INSTALLATION, OPERATION, MAINTENANCE

AND

REPAIR PARTS LIST

FOR

TWIN MILL

NICHOLS

W. H. NICHOLS COMPANY

48 Woerd Avenue, Waltham, Massachusetts 02154 U. S. A.

WARRANTY

W. H. Nichols Co. warrants all milling machine parts of its own manufacture to be free from defects in material or workmanship for a period of twelve months after date of original shipment. Expendable parts such as tooling, attachments, drive belts, bearings, and electrical contactors are excluded from this guarantee as are components such as electric and air motors, the Hydro-Check, coolant systems, and other items which are subject to the warranty of their own manufacturer.

Warranty credits will be granted only when defective parts are returned, inspected, and determined to be defective by W. H. Nichols Co. at its plant in Waltham, Massachusetts. W. H. Nichols Co. reserves all rights relative to disposition of defective parts.

Damage to the milling machine resulting from accident, fire and other casualty, misuse, negligence, or failure to provide proper lubrication is not covered by this warranty.

Neither W. H. Nichols Co. nor any of its representatives assume any responsibility for any loss of use of their machines, loss of time, inconvenience, commercial loss or consequential damages.

This warranty is in lieu of any other warranty expressed or implied by any other person or persons.

SAFETY

It is assumed that the User's Safety Department will have an extablished program of safety based on a thorough analysis of industrial hazards and in keeping with OSHA regulations and standards. Before installing, operating, or performing maintenance on the machinery described in this instruction book, it is suggested that the user review this safety program to be certain that it covers the hazards arising from heavy rotating, cutting, and reciprocating machinery.

It is also important that due consideration be given to those hazards which arise from the presence of electrical power, hot oil, pneumatic pressure, and flammable liquids. Proper installation and care of protective guards and emergency shut-down devices is an essential part of any safety program. Also essential are special precautionary measures to prevent the possibility of applying electrical or pneumatic power to the machine during the time maintenance work is in progress. In general, the user should be guided by all basic safety rules associated with heavy industrial equipment and with the required work process.

WARNING

Failure to understand operating or set-up sections of this manual may lead to bodily injury or damage to the machine.

TABLE OF CONTENTS

		Page No.
CHAPTER 1 - GENERAL INFORMATION ..		1-1
1-1.	Introduction	1-1
1-3.	Scope	1-1
1-5.	Equipment Description	1-2
1-6.	General	1-2
1-7.	Column, Saddle, and Knees ...	1-2
1-10.	Table	1-2
1-11.	Milling Heads	1-3
1-12.	Drives	1-3
1-13.	Special Options	1-3
1-14.	High Speed Ranges	1-3
1-15.	Special Power Options ..	1-3
1-16.	Automatic Transverse Feed ..	1-3
1-17.	Automatic Retraction ...	1-3
1-18.	Double Cycle on Skip Check ..	1-3
1-19.	Accessories	1-3
CHAPTER 2 - INSTALLATION		2-1
2-1.	General	2-1
2-3.	Shipment	2-1
2-5.	Site Selection	2-1
2-7.	Machine Handling	2-1
2-11.	Initial Set-up	2-1
2-14.	Electrical Connections	2-3
2-17.	Pneumatic Connections	2-3
CHAPTER 3 - OPERATION		3-1
3-1.	Safety Precautions	3-1
3-3.	General	3-1
3-5.	Table Cycle	3-1
3-6.	Head Retraction	3-2
3-7.	Double Cycle	3-3
3-8.	Controls and Indicators	3-3
3-10.	Machine Set-up	3-3
3-11.	Spindle and Drive	3-3
3-13.	Table Set-up	3-3
3-14.	Feed Stroke Starting Point	3-3
3-15.	Feed Stroke End Point	3-6
3-16.	Table Operation Check .	3-6
3-17.	Table Rapid Traverse Speed Adjustment	3-6
3-18.	Retraction Set-up	3-6
3-19.	Double Cycle	3-6
3-20.	Skip Check	3-6
CHAPTER 4— MAINTENANCE		4-1
4-1.	Introduction	4-1
4-3.	Scheduled Maintenance	4-1
4-4.	Cleaning	4-1
4-5.	Inspection	4-1
4-6.	Lubrication	4-1
4-11.	Parts Replacement	4-1
4-12.	Spindle Bearing Replacement ..	4-3
4-13.	Bearing Removal	4-3
4-14.	Bearing Installation	4-3
4-15.	Troubleshooting	4-4
CHAPTER 5 - REPAIR PARTS LIST		5-1
5-1.	Introduction	5-1
5-3.	Ordering Parts	5-1

LIST OF ILLUSTRATIONS

Fig. No.	Title	Page No.
1-1.	Nichols Twin Mill	1-1
2-1.	Outline Dimensions	2-2
3-1.	Air Motor and Control	3-1
3-2.	Hydro-Check	3-2
3-3.	Cutter Retraction	3-2
3-4.	Controls and Indicators	3-4
3-5.	Head Train, Plan View	3-5
4-1.	Lubrication Diagram	4-2
4-2.	Lubricator Adjustment	4-2
4-3.	Wiring Diagram - Spindle Control	4-6
4-4.	Wiring Diagram - Standard Feed	4-6
4-5.	Wiring Diagram - Double Cycle	4-7
4-6.	Wiring Diagram - Retraction	4-8
5-1.	Assembly Location Diagram	5-1
5-2.	Spindle and Outboard Arbor Support ..	5-3
5-3.	Primary and Intermediate Shafts	5-5
5-4.	Saddle and Coolant System	5-7
5-5.	Knee	5-9
5-6.	Table-Rear	5-11
5-7.	Table-Front	5-13
5-8.	Automatic Way Lubrication	5-15
5-9.	Cutter Retraction	5-17
5-10.	Transverse Pneumatic Feed	5-19

LIST OF TABLES

Table No.	Title	Page No.	Table No.	Title	Page No.
1-1	General Specifications	1-2	4-1	Troubleshooting	4-4
3-1	Controls and Indicators	3-5			

CHAPTER 1
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This manual contains descriptive data, installation instructions, operating procedures, maintenance suggestions, and replacement parts information for the Twin Mill manufactured by W. H. Nichols Company, 48 Woerd Avenue, Waltham, Massachusetts 02154. Information contained in this manual pertains to W. H. Nichols Company Models:

No. 41-51205-0001-2	30 In. Table, Standard Feed
No. 41-51205-0002-2	36 In. Table, Standard Feed
No. 41-51205-0003-2	30 In. Table, Retraction
No. 41-51205-0004-2	36 In. Table, Retraction
No. 41-51205-0005-2	30 In. Table, Rough & Finish
No. 41-51205-0006-2	36 In. Table, Rough & Finish

1-3. SCOPE

1-4. This manual is divided into the following five Chapters:

1. General Information
2. Installation
3. Operation
4. Maintenance
5. Replacement Parts

Data presented is intended to provide a guide-line to users. Individual installation requirements operating procedures, and maintenance practices must take precedence over data prescribed herein.

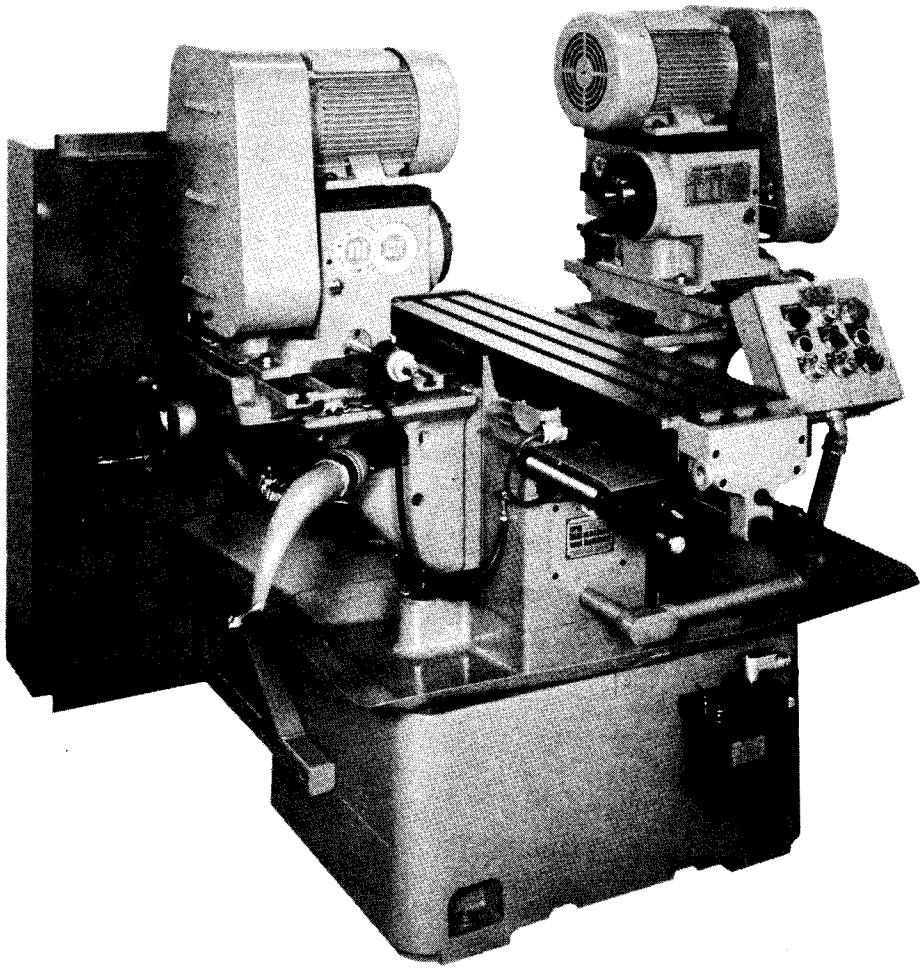


Figure 1-1. Nichols Twin Mill

1-5. EQUIPMENT DESCRIPTION

1-6. GENERAL. The Nichols Twin Mill is one of the foremost small precision milling machines available to industry. While affording the advantage of milling two surfaces simultaneously, the machine provides an unequalled degree of accuracy and speed of adjustment necessary to accommodate a wide variety of light-duty milling operations. Twin geared milling heads (completely independent units) are adjustable in seconds (vertically, transversely, or longitudinally) by means of micrometer screws, and a standard range of 15 different speeds is available for each head from 55 to 2,050 RPM (higher speeds are available on special order) for the milling of materials ranging from tool steel to soft plastics. Specifications for the Twin Mill are provided in Table 1-1.

1-7. COLUMN, SADDLE, AND KNEES. The twin mill column is of heavy, box-type construction with vertical ways for the knee dovetails cast into it. Heavy ribs behind the ways keep them straight and parallel and resist thrust loads imposed during milling operations. A chrome-plated dovetail guideway for the table is provided on top of the column, and control units for table motions are mounted inside of the column.

1-8. Saddles are heavy ribbed castings that provide large mounting areas for the milling heads. Dovetail ways are long, wide, hand-scraped, and fitted with heavy gibs.

1-9. Knees are also heavy, box-type castings with long, wide dovetail ways in order to provide support for the saddles and heads when in any position. Elevating screws, with bolt through bearings, provide for simple precise adjustment by means of micrometer dials. Provision is made within the knees for installation of an air-actuated, automatic, spindle-head retraction mechanisms if this option is desired.

1-10. TABLE. The table is a heavy casting, ribbed for stiffness, with three 11/16-inch standard "T" slots for 5/8-inch "T" bolts or 1/2-inch "T" nuts. The table travels on a long dovetail guide block which is hand-scraped and chrome-plated before it is bolted and doweled to the top of the machine column. Two flat guideways on the underside of the table are also chrome-plated in order to keep wear to a minimum and prolong accuracy. A Bijur system automatically lubricates the table ways. An automatic, pneumatic, table drive is push-button controlled and furnished with limit switches and adjustable trips to govern motion. Cutting feed is infinitely variable

Table 1-1. GENERAL SPECIFICATIONS

Table Working Surface, Standard	10 x 30 inches
Table Working Surface, Special	10 x 36 inches
Spindle Noses Bored	No. 40 American Standard Taper
Spindle Hole Diameter	1 inch
Spindle Diameter in Bearings	2 inches
Feed, Infinitely Variable	0- 50 inches/min
Rapid Traverse	300 inches/min
Air Pressure Required	75-120 psig
Height of Spindle Center Lines above Table	3-1/2 inches min 11-1/4 inches max
Spindle Nose Separation	4 inches min 16 inch max
Maximum Cutting Stroke - Hydraulically Governed	
Standard	15 inches
Special	20 inches
Maximum Longitudinal Offset of Heads	8-1/4 inches
Motors, 1,750 RPM Totally Enclosed	2 horse power
Net Weight	1,900 pounds
Shipping Weight (Domestic)	2,050 pounds
Power Requirements	460V, 3 phase, 60 Hz or 230V, 3 phase, 60 Hz; other on special order

Spindle Speeds
(Special speeds upon request)

Through Gears		Open Belt
55	205	700
75	270	925
100	355	1,215
130	460	1,585
165	590	2,050

and controlled and stabilized by a hydraulic cylinder (Hydro-Check). Standard table cycling provides for rapid approach to the cutters, slow cutting feed, and rapid return to the loading position. Multiple or continuous table cycling can be furnished on special order. Also available are "Skip-Check" arrangements, which allow rapid traverse between two separated cutting positions, and arrangements for synchronizing table movements with fixture clamping and indexing.

1-11. MILLING HEADS. Rigid preloaded ball bearing spindles are mounted in heavy, one-piece, bowl-type, head castings which also house gear trains for low speed ranges. Hardened and ground spindle noses are bored for No. 40 American Standard Taper, with maximum allowable run-out held within 0.00015 inches. This spindle accuracy ensures long tool life, smooth finishes, and accurate work. Four 5/16-18 holes are tapped in the face of each spindle nose to allow direct mounting of face mills. Cap screws can be inserted into diametrically opposite holes to serve as driving lugs for stub arbors or other spindle mounted tools. A circular "T" slot which encompasses each spindle nose is used for mounting vertical heads or arbor supports. Each milling head is equipped with an individual reversible motor and a belt and gear train drive that provides a selection of fifteen spindle speeds. Five high speeds from 700 to 2,050 rpm are obtained through the open belt drive, and ten low speeds from 50 to 590 rpm are obtained through the combination of a geared transmission and belt drive.

1-12. DRIVES. The spindles are driven through five-step "V" pulleys. Driven pulleys are mounted directly on spindle ends in a conventional belt drive for higher speeds. To obtain low and intermediate speeds, driven pulleys are changed from spindles to intermediate geared and splined transmission shafts. A change from intermediate to low speeds is obtained through a simple gear shifter. The gears revolve in an oil bath and an inspection window is provided in the head casting to monitor oil level.

1-13. SPECIAL OPTIONS

1-14. HIGH SPEED RANGES. High speed ranges are available on special order. These are obtained through factory installed high speed motors and/or modified "V" pulleys.

1-15. SPECIAL POWER OPTIONS. The standard twin mill is designed for 230/460, 3-phase, 60-cycle, 10 HP maximum.

1-16. AUTOMATIC TRANSVERSE FEED. Automatic pneumatic feed units are available to replace the standard transverse feed adjusting screws. The automatic feed units (factory installed) can be synchronized with table feed for special milling applications. Transverse movement of each head is adjustable up to 4 inches. Various combinations of inward and outward head motion can be furnished in conjunction with table cycle.

1-17. AUTOMATIC RETRACTION. Air motor actuated mechanical linkages are available for factory installation inside the knees to provide automatic retraction of the heads during the table return stroke. Head motion is adjustable up to 0.040 inch.

1-18. DOUBLE CYCLE AND SKIP CHECK. Double cycle and skip-check table functions are also available. These arrangements provide a roughing and finishing cycle in which the table makes two passes and for rapid traverse of the table between two separated cutting positions. Both options should be factory installed.

1-19. ACCESSORIES

1-20. Numerous accessories are available for the Twin Mill all of which can be readily installed by the user. Provision is made in the machine's design for installation of a motor-driven coolant system and/or a Bijur spray mist coolant system. A receptacle is provided on the lower left side of the control enclosure for the coolant system electrical connection.

1-21. Brake motors are available for the spindles. These are usually installed at the factory but can be simply installed by the user by following the wiring directions on the brake motor nameplate.

1-22. Swiveling overarms and arbor supports are available and they will accommodate Nichols standard piloted arbors up to 5 inches in length. Nichols precision vertical heads are also available for use on either or both Twin Mill spindles. The vertical heads are of anti-friction construction and can take full horsepower up to 2,000 rpm. The No. 40 American Standard Taper vertical spindle bore and identical spindle nose allows interchangeability of tools with the horizontal spindles.

CHAPTER 2
INSTALLATION

2-1. GENERAL

2-2. Instructions relative to shipment, site selection, uncrating, assembly, and electrical power and pneumatic connections are contained in this chapter.

2-3. SHIPMENT

2-4. The Twin Mill is skid mounted and weather protected with a pliable cover for shipment. The Twin Mill should remain skid mounted until moved to its final installation location. A lifting bar, installed at the factory, is clamped to the column between the heads and located so that the machine's weight is evenly distributed for lifting. Upon receipt, remove the protective covering and check the shipping list to ensure that all items are accounted for. Inspect the machine for signs of damage that may have occurred during shipment. Claims should be reported immediately to ensure appropriate action is taken and to avoid delay in settlement.

2-5. SITE SELECTION

2-6. Machining accuracy and fine finishes results from proper installation on a firm foundation. A concrete foundation is the most suitable. If installation must be made on a wooden floor, locate the machine over a supporting column if possible. Make certain the weight of the machine falls well within the prescribed floor loading limits. Outline dimensions of the machine are provided in figure 2-1. Make sure sufficient working space is provided for the operator and that the control enclosure is fully accessible.

2-7. MACHINE HANDLING

2-8. The milling machine weighs approximately 2,000 pounds; thus, rope of suitable strength must be selected for a lifting sling. If wire rope or chains are used, make certain they are padded. Attach the sling only to the factory installed lifting bar. After raising the twin mill with a suitable crane, remove the shipping skid and move the machine to its final location.

2-9. Four holes are provided in the base of the column to accommodate 1/2-inch holddown bolts. Prior to bolting the machine down, level the machine by inserting shims under the base. Place a precision level on the table and check the machine level on both the longitudinal and transverse axis. After installation remove the lifting bar and store it for possible subsequent use.

2-10. After securing the Twin Mill in its final location, wash the machine down with cleaning solvent (Varsal or equivalent) before moving any sliding member. After cleaning, wipe all finished surfaces with a good grade of lubricating oil. Lubricate the machine in accordance with figure 4-1. Prime the way lubrication system until oil appears on the table ways by using the auxiliary hand actuator.

NOTE

The auxiliary hand actuator is a cam actuated, spring-return device; therefore, when priming the lubrication system it is necessary only to lift the actuator handle and release it.

CAUTION

Do not use compressed air for cleaning because pressure air can drive foreign matter between bearing surfaces and cause damage during operation or cause injury to personnel.

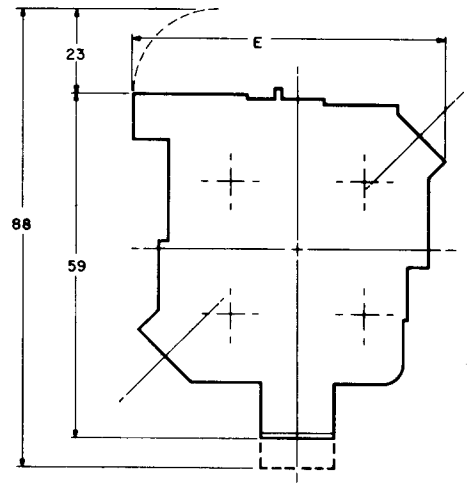
2-11. INITIAL SET-UP

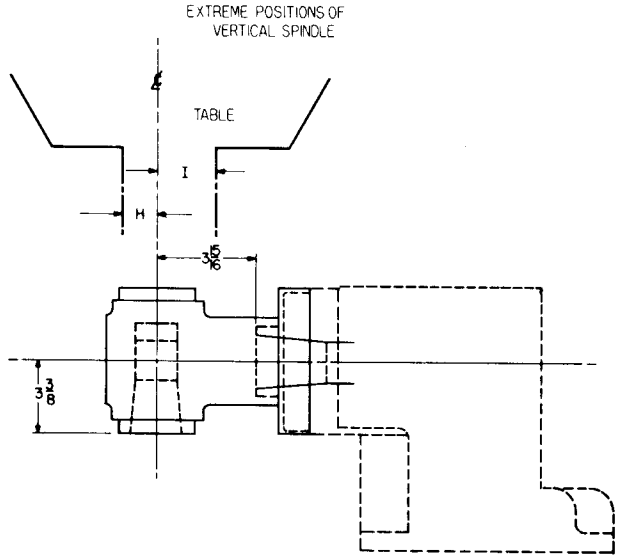
2-12. Install knee crank handles and right- and left-hand transverse handwheels (normally removed from the machine during shipment), and position each spindle nose from 6 to 8 inches away from the centerline of the table. Do not exceed the 8-inch position or the transverse screw and nut might become disengaged. The spindles (heads) are positioned vertically, transversely, and longitudinally by micrometer screws with locks for all screw adjustments. The vertical adjustment lock (27, figure 3-4) is on the knee; the transverse adjustment lock (10) is on the transverse screw; and the longitudinal adjustment locking nuts (21) are on the head base.

