motor cable connector to reduce electromagnetic emissions.

7. An appropriately rated Schaffner 2080 series AC power filter in combination with a Fair Rite model 5977002701 torroid (placed on the supply end of the filter) must be fitted to the AC supply of any MOSFET amplifier system in order to reduce conducted emissions fed back into the supply network.

IGBT Switching Amplifiers

8. An appropriately rated Schaffner 2070 series AC power filter in combination with a Fair Rite model 0443167251 round suppression core (placed on the supply end of the filter) must be fitted to the AC supply of any IGBT amplifier system in order to reduce conducted emissions fed back into the supply network.

9. A Fair Rite model 0443164151 round suppression core and model 5977003801 torroid must be fitted at the motor cable connector to reduce electromagnetic emissions.

Fitting of AC Power Filters

10. The above mentioned AC power filters should be mounted flat against the enclosure of the product using the two mounting lugs provided on the filter. Paint should be removed from the enclosure where the filter is fitted to

ensure good metal to metal contact. The filter should be mounted as close to the point where the AC power enters the enclosure as possible. Also the AC power cable on the load end of the filter should be routed as far from the AC power cable on the supply end of the filter and all other cables and circuitry to minimize RF coupling.

For reference purposes, the Technical Construction File Number is TCF No. J97001250.007 (Rev 1).

Below is contact information of filter and torroid suppliers:

Schaffner
Schaffner Elektronik AG
CH-4708 Luterbach
Switzerland
Phone: +41-65-802-626
Fax: +41-65-802-641

Fair Rite
P.O. Box J
One Commercial Row
Wallkill NY 12589
Phone: (914)-895-2055
Fax: (914)-895-2629
E-Mail: ferrites @fair-rite.com

USA (East Coast)
Phone: (201)-379-7778
Fax: (201)-379-1151

USA (West Coast)
Phone: (714)-457-9400
Fax: (714)-457-9510

3.10 CE-LVD Wiring Requirements

Instructions Necessary for Meeting LVD Requirements

The servo amplifiers covered in the LVD Reference report were investigated as components intended to be installed in complete systems that meet the requirements of the Machinery Directive. In order for these units to be acceptable in the end users equipment, the following conditions of acceptability must be met:

A. European approved overload and over current protection must be provided for the motors as specified in section 7.2 and 7.3 of EN60204.1.

B. A disconnect switch shall be installed in the final system as specified in section 5.3 of EN60204.1.

C. All amplifiers that do not have a grounding terminal must be installed in, and conductively connected to a grounded end use enclosure in order to comply with the accessibility requirements of section 6, and to establish grounding continuity for the system in accordance with section 8 of EN60204.1.

D. A disconnecting device that will prevent the unexpected start-up of a machine shall be provided if the machine could cause injury to persons. This device shall prevent the automatic restarting of the machine after any failure condition shuts the machine down.

E. European approved over-current protective devices must be installed in line before the amplifier, these devices shall be installed and rated in accordance with the installation instructions (the installation instructions shall specify an over current protection rating value as low as possible, but taking into consideration inrush currents, etc.). Amplifiers that incorporate their own primary fuses do not need to incorporate over current protection in the end users equipment.

These items should be included in your declaration of incorporation as well as the name and address of your company, description of the equipment, a statement that the amplifiers must not be put into service until the machinery into which they are incorporated has been declared in conformity with the provisions of the Machinery Directive, and identification of the person signing.

4. CAUTIONARY NOTES

DO NOT REVERSE THE POWER SUPPLY LEADS! SEVERE DAMAGE WILL RESULT!

- **USE SUFFICIENT CAPACITANCE!**

Pulse width modulation (PWM) amplifiers require a capacitor on the high voltage supply to store energy during the PWM switching process. Therefore, a 1000 μF (minimum value) capacitor is needed within one foot of wire length, in parallel with the high voltage supply of the amplifier module.

Insufficient power supply capacitance causes problems particularly with high inductance motors. During braking much of the stored mechanical energy is fed back into the power supply and charges its output capacitor to a higher voltage. If the charge reaches the amplifier's over-voltage shutdown point, output current and braking will cease. At that time energy stored in the motor inductance continues to flow through diodes in the amplifier to further charge the power supply capacitor. The voltage rise depends upon the power supply capacitance, motor speed, and inductance.

A 2 mH motor at 20 amperes can charge a 2000 μF capacitor an additional 30 VDC. An appropriate capacitance is typically 2000 μF/A maximum output current for a 50 V supply.

For battery supplied bus voltages, contact factory for capacitance requirements.

- **MAKE SURE MINIMUM INDUCTANCE REQUIREMENTS ARE MET!**

Pulse width modulation (PWM) servo amplifiers deliver a pulsed output that requires a minimum amount of load inductance to ensure that the DC motor current is properly filtered. The minimum inductance values for different amplifier types are shown in the individual data sheet specifications. If the amplifier is operated below maximum rated voltage, the minimum load inductance requirement may be reduced. Most servo motors have enough winding inductance. Some types of motors (e.g. "basket-wound", "pancake", etc.) do not have a conventional iron core rotor, so the winding inductance is usually less than 50 μH.

If the motor inductance value is less than the minimum required for the selected amplifier, use of an external filter card is necessary (see section "F").

- **DO NOT ROTATE THE MOTOR SHAFT WITHOUT POWER SUPPLIED TO THE AMPLIFIER!**

The motor acts as a generator and will charge up the power supply capacitors through the amplifier. Excessive speeds may cause over-voltage breakdown in the output power devices. Note that an amplifier having an internal power converter that operates from the high voltage supply will become operative.

- **DO NOT SHORT THE MOTOR LEADS AT HIGH MOTOR SPEED!**

When the motor is shorted, its own generated voltage may produce a current flow as high as 10 times the amplifier peak current. The short itself should not damage the amplifier but may damage the motor. If the connection arcs or opens while the motor is spinning rapidly, this high voltage pulse flows back into the amplifier (due to stored energy in the motor inductance) and may damage the amplifier.

5. SET-UP INSTRUCTIONS

5.1 Precautions

Do not install the amplifier without first determining that all chassis power has been removed for at least 10 seconds. Never remove an amplifier from an installation with power applied.

⚠ **To ensure reliable operation, the wiring and cautionary notes must be reviewed prior to set up.**

5.2 Brush Type Setup Instructions

ADVANCED **MOTION CONTROLS** amplifiers are designed to operate in a self-test mode, using the "offset" potentiometer to control an on-board signal source.

This test can be used to confirm that the amplifier is functionally operational. Read the setup instructions before applying power:

1. **Review cautionary notes and wiring section before proceeding.**
2. It is recommended to reduce the amplifier output current to avoid motor over heating during the setup procedure.
3. Connect power. Do *not* connect the motor yet!
4. Check that the LED indicates normal operation (green).
5. Set mode according to data sheet for voltage mode.
6. Set offset/test switch ON. Measure the voltage across motor output with a DC voltmeter, turn the "test" potentiometer. Voltage should vary between +/- bus voltage. Set the output voltage with the "test" potentiometer to a low value before connecting the motor leads.
7. Set current limit according to motor specifications. See amplifier data sheets for current limiting options.
8. Verify that the load circuit meets minimum inductance requirements and that the power supply voltage does not exceed amplifier rated voltage or 150% of the nominal motor voltage.
9. Turn the power off. Connect the motor. Turn the power back on. "Tweak" the "test" potentiometer to change motor speed in both directions. Set the offset/test switch OFF.
10. Ground both reference inputs and then using the offset pot, set motor for zero speed.
11. Set mode suitable for your application.

5.3 Brushless Amplifier Setup Instructions (trapezoidal and sinusoidal):

5.3.1 Trapezoidal Amplifiers

Read the setup instructions before applying power:

1. **Review cautionary notes and wiring instructions prior to set up.**
2. It is recommended to reduce the amplifier output current to avoid motor over heating during the setup procedure.
3. According to mode selection table, select *open-loop mode* and set offset/test switch ON.
4. Set current limit according to the motor specifications. See amplifier data sheets for current limiting options.
5. Check power and connect it to the amplifier. Do *not* connect motor lead wires.
6. Set 60/120 degree phase switch. Connect HALL sensor inputs. LED should be green. Manually turn motor shaft one revolution. LED should remain green. If LED turns red or changes color:
   - check 60/120 degree phase switch setting.
   - check power for Hall sensors.
   - check voltage levels of Hall inputs (see commutation sequence table below).
   - with 60 degree phasing interchange Hall1 and Hall2.
7. Remove power. Connect the three motor wires. There are six ways to connect the three wires to the Motor-A, Motor-B, and Motor-C pins. Try all six combinations (remove power prior to changing connection) and choose the best one. The motor should operate and reverse smoothly in both directions. If the motor runs slower in one

direction or if you have to move the shaft to start the motor, the combination is incorrect. The speed should be approximately the same in both directions if the combination is correct. Motor speed can be verified by using the velocity monitor or by measuring the frequency of the Hall sensors or the encoder. See below for velocity calculation equations.

8. To verify smooth operation, turn test/offset pot with test/offset switch in ON position. Set offset/test switch OFF, ground both reference inputs and then adjust offset/test potentiometer for zero speed.

9. Select mode suitable for your application.

COMMUTATION SEQUENCE TABLE

60 DEGREE			120 DEGREE			MOTOR		
HALL1	HALL2	HALL3	HALL1	HALL2	HALL3	A	B	C
1	0	0	1	0	0	H	X	L
1	1	0	1	1	0	X	H	L
1	1	1	0	1	0	L	H	X
0	1	1	0	1	1	L	X	H
0	0	1	0	0	1	X	L	H
0	0	0	1	0	1	H	L	X
1	0	1	1	1	1	X	X	X
0	1	0	0	0	0	X	X	X

1 - HIGH LEVEL HALL SENSOR INPUT
0 - LOW LEVEL HALL SENSOR INPUT

H - HIGH OR SWITCHING MOTOR OUTPUT
L - LOW MOTOR OUTPUT
X - MOTOR OUTPUT IS OFF (FLOATING)

THESE LAST TWO LINES ARE INVALID COMMUTATION STATES. IN THESE STATES RED LED INDICATES A DISABLED DRIVE.

To change direction: interchange Hall-1 and Hall-3, then Motor-A and Motor-B.

Calculating motor speed:
Hall sensor cycle / Mechanical revolution = Poles/2
Motor-speed[RPM] = Hall sensor frequency [Hz] * 60 / (Poles/2)
Motor-speed[RPM] = Velocity monitor[V]* Scale factor[Hz/V]*60 / (Poles/2)
Motor-speed[RPM] = encoder frequency [Hz] * 60 / (encoder resolution)
Motor-speed[RPM] = Velocity monitor[V]* Scale factor[Hz/V]*60 / (encoder resolution)

5.3.2 Sinusoidal Amplifiers (SE Series)

Read the setup instructions before applying power:

1. **Review cautionary notes and wiring instructions prior to set up.**

2. According to mode selection table, select *current mode* and set offset/test switch ON.

3. Set current limit to 10% of motor current to avoid high speeds. See amplifier data sheets for current limiting options.

4. Check power and connect it to the amplifier. Do *not* connect motor leads.

5. Set 60/120 degree phase switch. Connect HALL sensor inputs (the encoder can be connected as well without affecting correct set-up). The LED should be green. Turn the motor shaft manually one revolution. The LED should remain green. If the LED turns red or changes color:
   - check 60/120 degree phase switch setting.
   - check power for Hall sensors.
   - check voltage levels of Hall inputs.
   - with 60 degree phasing interchange Hall1 and Hall2.

6. Remove power. Connect the three motor wires. There are six ways to connect the three wires to the Motor-A, Motor-B, and Motor-C pins. Try all six combinations (remove power prior to changing connection) and choose the best one. The motor should operate and reverse smoothly in both directions. If the motor runs slower in one direction or if you have to move the shaft to start the motor, the combination is incorrect. The speed should be

approximately the same in both directions if the combination is correct. Motor speed can be verified by using the velocity monitor or by measuring the frequency of the Hall sensors or the encoder. See above for velocity calculation equations.

7. When the Hall sensor phasing is correct the amplifier will automatically switch to sinusoidal commutation. This can be verified by monitoring the "Phase" output.

8. To verify smooth operation, turn test/offset pot with test/offset switch in ON position. Set the offset/test switch OFF, and then adjust offset/test potentiometer for zero speed.

9. Select mode suitable for your application.

5.4 Brushless amplifier with brush type motor (trapezoidal only).

To drive a brush-type motor disconnect all Hall sensor inputs, set phase setting switch to 60 degrees, and use the Motor-A and Motor-B terminals. See brush-type set up instructions. For step number five configure the amplifier for open loop mode instead of voltage mode.

6. AMPLIFIER ADJUSTMENT (TUNING) PROCEDURE

6.1 Command Signal

The command signal is a reference voltage, which is applied to the amplifier to control the motor direction and speed. Depending on the amplifier mode, the command signal controls current, voltage or speed.

6.2 Feedback Elements

The feedback element can be any device capable of generating a voltage signal proportional to velocity, position or any parameter of interest. Such signals can be provided directly by a tachometer or potentiometer or indirectly by other feedback devices such as resolvers, Hall sensors or encoders. These latter devices must have their signals converted to a DC voltage (by an external converting circuit or by the amplifier).

The feedback element must be connected for negative feedback. This negative feedback will cause a difference between the command signal and the feedback signal. This difference is called the error signal. The amplifier compares the feedback signal to the command signal to produce the required output to the load by continually reducing the error signal to zero.

6.3 Initial Power-On Test

CAUTION: These initial adjustments should be performed with the motor uncoupled from its mechanical load!

With a zero speed command applied, momentarily apply power to the amplifier. If upon application of power the motor rapidly accelerates, a runaway condition exists due most likely to polarity reversal of either the motor or the feedback element. If the motor and feedback elements are properly connected, and the amplifier is functioning normally, the motor shaft will remain stationary or drift slightly in either direction with power applied. If the motor does not run away, but emits a high-pitched squeal, turn loop-gain potentiometer counter-clockwise until squeal stops.

6.4 Potentiometer Adjustments

- *Offset adjustment*

Before offset adjustment is made, reference inputs must be grounded or commanded to 0 volts. Put the test/offset switch in the OFF position (offset mode), and trim the "offset" potentiometer for minimum amplifier output current by observing motor drift. Offset adjustment is complete.

- *Loop gain adjustment*

This potentiometer adjusts the gain in the forward portion of the closed loop (velocity or voltage mode). Starting from the CCW position, turn CW until motor shaft oscillates. Then back off one turn.

Note: This potentiometer should be set completely CCW in current mode. Use the reference gain potentiometer for scaling.

- *Reference gain adjustment*

This potentiometer adjusts the ratio between the input signal and the output variable (voltage, current, or velocity). Turn this potentiometer clockwise until the required output is obtained for a given input signal.

- *Current limit adjustments*

It is critical to set the current limit such that the instantaneous motor current does not exceed the specified motor peak current rating. Should this occur, the motor permanent magnets may be demagnetized. This would reduce both torque constant and torque rating of the motor and seriously affect system performance.

Most *ADVANCED* MOTION CONTROLS servo amplifiers feature peak and continuous current limit adjustments. The maximum peak current is needed for fast acceleration and deceleration. Most amplifiers are capable of supplying the maximum peak current for 2 sec. and then the current limit is reduced gradually to the continuous value. The purpose of this is to protect the motor in stalled condition by reducing the current limit to the maximum continuous value. Current limiting is implemented in the amplifier by reducing the output voltage.

The current limit adjustment potentiometer (50kΩ) has 12 active turns plus 1 inactive turn at each end and is approximately linear. Thus, to adjust the current limit, turn the potentiometer counter-clockwise to zero (using ohmmeter between appropriate ground and potentiometer wiper, see amplifier block diagram), then turn clockwise to the appropriate value. If the peak current reference does not reach the set peak current limit, the time for peak current will be longer than 2 sec. The actual time will be a function of RMS current.

A selection of amplifiers feature separate peak and continuous current limit adjustments. This can be achieved by connecting an external resistor between the continuous current limiting pin and the signal ground. In addition, many amplifiers have the option of current limiting using the DIP-switches. If this is an option, it will be indicated in the switch function section of the particular amplifier.

6.5 Compensation Adjustments

Servo system performance can be judged by the following three characteristics:

- Stability
- Accuracy
- Responsiveness without over-shoot

Using *ADVANCED* MOTION CONTROLS servo amplifiers provides a short and straightforward process to meet all three of these criteria. The process involves obtaining a stable servo using the compensation adjustment while optimizing the response of the system.

For this purpose, it is necessary to be able to feed a small step at the reference input, and observe the appropriate feedback signal on an oscilloscope. Set the compensation adjustment to obtain a properly compensated response. This will be the fastest response without over-shoot. If the system is under-compensated (slow response without over-shoot), turn the compensation potentiometer clockwise. If the system is over-compensated (over-shoot and oscillation), turn the compensation potentiometer counter-clockwise.

Practical Hints About Loop Compensation:

NOTE: In most velocity control applications, the compensation can be adjusted by rotating potentiometer Pot 1 (loop gain) clockwise until the motor oscillates audibly and then backing off until it stops. This simple procedure also applies to voltage mode.

Except for model 10A8, all *ADVANCED* MOTION CONTROLS amplifiers feature optional user installed through-hole components for custom compensation. These components can be used to implement custom compensation. For most applications the standard built-in compensation is satisfactory. The amplifier block diagrams show the built-in SMT component values for every user installed through-hole component. These built in SMT components can be removed easily by a regular fine tip soldering iron by heating up both sides of the component alternatively, then gently lifting component.

Contact factory for custom compensation application help.

- Current loop (internal):

The current loop gain resistor determines the current loop response. A larger resistor value results in a faster response. Typically the 10K setting is recommended for load inductors less then 3 mH and the 100K setting is recommended for a load inductance of more than 3 mH. This may be accomplished by either switching in the extra resistor with the DIP-switch or installing a through-hole resistor. For load inductor values higher than 5 mH a 200K or larger through-hole resistor value can be installed for faster response. If the resistor value is too high for the inductance then overshoot or oscillation occurs in the current loop. A through-hole capacitor can be added to the current loop to increase the capacitance if the system is oscillatory. This should not be done to counter the effects of choosing a resistance value in the current loop that is too high for the inductance.

- Voltage loop:

Compensating the voltage loop requires the least amount of effort. Turn POT1 CW and back off if oscillation occurs.

- Velocity loop:

The velocity loop response is determined by the loop gain potentiometer P1. A larger resistor value (CW) results in a faster response. The velocity integrator capacitor can be used to compensate for large load inertia. Large load inertias require larger capacitor values. This may be accomplished by either switching in the extra capacitor with the DIP-switch or installing a through-hole capacitor. The need for an extra capacitor can be verified by shorting out the velocity integrator capacitor with the DIP-switch. If the velocity loop is stable with the capacitor shorted out and unstable with the capacitor in the circuit then a larger capacitor value is needed.

- IR feedback:

Start with a very high (or open) IR feedback resistor with an unloaded motor shaft. Command a low motor speed (about 20-200 RPM). Without the IR feedback the motor shaft can be stalled easily. Decreasing the IR feedback resistor will make the motor shaft more difficult to stop. Too much IR feedback, i.e. too low resistor value, will cause motor run-away when torque is applied to the motor shaft.

- Analog position loop:

Use of a tachometer is recommended to obtain a responsive position loop because the position loop is closed around the velocity loop. First the velocity loop must be stabilized (or voltage loop for undemanding applications). The position loop gain is determined by the fixed gain of the input differential amplifier of the servo amplifier. For best results the servo amplifier can be ordered with a higher differential amplifier gain. Extension ANP must be specified e.g. 25A8-ANP.

6.6 TEST POINTS FOR POTENTIOMETERS

After the potentiometer adjustments in the compensation section are complete, the resistance values can be measured for future adjustments or duplication on other amplifiers. Test points for the potentiometer wipers are provided and are located under all four potentiometers. **Make sure the power is off,** then measure the resistance between the test point and the outer leg of the potentiometer or between the test point and an appropriate ground. See the amplifier's functional block diagram to determine which ground should be used for each potentiometer. The potentiometers are all approximately 50K. Resistance measurements are only to be used to duplicate amplifier settings since some potentiometers have other resistors in series or parallel.

7. INVERTED INHIBIT INPUTS

Inputs INH and +/-INH can be inverted by removing "J1" jumper (0 ohm SMT resistor marked on PCB). Removing J1 jumper requires that all inhibit lines be brought to ground to enable amplifier. Most amplifiers except the 10A8 can be ordered with this option. Part number example would be B30A8X-INV. INV stands for inverted inhibit inputs. Some amplifiers such as the B30A40 have a dip switch to invert the inhibits. This option will be listed on the amplifier data sheets if it is available.

8. TROUBLE SHOOTING/FAULT CONDITIONS

A red LED can indicate any of the following fault conditions: over-temperature, over-voltage, under-voltage, short-circuits, invalid commutation, status and power on reset. All fault conditions are self-reset by the amplifier. Once the fault condition is removed the amplifier will become operative again without cycling power. Please see amplifier data sheets for protection features included.

- *Heat-sink Temperature*

  Verify that the heat-sink temperature is less than 65° C. If this temperature is exceeded the amplifier will remain disabled until the temperature at the base plate falls below 65° C.

- *Over-Voltage Shutdown*

  1. Check the power supply voltage for a value in excess of those listed in the data sheets. If a larger than listed value is observed, check the AC power line connected to the power supply for proper value. .

  2. Check the regenerative energy absorbed during deceleration. This is done with a voltmeter or scope monitor of the amplifier bus voltage. If the bus voltage increases above specified values, additional bus capacitance is necessary. Additional capacitors must be electrolytic type and located within a one foot lead distance from the amplifier. See also regenerative operation section.

- *Under-Voltage Shutdown*

  Verify power supply voltages for minimum conditions per specifications. Also note that the amplifier will pull the power supply voltage down if the power supply cannot provide the required current for the amplifier. This could result in a flickering LED when high current is demanded and the power supply is pulled below the minimum operating voltage required by the amplifier.

- *Short Circuit Fault*

  1. Check each motor lead for shorts with respect to motor housing and power ground. If the motor is shorted, it will not rotate freely when no power is applied while it is uncoupled from the load.

  2. Measure motor armature resistance between motor leads with the amplifier disconnected.

- *Invalid Hall Sensor State (Brushless Amplifiers only)*

  See the "Commutation Sequence" table for valid commutation states. If the LED is red or if it is changing between red and green as the shaft rotates check the following:

  1. Make sure that the 60 or 120 degree phasing switch is in the correct position per motor data sheets. When driving a brush type motor with a brushless amplifier, use the 60 degree phase setting.

  2. Check the voltage levels for all the Hall sensor inputs.

  3. Make sure all Hall lines are connected properly.

- *Status*

  Check ALL inhibit inputs for correct polarity (i.e. pull to ground to inhibit or pull to ground to enable). Inhibit configuration depends on weather J1 is installed or on the position of the inhibit/enable switch if this is a feature on the particular drive you are using. Please note that the master inhibit will cause a red LED but the plus and minus inhibits (+INH and –INH) featured on some amplifiers will disable the amplifier in the plus or minus direction without causing a red LED. Also, keep in mind that noise on the inhibit lines could be a cause for false inhibit signals being given to the amplifier.

- *Power-on Reset*

  All amplifiers will have a brief flicker of a red LED during power up. This is the power-on reset and is built into the amplifier to ensure that all circuitry on the board is functional prior to enabling the amplifier.

- *Overload*

  Verify that the minimum inductance requirement is met. If the inductance is too low it could appear like a short circuit to the amplifier and thus it might cause the short circuit fault to trip. Excessive heating of the

amplifier and motor is also characteristic of the minimum inductance requirement not being met. See amplifier data sheets for minimum inductance requirements

- *Over-current*

  All *ADVANCED* MOTION CONTROLS amplifiers incorporate a "fold-back" circuit that protects them against over-current (except for PWM and sinusoidal input amplifiers, which have different protection features). This "fold-back" circuit uses an approximate "I^2t" algorithm to protect the amplifier. All amplifiers can run at peak current for maximum 1 second (each direction). Currents below this peak current but above the continuous current can be sustained during a time period of approximately (peak current/current)^2 seconds. If such a current is commanded for a longer time period, the amplifier will automatically fold back to the continuous current. An over-current condition will not cause the LED to be red.

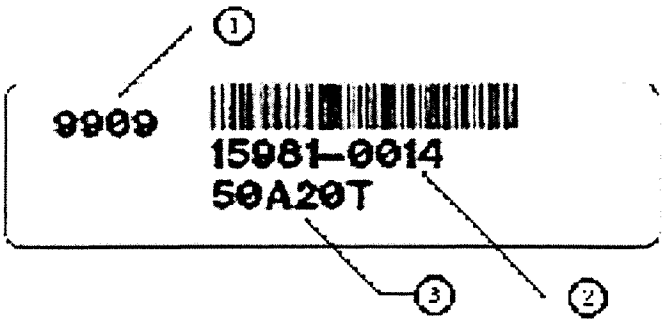
***Caution:* Sustained maximum current demand, when switching between positive and negative maximum current without fold-back, will result in amplifier damage. Amplifier RMS current should be below the continuous current setting!**

Causes of Erratic Operation

1. Improper grounding (e.g. amplifier signal ground is not connected to source signal ground).
2. Noisy command signal. Check for system ground loops.
3. Mechanical backlash, dead-band, slippage, etc.
4. Excessive tachometer noise.
5. Noisy inhibit input lines.
6. Excessive voltage spikes on bus.

9. PRODUCT LABEL DESCRIPTION

The following is a typical example of a product label as it is found on the amplifier:



1. Date Code: The date code is a 4-digit number signifying the year and week that the amplifier was built. The first two digits designate the year and the second two digits designate the week.
2. Serial number: The serial number is a 5-digit number followed by a 4-digit number. Some of the older amplifiers have a 6-digit serial number.
3. Part number: Refer to the amplifier data sheets for typical part numbers. The last letter refers to the revision (in the above example T). The part number can be proceeded by an X, which means the amplifier is a prototype unit. The part number can also have a suffix (e.g. 50A20T-AM1), which designates a special version of the standard amplifier (50A20T is the standard amplifier, -AM1 designates the special version).

10. FACTORY HELP

FAX service: (805) 389-1165
E-mail: techsupport@a-m-c.com

For aid in trouble shooting with amplifier set-up or operating problems please gather the following information and FAX or e-mail directly to *ADVANCED* MOTION CONTROLS:

A. DC bus voltage and range.

B. Motor type, including inductance, torque constant, and winding resistance.

C. Position of all DIP-switches.

D. Position of all potentiometers.

E. Length and make-up of all wiring and cables.

F. If brushless, include HALL sensor information.

G. Type of controller, plus full description of feed back devices.

H. Description of problem, i.e. instability, run-away, noise, over/under shoot, etc.

I. Complete part number and serial number of *ADVANCED* MOTION CONTROLS product. Original purchase order is helpful, but not necessary.

11. WARRANTY

ALL RETURNS (WARRANTY OR NON-WARRANTY) REQUIRE THAT THE CUSTOMER FIRST OBTAINS AN RMA NUMBER FROM THE FACTORY.

RMA number requests may be made by telephone at (805) 389-1935 or by fax at (805) 389-1165.

ADVANCED MOTION CONTROLS warrants its products to be free from defects in workmanship and materials under normal use and is limited to replacing or repairing at its factory any of its products which within one year after shipment are returned to the factory of origin, transportation charges prepaid, and which are determined to be defective. This warranty supersedes all other warranties, expressed or implied, including any implied warranty or fitness for a particular purpose, and all other obligations or liabilities on *ADVANCED* MOTION CONTROLS' part and it neither assumes nor authorizes any other person to assume for the seller any other liabilities in connection with the sale of the said articles.

The original warranty period is not extended by the above-mentioned provisions for any replaced or repaired articles. This warranty shall not apply to any of *ADVANCED* MOTION CONTROLS' products that have been subjected to misuse, negligence, accident, or modification by the user.

Chapter 10. Troubleshooting

10.1 INTRODUCTION

Troubleshooting consists of locating faults by starting with obvious things and moving to the less obvious. Field diagnosis of machine problems can be divided into 3 sets of checks which are listed below. A flow chart, Figure 10-1, is provided to assist in following the steps. The flow chart indicates which subsystem is likely to be at fault, and directs the technician to the proper section in this chapter

10.1.1 Procedure

Follow the chart, figure 10.1, to determine the best place to begin troubleshooting the system. The three major sets of checks are:

1. Incoming Power (section 10.2.1)
2. Power Supplies (section 10.2.2)
3. Error Messages (section 10.3)

Additional checks for axis stalling and spindle problems are presented in section 10.5 and the Axis Troubleshooting Chart (Table 10-2) at the end of this chapter.

Use the system wiring diagram (page 4-9) to follow the electrical checks, and to perform any additional electrical checks if necessary.

10.2 ELECTRICAL POWER TEST (Figure 10-2)

Lethal voltages are present in the Equipment Panel Assembly, even when the Main Disconnect switch is off. Use extreme caution whenever working in the Equipment Panel Assembly. Failure to do so may cause electrical shock, resulting in serious personal injury or death.

Power enters the machine at the Main Circuit Breaker on the Equipment Panel Assembly. Then it goes to the Interface Transformer.

10.2.1 Incoming Power

1. The proper AC power voltage is indicated on the label outside of the Equipment Power Assembly. Insure that the correct voltage is supplied to the machine. If not, refer to the System Wiring Diagram (page 4-11) for the proper jumper configuration.

2. Turn on the Main Circuit Breaker at the Equipment Panel Assembly. Measure the incoming power at the main pairs of terminals 1L1, 1L2, and 1L3.

Machine	Reading
208 VAC	187-229 VAC
230 VAC	220-240 VAC
460 VAC	415-506 VAC

3. Measure the input voltage of transformer T1. The voltage should be the same as between the fuses (1L1, 1L2, and 1L3). Make sure the transformer jumpers agree with voltage input. See Jumper Chart for T1 on System Wiring Diagram (Page 4-11).

The inputs to T1 are:

Wire No.	Machine
1L2, 1L3	208/230/460 VAC, 60Hz

4. Measure the output voltage from T1:

Wire No.	Machine
1, 2	110-120 VAC

If the output voltage is not correct, repair the connection(s) or replace T1.

10.2.2 Power Supplies

1. Turn on the power and locate the terminal strip for Drive Power Supply. Measure the following voltages:

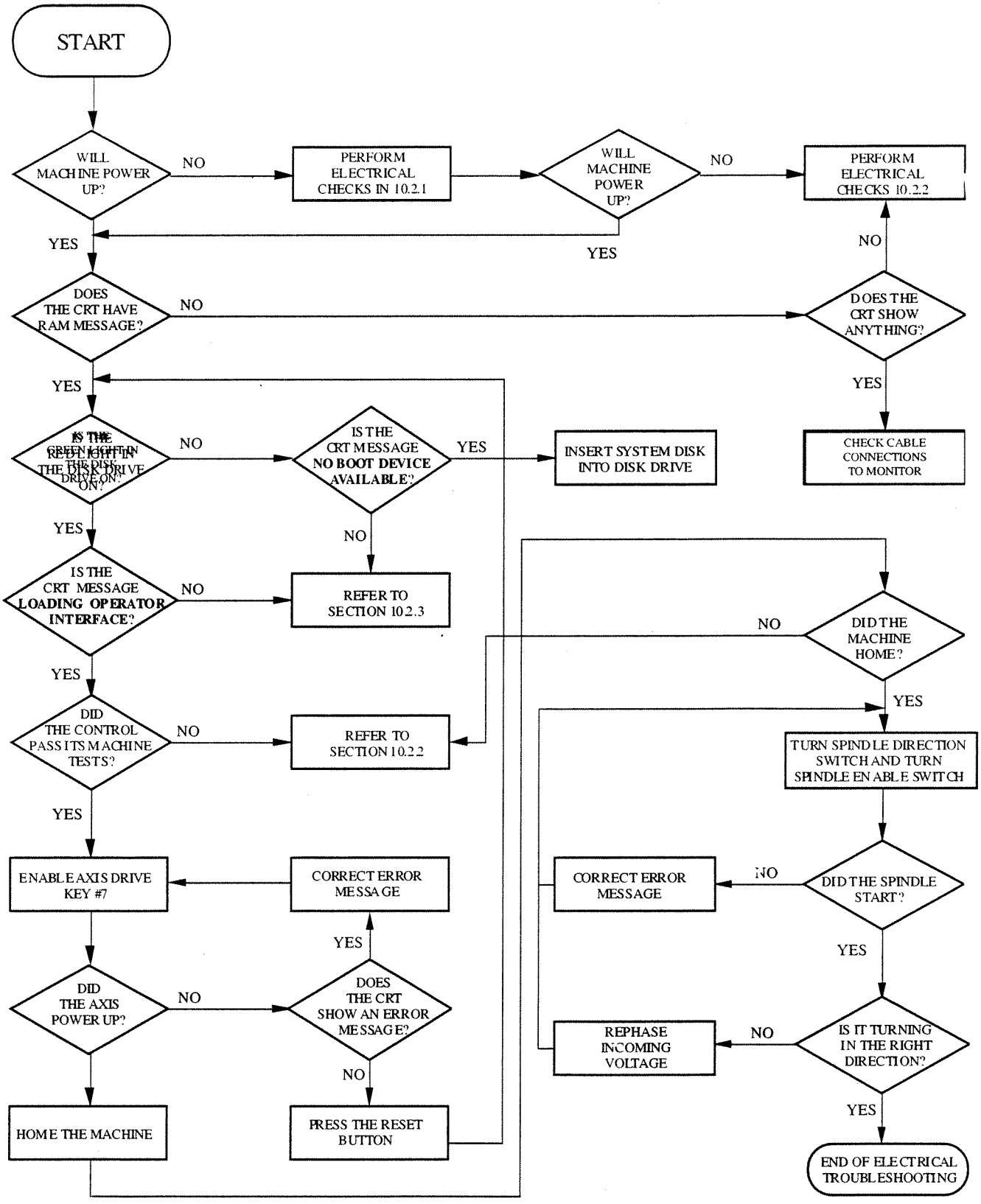


Figure 10-1. Troubleshooting Flow Chart

Wires	Readings
20 to 2	115 VAC
21 to 2	115 VAC

If the 72 VAC is present, but the 105 VDC is not, check fuses 9 and 10.

NOTE

This power supply will not work without a 10% load on the +5 VDC output. Insure that a hard drive is plugged in when taking readings.

2. The monitor (CRT) in the front panel is self-contained; the only supply voltage is 115 VAC on the power cord at the back of the unit. If this voltage is present and the CRT is still black, check to insure that the power OFF-ON switch is in the ON position. Also, this unit contains a fuse on the 115 VAC line. Insure that the fuse is in good working order.

3. Troubleshooting suggestions:

Problem	Checks to make
Monitor is dead.	1. Check voltages. 2. Check power-on switch. 3. Check in ternal fuse. 4. Check power cord. 5. Insure brightness thumb wheel is turned up.
Monitor has Raster but no video.	1. Check LCU for power. 2. Check that video cable is plugged into monitor.
Monitor is dark.	1. Adjust the brightness control.
Monitor will not synchronize.	1. Adjust the horizontal or vertical hold control.
Monitor display message: **NO BOOT DEVICE AVAILABLE.**	1. Check voltage on the floppy disk drive. 2. No system disk in the drive unit. 3. Check the signal cable from the Pentium to the floppy disk drive.
The machine did not pass the start-up test.	1. BMDC hardware check failed. 2. BMDC software load failed.

10.3 SPINDLE FAILURE

Lethal voltages are present in the Equipment Panel Assembly, even when the Main Circuit Breaker is off. Use extreme caution whenever working in the Equipment Panel Assembly. Failure to do so may cause electrical shock, resulting in serious personal injury or death.

1. If the spindle has stopped abruptly, check to see if the spindle overload (MOL) has tripped. If it has, give the heaters in the device a chance to cool and reset it by pushing the red **RESET** button. Make sure that all connections from the power line to the spindle motor are tight.

2. If the spindle will not start after a move has been completed, check the lubricant level. If the machine has enough lubricant, then the lube level float switch may be bad.

3. If the spindle stops turning as soon as the Spindle Control switch is released, the reversing contactor may be at fault.

4. Check all contacts to the logic boards and terminal strips.

5. If the spindle motor still will not turn, check the power coming into the motor at the motor terminals, T1, T2, and T3 (assuming that the elec trical power test has been completed). The spin dle motor itself may be at fault.

6. The spindle motor cannot reverse direction if the reversing contactor is defective.

10.4 OVERLOAD

RELAY TRIPOUT

Power to the motors may be disabled by a break in the overload relay. This may be restored by pushing the blue RESET switch located to the right of the relay in the Equipment Panel Assembly. Follow this procedure:

1. Turn the power **OFF.**

2. Wait 5 minutes.

3. Try the **RESET** by pushing in the switch. If it doesn't work, wait another 5 minutes and try again.

4. Insure that all connections from the power line to the spindle motors are tight.

5. Power should be restored to the motors. If the relays trip out more than twice, make sure the feedrate matches the type of material you are cutting.

Table 10-1. Axis Preventive Maintenance Procedures

Item	Procedure	Time
Motor Brushes and Commutator	Check the brushes for wear and arcing. Replace brushes, if necessary. Check the commutator for wear and arcing. (Wear is greatly dependent upon application).	Semiannual
Positioning Accuracy	As a normal manufacturing procedure, check the parts made. Check the electrical positioning accuracy and the mechanical machine accuracy.	As Required
Voltage Checks	Check voltages listed under paragraph 10.2.1, steps 1 through 4 and 10.2.2 step 1.	Semiannual

Table 10-2. Axis Troubleshooting Chart

Symptom	Possible Cause
Brush or Commutator Failure	Current limit is inoperative or improperly set. There is high current due to injected electrical noise at the transducer input to the servo. The motor is overspeeding.
Power Transistor Failure	The fault sensor is defective. Switching logic is defective on the printed circuit board.
Contouring Inaccuracy	Gains of all axes are not identical. There is servo current limiting in contouring speed range.
Inadequate Performance	The required accelerating current is not available. There is excessive lost motion such as backlash or windup. There is low frequency mechanical resonance (check by observing open loop response).
Position Overshoot	The current limit is too low, or the tachometer gain is too low.
Poor Surface Finish	The position loop gain is too high. The tachometer is noisy. There is a defective feedback device or device excitation. A machine drive member is defective. Machine tooling is defective.
No Motion (All Axes)	The customer's protective interlocks are set. The main circuit breaker is tripped.
Overcurrent Fault (1 Per Axis)	There is an armature circuit fault. The current limit is inoperative or set too high. The armature is shorted to ground.
Instability During Power Enable	The position or velocity transducer signal is reversed or the armature wires are reversed. The velocity command is not correct. The position or velocity transducer signal is lost. A printed-circuit board is defective.
Instability	The axis is not tuned properly. The position loop gain is too high. The lag capacitor is too small. The high frequency gain is improperly set. Multiply position loop gains are improperly adjusted (if they are used in the controller).
Instability Manifested by Low Amplitude and/or Frequency Oscillation	There is high static to running friction action. Backlash or deadband is present in the machine or transducer.
Positioning Accuracy	High friction is present. Position loop gain and/or low frequency gain of velocity loop is low. There is backlash or wind-up in the position transducer/motion connection. The tool reaction forces are too high to be consistent with high accuracy. Pulley is loose on motor shaft. Encoder output not accurate.

Symptom	Possible Cause
Positioning Cycle Time Too Long	The final position is overshot. The speed is low. Current limit is set too low.
Excessive Machine Wear	Current Limit is set too high or is inoperative. The ripple current in the motor is too high due to noise injected from the transducers.
Motor Overheats	The friction level is too high. Current limit is set too high or is inoperative. There is a noise from the transducers that is being injected into the servo. The duty cycle is too severe. The inertia is high. There are high tool reaction forces requiring high motor current. Permanent magnet fields have been demagnetized, causing high armature current to develop torque.
Poor Speed Regulation Top Speed	Friction is too high. The motor is incapable of operating at the speed being commanded.
Axis-to-Axis Speed Interaction	Power supply capacitance is too small, allowing voltage to dip during motor acceleration. Incoming AC line voltage is dipping during acceleration of the motor and allowing the DC volt bus to drop. High friction of inertia load is pulling the DC volt bus low. Poor ground connection. The rectifiers are bad or there is some other problem causing the rectification in the power supply to be half wave rather than full wave, creating a low voltage + 128 volt bus under load.
Erratic Motor Operation	Noise is manifested in the motor current introduced into the servo by transducers. There is poor grounding or there are loose connections. There is a jump on startup or shutdown due to improper interfacing.

Chapter 7. Preventive Maintenance

7.1 INTRODUCTION

This chapter is written for operators or designated customer representatives. The operator must know how to operate the machine, monitor the levels of pneumatic oil, lubricating oil and coolant reservoirs, and recognize problems that require Dealer or Bridgeport Field Service maintenance. Most operator tasks deal with the external machine; however, the operator should be able to locate the overload heater reset in the Power Equipment Enclosure if necessary.

The operator is not authorized to make adjustments or replace components.

7.2 OVERVIEW

Maintenance procedures required for proper upkeep of the machine are included in the following pages. The charts in this section are geared to two types of operating conditions. Follow the chart that applies to your operating conditions. Section 7.4 explains each procedure in detail.

Operating conditions are defined as follows:

1. **REGULAR SHIFT:** The machine is used eight hours a day, five days a week.

2. **MULTIPLE SHIFT:** The machine is used in a three shift operation, five or more days a week.

A third operating condition is DRY CUTTING. In this case, the machine is used to cut materials such as cast iron, magnesium or carbon that produce unusually large amounts of dust in the air. This cutting could take place in either REGULAR or MULTIPLE SHIFT conditions. This is considered to be a HOSTILE environment which requires more than the average amount of care.

If the workpiece is cut dry, you must take extraordinary precautions, both while cutting and in clearup to prevent dust and air from entering the system. Follow the maintenance procedures recommended for your shift conditions. In addition, use the following guidelines:

1. Check cooling system for proper operation. The air inlet should be filtered. This filtering system is not standard equipment supplied by Bridgeport and must be constructed by the machine owner.

2. Use an industrial vacuum cleaner and clean the exterior of the machine frequently. Do not use compressed air hoses to clean the machines.

3. Use specially designed vacuum systems at the cutting tool.

4. Use electrostatic filters if clean air cannot be directed to the head or the control cabinet inlets.

7.3 EQUIPMENT AND SUPPLIES

- Dry rags or paper cleaning cloths.
- Brush to sweep chips from the tables and ways.
- Industrial vacuum cleaner.
- Mobil DTE 24 or DTE light oil (for pneumatic system filter regulator)
- Coolant fluid. Bridgeport recommends Trim Sol or comparable antibacterial emulsified cutting oil.
- Lubricant for the way lubrication system. The following way lubricants are approved for use in this system:

  Gulfway 68
  Sunoco Way Lubricant 1180
  Mobil Vactra Oil No. 2
  Way Lubricant 68 (Texaco)
  Tonna 68 (Shell)

7.4 DESCRIPTION OF MAINTENANCE PROCEDURES

1. Check lube system oil level; fill if necessary. The most convenient procedure is to keep the level of oil to the top of the tank. Check it every day. If the reservoir is allowed to empty, a liquid level switch at its base will not allow the spindle to start.

