TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS LIST)

FOR

GRINDING MACHINE, SURFACE RECIPROCATING MODELS 618, 618PH, 618H, 818, 818PH (BROWN & SHARPE MFG. CO.) (NSN 3415-00-223-6336)

HEADQUARTERS, DEPARTMENT OF THE ARMY

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Technical Manual

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HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 15 July 1981

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(BROWN & SHARPE MFG. CO.)
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REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2, located in the back of this manual direct to: Commander, US Army Armament Materiel Readiness Command, ATTN: DRSAR-MAS, Rock Island, IL 61299. A reply will be furnished direct to you.

NOTE

This manual is published for the purpose of identifying an authorized commercial manual for the use of the personnel to whom this equipment is issued.

Manufactured by: Brown & Sharpe Mfg. Co.
Precision Park
Frenchtown Road
North Kingstown, RI 02852

Procured under Contract No. DAAA09-79-C-4767

This technical manual is an authentication of the manufacturers' commercial literature and does not conform with the format and content specified in AR 310-3, Military Publications. This technical manual does, however, contain available information that is essential to the operation and maintenance of the equipment.

INSTRUCTIONS FOR REQUISITIONING PARTS

NOT IDENTIFIED BY NSN

When requisitioning parts not identified by National Stock Number, it is mandatory that the following information be furnished the supply officer.

1 - Manufacturer's Federal Supply Code Number - 09058

2 - Manufacturer's Part Number exactly as listed herein.

3 - Nomenclature exactly as listed herein, including dimensions, if necessary.

4 - Manufacturer's Model Number - 618, 618PH, 618H, 818, 818PH

5 - Manufacturer's Serial Number (End Item)

6 - Any other information such as Type, Frame Number, and Electrical Characteristics, if applicable.

7 - If DD Form 1348 is used, fill in all blocks except 4,5,

6 - and Remarks field in accordance with AR 725-50.

Complete Form as Follows:

(a) In blocks 4, 5, 6, list manufacturer's Federal Supply Code Number-_____followed by a colon and manufacturer's Part Number for the repair part.

(b) Complete Remarks field as follows:
Noun: (nomenclature of repair part)
For: NSN: 3415-00-223-6336
Manufacturer: Brown & Sharpe Mfg. Co.

Model: 618, 618PH, 618Hi, 818, 818PH
Serial: (of end item)

Any other pertinent information such as Frame Number, Type, Dimensions, etc.

OPERATION & MAINTENANCE OF THE 618 & 818

SERIES SURFACE GRINDING MACHINES

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INSTALLATION

The following instructions for proper placement and preparation of the machine will insure subsequent operation at its full capabilities for precision performance.

Location

The machine should be installed on a firm, level foundation or floor that provides rigid, vibration-free support. When location is on an upper floor, choose a place where there is maximum structural bracing below it. If it is necessary to locate the machine where some vibration is unavoidable, Isolation Mountings should be used.

Moving the Machine

A fork truck of sufficient capacity to lift the machine is usually available, and this is the most efficient means of transferring it to its chosen location. The base of the machine is designed to accommodate the forks. These should be spaced so that, approaching from the left side, one is inserted in the slot at the bottom rear of the machine and the other below the lower front of the machine (see Fig. 1A).

With some trucks, the fork length may be insufficient to extend fully under the machine. If so, the table end guard should be removed and the table moved to the extreme right.

Caution: Do not attempt to lift the machine with forks in any other position than those provided.

Lifting with Slings

If a fork lift truck is not available, rope slings may be rigged for raising and moving the machine with a chain lift. Place wood blocks or other protective material between the slings and the machine to prevent strain and damage to any sensitive parts.

Caution: Never locate slings under the upright base or the table bed.

Removing Braces

The machine is shipped with a brace holding the upright in position and a block under the spindle head, inside the upright. These serve for protection during shipment (see Fig. 1A).

Remove the brace and the block after the machine is moved to its selected location.