CAUTION

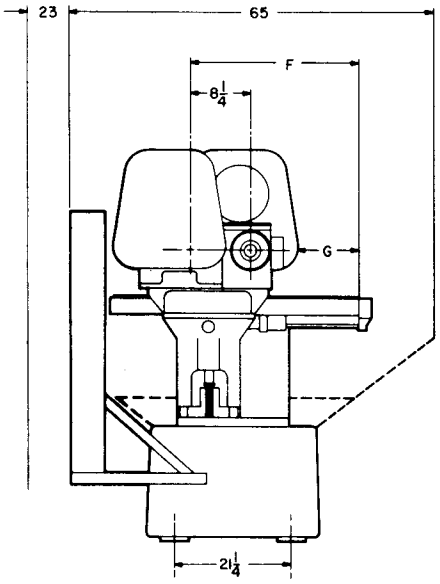
When positioning the heads, take care that the spindles do not strike the table or damage may result.

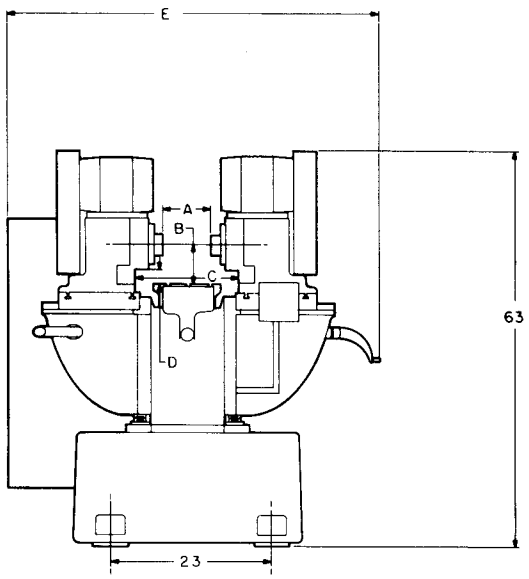
2-13. To set the initial or starting position of the table, open the Hydro-Check knob (16, figure 3-4) and, while standing in the operators position, grasp the table, pull it forward to its stop, and then close the Hydro-Check knob.

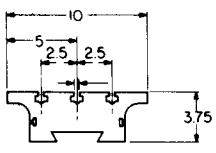




NICHOLS VERTICAL ATTACHMENT







T-SLOT WIDTH .6865-.6875

DIM.	MAX.	MIN.
A	16	4
B	11.2	3.5
C	24	12
D	7.8	
E	65	STD. FEED
	74	TRANSV. FEED
F	32.5	36" TABLE
	26.5	30" TABLE
G	20.7	36" TABLE
	14.7	30" TABLE
H	1.9	
I	4.1	

Figure 2-1. Outline Dimensions

2-14. ELECTRICAL CONNECTIONS

2-15. The Twin Mill is factory wired for each available equipment option (see figures 4-3 thru 4-6) and requires connection only to the shop power source. Drill an appropriate size cable entry hole in the top, bottom, or side of the control enclosure, and bring the main power line into the enclosure through oil-tight fittings. Connect the power leads to the main disconnect switch located in the top, right-hand corner of the enclosure.

CAUTION

Before connecting input power, check the primary power connections on the control voltage transformer in the top of the control enclosure. The Twin Mill is factory wired in accordance with each customer's purchase order. Improper power connections will result in serious electrical damage.

NOTE

The main disconnect switch is integral with the control enclosure door latch; thus, power to the machine is shut off whenever the control enclosure door is opened.

2-16. After making electrical connections, turn the main power disconnect switch on, turn the R.H. and L.H. SPINDLE selector switches to the FORWARD position, turn the SPINDLE AUTO/IND switch to IND, press the SPINDLE START button, and check spindle rotation. The left-hand spindle should rotate clockwise and the right-hand spindle should rotate counter-clockwise when viewed from the cutter end. If spindle rotation is incorrect, open the control enclosure, reverse any two of the input power leads, and recheck for proper spindle rotation.

2-17. PNEUMATIC CONNECTIONS

2-18. Shop air pressure of approximately 100 psi must be available for Twin Mill operation and connection to the machine must be made through a user installed shut-off valve. It is also advisable that a "drip leg" be installed in the shop air line prior to machine connection. With shop air pressure shut off, install the shut-off valve and make appropriate connections to the air filter at the rear of the machine beneath the table.

2-19. With the table pulled out to the starting position, depress the EMERGENCY STOP button while opening the air shut-off valve and pressurizing the system. After pressurizing the system, adjust the air line pressure regulator to provide approximately 15 psi below full shop pressure to ensure steady table operation. (Recommended operating pressure is 85 psi.)

WARNING

The EMERGENCY STOP button always returns the table to the starting position. Stand clear of the table to avoid injury.

NOTE

If it is subsequently desired to move the table by hand, close the air shut-off valve, and depress the EMERGENCY STOP button to permit all air to escape from the system.

2-20. Set up table motion initially by closing the hydro-check knob, and pressing the CYCLE START button. The table will rapid advance until it is stopped by the Hydro-Check piston rod nuts (28, figure 3-4). Turn the Hydro-Check knob counter-clockwise to increase the table feed rate, and clockwise to slow it down. Roughly set the end of the feed stroke with the adjustable table stop screw (17, figure 3-4) on the front of the table end cap. Final adjustment of feed rate and table stroke is based on the work to be performed.

NOTE

A momentary dwell period is provided at the end of each table stroke before it returns to the start position to permit the cutter to clear itself of chips.

CHAPTER 3
OPERATION

3-1. SAFETY PRECAUTIONS

3-2. Observe all in plant safety directives when operating the Twin Mill. Give due consideration to the hazards associated with the use of electrical power, hot oil, pneumatic pressure, and flammable liquids. Take care that protective guards are properly installed and that emergency shut-down devices are fully operative. Pay particular attention to CAUTIONS or WARNINGS as contained in instruction procedures in order to prevent damage to the machine or cutting tools or personal injury.

WARNING

1. Do not put hands into cutter area unless power is off.
2. Wear safety glasses during machine operation and maintenance.
3. Do not wear loose clothing or jewelry during machine operation and maintenance.
4. Do not start machine prior to checking for tightness of set-up and for proper machine adjustment.
5. Do not start machine without guards in place.

3-3. GENERAL

3-4. The Twin Mill functions automatically after it is set-up except for start-up and normal shut-down. However, its operation should be carefully monitored to ensure that lubrication, coolant, and pneumatic systems function properly and that work progresses satisfactorily.

3-5. TABLE CYCLE. Figures 3-1 and 3-2 illustrate how the air motor and Hydro-Check control table motion. When the CYCLE START button is depressed, a slide in the four-way, double-solenoid, air valve of the air motor is shifted to permit air to enter the rod end of the cylinder and send the table forward at a rapid traverse rate. The table moves forward rapidly until the piston rod stop and lock nuts on the Hydro-Check contact the table rear end cap at which point the flow of oil through the Hydro-Check slows the table forward speed to the desired cutting feed rate. Adjustment of the cutting feed rate is made by setting the feed rate adjustment (Hydro-Check) knob. At the end of the feed stroke, a cam on the side of the table strikes a cycle stop limit switch. The limit switch breaks contact and the slide in the air motor solenoid shifts to apply air pressure to the head end of the piston to drive the table back to the starting position. On the return stroke the table rear end cap picks up the single inboard Hydro-Check piston rod nut and returns the piston to its starting position. A one-way valve in the Hydro-Check piston opens during the return

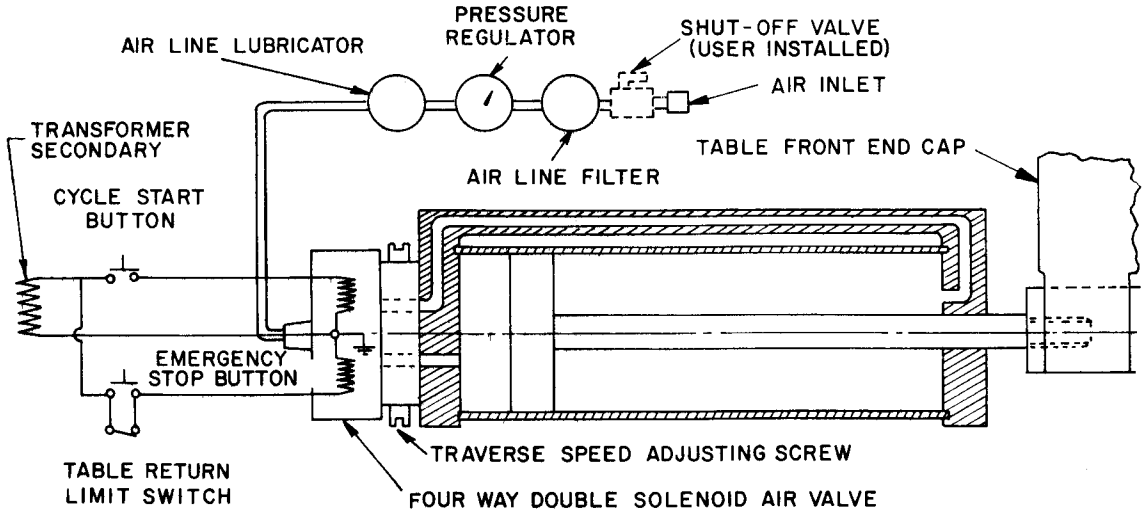


Figure 3-1. Air Motor and Control

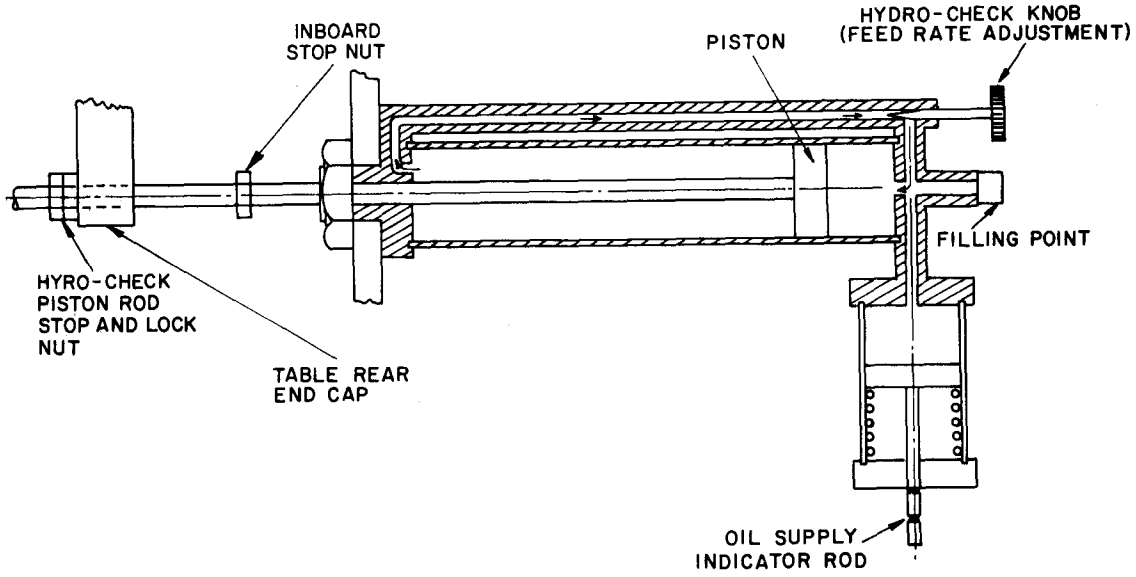


Figure 3-2. Hydro-Check

stroke so that the oil flow is not restricted and the table returns at rapid traverse.

3-6. HEAD RETRACTION. Figure 3-3 illustrates the head retraction mechanism. A floating nut on the transverse screw governs motion of the milling head. Outward motion of the air motor brings the nut against the thrust plate and moves the head in. Conversely, inward motion of the air motor moves the head out. An adjustment nut is provided to set-up the amount of head retraction desired. Manufacturing settings provide for 0.005 to 0.010 inch

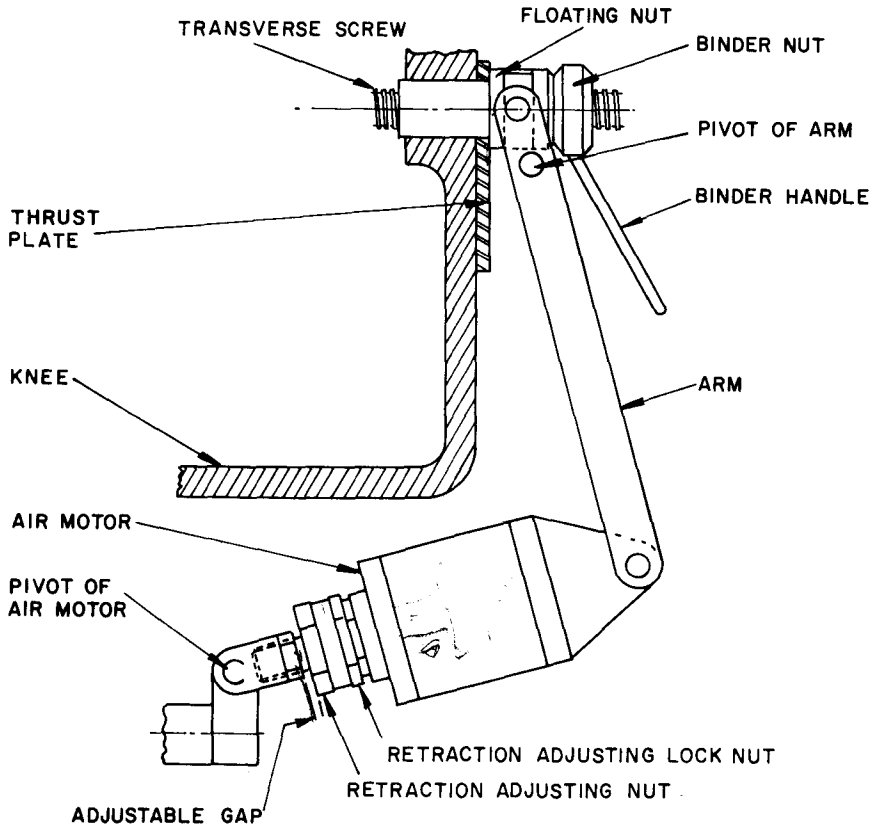


Figure 3-3. Cutter Retraction

retraction. However, this setting can be increased to 0.040 inch if desired.

3-7. DOUBLE CYCLE. A provision for double cycling with retraction makes possible a roughing and finishing cut in two strokes of the table. As the table moves forward on the first stroke both heads are retracted while taking a roughing cut. As the table returns a limit switch on the rear column is activated by a circular dog on the table to provide for a second traverse. The dog is set to allow the table to return to within 3/8 inch of the initial strating point before starting the second cycle. Therefore, the initial cutting stroke should be set to start when the cutters are at least 3/8 inch from the work. When the circular dog strikes the limit switch the heads move in and the table advances on the finishing cut.

3-8. CONTROLS AND INDICATORS

3-9. All machine controls and indicators are described in table 3-1 and illustrated in figure 3-4.

3-10. MACHINE SET-UP

3-11. SPINDLE AND DRIVE. Spindle motors are controlled from the pushbutton station. The left- and right hand spindle FORWARD-OFF-REVERSE switches permit independent operation of either spindle. Three spindle speed ranges (low, intermediate, and high) are provided to accommodate a wide variety of milling operations and a speed selection chart is provided as an instruction plate on the right hand milling head. Proceed as follows to set up the desired spindle range (see figure 3-5):

a. Low Range (55 to 165 RPM). Pull the No. 1 shifter out and push the No. 2 shifter in. Install the driven pulley on the primary shaft.

b. Intermediate Range (205 to 590 RPM). Pull both the No. 1 and No. 2 shifters out. Install the driven pulley on the primary shaft.

c. High Range (700 to 2050 RPM). Push the No. 1 shifter in and install the driven pulley on the spindle. The No. 2 shifter can be left in either the in or out position.

d. Speed Range Variations. Variations within each speed range are obtained through belt positioning on the stepped pulleys as indicated by the speed selection chart. Loosen belt adjustment lock nuts (24, figure 3-4), reposition the drive belt as required, reposition the spindle drive motor to retension the belt, and secure lock nuts (24).

NOTE

Tighten belt to 5/32 inch deflection at the midpoint with 3.5 to 5 pounds of force

3-12. If a vertical milling attachment or an outboard overarm support are required for a particular milling operation, install them on the spindle mounting ring (see figure 3-5). The circular "T" slot carries the tee bolts which secure either unit in place. Detents are provided in the "T" slot to hold the tee bolts for convenience of installation. If the Twin-Mill is equipped with brake motors, lift the finger levers (25, figure 3-4) to release the brakes permitting the spindles to free-wheel and facilitate accessory installation. The brake motors will be automatically reactivated when the spindle motors are started.

3-13. TABLE SET-UP. Install a production piece and its holding fixture securely on the table and position the work as close as possible to the table centerline. Correspondingly, locate the milling heads as close to the saddle centerlines as the production work permits.

CAUTION

Make sure that the under surfaces of all fixtures that are clamped to the table are perfectly flat or distortion may occur that will result in table binding. Bridge type fixtures should be mounted on their own subplates.

3-14. Feed Stroke Starting Point. The starting point of the feed stroke (or end point of table rapid advance) is established by adjustment of the Hydro-Check stop and lock nuts. Proceed as follows to set the feed stroke starting point:

a. Close the air line shut-off valve and press the EMERGENCY STOP button to exhaust the air pressure from the system and permit the table to be moved by hand.

b. Open the Hydro-Check and manually pull the table to its full forward or starting position.

c. Install the cutters on the spindles.

d. Manually move the table inward to the point at which the feed stroke should begin.

e. Set the Hydro-Check piston rod stop nut (see figure 3-2) until it is flush against the table rear end cap and lock it in place with the outboard lock nut.

CAUTION

Do not alter the position of the piston rod stop nut that is located behind the table rear end cap and locked with a set screw or damage to the Hydro-Check will result. This nut is factory set to allow at least 1/8 inch of Hydro-Check piston movement after the table is returned to the starting position and is held there by air pressure.

f. Make approximate vertical, transverse, and longitudinal adjustments of the milling heads using the micrometer adjusting screws. If the heads are

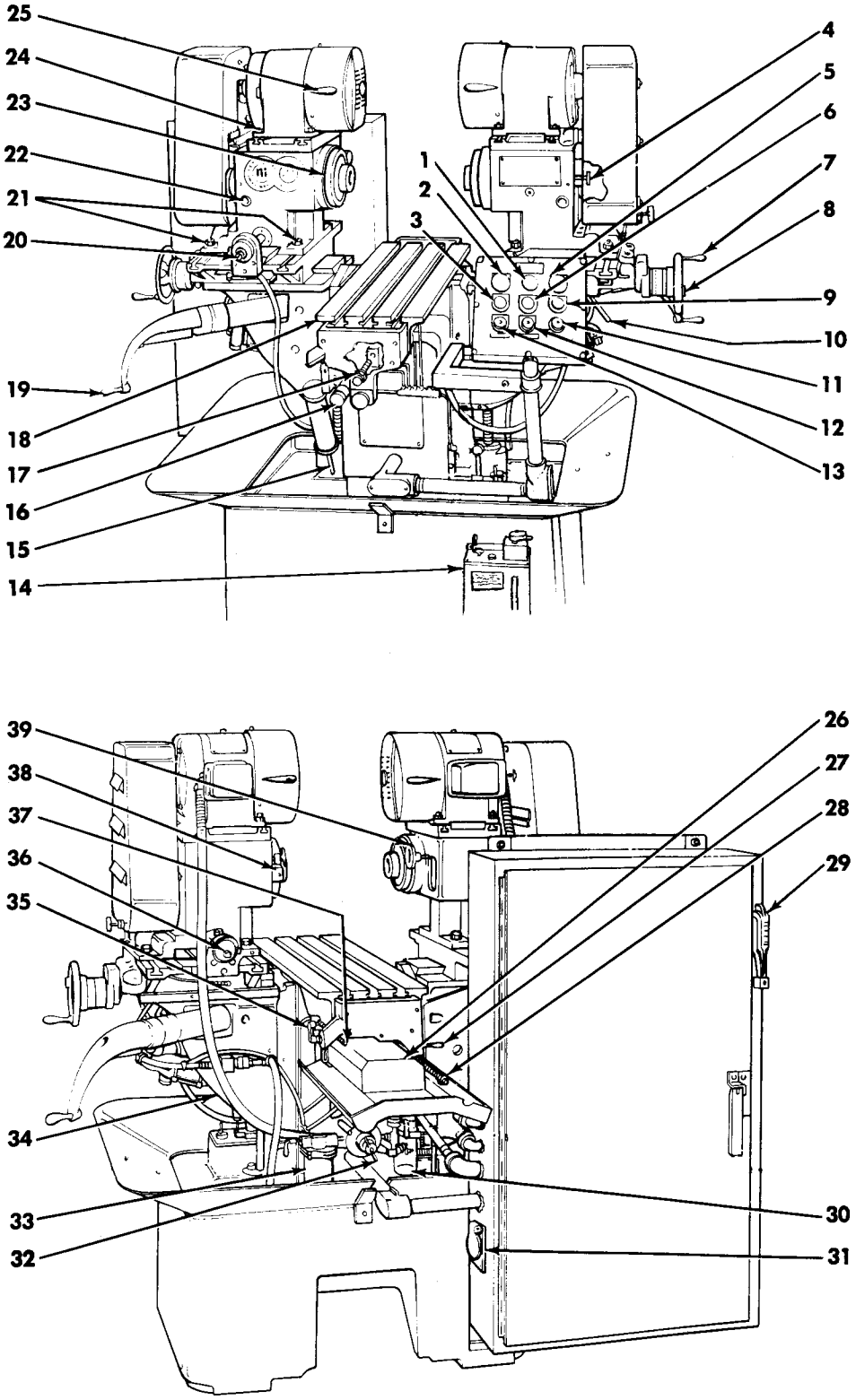


Figure 3-4. Controls and Indicators

Table 3-1. CONTROLS AND INDICATORS

Figure 3-4 Item No.	Control or Indicator	Figure 3-4 Item No.	Control or Indicator
1	Cycle Selection Switch	21	Longitudinal Positioning Head Lock Nuts
2	Lubrication Light	22	Head Oil Level Window
3	Spindle Start Button	23	Vertical Attachment or Outboard Arbor Support Mounting Ring
4	No. 1 Shifter-Spindle Gear	24	Belt Adjustment Lock Nut
5	Emergency Stop Button	25	Brake Release Lever
6	Coolant On-Off Selector Switch	26	Table Rapid Traverse Speed Adjusting Screw
7	Transverse Travel Handwheel	27	Knee Binder Lever
8	Transverse Dial Lock Nut	28	Hydro-Check Piston Rod Nuts
9	Cycle Start Button	29	Disconnect Switch
10	Transverse Positioning Saddle Lock	30	Air Line Lubricator
11	Spindle Automatic/Independent Switch	31	Coolant System Receptacle
12	Right-hand Spindle Forward-Off-Reverse Selector Switch	32	Air Line Pressure Regulator
13	Left-hand Spindle Forward-Off-Reverse Selector Switch	33	Air Line Filter
14	Lubricating Pump	34	Retraction Adjusting and Lock Nuts
15	Hydro-Check Oil Supply Indicator Rod	35	Second Table Cycle Initiation Limit Switch
16	Hydro-Check Knob	36	Head Longitudinal Positioning Screw
17	Adjustable Table Stop Screw	37	Limit Switch Adjusting Screw Cam
18	Table Return Limit Switch	38	Coolant Line Mounting Bracket Assembly
19	Knee Elevating Crank Handle	39	No. 2 Shifter-Cluster Gear
20	Left-hand Longitudinal Head Positioning Screw		