2. Clear dirt and chips from the ways at the end of the day. Use a brush and/or an industrial wet or dry vacuum cleaner, then wipe carefully to remove damage-causing abrasive material.

WARNING

Do not use compressed air to clean the ways or around the cabinets. Using compressed air could blow chips and other foreign material into the interlocking parts, control system, or at the operator, resulting in extensive damage or serious personal injury.

3. Clean machine exterior; clear intakes and exhausts. Clear dirt and chips from machine at the end of the day Use an industrial wet or dry vacuum cleaner, then wipe carefully to remove damage-causing abrasive material. Do not use compressed air to clean the machine.

NOTE

Check the air intakes and exhausts; clear any obstructions. Foreign materials in these areas can cause damage to the machine by entering the Control Power Enclosures.

4. Clean and apply a light coat of oil to the way covers once a week to keep them pliable.

5. Check coolant level; fill if necessary.

   Flood Coolant: Keep hose joint areas free of chips and dirt. The coolant will come out of the nozzle in spurts when the level is too low. Fill with Trim Sol or comparable antibacterial emulsified cutting oil.

   Mist Coolant: Wipe off excess grime from the top of the coolant reservoir periodically. It is recommended filling it only with the amount to be used in one operation.

6. Clean the air filters. When you can no longer see light through them, replace them. Dirty shop air can cause damage to the control system if not filtered properly.

NOTE

If mist coolant is used on this or on nearby machines, it will be necessary to change the filter frequently.

Keep the air filters clean to help prevent problems. Watch the air filters for the first few months of operation in order to get an idea of how often they should be replaced.

The time between filter changes can ıot be predicted because it depends on many thii gs, including the hours of operation per day and the nature of materials being machined in the vicinity.

7. Check pneumatic regulator system bowls; fill lubricator bowl if necessary. When the level drops below the EMPTY line, fill to FULL with Mobil DTE 24 or direct equivalent.

   a. Shut off the air pressure.
   b. Remove the screw from the fill hole at the left rear of the lubricator.
   c. Fill the bowl to the FULL line. Do not overfill.
   d. Replace the fill hole screw.

8. Drain and clear refill pneumatic regulator bowls. The bowl should be drained whenever it fills up with sludge. The bowls should be cleaned semiannually.

   a. Put a dry rag under the regulator to catch the drips.
   b. Drain the filter bowl by pressing up on the drain valve.

To clean the bowls:

a. Drain the filter bowl.
b. Gently unscrew both bowls.
c. Rinse them with WARM WATER only. Do not use soap.

WARNING

Use only warm water to clean the filter bowls. Using soap, solvent, or chemicals may weaken the bowl and cause it to burst, resulting in serious personal injury.

d. Replace the bowls. Fill the lubricator with Mobil DTE 24 or direct equivalent. See step 7 in this section.

9. Check the spindle motor for dirt; wipe if necessary. The spindle motor can become overheated if excessive grease and dirt are allowed to build up on it.

a. Remove spindle motor hood.
b. Inspect the motor for dirt.
c. Wipe the motor with a rag and remove as much of the build-up as possible.
d. Replace the hood.

10. Check spindle drive belt for dirt and wear. Notify Dealer Service to replace it if necessary. If the housing itself is excessively dirty, the belt may be worn or weak.
a. Remove the spindle drive belt cover.
b. Inspect the belt for wear, cracks, or damage.
c. If the belt looks worn, call Dealer Service to replace it.
d. Replace the cover.

11. Remove and clean the automatic oil system pump filter.
12. Clean the dirt and chips from inside the Power Equipment Enclosure and around the card frame. Metal chips can come into contact with the boards and disrupt the electronic signals of the PC boards.

Check each item listed in the checklist (in your appropriate Operator Daily Maintenance Requirements Table) on a regular basis. Refer to the step numbers in this section (7.4) for an explanation of each numbered item on the checklist.

7.5 OPERATOR MAINTENANCE REQUIREMENTS

Refer to tables 7-1 and 7-2 (Operator Maintenance Requirements, Regular Shift and Multiple Shift, respectively).

Periodicity Codes:

D = Daily, performed on a daily basis during a 24 hour period.
W = Weekly, performed on a weekly basis.
M = Monthly, performed on a monthly basis.
S = Semiannual, performed twice a year.
AS REQ. = Depends on working environment.

Table 7-1. Operator Maintenance Requirements - Regular Shift

REF#	REQUIREMENT	PERIODICITY				
		D	W	M	S	AS REQ.
1	Check lube system oil level; fill if necessary	X				
2	Clean dirt, chips from ways	X				
3	Clean machine exterior; clear intakes and exhausts			X		
4	Clean way covers; lightly oil		X			
5	Check coolant level; fill if necessary		X			
6	Check air filters; replace if necessary. Use electrostatic filters if dry cutting			X		
7	Check pneumatic lubricator bowl; fill if necessary				X	
8	Drain, clean, refill pneumatic filter bowl. See warnings				X	
9	Check spindle motor for dirt; wipe if necessary				X	
10	Check spindle drive belt for wear; notify Dealer Service to replace if necessary				X	
11	Clean lube system pump filter					X
12	Clean inside control cabinet			X		

Check each item listed in the checklist on a regular basis. Refer to the step numbers in section 7.4 for an explanation of each numbered item on the checklist.

Table 7-2. Operator Maintenance Requirements - Multiple Shift

REF#	REQUIREMENT	PERIODICITY				
		D	W	M	S	AS REQ.
1	Check lube system oil level; fill if necessary	X				
2	Clean dirt, chips from ways	X				
3	Clean machine exterior; clear intakes and exhausts					48 hrs
4	Clean way covers; lightly oil					48 hrs
5	Check coolant level; fill if necessary		X			
6	Check air filters; replace if necessary. Use electrostatic filters if dry cutting					48 hrs
7	Check pneumatic lubricator bowl; fill if necessary				X	
8	Drain, clean, refill pneumatic filter bowl. See warnings				X	
9	Check Tape for wear; replace if necessary	X				
10	Check spindle drive belt for wear; notify Dealer Service to replace if necessary			X		
11	Clean lube system pump filter				X	
12	Clean inside control cabinet					48 hrs

Check each item listed in the checklist on a regular basis. Refer to the step numbers in section 7.4 for an explanation of each numbered item on the checklist.

Chapter 8. Manual Controls

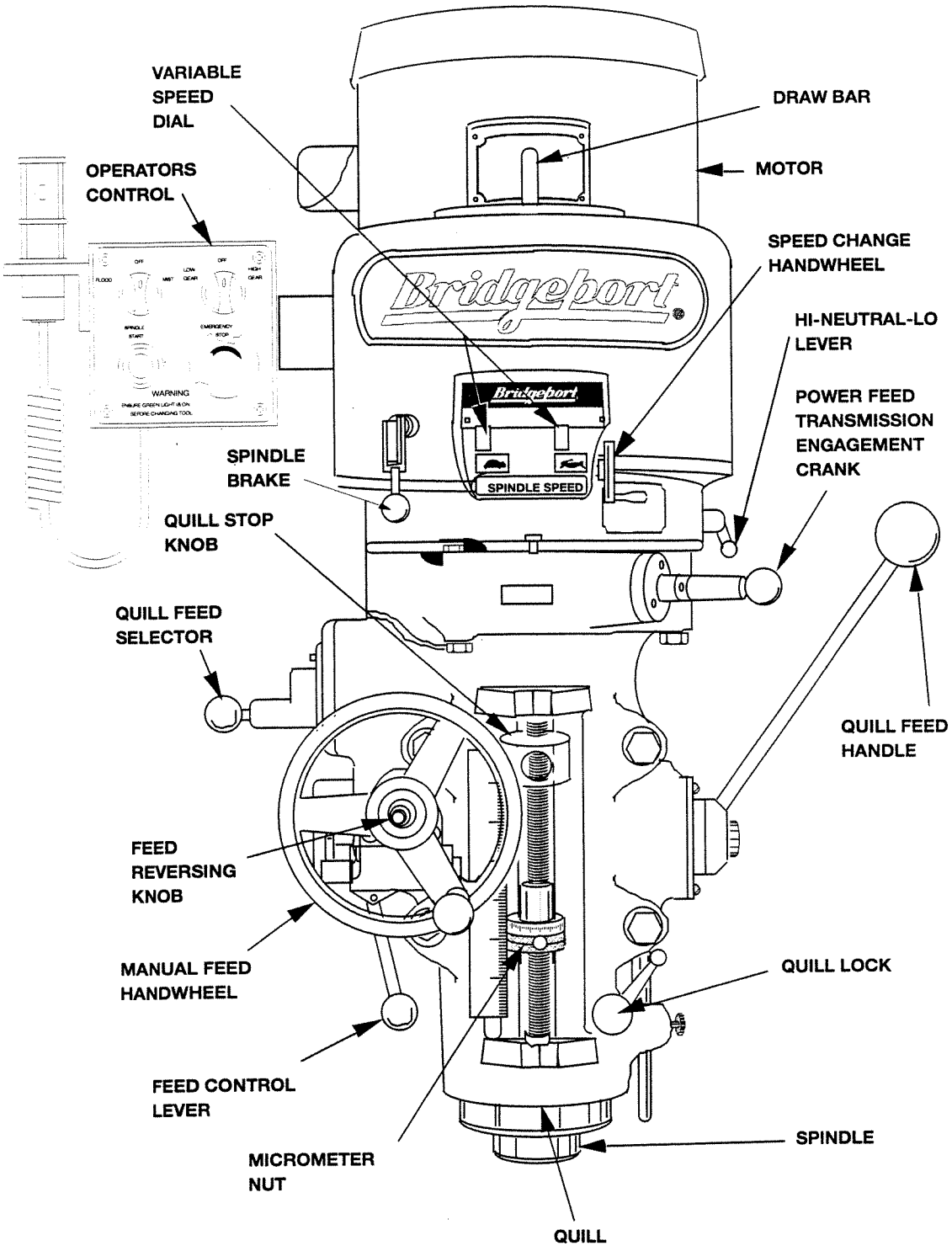


Figure 8-1. Head Controls and Components

8.1 OPERATOR'S CONTROL STATION (Figure 8-2)

The **EMERGENCY STOP** switch (A) will remove power from the spindle, coolant, and the axis motors. This switch is maintained on when activated by pushing it in towards the panel and will not release until it is manually pulled out.

The **OFF, HIGH GEAR, LOW GEAR** selector switch (B) permits the operator to select clockwise direction of the spindle by having the gear selector agree with this switch selection. The **OFF** position shuts the spindle off. When the attatchment is in direct drive **(HIGH GEAR)** the motor and spindle are turning in a clockwise direction as viewed from the top of machine. When the attachment is in "Back Gear" **(LOW GEAR)** the spindle would run backwards (counter-clockwise) unless the motor direction is reversed by moving switch to low.

The back-gear lever (paragraph 8.15) is marked **HI-LO.** This will indicate the proper switch position. They should be positioned alike or the spindle will run backwards.

NOTE

Spindle should run in clockwise direction.

The coolant **OFF, MIST, FLOOD** selector switch (C) will select the desired coolant. The coolant will turn on and off with the spindle.

CAUTION

Pressing the Emergency Stop button or spindle off selector removes power from the spindle motor, but does not apply the spindle brake. The brake must be activated manually.

The **SPINDLE START** switch (D) will start the spindle when the lighted portion of this switch is pressed. The light will go out after the spindle is started.

CAUTION

Never put hands near the spindle unless the spindle light is ON.

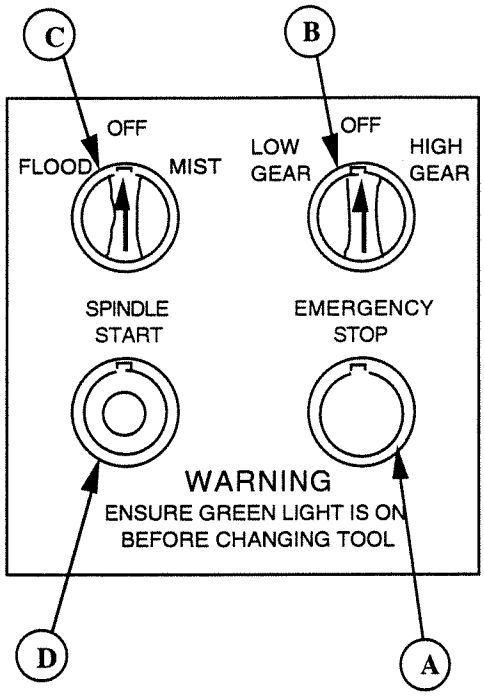


Figure 8-2. Operator's Control Station

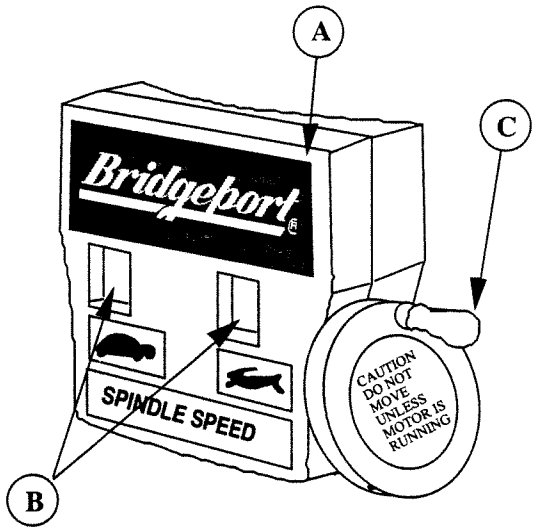


Figure 8-2.a Variable Speed Dial

8.2 VARIABLE SPEED DIAL (Figure 8-2a)

The variable speed dial (A) visibly indicates, in windows (B), the speed range in which machine is operating: 60-500 rpm (low range), 500-4200 rpm (high range). Rotate handwheel (C) to increase or decrease spindle speed.

8.3 SPINDLE BRAKE (Figure 8-3)

The spindle brake lever (A) can be moved in either direction to stop spindle; however, when locking spindle, lever should be moved by pulling it toward the operator or pushing away from the operator, and then raising the lever. When the brake is worn out it has to be replaced. There are no adjustments to be made.

CAUTION

Be sure that the spindle brake is released before starting the motor. The motor can be damaged if switch is turned on with the brake in locked position.

8.4 QUILL FEED SELECTOR (Figure 8-4)

The quill feed selector (A) is used for selecting the three feeds: 0.0015, 0.003, and 0.006 inch per revolution. It is shifted by pulling knob out and turning from one position to the other. Feeds are stamped on cover below indentation hole. Feed is more readily engaged when spindle is running.

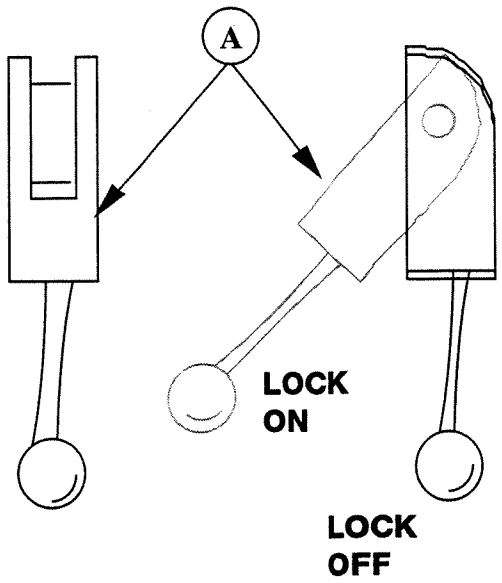


Figure 8-3. Spindle Brake

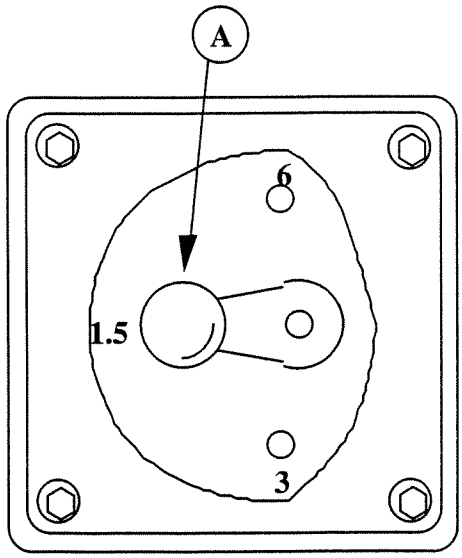


Figure 8-4. Quill Feed Selector

8.5 QUILL STOP KNOB
(Figure 8-5)

The quill stop knob (A) is used to disengage automatic feed in either direction as well as the stop point setting working depths.

8.6 MICROMETER NUT
(Figure 8-5)

The micrometer nut (B) is used for setting depths. Each graduation on nut indicated 0.001 inch of depth. It reads directly to scale mounted along side of it. Depths may be obtained by setting micrometer nut in conjunction with quill stop.

8.7 FEED REVERSE KNOB
(Figure 8-6)

The position of the feed reverse knob (A) depends upon direction of spindle rotation. If boring (quill feed down) with right hand cutting tools, push feed knob away from operator until clutch becomes engaged.

To engage clutch to feed up, pull knob to out position.

Neutral position is between in and out position. It is recommended that the handle be left in neutral position when not in use.

8.8 MANUAL FEED HANDWHEEL
(Figure 8-6)

NOTE

The manual feed handwheel may be removed when not in use.

The feed reverse knob (A) should be in neutral position and manual feed handwheel (B) engaged. Clockwise rotation of handwheel moves quill down. The manual feed handwheel and the quill feed handle may be disengaged by moving them outward about 1/8 inch.

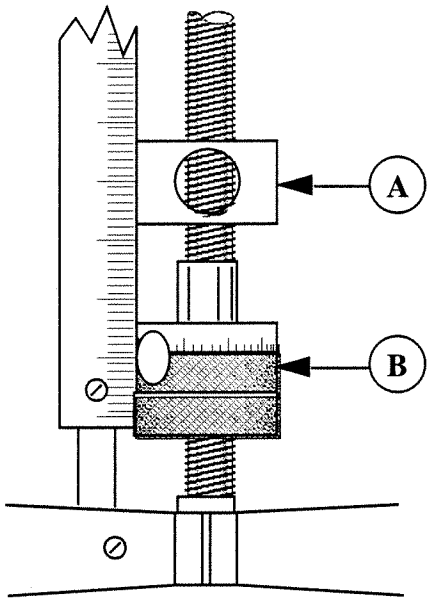


Figure 8-5. Quill Stop Knob and Micrometer Nut

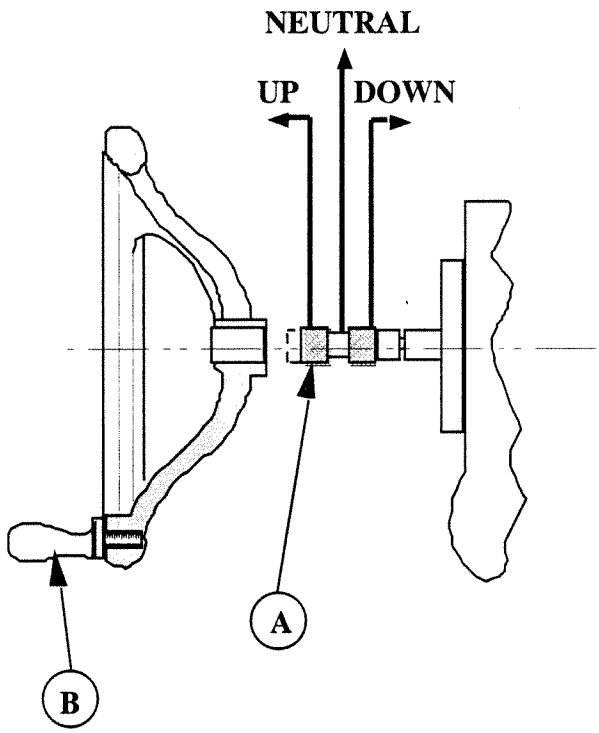


Figure 8-6. Feed Reverse Knob and Manual Feed Handwheel

8.9 QUILL FEED CONTROL LEVER (Figure 8-7)

The feed control lever (A) engages the overload clutch on the pinion shaft when positioned left and will stay engaged until either quill stop comes in contact with micrometer adjusting nut, forcing feed control lever to drop out automatically, or released manually by moving lever to right.

NOTE

The feed control lever must be engaged in order to use manual feed controls.

8.9.1 Feed Control Overload Clutch

CAUTION

Do not tamper with the feed control overload clutch in the field.

The feed control overload clutch is factory set to hold up to 200 lbs. down pressure on quill.

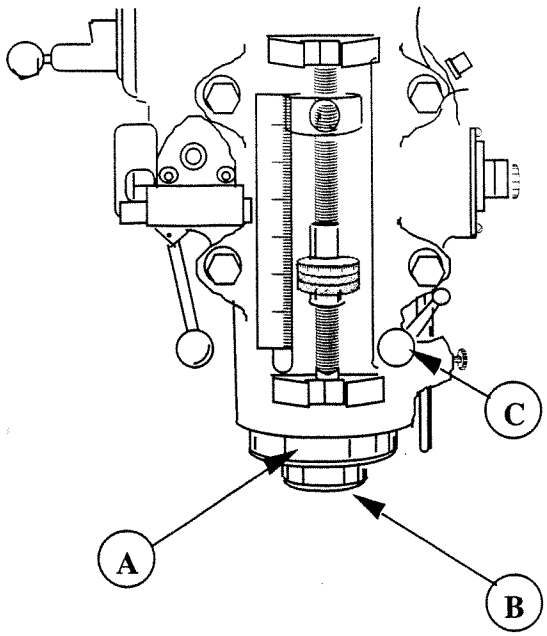


Figure 8-7. Feed Control Lever

8.10 QUILL (Figure 8-8)

The quill (A) contains the spindle assembly and can be raised or lowered by means of the Quill Feed Handle. Refer to paragraph 8.13.

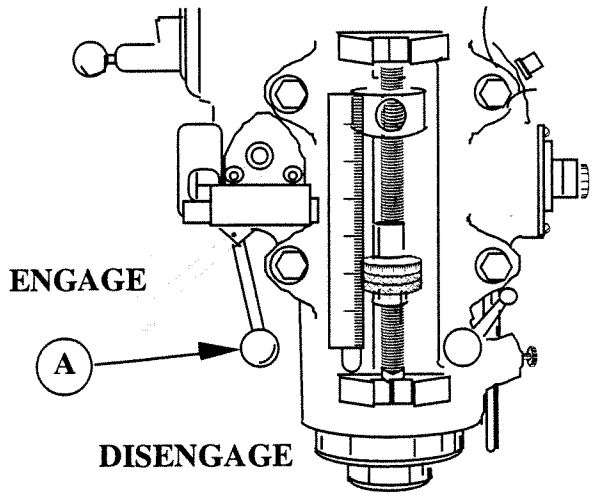


Figure 8-8. Quill, Spindle, and Quill Lock

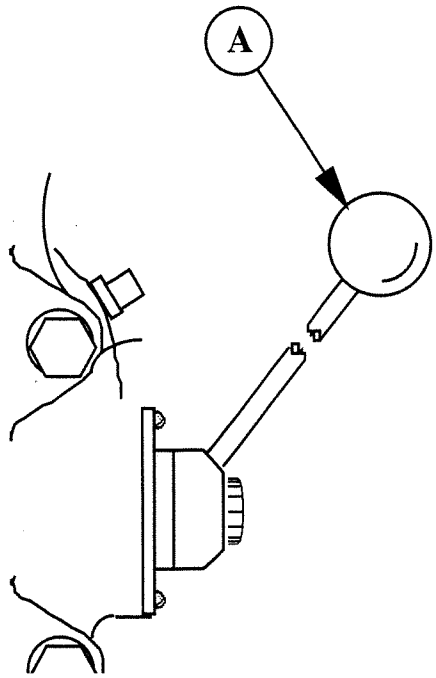


Figure 8-9. Quill Feed Handle

8.11 SPINDLE (Figure 8-8)

The spindle (B) does the actual rotation and also retains the machine tooling.

8.12 QUILL LOCK (Figure 8-8)

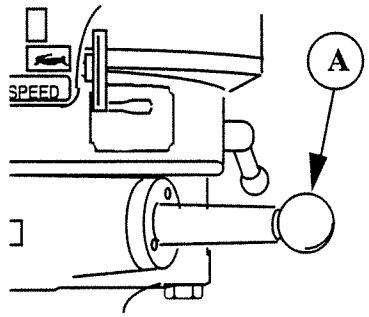
The quill lock (C) is a friction lock used when quill is in stationary position such as milling operations. It is recommended that this lock be used whenever quill movement is not desired.

8.13 QUILL FEED HANDLE (Figure 8-9)

The quill feed handle (A) may be removed by simply pulling handle off. It is recommended that handle be disengaged when using power feed. This handle is used to raise and lower the quill manually.

8.14 POWER FEED TRANSMISSION ENGAGEMENT CRANK (Figure 8-10)

The power feed transmission engagement crank (A) engages the power feed worm gear. When the lever is in right hand hole, the power feed worm gear is engaged. To disengage worm gear, pull knob out and crank handle in clockwise or down direction and move to opposite position.



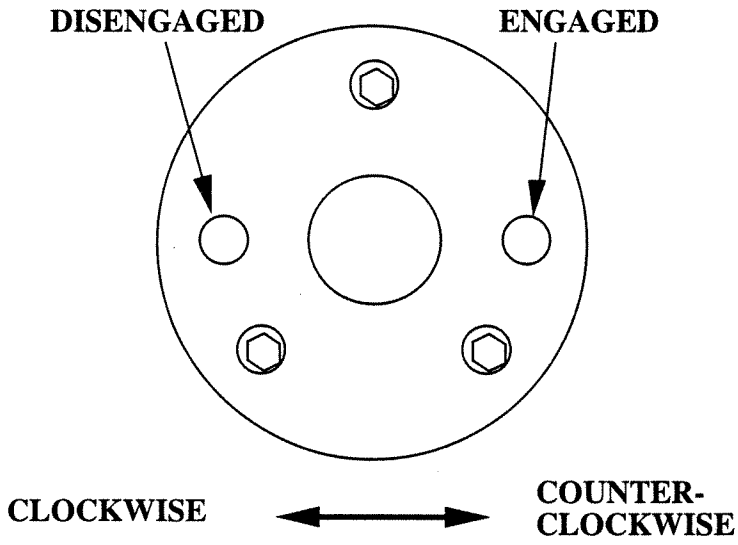


Figure 8-10. Power Feed Transmission Engagement Crank

8.15 HI-NEUTRAL-LO LEVER (Figure 8-11)

The HI-NEUTRAL-LO lever (A) is used to put the attatchment into either backgear or direct drive. Rotate the spindle by hand to facilitate meshing of clutch or gears.

Neutral is provided to permit free spindle rotation rotation for indicating and set-up work.

In the high speed position (direct drive) the spindle is driven by tapered tooth clutch. If the clutch is not meshed tightly, clutch rattle will be heard. This can be corrected by loosening the two securing screws on the lever while in high speed position. The clutch spring will automatically adjust the clutch. Tighten the two securing screws on the lever

CAUTION

Do not shift HI-LO lever while motor is running.

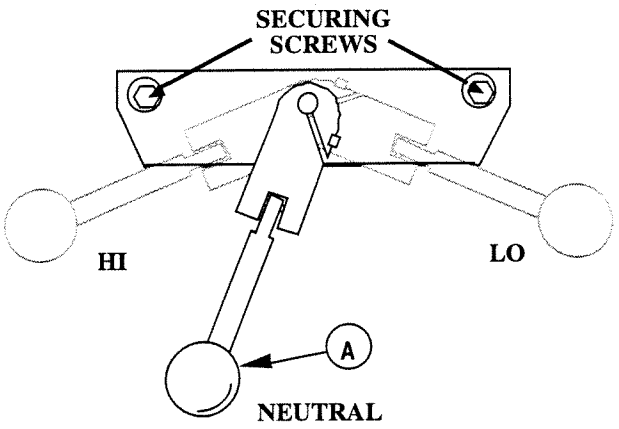


Figure 8-11. Hi-Neutral-Lo Lever

8.16 SPEED CHANGE HANDWHEEL (Figure 8-12)

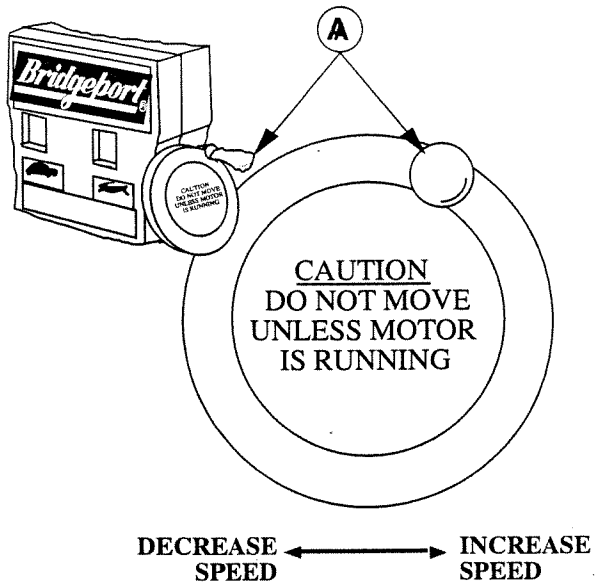


Figure 8-12. Speed Change Handwheel

CAUTION

Do not attempt to change spindle rpm unless the motor is running.

NOTE

Dial indicator speeds will only be approximate. Belt wear will cause a slight variation in speeds from what is indicated on the dial.

Spindle speeds are adjusted by turning the Speed Change Handwheel (A) on the front of the belt housing. There are two ranges: 60 to 500 rpm and 500 to 4200 rpm.

60 to 500 rpm is obtained through the back-gear drive and is referred to as the low range. To engage the back gears, use the lever marked Hi-Neutral-Lo on the right rear sde of the attatchment. Move this lever to the **"LO"** position and use the low range on the drum switch.

When shifting to **"LO,"** DO NOT FORCE THE LEVER if the back gears do not mesh. Hold the lever so the gears are clear of one another, rotate the spindle nose by hand until the gears line up, then put the unit in **"LO"** (back gear).

500 to 4200 rpm is obtained through direct drive and is the high range. The same lever and switch as above are used selecting the **"HI"** range.

When shifting to **"HI"**, DO NOT FORCE THE LEVER if the clutch teeth do not mesh. It is a simple matter to engage the brake and rotate the spindle nose by hand until the clutch engages.

CAUTION

Avoid shifting the Hi-Lo lever when the feed gear is engaged.

8.17 MOTOR (Figure 8-13)

The spindle motor (A) is 2 HP (continuous) variable speed with a 3 HP power rating (30 minute duty rated).

8.18 DRAWBAR (Figure 8-13)

When tightening or loosening the drawbar (B), it is necessary to lock the spindle. To accomplish this, use the spindle brake (paragraph 8.3) which is located on the left side of the belt housing; pull the lever or push it away until it binds, then raise the quill feed handle to lock it in place (paragraph 8.13).

The drawbar has a 7/16-20 right hand thread and should be tightened by hand with a normal amount of pressure using the wrench furnished with the machine. To loosen the collet, back off the drawbar; if collet does not open immediately, give the knob on top of the drawbar a slight tap. The spindle has a non-sticking taper and the collet should release readily.

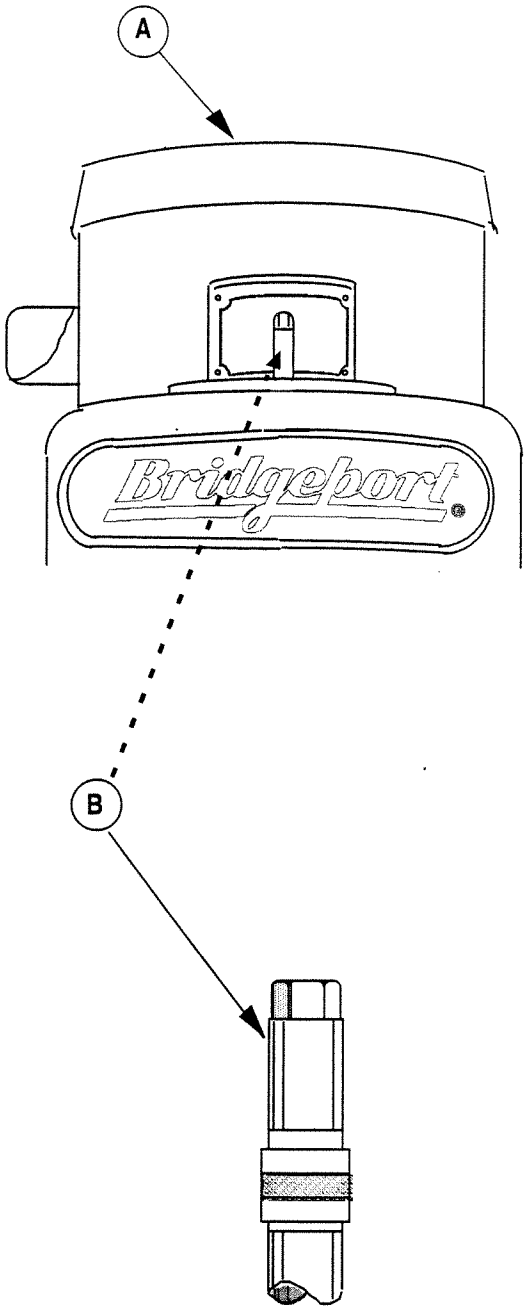


Figure 8-13. Motor and Drawbar

8.19 CHANGING SPINDLE SPEEDS (Figure 8-14)

8.19.1 Change Speed Within Range

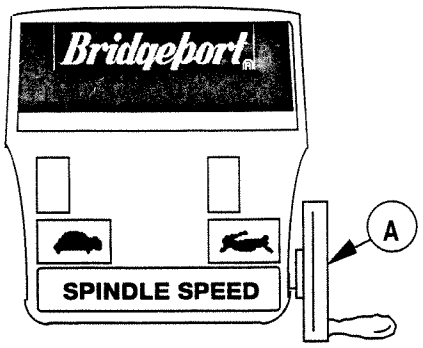
NOTE

Change spindle speed only when spindle is running.

a) Start spindle.

b) Turn handwheel (A) to select required speed.

c) Change only when spindle is running.



DO NOT CHANGE SPEED WHEN SPINDLE IS STATIONARY

8.19.2 Change Range From Direct Drive To Back Gear Drive

a) Switch (B) to **OFF** (stop spindle rotation).

b) Move lever (C) through neutral to **LO** (this reverses the spindle rotation).

c) Switch (B) to **LOW GEAR.**

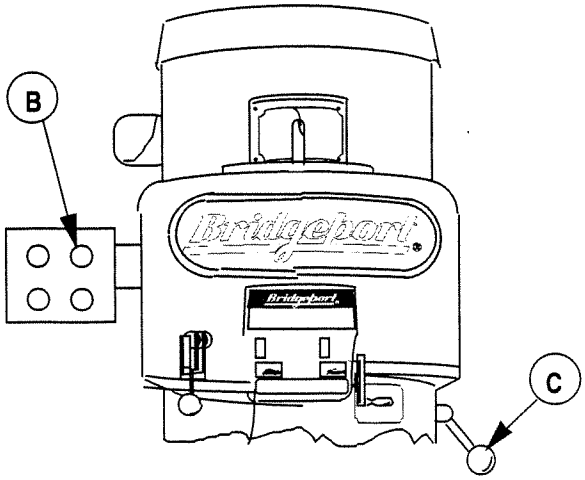
8.19.3 Change Range From Back Gear Drive To Direct Drive

a) Switch (B) to **OFF** (stop spindle rotation).

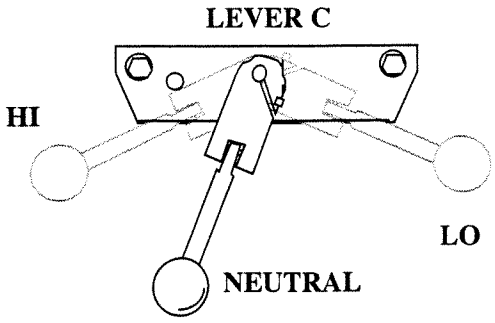
b) Move lever (C) through neutral to **HI.**

c) Rotate spindle by hand until the clutches are felt to engage.

d) Switch (B) to **HIGH GEAR.**



DO NOT CHANGE RANGE WHILE THE SPINDLE IS RUNNING



8.20 QUILL FEED (Figure 8-15)

8.20.1 Fine Hand Feed

a) Disengage auto quill feed (A).

b) Locate (C) in mid (neutral) position.

c) The quill is now under handwheel control.

Figure 8-14. Changing Spindle Speeds

8.20.2 AUTOMATIC FEED

NOTE

Do not engage quill feed (A) over 3,000 R.P.M.

a) Maximum loading 3/8 inch (9.5 mm) diameter drill steel.

b) Ensure quill lock is off (D).

c) Set micrometer dial to required depth (E).

d) Engage auto quill feed (A) when motor is stopped.

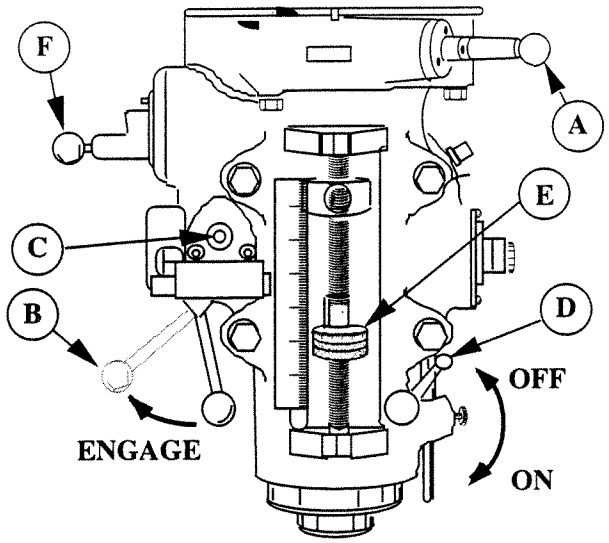
e) Select feed rate (F).

f) Select feed direction (C).

g) Engage feed trip lever (B).

h) The feed will automatically trip out to depth setting within 0.010 inch (0.25 mm).

i) Hand feed to dead stop for repeating accuracy 0.001 inch (0.025 mm).



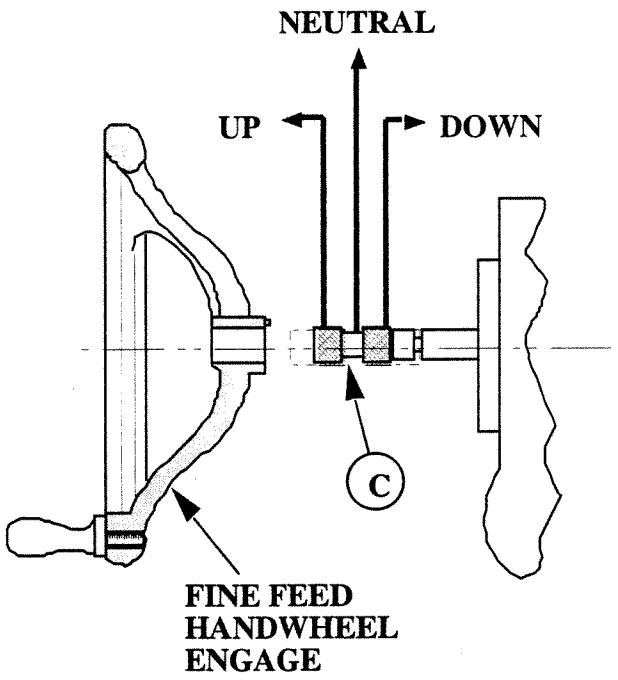


Figure 8-15. Quill Feed

8.21 SWIVEL BELT HOUSING (Figure 8-16)

WARNING

To prevent personal injury or damage to machine, do not remove the three locking nuts after loosening.

a) Loosen the 3 locking nuts (A).
b) Swivel to required angular setting.

CAUTION

Incorrect spline alignment can be caused by unequal tightening of the locking nuts, causing fluctuation of the quill feed which can be felt through the sensitive feed handle. It is advised to call Bridgeport Machines Service Department before attempting this procedure.

c) Tighten 3 locking nuts snugly before final tightening of locking nuts. Run spindle to give correct spine alignment, then retighten locking nuts securely.

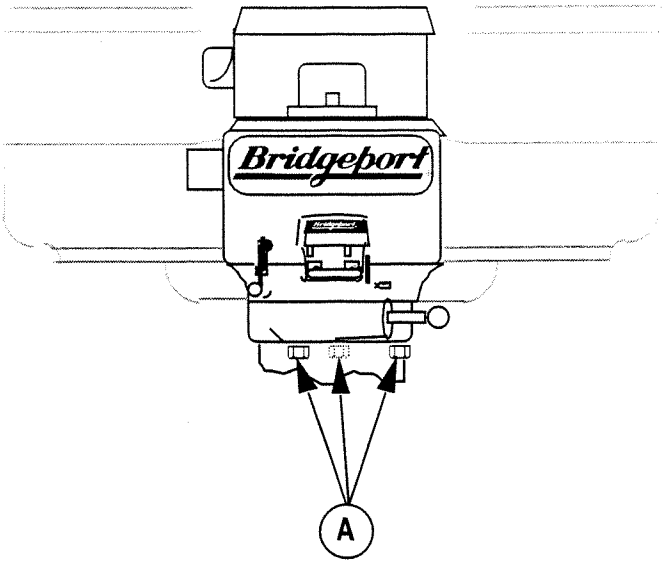


Figure 8-16. Swivel Belt Housing

8.22 SPINDLE BRAKE (Figure 8-17)

Brake lever has capability to rotate in either direction to brake and lock, Cam upwards to lock and prevent movement of spindle.

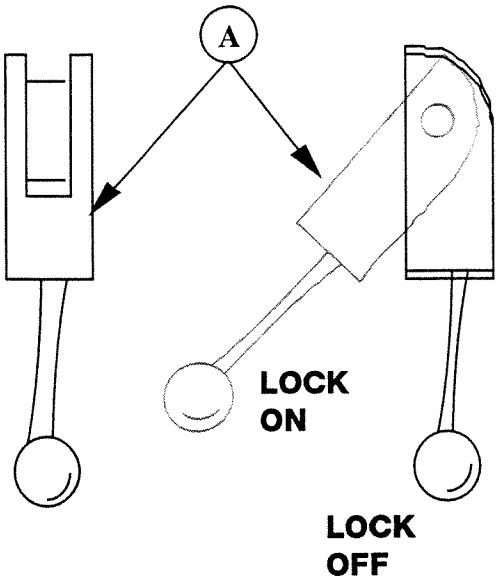


Figure 8-17. Spindle Brake

8.23 QUILL SENSITIVE HAND FEED (Figure 8-18)

a) Place the handle on the quill feed shaft.
b) Select the most suitable position
c) Push home until the locating pin engages

8.24 SWIVEL TURRET (Figure 8-19)

WARNING

Do not remove bolts.

a) Use Bridgeport wrench and loosen the 4 bolts.

b) Index to the required setting.

c) Lock the 4 bolts to 47 ft. lbs.

8.25 MOVE RAM SLIDE (Figure 8-20)

a) Use Bridgeport wrench and loosen bolts 1 and 2.