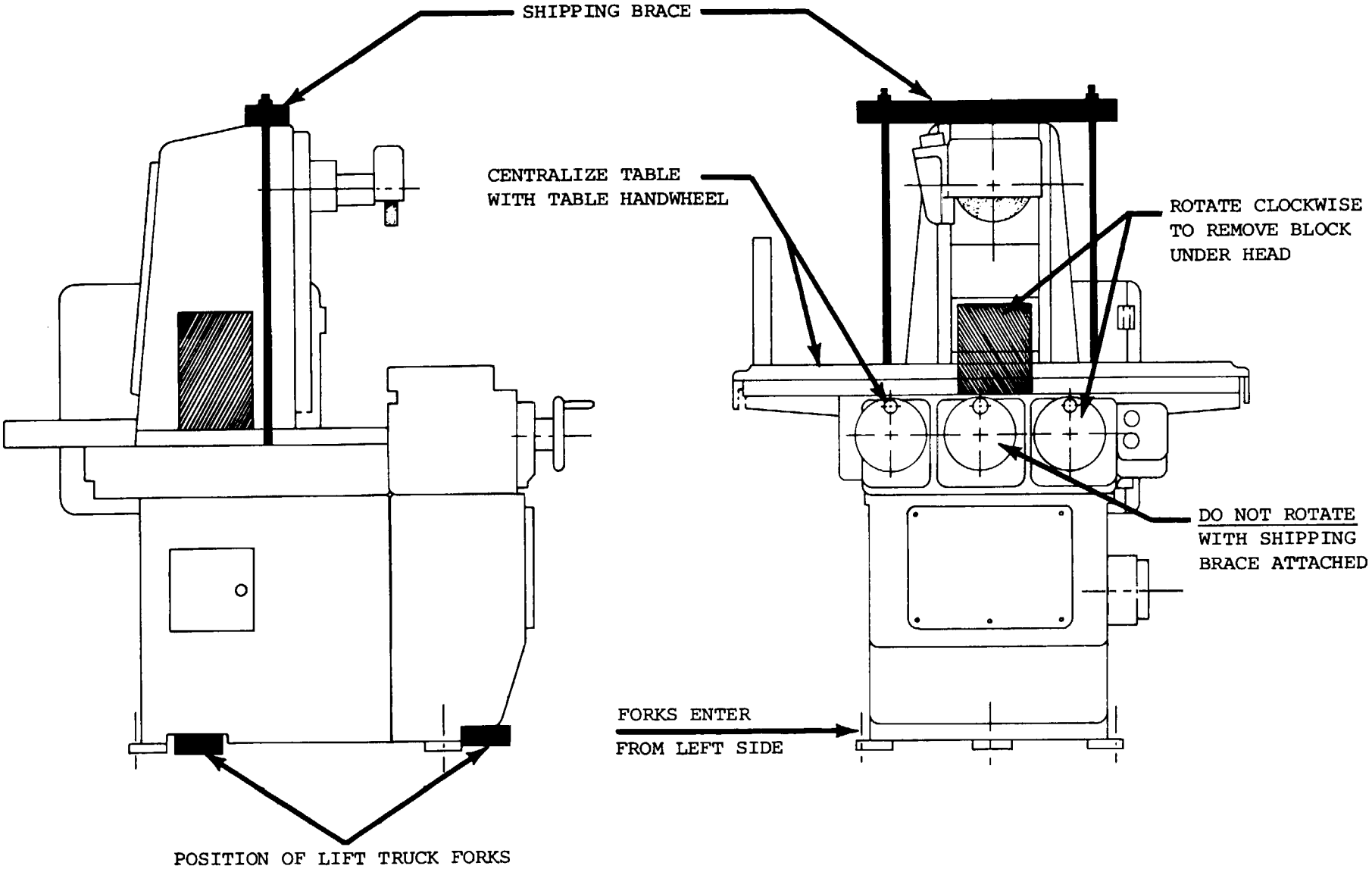

Fig. 1A. Machine arranged for shipment.

It is recommended that the upright brace and block be re-installed at any time the machine is moved to another location. The upright is held to the upright base solely by its own weight. If the upright is lifted or tilted, without the holding brace in position, serious damage could be done to the cross feed screw, elevating splined shaft, and crossfeed piston rod. It is also recommended that the table be securely fastened to the table bed.

Leveling

With the table in centered position, test the surface both longitudinally and transversely with a precision spirit level. Place shims under any machine foot as required to correct the level. Tighten the lag screw, then test the level of the table again, in both directions. Readjust again with shims if necessary.

Connecting to Power Supply

Connecting the machine to the power line, properly grounded, is the next step in installation. The lines from the power source should be connected to the control panel through the hole provided in the back of the cabinet. Specifications for the electrical system are printed on a plate affixed to the control cabinet door.

Checking Motor Rotation

Before operating a newly connected machine, check the direction of motor rotation as follows:

Press the Start button, then immediately press the Stop button. Observe the direction of rotation of the wheel spindle. The spindle should rotate clockwise as seen from the front. If the direction of rotation is counterclockwise, reverse one phase of the power supply. This is done conveniently by transposing two of the wires at the line disconnect switch. Do not change the internal wiring of the machine. The wiring as installed at the factory gives the proper relationship of hydraulic pump motor rotation to spindle motor rotation. Also, both motors have been correctly wired to their respective overload relays.

Filling the Oil Reservoir

The hydraulic system and the lubricating system of the grinding Machine are served by a common oil reservoir, which must be filled before the machine is operated. Note: It is also advisable to check the reservoir before start-up of any machine that has not been operated for a prolonged period of time.

Open the access door on the left side of the machine and fill the reservoir. Add oil until the level reaches the Full mark on the sight gage located on the same side of the machine (see Fig. 2A). Oil requirements are as follows:

For Hand Feed machines Fill the oil reservoir with approximately 6 gallons (22.7 liters) of high lubricity slide way oil with a viscosity of 150 SUS (32 CST) at 100° F (38° C), which complies to ASLE W-150 standards.

For Power Feed machines Fill the oil reservoir with approximately 22 gallons (83.3 liters) of "combination hydraulic fluid and slide way lubricant" with a viscosity of 150 SUS (32 CST at 1000 F (380 C), which complies with ASLE W-150 standards.

After filling the new machine reservoir (and after changing the oil at any time) run the pump for about an hour with the table throttle lever in the Off position. This will distribute oil throughout the system and remove air from the hydraulic cylinders. When this run is completed, check the sight gage and add oil as necessary to bring it to the Full level.

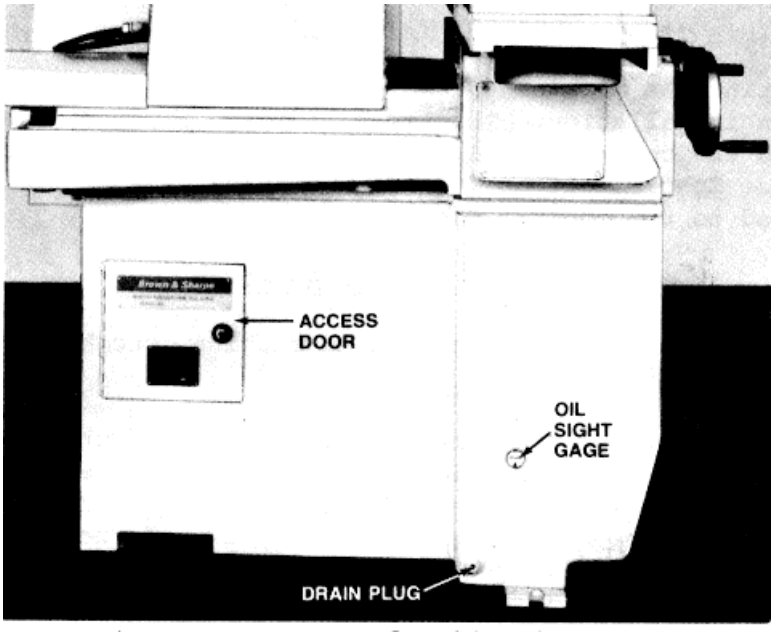

Fig. 2A. Lower left side of machine.

Relocating the Machine

At any time it is necessary to move the machine to a new location in the plant, follow the same directions as for original installation. It is recommended that the upright brace and spindle head support block (received with the new machine) be replaced before the machine is moved.

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OPERATING CONTROLS AND INDICATORS

The controls, indicators and other devices necessary for operation of the machine are listed and described below, and are indicated by corresponding numbers on the accompanying illustrations (Figs. 1B, 2B and 3B).

Functions of Controls

1. MACHINE START PUSHBUTTON
On Hand Feed machines starts spindle motor. On Power Feed machines starts spindle motor and the motor for the hydraulic pump that pressurizes the hydraulic and lubrication systems. Note:
The machine will not start unless the table throttle lever (Item 14) is in the OFF position.