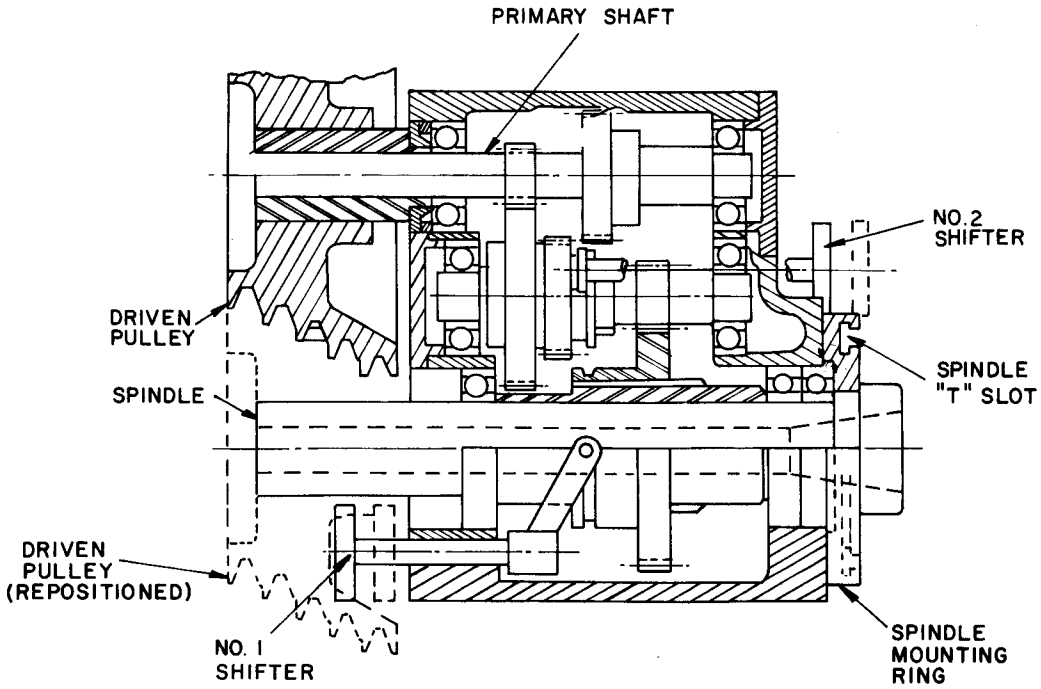


Figure 3-5. Head Train, Plan View

offset longitudinally, make sure that the Hydro-Check is set properly for the one nearest the loading station.

3-15. Feed Stroke End Point.

a. Open the Hydro-Check and move the table manually to the point where the feed stroke is to be completed.

b. Adjust the table stop screw (17, figure 3-4) on the front table end cap until it contacts the column. The cam on the left front side of the table should be set to actuate limit switch (LS-1) just before the stop screw hits. The limit switch activates a time delay relay in the control enclosure that returns the table to the starting position. The relay is adjustable in a range of 0 to 60 seconds.

3-16. Table Operation Check.

a. Close the Hydro-Check and open the air line shut off valve.

b. With the Hydro-Check closed and the spindles operating, press the CYCLE START button.

c. When the table rapid advances it will be stopped by the Hydro-Check at the starting point of the feed stroke. Open the Hydro-Check slowly to obtain the desired feed rate.

d. Take two or three trial cuts and readjust stops and head positions as desired.

3-17. Table Rapid Traverse Speed Adjustment.

a. Adjust air motor speed with power to the Twin Mill shut-off and the table in the starting position.

b. Turn the upper air motor speed adjusting screw (26, figure 3-4) clockwise to slow forward motion of the table. Turn the lower air motor adjusting screw clockwise to slow return motion of the table.

3-18. RETRACTION SET-UP. On Twin Mills set-up for retraction, the milling heads will move in and out in sequence with table operation. The heads move in when the CYCLE START button is depressed, and at the end of the dwell period and end of the table stroke the heads move out to their retracted position while the table returns. On double cycle set-up, the heads remain in the out position for the first table stroke or the roughing cut. At the start of the second table stroke the heads move in for a finishing cut. To adjust the amount of head retraction proceed as follows:

a. Remove the quick disconnect air line from the table air motor and depress the CYCLE START button to exhaust air from the table drive system.

b. Install the required indicators on the table and secure them in position to measure head motion.

c. Press the CYCLE START and EMERGENCY STOP buttons alternately to energize the head air motors and measure the amount of retraction.

d. To adjust the amount of head retraction reposition the retraction adjusting nut on the nose end of the head air motor. Make sure the retraction adjusting lock nuts are secure before recycling the heads.

e. The speed of the retraction air motor can be set as in the case of the table air motor. Clockwise rotation upper set screw (see figure 3-1) slows the rate of head outfeed. Clockwise rotation of the lower set screw slows the rate of head infeed.

f. After adjustment of the head retraction mechanisms, reconnect the air line to the table air motor.

3-19. DOUBLE CYCLE. On machines with double cycle and retraction the table makes two cutting passes providing a roughing and finishing cycle. The first pass is made with heads retracted to make a roughing cut; the second is made with the heads in the in position to make a finishing cut. Adjustment of head retraction is described in paragraph 3-18. Adjustment of table double cycle is made as follows:

a. Re-set the Hydro-Check (see paragraph 3-14) so that the start of the feed stroke for the first cutting pass begins slightly more than 3/8 inch before the cutters reach the work.

b. Set the circular dog so that it will trip limit switch LS-2 for a second cycle before the table returns fully to the first stroke cutting position as established in step a.

3-20. SKIP CHECK. Skip check, a factory installed option, requires the installation of a special Hydro-Check that incorporates a solenoid valve in feed rate adjustment line. The solenoid valve is actuated by an elongated cam on the side of the table and a limit switch (LS-3). As the table moves forward and completes its cut on the first position, the limit switch is activated by the cam and trips the solenoid valve to permit oil to bypass the feed rate adjustment knob and the table to rapid advance to the second cutting position. At the start of the second cut the limit switch falls off the elongated cam and the solenoid valve is deactivated again restricting oil flow through the Hydro-Check to the feed rate setting. Skip check cams must be user designed for each different production application.

CHAPTER 4
MAINTENANCE

4-1. INTRODUCTION

4-2. Instructions pertaining to maintenance are contained in this chapter. Conscientious adherance to scheduled maintenance procedures combined with careful and intelligent machine operation will minimize the need for costly repair and parts replacement.

4-3. SCHEDULED MAINTENANCE

WARNING

Prior to performing maintenance close the main airline shut-off valve and press the cycle start button to cycle the machine and exhaust pressure air from the pneumatic system. After depressurizing the pneumatic system open the main disconnect switch to remove all electrical power from machine and control enclosure components. High voltages associated with Twin Mill components can be lethal.

4-4. CLEANING. Clean the Twin Mill daily or after each use. Use a stiff bristled brush moistened in solvent (Varsol or equivalent) to remove metal particles and chips and wipe all parts of the machine with a soft cloth moistened with a good quality, light machine oil. Clean all electrical components within the control enclosure when necessary using a soft bristled brush. Make certain that electrical components are kept free from oil or moisture.

CAUTION

Do not use compressed air for cleaning. High pressure air is likely to drive metal particles between bearing surfaces thus damaging the machine when in operation or cause injury to personnel.

4-5. INSPECTION. Inspect the machine daily or before each use for signs of obvious wear or damage. Check particularly for loose components. Check the belt drives for proper tension and make sure all operating controls, handwheels, and shifters function properly and without binding. Check that all pneumatic, coolant, and electrical lines are free from damage and that all connections are secure. Inspect all limit switches and actuators, air motors and the Hydro-Check for security of mounting and proper setting. Inspect bearing surfaces for scoring, pitts, or other signs of damage or inadequate lubrication. Careful visual inspection of the machine will usually disclose signs of potential damage and make it possible to avoid downtime and costly repairs.

4-6. LUBRICATION. Proper lubrication of the Twin Mill is essential for long life. Refer to the lubrication diagram (figure 4-1) for lubrication points and instructions. Note that the spindles and gears revolve in an oil bath; thus, the lubricant level should be checked before each use of the machine. Similarly the table and saddle ways as well as some retraction assembly components are lubricated from a reservoir on the Bijur lubricator which must be kept full at all times.

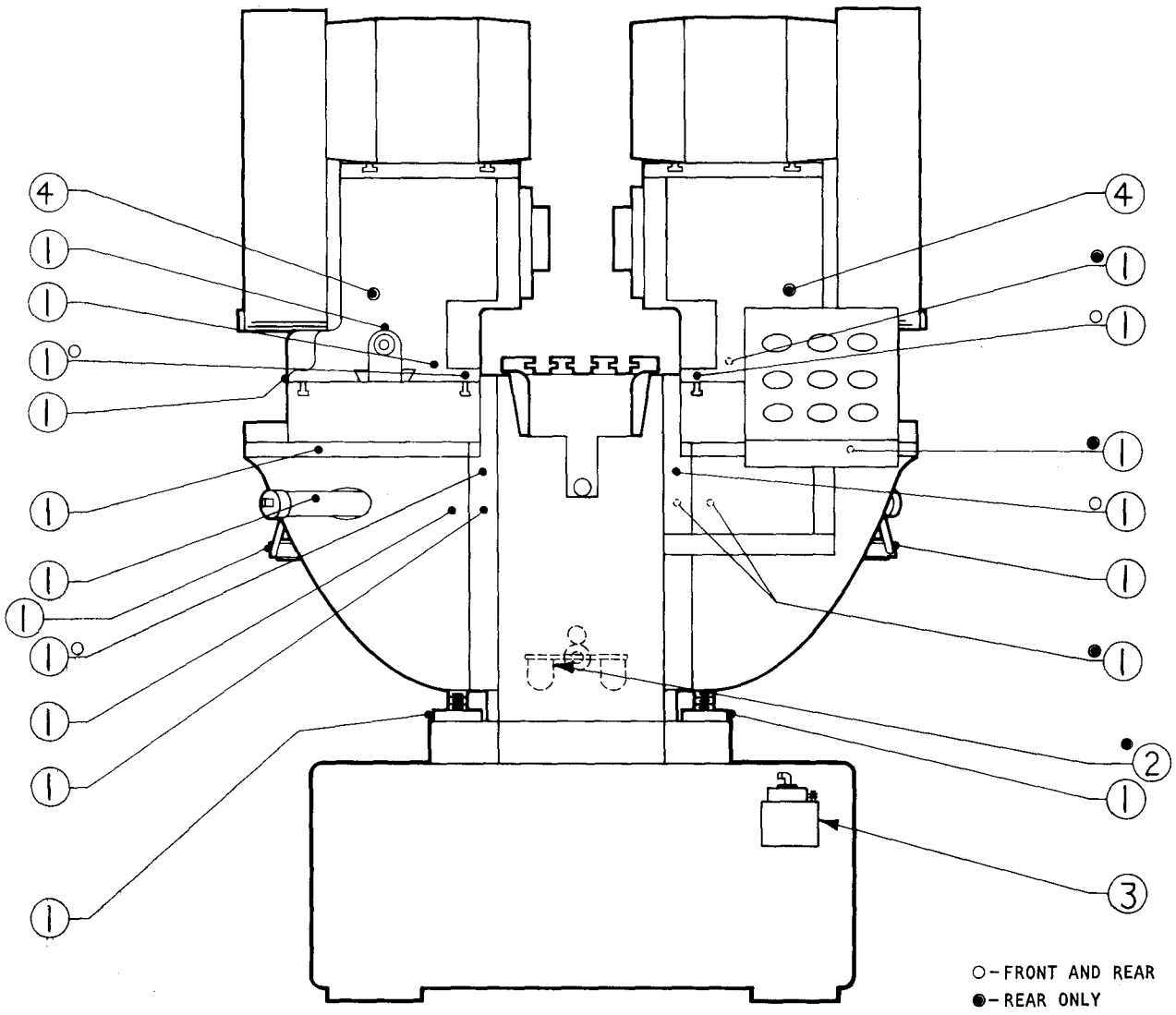
4-7. The Bijur lubricator incorporates a motor driven piston pump which is automatically actuated whenever the CYCLE START button is depressed. A gear reduction unit provides for pump operation at 10.6 minutes per cycle and the discharge volume is variable from a factory setting of 28.0 cubic centimeters per hour to 14.0 cubic centimeters per hour. To set the flow refer to figure 4-2, remove the lock screw, and turn the adjusting screw clockwise to increase dimension A as shown in table column B and change the flow rate.

4-8. The Bijur lubricator also incorporates a liquid level switch, which in conjunction with an indicator light on the control panel, indicates to the operator when the lubrication system is functioning. When the reservoir lubricant level falls below that required for safe operation or the system otherwise fails the switch opens and the indicator light is extinguished.

4-9. Prior to each use of the Twin Mill and during the first few cycles of the table and/or milling heads, pump the hand actuator on top of the Bijur lubricator two or three times and check that lubricant flows on both the table and saddle ways.

4-10. A Norgren Lubro Unit is provided in the pneumatic system for air line lubrication. Set the unit for a minimum amount of lubrication. Over lubrication will cause a discharge of oil mist from Bellows units and leakage around gaskets both of which may precipitate air leaks or cause sticking of the four-way solenoid air valve in the air motors.

4-11. PARTS REPLACEMENT. Because the milling machine is of heavy construction it will provide many years of normal operation before major repair or rebuild is necessary. Therefore, routine maintenance is limited for the most part to adjustment and the replacement expendable parts such as spindle bearings, drive belts, electrical switches and contactors, air and electric motors, filters, valves and other pneumatic and coolant components. The replacement procedure for most parts is obvious; instructions for more difficult procedures are contained in the following paragraphs. To facilitate the replacement of mechanical parts refer to the illustrations in Chapter 5. Order replacement parts by their full part



LUBRICATION POINTS

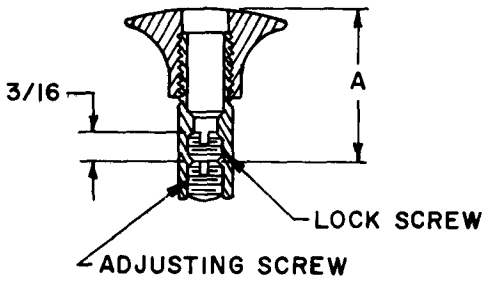
① LUBRICATE ALL POINTS 600W OR EQUAL EVERY 40 HRS.

② AIR LUBE SAE 20 OR EQUAL FILL TO LINE AS NEEDED

③ MACH. LUBE (FILL WITH NICHOLS WAY OIL) FILL TO LINE AS NEEDED

④ VACTRA EXTRA HEAVY, KEEP AT MIDDLE OF SIGHT GAGE

Figure 4-1. Lubrication Diagram



B (INCHES)	DISCHARGE	10.6 CYCLE
0.400	2.5 cc	14.0 cc/hr
0.320	3.0 cc	16.8 cc/hr
0.240	3.5 cc	18.5 cc/hr
0.160	4.0 cc	22.4 cc/hr
0.080	4.5 cc	25.2 cc/hr
0.0	5.0 cc	28.0 cc/hr

INCREASE "A" BY "B" TO OBTAIN DISCHARGE RATE REQUIRED

Figure 4-2. Lubricator Adjustment

number and nomenclature, and provide the machine serial number. When removing electrical components make notes of tags on leads before disconnecting them in order to facilitate reinstallation. Refer to figures 4-3 through 4-6 for wiring details.

4-12. SPINDLE BEARING REPLACEMENT

4-13. BEARING REMOVAL. Proceed as follows to remove the front and rear spindle bearings:

a. Open the belt drive cover and remove the drive belt, the pulley and the key from the spindle or primary shaft.

b. Loosen "T" bolts and nuts (53 and 55, figure 5-2) and disconnect and remove the spindle motor.

c. Remove motor mounting plate (72).

d. Remove rear bearing cover (31).

e. Remove the setscrew in the housing rear bearing flange to make setscrew (28) and pad (29) accessible. Loosen set screw (28) which locks spindle nut (30).

f. Install two 5/16 x 1/2 capscrews in opposite holes in the spindle nose. Insert a bar between the two screws to hold the spindle while removing spindle nut (30) with a spanner wrench.

g. Remove cap screws (16) that secure front bearing cap (17).

h. Remove detent screw (21), spring (22), and detent ball (23) from spindle gear (24).

i. Loosen set screw (28) and remove detent screw (52) spring (51) and detent ball (50).

j. Back off set screw (40) and remove shifter rod (38) and fork (41).

k. Use a pair of "C" clamps to hold the rear spindle bearing (27) in the housing, and tap the spindle with a hammer on the extension end to drive the spindle out of the rear bearing.

NOTE

Front and rear bearings are pressed on to their seats on the spindle.

l. Slide the spindle (12) with front bearing cap (17), flinger (18) front bearings (19 and 20) and spindle sleeve (26) attached sufficiently out of the housing to slide spindle gear (24) off the spindle and lift it out of the housing. Remove the spindle and attached parts from the housing. Disengage the "C" clamps and remove rear bearing (27) from the housing.

m. Remove screws (7) and sleeve key (25) and slide sleeve (26) off the spindle.

n. Square the ends of a 9-inch length of 3-inch I.D. steel tubing. Insert the spindle nose in the tubing and, with an arbor press, press front bearings (19 and 20) off the front bearing seat and then off the rear bearing seat. (The spindle has a reduced diameter about five inches long between the front and rear bearing seats.)

4-14. BEARING INSTALLATION.

a. Inspect flinger (18) and stone both faces as necessary to remove nicks or scratches.

b. Install spindle (12) nose down on an arbor press and install front bearing cap (17) and flinger (18).

c. To facilitate alignment, new bearings are marked by the manufacturer with copper spots on the inner and outer races. Prior to installation use a stone and mark each bearing on the outside diameter in line with the copper alignment spot.

d. Install outer front bearing (19) on the spindle with the flange down. Align the copper spot on the inner race with the pulley keyway on the spindle and press the bearing on to its seat.

NOTE

Apply pressure only to the bearing inner race. The front bearings have to be pressed beyond the rear bearing seat and then on to the front bearing seat.

e. Install inner front bearing (20) in the same manner as described in step d. Make sure the manufacturers alignment marks face up, the alignment marks line up with the pulley keyway, and that the stone marks on the bearing outside diameters are in line with each other.

f. Install spindle sleeve (26) and sleeve key (25). Tighten screws (7) securely. Note that an arrow and number are etched on the sleeve and spindle gear. These must line up when the gear is installed.

g. Insert the spindle in the housing, and install spindle gear (24) through the top of the housing. With the stone marks on the bearing outer races in a horizontal position, tap the spindle nose lightly to seat the bearings in the housing.

h. Install rear spindle bearing (27) with the manufacturers name facing out. Apply pressure only to the inner race.

i. Install and tighten spindle nut (30) to a torque of 25 pound-feet. Align the set screw hole in the nut with the hole in the top of the rear bearing flange, install and tighten spindle nut pad (29) and lock screw (28), and install the second set screw that was removed in step 4-13e.

j. Install shifter rod (38) and fork (41) and tighten set screw (40).

k. Install detent ball (23) spring (22) and screw (21) in spindle gear (24).

l. Install detent ball (50) spring (51) and screw (52) in the housing and adjust them for proper shifter motion. Install and tighten detent pad (49) and lock screw (28).

m. Position front bearing cap (17) with the "T" bolt slot opening at the bottom and install and secure screws (16) and detent caps (15).

n. Install rear bearing end cap (31) and secure it in place with screws (7).

o. Reinstall motor mounting plate (72) and spindle motor. Install the drive pulley, key, and belt and adjust the belt tension before tightening "T" bolts (53) and nuts (55).