NOTE

It is recommended that on heavy milling work, head should be kept as close to the column as possible, where maximum rigidity is obtained.

b) Use wrench to move the slide to the desired position using bolt 3.

c) Retighten bolts 1 and 2 starting with rear bolt.

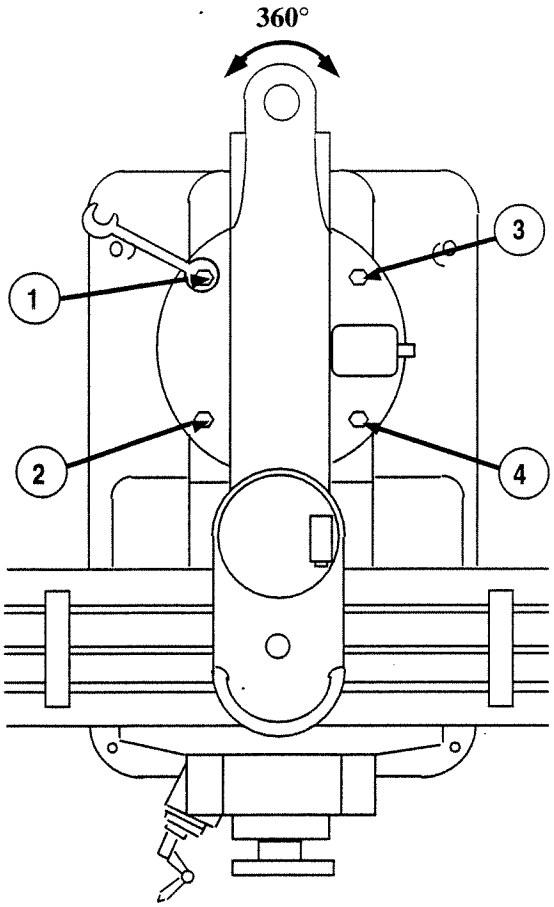


Figure 8-19. Swivel Turret

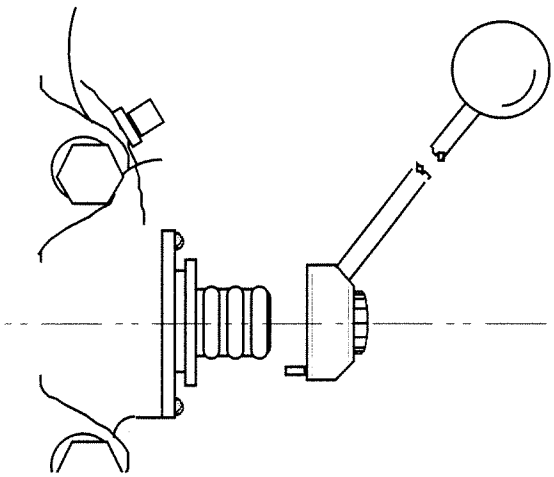


Figure 8-18. Quill Sensitive Hand Feed

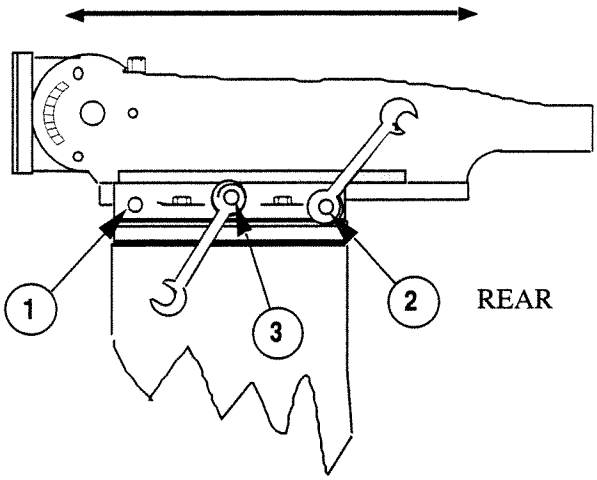


Figure 8-20. Move Ram Slide

8.26 SADDLE CLAMPING (Figure 8-21)

When milling with longitudinal table feed only, it is advisable to clamp the knee to the column (paragraph 8.27) and the saddle to the knee to add rigidity to these members and provide for heavier cuts with a minimum of vibration. The saddle locking lever is located on the left-hand side of the saddle.

Excessive pressure can cause slight table bind. Use moderate clamping pressure, as this will hold saddle sufficiently.

8.27 TABLE CLAMPING (Figure 8-22)

The table clamp levers are located on the front of the saddle and should always be clamped when longitudinal movement is not required.

8.28 KNEE CLAMPING (Figure 8-23)

The knee clamping levers are at the left side of the knee and front of knee. Leave clamped at all times unless raising or lowering the knee.

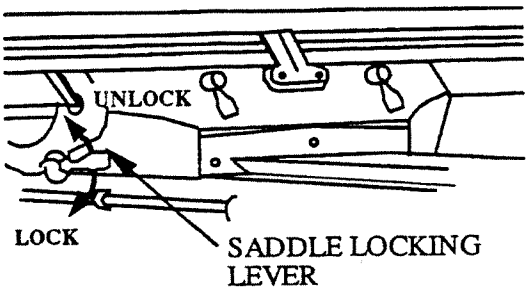


Figure 8-21. Saddle Clamping

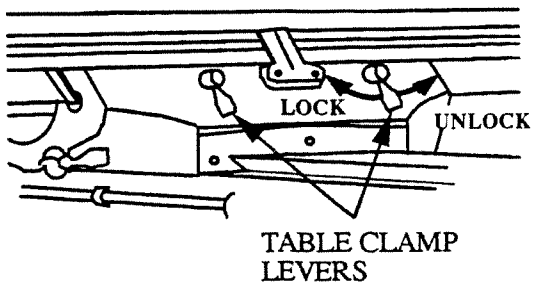


Figure 8-22. Table Clamping

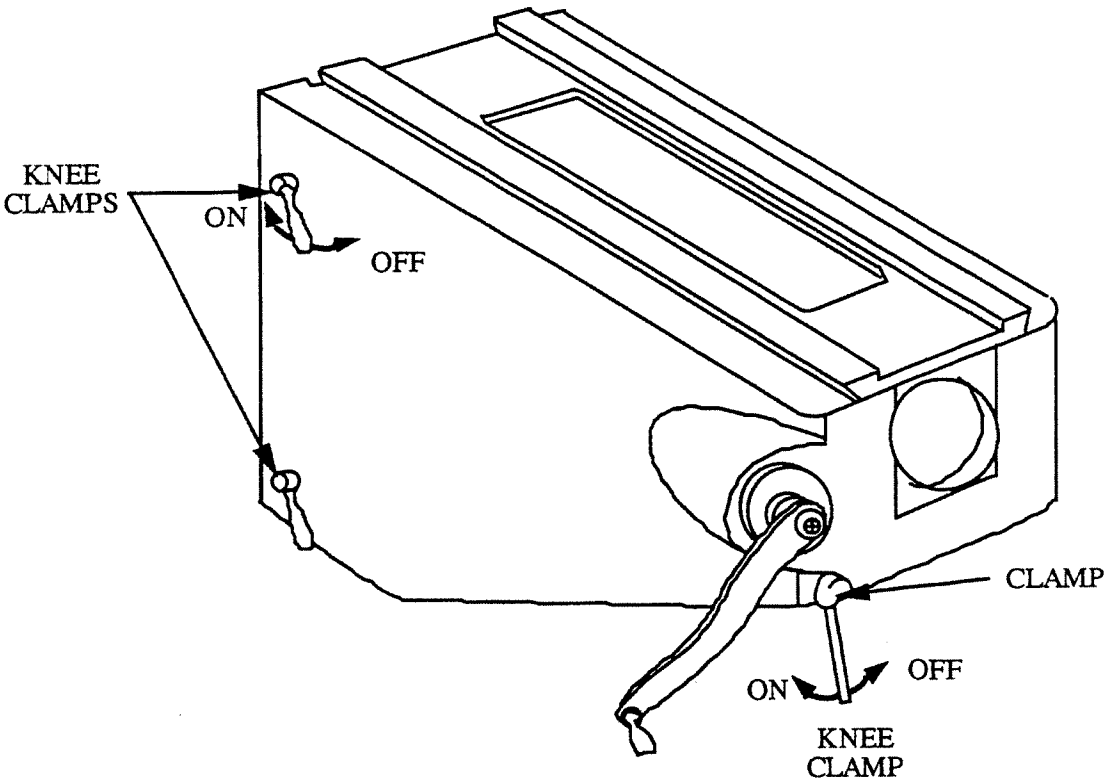


Figure 8-23. Knee Clamping

Chapter 9. Maintenance

9.1 MOTOR REMOVAL (Figure 9-1)

1. Run head to adjust to lowest speed.
2. Disconnect power.
3. Remove 3 screws (A) and cover (B).
4. Using the two screws (A), compress spring (C).
5. Rotate the speed changer to the highest speed.
6. Remove the reversing switch from the belt housing.
7. Remove the two securing screws (D).
8. Lift the motor and rest the case on stud (E).
9. Ease the belt over the lower drive disc and remove the motor.

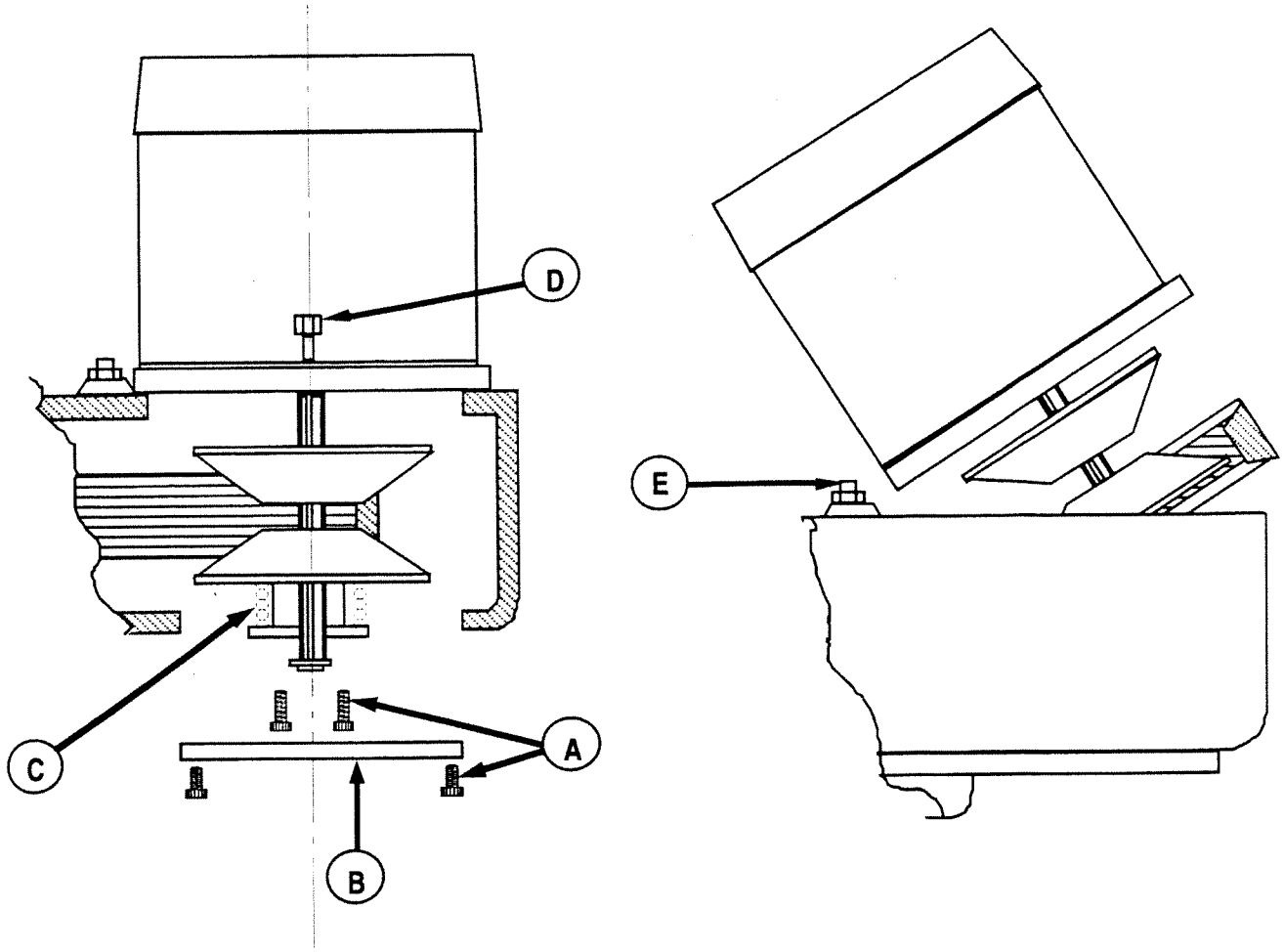


Figure 9-1. Motor Removal

9.2 DRIVE BELT REPLACEMENT (Figure 9-2)

1. Remove the motor as described in paragraph 9-1.
2. Remove the three screws (A); insert into the adjacent tapped holes and withdraw bearing housing (B).
3. Remove the two screws and the bushings (C).
4. Remove four screws (D) and one screw (E).
5. Remove four screws securing speed changer (F).
6. Remove top housing (G); tap to clear the dowels.
7. Replace the belt.

9.3 TIMING BELT REPLACEMENT (Figure 9-3)

1. Remove the motor.
2. Lower the quill to full extent.
3. Remove the two lower cap screws (A) from the speed changer housing.
4. Remove the four cap screws (B).
5. Remove the top assembly (C) and tap to clear dowels.
6. Replace the belt.

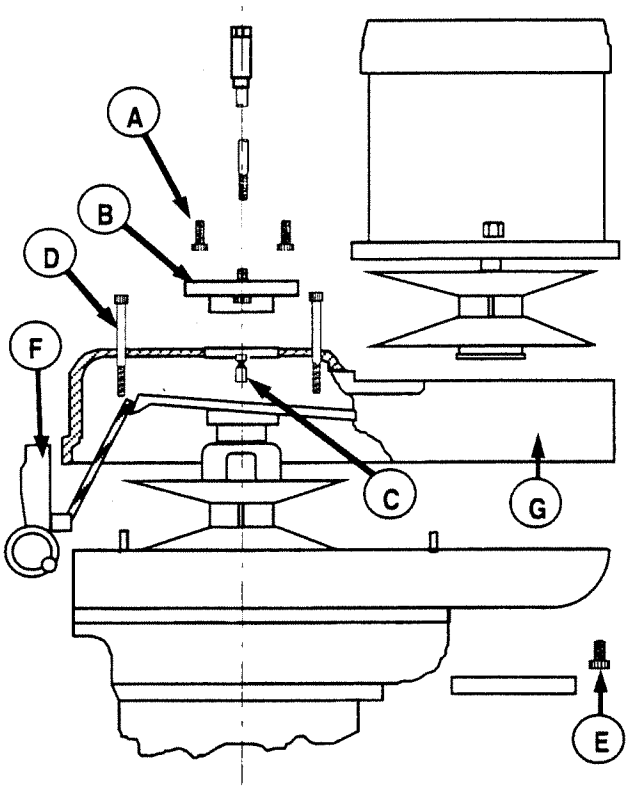


Figure 9-2. Drive Belt Replacement

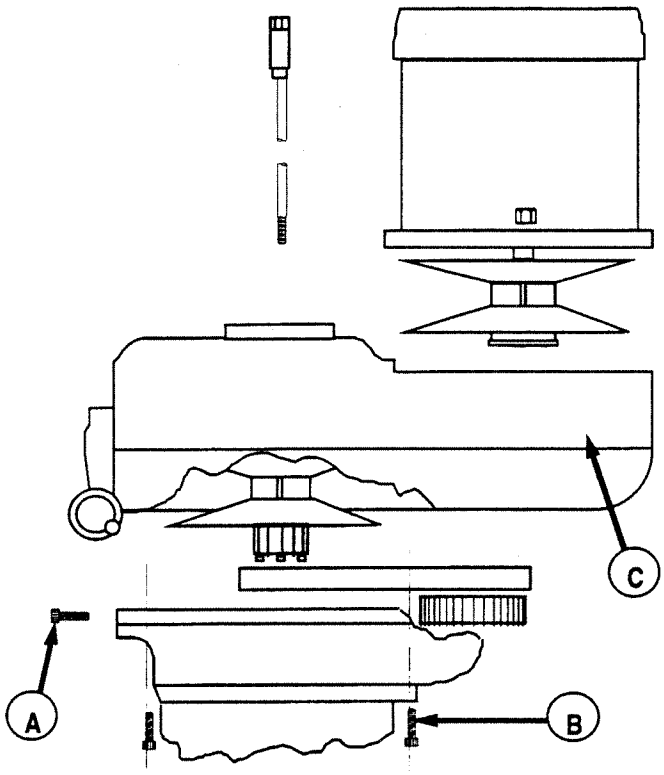


Figure 9-3. Timing Belt Replacement

9.4 BRAKE SHOE REPLACEMENT (Figure 9-4)

1. Remove the top housing (refer to motor removal and timing belt replacement in paragraph 9-1).
2. Remove the two screws (A).
3. Remove the clutch hub assembly (B).
4. Replace the brake shoes (C).
5. Remove the bearing, drive discs and circlips from the hub assembly (B).
6. Replace the bearing and housing (D).
7. Thread the hub (B) through the bearing and reassemble the discs. Replace top housing and motor.

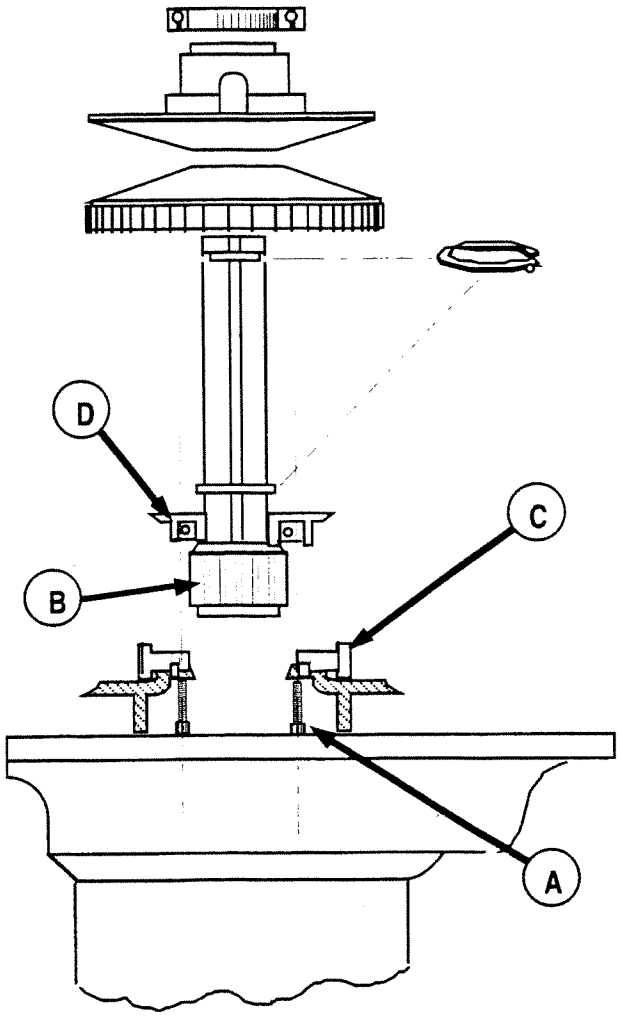


Figure 9-4. Brake Shoe Replacement

9.5 MICRO FEED TRIP ASSEMBLY AND QUILL REMOVAL (Figure 9-5)

1. Remove screw (D) and ball reverse lever (E).
2. Remove retaining ring (F), screw (G) and arm (H).
3. Thread shaft (J) through micro nuts and remove.
4. Remove screw (K) and stop (L).
5. Remove quill.
6. Clean all areas, oil liberally and reassemble.
7. Check correct operation of micro feed trip assembly together with feed trip linkage as per feed tripping adjust ment. See paragraph 9-7.

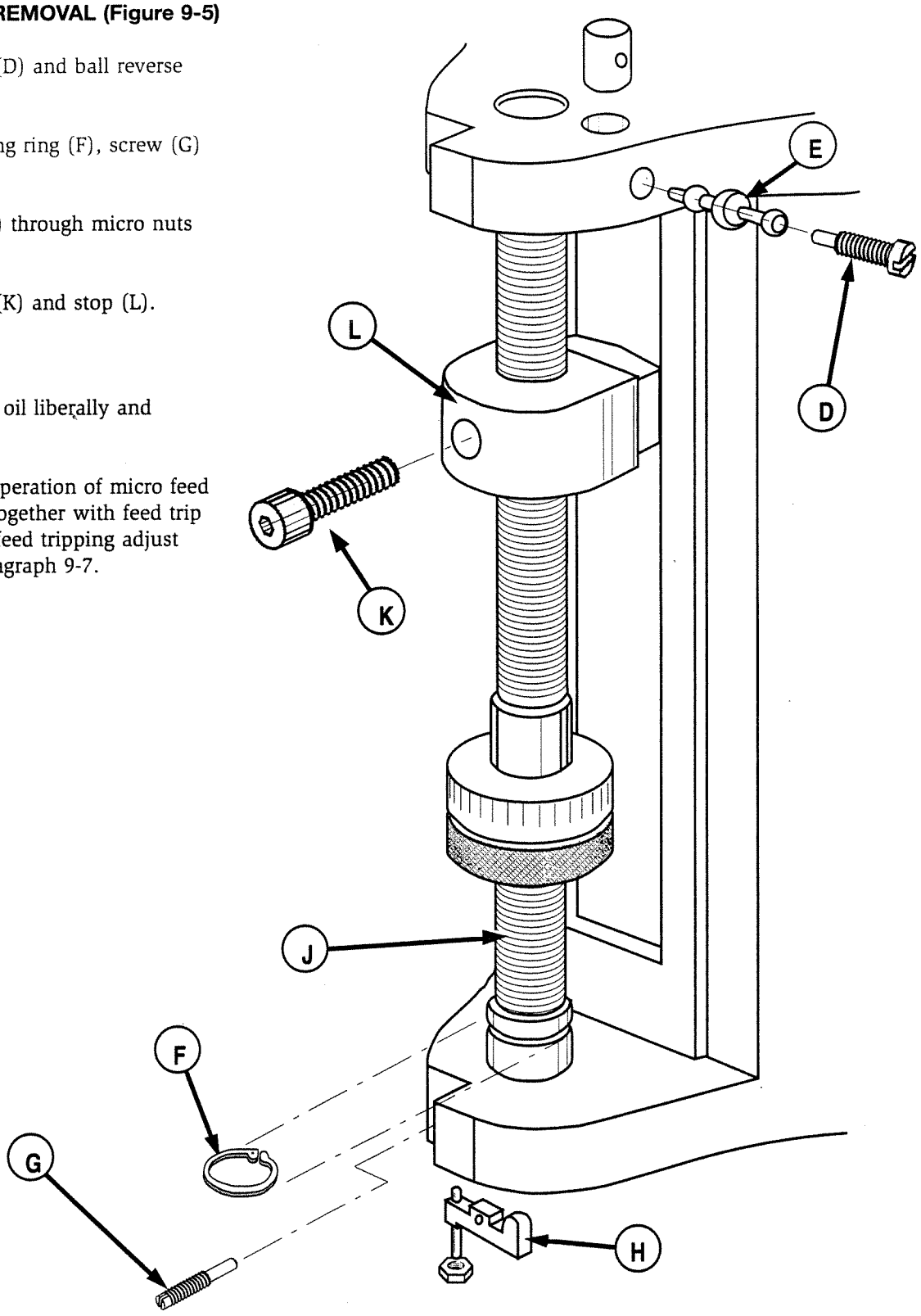


Figure 9-5. Micro Feed Trip Assembly and Quill Removal

9.6 BALANCE SPRING REPLACEMENT (Figure 9-6)

1. With quill at maximum up position apply quill lock.
2. Remove screw (A), hub (B), and key (C).
3. Remove screws (D), allowing housing to rotate slowly, releasing spring tension.
4. Lift end of spring from pin on the pinion shaft.
5. Rotate housing (E) counterclockwise from head casting.
6. Remove spring from housi ng and replace.
7. Refit spring to main housing casting. Turn housing clockwise until spring locates on pin in pinion shaft

9.7 FEED TRIP ADJUSTMENT (Figure 9-7)

1. Release locknut (A).
2. Engage trip handle (C).
3. Adjust micro nuts against quill stop (B).
4. Slowly turn adjusting screw (D) until lever (C) trips. If set too light it will not be able to drill.
5. At this point, secure locknut (A).
6. Check for quick action response.

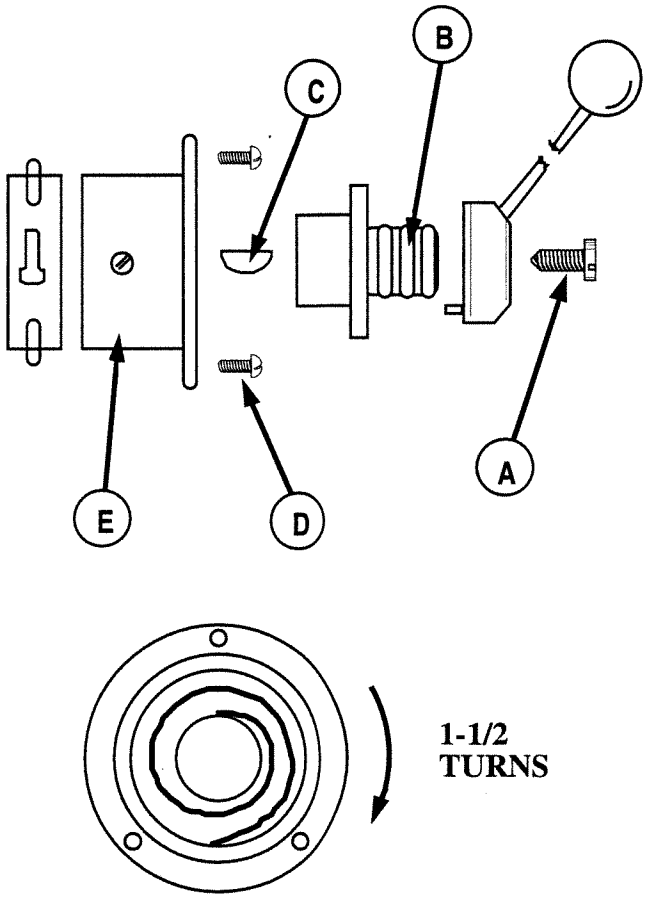


Figure 9-6. Balance Spring Replacement

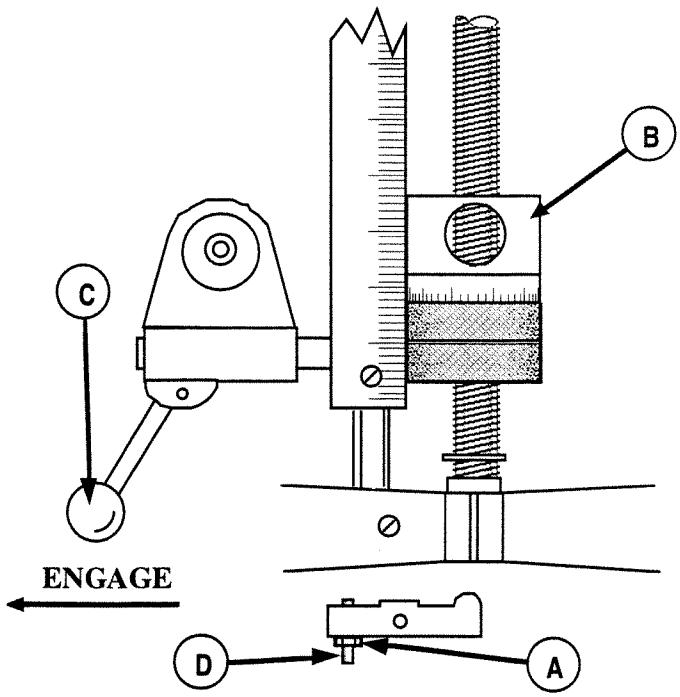


Figure 9-7. Feed Trip Adjustment

9.8 COLLET ALIGNING SCREW REPLACEMENT (Figure 9-8)

1. Use felt pen, mark reference line on quill and nose cap (B).
2. Remove set screw (A).

CAUTION

Do not attempt to remove nose cap before removing set screw (A). Doing so will cause serious damage.

3. Unscrew nose cap (B).
4. Remove lock screw (C) and collet aligning screw (D).
5. Replace (D); insert collet and check that the dog on the end of the screw does not interfere with the bottom of the guide slot.
6. Replace lock screw (C).
7. Replace nose cap (B); check felt pen markings for correct alignment.
8. Replace set screw (A).

CAUTION

Do not overtighten as this will cause distortion.

9. Check gap (E) 0.003 in. (0.08 mm).

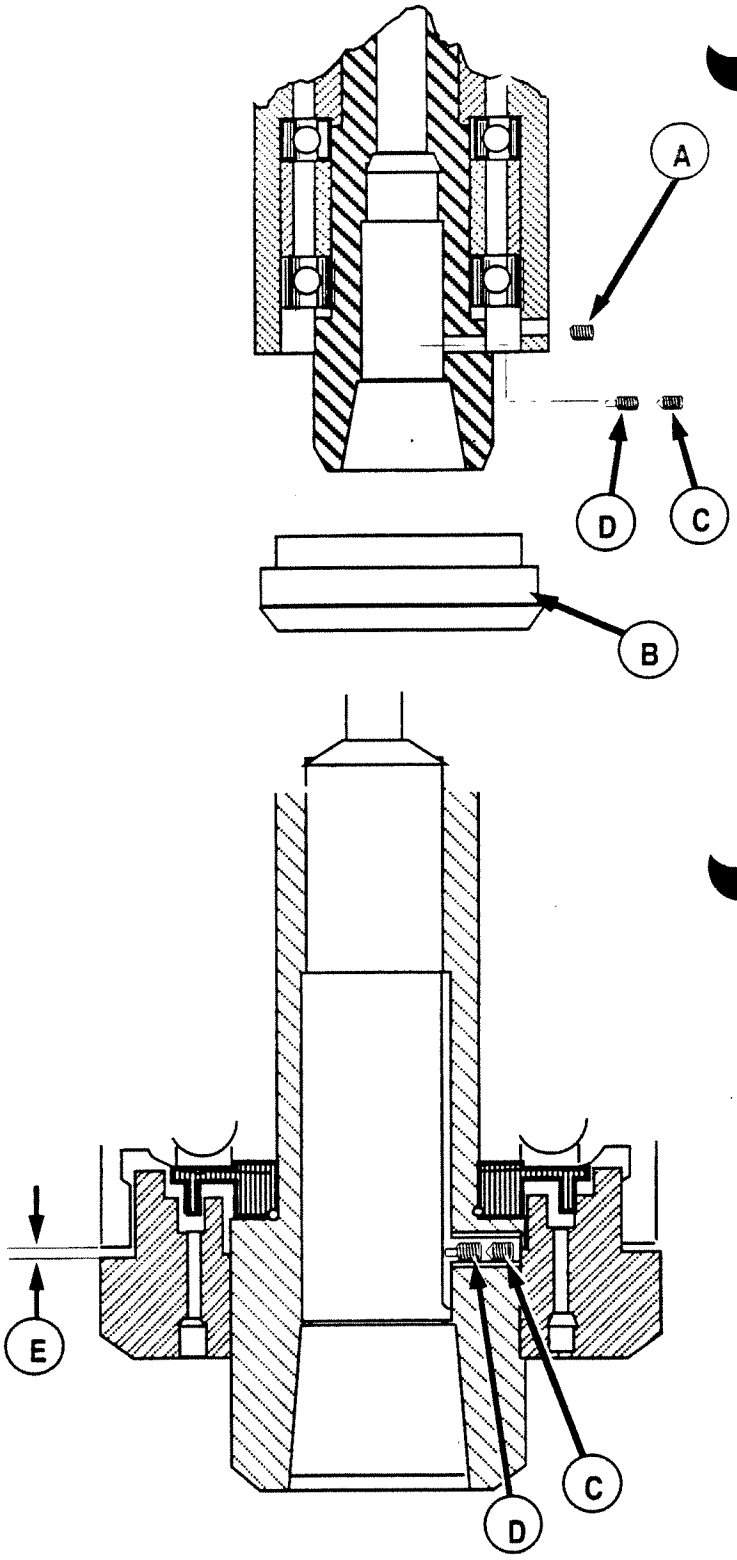


Figure 9-8. Collet Aligning Screw Replacement

9.9 ADJUSTMENT OF TABLE GIB (Figure 9-9)

The table is provided with a full length tapered gib in the saddle, and an adjusting screw on the left side. To take up gib, tighten gib adjusting screw slightly and repeat until a slight drag is felt when the table by hand.

9.10 ADJUSTMENT OF SADDLE AND KNEE GIBS (Figure 9-10)

A tapered gib is used for adjusting the saddle bearing on the knee. This forms a guide for the saddle. To tighten gib, the same principle as described above is used; however, the chip wiper has to be removed first.

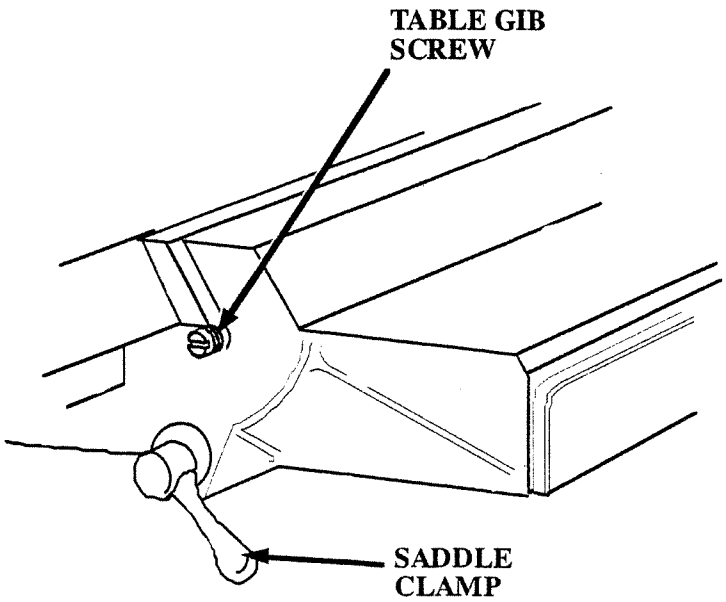


Figure 9-9. Adjustment of Table Gib

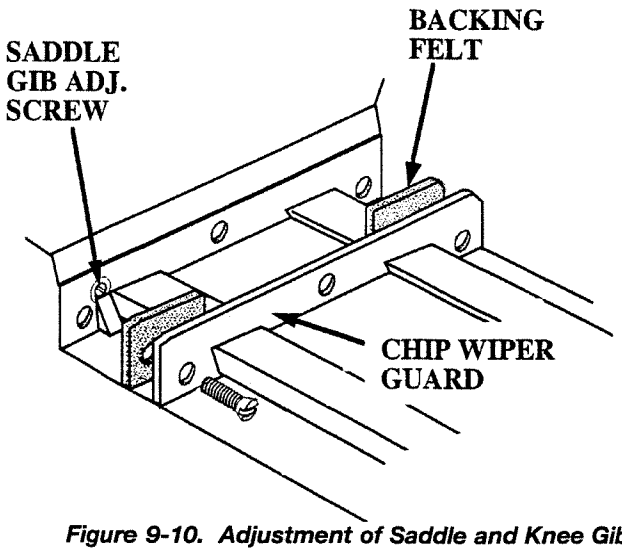


Figure 9-10. Adjustment of Saddle and Knee Gibs

9.11 ADJUSTMENT OF KNEE GIB (Figure 9-11)

Remove chip wiper guard and adjust screw until smooth movement is attained.

NOTE

Important: Loose gibs will cause loss of machine's accuracy.

9.12 HOME SWITCH ADJUSTMENT

The home switches should be adjusted to permit equal travel in the plus and minus direction about the centerline of the spindle.

9.12.1 X-Axis Switch Adjustment

1. Establish the center of the table to the center line of the spindle with the hand crank.
2. Power up the control.
3. Crank the table to the left until the read out is reading 14.815 inches. This is the point that the home switch trip dog should make the home switch close.
4. Remove the cover plate from the bottom of the home switch enclosure. Attach a voltmeter to wire #59 and ground. Set the voltmeter to the 12 volt range.
5. Move the X-axis trip dog from the center of the table over to the home switch plunger and slowly adjust the dog toward the right until the meter reads 12 volts. Lock up the trip dog.
6. Crank the table to the right until the switch is clear.
7. Remove the X-axis motor and set it on the floor so that the shaft end can be observed. Leave the motor functional.
8. Home the control. When the X-axis starts to move, manually push the home switch plunger down. When the motor stops, the motor is home.
9. Set the X-axis read-out to zero.
10. Jog the X-axis to read -0.285 on the readout. The motor is now set to the point where the control will be expecting to see the home switch close.
11. Carefully crank the table to the left until the switch just closes, 12 volts on the meter.
12. Carefully install the motor onto the machine.

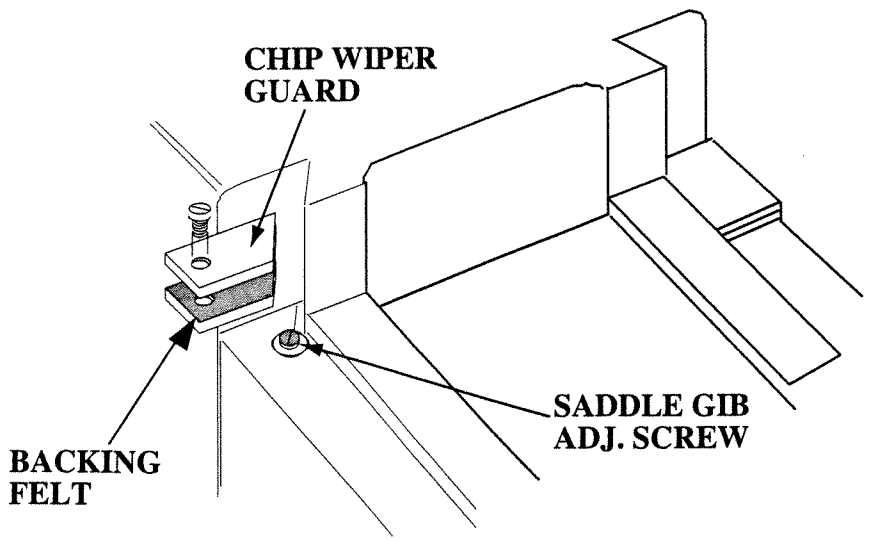


Figure 9-11. Adjustment of Knee Gibs

13. Manually crank the trip dog off of the home switch and slowly crank it back on to the switch.

14. At the time the meter changes to 12 volts the read out for the X axis should be -0.280 to -0.290 inches.

15. If the readout is out of the above range, carefully adjust the trip dog until the reading is within that range when steps 13 and 14 are repeated.

9.12.2 Y-Axis Switch Adjustment

1. Establish the center of the table to the center line of the spindle with the hand crank.

2. Power up the control.

3. Crank the table forward until the read out is reading 5.715 inches. This is the point that the home switch trip dog should make the home switch close.

4. Remove the cover plate from the bottom of the home switch enclosure. Attach a volt-meter to wire #58 and ground. Set the volt-meter to the 12 volt range.

5. Move the Y-axis trip dog from the center of the knee over to the home switch plunger and slowly adjust the dog forward until the meter reads 12 volts. Lock up the trip dog.

6. Crank the table to the back until the switch is clear.

7. Remove the Y-axis motor and set it on the floor so that the shaft end can be observed. Leave the motor functional.

8. Home the control. When the Y-axis starts to move, manually push the home switch plunger down. When the motor stops, the motor is home.

9. Set the Y-axis read out to zero.

10. Jog the Y-axis to read -0.285 on the readout. The motor is now set to the point where the control will be expecting to see the home switch close.

11. Carefully crank the table forward until the switch just closes, 12 volts on the meter.

12. Carefully install the motor onto the machine.

13. Manually crank the trip dog off of the home switch then slowly crank it back on to the switch.

14. At the time the meter changes to 12 volts the read-out for the Y-axis should be -0.280 to -0.290 inches.

15. If the read-out is out of the above range, carefully adjust the trip dog until the reading is within that range when steps 13 and 14 are repeated.

Chapter 10. Troubleshooting

10.1 INTRODUCTION

Troubleshooting consists of locating faults by starting with obvious things and moving to the less obvious. Field diagnosis of machine problems can be divided into 3 sets of checks which are listed below. A flow chart, Figure 10-1, is provided to assist in following the steps. The flow chart indicates which subsystem is likely to be at fault, and directs the technician to the proper section in this chapter

10.1.1 Procedure

Follow the chart, figure 10.1, to determine the best place to begin troubleshooting the system. The three major sets of checks are:

1. Incoming Power (section 10.2.1)
2. Power Supplies (section 10.2.2)
3. Error Messages (section 10.3)

Additional checks for axis stalling and spindle problems are presented in section 10.5 and the Axis Troubleshooting Chart (Table 10-2) at the end of this chapter.

Use the system wiring diagram (page 4-9) to follow the electrical checks, and to perform any additional electrical checks if necessary.

10.2 ELECTRICAL POWER TEST (Figure 10-2)

Lethal voltages are present in the Equipment Panel Assembly, even when the Main Disconnect switch is off. Use extreme caution whenever working in the Equipment Panel Assembly. Failure to do so may cause electrical shock, resulting in serious personal injury or death.

Power enters the machine at the Main Circuit Breaker on the Equipment Panel Assembly. Then it goes to the Interface Transformer.

10.2.1 Incoming Power

1. The proper AC power voltage is indicated on the label outside of the Equipment Power Assembly. Insure that the correct voltage is supplied to the machine. If not, refer to the System Wiring Diagram (page 4-11) for the proper jumper configuration.

2. Turn on the Main Circuit Breaker at the Equipment Panel Assembly. Measure the incoming power at the main pairs of terminals 1L1, 1L2, and 1L3.

Machine	Reading
208 VAC	187-229 VAC
230 VAC	220-240 VAC
460 VAC	415-506 VAC

3. Measure the input voltage of transformer T1. The voltage should be the same as between the fuses (1L1, 1L2, and 1L3). Make sure the transformer jumpers agree with voltage input. See Jumper Chart for T1 on System Wiring Diagram (Page 4-11).

The inputs to T1 are:

Wire No.	Machine
1L2, 1L3	208/230/460 VAC, 60Hz

4. Measure the output voltage from T1:

Wire No.	Machine
1, 2	110-120 VAC

If the output voltage is not correct, repair the connection(s) or replace T1.