2. MACHINE STOP PUSHBUTTON
Stops all machine operations at end of work period. Also serves as emergency stop.

3. ELEVATING HANDWHEEL
Rotation of this handwheel counterclockwise feeds the spindle down .050" (1 mm) per revolution. The handwheel has an adjustable dial graduated to read to .0002" (.005 mm).

4. INDICATOR RING CLAMP
For clamping the handwheel (3) adjustable dial in set position.

5. FINE FEED DIAL
Clockwise rotation of this dial feeds the spindle down. The dial is graduated to read to .0001", (.001mm).

6. FINE FEED LOCK
A clockwise turn engages the Fine Feed Dial (5). When unclamped, the fine feed dial is inoperative, and spindle feed is accomplished with the Elevating Handwheel (3).

7. CROSS FEED DIRECTION LEVER
A three position control, with the center position neutral. Pulling the lever forward moves the upright forward hydraulically. Pushing the lever back moves upright in reverse direction.

8. CROSS FEED MOUNT KNOB

Rotate counterclockwise to increase the pick-feed of the upright from .010" (.25nm) to .250" (6.35mm) per pick.

9. CROSS FEED MODE (3-position selector)

Truing position Provides a fine upright feed, 10" per min. (254 mm/min.). The Cross Feed Direction Lever (7) selects the direction. Used for Truing the wheel from the table. There is a mechanical interlock to prevent hydraulic table movement in this position.

Grinding position In this position, the upright will feed at each table reversal when the Cross Feed Direction Lever (7) selects the direction.

Rapid traverse position The upright rapid traverse rate is 12 fpm (3.6m/min) and will operate when the direction is selected by use of the Cross Feed Lever (7). A mechanical interlock prevents hydraulic table movement in this position.

10. CROSS FEED HANDWHEEL

Rotation of this handwheel clockwise feeds the upright forward .100" (2mm) per revolution. The handwheel has an adjustable dial with a dual set of numerals on the graduations. The inner set of numerals read 0 to .100" (2mm) in the clockwise direction. These numerals are used when grinding from front to back. The outer set of numerals read 0 to .100" (2mm) in the counterclockwise direction. These numerals are used when grinding from back to front. Both sets of numerals are used when slot or side wheel grinding.

11. INDICATOR RING CLAMP

For clamping the Cross Feed adjustable dial (10) in set position.

12. TABLE HANDWHEEL

One clockwise revolution of the handwheel moves the table to the right 2" (50.8 mm) on Power Feed machines. On Hand Feed machines, the standard travel per revolution is 2 7/8" (73 mm), with 2" (50 mm) optional.

13. REVERSING LEVER

The table direction is reversed, when under power, by moving this lever in the desired direction of travel.

14. TABLE THROTTIE LEVER

This lever is used to start and stop the power table travel and to regulate the table speed. In the OFF position (0) all functions must be hand operated. In the middle position (just before the table starts to creep), the table handwheel is disengaged and the power crossfeed can be operated. Between the middle position and the full On position, the lever is used to regulate the table speed at any rate from 5 ft. to 100 ft. per min. (1.5 to 30.5 m/Min 60 cy. or 1.3 to 25.4 m/min 50 cy.)., An interlock switch is incorporated within the table throttle to prevent unexpected table motion when the machine is started. The throttle must be in the Off position to start the machine.

15. ADJUSTING BUSHING

When the desired table speed is attained, it can be set by rotating this bushing counterclockwise until it stops against the Throttle Lever.

16. ADJUSTING BUSHING LOCK

Turned clockwise, this locks the adjusting bushing (15). This permits the operator, after turning the table off, to resume operations at the same table speed.

17. TABLE DOG KNOB

This knob releases the two table dogs for adjustment. Each dog reverses the table travel during power feed operation.

18. WHEEL GUARD

This guard houses a built-in exhaust nozzle that must be connected to the Exhaust Attachment or a central exhaust system when dry grinding. The removable cover permits access to the wheel.

WARNING At completion of wheel mounting, the Wheel Guard and cover shall be in place and all fasteners properly tightened. Never run a wheel without having the guard and its cover in place.

19. HYDRAULIC MOTOR

This 1 hp (.746 kw) motor is directly coupled to a B&S #25 Rotary Gear Pump that supplies pressure to the hydraulic and lubrication systems.

20. DISCONNECT SWITCH

Turns off power to the entire machine. This Switch must be in Off position before the electrical cabinet door can be opened.

21. LUBRICATION FILTER DOOR

Access door to the Lubrication Filter and Hydraulic Pump. On some machines, the By-pass Filter (F, Fig. 3E) is also located behind this door.