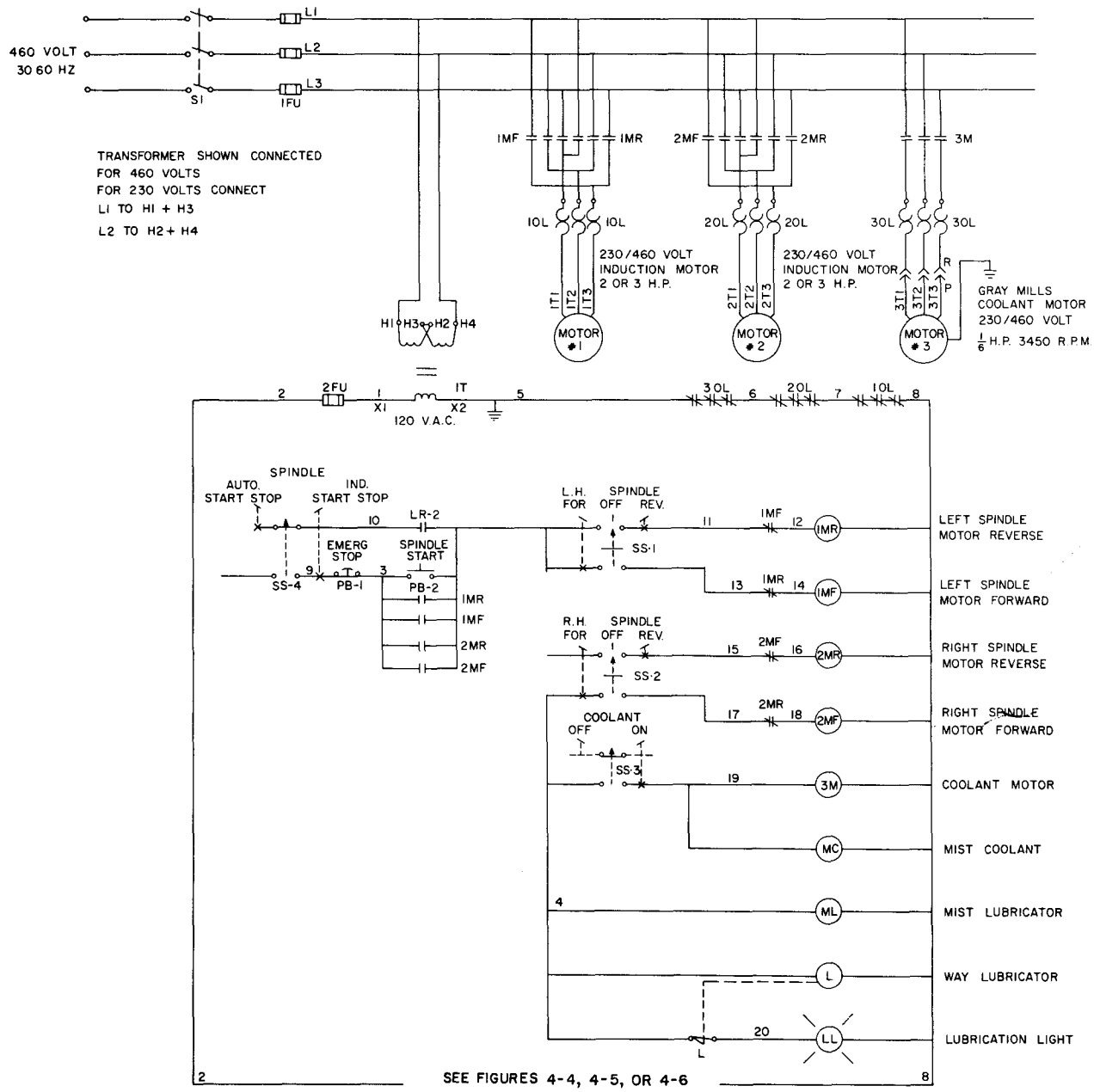
p. Before test running spindle fill the housing with Vactra extra heavy lubricant as described in figure 4-1.

4-15. TROUBLESHOOTING

4-16. Table 4-1 is a summary of the more common troubles to be found in machine operation together with a listing of the probable cause and remedy of each.

Table 4-1. TROUBLESHOOTING

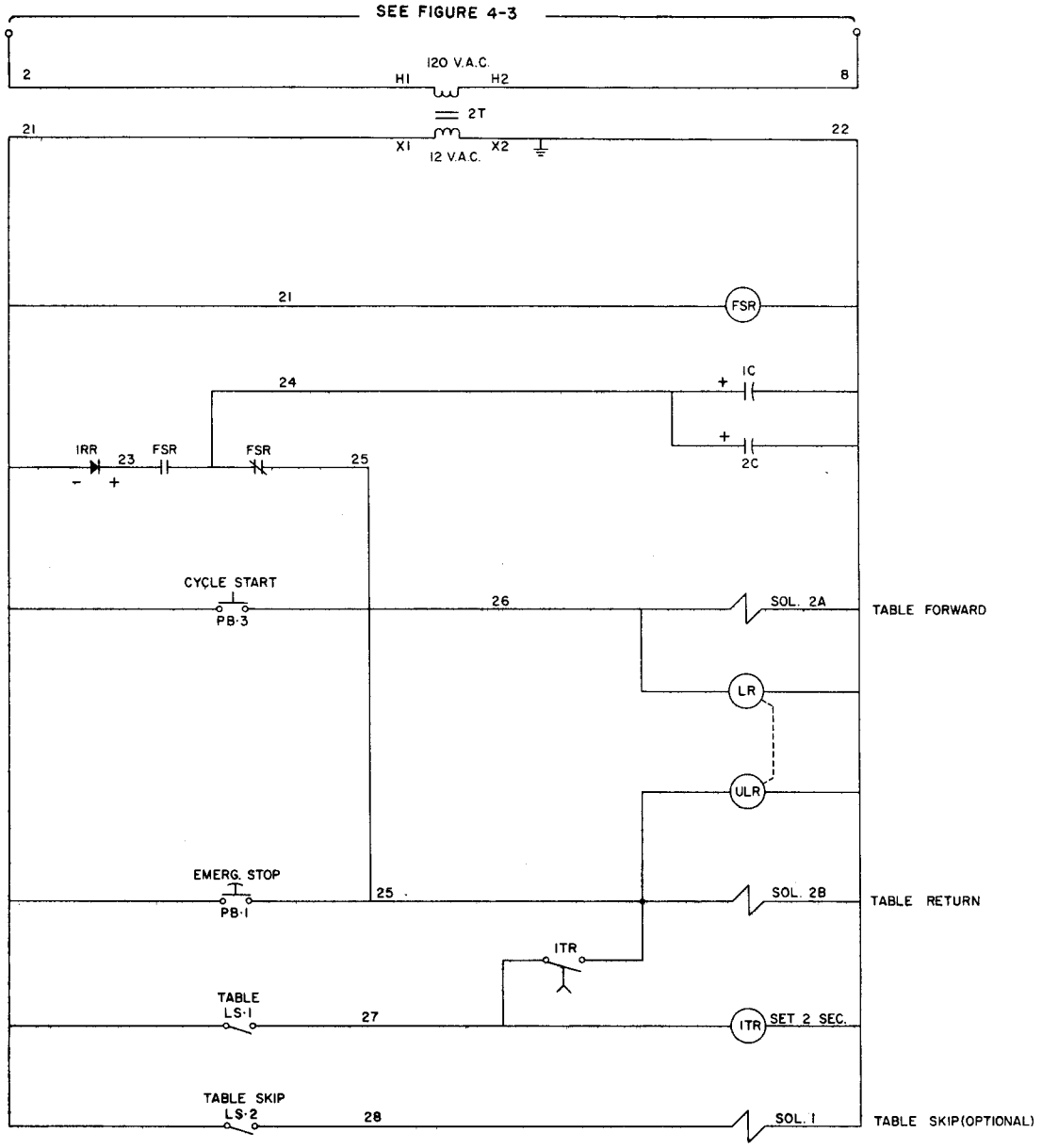
Trouble	Probable Cause	Remedy
Machine doesn't operate	Blown fuses	Replace fuses.
Spindle rotation incorrect	Improper input wiring connections	Reverse any two input wire leads.
Erratic table motion	Holding fixture not flat	Check for flatness, and tighten hold downs evenly.
	Air in Hydro-Check	Check indicating rod in balance cylinder (three grooves should be exposed). Add bellows 80-20 oil with handgun and bleed the Hydro-Check.
	Low shop air pressure	Check regulator and adjust system to 85 pounds.
	Water in air line	Bleed water from filter and/or drip leg.
	Insufficient lubrication	Fill lube oil reservoir and/or increase lubricant flow.
Pause in table motion or jolt at start of feed stroke	Insufficient air for air motor	Adjust forward traverse speed adjusting screw (see paragraph 3-17).
Twin Mill cuts out when starting spindles together	Blown fuse	Replace fuse with dual element fuses to handle initial surge voltage.
Machine will not double cycle	Improper adjustment of limit switch actuator	Adjust circular dog (37, figure 3-4) so that it overrides the limit switch when the table returns to loading position and stops.
Heads do not hold over-all dimensions (Retraction)	Loose retraction linkage	Tighten linkage and/or tighten Nylock binder nut on traverse screw until drag is felt.
Table shock absorber does not engage when table returns to loading position	Improper setting of Hydro-Check in board stop nut (9, figure 5-6)	Readjust adjusting screw (3, figure 5-6) and lock securely with jam nut (4). Reposition Hydro-Check in board stop nut (9) to permit at least 1/8-inch of piston rod movement after table is returned to the starting position and held by air pressure.



MAJOR ELECTRICAL COMPONENTS

SYMBOL		SYMBOL	
	CABINET NEMA 12 42" x 24" x 8" ENCLOSURE DIE CAST A.B. 800T 9TZ	L	WAY LUBRICATOR BIJUR TYPE No. C-2803 115 V.A.C.
1M, 2M	STARTER A.B. No. 705A0D 103	LL	PILOT LIGHT A.B. No. 800T P16G
3M	STARTER A.B. No. 709T0D 103		
1T	TRANSFORMER NAT. ACME No. TA81012 230/460/115 V.A.C. 150 V.A.		OPTIONAL EQUIPMENT
PB-1	OPERATOR A.B. No. 800T D-6		
PB-2	OPERATOR A.B. No. 800T A-2	MC	MIST COOLANT BIJUR TYPE No. UBA 115 V.A.C.
SS-1, SS-2	OPERATOR A.B. No. 800T J-44		
SS-3, SS-4	OPERATOR A.B. No. 800T H2	ML	MIST LUBRICATOR BIJUR TYPE No. ZAA 115 V.A.C.
S1	DISCONNECT SW. SQ. D. No. 9422-R3		

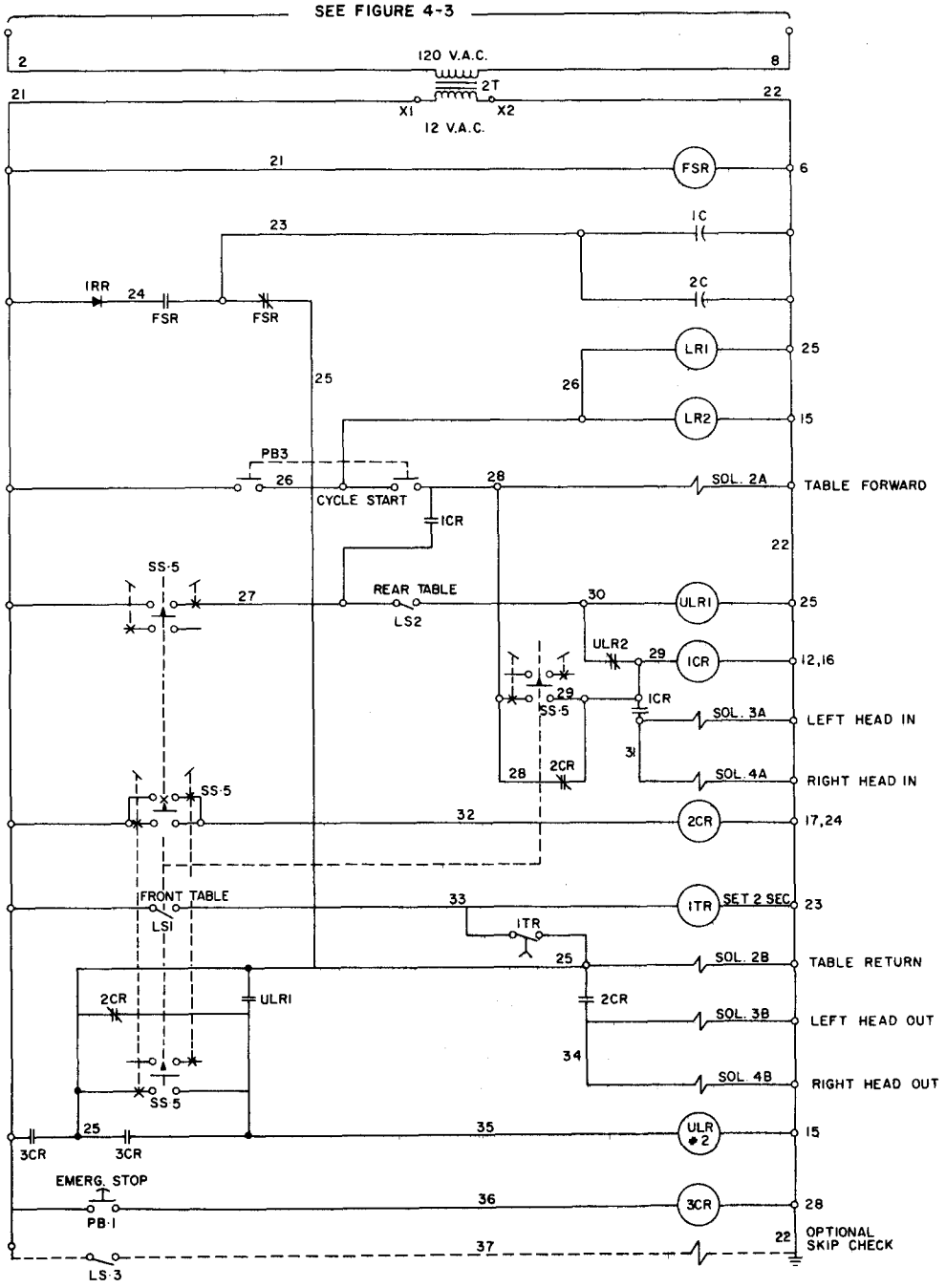
Figure 4-3. Wiring Diagram - Spindle Control



MAJOR ELECTRICAL COMPONENTS

SYMBOL		SYMBOL	
2T	TRANSFORMER JEFFERSON No. 637-461 120/12 V.A.C. 50 V.A.	1C, 2C	CAPACITOR SPRAGUE No. T.V.A.-1170 200 M.F.D.
PB-3	OPERATOR A.B. No. 800 T A-1	1RR	RECTIFIER SARKES TARZIAN MOD. No. 50-75
PB-1	OPERATOR A.B. No. 800 T D-6		
LR	RELAY P.+B. No. KB.17.AY 12 V.A.C.	FSR	RELAY ROWAN No. 2190-E44ZA 12 V.A.C.
1TR	RELAY TIME DELAY A.B. No. 849ZOV24	LS-1	LIMIT SWITCH HONEYWELL BZ-2RS55-A2

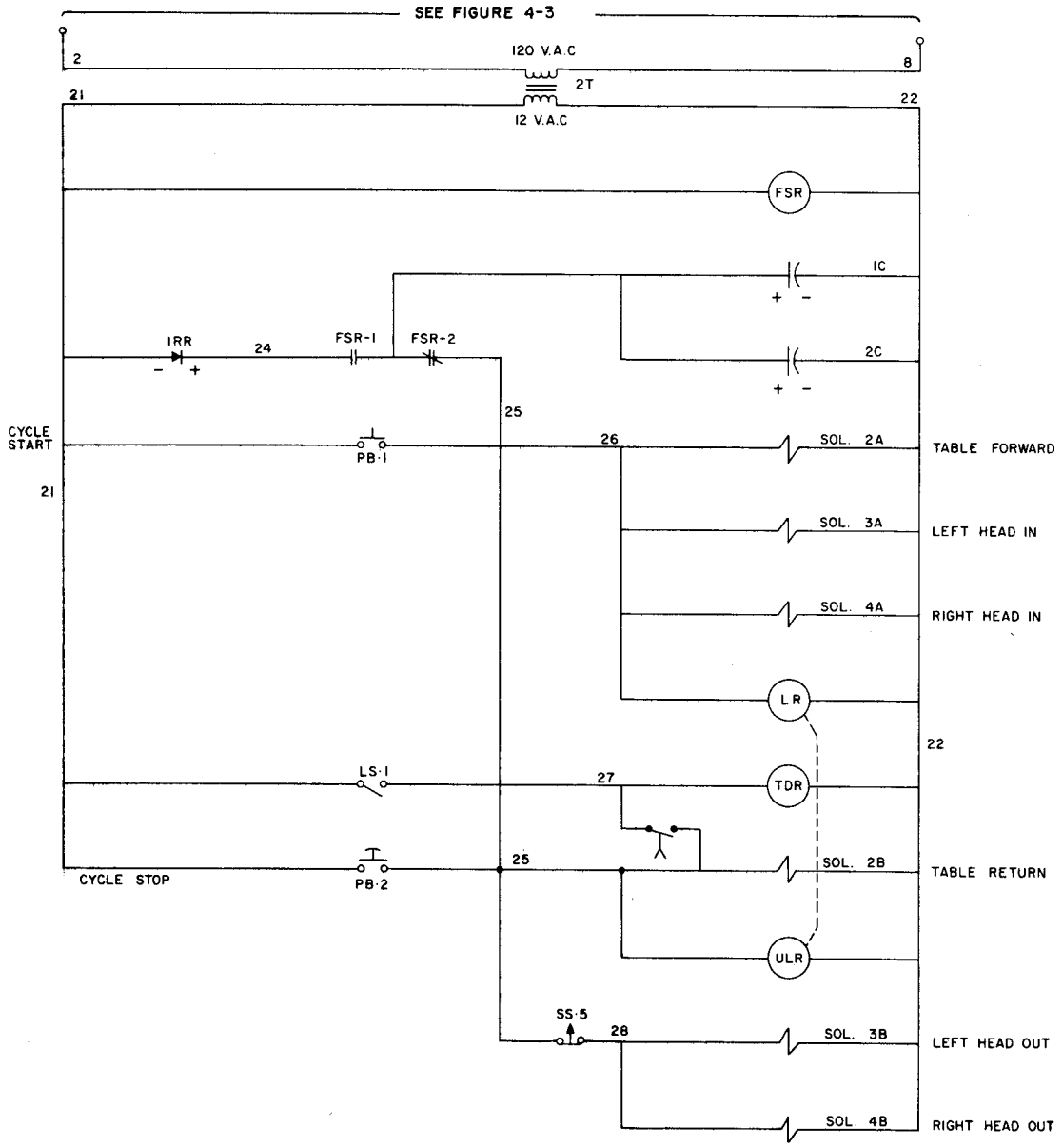
Figure 4-4. Wiring Diagram - Standard Feed



MAJOR ELECTRICAL COMPONENTS

SYMBOL		SYMBOL	
	CABINET NEMA 12 42" x 24" x 8" ENCLOSURE DIE CAST AB No. 800T 9TZ	LR-1, LR-2	RELAY ROWAN No. 2190-E22ZA No. KB17AY 12 V.A.C.
PB-3	OPERATOR A.B. No. 800T A-1	1C, 2C	CAPACITOR SPRAGUE No. TVA-1170 2000 MFD
PB-1	OPERATOR A.B. No. 800T D-6		RECTIFIER SARKES TARZEN MODEL 50-75
SS-5	OPERATOR A.B. No. 800T J-44	LS-1	LIMIT SWITCH HONEYWELL No. BZ-2RS55-A2
	CONTACT BLOCKS A.B. No. 800T XA	LS-2	LIMIT SWITCH HONEYWELL No. 1LS1
2T	TRANSFORMER NAT. ACME 240/480/120 V.A.C. 150 VA.		
FSR, 1CR, 2CR, 3CR	RELAY ROWAN No. 2190-E22ZA 12 V.A.C.		

Figure 4-5. Wiring Diagram - Double Cycle



MAJOR ELECTRICAL COMPONENTS

SYMBOL		SYMBOL	
	CABINET NEMA 12 42" x 24" x 8" ENCLOSURE A.B. No. 800T 9TZ	2T	TRANSFORMER No. 637-461 120/12 V.A.C. 50 V.A.
S-1	DISCONNECT SWITCH SQ-D No. 9422	FSR	RELAY ROWAN No. 2190E22ZA
1T	TRANSFORMER NAT. ACME No. TA81012 240/480/120V, 150 V.A.	LR, ULR	RELAY POTTER & BRUMFIELD No. KB17.AY 12 V.A.C.
PB-1	OPERATOR A.B. No. 800T A-1	TDR	RELAY A.B. No. 8492OV24 12 V.A.C.
PB-2	OPERATOR A.B. No. 800T D-6	LS-1	LIMIT SWITCH HONEYWELL No. BZ-2RS66-A2
SS-1, SS-2	OPERATOR A.B. No. 800T J-44		
SS-3	OPERATOR A.B. No. 800T H-2 CONTACT BLOCKS A.B. No. 800T XA	L	LUBRICATION BIJUR TYPE C-2741 115 V.A.C.
1M, 2M	STARTER A.B. No. 705 AOD SIZE "0"	SS-5	OPERATOR A.B. No. 800T H33 RETRACTION ONLY
3M	STARTER A.B. No. 709 TOD SIZE "00"		

Figure 4-6. Wiring Diagram - Retraction

CHAPTER 5
REPAIR PARTS LIST

5-1. INTRODUCTION

5-2. This chapter contains listings and illustrations of common repair parts for the Twin Mill. Figure 5-1 provides an index to the location of assemblies, and figures 5-2 through 5-10 provide an index to the location of detail parts. Except as otherwise indicated in the listings all part numbers are those of the W. H. Nichols Company.