10.2.2 Power Supplies

1. Turn on the power and locate the terminal strip for Drive Power Supply. Measure the following voltages:

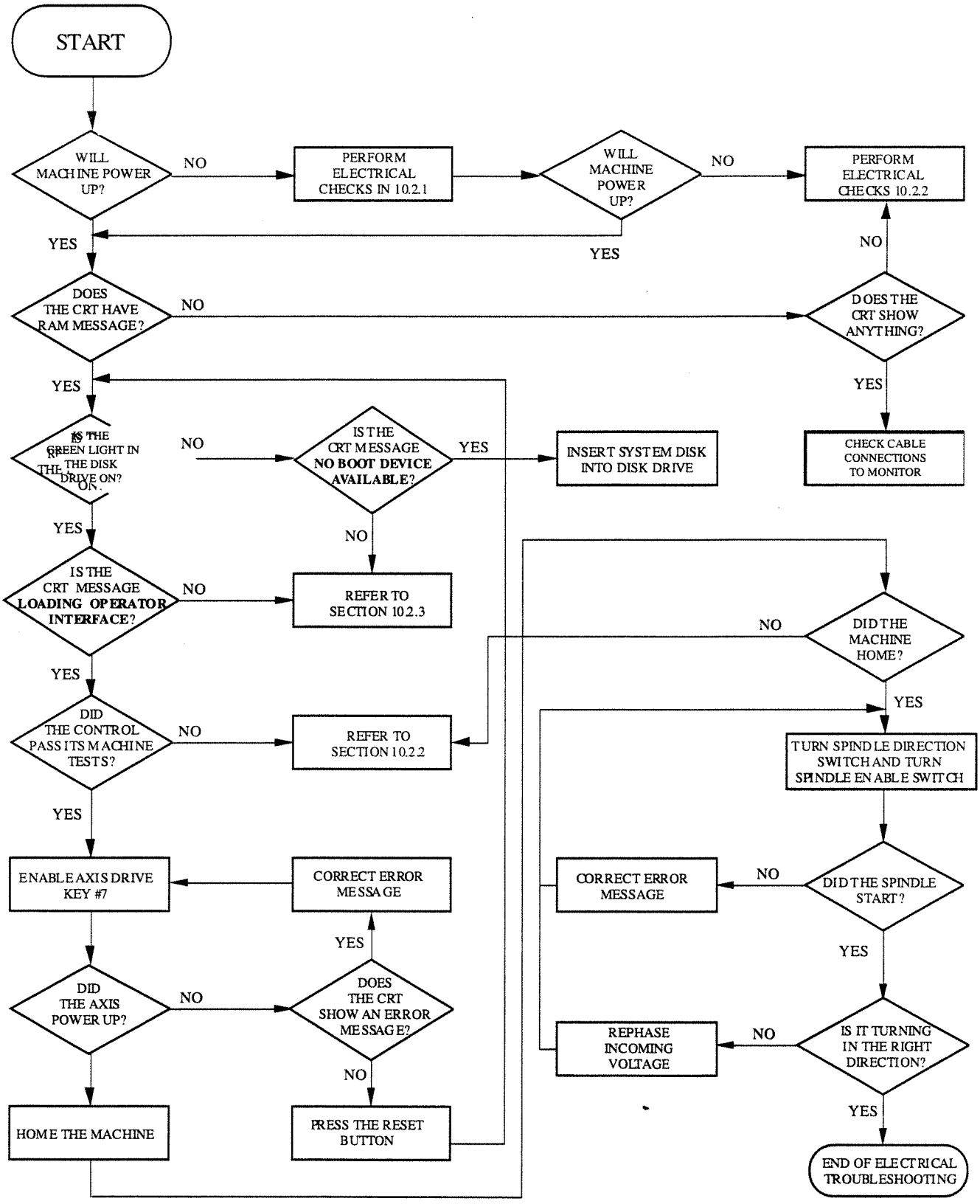


Figure 10-1. Troubleshooting Flow Chart

Wires	Readings
20 to 2	72 VAC ± 5 VAC
21 to 2	72 VAC

If the 72 VAC is present, but the 105 VDC is not, check fuses 9 and 10.

NOTE

This power supply will not work without a 10% load on the +5 VDC output. Insure that a hard drive is plugged in when taking readings.

2. The monitor (CRT) in the front panel is self-contained; the only supply voltage is 115 VAC on the power cord at the back of the unit. If this voltage is present and the CRT is still black, check to insure that the power OFF-ON switch is in the ON position. Also, this unit contains a fuse on the 115 VAC line. Insure that the fuse is in good working order.

3. Troubleshooting suggestions:

Problem	Checks to make
Monitor is dead.	1. Check voltages. 2. Check power-on switch. 3. Check in ternal fuse. 4. Check power cord. 5. Insure brightness thumb wheel is turned up.
Monitor has Raster but no video.	1. Check IPC for power. 2. Check that video cable is plugged into monitor.
Monitor is dark.	1. Adjust the brightness control.
Monitor will not synchronize.	1. Adjust the horizontal or vertical hold control.
Monitor display message: **NO BOOT DEVICE AVAILABLE.**	1. Check voltage on the floppy disk drive. 2. No system disk in the drive unit. 3. Check the signal cable from the Pentium to the floppy disk drive.
The machine did not pass the start-up test.	1. BMDC hardware check failed. 2. BMDC software load failed.

10.3 SPINDLE FAILURE

Lethal voltages are present in the Equipment Panel Assembly, even when the Main Circuit Breaker is off. Use extreme caution whenever working in the Equipment Panel Assembly. Failure to do so may cause electrical shock, resulting in serious personal injury or death.

1. If the spindle has stopped abruptly, check to see if the spindle overload (MOL) has tripped. If it has, give the heaters in the device a chance to cool and reset it by pushing the red **RESET** button. Make sure that all connections from the power line to the spindle motor are tight.

2. If the spindle will not start after a move has been completed, check the lubricant level. If the machine has enough lubricant, then the lube level float switch may be bad.

3. If the spindle stops turning as soon as the Spindle Control switch is released, the reversing contactor may be at fault.

4. Check all contacts to the logic boards and terminal strips.

5. If the spindle motor still will not turn, check the power coming into the motor at the motor terminals, T1, T2, and T3 (assuming that the elec trical power test has been completed). The spin dle motor itself may be at fault.

6. The spindle motor cannot reverse direction if the reversing contactor is defective.

10.4 OVERLOAD

RELAY TRIPOUT

Power to the motors may be disabled by a break in the overload relay. This may be restored by pushing the blue RESET switch located to the right of the relay in the Equipment Panel Assembly. Follow this procedure:

1. Turn the power **OFF.**

2. Wait 5 minutes.

3. Try the **RESET** by pushing in the switch. If it doesn't work, wait another 5 minutes and try again.

4. Insure that all connections from the power line to the spindle motors are tight.

5. Power should be restored to the motors. If the relays trip out more than twice, make sure the feedrate matches the type of material you are cutting.

Table 10-1. Axis Preventive Maintenance Procedures

Item	Procedure	Time
Motor Brushes and Commutator	Check the brushes for wear and arcing. Replace brushes, if necessary. Check the commutator for wear and arcing. (Wear is greatly dependent upon application).	Semiannual
Positioning Accuracy	As a normal manufacturing procedure, check the parts made. Check the electrical positioning accuracy and the mechanical machine accuracy.	As Required
Voltage Checks	Check voltages listed under paragraph 10.2.1, steps 1 through 4 and 10.2.2 step 1.	Semiannual

Table 10-2. Axis Troubleshooting Chart

Symptom	Possible Cause
Brush or Commutator Failure	Current limit is inoperative or improperly set. There is high current due to injected electrical noise at the transducer input to the servo. The motor is overspeeding.
Power Transistor Failure	The fault sensor is defective. Switching logic is defective on the printed circuit board.
Contouring Inaccuracy	Gains of all axes are not identical. There is servo current limiting in contouring speed range.
Inadequate Performance	The required accelerating current is not available. There is excessive lost motion such as backlash or windup. There is low frequency mechanical resonance (check by observing open loop response).
Position Overshoot	The current limit is too low, or the tachometer gain is too low.
Poor Surface Finish	The position loop gain is too high. The tachometer is noisy. There is a defective feedback device or device excitation. A machine drive member is defective. Machine tooling is defective.
No Motion (All Axes)	The customer's protective interlocks are set. The main circuit breaker is tripped.
Overcurrent Fault (1 Per Axis)	There is an armature circuit fault. The current limit is inoperative or set too high. The armature is shorted to ground.
Instability During Power Enable	The position or velocity transducer signal is reversed or the armature wires are reversed. The velocity command is not correct. The position or velocity transducer signal is lost. A printed-circuit board is defective.
Instability	The axis is not tuned properly. The position loop gain is too high. The lag capacitor is too small. The high frequency gain is improperly set. Multiply position loop gains are improperly adjusted (if they are used in the controller).
Instability Manifested by Low Amplitude and/or Frequency Oscillation	There is high static to running friction action. Backlash or deadband is present in the machine or transducer.
Positioning Accuracy	High friction is present. Position loop gain and/or low frequency gain of velocity loop is low. There is backlash or wind-up in the position transducer/motion connection. The tool reaction forces are too high to be consistent with high accuracy. Pulley is loose on motor shaft. Encoder output not accurate.

Symptom	Possible Cause
Positioning Cycle Time Too Long	The final position is overshot. The speed is low. Current limit is set too low.
Excessive Machine Wear	Current Limit is set too high or is inoperative. The ripple current in the motor is too high due to noise injected from the transducers.
Motor Overheats	The friction level is too high. Current limit is set too high or is inoperative. There is a noise from the transducers that is being injected into the servo. The duty cycle is too severe. The inertia is high. There are high tool reaction forces requiring high motor current. Permanent magnet fields have been demagnetized, causing high armature current to develop torque.
Poor Speed Regulation Top Speed	The + 105 volt bus is low. Friction is too high. The motor is incapable of operating at the speed being commanded.
Axis-to-Axis Speed Interaction	Power supply capacitance is too small, allowing voltage to dip during motor acceleration. Incoming AC line voltage is dipping during acceleration of the motor and allowing the + 128 volt bus to drop. High friction of inertia load is pulling the + 128 volt bus low. Poor ground connection. The rectifiers are bad or there is some other problem causing the rectification in the power supply to be half wave rather than full wave, creating a low voltage + 128 volt bus under load.
Erratic Motor Operation	Noise is manifested in the motor current introduced into the servo by transducers. There is poor grounding or there are loose connections. There is a jump on startup or shutdown due to improper interfacing.

Chapter 11. Auxiliaries

11.1 INTRODUCTION

The first section of this chapter supplies general information concerning the EZTRAK milling machine auxiliaries system. The following pages provide adjustment procedures and parts replacement information for the pneumatic and lubrication systems in the milling machine. Vendor information, specifications and replacement part numbers are also included.

11.2 LUBRICATION SYSTEM

11.2.1 Overview

The bearings in the spindle, the spindle drive transmission, and the ballscrew mountings have antifriction angular contact bearings greased for life.

The moving members are all fed from a central lubricating tank, which contains a filter and motorized timed plunger pump.

Approved Lubricants

(The viscosity range is 150 to 8000 SUS at operating temperature.) The following lubricants or equivalents are approved for use in the automatic lubrication system. See Specification Sheet 1-037-0020 on page 11-5.

Gulf Oil Corp.	Gulfway 52 and subsidiaries
Mobil Oil Corp.	Mobil Vactra Oil No. 2
Shell Oil Co.	Tonna 68
Sun Oil Corp.	Sunoco Way Lubricant 1180
Texaco Inc.	Way Lubricant D

11.3 LUBRICATOR UNIT

NOTE

When starting a new machine, fill reservoir. It has a 1 quart (1 liter or 1000 cu cm) refill capacity. Pull and release the "Instant Feed" button at the top of the reservoir several times until the oil flows freely on all bearing surfaces.

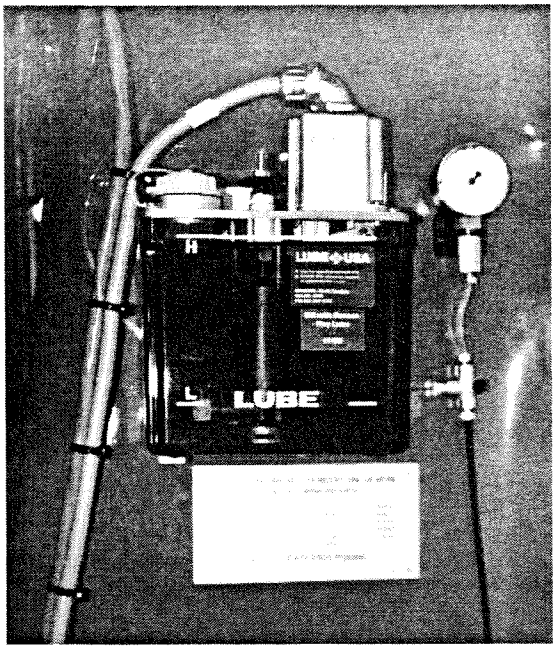


Figure 11-1. Lube unit mounted on left side of machine (1 quart capacity).

11.3.1 Maintenance

1. Check the oil level daily and refill the reservoir when required.
2. Check the system periodically for loose or broken tubing, worn hoses, and loose fittings and connections.
3. Check the bearing surfaces daily. If there is too little oil, check the following and repair as necessary:

    a. Low oil level
    b. Broken, cracked tubing
    c. Loose connections
    d. Flattened lubricator outlet tube
    e. Clogged filter

11.3.2 Motor Replacement

1. Remove the motor cover and the two screens holding the motor to the top of the reservoir.
2. Replace the motor (Code No. 1-141-7850).
3. Upon reassembly, ensure the slot in the motor shaft is engaged with the pin in the drive shaft before replacing the screens.

11.3.3 Specifications

VENDOR: BIJUR NO.:D-2988	DESCRIPTION LUBRICATOR UNIT TYPE TM-5	Bridgeport Code No.: 1-141-3209 Page 1 of 3

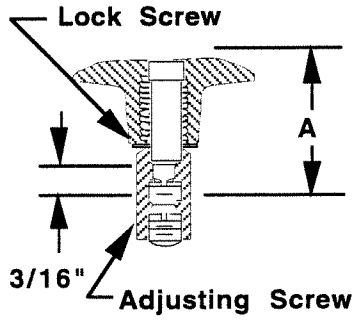
When Ordering, Specify Lubricator Type and Part Number such as: Lubricator Type TM-5 D-2994.

LUBRICATOR CYCLE TIME IN MINUTES		PART NUMBER WITH LIQUID LEVEL SWITCH
50 Hz	60 Hz	BIJUR
10.6	8.8	D-2988

OPERATION Lubricator is a motor-driven piston pump, spring-discharge type. Pump cycle time is controlled by an integral gear reduction in the motor. Lubricator can be actuated manually by raising and releasing the Instant Feed Button. Available cycle times are shown in the above table.

DISCHARGE VOLUME PER CYCLE Adjustable from 2.5cc minimum to 5.0cc maximum. The lubricator is supplied at the maximum stroke setting. To reduce oil delivery, remove the lockscrew; measure A, and turn adjusting screw clockwise, increasing dimension A in the increment (corresponding to the desired discharge), as shown on the following table.
* Factory set

DISCHARGE PRESSURE 60 psi maximum. Peak system pressure will decrease when: (a) discharge volume decreases; (b) number of Meter-Units in system increases; (c) oil viscosity decreases.



	INCH	DISCHARGE
*	0.400	2.5cc
	0.320	3.0cc
	0.240	3.5cc
	0.160	4.0cc
	0.080	4.5cc
	0	5.0cc

OIL VISCOSITY RANGE 150 to 8,000 SSU at operating temperature.

LUBRICATOR FILTER 40 micron particle separation. It should be inspected periodically and cleaned or replaced as required (Bijur S-109, Code No. 1-141-0078).

DISTRIBUTION SYSTEM Use Type F Meter Units (see Data Sheet 2400) limitations. The maximum number of meter units possible is 70. For system Flow Value (Øt) limitations, refer to the following table:

Number of Meter-Units	CC's Per Cycle 2.5	3	4	5
5		700	800	800
10		550	680	750
15		440	520	650
20		360	460	520
25		320	400	450
30		275	325	390
40		210	245	290
50		155	185	220
60		110	135	160
70		70	85	96

Max. Permissible Flow Value

Max. Permissible System Flow Value, Øt

VENDOR: BIJUR NO.:D-2988	DESCRIPTION: LUBRICATOR UNIT TYPE TM-5	Bridgeport Code No.: 1-141-3209 Page 2 of 3

MOTOR Continuous duty, single phase, synchronous induction timing motor for 50/60 Hz, dual wound for 115/230 volts AC. Power consumption: 3 watts. Code No. 1-141-7850.

For correct wiring, see instruction tag attatched to lubricator.

Bijur reserves the right to change motor size, mounting dimensions, and/or manufacturer.

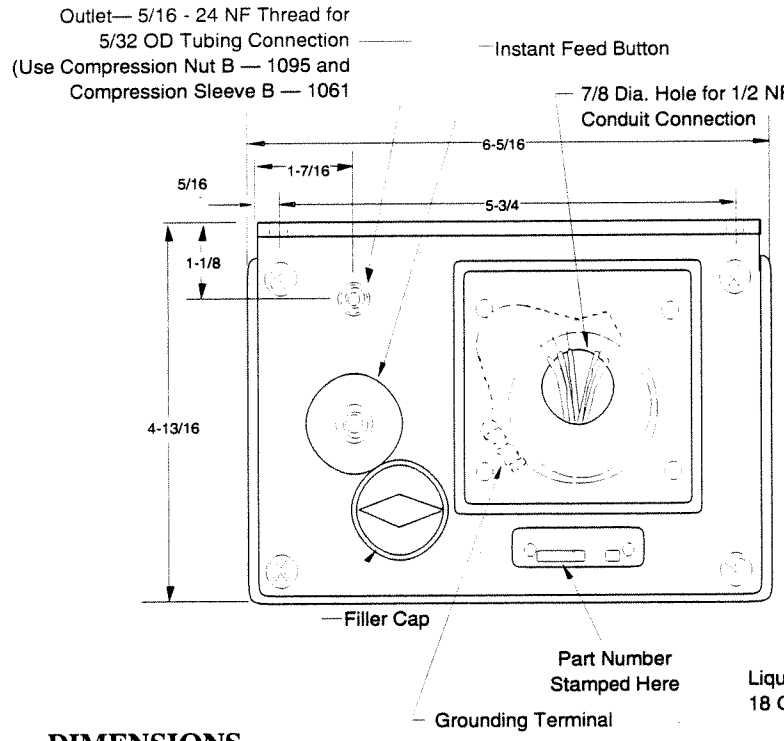
LIQUID LEVEL SWITCH The liquid level switch will close an electrical circuit whenever the oil in the reservoir is above the minumum operating level. Thus, when connected to a light or other indicating device, the liquid level can be monitored.

Customers may reverse the operation when desired by inverting the float. When the float is reversed, the switch will close an electrical circuit whenever the oil level is below the minimum operating level.

NOTE

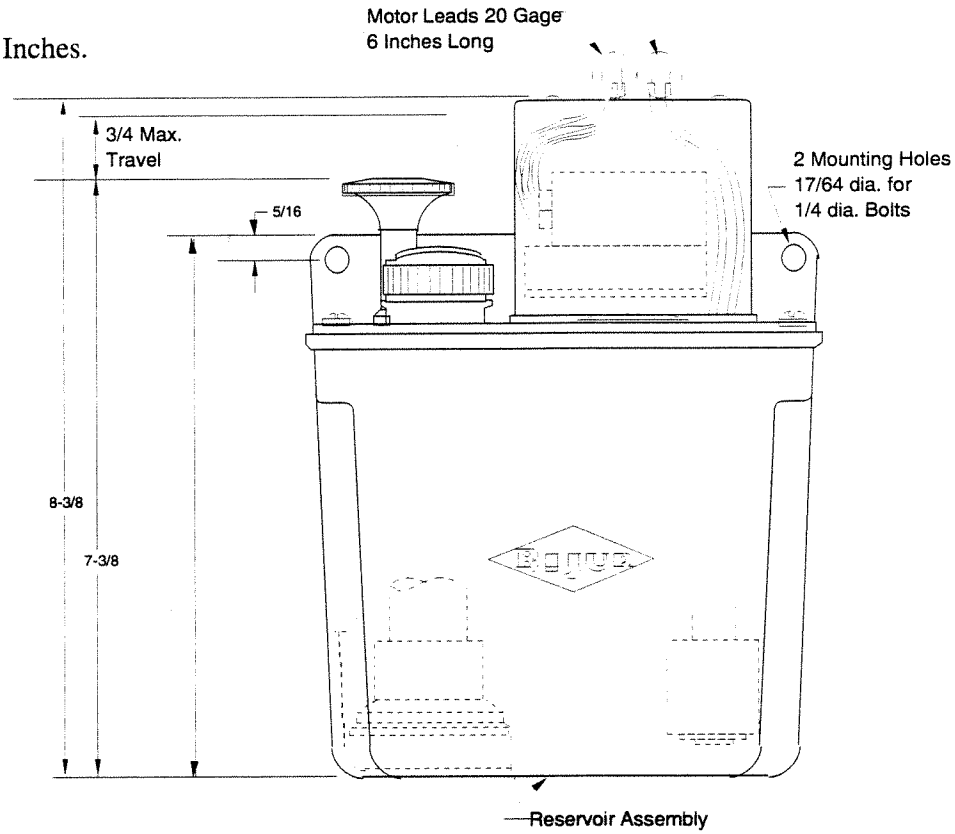
Switch contact rating: 10 Watts maximum
(Light or indicating device not supplied by Bijur)

VENDOR: BIJUR NO.:D-2988	DESCRIPTION LUBRICATOR UNIT TYPE TM-5	Bridgeport Code No.: 1-141-3209 Page



DIMENSIONS

All dimensions are in Inches.



LUBE SPECIFICATION NO. 1-037-0020

GENERAL DESCRIPTION: Waylube — Must contain tackiness additives; must NOT contain lead or chlorine compound additives.

USES: Machine tool way, heavy loaded journals, and screws.

Lubricant specifications listed here are minimum standards which must be met by all lubricants recommended for use on the machine. For specific applications to the machines, see lubrication sheets for individual machines.

LUBE CODE NO. 1-037-0020			1-037-0021
			Waylube
ASTM or ASLE Lube No.			315
Viscosity S.U.S.	100 °F		283/347
	210 °F		—
V.I. — Min.			—
Flash Pt. — °F Min.			350
Pour Pt. — °F Max.			0
Max Op. Temp. — °F			150
Additives or Inhibitors			R.F.S.
TEST REQUIREMENTS			
Timken O.K. Ld. — Min.			
Oxidation	ASTM D-943	Min. Hrs.	—
		Neut. No. Chg	—
	ASTM D-943 Modified		—
Cu. Corrosion — ASTM — D-130 STAIN			—
ASLE Accelerated Breakdown Test			5
Foam — ASTM D-892			2
Emulsion — ASTM — D-1401			—
Bijur Differential Filtration Test			PASS
Evaporation Rockwell Test			6
Stick Slip Ratio — CMM Test — Max.			.85
Rust — ASTM D-665A			PASS

Chapter 12. Optional Equipment

12..1 INTRODUCTION

The following optional equipment is available for the Bridgeport Series I EZTRAK system:

1. Tool Kits.
2. Coolant System - Mist and/or Flood
3. EZ-CAM®

12.2 TOOL KITS

These options contain a basic tooling package composed of collets and corresponding tool holders, a locking fixture for assembly of cutters in the holder, and appropriate wrenches. Consult with a sales representative for full details.

12.3 COOLANT SYSTEM - MIST AND/OR FLOOD

With the coolant system option, the coolant will be turned ON/OFF with the spindle. A separate COOLANT switch is provided.

All coolant systems must be ordered as Coolant Tank Kits and as Nozzle Assemblies, either separate or installed. The tank units are designated as 115/1/50 or 115/1/60 units, and all heads will have one flood nozzle.

12.3.1 Ratings

Flood Coolant

Electrical	Transformers 115V secondary and Triac (4ASB fuse)
Motor	115 volts, 1-phase, 50/60 Hertz, 3450 RPM
Flow	3 gpm at 6 ft. head (water soluble oil)
Tank Cap.	15 Gallons

12.4 EZ-CAM®

The EZ-CAM® (Computer Aided Manufacturing) is a desktop computer with interactive graphics and part programming capability. This option permits the operator to accomplish the following:

1. Reproduce a part graphically on the CRT from an engineering drawing.
2. Program the part through an interactive menu format.
3. Display the shape and tool path to "prove" the program before committing it to production.
4. Load the generated programs, through the DNC mode, directly into the CNC milling machine.

Refer to the Bridgeport EZ-CAM User's Manual for information on Installation and Troubleshooting.

12.5. MACHINE OPTIONS

Description

*Erickson #30 Quick-Change Spindle (Installed)
(*Not available with 3rd Axis Option)
*Universal #200 Kwik-Switch Spindle (Installed)
(*Not available with 3rd Axis Option)
Export Crating
Chip Floor Pan & Splash-Back Mist Coolant System
Flood Coolant System (Includes Chip Floor Pan & Splash Back)
4 inch Riser Block
7 inch Riser Block
Left Hand Machine Work Light
Collet Tray

12.6 MISCELLANEOUS OPTIONS

Code	Description
12570575	2-Axis Power Drawbar Kit for R-8 Spindle
12570990	3-Axis Power Drawbar Kit for R-8 Spindle
12570578	Power Drawbar Kit for Erickson #30 Quick-Change Tooling
12490000	R-8 Collet Kit (11 collets, 1/8 to 3/4)
11570003	#30 Tool Holder Kit
11570550	H-1 Erickson #30 Quick-Change Tooling Kit
11570551	H-10 Erickson #30 Quick-Change Tooling Kit
11576093	H-7 Erickson #30 Quick-Change Wrench Kit
11575033	H-12 Erickson #30 Quick-Change Collet Kit
11680732	Universal #200 Kwik-Switch Tooling Kit
11749046	Full Table Chip & Coolant Shield
11680000	Kurt Plain D-60 Vice
11680002	Kurt Swivel Base for D-60 Vice
12530003	Bridgeport Plain 6 inch Vice
12530001	Bridgeport Swivel 6 inch Vice
13380000	Special Paint
31942590	Bridgeport communication utilites software supplied on 3.5 inch IBM compatible floppy disk

12.7 MANUALS

NOTE:

One set of manuals is included with each machine.

11046148	Operating & Programming Manual
11042900	Installation, Operation, Maintenance, and Parts Breakdown Manual
11042740	EZTRAK 3rd Axis Operator's Manual

Chapter 13. EZTRAK Third Axis Option

INTRODUCTION

With an optional attachment, the Z-axis on EZTRAK machines may be fully automated while still allowing the operator the choice of manual control. The EZTRAK Third Axis Option basically consists of a Z-axis motor and ballscrew which mount on the front of the quill (See Fig. 13-1A).

This chapter describes the parts breakdown and procedure for retrofit installation of the Third Axis Option.

NOTE

Retrofit can only be done by a qualified service technician.

Retrofit can only be done on controls with Third Axis capabilities, consisting of a Third Axis equipment panel and a knock-out in the electrical cabinet for Z-Axis Power cable.

Installation of the Third Axis Option will alter the following specification:

Quill travel is reduced by 0.5 inches for a total of 4.5 inches.

Retrofit requires modifications in the mechanical and electrical configurations of the machine. The basic steps in the retrofit procedure include: assembly of the Third Axis unit, assembly of the unit on the machine, rewiring the control in the electrical cabinet, and installation of the EZTRAK software.

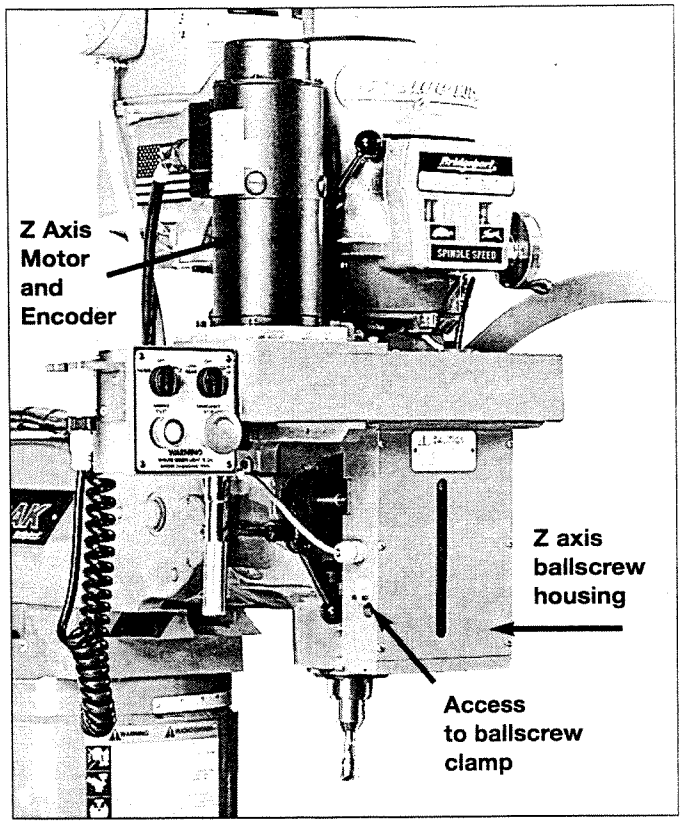


Figure 13-1A. Third Axis Option, Mounted

OPERATION

The Third Axis Option enables the machine to be operated in either 2-axis or fully automated 3-axis mode. Changing the operating mode of the machine from 2-axis to 3-axis, or vice versa, is done by adjusting a clamp on the Z-axis ballscrew inside the boxlike housing. Access to the clamp is through a small hole on the left side of the box, covered by a hinged metal flap. The clamp must be torqued to 22 ft lbs using a torque wrench provided with the machine. The operator is prompted to make this adjustment by messages on the control panel screen (see EZTRAK Third Axis Programming and Operating Manual, Chapter 2: Starting Up).

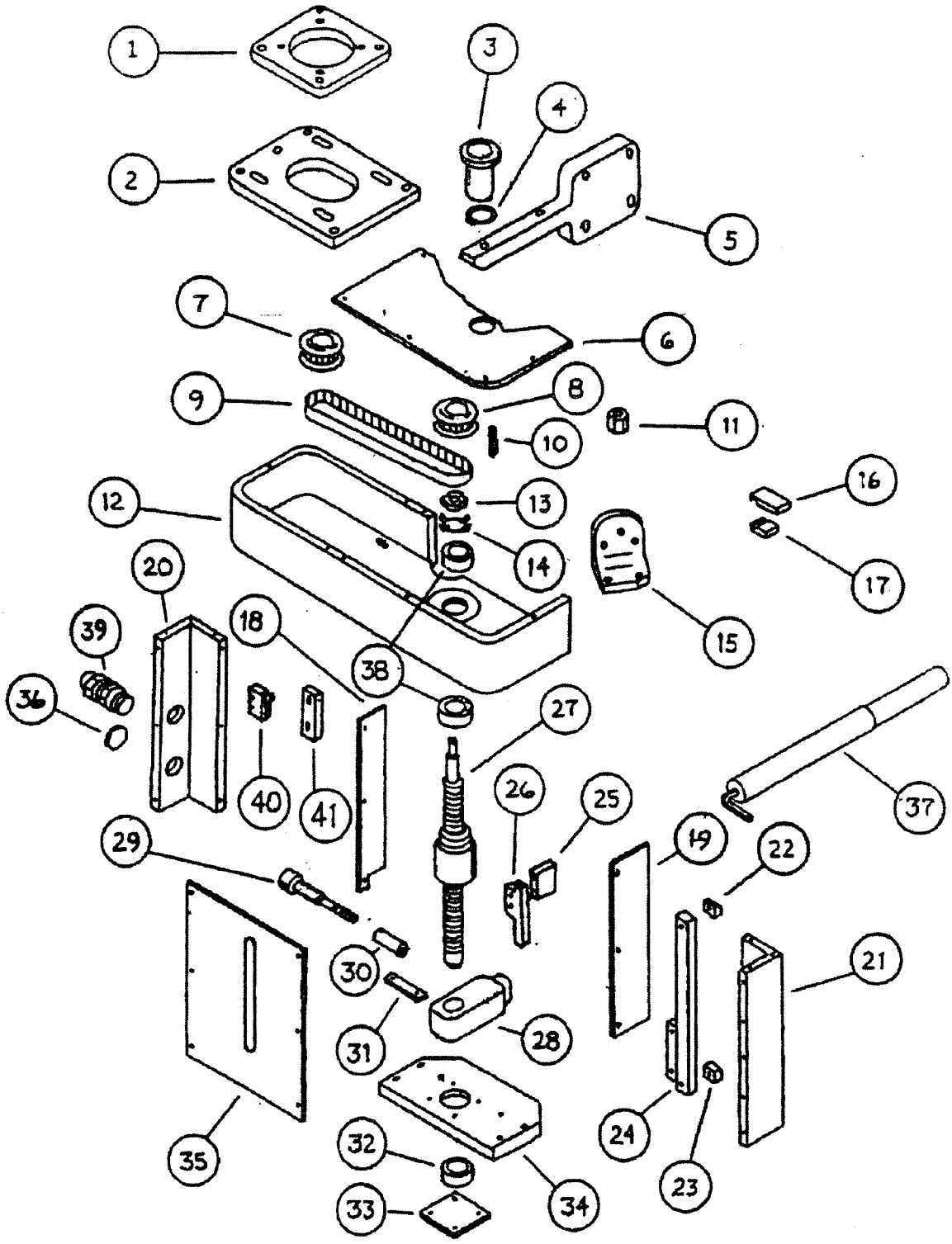


Figure 13-1B. Third Axis Option, exploded view.

PARTS LIST

1 Nema 42 Adaptor plate
Fastener using Qty. (4) 1/4-20 x 1 1/2 SHCS Qty. (4) 1/4-20 Nuts Qty (4) 5/16-24 x 3/4" SHCS
2 Motor Mounting Plate
Fastener using Qty (4) 10-32 x 3/4" SHCS and 1/4-20 x 2 1/2" Pan Head Screw 1/4-20 fullnut
3 Scale Cable Tube
4 Circlip Cable tube
5 Left Mount Plate
Fastener Qty. (4) 10-24 x 1 1/4 SHCS Qty (4) #10 Flat washers Qty. (2) 5/16-18 x 1 1/2 SHCS Qty. (2) washers
6 Top cover
Fastener Qty. (4) 10-23 x 3/8 BHCS
7 Pulley Motor
8 Pulley Ball Screw
9 Belt
10 1/8 Sq. Key
11 Front 3/8-16 ext. nut for Top Housing
12 Top Casting
13 Lock nut
14 Lock Washer
15 Right Mount Angle
Fastener Qty. (2) 10-32 x 1 SHCS Qty (2) 10-24 x 1 1/4 SHCS Qty. (4) #10 Flat Washer
16 Cable Strain Relief top
17 Cable Strain Relief bottom
18 Left Chip cover
Fastener Qty. (3) 8-32 x 3/8 BHCS
19 Right chip cover
Fastener Qty. (3) 8-32 x 3/8 Hex screw
20 Left Angle
Fastener Qty. (3) 10-32 x 3/4 SHCS
21 Right Angle
Fastener Qty. (3) 10-32 x 3/4 SHCS
22 Scale Stand Off Top
23 Scale Stand Off Bottom
24 Acu Rite Micro Scale
Fastener Qty. (2) 6-32 x 1 SHCS
25 Reader Head Carrier Part 1
26 Reader Head Carrier Part 2
Fastener Qty (2) 6-32 x 1/2 SHCS
27 Ball Screw Assy
28 Ball Nut Block
29 5/16-24 x 3 SHCS
30 Spacer Tube
31 Spacer Block
Fastener Qty (4) 4-40 x 1/4 SHCS
32 Radial Bearing
33 Access Plate
Fastener Qty. (4) 4-40 x 1/4 SHCS
34 Bottom Plate
Fastener Qty (4) 10-32 x 3/4 SHCS Qty. (1) 7/16-14 x 2 FHCS Qty. (1) 7/16-14 full nut Qty. (1) Hard washer
35 Front Cover
Fastener Qty. (4) 8-32 x 3/8 SHCS/ 1/6 Plexi window
36 QD Access Plate
Fastener Qty. (1) 4-40 x 3/8 BHCS Qty. (1) 4-40 x 3/8 SHCS
37 Torque Wrench with Holder
Fastener Qty. (2) 8-32 x 3/8 BHCS
38 Thrust Bearing Qty (2)
39 Strain Relief
40 Limit Switch
Fastener Qty. (2) 6x32 x 7/8 SHCS
41 Limit Switch Mount Plate
Fastener Qty (2) 8-32 x 3/8 BHCS

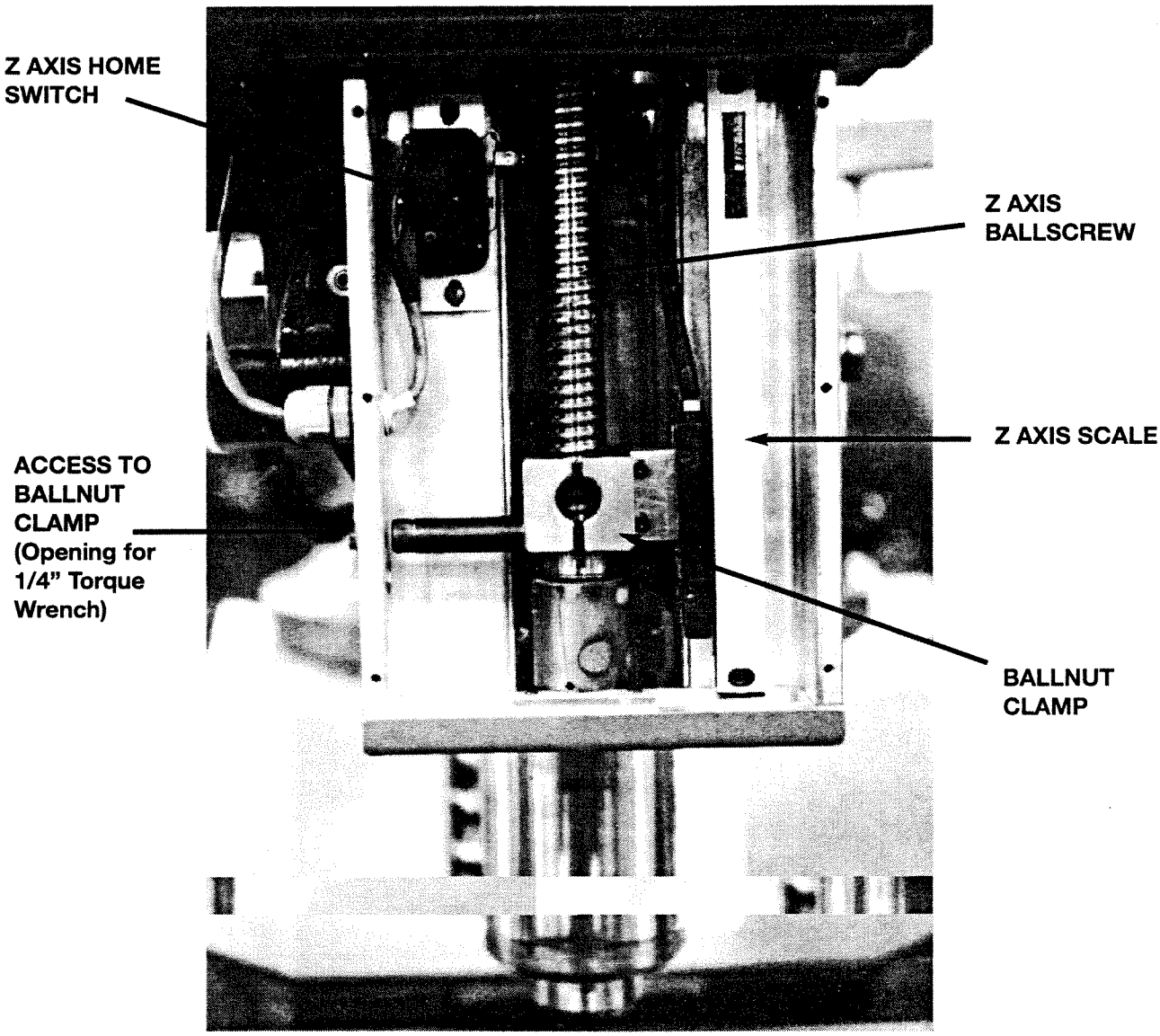


Figure 13-2. Z axis ballscrew housing with front cover removed

EZTRAK 3RD AXIS RETROFIT PROCEDURE

1. MECHANICAL INSTRUCTIONS:

Machine Preparation

1. Put the quill feed engagement lever in the disengaged position.

2. Remove the quill feed handle.

3. Leave the spindle in the disengaged position.

4. Remove the 3 10-24 SHCS on the feed disengage boss (@ 4, 8 and 12 o'clock).

5. Remove the Reverse trip ball lever on the top of the 1/2-20 depth stop screw. (This is the part that looks like an hour glass with a 5-40 tapped hole in the end.)

6. Remove the engagement lever on the bottom of the same rod.

7. Remove the circlip on the bottom of the screw and slide it out through the bottom while screwing the depth ring off from the top.

8. Remove the original depth stop block from the quill.

9. Slide the feed kick out rod out.

10. Remove the quill feed transmission cover on the left side of the head. This is the cover you use to adjust your quill feed (.0015, .003, .006).

11. Tram the head of your mill.

12. Change the brake handle position from the round knob at the bottom to the round knob at the top.

13. Remove the front 3/8-16 swivel belt housing nut that fastens the Top Belt Housing to the lower quill housing and replace it with the longer 3/8-16 nut provided. (This nut is up and to the left if you are standing in front of the head.)

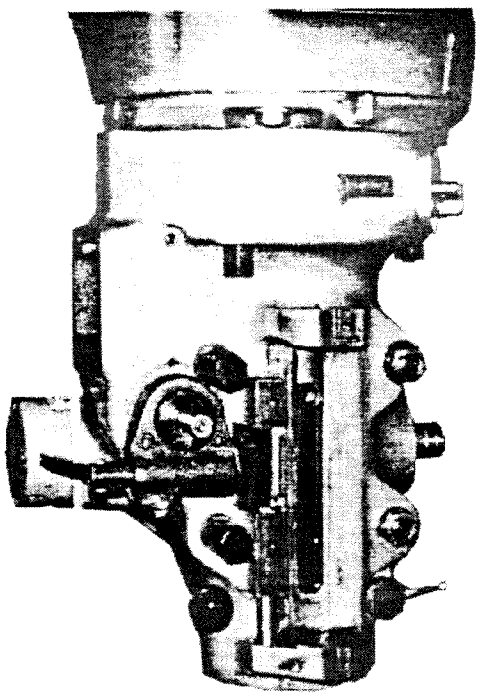


Figure 1

14. Remove the paint from the bottom of the flange where the depth rod was removed from and also the wall that is perpendicular with it. **See Figure 1.**

15. Using an indicator, rotate the turret and indicate using the X-axis until this wall is parallel with the X axis **See Figure 2.**

16. Retighten the turret.

Quill Unit Installation

1. Locate the ballnut block and the 3/8-24 x 1 1/2" SHCS that fastens it to the quill. Insert the screw into the block and measure the length of its protrusion on the opposite end of the block. The screw should not protrude any longer than .465" out of the block. If it does, file or grind the end of the screw until this dimension is obtained.

2. Fasten the supplied ball nut block to the quill using the supplied 3/8-24 SHCS . The 5/16-24 tapped hole is at the bottom. Torque to 42-44 ft.