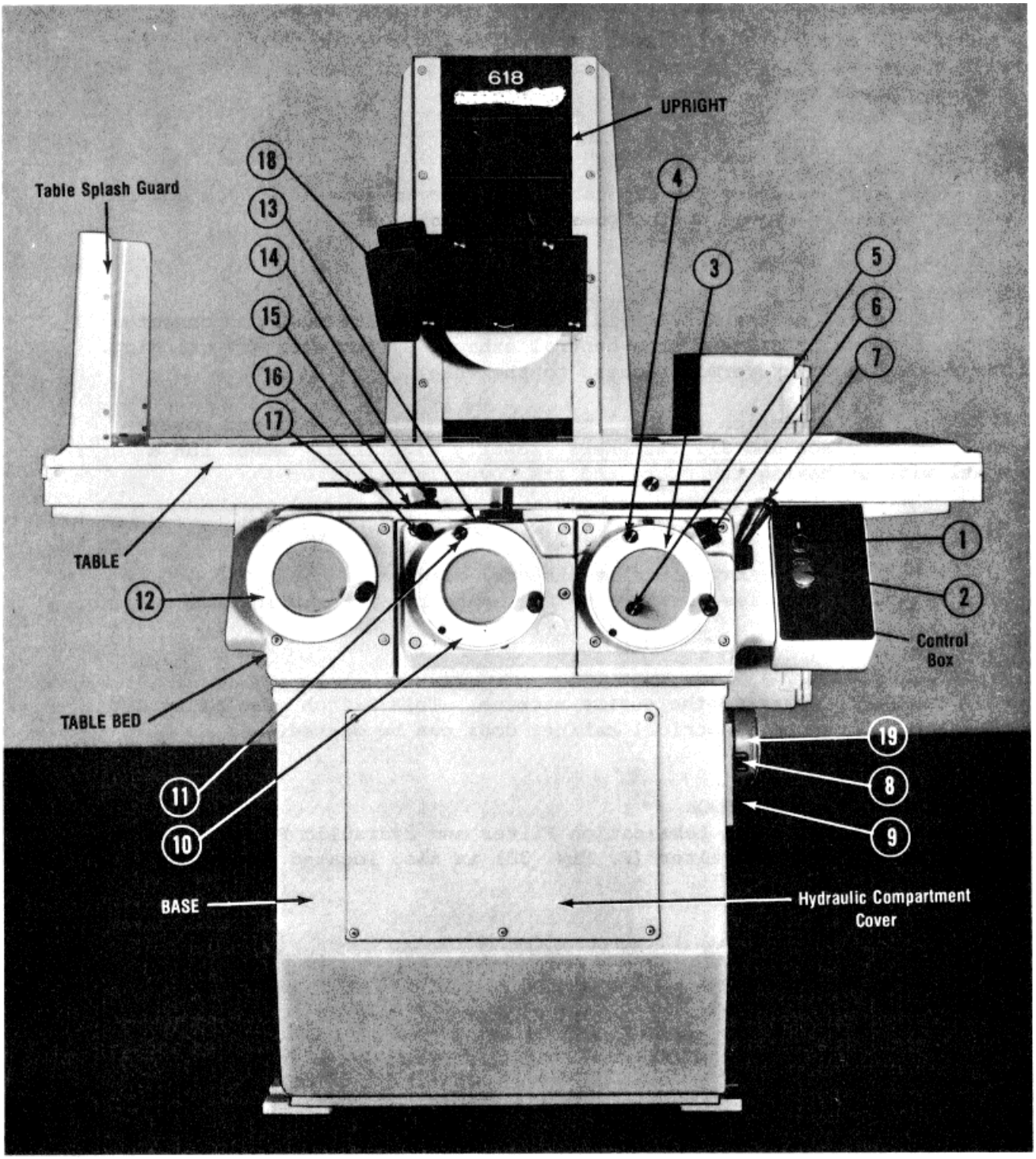

Fig. 1B. Front of machine.

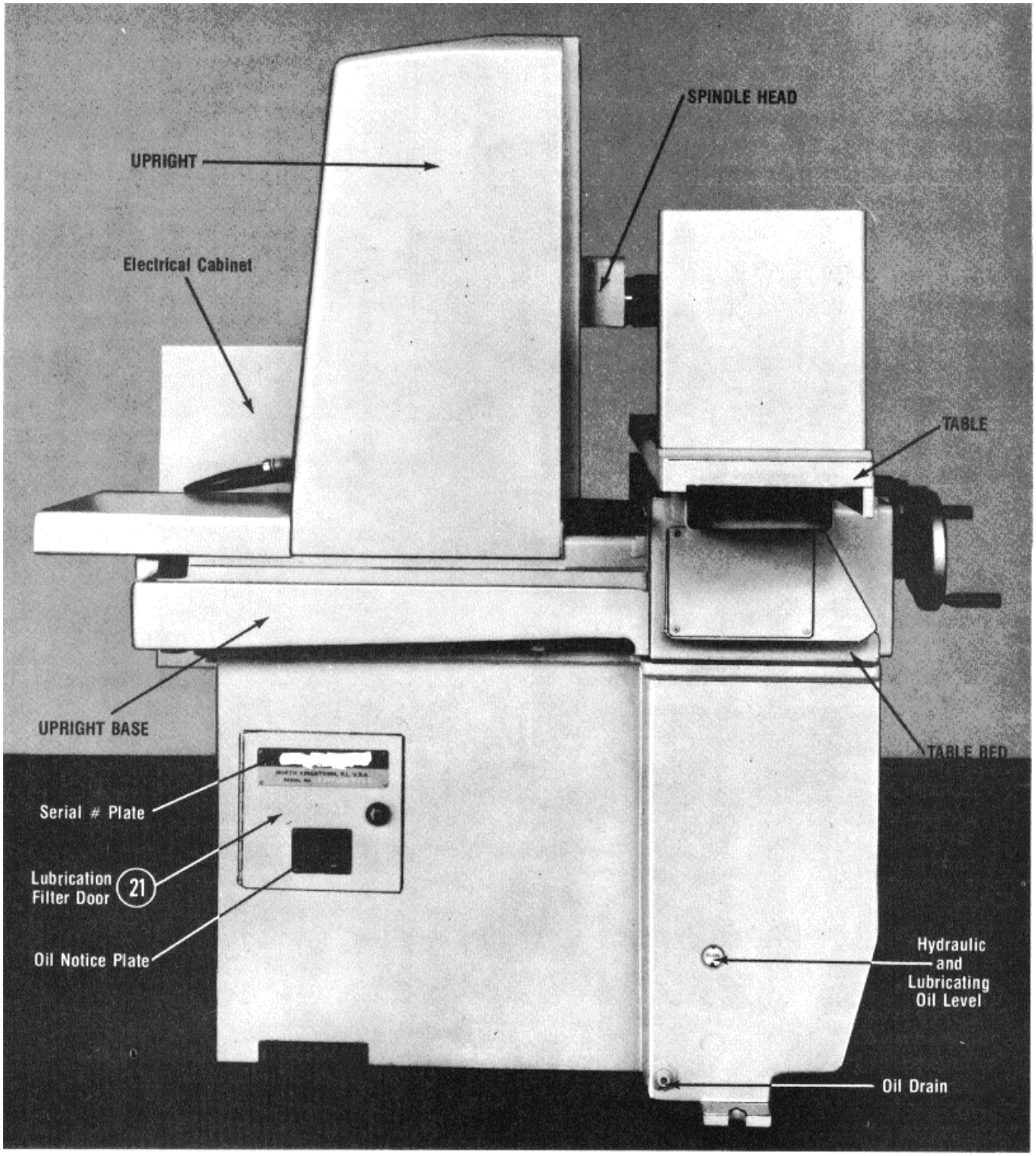

Fig. 2B. Left side of machine.