5-3. ORDERING PARTS

5-4. When ordering parts furnish the following information:

a. Machine type and serial number (nameplate on left-hand head).

b. Full part number and description as contained in the parts list.

c. Quantity of repair part required.

d. Complete forwarding address and packaging requirements if special.

5-5. Replacement electrical components and parts can be ordered directly from their respective manufacturer or from W. H. Nichols Company. When ordering, be sure to provide complete nameplate data.

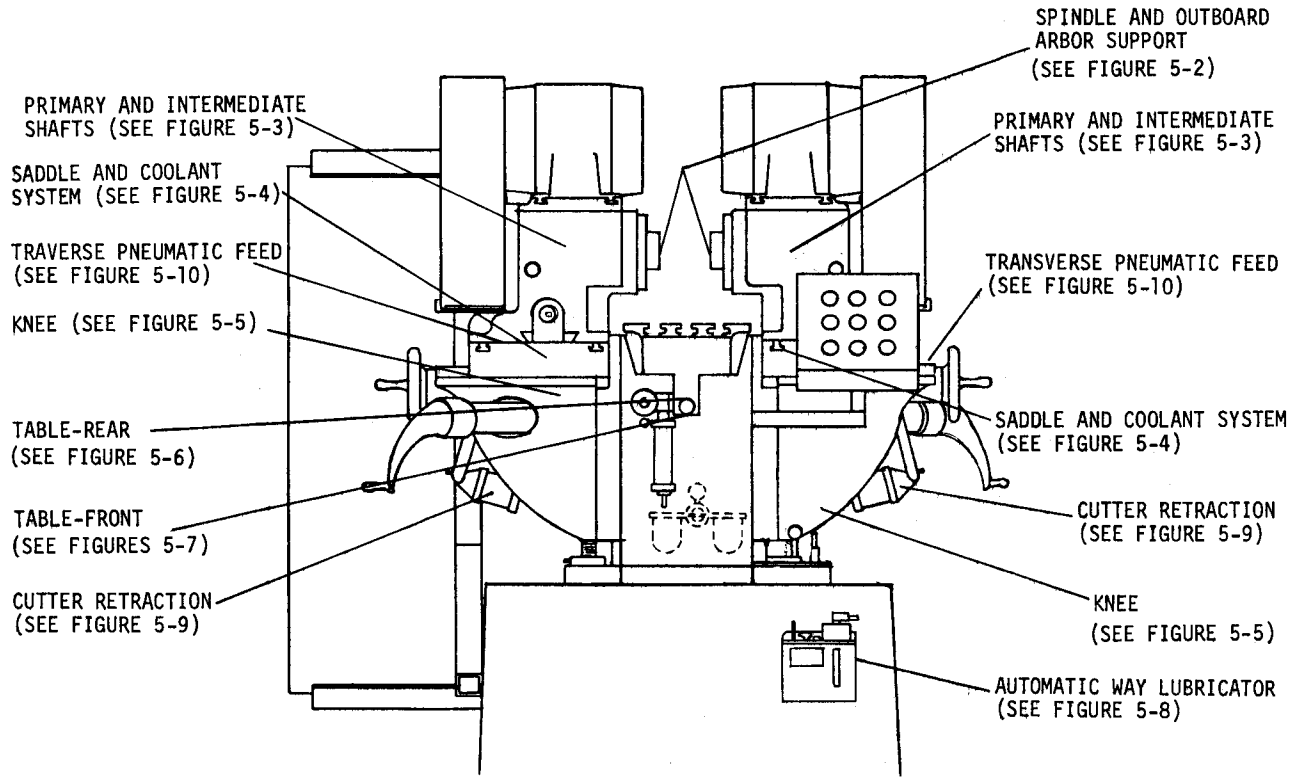


Figure 5-1. Assembly Location Diagram

28.31
3.09

Key No.	Part No.	Part Name	Quant.
1	45-78513-0002-1	Thumb Screw-Dial	2
2	45-15003-0002-1	Dial-No. 5 English	2
*	45-15003-0003-1	Dial-No. 5 Metric	
3	48-18901-0006-1	Grease Fitting-Alemite	4
4	45-05205-0007-2	Block-Screw Mounting	2
5	48-91537-1116-2	Screw-Socket Head Cap	6
6	45-78519-0002-2	Screw-Longitudinal Head Feed-English	2
*	45-78519-0003-2	Screw-Longitudinal Head Feed-Metric	2
7	48-91525-1016-2	Screw-Socket Head Cap	18
8	45-80511-0001-1	Spacer	2
9	48-91525-1024-2	Screw-Socket Head Cap	6
10	45-76205-0001-1	Retainer	2
11	45-59019-0001-1	Nut-Head Feed Screw	2
12	45-81003-0001-3	Spindle	2
13	48-93805-1012-2	Screw-Spindle Key	2
14	45-56010-0002-1	Key-Spindle	2
15	48-14002-0001-1	Detent-Bearing Cap	8
16	48-91531-1028-2	Screw-Socket Head Cap	8
17	45-08507-0008-2	Cap-Front Bearing	2
18	45-87501-0001-1	Flinger	2
19 20	48-04501-0008-1	Spindle Bearings Front (Pair)	2
21	45-78515-0003-1	Screw-Spindle Gear Detent	2
22	48-82001-0003-1	Spring-Detent	2
23	48-03001-0001-1	Ball-Detent	2
24	45-20006-0001-2	Gear-Spindle	2
25	45-56010-0005-1	Key-Sleeve	4
26	45-80001-0003-2	Sleeve-Spindle	2
27	48-04501-0006-1	Bearing-Rear Spindle	2
28	48-92731-1008-2	Screw-Socket Set-Flat Point	4
29	45-07801-0009-1	Pad-Spindle Nut	2
30	45-59009-0005-1	Nut-Spindle	2
31	45-08507-0007-2	Cap-Rear Bearing	2
32	48-92737-1010-2	Screw-Socket Set-Flat Point	4
33	45-59012-0002-2	Nut-Draw-in Rod	2
34	48-92348-1024-2	Screw-Draw-In Rod Nut	2
35	45-77502-0003-2	Rod-Draw-in	2
36	45-52002-0001-1	Knob-No. 1 Shifter-Spindle Gear	2
37	48-18308-0008-1	Pin-No. 1 Shifter Knob	2
38	45-77504-0002-1	Rod-No. 1 Spindle Gear Shifter	2
39	48-76504-0001-1	"O" Ring	2
40	48-92925-1008-2	Screw-Socket Set-Half Dog Point	2
41	45-02002-0001-2	Shifter Fork Assembly (Fork and Pins)	2
42	48-18901-0002-1	Grease Fitting-Alemite	2
43	Deleted		
44	48-95002-1043-2	Flange Nut	8
45	45-06503-0010-1	Tee Bolt-Head	8
*	45-50502-0004-2	Gib - Head - L.H.	1
46	45-50502-0005-2	Gib - Head - R.H.	1
47	48-91537-1124-2	Screw-Socket Head Cap	8
48	48-19504-0001-1	Window Unit - Bijur	2
49	45-07801-0007-1	Pad-Detent Screw Lock Screw	2
50	48-03001-0002-1	Ball-Detent	2
51	48-82001-0005-1	Spring-Detent	2
52	45-78515-0001-1	Screw-No. 1 Shifter Rod Detent	2
53	45-06503-0007-1	Tee Bolt-Motor	8
54	45-87510-0003-1	Washer-Hardened	8
55	48-59007-0004-1	Nut-Regular S.F.	8
56	45-07007-0003-1	Bracket-Overarm	2
57	48-96321-0150-2	Pin-Taper	2
58	45-73005-0001-1	Plug-Overarm Bracket	2
59	48-91548-1124-2	Screw-Socket Head Cap	8
60	48-78514-0001-1	Jack Screw	4
61	45-59502-0003-2	Overarm - 5" Arbor	2
*	45-59502-0005-2	Overarm -10" Arbor	2
62	48-04509-0002-1	Bearing-Thrust-Andrews	2
63	48-04502-0001-1	Bearing-Needle-Torrington	2
64	48-95003-1037-2	Nut-Regular S.F.	8
65	45-07007-0007-3	Overarm Support-L.H. or R.H.	2
66	45-06503-0009-1	Tee Bolt-Overarm Support	8
67	48-18927-0001-1	Pipe Plug - Socket	2
68	48-91531-1024-2	Screw-Socket Head Cap	8
69	48-90025-1016-2	Screw-Assembly-Button Head	16
70	45-07006-0013-1	Bracket-Upper-Guard	4
71	45-73011-0001-1	Vent Plug	2
72	45-62311-0004-4	Plate-Motor Mounting	2
73	45-07011-0005-1	Bracket-Guard Support	2
74	48-93725-1016-2	Screw-Wing	2
*	45-53003-0003-5	Head - L.H.	1
*75	45-53003-0004-5	Head - R.H.	1
*	45-51502-0007-3	Guard Belt L.H.	1
*	45-51502-0008-3	Guard Belt R.H.	1
*	48-62006-0001-1	Instruction Plate - Gear Box Lubrication	1
*	48-62005-0001-1	Name Plate	1
*	48-62008-0005-1	Speed Chart	1
*	48-93402-0006-2	Drive Screws	4
*	48-18927-0002-2	Drain Plug	2
76	45-56015-0002-1	Special Key	2

* Parts Not Shown

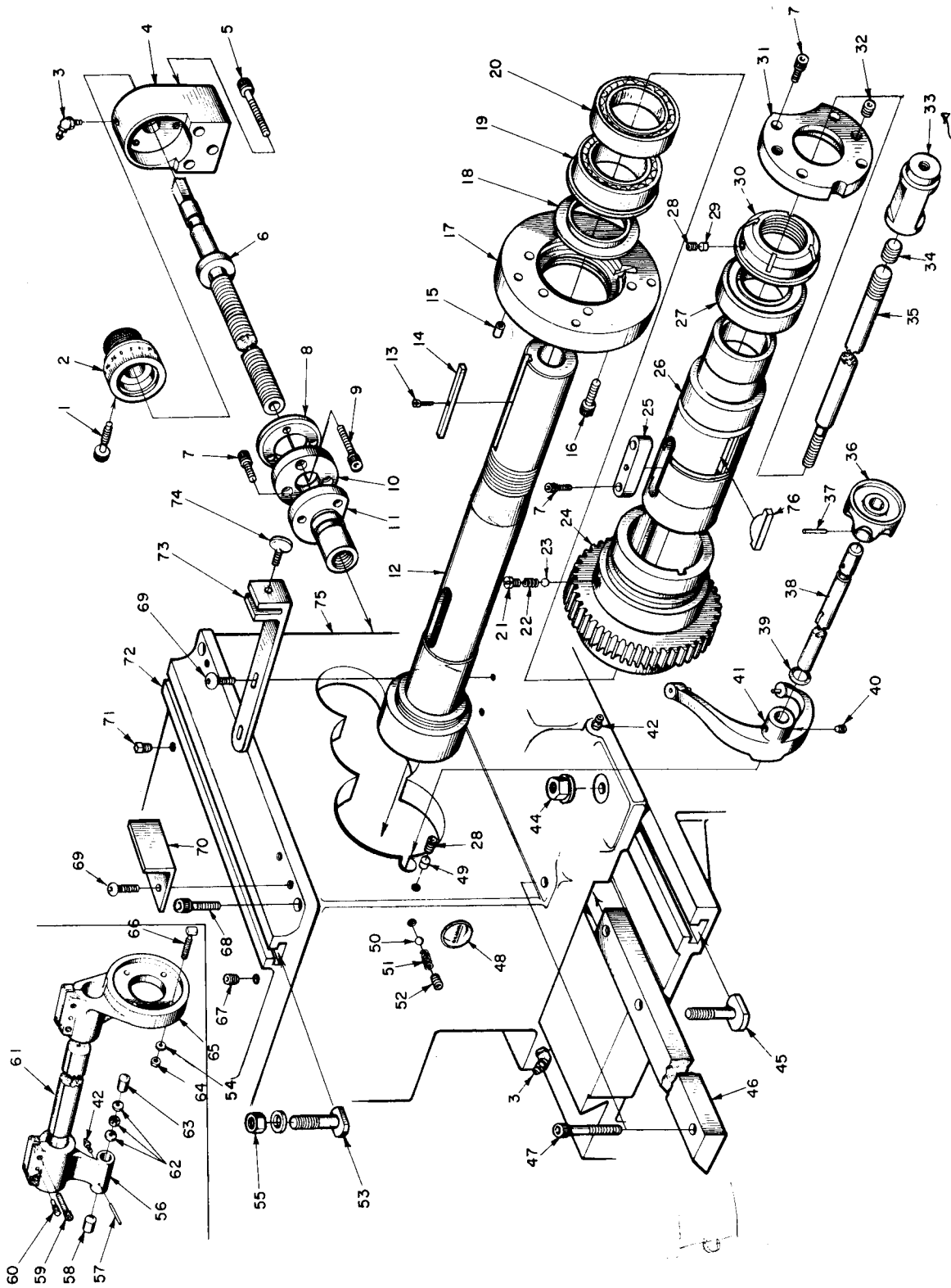


Figure 5-2. Spindle and Outboard Arbor Support

Parts List for Figure 5-3

Key No.	Part No.		Quant.
1	48-92743-1016-2	Screw-Socket Head Set	4
2	Deleted		
3	45-74008-0004-3	Pulley-Motor (60 Hz)	2
*	45-74008-0009-3	Pulley-Motor (50 Hz)	2
4	45-79504-0002-2	Primary Shaft	2
5	45-56010-0003-1	Key	2
6	48-56010-0001-1	Key - Primary Shaft Gear	2
7	45-20010-0001-1	Gear-Primary Shaft	2
8	48-92431-1016-2	Screw-Socket Set-Cup Point	2
9	48-18307-0001-1	Snap Ring-Internal-Waldes	2
10	48-04501-0001-1	Bearing-Intermediate Shaft	4
11	48-18304-0002-1	Snap Ring-External-Waldes	8
12	48-04501-0001-1	Bearing - Primary Shaft	4
13	48-79004-0001-1	Seal - Primary Shaft	2
14	48-93805-1012-2	Screw - 1/4 Sq. Key	2
15	45-07507-0001-1	Bushing-Pulley	2
16	48-92731-1008-2	Screw-Socket Set-Flat Point	2
17	45-74007-0004-3	Pulley - Large	2
18	48-05003-0004-1	Belt	2
19	48-18307-0007-1	Snopring-Internal	2
20	48-92525-1016-2	Screw-Socket Head Cap	14
21	45-07803-0001-1	Pad-Brass-Large Pulley	2
22	45-13016-0001-1	Cover-Intermediate Shaft	2
23	45-19806-0002-1	Gasket-Intermediate Shaft Cover	2
24	45-20004-0002-2	Gear-Cluster-50 Tooth	2
25	48-82001-0003-1	Spring-Detent	2
26	48-03001-0001-1	Ball-Detent	2

Key No.	Part No.	Part Name	Quant.
27	48-18304-0005-1	Snap Ring-Cluster Gear	2
28	45-20004-0001-1	Gear - Cluster - 31 Tooth	2
29	48-91510-1016-2	Screw-Socket Head Cap	4
30	45-56013-0001-1	Key - Cluster Gear	2
31	45-79502-0001-2	Intermediate Shaft	2
32	48-91525-1100-2	Screw-Socket Head Cap	2
33	45-77503-0004-1	Extension-No. 2 Shifter Rod	2
34	45-77504-0003-1	Rod-No. 2 Cluster Gear Shifter	2
35	48-03001-0002-1	Ball-Detent	2
36	48-82001-0005-1	Spring-Detent	2
37	45-78515-0001-1	Screw-No. 2 Shifter Rod Detent	2
38	48-76504-0001-1	"O" Ring	2
39	48-96319-0100-2	Pin-No. 2 Shifter Knob	2
40	48-52002-0002-1	Knob-No. 2 Shifter-Cluster Gear	2
41	45-19806-0001-1	Gasket-Primary Shaft Cover	2
42	45-13015-0002-1	Cover Primary Shaft R. H.	1
*	45-13015-0001-1	Cover Primary Shaft L. H.	1
43	48-91531-1100-2	Screw-Socket Head Cap	1
44	45-05203-0001-1	Guide-Hose Support Arm	1
45	48-19802-0002-1	Gasket-Head	2
46	48-92431-1020-2	Screw-Jack-Intermediate Shaft	2
47	48-92731-1008-2	Screw-Socket Set-Flat Point	2
48	45-07801-0008-1	Pad-Detent Screw Lock Screw	2
49	45-56010-0002-1	Key	2

* Parts Not Shown

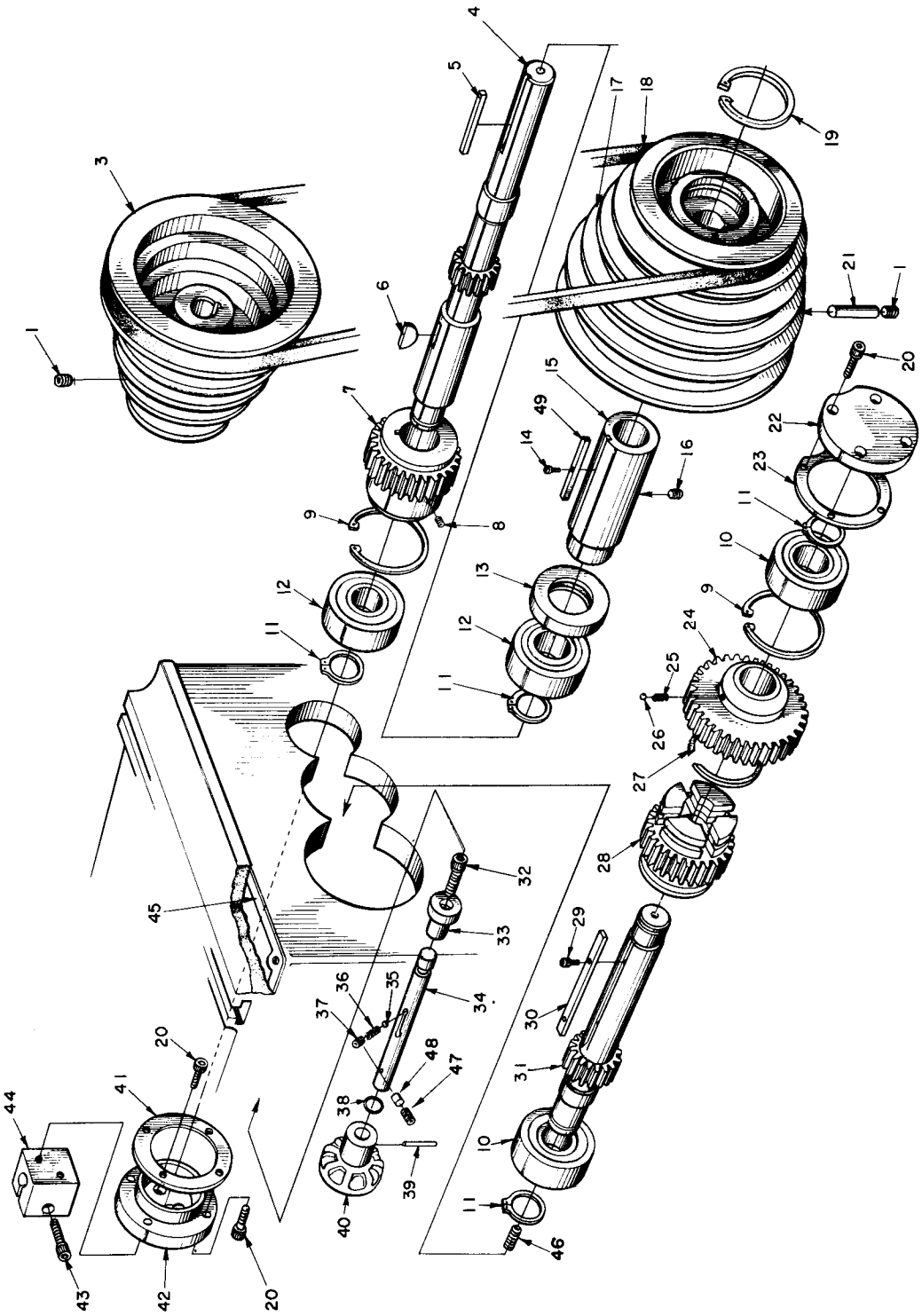


Figure 5-3. Primary and Intermediate Shafts

Parts List for Figure 5-4

Key No.	Part No.	Part Name	Quant.
1	48-91537-1020-2	Screw-Socket Head Cap	2
2	48-96003-0037-2	Washer-Plain	2
3	45-59003-0004-1	Nut-Dial Binder	2
4	45-87510-0002-1	Washer - Hardened	2
5	48-52003-0001-1	Handle - Handwheel	2
6	45-52501-0001-3	Handwheel	2
7	45-15002-0005-2	Dial-Transverse Feed-English	2
*	45-15002-0007-2	Dial-Transverse Feed-Metric	2
8	45-06501-0001-1	Bolt-Dial Binder	2
9	45-87507-0001-1	Washer - Handwheel	2
10	48-59008-0004-1	Locknut-Bearing-Whittet Higgins	2
11	48-91525-1016-2	Screw-Socket Head Cap	22
12	45-76201-0001-1	Retainer - Bearing	2
13	45-04508-0004-1	Side Race - Thrust Bearing	4
14	48-04508-0003-1	Bearing-Thrust-Torrington	4
15	45-80503-0004-1	Spacer-Thrust Bearing	4
16	45-04508-0005-1	Center Race-Thrust Bearing	2
17	45-78517-0001-2	Screw-Transverse	2
18	48-56007-0003-1	Key - Handwheel	2
19	45-73501-0007-2	Post - Saddle - Offset	2
20	48-91537-1208-2	Screw-Gib & Assembly-Socket Head Cap	6
21	45-52001-0002-1	Handle-Saddle Binder	2
22	45-59003-0002-1	Nut-Saddle Binder	2
23	48-04508-0006-1	Washer-Saddle Binder Nut Thrust	4
*	48-04509-0005-1	Thrust Bearing	2
24	45-59017-0003-1	Nut-Transverse	2
25	48-91550-1124-2	Screw-Socket Head Cap	2
26	48-91537-1208-2	Screw-Gib-Socket Head Cap	4
27	48-91537-1308-2	Screw-Gib-Socket Head Cap	4
28	45-50503-0005-2	Gib Saddle - R. H.	1
*	45-50503-0004-2	Gib Saddle - L. H.	1
29	45-84501-0002-3	Coolant Tank	1
30	48-13005-0002-3	Cover - Coolant Tank	1
31	48-95008-1025-2	Nut- Heavy S. F.	3
32	48-96101-0025-2	Spring Lock Washer-Heavy	3
33	48-90425-1024-2	Screw-Hex. Head Cap	3
34	48-74501-0001-1	Coolant Pump-220-440v.	1
35	48-18937-0003-1	Reducing Bushing	1
36	48-91531-1016-2	Screw-Socket Head Cap	2
37	48-95007-1037-2	Wing Nut	1
38	Assembled with item 39		
39	45-83504-0004-1	Strap - Oil Hose	1
40	45-18905-0009-1	Nipple-Nozzle	1
41	48-53502-0001-1	Coolant Hose Assembly	1
42	45-02004-0001-1	Arm-Support	1
43	45-05203-0001-1	Guide-Hose Support Arm	1
44	48-91531-1100-2	Screw-Socket Head Cap	2
45	45-13015-0002-1	Cover-Primary Shaft	1
*46	45-78004-0001-5	Saddle - L. H.	1
47	45-78004-0002-5	Saddle - R. H.	1
*48	48-18901-0001-1	Grease Fitting-Alemite	4
49	45-05209-0001-1	Block-Support	1