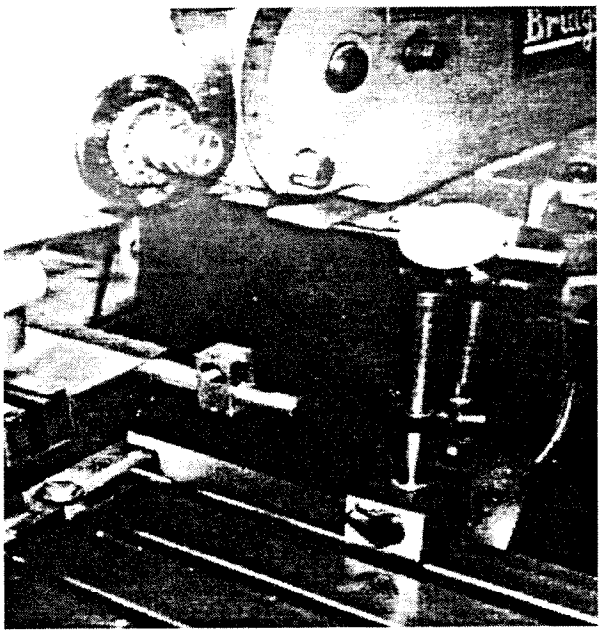


Figure 2

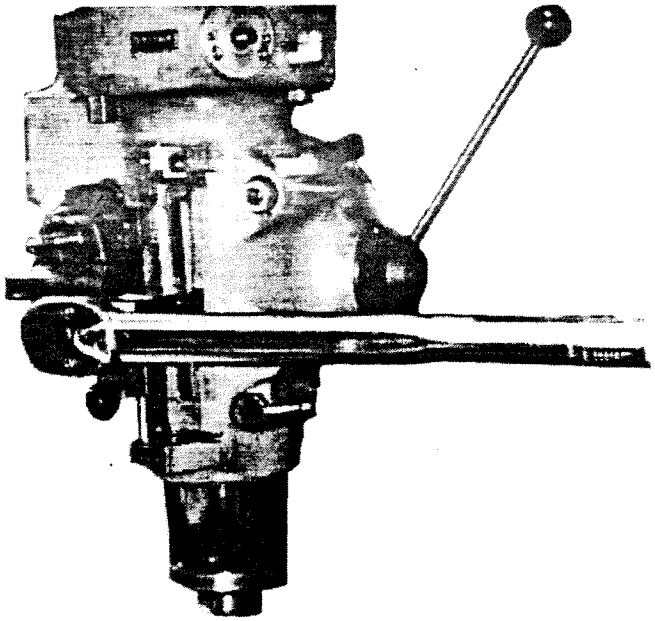


Figure 3

lbs. **See Figure 3.**

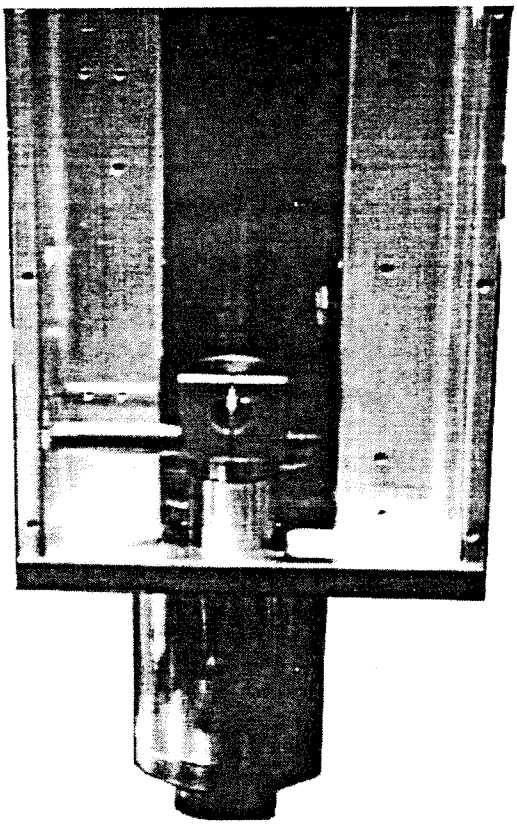


Figure 4

3. Install the left chip cover on the inside of the left angle on the lower assembly. The correct placement is with the large notch to the bottom. Use (3) of the (6) 8-32x3/8" Hex head bolts supplied.

4. Place the lower assembly underneath the flange you scraped.

5. Place the 7/16-14 x 2" FHCS through the lower assembly and the lower flange.

6. Place the supplied hard washer and nut on the exposed end of the screw and tighten it just enough to hold it in place.

7. Place the quill in the middle of its travel.

8. Place the installation tool in the bottom of the ball nut block and tighten the 5/16-24 x 3 1/4" SHCS firmly to hold it in place.

9. Roll the quill down until the installation tool is close to the bearing bore in the bottom assembly. **See Figure 4.**

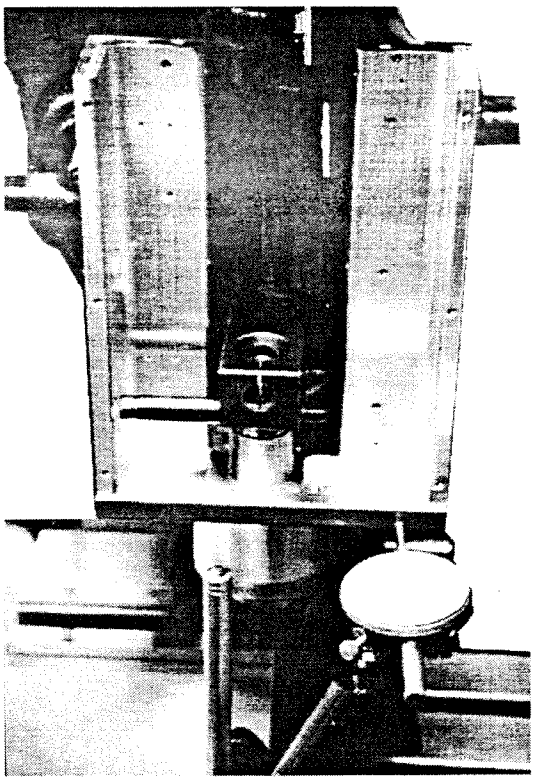


Figure 5

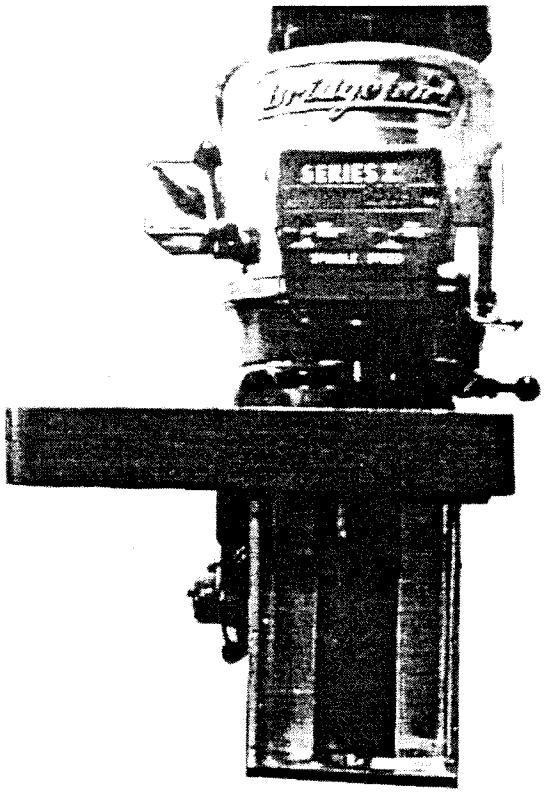


Figure 6

10. Remove the bearing access plate in the bottom of the lower assembly.

11. Carefully roll the quill down and place the installation tool into the bearing bore; this is a 2-part operation. The bottom assembly has to be positioned under the tool while rolling the quill down to achieve your goal.

12. Keep the quill in the lower position using the lock lever.

13. Position an indicator on the front face of the bottom plate of the lower assembly.

14. Move the X axis plus and minus and rotate the lower assembly until the plate is parallel with the table. (or no movement on the indicator is detected).

15. Leave the indicator on one end of the plate at zero.

16. Tighten the 7/16-14 screw with a hex wrench on the head of the screw while holding the nut with a combination wrench. Watch for any movement on the indicator detecting the lower assembly is twisting out of alignment.

17. If this condition starts to happen, unlock the quill lever and roll the quill up to the top position. Hold the screw head secure using a hex wrench and tighten the nut with a combination wrench from the top.

18. Unlock the lever and roll the quill down to the center of the travel once again.

19. Loosen the 5/16-24 x 31/4" SHCS on the ball nut block and place the installation tool in from the top of the ball nut block.

20. Retighten the 5/16-24 x 3 1/4" SHCS.

21. Lube one 7201 bearing using lithium type grease supplied.

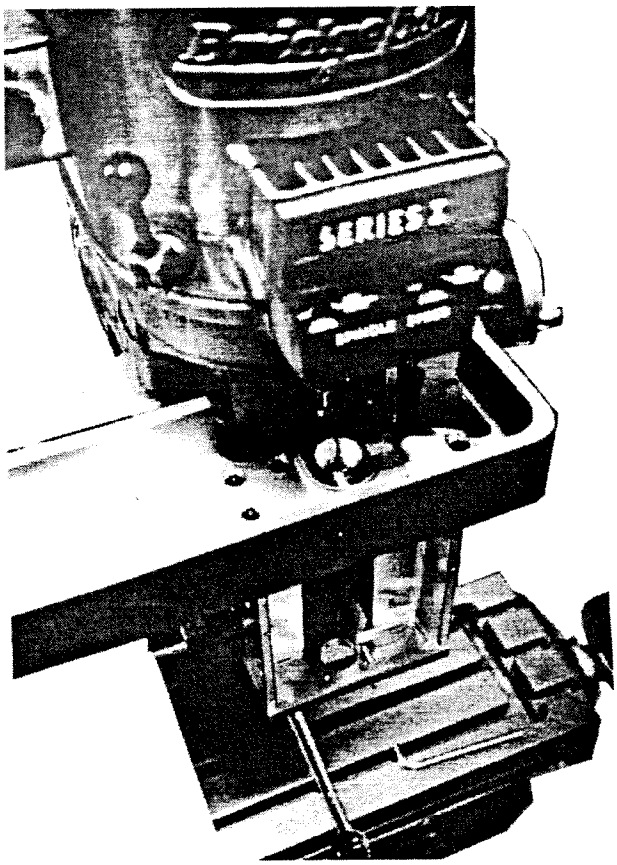


Figure 7

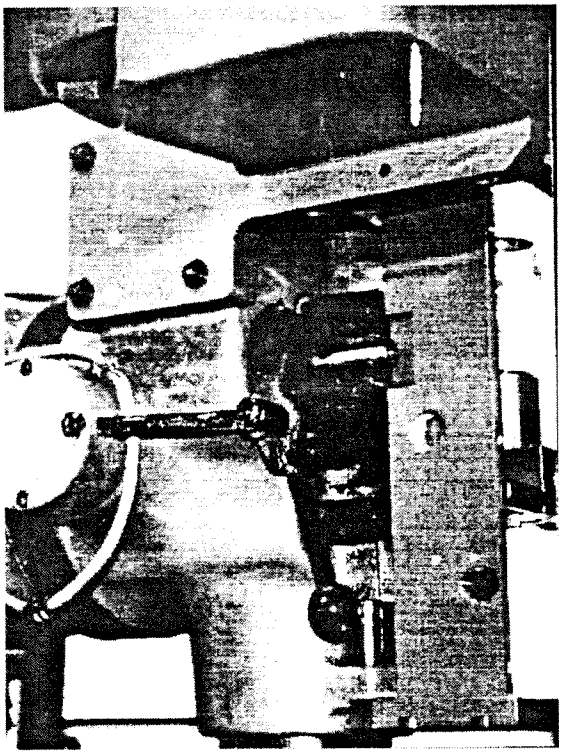


Figure 8

22. Install the 7201 bearing with the thrust side facing down in the upper bore of the top housing.
23. Place the top housing on the top of the lower assembly. **See Figure 6**

24. Fasten the two together using the supplied 10-32 x 1" SHCS and hard washers, but only enough so that the top housing can be moved around.

25. Roll the quill up until the installation tool is close to the bearing bore in the bottom of the top housing.

26. Move the top housing until it is approximately over the installation tool.

27. Carefully try to roll the quill up and move the top housing until the installation tool slides into the bearing bore.

28. Place the right mount angle inside the top housing on the machined surface and attach to the front of the feed disengage lever boss, then fasten the base of the angle to the floor of the top housing. **See Figure 7.**
29. Rotate the top housing until the 10-32 tapped holes line up with the holes in the base of the mount.

30. Carefully remove the mount and tighten the (6) 10-32 x 1" SHCS securely.

31. Place the feed disengage mount back in place and fasten it to the front of the flange using the (2) 10-24 x 1 1/4" SHCS and (2) hard washers supplied.

32. Fasten the base of the flange to the top housing using the (2) 10-32 x 1" SHCS and (2) hard washers supplied.

33. Place the 10-32 set screw supplied into the side of the mount and firmly snug it against the shaft of the Feed disengage lever holding it in the disengaged position.

34. Place the left side brace over the open cavity where the transmission feed cover was removed. **See Figure 8**

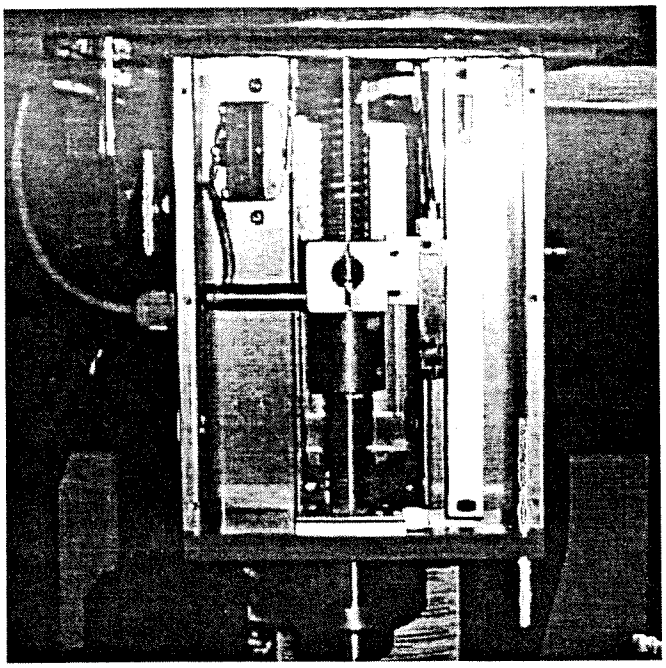


Figure 9

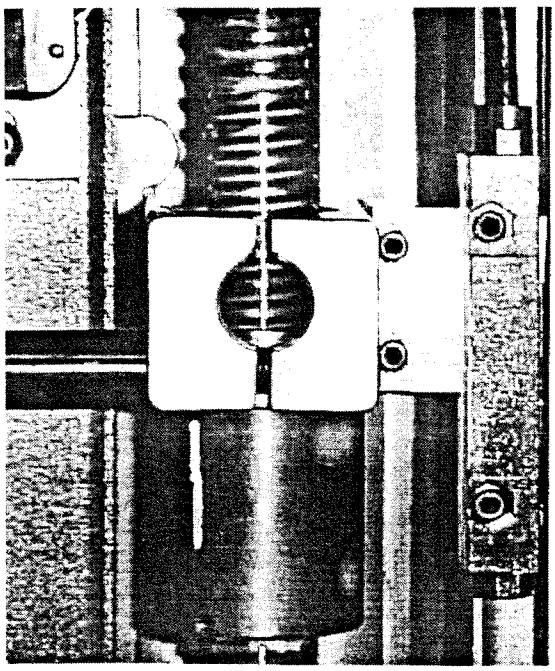


Figure 10

35. The correct position is with the 45-degree angle in the front to the bottom and pushed up against the milled surface on the bottom of the top housing.

36. Fasten it to the head using (4) 10-24 x 1 1/4" SHCS and hard washers supplied.

37. Fasten the left brace to the top housing using the (2) 5/16-18 x 1 1/4" SHCS and washers supplied. Fasten the screws from inside the top housing into the brace.

38. Locate the 9" of black spiral wrap supplied and cover the vinyl cable starting from the readerhead.

39. Place the Acu-Rite scale on the inside of the lower assembly on the face of the right angle. This is accomplished using the spacer blocks on each end of the scale with the relief on the top block to the outside and to the top. This clears the window in the bottom of the top housing. Loosely fasten the two ends of the scale using the (2) 6-32 x 1" SHCS supplied for now. **See Figure 9.**

40. Feed the vinyl cable through the top housing.

41. Fasten the reader head mount to the ball nut block using (2) 10-32 x 1/2" supplied.

42. Roll the quill down to the bottom position.

43. Slide the reader head mount forward until it bears against the backside of the reader head on the scale.

44. Move the quill until the mounting holes are in line on the Y axis, and slide the scale left to right until they are in line on the X axis.

45. At this point measure the distance between the right side of the scale and the inside wall of the angle and record this number.

46. Rotate the top of the scale until the same distance is achieved.

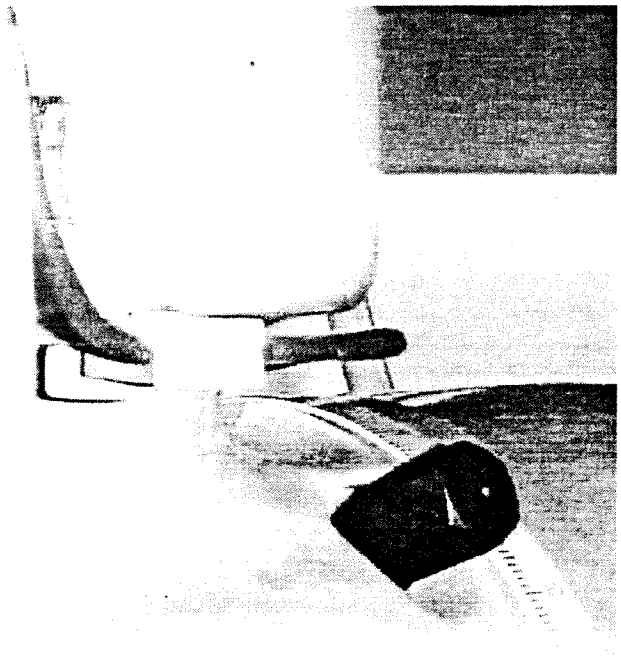


Figure 11

47. Align the scale by mounting a magnetic base with an indicator on the ball nut block and adjust the right side of the scale so it is parallel with the Z axis within .005 TIR.

48. Tighten the (2) 6-32 x 1" SHCS.

49. Fasten the reader head to the reader head bracket using the (2) 6-32 x 5/8"SHCS suppled. **See Figure 10.**

50. Remove the reader head shipping clips from both ends of the reader head.

51. Install the Scale Cable Clamp on the right side belt housing swivel nut. **See Figure 11.**

52. Install the right chip cover from the back of the lower assembly and secure it using the remaining (3) 8-32 x 3/8" Hex head bolts.

53. Slide the black rubber pinch molding on the exposed edge of the right chip cover.

54. The quill will have to be moved up and down to permit wrench access for tightening the (3) bolts.

55. Lube the other 7201 bearings using a lithium type grease.

56. Place it in the bottom bore of the top housing with the **thrust sides facing up!** (Hint: If the bearing starts and gets slightly cocked, you can use the install tool in the block to help push it in the bore by simply rolling up the quill until the install tool contacts the bearing and pushes it in.)

57. Remove the installation tool from the ball nut block.

58. Place the quill in the middle of the travel.

59. Slide the ball screw assembly in from the top of the bottom plate of the lower assembly and in front of the ball nut block. Slide it through the bottom bearing hole in the lower assembly until it can be slide through the bottom of the ball nut block. Slide the ball screw assembly up until the ball nut journal engages into the bore of the ball nut. Snug the 5/16-24 SHCS to hold the screw assembly in the ball nut block.

60. Roll the quill up until the screw slides through the 7201 bearings completely.

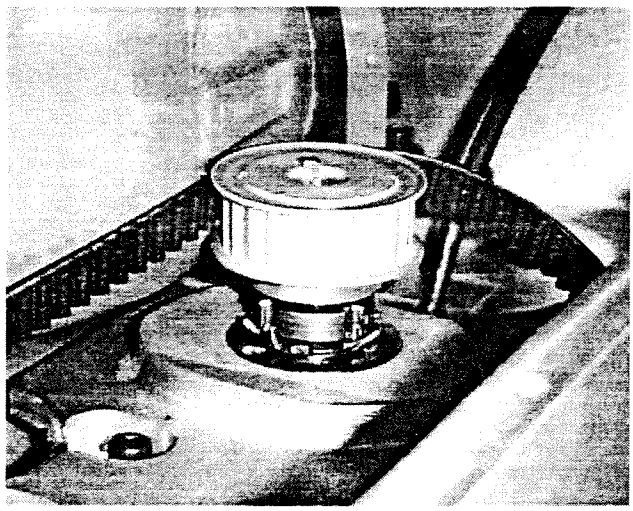


Figure 12

51. Place the W01 lock washer over the top of the screw and against the top of the 7201 bearing.

52. Screw the N01 lock nut on the threads of the screw until it pre-loads the 7201 bearings.

53. The main objective here is to tighten the nut enough to obtain little or no endplay in the bearings, but not so tight that the bearings will not turn.

54. Find a tooth on the washer and slot on the nut that line up and bend the tooth in the washer into the slot on the nut.

55. Slide the 6201 bearing into the bottom of the lower assembly and on to the lower journal of the screw.

56. Re-install the bearing accessplate on the bottom of the lower assembly. Fasten using the (4) 4-40 x 3/8" BHCS that were removed at dis-assembly.

57. Place the screw pulley (**hub down**) and key in place on the end of the ball screw and fasten securely. Note: depending on the thickness of the serial # boss you might have to install the 480 5 m belt with the pulley at the same time. **See Figure 12.**

58. Rotate the pulley by hand until the ball nut is at the top position and place the limit switch assembly on the inside face of the left angle. Slide it so the switch trips at this position. Precise actuation can be obtained by hearing the switch trip or by using an OHM meter to detect tripping. See Figure 9 for limit switch placement.

59. Fasten securely using the (2) 8-32 x 1/2" SHCS supplied.

60. Place the Nema adapter plate on the Servo motor and fasten using the (4) 5/16-24 x 5/8" supplied.

61. Fasten the Nema plate and motor assembly to the motor plate using (4) 1/4-20 x 1 1/2" SHCS and nuts. The nuts are placed in the 7/16 wide slots in the bottom of the motor plate and the screws are placed in

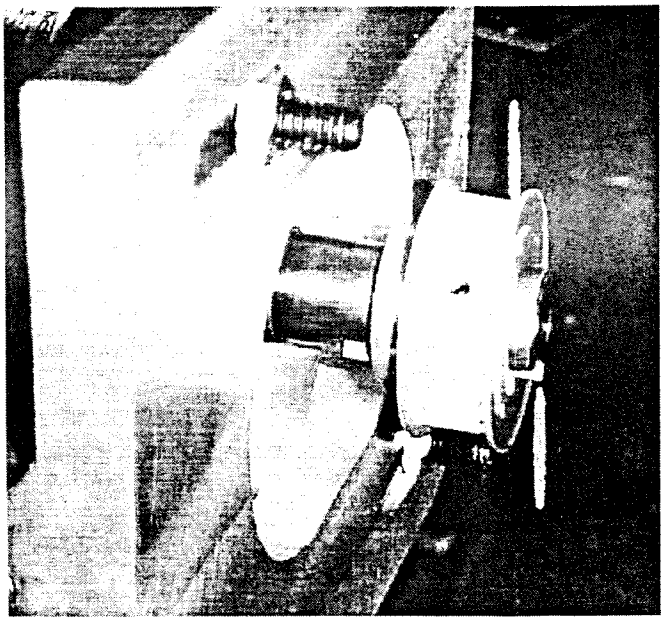


Figure 13

from the top of the Nema flange. **Make sure that when the assembly is placed on the top housing the cable connector on the motor faces the back of the machine.**

62. Measure the distance from the top of the top housing to the first flange on the screw pulley. Note: Record this number on a piece of paper, as it will be used for installation of the motor pulley.

63. Slide the motor pulley **(Hub up)** over the shaft of the Servo motor until the same distance is achieved from the face of the motor plate to the first flange. Secure the pulley. **See Figure 13.**

64. Holding the motor assembly in one hand, place the 480 5M belt over the pulley with the other hand.

65. Set the assembly on top of the top housing and slide the belt over the screw pulley.

66. Position the motor plate over the mounting holes on the top housing and fasten it using the (5) 10-32 x 3/4" SHCS supplied.

77. Screw the 1/4-20 pan head screw against the Nema flange until the 480 belt is preloaded with tension. Tighten the 1/4-20 jam nut to lock the screw.

78. Slide the vinyl cable through the top cover and fasten the top cover to the top housing using the (5) 10-32 x 3/8" BHCS supplied.

79. Install the strain relief in the left side of the lower assembly.

80. Slide the home switch cable through strain relief and fasten to the micro switch in the normally open position.

81. Place the bottom travel stop on the inside of the lower assembly and in line with the 2 front 4-40 tapped holes. Fasten the plate to the lower assembly using the (2) 4-40 x 3/8" SHCS supplied.

82. Connect the motor cable to the controller.

83. Connect the home switch to the controller.
84. Connect the scale to the controller.

85. Power up controller and set software travels in + and - directions.
86. Install the 7/32" E ring on the right end of the 5/16-24 x 3 1/4" SHCS in the ball nut block assembly.

87. Slowly jog the Quill down the controller and apply white lithium grease on the screw above the ballnut block. Slowly jog the quill up and then down again and repeat the process until the white grease is visible on the bottom of the screw. The main idea is to fully pack the ball nut with grease. **For maintenance purposes regrease the ball screw every 6 months or whenever it looks dry**

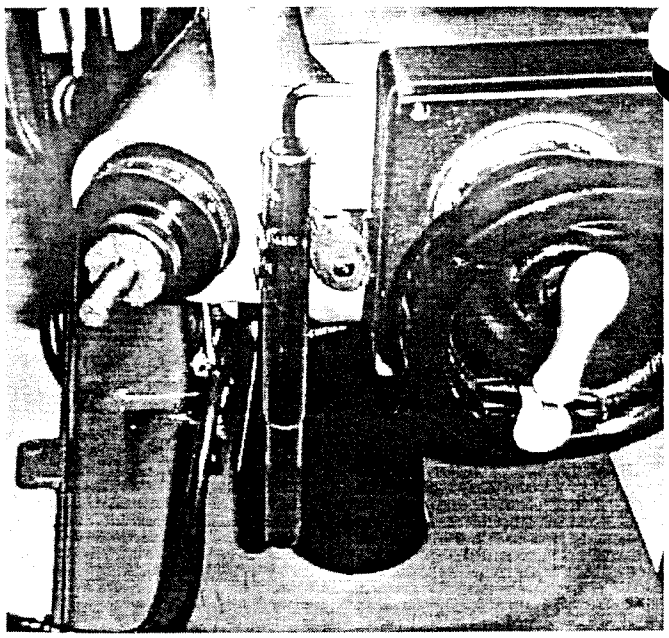
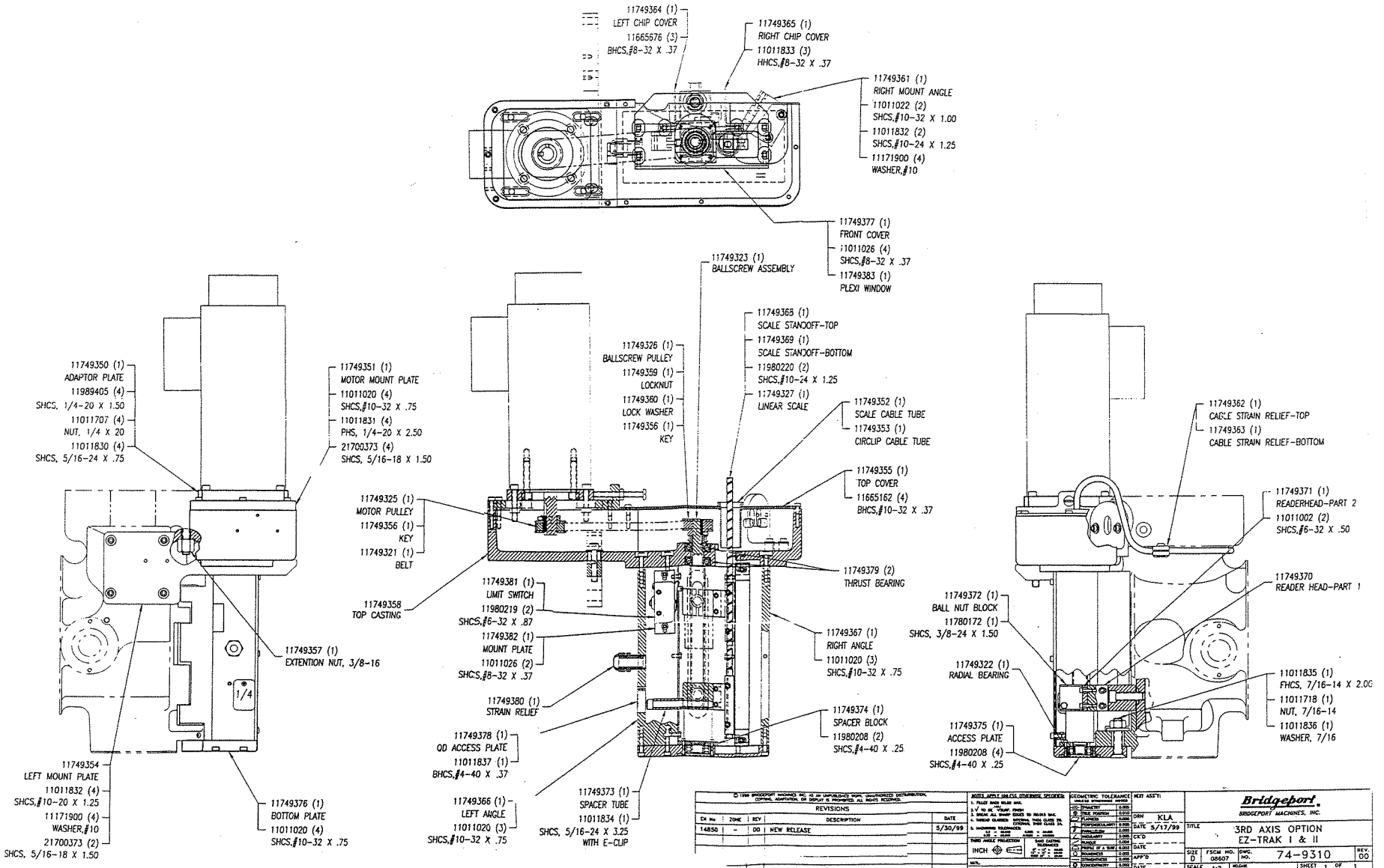


Figure 14

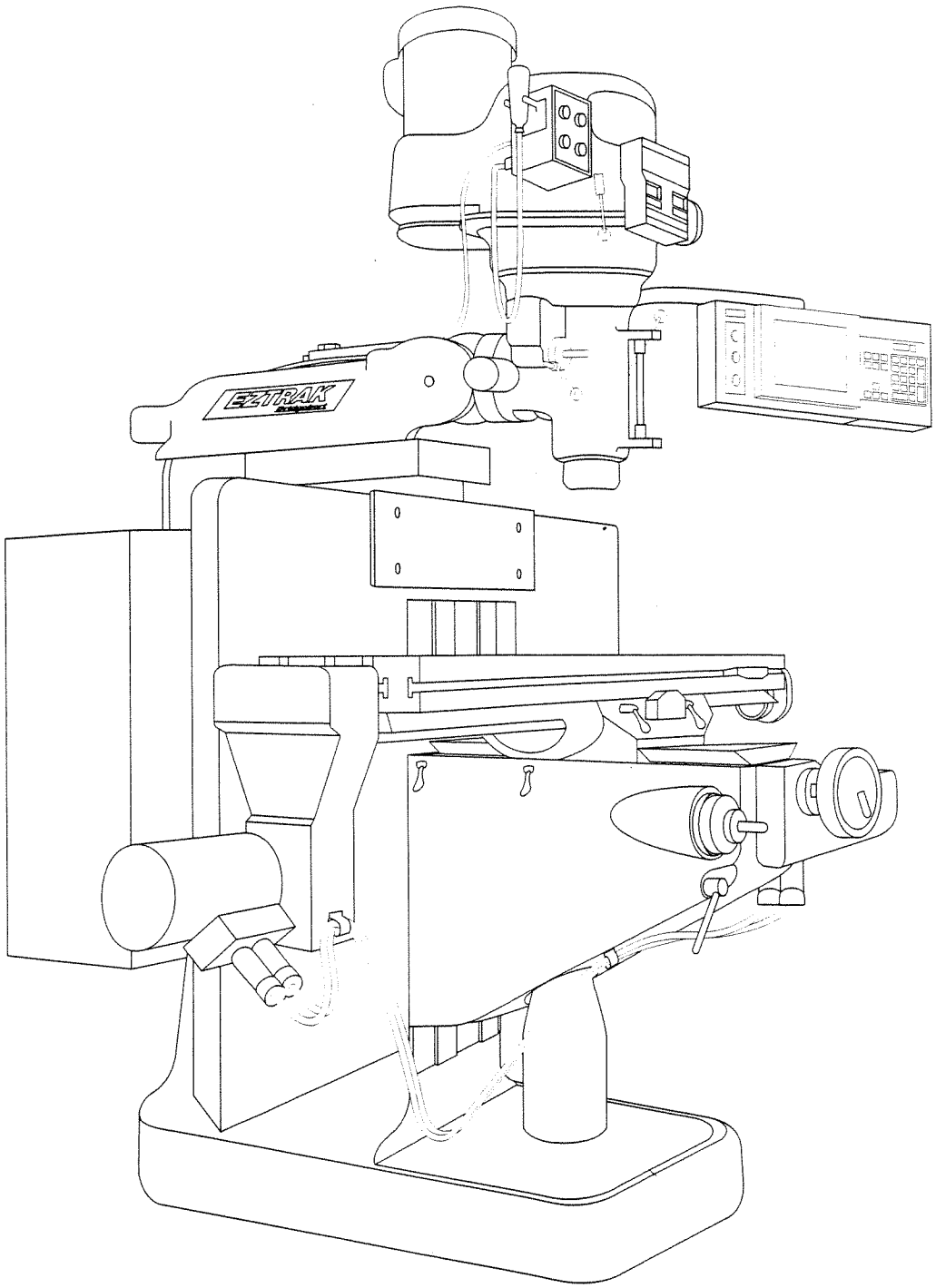
88. Install Front cover using the (6) 8-32 x 3/8" BHCS supplied.

89. Fasten the torque wrench holder to the knee using the (2) 8-32 x 3/8" BHCS supplied.

90. Correct placement is in the front of the knee between the Graduated knee dial and Y axis bracket. **See Figure 14.**

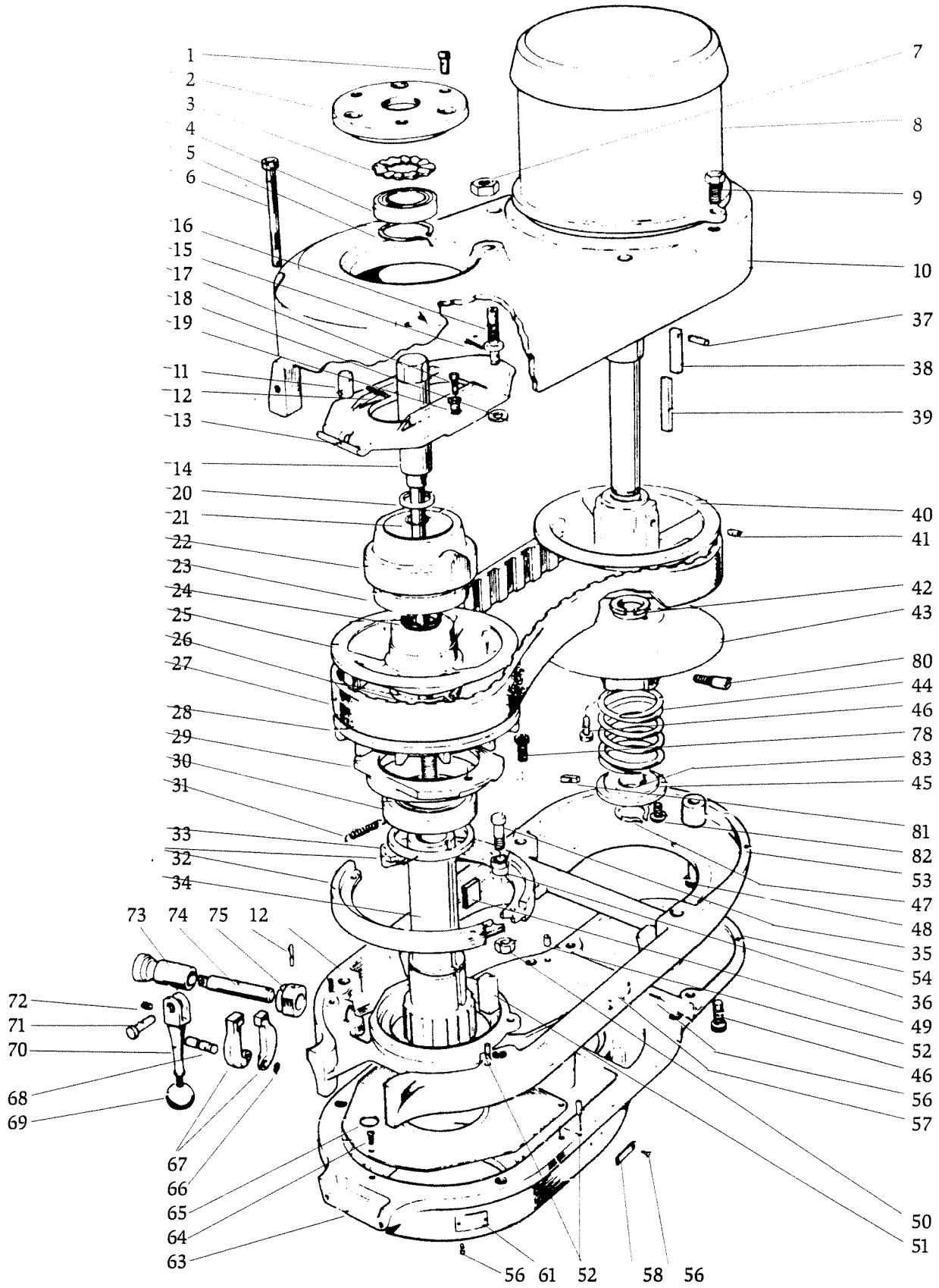

11749364 (1)
LEFT CHIP COVER
11665676 (3)
BHCS,#8-32 X .37
11749365 (1)
RIGHT CHIP COVER
11011833 (3)
HHCS,#8-32 X .37
11749361 (1)
RIGHT MOUNT ANGLE
11011022 (2)
SHCS,#10-32 X 1.00
11011832 (2)
SHCS,#10-24 X 1.25
11171900 (4)
WASHER,#10
11749377 (1)
FRONT COVER
11011026 (4)
SHCS,#8-32 X .37
11749383 (1)
PLEXI WINDOW
11749323 (1)
BALLSCREW ASSEMBLY
11749368 (1)
SCALE STANDOFF-TOP
11749369 (1)
SCALE STANDOFF-BOTTOM
11980220 (2)
SHCS,#10-24 X 1.25
11749327 (1)
LINEAR SCALE
11749326 (1)
BALLSCREW PULLEY
11749359 (1)
LOCKNUT
11749360 (1)
LOCK WASHER
11749356 (1)
KEY
11749352 (1)
SCALE CABLE TUBE
11749353 (1)
CIRCLIP CABLE TUBE
11749355 (1)
TOP COVER
11665162 (4)
BHCS,#10-32 X .37
11749350 (1)
ADAPTOR PLATE
11989405 (4)
SHCS, 1/4-20 X 1.50
11011707 (4)
NUT, 1/4 X 20
11011830 (4)
SHCS, 5/16-24 X .75
11749351 (1)
MOTOR MOUNT PLATE
11011020 (4)
SHCS,#10-32 X .75
11011831 (4)
PHS, 1/4-20 X 2.50
21700373 (4)
SHCS, 5/16-18 X 1.50
11749325 (1)
MOTOR PULLEY
11749356 (1)
KEY
11749321 (1)
BELT
11749358
TOP CASTING
11749357 (1)
EXTENTION NUT, 3/8-16
11749379 (2)
THRUST BEARING
11749381 (1)
LIMIT SWITCH
11980219 (2)
SHCS,#6-32 X .87
11749382 (1)
MOUNT PLATE
11011026 (2)
SHCS,#8-32 X .37
11749367 (1)
RIGHT ANGLE
11011020 (3)
SHCS,#10-32 X .75
11749380 (1)
STRAIN RELIEF
11749374 (1)
SPACER BLOCK
11980208 (2)
SHCS,#4-40 X .25
11749378 (1)
QD ACCESS PLATE
11011837 (1)
BHCS,#4-40 X .37
11749354
LEFT MOUNT PLATE
11011832 (4)
SHCS,#10-20 X 1.25
11171900 (4)
WASHER,#10
21700373 (2)
SHCS, 5/16-18 X 1.50
11749376 (1)
BOTTOM PLATE
11011020 (4)
SHCS,#10-32 X .75
11749366 (1)
LEFT ANGLE
11011020 (3)
SHCS,#10-32 X .75
11749373 (1)
SPACER TUBE
11011834 (1)
SHCS, 5/16-24 X 3.25
WITH E-CLIP
11749362 (1)
CABLE STRAIN RELIEF-TOP
11749363 (1)
CABLE STRAIN RELIEF-BOTTOM
11749371 (1)
READERHEAD-PART 2
11011002 (2)
SHCS,#6-32 X .50
11749370
READER HEAD-PART 1
11749372 (1)
BALL NUT BLOCK
11780172 (1)
SHCS, 3/8-24 X 1.50
11749322 (1)
RADIAL BEARING
11011835 (1)
FHCS, 7/16-14 X 2.00
11011718 (1)
NUT, 7/16-14
11011836 (1)
WASHER, 7/16
11749375 (1)
ACCESS PLATE
11980208 (4)
SHCS,#4-40 X .25
1/4
REVISIONS
ZONE | REV | DESCRIPTION | DATE
- | 00 | NEW RELEASE | 5/30/99
NEXT ASS'Y:
DRN KLA
DATE 5/17/99
CK'D
DATE
APP'D
DATE
Bridgeport
BRIDGEPORT MACHINES, INC.
TITLE 3RD AXIS OPTION
EZ-TRAK I & II
SIZE D
FSCM NO. 08607
DWG. NO. 74-9310
REV. 00
SCALE 1:2
SHEET 1 OF 1