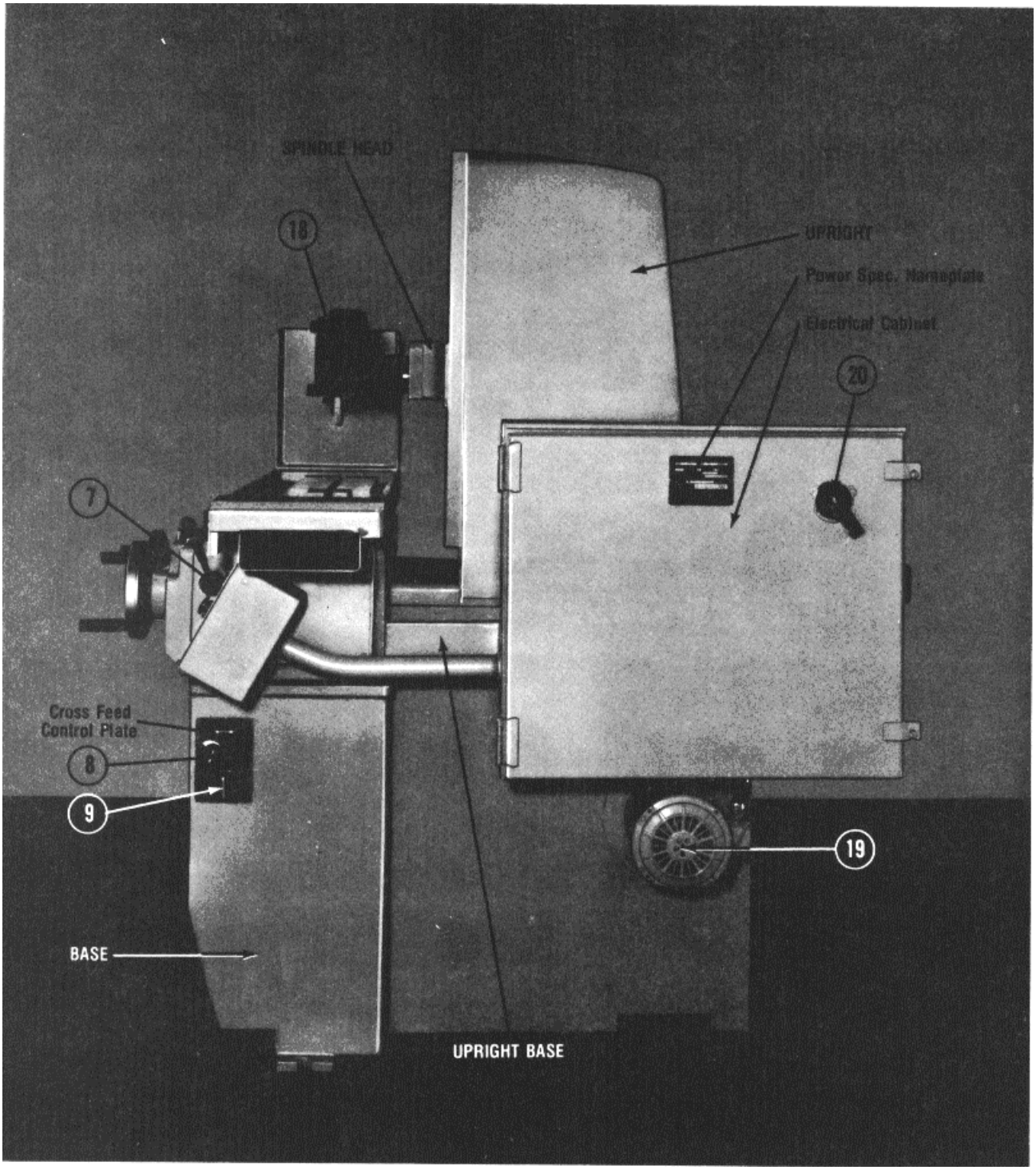

Fig. 3B. Right side of machine.

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SELECTION AND USE OF GRINDING WHEELS

The primary consideration in the selection of grinding wheels is the nature of the material to be ground. Other factors of importance are surface speed of wheel and work, amount of material to be removed, and accuracy and quality of finish desired.

The wheel regularly furnished with a Surface Grinding Machine has characteristics which suit this wheel to general-purpose grinding. However, the material, volume of work, or finish requirements may make it advisable to use another selection more exactly suited to the job in process.

The various wheel manufacturers publish information which will be of help in selecting wheels of their own make. If desired, all details of the grinding operation may be submitted to the manufacturer for advice and recommendations.

Wheel Mounting, Balancing and Truing

Mounting Wheels:

One general purpose grinding wheel and one wheel sleeve are furnished with the machine. When additional wheels are used, extra wheel sleeves should be procured so that each wheel can be kept on its own sleeve. Then, in changing from one type of wheel to another, the wheel and sleeve can be changed as a unit and will remain concentric, requiring only a minimum amount of truing.

The wheel should fit easily on the wheel sleeve, yet not loosely. If it is loose, it can not be centered accurately and will consequently be out of balance. Do not wrap the sleeve with paper, etc., to make a wheel fit when the hole is too large. It is better from all standpoints either to discard such a wheel or recast the core.

A wheel that fits too tightly may crack if forced on the sleeve. If the hole is only a little under size, it can easily be scraped out to fit.

Before mounting a wheel, hang it in the air on one finger, then tap it lightly at the edge to see if it gives a clear ringing sound. A wheel that does not ring clear is probably cracked and should not be used.

The inner of the two flanges between which the wheel is mounted is part of the wheel sleeve (see Fig. 1C). The outer flange is keyed to the wheel sleeve to keep it from turning and loosening the clamping nut.

To equalize the clamping pressure, washers of cardboard or rubber should be placed between the wheel and the two flanges. Most wheels of the size used on this machine have a ring of heavy blotting paper on each side, which serves the purpose.

Using the pin wrench furnished, tighten the clamping nut only enough to hold the wheel firmly in place on the sleeve. Do not overtighten. Excessive clamping pressure will crack the wheel.

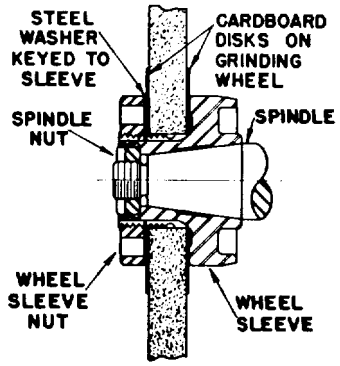

Fig. 1C. Proper mounting of grinding wheel.

Changing Wheels:

In removing a wheel sleeve from the spindle, always use the wheel sleeve puller (furnished with the machine) to avoid any risk of cracking the wheel or damaging the spindle bearings by pounding. Remove the spindle nut (this nut has a left-hand thread), then thread the outer member of the wheel sleeve puller into the wheel sleeve and tighten the inner screw against the spindle, thus loosening the wheel sleeve without harmful jarring.