* Parts Not Shown

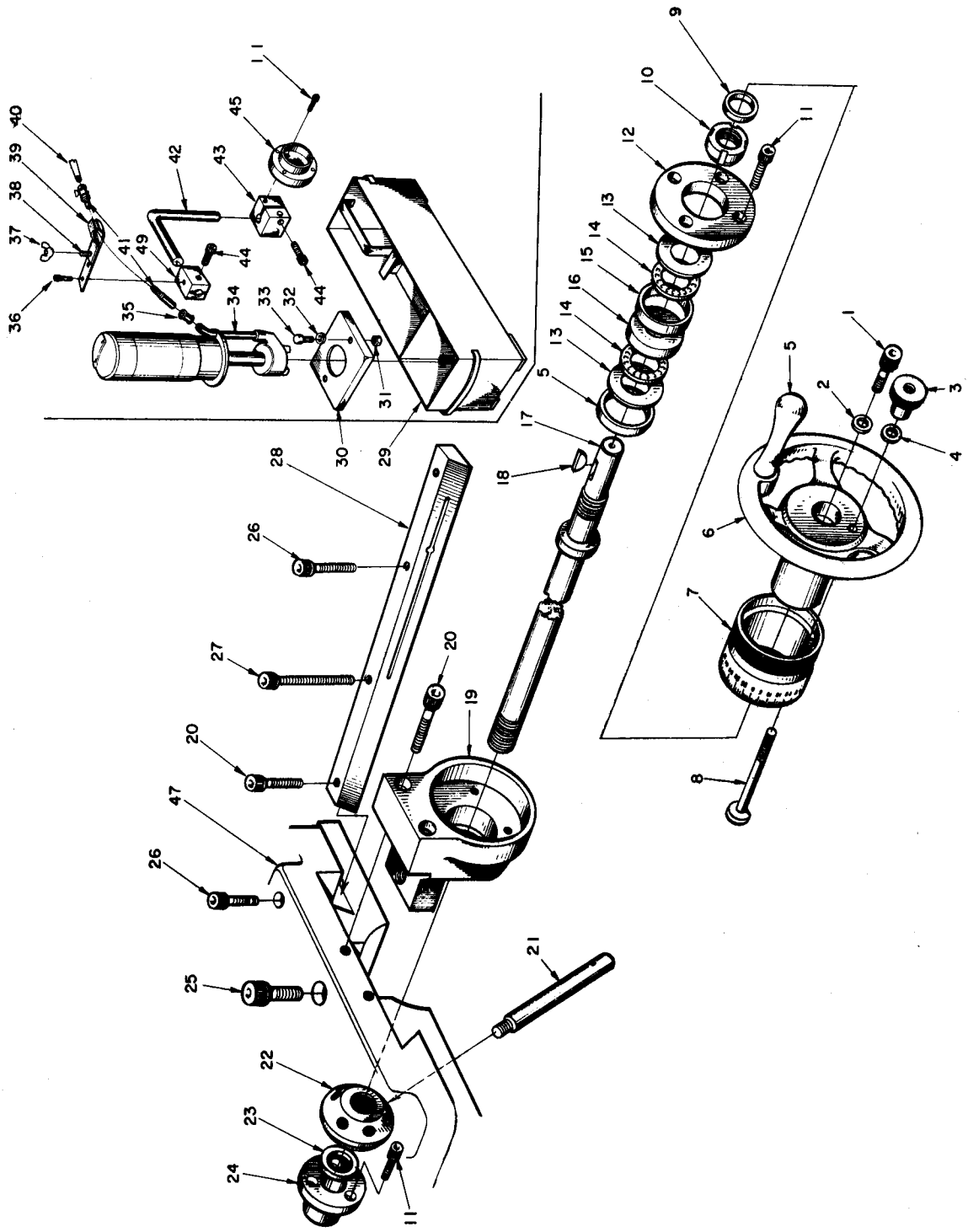


Figure 5-4. Saddle and Coolant System

45-52001-0008-0

Key No.	Part No.	Part Name	Quant.
1	~~48-78503-0012-0~~	Binder Knee	2
2	Deleted		
3	Deleted		
4	Deleted		
5	Deleted		
6	48-91537-1216-2	Screw - Gib - Socket Head Cap	8
7	45-50506-0001-2	Gib - Knee	2
8	48-52003-0001-1	Handle - Rockwood	2
9	45-13503-0001-2	Crank - Knee	2
10	48-56007-0001-1	Key - Dial Holder	2
11	45-79505-0001-2	Shaft - Elevating	2
12	48-95004-1013-2	Nut - Regular Jam	2
13	48-92431-1016-2	Screw - Socket Set- Cup Point	2
14	48-82001-0001-1	Spring - Crank Detent	2
15	45-14003-0002-1	Detent - Crank	2
16	48-91525-1016-2	Screw - Socket Head Cap	8
17	45-62303-0001-1	Plate - Crank	2
18	45-00511-0001-1	Holder - Dial	2
19	48-78520-0001-1	Screw - Hollow Lock	2
20	48-92431-1028-2	Screw - Socket Set - Cup Point	2
21	45-15002-0005-2	Dial - Knee-English	2
*	45-15002-0007-2	Dial - Knee-Metric	2
22	45-87513-0001-1	Washer - Dial Spring Thrust	2
23	45-07508-0001-1	Bushing - Elevating Shaft Inner	2
24	48-18901-0009-1	Grease Fitting - Alemite	2
25	45-86503-0002-2	Tube	2
26	48-91537-1016-2	Screw - Socket Head Cap	2
27	48-95002-1050-2	Flanged Nut	2
28	Deleted		
29	45-20009-0003-1	Gear - Large	2
30	45-20009-0002-1	Gear - Small	2
31	48-04509-0001-1	Bearing - Ball Thrust	2
32	48-96321-0125-2	Pin - Taper	1
32A	48-18303-0007-1	Snap Ring	2
33	45-10505-0002-1	Collar - Elevating Screw	2
34	45-78504-0001-2	Elevating Screw	2
35	48-91531-1028-2	Screw - Socket Head Cap	6
36	45-59004-0002-2	Elevating Nut	2
37	48-18901-0006-1	Grease Fitting - Alemite	2
*38	45-56501-0002-3	Knee	2
39	Deleted		
*40	48-18901-0001-1	Grease Fitting - Alemite	8
41	45-07508-0002-1	Bushing - Elevating Shaft Outer	2
42	45-61001-0001-1	Pin- Crank	2
*43	48-13013-0001-1	Cover	2
*44	48-90310-1012-2	Screw - Flat Head Machine	8
*45	48-92425-2008-2	Screw-Plug-Socket Set-Cup Point	2
46	48-82001-0008-1	Spring - Dial	4
*	48-82001-0002-1	Spring - Dial	4
47	48-04508-0001-1	Race - Torrington	4
48	48-04509-0004-1	Bearing - Needle Thrust	2

* Parts Not Shown

Parts List for Figure 5-5

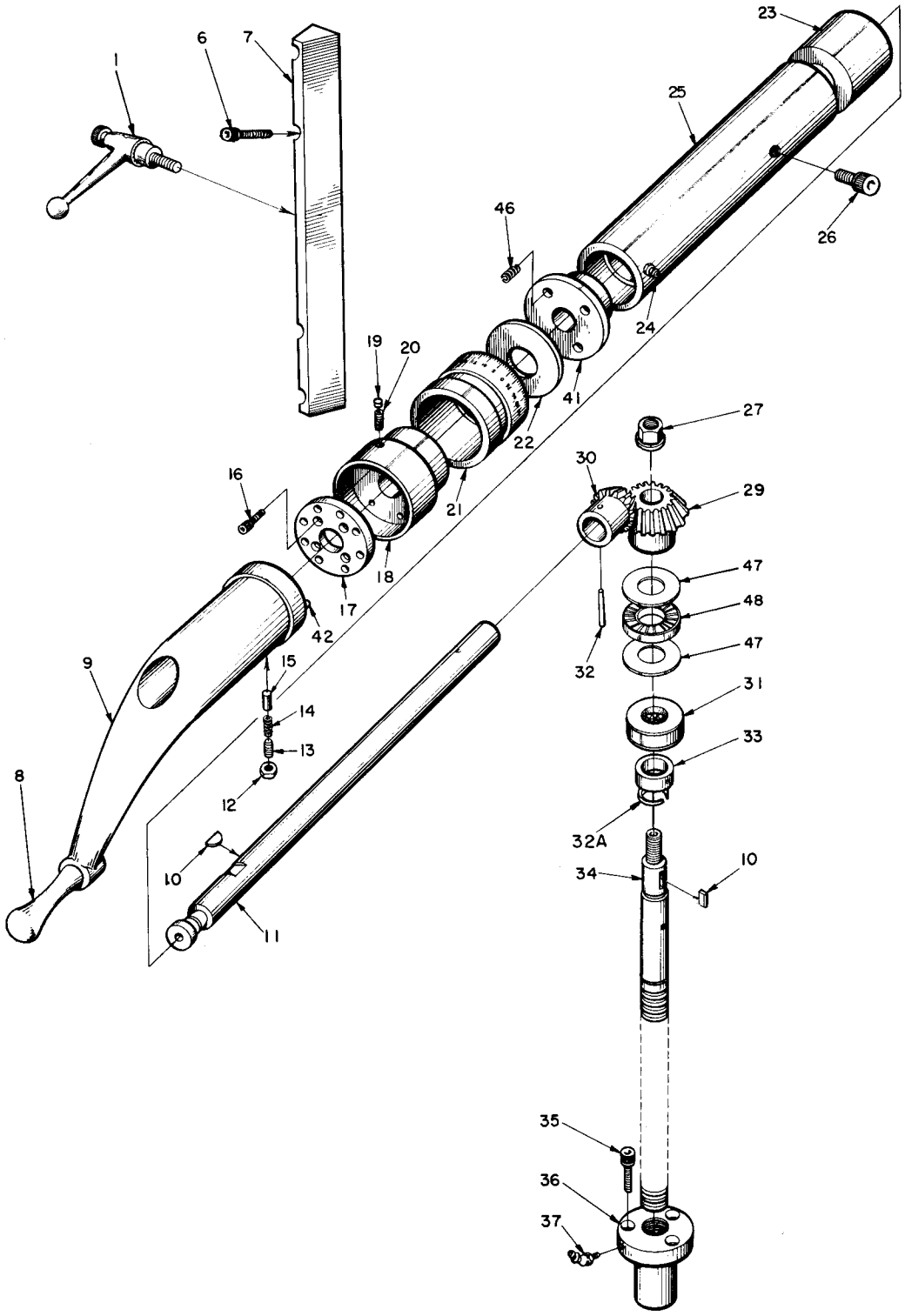


Figure 5-5. Knee

Key No.	Part No.	Part Name	Quant.
1	45-83003-0001-1	Stop - Shock Absorber	1
2	48-90037-1024-2	Screw-Button Head Socket Cap	2
3	48-90937-1100-2	Screw-Adjusting-Hex Head-Cap	1
4	48-95004-1037-2	Nut - Regular Jam	1
5	45-87511-0005-1	Plunger - Shock Absorber	1
6	48-82005-0002-1	Spring - Shock Absorber	1
7	45-84002-0002-4	Table - 36"	1
*	45-84002-0001-4	Table - 30"	1
**8	S10-41-2	Set Screw Bellows	1
**9	A2830	Nut Hydrocheck	1
10	45-08505-0004-3	Cap-Rear Table End	1
11	48-91225-1016-2	Screw-Round Head Machine	1
12	48-91531-1308-2	Screw-Socket Head Cap	4
13	48-95003-1031-2	Nut - Regular Jam	1
14	45-78501-0001-1	Screw - Dog Mounting	1
15	45-08005-0003-1	Dog - Circular	1
16	48-92431-1008-2	Screw-Socket Set-Cup Point	1
17	48-16805-0001-1	Limit Switch - Microswitch 1LS1	1
18	45-05205-0003-1	Block-Limit Switch Mounting	1
19	48-91525-1124-2	Screw-Socket Head Cap	2
20	45-07016-0003-3	Support-Rear-Air Motor-36" Table	1
*	45-07016-0001-2	Support-Rear-Air Motor-30" Table	1
21	48-91537-1024-2	Screw-Socket Head Cap	3
22	48-58502-0008-1	Air Motor - 36" Table	1
*	48-58502-0007-1	Air Motor - 30" Table	1
23	48-90437-1100-2	Screw-Hex Head Cap	2
24	45-87510-0003-1	Washer-Hardened	2
25	48-96102-0037-2	Washer - Spring Lock-Heavy	2
26	48-95003-1056-2	Nut - Reg.	2
27	48-18010-0002-1	Lubro - Unit - Norgren	1
28	Deleted		
29	Deleted		
30	Deleted		
31	Deleted		
32	Deleted		

Key No.	Part No.	Part Name	Quant.
33	Deleted		
34	45-50501-0004-4	Guard Air Motor 36" Table	1
*	45-50501-0005-4	Guard Air Motor 30" Table	1
35	45-73007-0001-1	Plug - Shock Nut	1
36	45-59016-0001-1	Nut - Shock	1
**37	A2428	Washer	1
**38	A2845	Nut-Hydro-Check Piston Rod	1
39	48-95001-2050-2	Nut - Acorn	1
40	Deleted		
41	Deleted		
42	45-18603-0001-1	Base Screen	1
43	48-58501-0005-1	Hydro-Check-36" Table	1
*	48-58501-0003-1	Hydro-Check-30" Table	1
44	48-95005-1012-2	Nut - Machine Screw	2
45	45-16006-0001-1	Stud-Lubro-Unit Mounting	2
46	Deleted		
*	48-90125-1016-2	Screw-Guard Mounting - Fillister Head Cap	4
*	48-91510-1124-2	Screw-Limit Switch Mounting - Socket Head Cap Screw	2
47	45-50507-0001-3	Gib - Table	1
48	48-91543-1108-2	Screw-Socket Head Cap	8
49	48-56009-0007-1	Key - Table Gib	2
50	Deleted		
51	48-18918-0002-1	Elbow Connector	4
52	48-18926-0002-1	Meter Unit No. FSA-1	4
53	48-18929-0001-1	Sleeve - Compression	4
54	48-18916-0001-1	Nut - Compression	4
*55	48-18913-0001-1	Adapter - Straight	4
*56	48-18915-0001-1	Bushing - Compression	4
*57	48-18012-0001-1	Tubing	12 ft

*Parts Not Shown
**Order from Bellows-Valvair Div. Akron, Ohio 44309

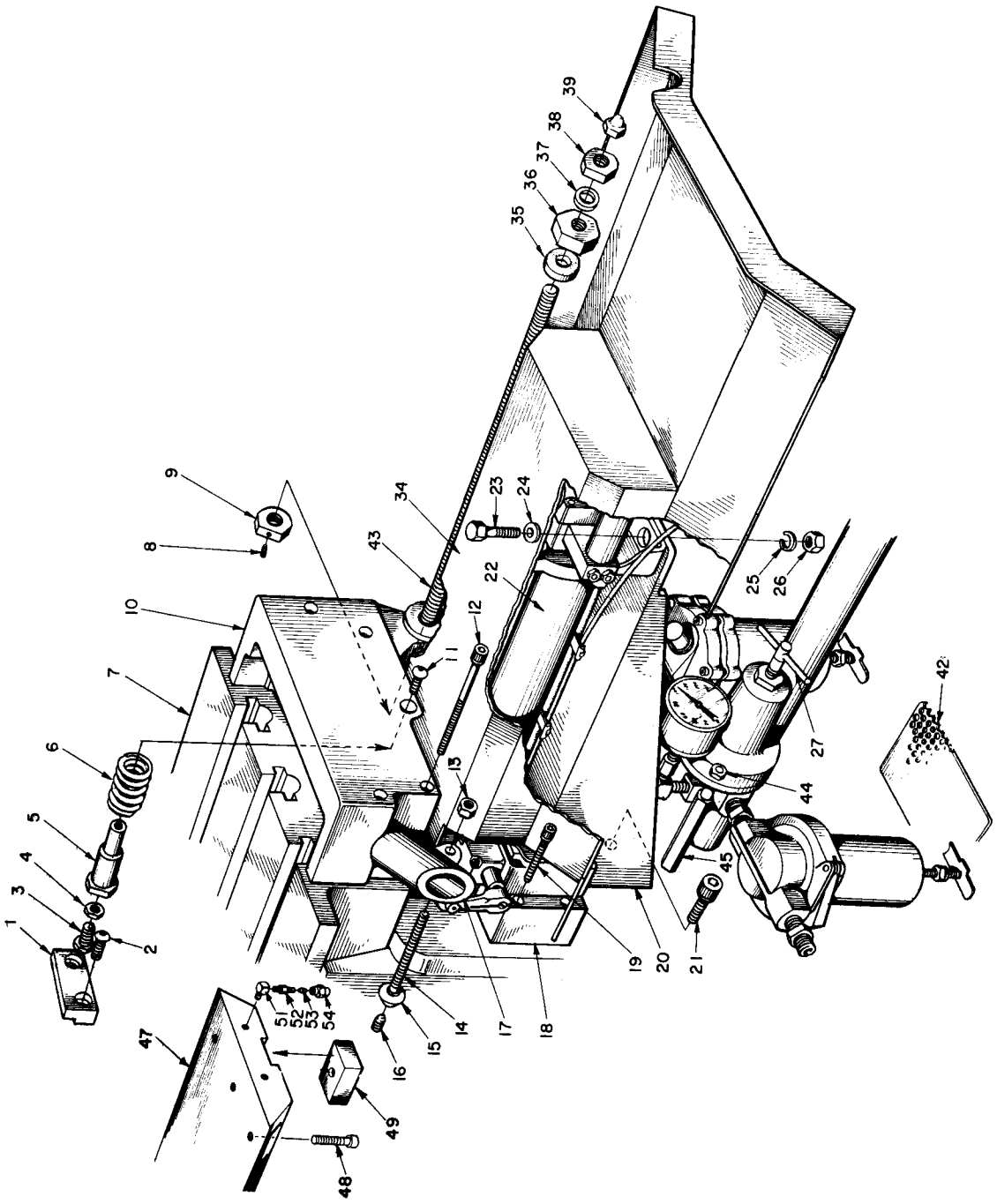


Figure 5-6. Table-Rear

Parts List for Figure 5-7

Key No.	Part No.	Part Name	Quant.
1	45-08505-0006-3	Cap-Front Table End	1
2	45-51505-0001-3	Guard-Balance Cylinder-30" Table	1
*	45-51505-0002-3	Guard-Balance Cylinder-36" Table	1
3	48-91531-1308-2	Screw-Socket Head Cap	4
4	48-58501-0005-1	Hydro-Check - 36" Table	1
*	48-58501-0003-1	Hydro-Check - 30" Table	1
5	48-96004-0050-2	Washer-Plain	1
6	48-95010-1050-2	Nut- Heavy Jam- S. F.	1
7	45-78509-0006-1	Screw- Table Stop	1
8	45-08504-0001-1	Cap - Table Stop Screw	1
9	Deleted		
10	Deleted		
11	Deleted		
12	48-92431-1028-2	Screw-Socket Set-Cup Point	1
13	45-08503-0004-1	Cap - Piston Rod	1
14	Deleted		
15	48-16805-0021-1	Limit Switch - Micro Switch	1
16	Deleted		
17	Deleted		
18	45-03507-0003-1	Bar-Piston Rod Support	1
19	48-90010-1016-2	Screw-Button Head Socket Cap	2
20	48-92710-1020-2	Screw-Socket Set-Flat Point	1
21	48-95005-1010-2	Nut-Machine Screw	1
22	45-07006-0005-3	Bracket	1
23	48-91537-1124-2	Screw-Socket Head Cap	2
*	48-91525-1016-2	Screw-Guard Mounting-Socket Head Cap	2
24	45-84002-0001-4	Table - 30"	1
*	45-84002-0002-43	Table -36"	1
25	48-95001-1050-2	Nut - Acorn	1
*26	45-07513-0001-1	Seal Bushing - (see footnote)	1
*27	45-76504-0006-0	"O" Ring - (see footnote)	1
28	45-05201-0001-1	Adapter Block	1
29	48-91525-1024-2	Screw - Socket Head Cap	2
30	48-91525-1016-2	Screw - Socket Head Cap	2
31	48-18927-0001-1	Pipe Plug - Hex Socket	2
*	45-07008-0019-3	Bracket - L.S. Mounting	1
*	45-62302-0086-2	Plate - L.S.	1
*	45-05205-0038-2	Block - L.S.	1