Chapter 14. Parts Breakdown

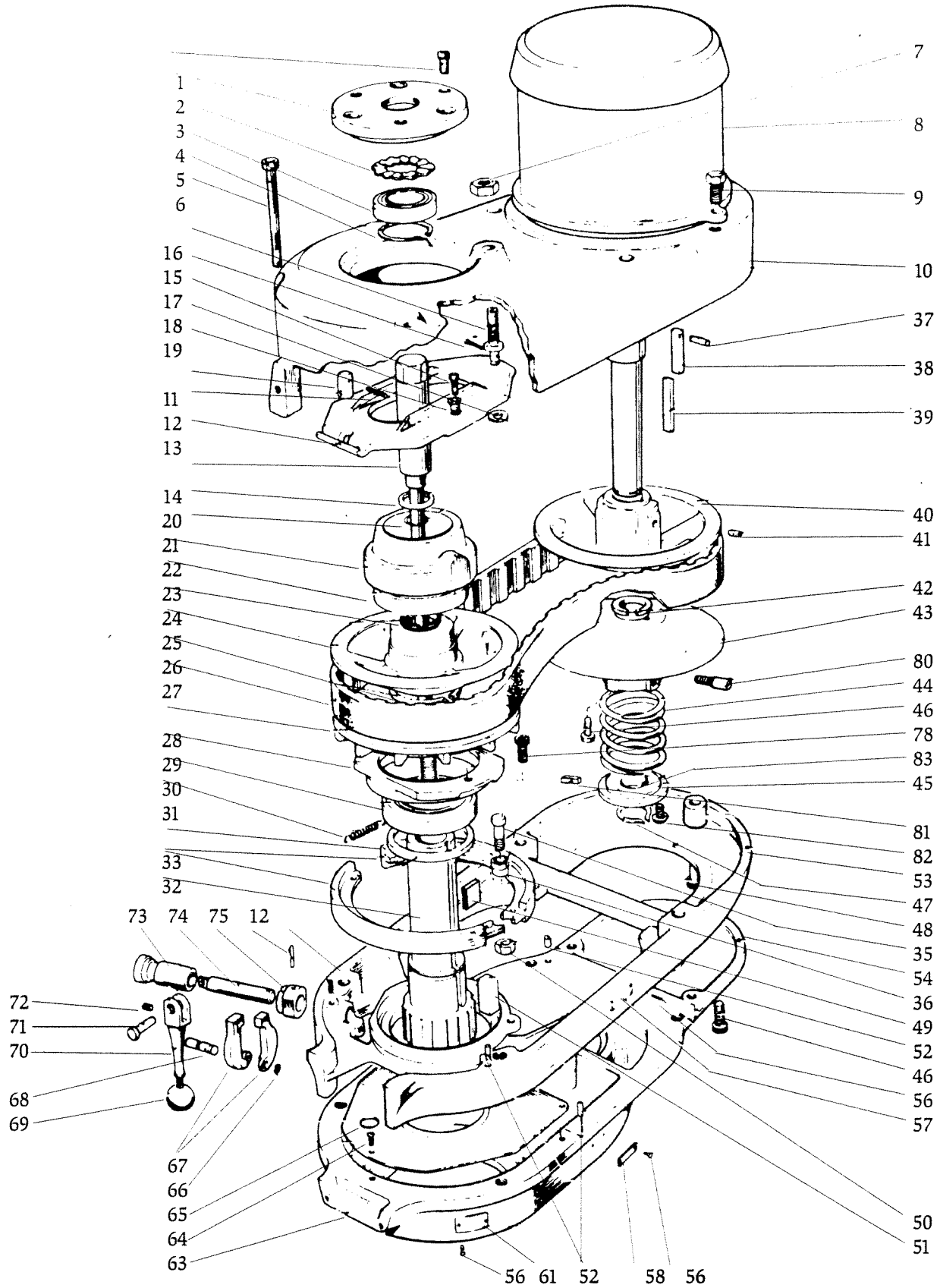


Series I EZTRAK

PARTS BREAKDOWN

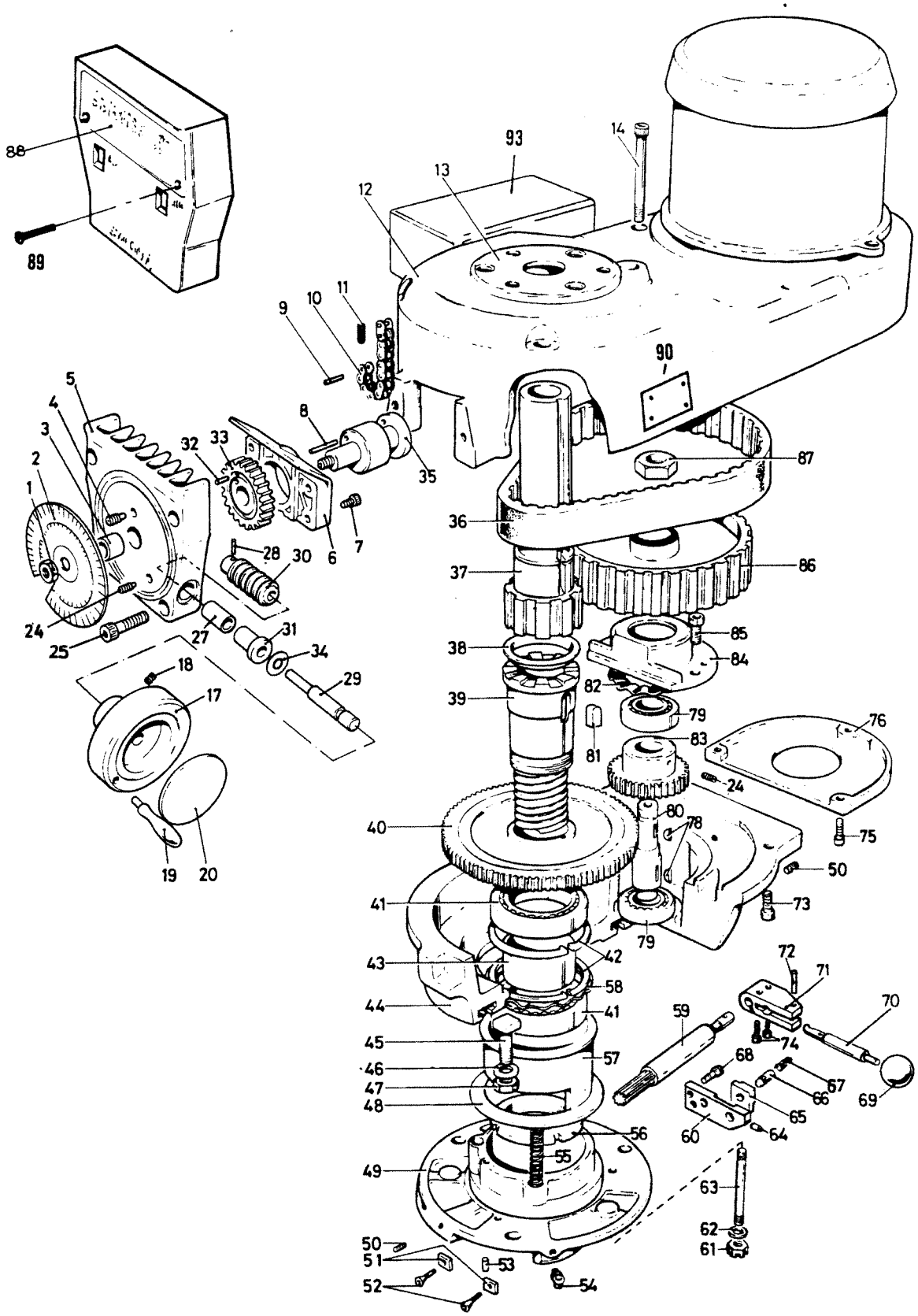

1
2
3
4
5
6
16
15
17
18
19
11
12
13
14
20
21
22
23
24
25
26
27
28
29
30
31
33
32
34
73
74
75
12
72
71
70
68
69
67
66
65
64
63
56
61
52
58
56
7
8
9
10
37
38
39
40
41
42
43
80
44
46
78
83
45
81
82
53
47
48
35
54
36
49
52
46
56
57
50
51

ITEM	CODE NO.	DESCRIPTION	QTY.
1	11011033	Socket Cap Screw 1/4-20 x 3/4 in.	3
2	12180094	Top Bearing Cup	1
3	11181977	Wave Spring Washer	1
4	11180252	Ball Bearing Fafnir No. 9107 NNP	1
5	11180848	Snap Ring No. 5100-137	1
6	11011069	5/16-18 x 6 in. Socket HD. Cap Screw	2
7	11011745	3/8-16 in. UNC Hex. Jam Nut	1
8	11550001	Motor 2 HP 230/460-3-50/60	1
9	11011148	3/8-16 x 1 in. Hex. HD. Screw	2
10*	12180051	Belt Housing, Upper	1
11	12180066	Speed Change Chain Stud	1
12	11010535	5/32 in. Dia. x 1.00 in. long Roll Pin	2
13	11180058	Speed Change Plate	1
14	12184920	Drawbar Assy.	1
15	11010606	3/32 in. Dia. x 3/4 in. Cotter Pin	1
16	12180074	Speed Change Plate Pivot Stud	1
17	11011020	10-32 x 3/4 in. Socket HD. Cap Screw	2
18	11180095	Washer	1
19	12180089	Pivot Sleeve	2
20	12180093	Drawbar Washer	1
21	11180915	"O" Ring Parker No. 2-14	1
22	12180056	Spindle Pulley Bearing Sliding Housing	1
23	11170262	Ball Bearing Fafnir No. RM9110NPP	1
24	11182124	Plastic Insert	2
25	12183934	Adjustable-Driven Varidisc A	1
26	11180855	Retaining Ring No. 5102-156	1
27	11182120	Belt	1
28	12180082	Stationary Drive Varidisc	1
29	12180043	Brake Cap and Bearing	1
30	11170262	BallBearing Fafnir No. RM9110NPP	1
31	11182081	Brake Spring	2
32	12180073	Brake Shoes	2
33	12180078	Spindle Pulley Spacer	1
34	12180042	Spindle Pulley Hub Assy.	1
35	11011138	1/4-20 x 3/4 in. Hex. HD. Screw	1
36	12180071	Brake Shoe Pivot Sleeve	1
37	11010513	Roll Pin	1
38	12550007	Key, Pulley	1
39	12550004	Key Assembly, Plastic	1
40	12550006	Stationary Motor Varidisc	1
41	11011287	1/4-20 x 1/4 in. Socket Set Screw	2
42	11182126	Insert, Plastic	2

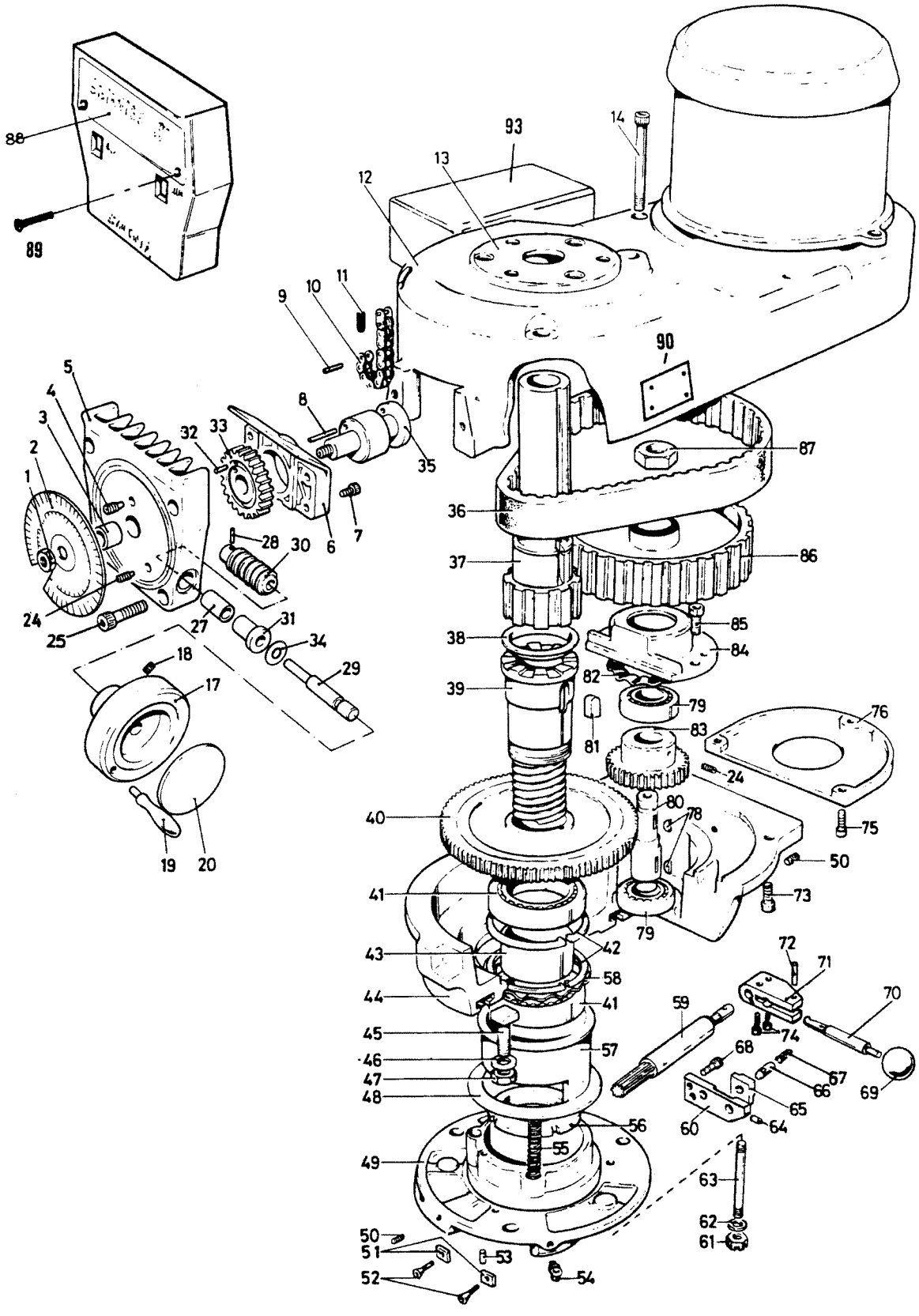

1
2
3
4
5
6
16
15
17
18
19
11
12
13
14
20
21
22
23
24
25
26
27
28
29
30
31
33
32
73
74
75
12
72
71
70
68
69
67
66
65
64
63
56
61
52
58
56
7
8
9
10
37
38
39
40
41
42
43
80
44
46
78
83
45
81
82
53
47
48
35
54
36
49
52
46
56
57
50
51

ITEM	CODE NO.	DESCRIPTION	QTY.
43	12550046	Adjustable Motor Varidisc Assy.	1
44	11182083	Spring for Varidisc Motor Shaft	1
45	11550003	Adjustable Varidisc Spring Collar	1
46	11011022	10-32 UNC x 1.00 in. Long Socket Cap Head Screw	3
47	11150843	Ring, Snap	1
48	11011052	5/16-18 x 3/4 in. Socket Cap Screw	1
49	11182122	Plastic Key	1
50	11011707	Nut. Hex Jam 0.250-20 in.	1
51	12180084	Key	1
52	12180107	Taper Pin No. 4 x 1.00 in.	4
53*	12180052	Belt Housing Base	1
54	12180088	Motor Pulley Cover	1
56	11011552	Drive Screw 0 x 1/4 in.	8
58	11182893	HI-LOW Range Nameplate	1
61	11182894	Quill Feed Nameplate	1
63	12180053	Gear Housing	1
64	11011443	10-24 x 3/8 in. Round HD. Machine Screw	3
65	11185030	Gear Housing Plate	1
66	11180818	Snap Ring No. 5100-25	1
67	11182306	Brake Operating Finger	2
68	12180083	Brake Finger Pivot Stud	1
69	11192151	1/4 x 20 in. Brakelite Ball Handle	1
70	12190133	Brake Lock Handle	1
71	12190134	Brake Lock Pin	1
72	11011260	10-32 x 1/4 in. Long Socket Set Screw	1
73	12180104	Sleeve for Brake Lock Shaft	1
74	28025521	Brake Lock Shaft	1
75	12180069	Brake Lock Cam	1
78	11011031	S.H.C.S., 1/4-20 x 5/8 in.	1
80	11011016	F.H.C.S., 10-32 x 0.500 in.	1
82	11011006	S.H.C.S., 8-32 x 0.250 in.	1
83	12550008	Key	1

* Item 10 and 53 sold as assembly only


88
89
93
14
13
12
9
10
11
90
5
4
3
2
1
32
33
8
35
87
36
6
7
28
30
37
86
24
25
27
31
34
38
85
84
18
29
39
82
17
79
76
81
83
24
40
80
78
75
50
19
20
41
73
79
43
42
72
71
58
44
41
59
70
45
57
74
68
46
67
47
66
69
48
65
60
64
56
55
49
63
62
61
50
51
53
52
54

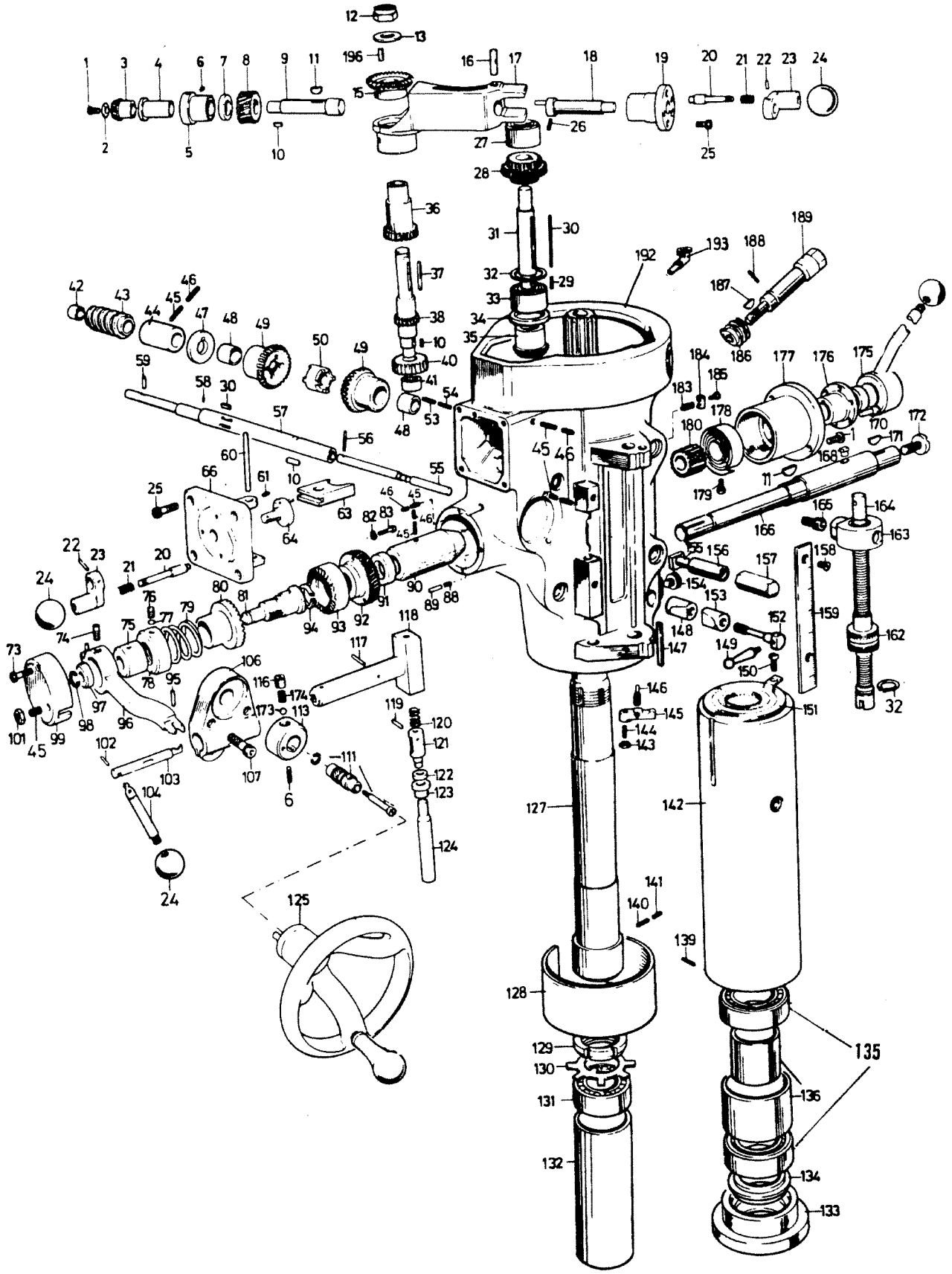
ITEM	CODE NO.	DESCRIPTION	QTY.
1	11011710	5/16 in. Nut	1
2	11180133	Spindle Speed Dial	1
3	11183646	Bronze Bearing Boston No. B810-4	1
4	11011380	1/4-20 x 1/2 in. Full Dog Socket Set Screw	1
5	12180055	Speed Changer Housing	1
6	12182003	Plastic Bearing Block	1
7	11011031	1/4 UNC x 5/8 in. Socket Head Cap Screw	4
8	11010516	1/8 in. Dia. x 5/8 in. Long Roll Dowel	1
9	11010520	1/8 in. Dia. x 1.00 in. Long Roll Pin	1
10	11183720	Speed Changer Chain #35, Morse	1
11	12180066	Chain Stud	1
12	12180051	Belt Housing	1
13	12180094	Top Bearing Cap	1
14	11011065	5/16-18 x 4 in. Socket Head Cap Screw	1
17	12182001	Speed Change Hub	1
18	11181233	1/4 UNC x 3/8 in. Socket Set Screw	1
19	11182178	Machine Handle No. 3302	1
20	11182892	Caution Plate	1
24	11011287	1/4-20 x 1/4 in. Socket Set Screw	2
25	11011037	S.H.C.S., 1/4-20 x 1-1/4 in.	4
27	11183645	Oilite Bushing	1
28	28300619	Dowel Pin, 0.125 x 0.500 in. Roll	1
29	28025716	Shaft, Speed Changer	1
30	28007307	Boston Worm Gear	1
31	11180214	Oilite Bushing, Flanged-FB	1
32	11010539	3/16 in. Dia. x 3/8 in. Long Roll Dowel	1
33	12180090	Speed Change Spur Gear	1
34	11181923	Wavy Spring Washer	1
35	12180065	Speed Change Chain Drum	1
36	11552106	Timing Belt	1
37*	12180042	Spindle Pulley Hub	1
38*	12180064	Timing Pulley Clutch Sleeve	1
39	12180059	Splined Gear Hub	1
40**	12180062	Spindle Bull Gear	Set
41	11180254	Ball Bearing Fafnir No. RM9308NPP	2
42	11180803	Snap Ring No. 5000-244	2
43	12180063	Bull Gear Bearing Spacer	1
44	12180052	Gear Housing	1
45	11181650	Tee Bolts	3
46	11181906	Washer, Flat 15/32 in. ID x 15/16 in. OD x 1/16 in.	3
47	11011750	7/16-14 Hex. Jam Nut-finished HDN	3
48	11181986	Ball Bearing Gear Sleeve Washer	3


88
89
93
14
13
12
9
10
11
90
5
4
3
2
1
32
33
8
35
87
36
6
7
28
30
37
86
24
25
27
31
34
38
85
84
29
39
82
79
18
17
83
76
81
24
40
80
78
75
19
20
50
41
73
79
43
42
72
71
58
44
41
59
70
45
57
74
68
46
67
47
66
69
48
65
56
60
64
55
49
63
62
61
50
51
53
52
54

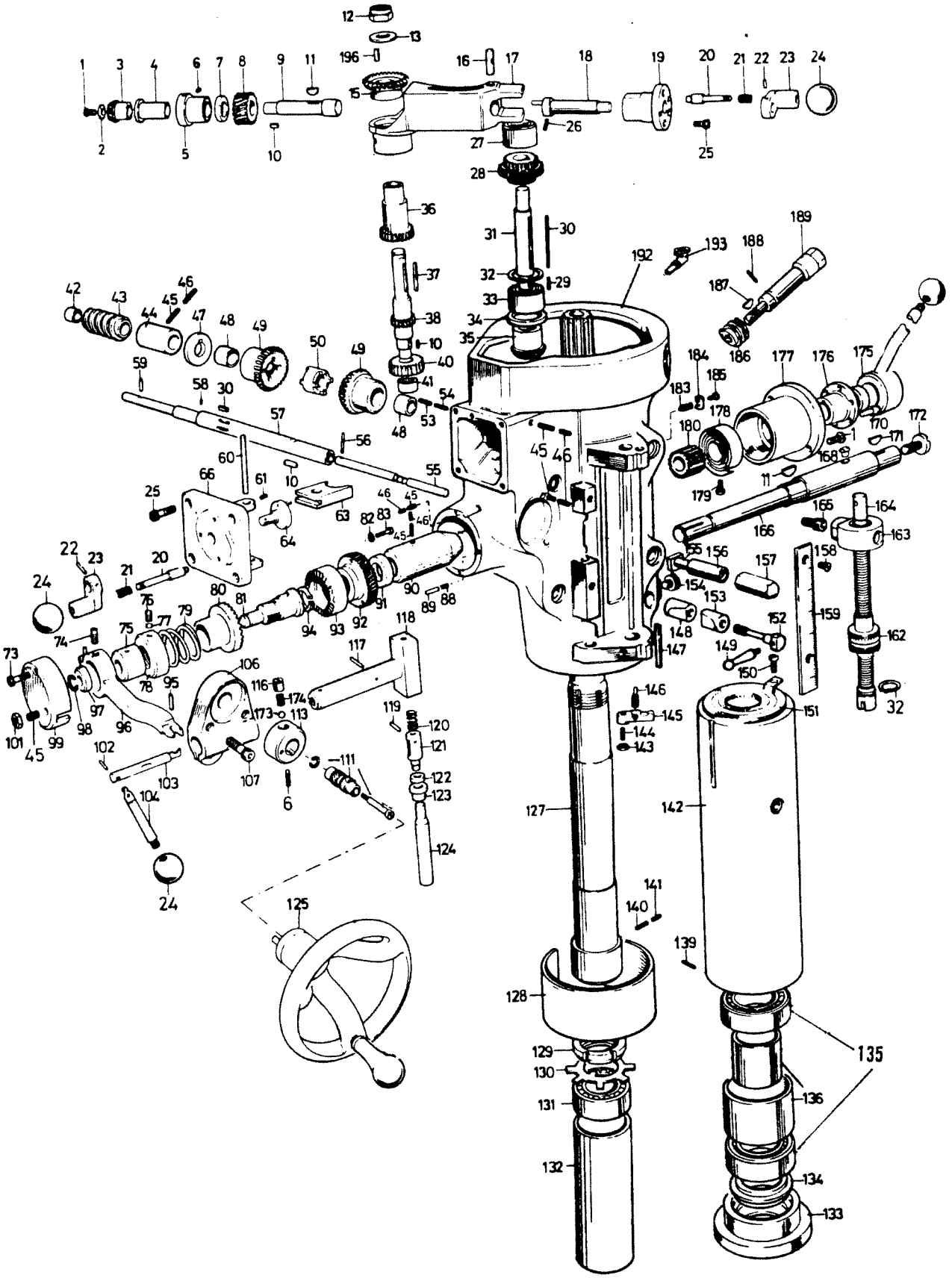
ITEM	CODE NO.	DESCRIPTION	QTY.
49	12180054	Fixed Clutch Bracket	1
50	11011246	5/16-18 x 5/16 in. Socket Set Screw	2
51	28025615	Guide	2
52	28025671	10-32 x 3/8 in. Flat HD. Socket Cap Screw	2
53	11010511	Roll Dowel 1/8 x 1/4 in. Long Loc-wel	1
54	11183104	Gits Style L No. 1202 Oil Cup	1
55	11182071	3/8 in. OD x 3.00 in. Long Compression Spring	3
56	11181794	N-08 Bearing Locknut	1
57	12180061	Bearing Sleeve	1
58	11181977	Wave Spring Washer	1
59	12180067	Bull Gear Shift Pinion	1
60	12180161	HI-LOW Detent Plate	1
61	11181732	3/8-16 in. Hex Nut	3
62	11151913	3/8 in. Lock Washer	3
63	12180085	Studs	3
66	12180100	HI-LOW Detent Plunger	1
67	11182072	Spring 3/4 x 0.032 x 9/16 in.	1
68	11011017	10-32 x 1/2 in. Long Socket Cap Screw	2
69	11192151	1/4 x 20 in. Bakelite Ball Handle	1
70	12180099	HI-LOW Shift Crank	1
71	12180096	HI-LOW Pinion Block	1
72	11010516	1/8 in. Dia. x 5/8 in. Long Roller Pin	1
73	11011052	5/16 x 3/4 in. Socket Cap Screw	4
74	11181007	8/32 UNF x 0.625 in. Socket Cap Screw	2
75	11011022	10-24 x 1.00 in. Socket HD. Cap Screw	1
76	12180088	Motor Pulley Cover	1
78	11013079	No. 9 Woodruff Key	2
79	11180235	Ball Bearing Fafnir No. 203Npp-C8	2
80	12180075	Bull Gear Pinion Counter Shaft	1
81	12180103	5/16 in. Square Key	1
82	11181975	Wave Spring Washer	1
83**	12180077	Bull Gear Pinion	Set
84	12180076	Bull Gear Pinion Bearing Cap	1
85	11011011	10-24 x 5/8 in. Socket HD. Cap Screw	2
86	12550016	Timing Belt Pulley	1
87	11191738	5/8-18 in. NF Jam Nut	1
88	11182912	Speed Change Name Plate	1
89	11011139	F.H.M.S., 8-32 x 0.750 in.	2
90	11182897	Lubrication Plate	1
93	11182655	Switch Drum	1

* Items 37 and 38 sold as assembly only

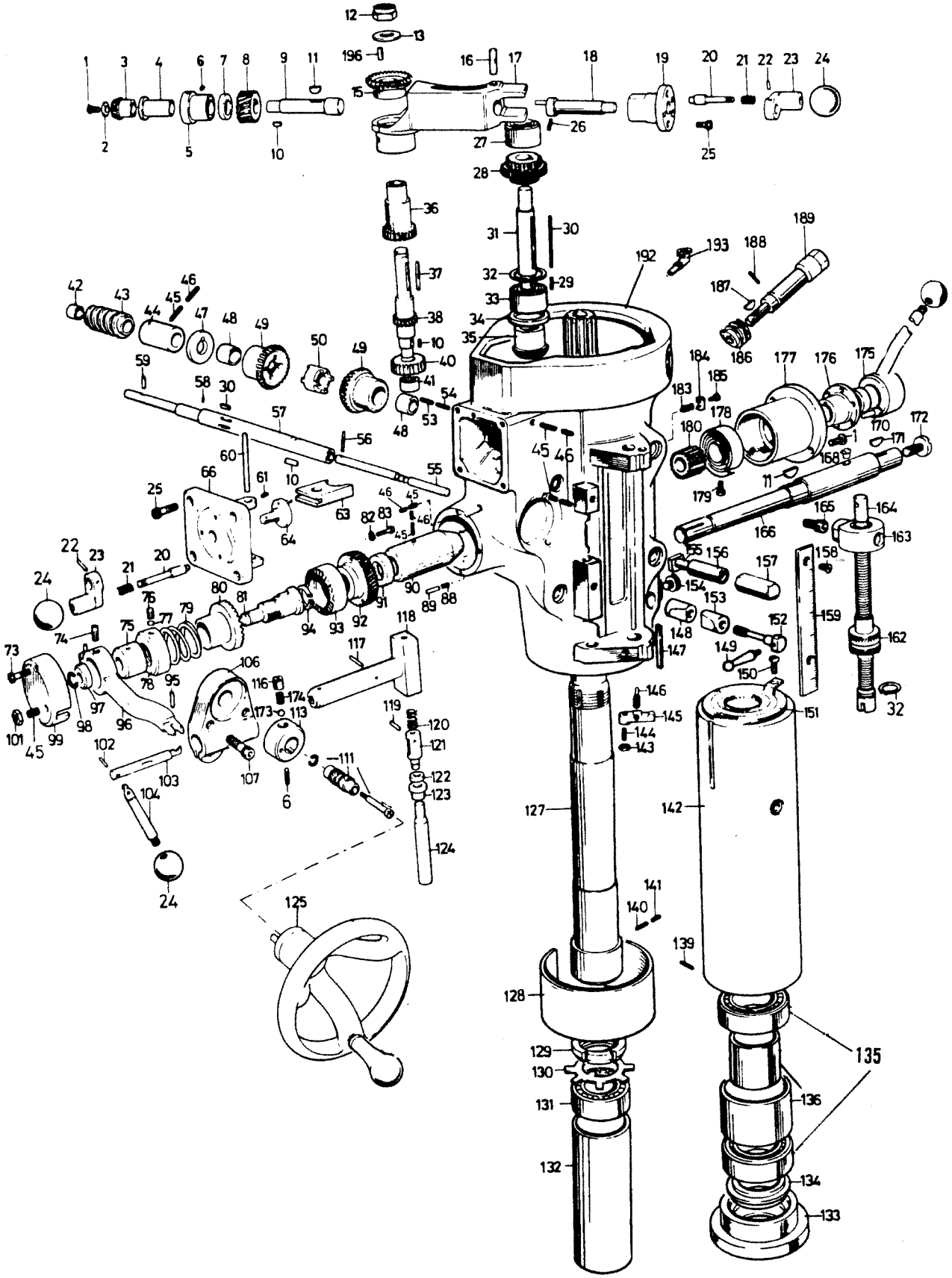
** Items 40 and 83 sold as assembly only


12
13
196
1
3
4
6
7
8
9
11
16
17
18
19
20
21
22
23
24
15
2
5
10
27
26
25
28
36
31
30
189
193
188
192
187
37
32
29
33
38
34
10
35
40
41
54
53
48
42
43
46
45
44
47
48
49
50
49
59
58
30
57
56
60
61
10
55
63
64
66
25
46
45
82
83
45
46
22
23
20
21
24
76
77
79
80
81
94
93
92
91
90
89
88
74
75
118
117
73
78
95
106
116
174
173
113
119
120
121
122
123
124
101
45
99
98
97
96
102
103
107
6
111
104
24
125
127
142
141
140
139
128
129
130
131
132
135
136
134
133
179
180
178
183
184
185
186
177
176
175
172
170
171
168
11
166
165
164
163
162
32
158
159
157
156
155
154
153
152
149
150
151
148
147
146
145
144
143

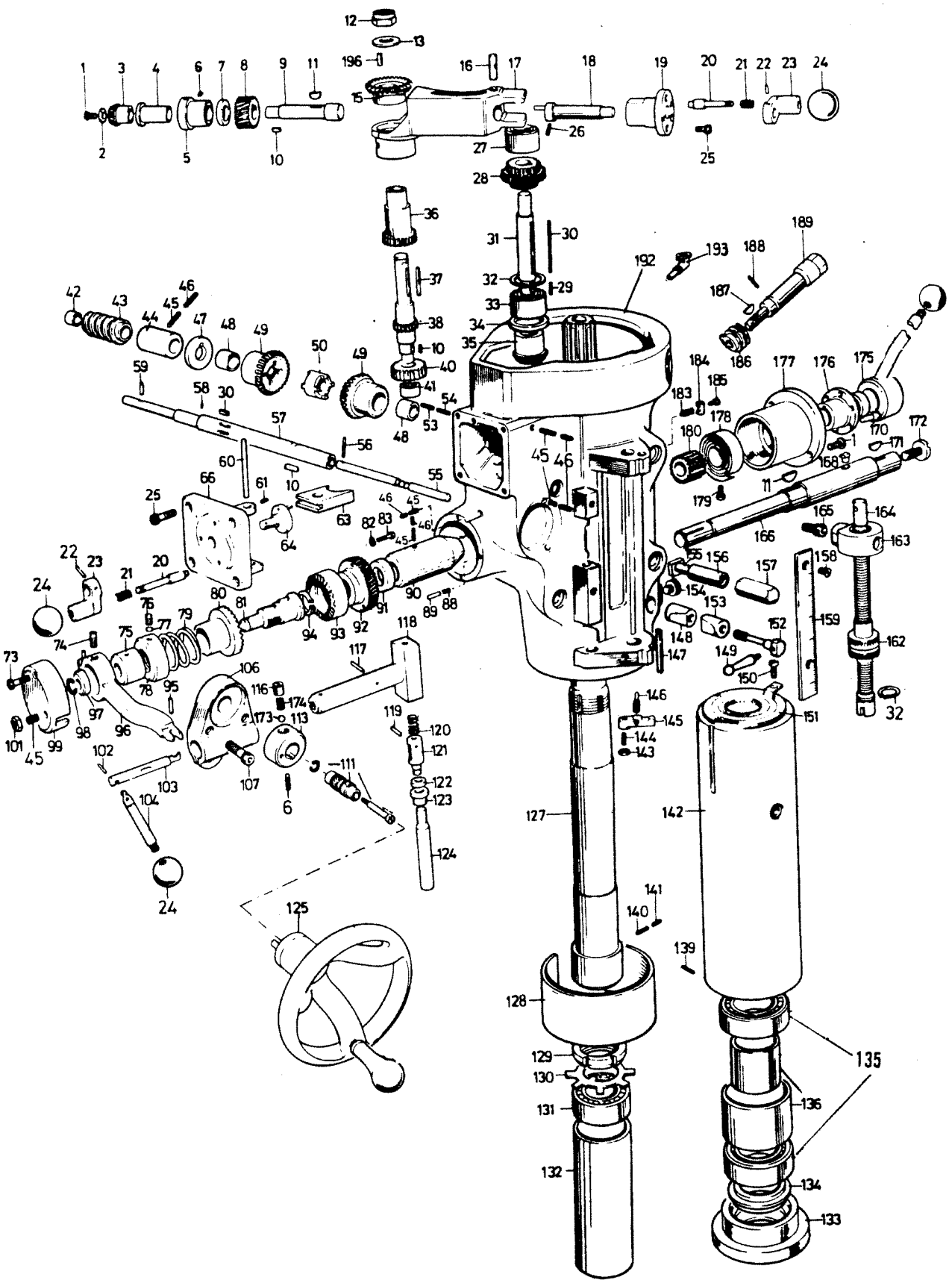
ITEM	CODE NO.	DESCRIPTION	QTY.
1	11011445	10-24 x 3/8 in. Long RD. HD. Screw	3
2	12190163	Bevel Pinion Washer	1
3	12190203	Feed Bevel Pinion Gear	1
4	12190164	Feed Worm Gear Shaft Sleeve	1
5	11192303	Worm Cradle Bushing	1
6	11011287	1/4-20 x 5/16 in. Set Screw	2
7	12190165	Worm Gear Spacer	1
8	12190266	Feed Drive Worm Gear	1
9	12190167	Feed Drive Worm Gear Shaft	1
*	12193440	Shaft Assembly, Gear Drive	
10*	12190162	1/8 in. sq. x 5/16 in. Key, Worm Shaft	3
11	11013078	No. 7 Woodruff Key	3
12	11191796	3/8-24 in. Flexloc Locknut	1
13	12190199	Washer, 3/8 in.	1
15	11192209	Feed Reverse Bevel Gear	1
16	12190168	Feed Engage Pin	1
17	12190059	Word Gear Cradle	1
18	12190169	Worm Gear Cradle Throw-out	1
19	12190170	Shift Sleeve	1
20	12190138	Pin, Shift	2
21	11192052	Compression Spring	2
22	11010517	1/8 x 3/4 in. Roll Pin	2
23	12190064	Shift Crank	2
24	11192151	Black Plastic Ball 1 in. Dia.	4
25	11011010	10-24 x 1/2 in. Long Cap Screw	7
26	11011258	10-24 x 3/8 in. Set Screw	1
27	12190181	Cluster Gear Shaft Upper Bushing	1
28	28007099	Cluster Gear Assembly (Supplied as one unit)	1 unit
29	12190148	1/8 in. sq. x 3/4 in. Key	1
**	12193544	Pinion Assembly, Bevel Feed	
30*	12190175	1/8 in. sq. x 9/16 in. Key Assembly	2
31	28007106	Cluster Gear Shaft	1
32**	11190836	External Retaining Ring 5100-62	2
33**	12190149	Bevel Gear Bearing	1
34**	12190150	Bevel Gear Thrust Spacer	1
35**	12190180	Feed Reverse Bevel Pinion	1
36*	12190146	Feed Driving Gear	1
37*	12190176	1/8 in. sq. x 3/4 in. Round End Key	1
38*	12190145	Cluster Gear Input Shaft	1
40*	12190144	Feed Drive Gear	1
41	1110-310	B-66 Torrington Needle Bearing	1
42	11193637	Bushing	1



ITEM	CODE NO.	DESCRIPTION	QTY.
43	28007307	Gear, Worm Speed Control	1
44	12190155	Feed Worm Shaft Bushing	1
45	11011268	1/4-20 x 1/2 in. Long Socket Set Screw	6
46	11011542	5/16-18 x 15/16 in. Long Set Screw	5
47	11190152	Feed Worm Shaft Thrust Washer	1
***	12193432	Gear Assembly, Bevel Feed	
48***	11183646	Oilite Bearing	2
49***	12190151	Feed Reverse Bevel Gear	2
50	12190153	Feed Reverse Clutch	1
53	11011547	S.S.S., 0.312-18 x 0.156 in. Lock	1
54	11011375	Dog Point Set Screw, 0.312-18 x 0.250 in. Half	1
55	12190157	Reverse Clutch Rod	1
56	11010509	3/32 x 3/4 in. Long Roll Pin	1
57	12190198	Feed Worm Shaft	1
58	12190200	3/32 x 5/16 in. Long Pin	1
59	28007308	0.110 x 7/16 in. Long Pin	1
60	12190179	Feed Shift Rod	1
61	11011260	10-32 x 1/4 in. Long Set Screw	1
63	11190061	Feed Gear Shift Fork	1
64	12193446	Cluster Gear Shift Crank Assembly	1
66	12190065	Cluster Gear Cover	1
73	11011014	10-32 x 1-1/2 in. Cap Screw	2
74	12190188	Clutch Ring Pin	2
75	12190098	Clutch Ring	1
76	11011265	1/4 UNC x 1/4 in. Set Screw	1
77	12190073	Brass Plug 3/16 in. Dia. x 3/32 in.	1
78	12190105	Overload Clutch Locknut	1
79	11192055	Safety Clutch Spring	1
80	28007058	Overload Clutch	1
81	28007054	Overload Clutch Sleeve	1
82	11191920	Single Spring Washer	3
83	11011431	8-32 x 5/8 in. Round Head Screw	3
88	11192032	Compression Spring 1/4 in. Dia. x 1-1/4 in.	1
89	12190096	Overload Clutch Lever Spring Plunger	1
90	12190106	Quill Pinion Shaft Bushing	1
91	12190104	Pinion Shaft Worm Gear Spacer	1
92	11190103	Overload Clutch Worm Gear	1
93	28007059	Overload Clutch Ring	1
94	11190870	External Retaining Ring	1
95	11010717	3/16 x 5/8 in. Dowel Pin	1
96	12193427	Overload Clutch Trip Lever Assembly	1
97	12190097	Overload Clutch Washer	1