In putting a wheel on the spindle, first see that both the wheel sleeve hole and the spindle end are perfectly clean. Then slip the sleeve onto the spindle, seat it by hand and tighten by means of the clamping nut and wrench.

Balance of Wheel:

It is essential that the wheel run perfectly true and without vibration. Grinding wheels are balanced by the manufacturer and, in the case of wheels of the size used on these machines, should not require attention in this respect other than truing. However, wheel sleeves with balancing segments are available as optional equipment.

A wheel that runs badly out of balance after truing should be discarded or returned to the manufacturer. When necessary, the condition may sometimes be corrected by digging out part of the wheel beneath the flange and filling with lead as indicated by a test for static balance.

Wheel Truing:

A wheel truing fixture is furnished with the machine. The truing diamond (not furnished) may be applied to the wheel along any line on the lower half of the wheel circumference, though preferably at the bottom of the wheel as shown in Fig. 2C. To prevent gouging, the center line of the diamond tool should point slightly beyond the center of the wheel in the direction of movement of the wheel surface.

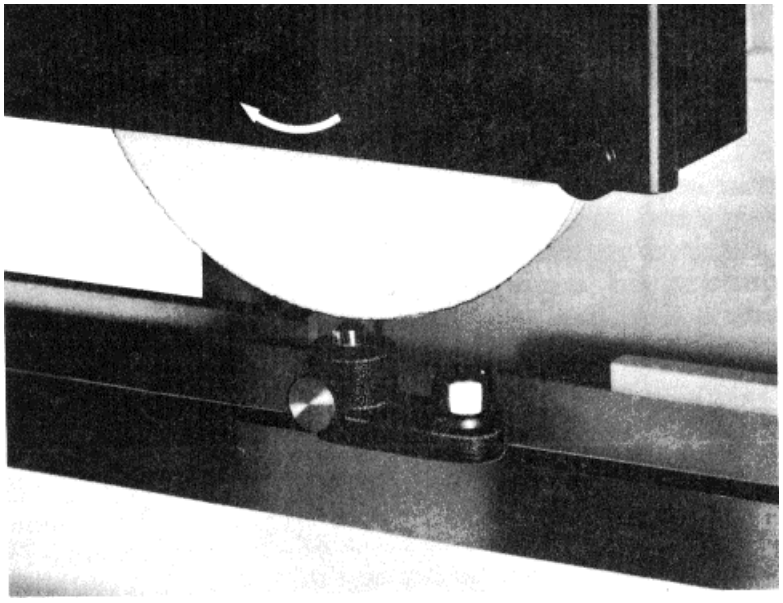

Fig. 2C. Table type wheel truing fixture.

The wheel should be trued each time it is put on the spindle and whenever it becomes loaded, dull or glazed. Pass the diamond across the wheel with a slow, steady cross feed, taking care to avoid any longitudinal movement of the table.

In truing a wheel for rough grinding, take a cut about .0005" (.01 mm) deep in one pass of the diamond across the wheel and finish with a similar cut .00025" (.006 mm) deep. If the wheel is to be used for finish grinding, take two .0005" (.01 mm) cuts, then take two or three additional cuts removing about .00025" (.006 mm) each time, and finally pass the diamond across the wheel once or twice without further advance of the wheel. The above amounts are approximate and may be varied somewhat as necessary to give desired results.

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SETUP AND OPERATION

The principal machine functions involved in machine operation are Start-up, Longitudinal Table Travel, Cross Feed Travel, Vertical Adjustment and Stop. The procedures for utilizing each of these functions are outlined below. (Refer to Section B, Figs. 1B, 2B, and 3B.)

1. Start-Up:
    a. Turn on Disconnect Switch (20).
    b. Check position of Table Throttle Lever (14) by rotating CCW to its Off position. The machine will not start with the lever in the On position
    c. Press machine Start Pushbutton (1). This starts the spindle motor and the motor driving the pump for the hydraulic and lubricating systems.

2. Longitudinal Table Travel - Hand Feed Operation:

    a. Use the Table Handwheel. This is located on the left front of the machine. The Handwheel drives the table through a timing belt system under the table. One revolution of the handwheel moves the table 2 7/8" (73 mm). This is standard; 2" (50 mm) travel per revolution is optional. Clockwise rotation moves the table to the right.

3. Longitudinal Table Travel - Power Feed Operation :

    The table handwheel on Power Feed Machines moves the table 2" (50 mm) per revolution. Clockwise rotation moves the table to the right. For Power Feed travel:

    a. Turn Cross Feed Selector (9) to Grind position.
    b. Set table dogs (17). These dogs can be set to limit the table travel as required in either direction.

Caution: Do not reciprocate the table until the dogs have been set. To set, loosen the table dog knobs to permit moving them along the front of the table. Using the Table Handwheel, move the table to the left and locate the desired point of reversal. Then move the right table dog until it contacts the reversing lever contact roller and set this dog by tightening the knob. Again with the Handwheel, move the table to the right until it reaches the opposite point of reversal. Then move the left table dog until it contacts the reversing lever roller, and set by tightening the knob.

In setting reversal limits for automatic power operation, be sure to allow sufficient over-travel. The work must travel far enough beyond the grinding wheel, in both directions, to allow time for the completion of cross feed before returning under the wheel.

c. To start Power Feed of Table, turn the Table Throttle Lever (14) clockwise. The Table Handwheel disengages and the table starts to move. Travel is progressively faster as the Throttle is opened. The table speed range is from 5 fpm (1.5 m per min.) to 100 fpm (30.5 m per min.).

d. Setting Table Speed. When the table is traveling at the desired speed, loosen the Bushing Lock Screw (16) and turn the Throttle Adjusting Bushing (15) counterclockwise until it stops against the Throttle Lever, then tighten the Lock Screw. The machine is now set at a table speed which will not require resetting if the machine is stopped and restarted.

e. To decrease Table Travel Speed. Turn the Table Throttle Lever in a counterclockwise direction to reduce table speed. Turn to off position to stop table travel.

f. Flushing Table Cylinder. If the table travel is jumpy when first started, it is usually due to air in the Hydraulic cylinder. This can be corrected by reciprocating the table at high speed, under power feed, with the table dogs set far apart.