*Parts Not Shown

**Order from Bellows-Valvair Div. Akron, Ohio 44309

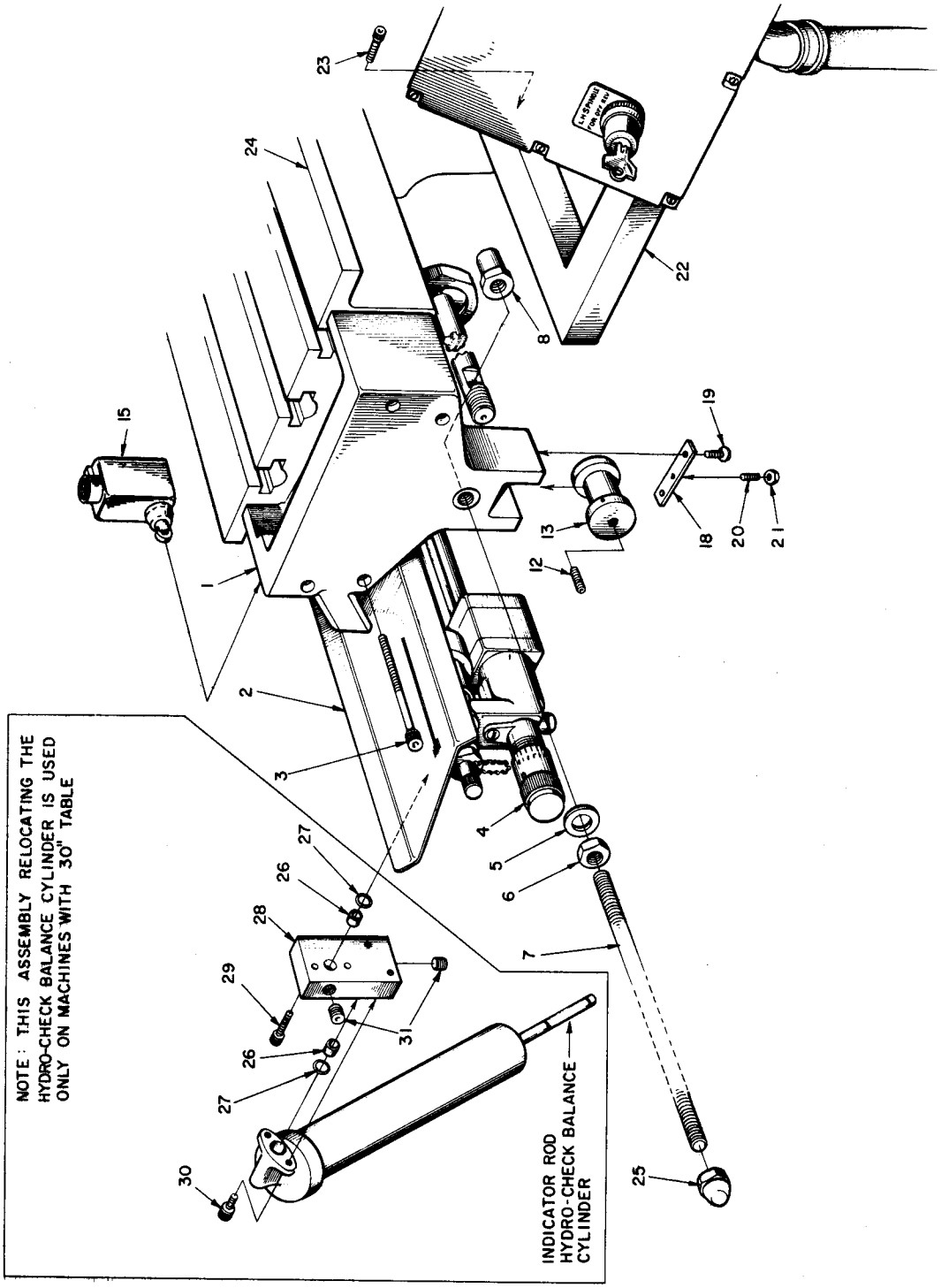


Figure 5-7. Table-Front

Parts List for Figure 5-8

Key No.	Part No.	Part Name	Quant.
1	48-18006-0004-1	Lubricator-Automatic Bijur No. D-2988	1
2	48-93825-1012-2	Screw-Lubricator Mounting 1/4-20 x 3/4 long	2
3	48-62006-0007-1	Plate-Instruction	1
4	48-18924-0004-1	Junction-7 Way	1
5	48-18924-0002-1	Junction-5 Way	4
6	48-18928-0001-1	Closure Plug	6
7	48-18916-0001-1	Nut-Compression	13
8	48-18926-0001-1	Meter Unit	12
9	48-18918-0001-1	Elbow-Connector	8
10	48-18915-0001-1	Bushing-Compression	25
11	48-18929-0001-1	Sleeve-Compression	38
12	48-18918-0001-1	Elbow Adapter-90°	4
13	48-00501-0002-0	Bulkhead Fitting	2
14	48-18012-0001-1	Tubing-Copper-12 ft	1
15	48-02501-0003-1	Hose Assembly	2
16	48-18918-0002-1	Elbow Adapter	4
17	48-18911-0002-1	Elbow Adapter	3

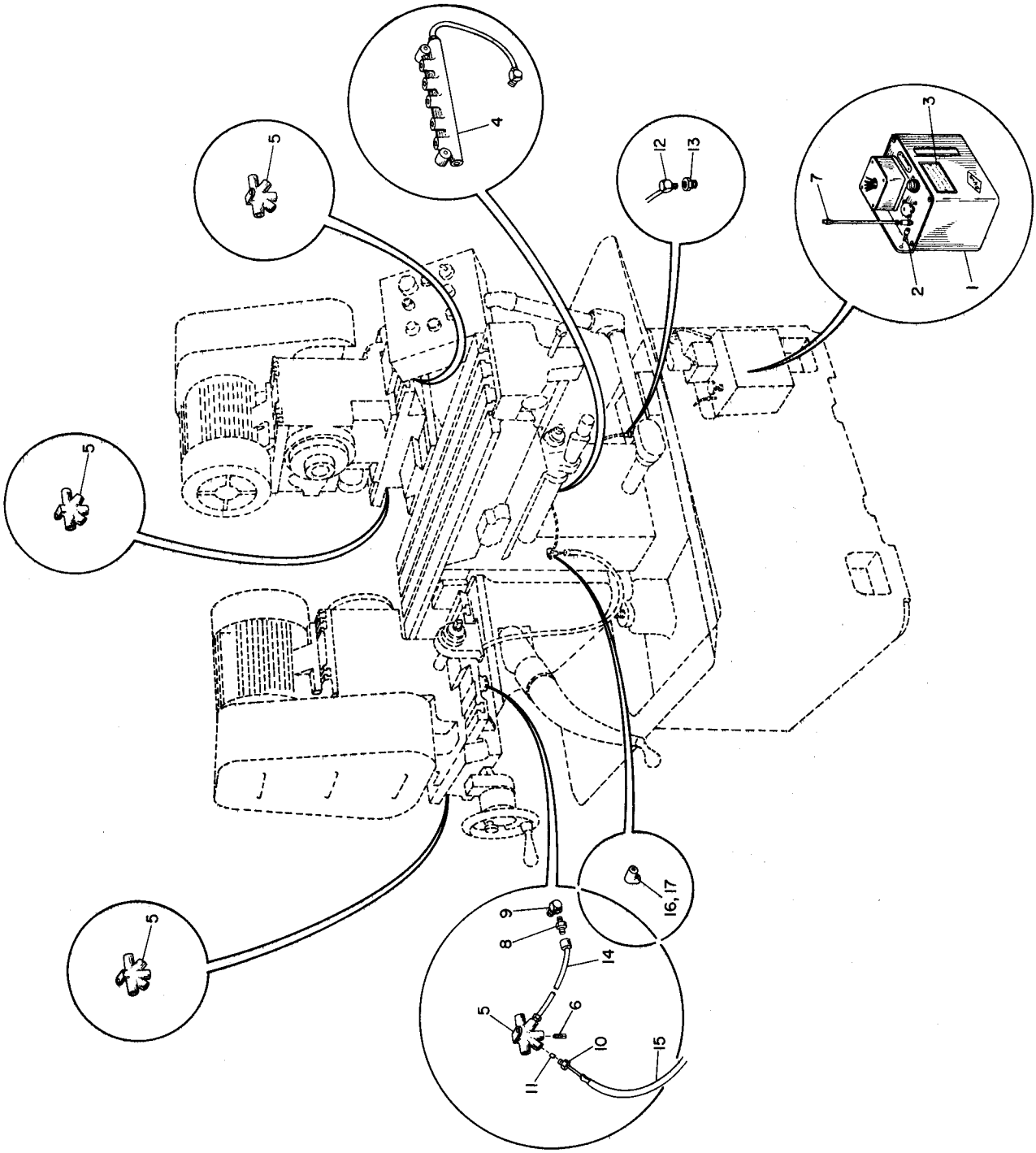


Figure 5-8. Automatic Way Lubrication

Parts List for Figure 5-9

Key No.	Part No.	Part Name	Quant.
1	45-62305-0002-1	Plate - Thrust	2
2	45-59005-0002-1	Nut - Floating	2
3	45-05203-0002-1	Block - Guide	4
4	45-07015-0001-2	Bracket - Upper Pivot	2
5	48-91543-1124-2	Screw - Socket Head Cap	8
6	48-92925-1012-2	Screw-Socket Set-Half Dog Point	4
7	45-61004-0001-1	Pin - Arm Pivot	2
8	48-92406-1004-2	Screw-Socket Set-Cup Point	4
9	45-02001-0001-2	Arm	2
10	48-04503-0001-1	Bearing - Floating Nut	4
11	48-04503-0002-1	Bearing - Arm Pivot Pin	4
12	48-92425-2006-2	Screw-Socket Set-Cup Point	4
13	45-03509-0001-1	Side Piece - Arm - L.H.	2
*	45-03509-0002-1	Side Piece - Arm - R.H.	2
14	48-91537-1100-2	Screw - Socket Head Cap	4
15	48-18308-0002-1	Dowel	2
16	48-18918-0001-1	Elbow Connector	2
17	48-18918-0002-1	Elbow Connector	2
18	48-18926-0002-1	Meter Unit No. FSA-1	2
19	48-18929-0001-1	Sleeve - Compression	2
20	48-18916-0001-1	Nut - Compression	2
21	48-02501-0001-1	Hose Assembly - 10"	4
22	48-18901-0006-1	Grease Fitting - Alemite	2
23	48-53501-0003-1	Hose-Air-Junction to Cylinder	4
24	48-18919-0001-1	Hose Connector-3/8 I.D. Hose	2
25	48-18922-0001-1	Elbow - 90° Street	1
26	48-58502-0010-1	Air Motor - Standard Retraction	2
27	45-02508-0001-1	Block-Lower Pivot	2
28	45-03501-0001-1	Bar - Lower Pivot	1
29	45-07505-0001-1	Bushing - Retracting Adjusting	1
30	45-59008-0002-1	Locknut - Retraction Adjusting	1
31	45-59015-0001-1	Nut - Retraction Adjusting	1
32	45-10001-0001-1	Jam Nut	1
33	48-91502-1100-2	Eye - Piston Rod	1
34	48-90462-1100-2	Screw - Socket Head Cap	1
35	48-92925-1008-2	Screw-Socket Set-Half Dog Point	1
36	48-53501-0004-1	Hose-Air-Elbow to Junction	1
37	48-18927-0004-1	Pipe Plug-Square Head	1
38	48-18931-3002-1	Pipe Tee	2
39	48-615-1-0001-1	Pipe	2
40	48-18922-0003-1	Elbow - Standard - 90°	1
41	48-18905-0005-1	Nipple - Long	1
42	48-18937-0002-1	Reducing Bushing	1
43	48-18931-0003-1	Tee - Pipe	1
44	48-18905-0002-1	Nipple - Hex Close	1
45	Deleted		
46	Deleted		
47	Deleted		
48	Deleted		
49	Deleted		
50	Deleted		
51	48-18906-0000-2	Quick Coupler Assembly - 1/4" - Hansen	1
52	48-18905-0003-1	Nipple - 3"	1
*	48-00501-0001-0	Adapter, Bulkhead	2

*Parts Not Shown

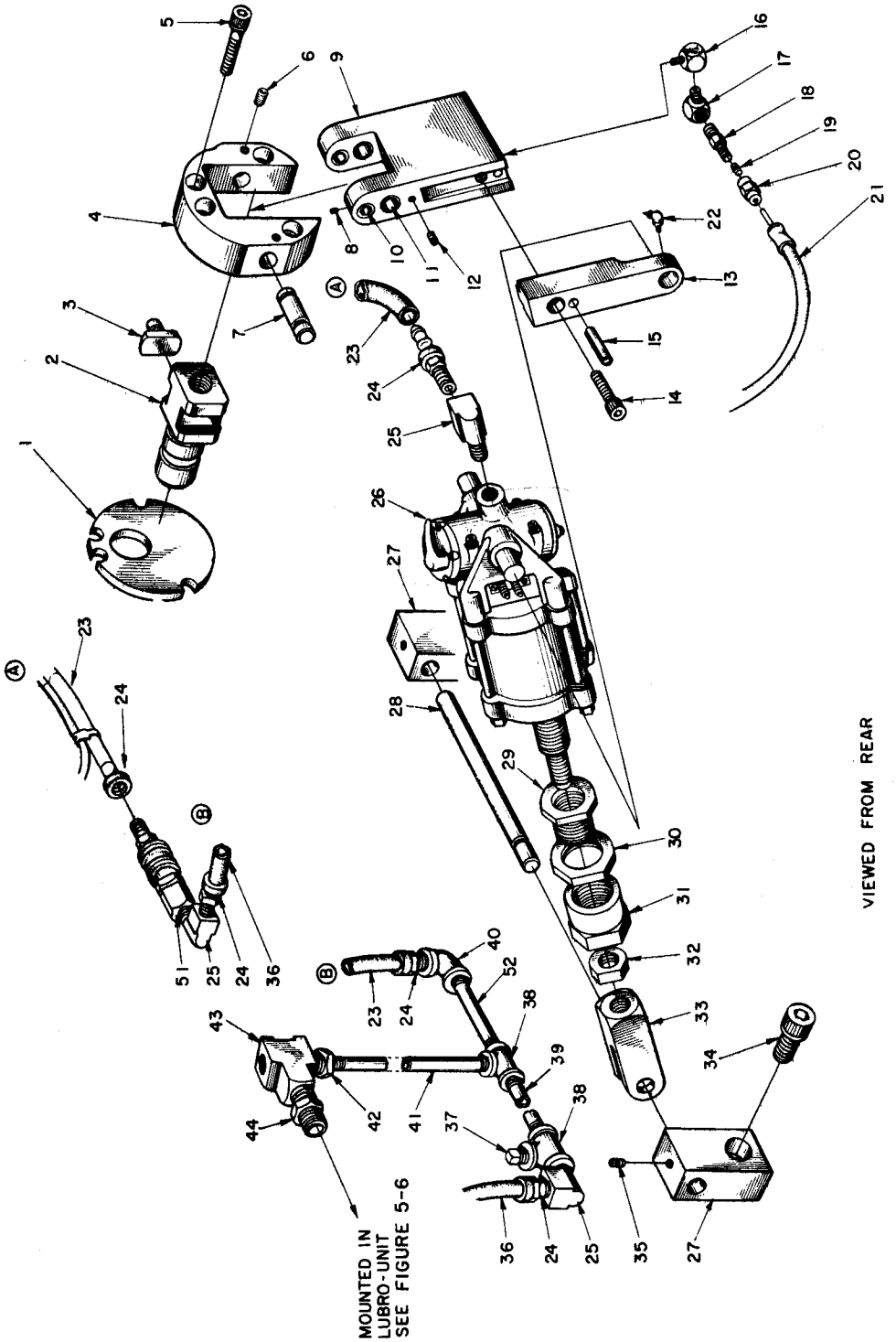


Figure 5-9. Cutter Retraction

Parts List for Figure 5-10

Key No.	Part No.	Part Name	Quant.
1	45-62302-0001-2	Plate-Saddle Way Protector	4
2	48-91208-1008-2	Screw-Flat Head Mach.	8
3	45-50508-0001-1	Gib - Ways Plate	4
4	45-62302-0001-2	Plate - Way Protector	4
5	48-90310-1020-2	Screw - Flat Head Mach.	8
6	45-51506-0001-3	Protector - Way	1
7	45-78513-0002-1	Thumb Screw	1
8	45-15003-0002-1	Dial - No. 5	1
9	48-18901-0006-1	Grease Fitting-Alemite	1
10	45-05205-0007-2	Block - Screw Mounting	1
11	48-91537-1116-2	Screw-Socket Head Cap	3
12	45-78519-0002-2	Feed Screw - Head	1
13	45-80511-0001-1	Spacer	1
14	48-91525-1024-2	Screw-Socket Head Cap	3
15	48-91525-1016-2	Screw-Socket Head Cap	3
16	45-76205-0001-1	Retainer	1
17	45-59019-0001-1	Nut - Feed Screw - Head	1
18	48-91537-1100-2	Screw-Socket Head Cap	4
19	48-91550-1200-2	Screw-Socket Head Cap	2
20	48-95008-1043-2	Nut - Heavy S. F.	8
21	48-96004-0043-2	Washer - Tee Bolt	8
22	48-78001-0003-3	Auxiliary Saddle-L. H. or R. H.	2
23	45-06503-0005-1	Tee Bolt - Head - 3rd Slide Type	8
24	45-08503-0003-1	Cap- Piston Rod	1
25	45-08504-0001-1	Cap - Stop Screw	1
26	45-78509-0003-1	Screw - Saddle Stop	1
27	48-95010-1050-2	Nut - Heavy Jam	1
28	45-73501-0008-3	Post - Saddle	1
29	45-51501-0003-3	Guard-Air Motor	2
**30	S234	Nut 3/4-16	1
31	48-58502-0005-1	Air Motor-Transverse Feed	1
32	45-07010-0005-3	Bracket-Hydro-Check	1
**33	S269	Nut Hydrocheck Mounting	1
**34	A2830	Nut Hydrocheck Piston Rod	1
**35	A2845	Nut Hydrocheck Piston Rod	2
36	48-91543-1124-2	Screw - Socket Head Cap	4
37	45-62305-0004-1	Thrust Plate	2
38	45-06503-0010-1	Tee Bolt	8
39	45-07006-0014-1	Bracket-Limit Switch Mounting	2
40	48-16805-0003-1	Limit Switch-Micro Switch No. BZE-2RQ9	2
41	48-96004-0025-2	Washer - Plain	2
42	48-90125-1016-2	Screw-Fillister Head Cap	2
43	45-08001-0001-1	Dog - Limit Switch Trip	2
44	48-92425-1008-2	Screw-Socket Set-Cup Point	2
45	45-77501-0001-1	Rod - Trip Dog	2
46	45-00509-0001-1	Bar - Rod Mounting	1
47	48-95008-1037-2	Nut - Regular S. F.	2
48	48-95004-1037-2	Nut - Jam - Regular S. F.	2
49	48-58501-0008-1	Hydro-Check-Transverse Feed	2
50	48-18922-0001-1	Street Elbow	1
51	48-18906-0001-1	Quick Coupler Assy-Hansen	1
*52	48-18906-0002-1	Plug-Quick Coupler	2
53	45-78005-0001-3	Saddle-3rd Slide Type -L. H.	1
*53	45-78005-0002-3	Saddle-3rd Slide Type- R. H.	1
54	45-50502-0002-2	Gib - Head-3rd Slide Type	2
55	45-50501-0001-2	Gib - Auxiliary Saddle	2
56	45-53003-0001-2	Head-3rd Slide Type-L. H.	1
*56	45-53003-0002-2	Head-3rd Slide Type -R. H.	1
*57	48-18901-0002-1	Grease Fitting - Alemite	8
*58	45-50503-0002-2	Gib-Saddle-3rd Slide Type-L. H.	1
58	45-50503-0003-2	Gib-Saddle-3rd Slide Type-R. H.	1
59	48-90025-1016-2	Screw-Button Head Socket	4
60	48-53501-0004-1	Hose - Air	1