ITEM	CODE NO.	DESCRIPTION	QTY.
98	11190822	External Retaining Ring 5100-37	1
99	12190068	Clutch Arm Cover	1
101	11011740	Chem. Blacked Locknut 1/4 x 20 UNC	1
102	11010717	3/16 x 3/4 in. Dowel Pin	1
103	12190094	CAM Rod	1
104	12190095	Trip Handle	1
106	12190067	Feed Trip Bracket	1
107	11011035	1/4-20 x 1 in. Long Cap Screw	2
111	12193433	Reverse Knob Assembly	1
113	12190159	Handwheel Clutch Assembly	1
116	12190154	Handwheel Clutch Spring Screw	1
117	11010515	1/8 x 9/16 in. Long Roll Pin	1
118	12190093	Cam Rod Sleeve Assembly	1
119	11010513	1/8 x 7/16 in. Long Roll Pin	1
120	11192053	Compression Spring	1
121	12190091	Trip Plunger	1
122	12190092	Feed Trip Plunger Bushing	1
123	12190090	Trip Plunger Bushing	1
124	12190089	Feed Trip Plunger	1
125	28007120	Handwheel Assembly	1
127	12190191	Spindle	1
128	11190081	Quill Skirt	1
129	11191790	No. 06 Locknut	
130	11191942	W-06 Lockwasher	1
131	11190237	Fafnir Bearing M206 K	1
132	12190197	Bearing Sleeve	1
133	12190196	Nose-piece	1
134	12780915	Spindle Dirt Shield	1
135	11190238	Spindle Bearing Set	1
136	12193513	Bearing Spacer Set	1
139	11011265	1/4 UNC x 1/4 in. Set Screw	1
140	12193540	1/4-32 in. Collet Alignment Screw	1
141	11011545	1/4-32 x 1/8 in. Special Locking Set Screw	1
142#	12190192	Quill	1
143	28300336	Steel Nut, 6-32 in. NC	1
144	28300609	6-32 x 3/4 in. Set Screw	1
145	28007042	Feed Trip Lever	1
146	12190185	Trip Lever Pin	1
147	12200103	Indicator Rod	1
148	12190109	Quill Lock Sleeve Tapped	1
149	12200098	Lock Handle	1
150	11011595	10-32 x 3/8 in. Long RD. HD. Screw	2


12
13
196
1
3
4
6
7
8
9
11
16
17
18
19
20
21
22
23
24
15
26
27
25
2
5
10
28
36
31
30
189
192
193
188
187
37
32
29
33
38
34
35
10
40
41
54
53
48
42
43
44
45
46
47
48
49
50
49
59
58
30
57
56
60
55
66
61
10
63
64
25
46
45
83
82
45
46
45
22
23
21
20
24
76
80
81
90
89
88
94
93
92
91
75
77
79
74
118
117
73
106
116
174
173
113
78
95
97
98
96
101
45
99
102
103
104
107
6
111
119
120
121
122
123
124
24
125
45 46
184
185
183
178
177
176
175
180
179
168
170
171
172
11
166
165
164
163
155
156
157
158
154
153
159
148
152
162
147
149
150
32
146
145
144
143
151
127
142
141
140
139
128
129
130
131
132
135
136
134
133

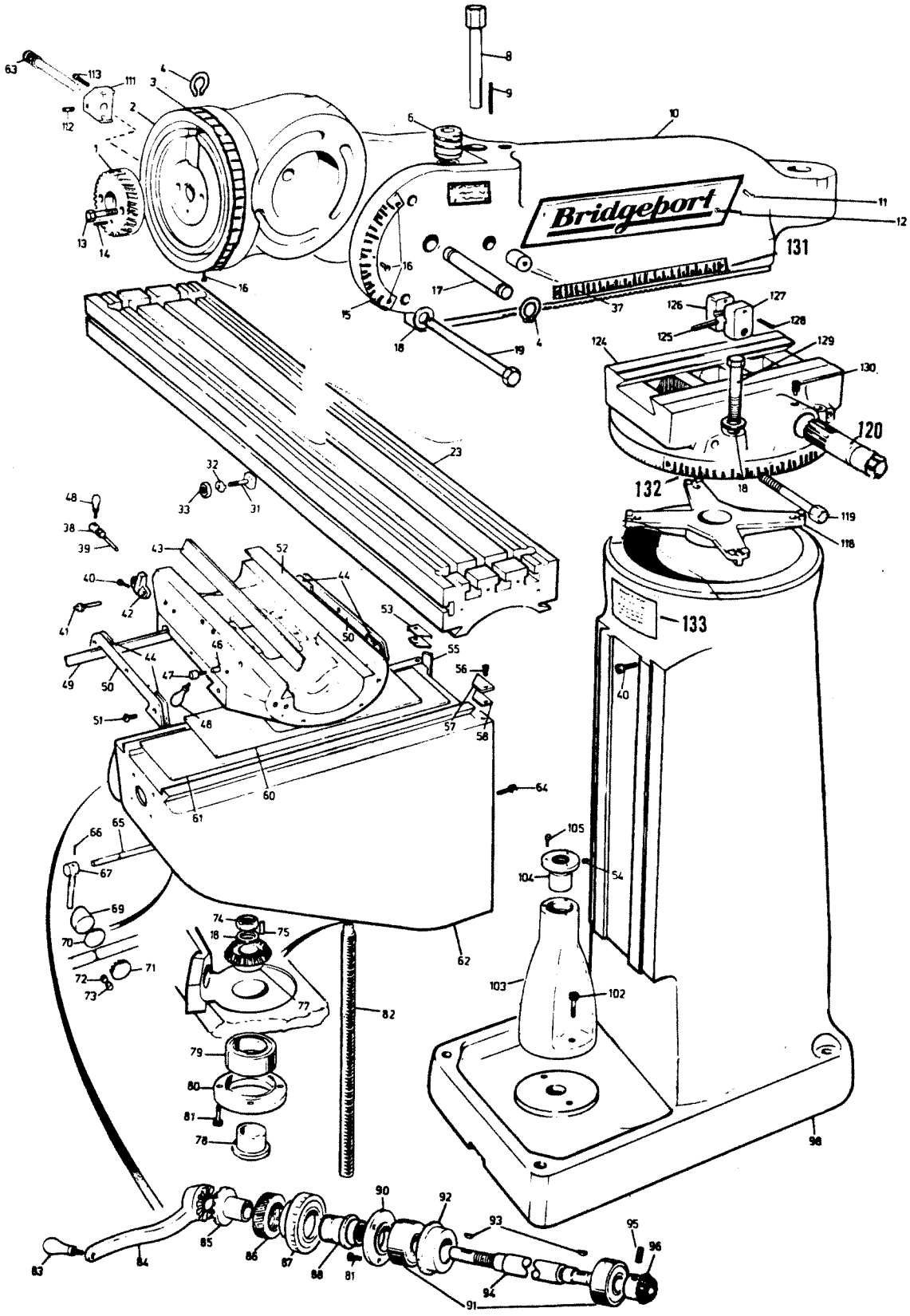
ITEM	CODE NO.	DESCRIPTION	QTY.
151	11192403	Felt Oil Strainer	1
152	12190111	Quill Lock Bolt	1
153	12190110	Quill Lock Sleeve Untapped	1
154	12200102	Screw, Rod Indicator Thumb	1
155	12191620	1/2 in. Tee Bolt	4
156	12190135	Lower Clamping Bolt Spacer	2
157	12191736	1/2 x 1-1/2 in. Nut, Hex	2
158	11011411	6-32 x 1/4 in. Chem. Blacked RD. HD. Screw	2
159	11195306	Scale, Quill, Micrometer Inch	1
162	12190344	Quick Nut Assembly	1
163	12190082	Stop Nut, Quill	1
164	12190083	Micro-Screw Quill Stop	1
165	11011090	3/8 UNF x 5/8 in. Cap Screw	1
166	28007063	Quill Pinion Shaft	1
168	12200111	Spring Pin	1
170	11010541	3/16 x 3/4 in. Long Dowel Pin	1
171	11013076	No. # Woodruff Key	1
172	12190182	Pinion Shaft Hub Screw	1
173	11192165	Ball, Steel	1
174	11192054	Spring, Compression	1
175	12201031	Quill Feed Handle Assembly	1
176	28009053	Hub, Quill Pinion	1
177	12190066	Spring Cover	1
178	11192020	Clock Spring	1
179	28007150	Outside Clock Spring Pin	1
180	28007064	Quill Pinion	1
183	12190085	Reverse Trip Ball Lever	1
184	12190086	Feed Reverse Trip Plunger	1
185	12190087	Reverse Trip Ball Lever Screw	1
186	11192207	Worm Gear	1
187	11013077	No. 5 Woodruff Key	1
188	11011370	Socket Set Screw 1/4 UNC x 20 x 3/8 in.	1
189	12190850	Shaft, Adjust. Worm	1
192#	12190051	Quill Housing	1
193	11193111	Oil Cup	1
196	12190162	1/8 in. sq. x 5/15 in. Key, Worm Shaft	1

* Item Numbers 10, 36, 37, 38, and 40 sold as assembly 12193440

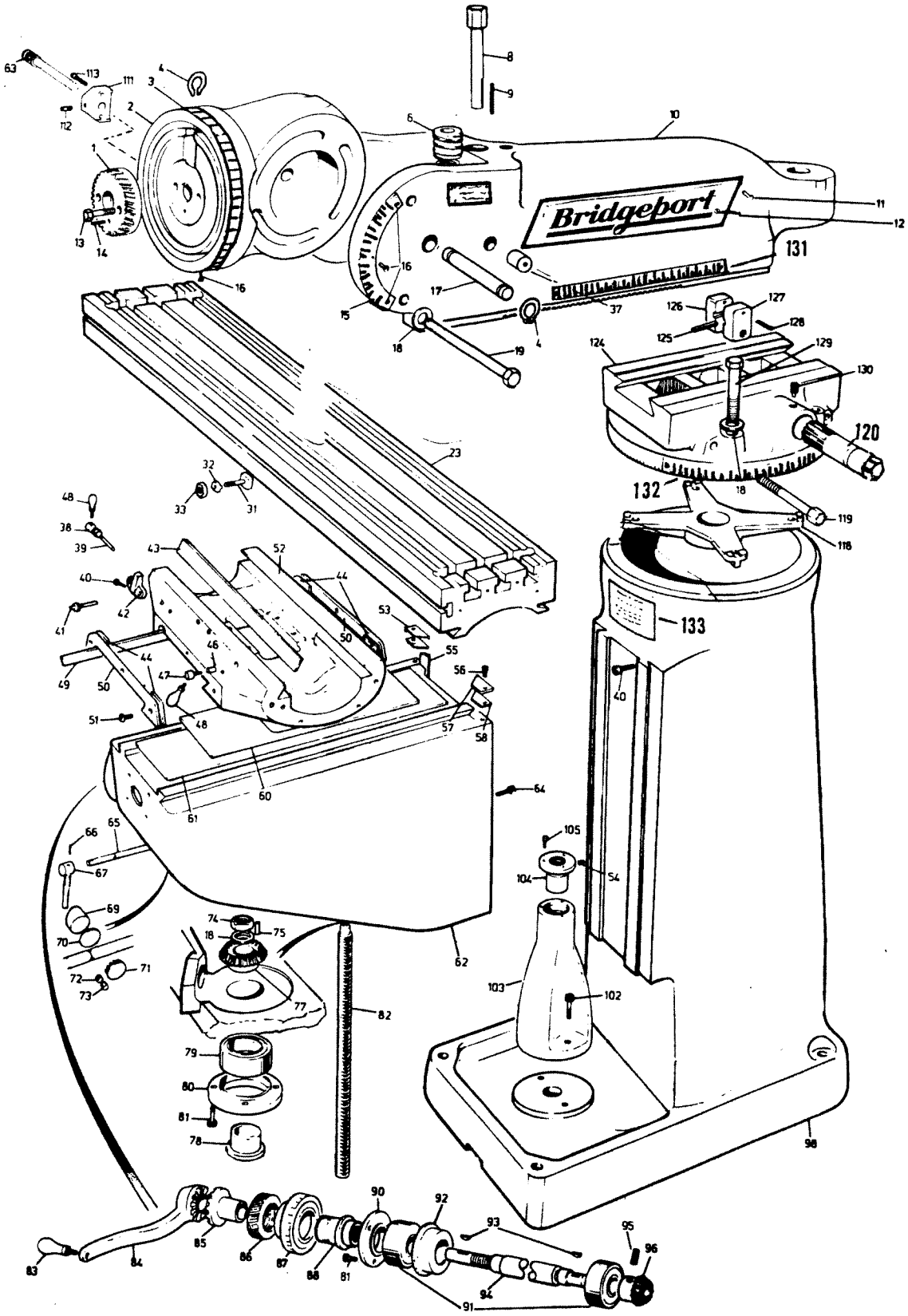
** Item Numbers 32, 33, 34, and 35 sold as assembly 12193544

*** Item Numbers 48 and 49 sold as assembly 12193432

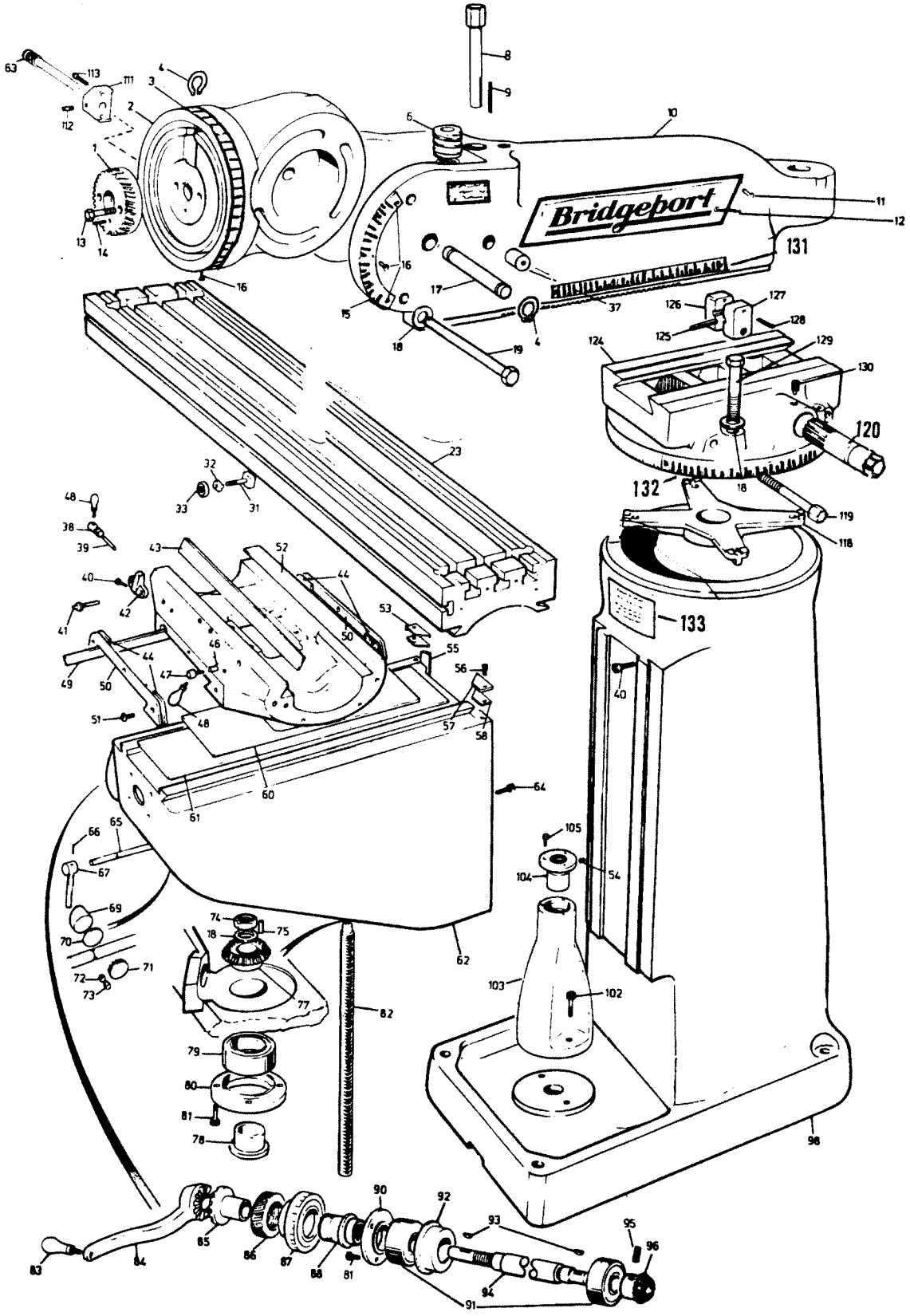
\# Item Numbers 142 and 192 sold as assembly 12124541


Bridgeport
131
120
132
133

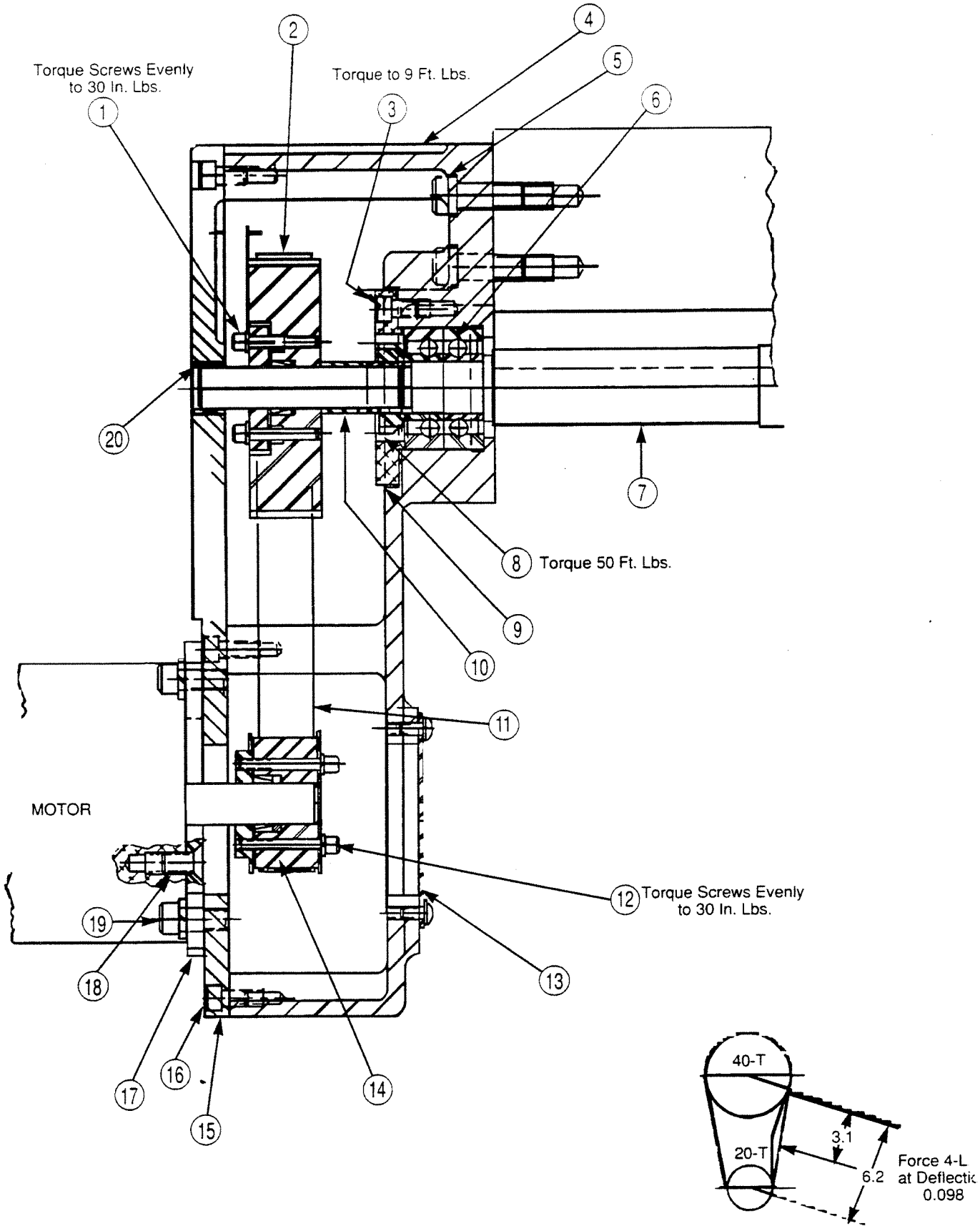
ITEM	CODE NO.	DESCRIPTION	QTY.
1	12190178	Quill Housing Adj. Gear Tilting	1
2	12069013	Ram Adapter Assembly	1
3	11060603	Adapter Scale	1
4	11060892	External Retaining Ring	2
6	11062206	Vertical Adjusting Worm	1
8	12060130	Vertical Adjusting Worm Shaft	1
9	12060138	Key, Sq. 0.188 x 1.938 in.	1
10	12060128	Ram	1
11	11011556	Drive Screw 6 x 0.375 in. Type 0	4
12	11060502	Ram Nameplates	2
13	11011035	1/4-20 x 1 in. S.H.C.S.	2
14	11010590	0.312 x 1.50 in. Roll Pin	1
15	11062826	Angle Plate-Graduated	1
16	11011555	Round HD. Drive Screw	5
17	12061028	Adapter Pivot Pin	1
18	11200109	1/2 x 1/8 x 1 in. Chamfered & Hardened Washer	2
19	11061180	Adapter Locking Bolt Hex HD. 0.500-13 x 7.25 in.	3
23	12060347	Table - 48 in. Long	1
31	11061602	Stop Piece T-Bolt	2
32	11062301	Table Stop Piece	2
33	11011720	3/8-16 Hexagon Nut	3
34	12060122	Washer	2
37	12060328	Clamping Bushing	1
38	12060119	Saddle Lock Bolt	1
39	12060125	Saddle Lock Plunger	1
40	11770252	Low Head Screw	2
41	11060088	Gib Adjusting Screw	3
42	12060300	Table Stop Bracket	1
43	12060482	Table Gib with Chrome	1
44	11062406	Felt Wipers	4
46	12060118	Table Lock Plug, Table/Saddle Lock R.H.	2
47	12060119	Table Lock Bolt - R.H. (12060114 for L.H.)	1
48	11062179	Table Lock Handle	2
49	12060124	Saddle/Knee Gib	1
50	12060123	Saddle/Knee Wiper Plate	2
51	11011580	10-32 x 1/2 in. Oval Head Screw	6
52	12060487	Saddle with Chrome	1
53	12060093	Left Hand Column Wiper Holder	1
55	12060146	Knee/Column Gib	1
56	11011031	Cap Screw, 0.250-20 x 0.625 in.	2
57	12060094	Right Hand Column Wiper Holder	1
58	11062405	Knee Wiper Felt	2


Bridgeport
131
120
132
133

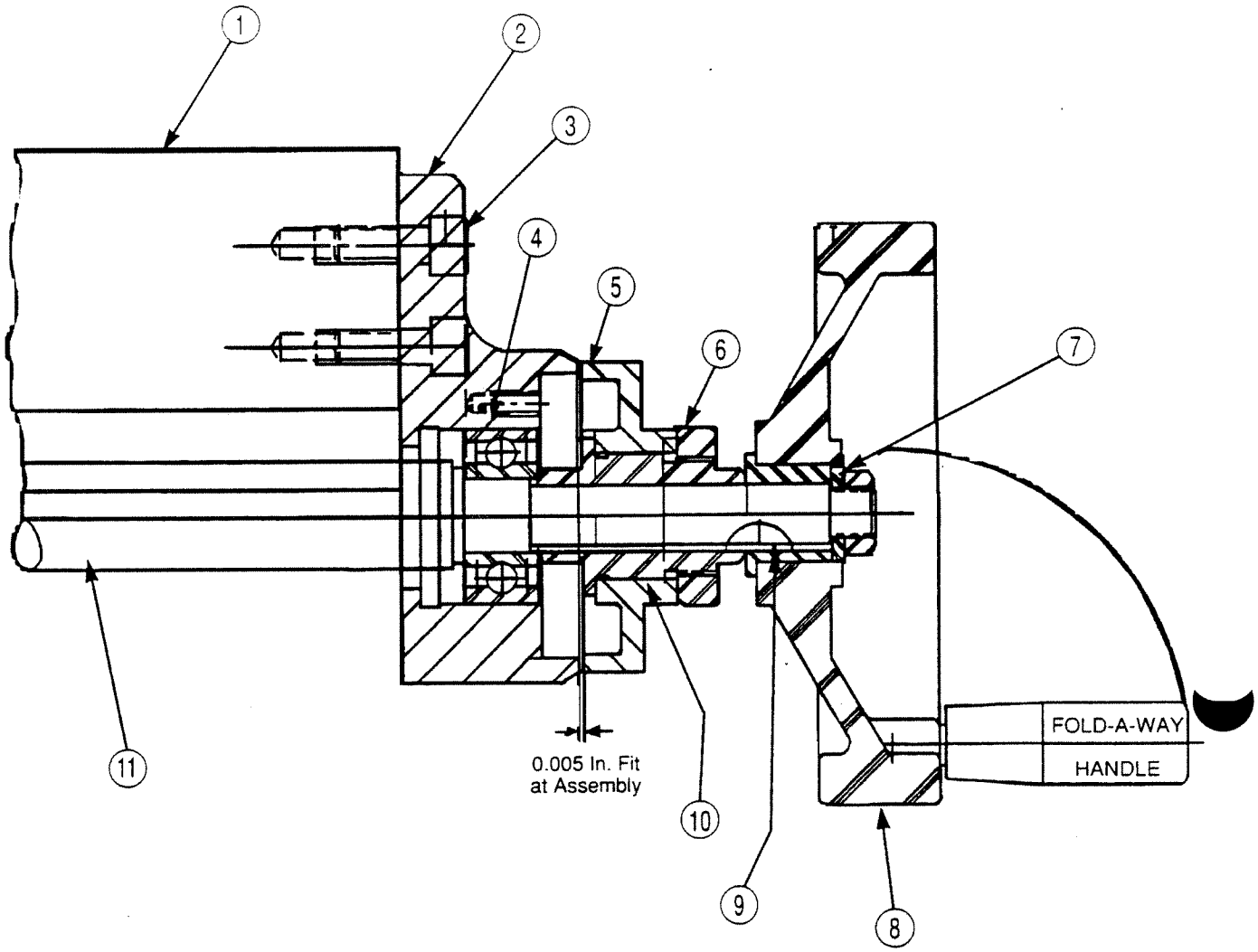
ITEM	CODE NO.	DESCRIPTION	QTY.
60	11060153	Chip Guard Upper	1
61	11060152	Chip Guard Lower	1
62	11060493	Knee with Chrome	1
63	12069999	Head Rotation Stop Pin	1
64	11770252	Low HD Screw	1
65	12060148	Knee Lock Shaft	1
66	11010409	1 x 1 in. Taper Pin	1
67	12061230	Lock Shaft Hub	1
69	12060089	Knee Lock Plunger	1
70	12150131	Washer, Table Locking	1
71	11010786	Knee Binder Plug (Plastic)	1
72	11011375	5/16-18 x 5/16 in. Dog Pt. Set Screw	1
73	11011270	5/16-18 x 5/16 in. Set Screw	1
74	11011755	1/2-20 in. Jam Nut	1
75	12060071	3/16 x 3/16 x 7/8 in. Key	1
77	11062204	Bevel Gear	1
79	11060205	Bearing Fafnir W306PP3	1
80	12060070	Bearing Retaining Ring	1
81	11011031	1/4-20 x 5/8 in. Cap Screw	6
82	12060069	Elevating Screw Inch	1
83	12060060	Handle	1
84	11060080	Elevating Crank	1
85	12060079	Gearshaft Clutch	1
86	12060078	Dial Locknut	1
87	12060213	Dial with 100 Graduations	1
88	12060077	Dial Holder	1
90	12060210	Bearing Retaining Ring	1
91	11060204	Fafnir Bearing H204KTT	2
92	11011030	1/4-20 x 1/2 in. Cap Screw	3
93	11013078	No. 7 Woodruff Key	2
94	12060147	Elevating Shaft Z-Axis	1
95	11011220	1/4-20 x 1/4 in. Long Set Screw	2
96	11062205	Bevel Pinion Gear	1
98	12060209	Column	1
102	11011074	3/8-16 x 1 in. Cap Screw	2
103	12060207	Pedestal	1
104	12060051	Elevating Screw Nut	1
105	11011195	1/4-20 x 1 in. Head Cap Screw	3
111	12650180	Stop Block (Head Rotation)	1
112	11152094	Spring Plunger	1
113	11011017	S.H.C.S., 10-32 x 0.500 in.	2
118	12060144	Spider	1


Bridgeport
131
132
133
120

ITEM	CODE NO.	DESCRIPTION	QTY.
119	11060112	Ram Lock Stud	2
120	12060255	Ram Pinion	1
124	12060208	Turret	1
125	12060137	Ram Clamp Bar	2
126	12060141	Ram Clamp-Blank	2
127	12060113	Ram Clamp-Tapped	2
128	11010619	Cotter Pin	2
129	11061178	1/2-13 x 5 in. Hex Bolt	4
130	12060140	Ram Pinion Screw	1
131	11060602	Ram Scale	1
	11980426	Drive, Screws	2
132	11060601	Turret, Scale	1
	11989426	Drive Screws	2
133	11010200	Plate, Warning	1
	11980426	Drive Screws	4

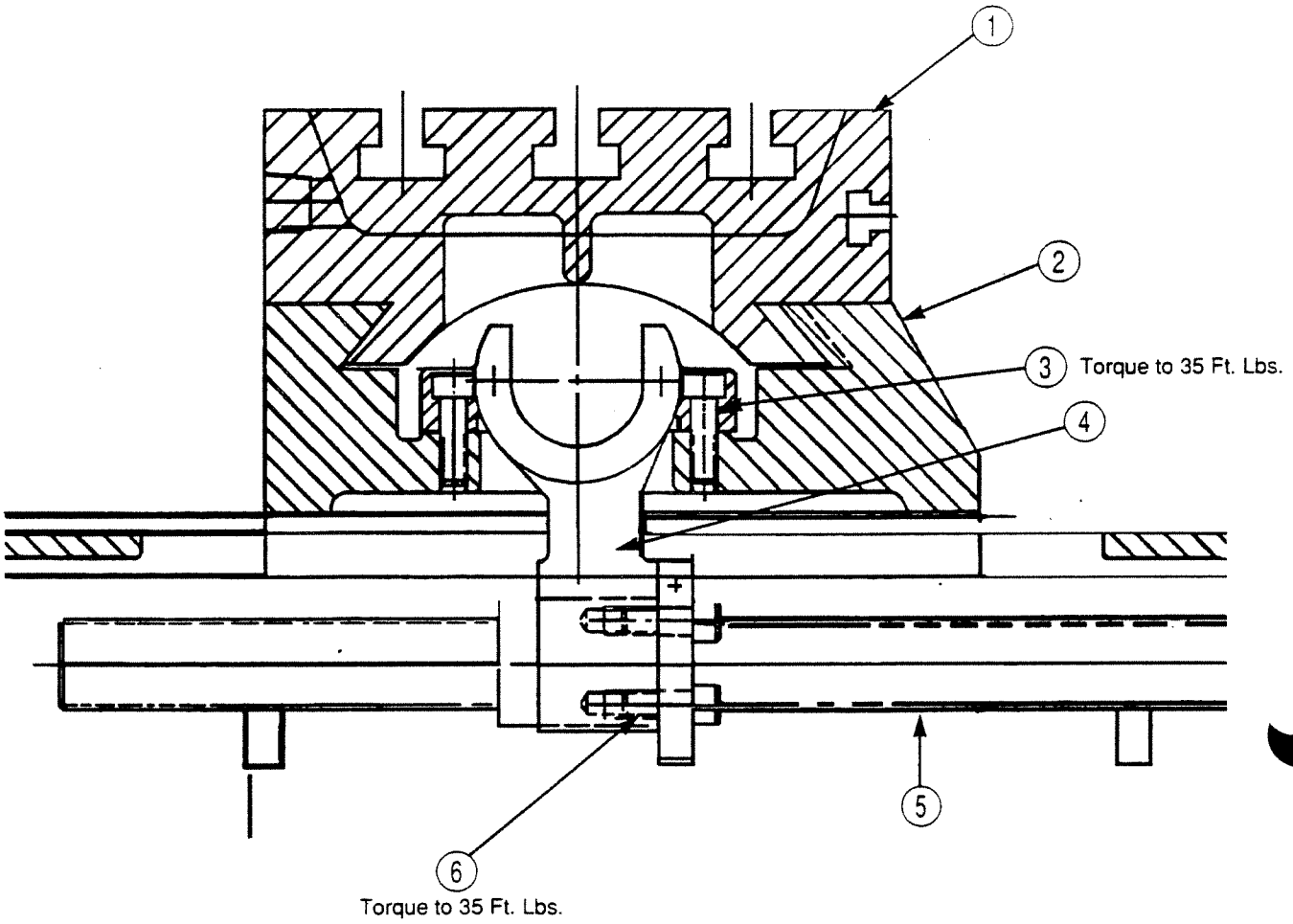

Torque Screws Evenly to 30 In. Lbs.
1
2
Torque to 9 Ft. Lbs.
3
4
5
6
7
8 Torque 50 Ft. Lbs.
9
10
11
MOTOR
12 Torque Screws Evenly to 30 In. Lbs.
13
14
15
16
17
18
19
20
40-T
20-T
3.1
6.2
Force 4-L
at Deflecti
0.098

ITEM	CODE NO.	DESCRIPTION	QTY.
1	11010210	S.H.C.S., #8-32 x 1.000 in.	4
	61705552	Washer, 4 mm, Plastic Nylite	4
2	24649915	Pulley Assembly (40-T)	1
3	11011030	S.H.C.S., 1/4-20 x 0.500 in.	3
4	12749003	Bracket	1
5	11011075	S.H.C.S., 3/8-16 x 1.250 in.	4
6	11060203	Bearing, FAFNIR RM 204-KT4	1
7	12746209	Ballscrew, X-Axis	1
	11011075	S.H.C.S., 3/8-16 x 1.250 in.	2
8	11151779	Locknut	1
9	12746126	Bearing Retainer	1
10	12746109	Pulley Spacer	1
11	21577911	Belt HTD 560-8M-20	1
12	11980227	S.H.C.S., #8-32 x 1.250 in.	4
	11191920	Lockwasher #8	4
13	12780491	Cover	2
	11665162	B.H.C.S., #10-32 x 0.375 in.	1
14	64649912	Pulley Assembly (20-T)	1
15	12746116	Bracket Cover	1
	11010543	Roll Pin, 3/16 x 1 in.	2
16	11011031	S.H.C.S., 1/4-20 x 0.625 in.	6
17	12746122	Adapter, Motor Counting	1
18	11010173	F.H.C.S., 5/16-24 x 0.625 in.	4
19	11665570	S.H.C.S., 5/16-18 x 0.750 in.	4
	11421984	Washer	4
20	11746111	Needle Bearing, Torrington M-1081	1


1
2
3
4
5
6
7
11
0.005 In. Fit
at Assembly
10
9
8
FOLD-A-WAY
HANDLE

ITEM	CODE NO.	DESCRIPTION	QTY.
1	12060347	48 in. Table	1
2	1260115	Bracket	1
3	11011074	S.H.C.S., 3/8-16 x 1.000 in.	4
4	11060204	Bearing, FAFNIR H 204K	1
5	12060214	Dial	1
6	12060078	Lock Nut	1
7	11011755	Jam Nut, 1/2-20 NF	1
	12150164	Flat Washer	1
8	12746140	Handwheel	1
9	11013078	Woodruff Key	1
10	12060084	Dial Holder	1
11	12746209	Ballscrew, X-Axis	1
	11011075	S.H.C.S., 3/8-16 x 1.250 in.	2

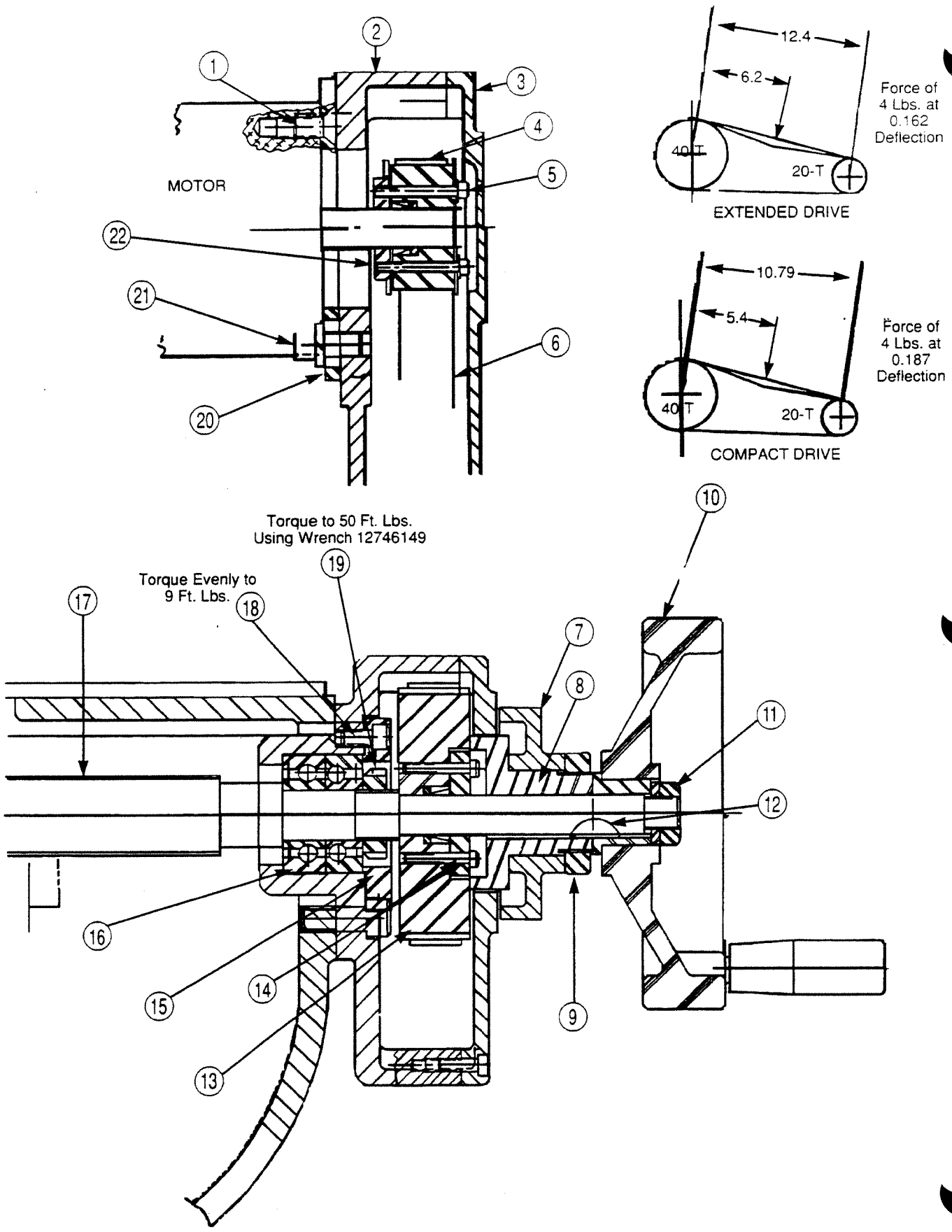
14. Parts Breakdown Ballscrew with Bridgeport Nut Block



14. Parts Breakdown Ballscrew with Bridgeport Nut Block

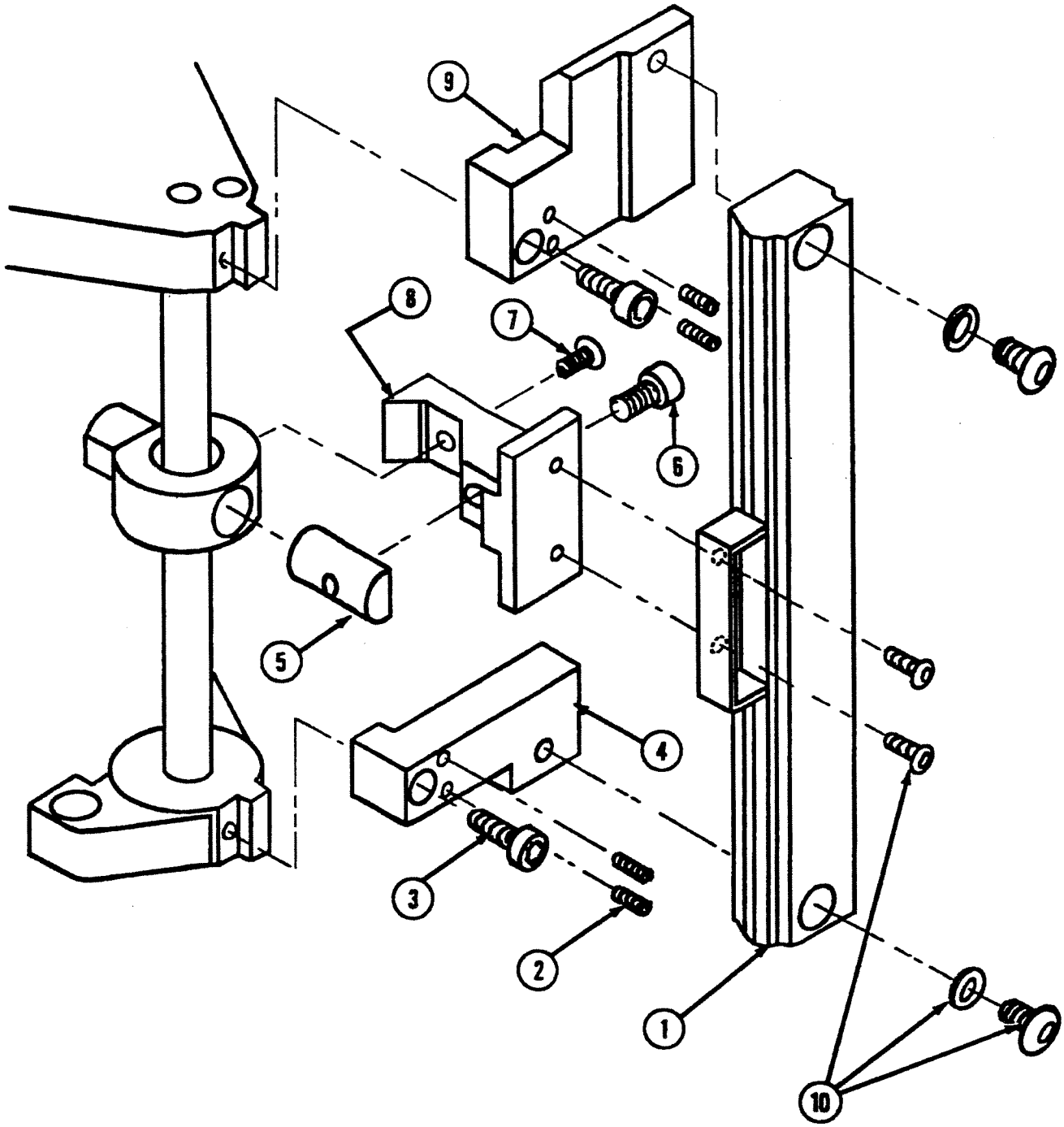
ITEM	CODE NO.	DESCRIPTION	QTY.
1	12060347	Table, 48 in.	1
2	12060487	Saddle	1
3	11011075	S.H.C.S., 3/8-16 x 1.250 in.	4
4	12749023	Nut Block (Bridgeport)	1
5	11746208	Ballscrew	1
6	11011074	S.H.C.S., 3/8-16 x 1.000 in.	3