4. Cross Feed Travel:

a. Hand Feed Handwheel Operation. The Cross Feed Handwheel is centrally located on the front of the machine. It controls forward and backward movement of the upright carrying the grinding wheel spindle. Clockwise rotation of the Handwheel feeds the wheel forward..100" (2.54 mm) per revolution. It has an adjustable dial with a dual set of numerals on the graduations. The inner set of numerals read 0 to .100" (2.54 mm) in the clockwise direction. These numerals are used when grinding from front to back. The outer set of numerals read 0 to .100" (2.54 mm) in the counterclockwise direction. These numerals are used when grinding from back to front. Both sets of numerals are used when slot or side wheel grinding.

b. Hand Cross Feed with Fine Feed. A Fine Feed Dial graduated to .0001" (.001mm) is available as optional equipment for these machines. This dial is engaged by rotating the fine feed lock clockwise. Clockwise rotation of the dial moves the wheel back.

c. Power Cross Feed Operation. Three modes of Power Cross Feed operation are provided Truing, Grind and Rapid Position. These are established with the Selector Knob on the right side of the machine.

Grind Turn the Cross Feed Selector Knob to Grind. This selects the intermittent cross feed. With the Cross Feed

Direction Lever (7) in the neutral position, start the table travel with the Table Throttle Lever. Next, position the Direction Lever for forward or reverse travel of the upright and adjust the amount of cross feed desired with the Cross Feed Amount Knob (8).

Truing Turn the Cross Feed Selector Knob (9) to True. The direction of upright travel is selected with Cross Feed Direction Lever (7). With the Direction Lever set for forward or reverse travel, turn the Table Throttle Lever clockwise until it stops. This will start the cross feed. The truing rate is 10" (250 mm) per minute.

Rapid Position Turn the Cross Feed Selector Knob to Rapid Position. Turn the Table Throttle Lever clockwise until it stops. Select the upright travel direction with the Cross Slide Direction Lever. The rapid positioning rate is 12 fpm (3.6 m per min.).

d. To stop the cross feed motion, turn the Cross Feed Direction Lever to Neutral. Also, both the cross feed and table can be stopped by turning the Table Throttle Lever to its Off position. The machine Stop pushbutton will stop all motions in an emergency.

5. Vertical Feed:

a. Handwheel Operation. The Elevating Handwheel, for vertical feed of the wheel to the work, is located on the right front of the machine. Counterclockwise rotation of the Handwheel feeds the spindle down .050" (1 mm) per revolution. An adjustable dial on the Handwheel is graduated to read to .0002" (.005 mm).

b. Vertical Fine Feed. A Fine Feed Dial (5), mounted adjacent to the Handwheel, is graduated to read to .000 (.001 mm). This dial is engaged by rotating the Fine Feed Lock clockwise. Clockwise rotation of the dial feeds the spindle down.

(A Power Downfeed Arrangement, available at extra cost, is described in Section I Optional Mechanisms and Equipment.

6. Machine Stop:

a. Press Stop pushbutton. This stops all machine motions including spindle and pump motors.

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HYDRAULIC SYSTEM AND SPINDLE DRIVE

The principal components of the machine involved in its control and operation are the hydraulic system and the spindle drive. These are described in this Section, with instructions for maintenance procedures that will assure lasting efficiency and precision performance.

Hydraulic System

On Power Feed machines, the hydraulic system includes an oil reservoir, a motor-driven pump and the various valves necessary to transmit hydraulic power to the table drive and cross feed circuits. These elements are accessible through the opening in the front of the machine base by removing the face plate. The various units referred to in the following text are identified in the machine illustrations in Section B, and Figs. 1E, 2E, and 3E.

The machine Start pushbutton starts operation of the hydraulic pump, which continues until the Stop pushbutton is pressed.

Table Circuit:

The Table Throttle Valve (T) is actuated by the Table Throttle Lever (14) on the front shelf of the machine. This lever has three positions Off, Middle and Open.

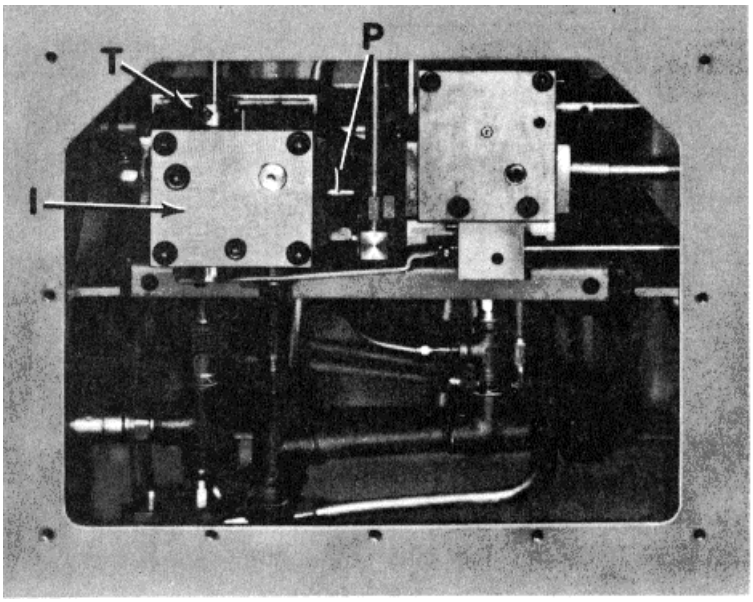


Fig. 1E. Hydraulic compartment in front of machine.

1. In the Off position, the two table cylinder lines are connected together, which allows oil from the pump to return to the reservoir at low pressure, with minimum increase in temperature. The Off position permits hand operation of the table only. The hydraulic system pressure should read 25 psi (1.76 kp/cm²) or less.

2. In the Middle position, the oil from the pump is blocked, and the flow is diverted through the high pressure relief valve. The hydraulic pressure increases to 120 psi (8.44 kp/cm²). This pressure in the handwheel piston serves to disconnect the table handwheel. It also permits rapid cross slide positioning and truing. On a machine with no hydraulic power cross feed, the Middle position is not used unless a hydraulically powered Over-the Wheel Truing Attachment (extra equipment) is used.

3. The Table Throttle Lever is Open when it is turned to any point beyond the Middle position. This permits the oil to flow to the table cylinder at increasing rates to provide table speeds from 5 to 100 fpm (1.5 to 30.5 m/min. 60 cy. or 1.2 to 25.4 m/min. -50 cy.).

The table can be operated under manual control only when the Table Throttle Lever is in the Off position.