* Parts not shown

** Obtain From Bellows Valvair Division, Akron, Ohio 44309

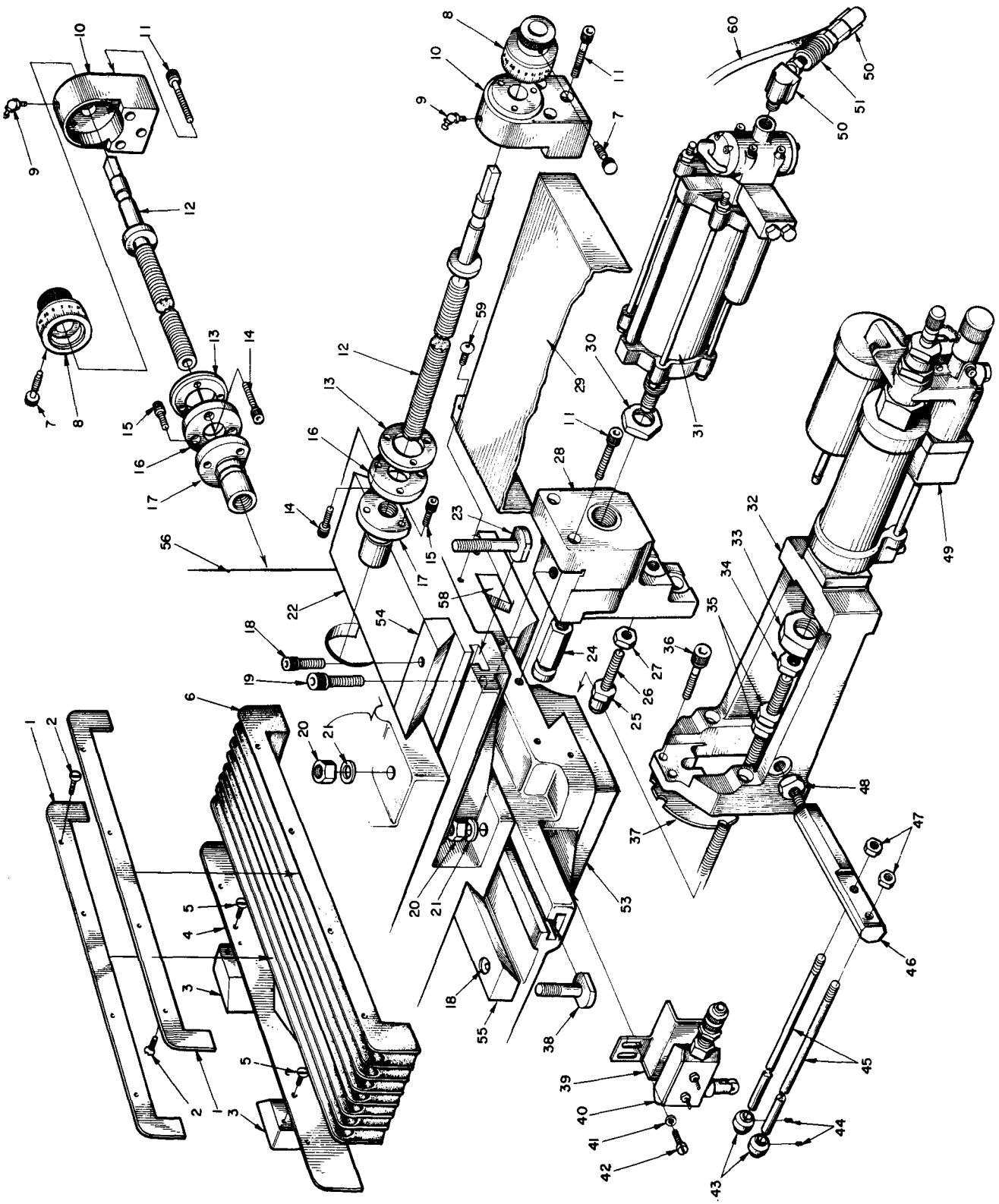


Figure 5-10. Transverse Pneumatic Feed

SUPPLEMEMENT

COVERING ELECTRIC BALL-SCREW FEED

The instructions contained in Chapters 1 through 5 of this manual apply, except for the differences noted in this supplement.

CHAPTER 1 - GENERAL INFORMATION

The Twin Mill with Electric Ball-Screw Table Feed (42 02518 0013 0) is similar to the Standard Twin Mill with Air Table Feed and 36" Table (41 51205 0006 2), except that it incorporates a ball-screw table feed, which is driven by a variable speed, reversible DC motor.

CHAPTER 2 - INSTALLATION

Same as for Standard Twin Mill 41 51205 0006 2 except:

Delete paragraph 2-13.

Add the following paragraph:

2-16A. Move the table to center manually with its hand crank. Select a low forward and reverse feed rate for jogging the table, set SS-9 to "Manual" and set dials on potentiometers on main pushbutton station, approximately to position 2. Turn TABLE JOG switch to IN to move the table away from the operator and then OUT to move the table toward the operator. The limit switch (LS2) on the left front of the column should stop the table when it is moving in, and the limit switch (LS3) on the right rear of the column should stop the table when it is moving out. If these switches do not function correctly, make the necessary adjustments before proceeding further.

2-17. Applies only to machines equipped with automatic head retraction.

Replace paragraph 2-19 with the following:

2-19. With the handle on the air pressure regulator under the drip pan on the rear of the column adjust the air pressure at the gauge to 15 psi less than the line pressure to ensure proper retraction operation. An operating pressure of 85 psi is recommended, so a line pressure of 100 psi is required.

Replace paragraph 2-20 with the following:

2-20. The Twin Mill is now ready for final set up. The positions of the cams on the table that actuate the limit switches are determined by the milling to be performed.

NOTE

A momentary dwell period is provided at the end of each table stroke before it returns to the start position to permit the cutter to clear itself of chips.

CHAPTER 3 - OPERATION

Same as for Standard Twin Mill 41-51205 0006 2, except:

Delete figures 3-1 and 3-2 and replace paragraph 3-5 with the following:

3-5. TABLE CYCLE. Twin Mills with ball-screw drives are shipped with the table centered on the column, and, as a safety feature, the table cannot be automatically cycled without its stroke being initiated from the starting position. To set the table feed, it is therefore necessary to move the table to the starting position manually by means of the table feed hand crank or electrically by activating the table JOG OUT switch. The table initial start position, the cutting stroke start position, and the table end of stroke position are governed by limit switches mounted on the column and cams located on the sides of the table. Limit switch actuating positions are set as necessary to accommodate the type of work being performed. The front end table stop screw may only be used with the dwell at the end of the table stroke, and the cam must actuate the limit switch (LS2) prior to the table reaching the solid stop. Basically, the table rapid advances from the starting position to the point at which the cutting stroke starts, then feeds slowly through the cutting stroke, and rapid returns to the starting position. The cutting feed rates are adjusted by means of potentiometers on the pushbutton station.

Add the following to Table 3-1:

40	Forward Feed Rate Potentiometer
41	Reverse Feed Rate Potentiometer
42	Retraction In-Off-Out Selector Switch
43	Spare
44	Auto-Manual Selector Switch
45	Heads In-Out Selector Switch
46	Table Jog In-Out Selector Switch

In addition, supplement Figure 3-4 with Figure 3-4A.

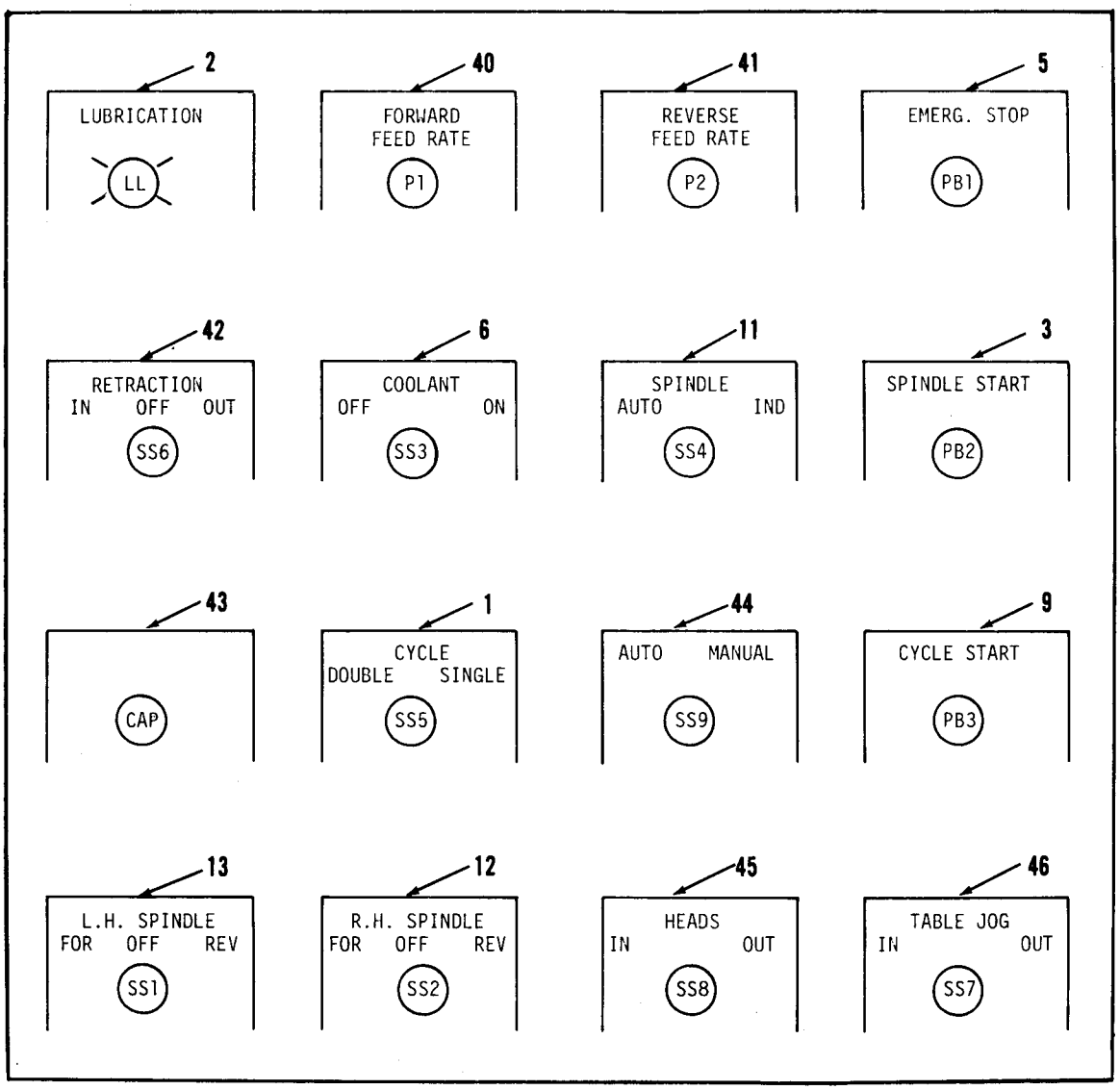


Figure 3-4A. Operator's Control Station for Electric Ball-Screw Feed

Replace paragraph 3-14 with the following:

3-14. Feed Stroke Starting Point. To set the starting point of the feed stroke, which is the termination of the rapid advance, mount the cutters (one LH and one RH) on the spindles, and move the table forward (by jogging or manually) until the cutters are approximately where the feed stroke should begin. At the same time, make the approximate vertical, transverse, and longitudinal head adjustments with their respective micrometer screws. If the heads are to be offset longitudinally from one another, be sure that the one nearer the loading position is used for locating the starting point of the feed stroke. At this point, position the cam on the right side of the table, at the front, so that it just closes limit switch LS-1.

Replace paragraph 3-15 with the following:

3-15. Feed Stroke End Point. To set the end of the feed stroke, move the table by jogging or manually to the point where the feed stroke is to be completed. Adjust the cam on the left side of the table, at the rear, so that it closes limit switch LS-2. This switch actuates a time delay relay in the electrical panel that returns the table to the starting position. This relay is adjustable, with a range of 0.2 to 60 seconds.

Replace paragraph 3-16 with the following:

3-16. Table Operation Check. It is recommended that test or dry runs of the Twin Mill be made before actual production cuts are taken. With the spindles operating independently of the table cycle (SPINDLE AUTO/IND switch SS-4 at IND) and the FORWARD FEED RATE P-1 set at 0, start the cycle by pressing the CYCLE START PB-3 pushbutton. The table will rapid advance and almost stop when limit switch LS-1 closes. Turn the SPEED CONTROL dial slowly and the table will continue on through the feed stroke and complete the cycle. From here, finer adjustments on the cams and positioning of the heads can be made. Continue taking trial cuts on the work piece until the desired dimensions are obtained.

Delete paragraph 3-17.

Delete steps a.) through f.) of paragraph 3-18, and add the following:

1. When Cycle SS-5 switch is set on SINGLE CYCLE, the following three optional cycles are available by using Retraction SS-6 switch.

a. When Retraction switch is placed in the OFF position: heads do not move; table rapid advances and feeds to dead stop; table rapid returns to loading position.

NOTE

Rapid advance is factory set, feed forward is set by forward potentiometer, and rapid return is obtained by adjusting reverse potentiometer.

b. When Retraction switch is placed in the OUT position: heads move in and table rapid advances and feeds to dead stop; heads move out and table rapid returns to loading position.

c. When Retraction switch is placed in the IN position: heads move out and table rapid advances and feeds to dead stop taking rough cut; heads move in and table reverse feeds taking finish cut; table rapid returns to loading position.

NOTE

Cam operated limit switch LS4 on left rear of column can be adjusted to determine point of rapid return from reverse feed; reverse potentiometer must be adjusted to obtain desired return feed rate.

2. When Cycle switch is set on DOUBLE (Retraction switch can be in any position), the cycle is: table rapid advances and feeds to dead stop taking rough cut; table rapid returns to loading position; heads move in and table rapid advances and feeds to dead stop taking finish cut; heads move out and table rapid returns to loading position.

NOTE

Reverse potentiometer must be adjusted to obtain desired rapid return rate.

3. To adjust the amount of head retraction, proceed as follows:

a. Mount the necessary gauges and/or instruments on the table for measuring retraction.

b. Set the Auto-Manual Selector switch SS-9 at MANUAL.

c. Press the HEADS IN and the HEADS OUT push buttons as necessary to position the heads for determining the amount of retraction.

d. Adjust the gap as required, and lock the retraction adjusting nut with its lock nut (see figure 3-3).

4. To adjust the speed of the retraction air motor, use the speed adjusting screws as follows:

a. Adjust the lower screw for the rate of infeed of the head.

b. Adjust the upper screw for the rate of outfeed of the head.

Delete Paragraphs 3-19 and 3-20.

CHAPTER 4 - MAINTENANCE

Same as for Standard Twin Mill 41 51205 0002 0, except:

Add the following paragraphs:

4-6A. The ball-screw drive bearings (item 11 on plate 5-6A) are lubricated by applying 600W grease, or equal, every 40 hours of operation.

4-11A. The ball-screw nut should not be disassembled without consulting the manufacturer or W. H. Nichols Company, as damage to the ball-screw could result. The ball-screw nut preload is factory adjusted and no attempt should be made to adjust it in the field.

Delete from Table 4-1 the Possible Causes and Remedies of table operation resulting from the air table feed, and add the following:

Trouble	Probable Cause	Remedy
Erratic table motion	Loose electrical connections	Tighten connections referring to wiring diagram.
	Dirt in limit switch	Clean contacts.
	Faulty SCR drive	Remove and return to manufacturer.

CHAPTER 5 - REPAIR PARTS LIST

Same as for Standard Twin Mill 41 51205 0002 0, except:

Delete From Figures 5-6 and 5-7 and their associated Parts List all parts used with the air table feed, and add Parts List for Figure 5-6A and Figure 5-6A.

Key No.	Part No.	Part Name	Quant.
1	45 13502 0001 2	Crank-Wrench	1
2	45 15002 0009 2	Dial - 3" Table Feed	1
3	45 78513 0002 1	Thumb Screw - Dial	1
4	48 91525 1016 2	Screw - Socket Head Cap	7
5	45 08516 0005 2	Cap - Feed Screw Cover	1
6	48 59008 0012 1	Locknut - Bearing	1
7	48 87505 0002 1	Lockwasher - Bearing Locknut	1
8	48 91525 1024 2	Screw - Socket Head Cap	6
9	45 19806 0003 1	Gasket	1
10	45 76201 0005 1	Retainer - Bearing	1
11	48 04505 0011 1	Bearings - Feed Screw	2
12	45 80503 0010 1	Spacer - Bearing	1
13	45 10503 0004 1	Collar - Bearing Retaining	1
14	48 91537 1316 2	Screw - Socket Head Cap	6
15	45 08505 0020 3	Cap - Front	1
16	45 62302 0152 3	Plate - Spacer - Front	1
17	48 91537 1112 2	Screw - Socket Head Cap	4
18	45 62302 0151 3	Plate - Spacer - Rear	1
19	45 08505 0019 3	Cap - Rear	1
20	48 91537 1400 2	Screw - Socket Head Cap	6
21	45 56004 0022 1	Key - Coupling to Motor Shaft	1
22	48 58503 0115 0	Motor - Table Feed	1
23	48 13023 0001 1	Cover - Feed Screw	2
24	45 78518 0013 2	Screw - Ball Feed	1
25	45 08505 0018 2	Cap	1
26	48 92410 2024 2	Screw - Hex Socket Set	3
27	48 91537 1100 2	Screw - Socket Head Cap	4
28	45 62302 0107 3	Plate - Bracket Mounting	1
29	45 07006 0049 2	Bracket - Ball Feed Nut Lock	1
30	48 91531 1024 2	Screw - Socket Head Cap	4
31	48 59018 0005 1	Nut - Ball Feed	1
32	45 12503 0006 1	Coupling - Ball Screw to Motor Shaft	1
33	48 96321 0125 2	Pin - Taper	1
*	45 84002 0007 3	Table	1

*Not shown.

Parts List for Figure 5-6A

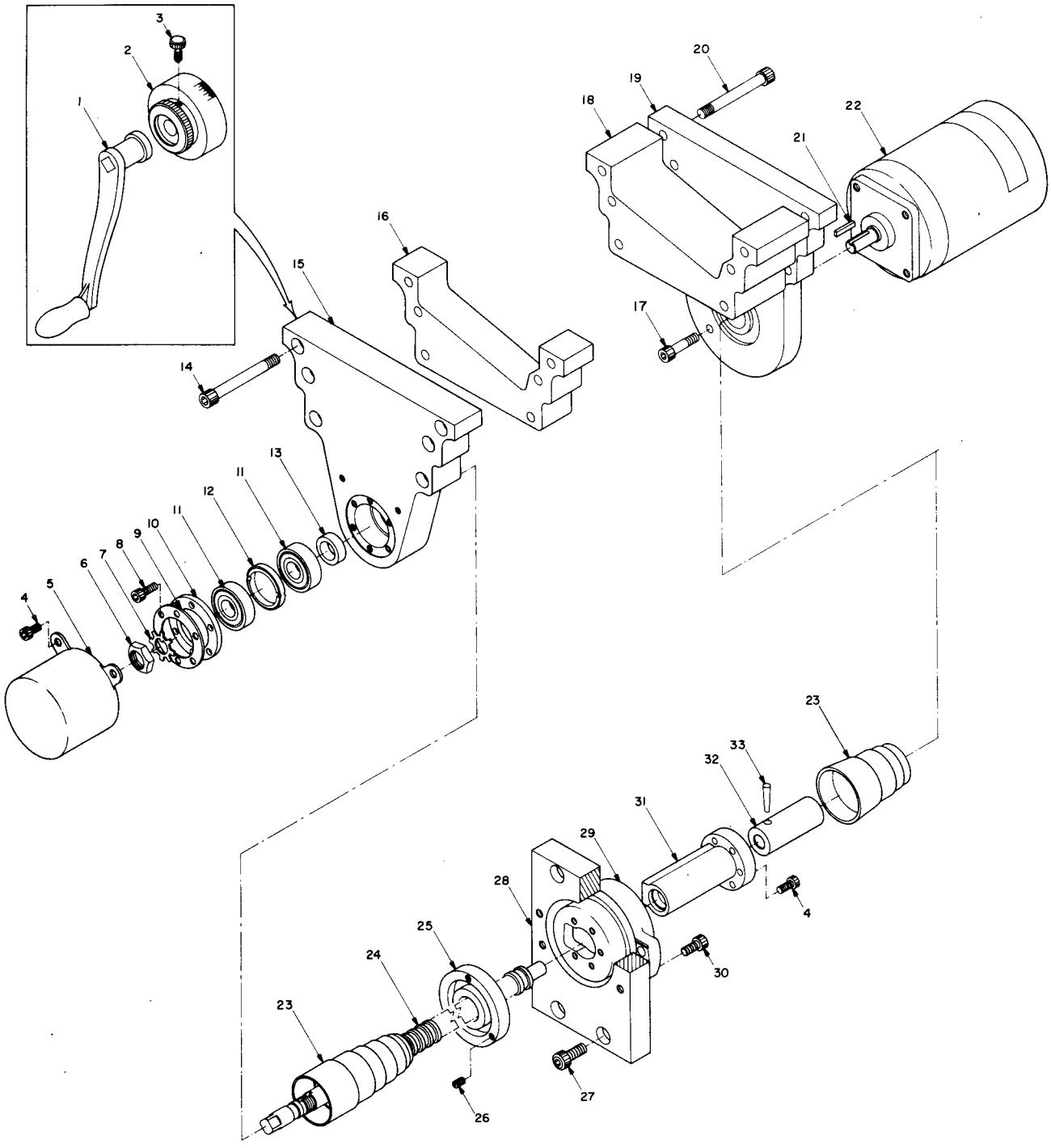


Figure 5-6A. Electric Ball-Screw Feed