14. Parts Breakdow Y-Axis Drive with Bridgeport Nut Block



14. Parts Breakdown Y-Axis Drive with Bridgeport Nut Block

ITEM	CODE NO.	DESCRIPTION	QTY.
1	1101073	F.H.C.S., 5/16-24 x 0.620 in.	4
2	12746205	Housing (Compact Drive)	1
	12746117	Housing (Extended Drive)	1
3	12746214	Cover (Compact Drive)	1
	12746118	Cover (Extended Drive)	1
4	64649912	Pulley Assembly (20-T)	1
5	11980227	S.H.C.S., #8-32 x 1.250 in.	4
	11191920	Lockwasher #8	4
6	21577910	Belt (Extended Drive) HTD 880-8M-20	1
	11601076	Belt (Compact Drive) HTD 800-8M-20	1
7	12060214	Dial	1
8	12746143	Dial Holder	1
9	12060078	Locknut	1
10	12746140	Handwheel	1
11	11011755	Jamnut, 1/2-20	1
12	11011078	Flat Washer	1
13	11665570	S.H.C.S., 5/16-18 x 0.750 in.	4
	11421984	Washer	4
14	11011011	S.H.C.S., #10-24 x 0.625 in.	6
15	24649915	Pulley Assembly (40-T)	1
16	11010210	S.H.C.S., #8-32 x 1.000 in.	4
	61705552	Washer, 4 mm, Plastic Nyltie	4
17	12746126	Bearing Retainer	1
18	11060203	Bearing	1
19	11746208	Ball Screw	1
20	11011030	S.H.C.S., 1/4-20 x 0.500 in.	4
21	11151779	Lock Nut	1
22	12746122	Adapter, Motor Mounting	1
	11010543	Rollpin, 3/16 x 1.000 in.	2


9
8
7
6
5
4
3
2
1
10

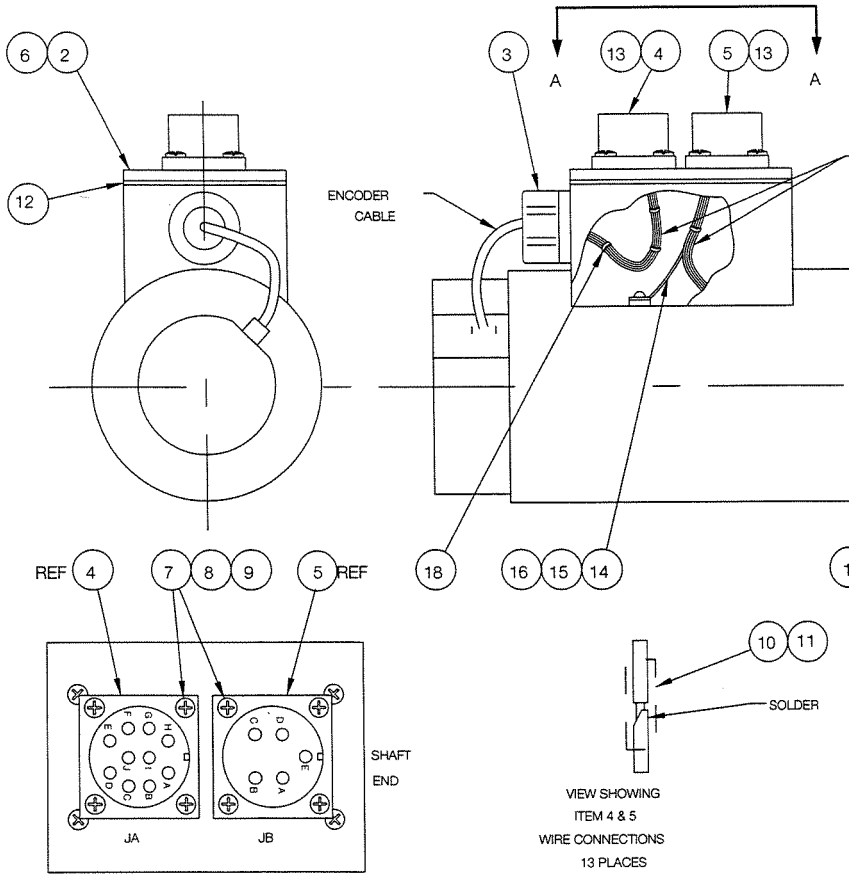
ITEM	CODE NO.	DESCRIPTION	QTY.
1	11813104	Scale, Z-Axis (.0005" Resolution)	1
	11819050	Scale, Z-Axis (.00025" Resolution)	1
2	385026-105	S.H.S.S. #6-32 x 0.500 in.	4
3	385026-104	S.H.C.S., #10-32 x 0.750 in.	2
4	385026-101	Bracket, Lower	1
5	385011-153	Pin	1
6	385001-372	S.H.C.S., 1/4-20 x 1.000 in.	1
7	385026-103	B.H.C.S., #10-32 x 0.625 in.	1
8	385026-100	Bracket, Reading Head	1
9	385026-102	Bracket, Upper	1
10	383106-351	Hardware Kit (supplied with scale)	AR

ITEM	CODE NO.	DESCRIPTION	QTY.
1	31943721	Encoder and Motor Assembly*	1
2	31937757	Motor Cable Cover Plate	1
3	31504221	Conn Str. .500", .125-.250	1
4	31500331	Conn. Rcpt Box Mtg 10P	1
5	31501245	Conn., Rcpt Box Mtg	1
6	31938894	Screw Flat Head Modified	4
7	31506401	Scr, PHP, #4-40x3/8	8
8	31506556	Washer, Flt #4	8
9	31506588	Washer Lock Splt #4	8
10	31541747	Tubing Ht Shrink 1/16" ID	.5 ft.
11	31541549	Tubing Ht Shrink, 3/32" ID	.33 ft.
12	31938302	Gasket, Top 1/16" Thick NPRN	1
13	31505104	Gasket, Plain, 10-40450-18	2
14	31505179	Wire 16 awg, Green/Yellow	1 ft.
15	31500531	Term-Ring, PIDG, 22/16 #10	1
16	31506581	Washer, Lock Type A No. 8	1
17	31542725	Label	1
18	31500583	Tie Cable 4"	6

*31943721 Encoder and Motor Assembly:

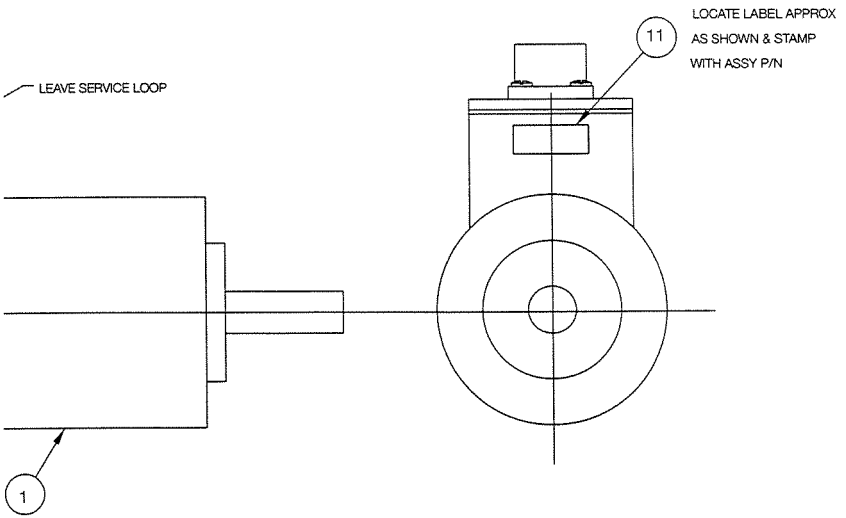
31542636 Motor
31542716 Encoder

14. Parts Breakdown



VIEW A-A

1 CUT THE WHITE, YELLOW, BLUE AND PURPLE WIRES OFF AND SHRINK TUBE BACK USING ITEM 11.
CAUTION: DO NOT SHORT LEADS TOGETHER.

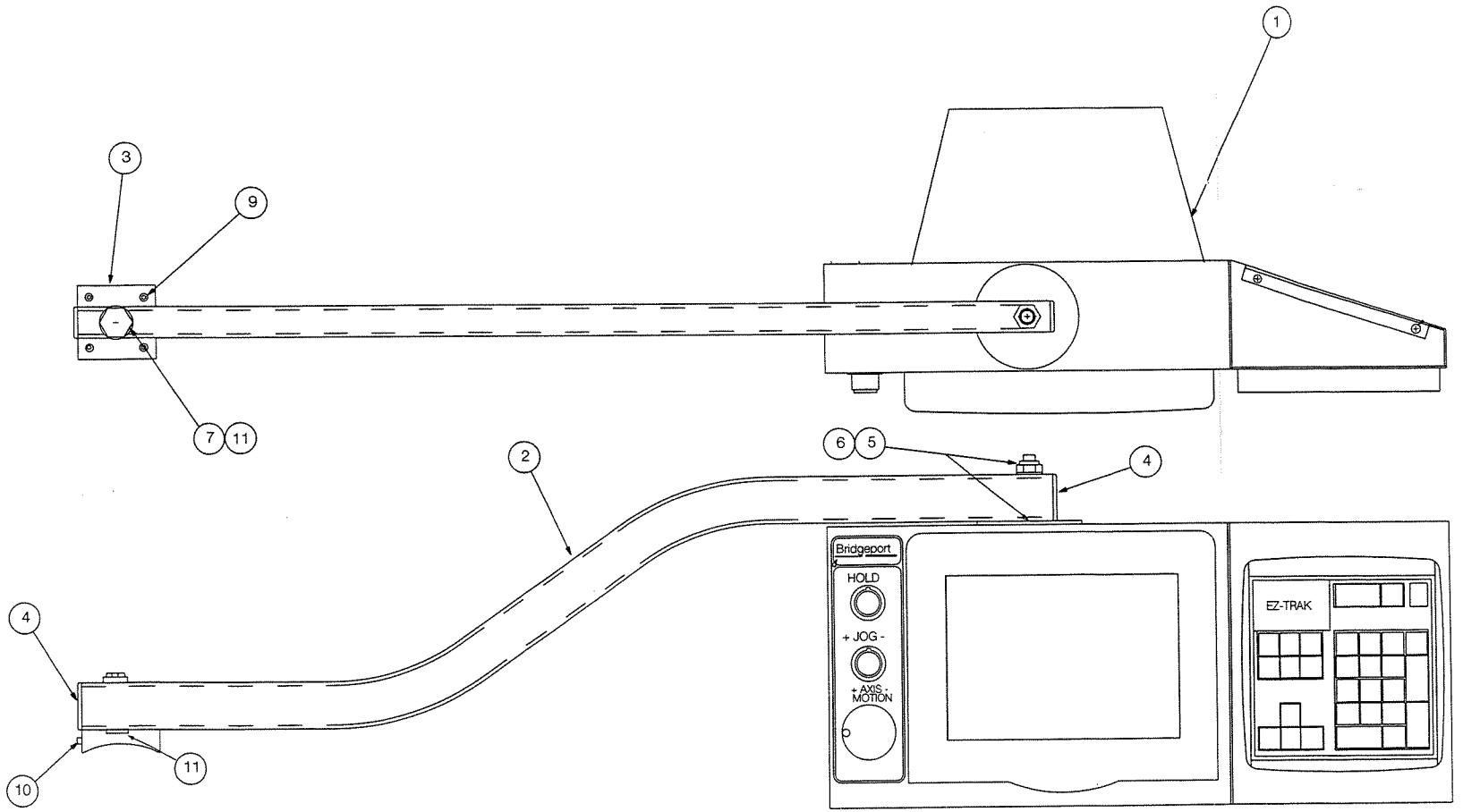


ARMATURE CONNECTIONS		
WIRE AWG	FROM	TO
BLK-18AWG	ARM +	JB-A
RED-18AWG	ARM -	JB-B
BLK-20AWG	TACH +	JB-C
RED-20AWG	TACH -	JB-D
GRN-16AWG	GND	JB-E

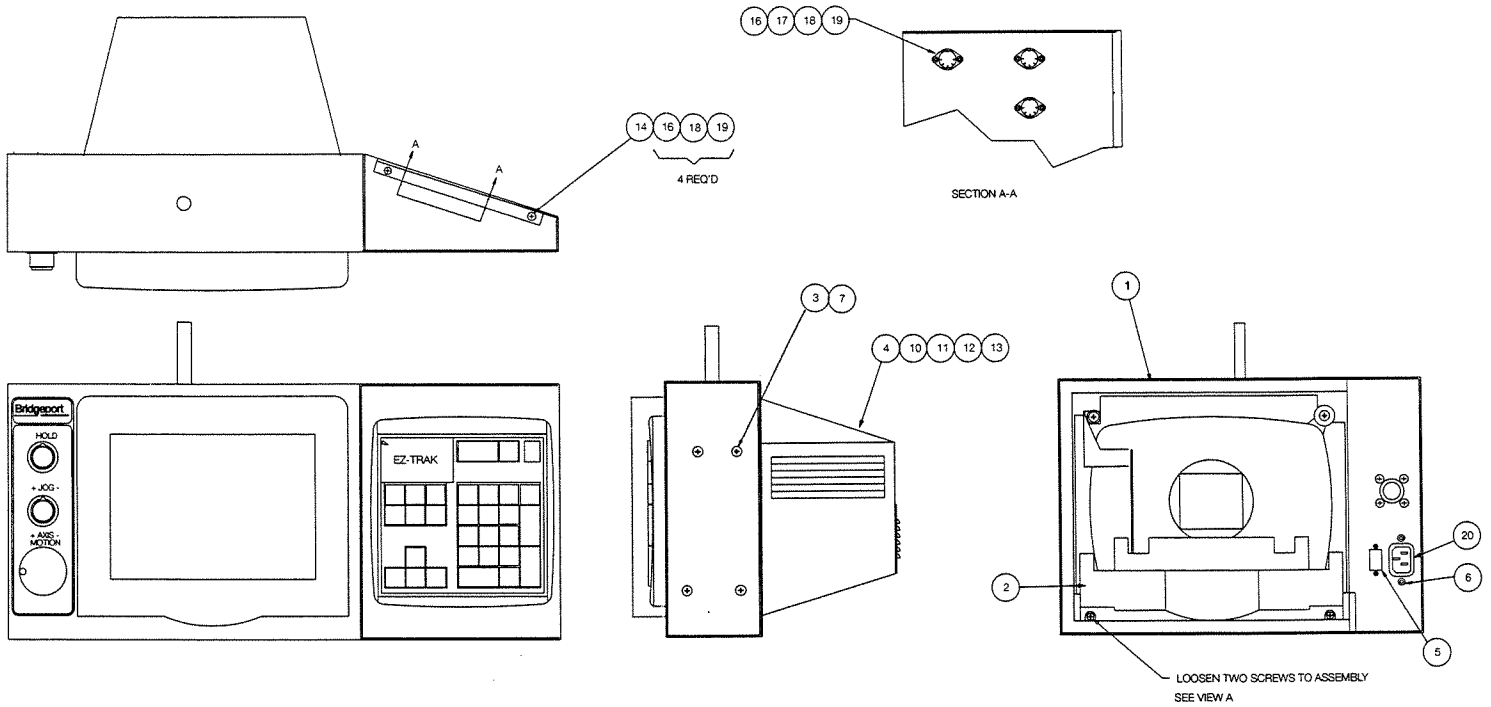
EZ-Trak
Motor Assembly (Z Axis)
(Drawing No. 1944165)

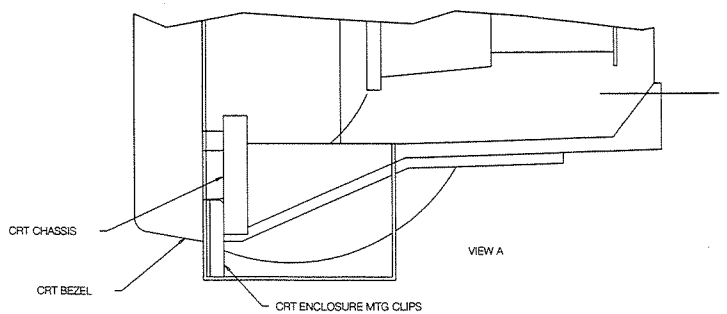
ITEM	CODE NO.	DESCRIPTION	QTY.
1	31542636	Motor DC Servo, MT30H4-44	1
2	31501245	Conn., Rcpt, Box Mtg, 5P	1
3	31505104	Gasket	1
4	31944166	Cover Plate, Motor Box	1
5	31505179	Wire, 16 AWG, Green/Yellow	1 ft
6	31500531	Term-Ring PIDG, 22/16 #10	1
7	31506556	Washer, Flt #4	4
8	31506588	Washer, Lk, Split #4	4
9	31506401	Scr, PHP, #4-40 x 3/8" lg	4
10	31541549	Tubing, Heat Shrink 3/32" ID	.34 ft
11	31542725	Label	1
12	31500583	Tie, Cable 4"	3
13	31506581	Washer, Lock, Int Tooth #10	1
14	11014001	SSS, M10 x 1.0 x 10 mm, Cup Pt	1
15	11665280	Loctite #222	0

ITEM	CODE NO.	DESCRIPTION	QTY.
1	31942884	CRT Enclosure Assy.	1
2	31942838	Arm Weldment	1
3	31942897	Mtg. Block Arm	1
4	31542542	Plug Rect. Cap 1 x 1 1/2	2
5	31542557	Lock Nut Elastic Standard	1
6	11151913	Washer .375 x .81 x .06	2
7	11011174	Bolt .625-11 x 3 " Hex Hd	1
8	Not Used		
9	11721226	SSS, .250-20x .500, Oval Pt.	4
10	11011219	SSS, #10-32 x .500", Cup Pt.	1
11	12150468	Washer, Turret Clamp Bolt	2



EZ-Trak
Arm and CRT Assy.
(Ref. Dwg. No. 1942940)

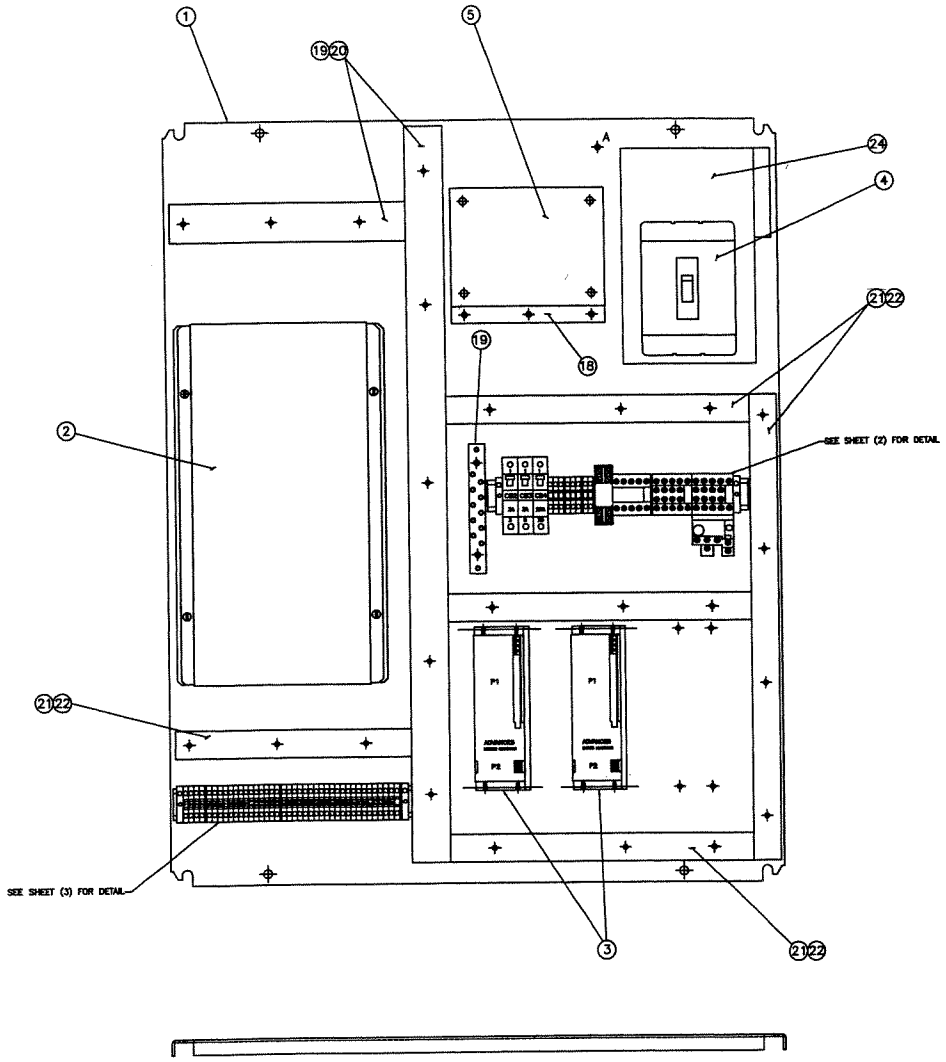




EZ-Trak Series I
CRT Enclosure Assy.
(Dwg. No. 31942884 Rev. C)

ITEM	CODE NO.	DESCRIPTION	QTY.
1	31942881	Front Panel Assy.	1
2	31942883	Monitor Assy.	1
3	31942882	Keypad Assy.	1
4	31942936	Back Cover Assy.	1
5	31540217	Connector, El. Jack Socket	2
6	31500245	Pop Rivet	2
7	31541113	Fastener, Screw Thd Form	4
10	31505517	BHCS #6-32 x .500" lg	8
11	31506616	Washer, Flat #6 Plain CS	8
12	31507217	Washer, Loc-Spr Med Ser #6	8
13	31502413	Gasket, Weather Strip	4
14	31943039	Keypad Cover Assy.	1
16	31505528	Scr, BHC, #4-40x3/8	6
17	31506533	Nut, Plain Hex Size 4-40	6
18	31507207	Washer, Flat, Plain Carbon	6
19	31507216	Washer, Loc-Spr Med Series	10
20	31542535	Receptacle AC Male 6 amp	1

THIS PAGE INTENTIONALLY LEFT BLANK



HOLE CHART

LETTER	HOLE	REMARKS	QTY
A	.250 +.003 -.000 ø	SS-M5-2-ZI PEM NUT	8
B	.344 +.003 -.000 ø	S-M6-2-ZI PEM NUT	8
C	.437ø	EXISTING PANEL HOLES	4
D	.136ø	RIVET HOLES FOR DINRAIL	6
E	.213 +.003 -.000 ø	S-M4-2-ZI PEM NUT	38

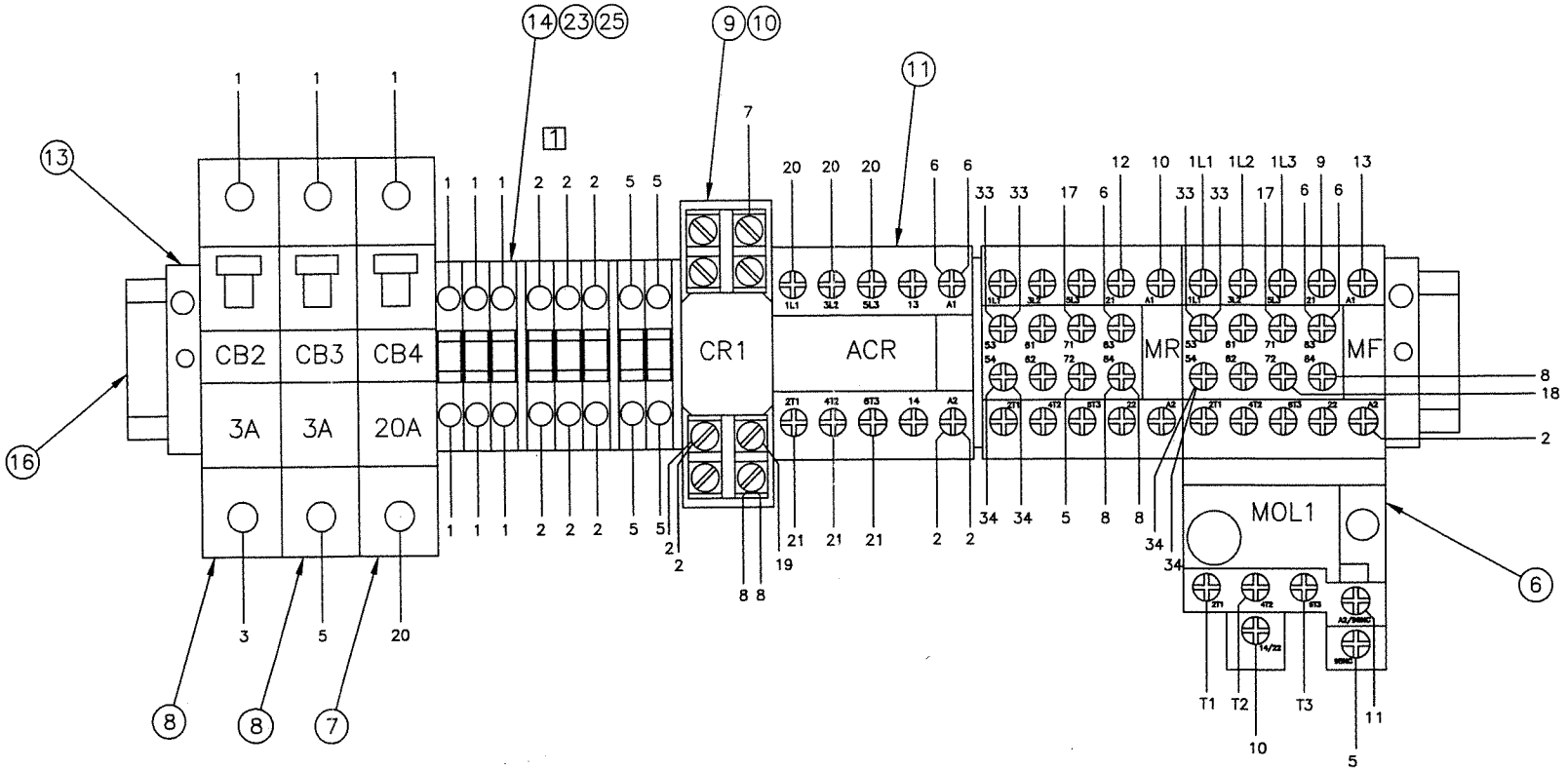
ITEM	PART #	DESCRIPTION	QTY	U/M
31				
30				
29				
28				
27				
26				
25				
24	11598897	KIT, FLANGE HANDLE/OPERATING MECH	1	EA
23	31508860	TERMINAL BLOCK PARTITION	8	EA
22	31541773	COVER, WIREWAY, 1" WIDE	1	EA
21	11598868	WIREWAY, 1" WIDE X 3" HIGH	1	EA
20	11597388	COVER, WIREWAY, 1.5" WIDE	1	EA
19	11598867	WIREWAY, 1.5" WIDE X 3" HIGH	1	EA
18	11598895	BAR, TRANSFORMER SUPPORT	1	EA
17	11598835	GROUND BAR KIT, BRASS	1	EA
16	11598411	DIN RAIL, 11.75" LONG, 35mm	1	EA
15	11598868	HARNESS, INTERNAL	1	EA
14	31508130	TERMINAL BLOCK, M4/8, 10-22 AWG	48	EA
13	31541663	END CLAMP, DIN RAIL	4	EA
12	11598409	DIN RAIL, 10.75" LONG, 35mm	1	EA
11	11598797	CONTACTOR ASSY, SERVO AMP POWER	1	EA
10	11598883	SOCKET, RELAY	1	EA
9	11598882	RELAY, 2 POLE	1	EA
8	11598896	CIRCUIT BREAKER, 3 AMP, 1 POLE	1	EA
7	11598894	CIRCUIT BREAKER, 20 AMP, 1 POLE	1	EA
6	11598891	CONTACTOR/OVERLOAD ASSY, MOTOR REV	1	EA
5	11598487	TRANSFORMER	1	EA
4	11598893	CIRCUIT BREAKER, MAIN	1	EA
3	11598892	DRIVE, MOTOR	2	EA
2	11598898	LOGIC CONTROL UNIT	1	EA
1	11598858	ENCLOSURE, WITH PANEL	1	REF

Bridgeport
BRIDGEPORT MACHINES, INC.

TITLE: EQUIPMENT PANEL ASSY
EZ-TRAK

SIZE	FSCM NO.	DWG. NO.	REV.
D	05607	59-8896	01

SCALE NONE | RELEASE DATE 12-10-99 | SHEET 1 OF 3

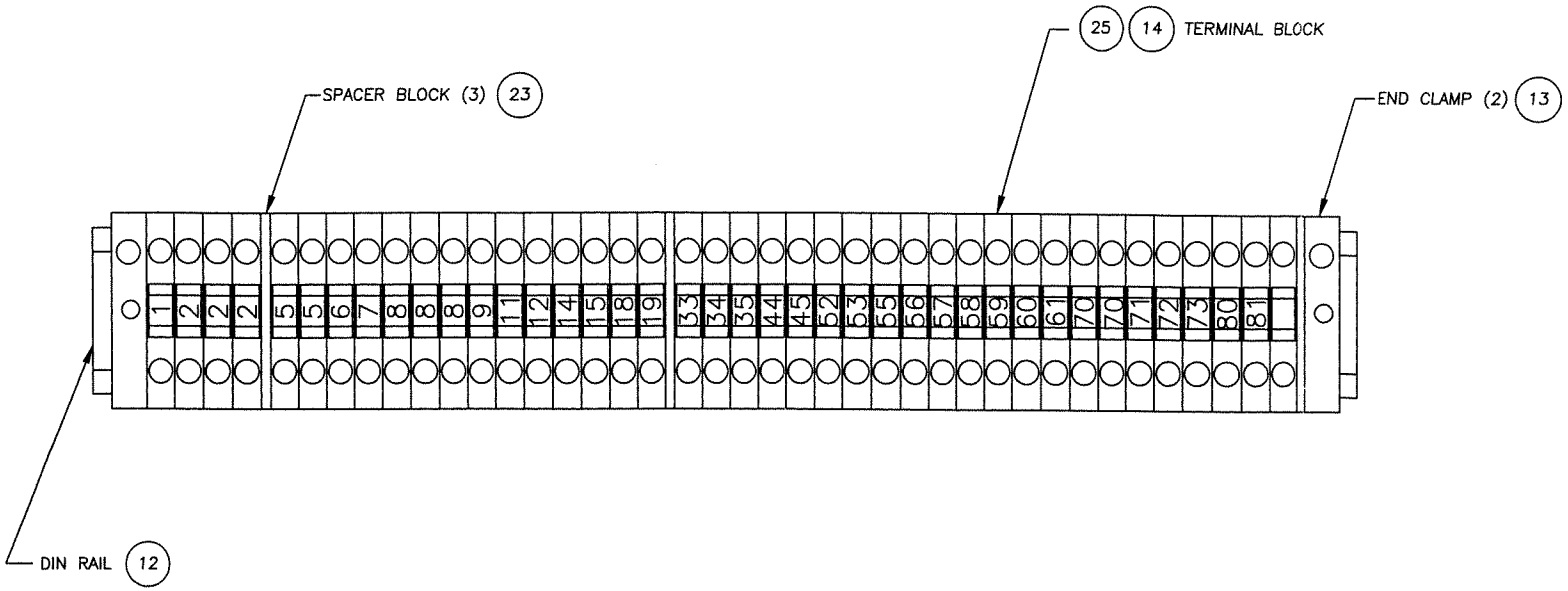


NOTES:

1.) [1] ELECTRICALLY STRAP COMMON TERMINALS TOGETHER

2.) REMOVE TERMINAL A2 FROM INPUT SIDE OF MOL1

EZTRAK SERIES I & II
TB1 WIRE ROUTING
Dwg. 59-8896 Rev. 01
Sheet 2 of 3



[1] ELECTRICALLY STRAP COMMON TERMINALS TOGETHER
NOTES:

EZTRAK SERIES I & II
TB1 WIRE ROUTING
Dwg. 59-8896 Rev. 01
Sheet 3 of 3

APPENDIX A - Static Sensitive Equipment

A.1 STATIC SENSITIVE MATERIALS

This is to notify the appropriate personnel of the potential damage static electricity can cause to delicate electronic components and to outline guidelines to be followed when handling these electric components or assemblies.

Static damage of components by operating personnel is becoming a significant problem plaguing the electronics industry. Technological advances in IC manufacture make possible devices with greater circuit densities, higher unit performance and quite often, higher static susceptibility. Fortunately, the problems associated with static charges in the electronics environment can be controlled.

The following are some general guidelines to follow during assembly or handling of static sensitive devices or assemblies.

A.2 GENERAL GUIDELINES

1. Since August, 1981, all printed circuit boards, or assemblies containing static sensitive devices have been **IDENTIFIED** by this label.

2. All assembly operations involving static sensitive devices must be performed at a specially grounded work station.

3. The technician must be grounded by use of the wrist strap when working at this station.

4. All electrical assembly equipment, such as soldering iron, should be grounded.

5. Avoid handling static sensitive devices except when absolutely necessary.

6. Under no circumstances should the static sensitive devices or assemblies containing static sensitive devices be allowed to come in direct contact with plastics (polyethylene bags, styrofoam, styrene boxes, plexiglass, etc.).

It is necessary for all field personnel to follow proper static prevention procedures when servicing Bridgeport equipment containing static sensitive assemblies. The following is a recommended procedure to follow when removing/replacing a printed circuit board containing devices from the card rack.

A.2.1 Equipment Required

1. Portable static-free work station kit containing floormat, grounding wire and wrist strap.

2. Protective connector shunt for printed circuit board, 3M Co. 5020.

3. Protective shipping/handling bag Part No. 3M Co. 2004.

A.2.2 Procedure

1. Place a floor mat in front of the cabinet and connect ground wire to an appropriate earth ground. Check to make sure wrist strap is secure.

2. Stand on the mat and place a wrist strap on your wrist.

3. Carefully remove the printed circuit board from the unit.

4. Place the PC board in a protective shipping/handling bag.

A.3 VENDOR INFORMATION FOR STATIC PROTECTION EQUIPMENT

1. Work station kits:

   a. 3M portable field service kit - 8005
      (Recommended for light duty).

   b. 3M Velostat floor mat - 1864
      3M static control Wrist strap - 2064

   (Recommended for heavy use).

2. Velostat PC board edge protector - 5200

3. Velostat shipping/handling PC board protective bag - 204

All equipment available from:

3M Static Control System
223-2 Southwest 3M Center
St. Paul, MN 55101
(612) 733-9420

APPENDIX B. Safeguard Installation

R-8 SPINDLE GUARD
Code No. 1119-1200
(SHOWN)

EZTRAK
Code No. 1106-0813

PAT. 4,484,845

(See Page B-4 for item number reference.)

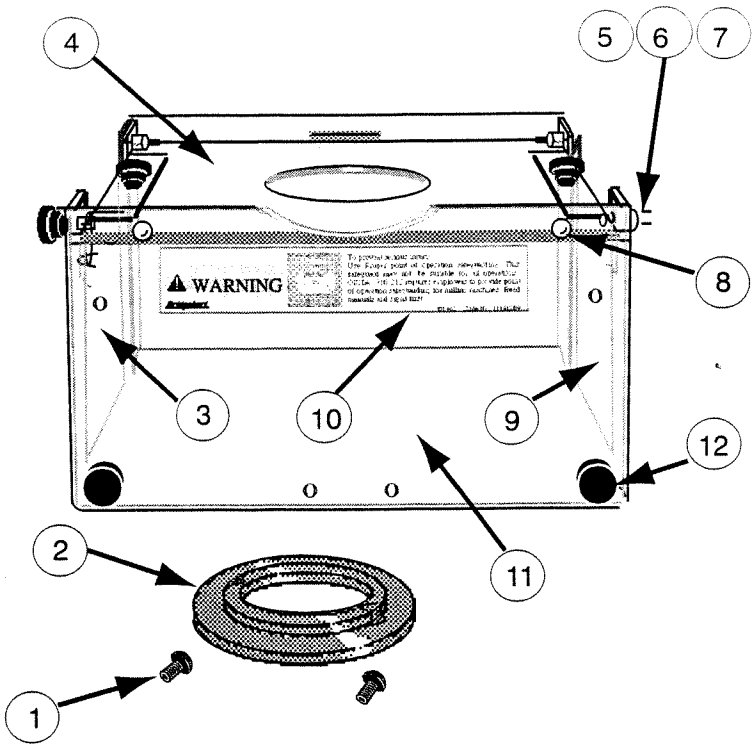


Figure B-1. New Machine With R-8 Spindle Taper

B.1 BRIDGEPORT GENERAL PURPOSE SAFEGUARD

To prevent serious injury resulting from the rotating cutter, flying chips, or splashing coolant, point of operation safeguarding should be used on Bridgeport milling machines to the greatest extent practicable.

Both American National Standard B11.8 and OSHA Section 1910.212 assign responsibility for point of operation safeguarding of milling machines to the user/employer. To assist you in meeting your responsibility, Bridgeport provides a General Purpose Safeguard for use on the Bridgeport Series I EZTRAK milling machine.

There is no single safeguard which can match the versatility of the Series I EZTRAK machine. As a result, you will find that the Bridgeport General Purpose Safeguard, like all safeguards, will be suitable for some operations, but not for others. Carefully analyze the operation to be performed before deciding whether this safeguard is suitable. Adjust the safeguard to suit your special requirements. If you find that it is not suitable for a particular application, you should use an alternate form of protection.

This section provides basic information for the installation and use of the Bridgeport General Purpose Safeguard. It also contains the names of several manufacturers of other types of point of operation safeguarding for vertical milling machines. You should refer to the **Safety Manual for Bridgeport Milling Machines** for additional information on selecting safeguarding.

Remember, point of operation safeguarding is **your** responsibility as the employer/user. **You** are in the best position to evaluate your safeguarding needs and

ensure that the proper safeguards are installed and used. We hope that this information will help you in that effort.

NEW MACHINES WITH R-8 SPINDLE TAPER

(1) Place the mounting ring underneath the top of the guard.

(2) Place the two socket head cap screws through the holes in the ring, and hand-start them into the htreaded holes in the nose cap until hand tight.

(3) Align the guard to be square with the table of the machine (unless angular mounting is desired).

(4) Tighten the cap screws with a 3/16 inch Allen wrench.

ERICKSON #30 AND UNIVERSAL #200 QUICK CHANGE SPINDLE GUARD
Code No. 1190341
(SHOWN)

EZTRAK
Code No. 1106-0814

PAT. 4,484,845

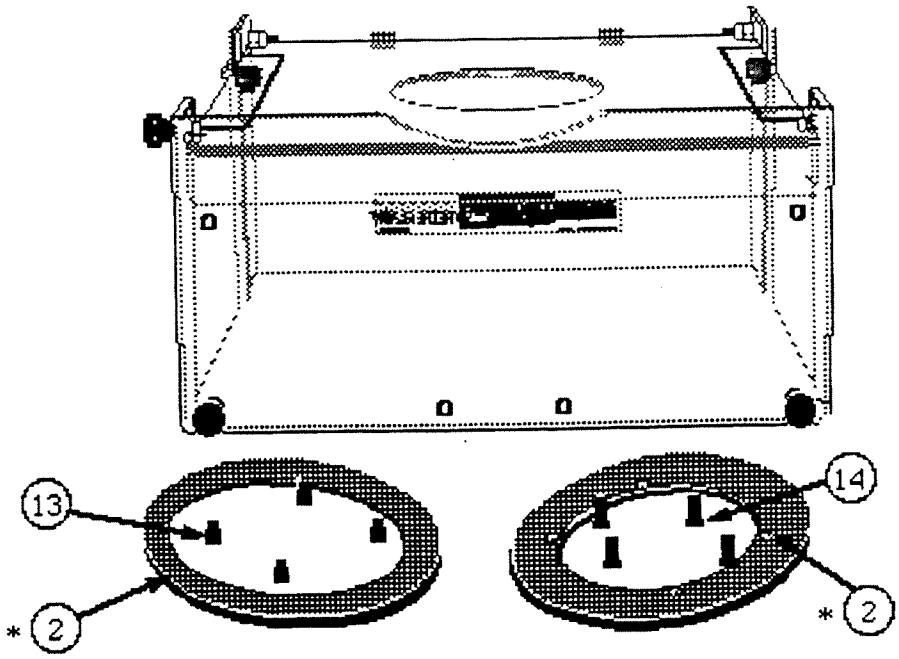


Figure B-2. New Machines With Erickson #30 Quick Change or Universal #200 Quick Change Spindles

B.2.2 Erickson #30 Quick Change or Universal #200 Quick Change Spindle (Figure B-2).

NOTE

If the nose cap mounting ring has been installed, omit steps 1, 2 and 6.

1. Remove the spindle locknut. This is done by removing the long socket button head black finish screw, which is normally left of the cadmium-finished button head screw on the locknut of the spindle. This will allow you to unscrew the locknut by turning it counter-clockwise.

NOTE

The counterbored side of the nosecap mounting ring fits against the nose cap.

2. Place the nose cap mounting ring up against the quill nose cap and install the (4) 8-32 x3/8 inch long button head cap screws.
3. Lower the quill. Place the clamping ring underneath the top of the guard and position the guard under the spindle.
4. Install the (4) 8-32x 3/8 inch long socket head cap screws through the nose cap mounting ring and thread them into the clamping ring.
5. Align the front of the guard parallel to the front of the table. Tighten the (4) 8-32 screws clamping the guard in position.
6. Reinstall the quick change locknut. Refer to assembly instructions.

B.3 UNIVERSAL #200 QUICK CHANGE SPINDLE

The quick change locknut is not removed. To install the spindle safeguard, do the following steps listed above: (2), (3), (4), and (5).

WARNING

This safeguard does not take the place of any other safety practice or safety equipment.

(1) You must always wear safety glasses and safety shoes.

(2) You must always stop the spindle of the machine completely before changing or adjusting the workpiece, fixture or tool.

(3) You must never wear gloves, long sleeves, long hair, rings, watches, neckties, jewelry or other loose items.

B.4 PARTS BREAKDOWN

ITEM	CODE NO.	DESCRIPTION	QTY.
1	11011031	S.H.C.S., 0.250-20 X 0.625 IN.	2
2*	12191201	Ring, Guard	1
2**	12190330	Ring, Guard	1
2**	12190331	Ring, Guard	1
3	11191204	Shield, Left Side	1
4*	11191206	Shield Assy., Top	1
4**	11191207	Shield Assy., Top	1
5	11665810	B.H.C.S., 10-32 x 0.750 in.	3
6	11010065	Washer, Plastic 10-32	8
7	11010055	Nut, Stop 10-32 Plastic	3
8	11010063	Screw, Drive 12 x 0.625 in. Type U	2
9	11191205	Shield, Right Side	1
10	11191203	Shield Assy., Rear	1
11	11191202	Shield Assy., Front	1
12	11010056	Handscrew, 10-32 x 0.750 in.	4
13**	11651199	B.H.C.S., 8-32 x 0.500 in.	4
14**	11980224	S.H.C.S., 8-32 x 0.625 in.	4

NOTE

* For R-8 (11191200) (only)

** For Quick Change (11190341) (only)

INDEX

NOTES