Table reversing involves the operation of two valves in the hydraulic system a pilot valve and a table reversing valve. The pilot valve (P) is connected mechanically to the Table Reverse Lever (13), which, when it contacts the table dog, switches the pilot spool. This permits oil flow to one or the other end of the reversing valve spool, shifting the spool to reverse the flow of oil to the table cylinder.

All table circuit valves throttle, pilot and reversing are combined in one valve block (I). This block, mounted on its own subplate, is located at the left in the hydraulic system compartment.

Cross Feed Circuit:

Machines equipped with Power Cross Feed provide three different modes of operation under hydraulic power.

1. Rapid Positioning. The wheel can be move a rapidly to working position at the rate of 12 fpm (3.6 m/min.), permitting faster setups.

2. Wheel Truing. This mode permits dressing the wheel with a table-mounted diamond at the rate of 10 ipm (254 mm/min.), an optimum speed for wheel truing to assure fine finish.

3. Intermittent Cross Feed. This permits setup for cross feed travel, either in or out, in increments ranging from .01" (.25 mm) to .25" (6.35 mm) at each table reversal.

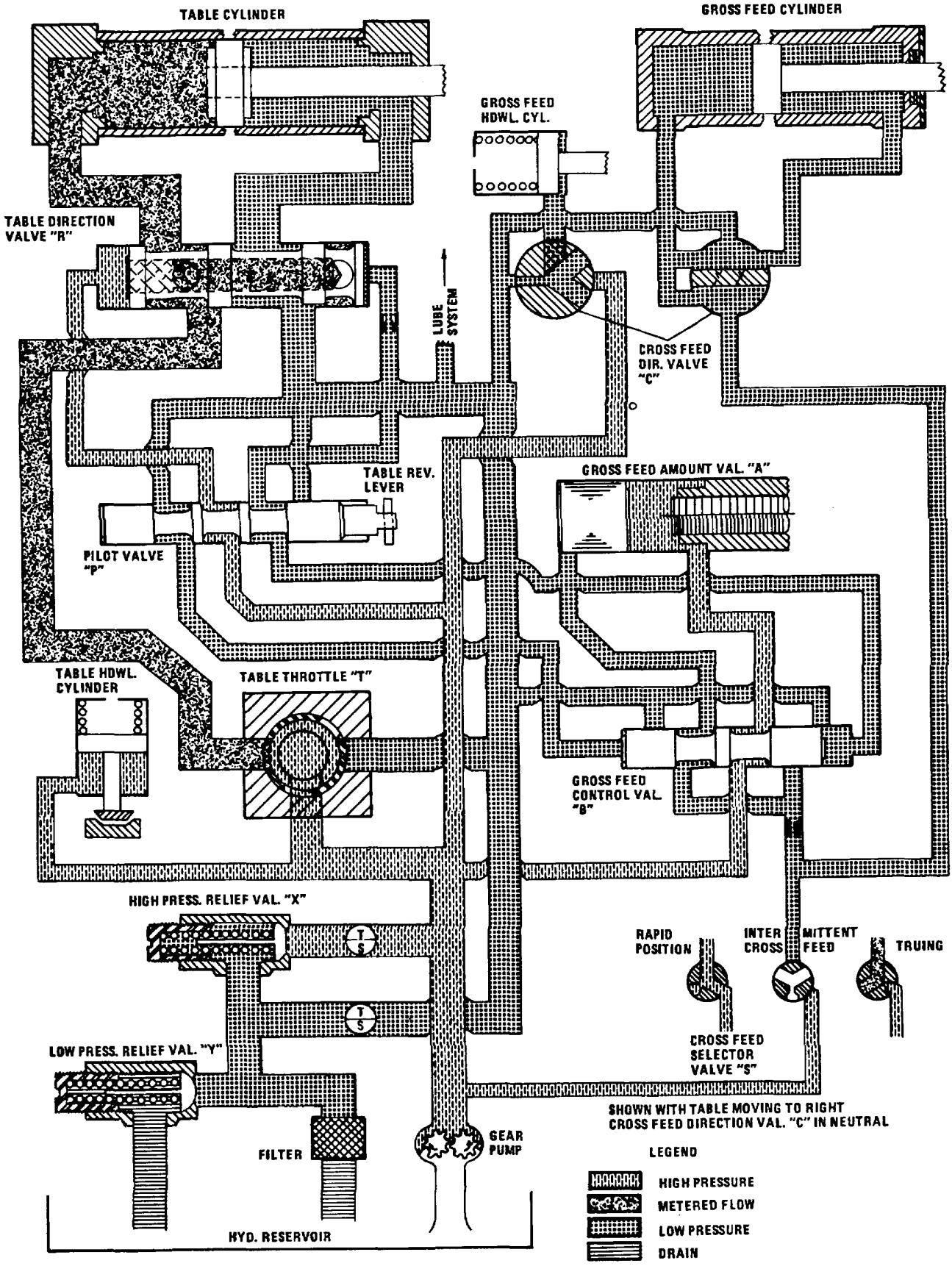


Fig. 2E. Schematic diagram of hydraulic circuits.

When the machine is operated in the Rapid Positioning or Wheel Truing modes, a mechanical interlock in the hydraulic system prevents movement of the table either manually or by power. Change from Rapid Positioning to Wheel Truing and vice versa can be made without first turning the table throttle to the OFF position.

<u>Caution</u>: Do not attempt to switch to either of these modes with the table moving. This may cause damage to the mechanical interlock which prevents table movement in these modes.

The cross feed circuit requires four control valves a cross feed direction valve, a cross feed control valve, a cross feed amount valve, and a cross feed truing and rapid-positioning valve. These are combined in one valve block. This block, mounted on its own subplate, is located at the right in the hydraulic system compartment. In machines without power cross feed, the block is omitted.

The direction valve is actuated manually by a lever (7) on the right side of the machine. This valve has three positions Off, Forward and Back.

Off. When the lever is in this position, both the upright cylinder leads and the cross feed handwheel piston are connected to exhaust. This is the only lever position in which the upright can be moved manually.

Forward and Back. Moving the lever forward sets up a flow of oil to the cross feed cylinder, which causes the upright to move forward. Moving the lever back reverses the flow of oil and the motion of the upright. When the lever is in either forward or back position, the Cross Feed Handwheel and screw are disconnected by means of pressure flow which raises the cross feed screw nut.

After starting the table, cross feed movement at table reversal is obtained by setting the Cross Feed Direction Lever forward or back. When the Table Reverse Lever (13) contacts either table dog, it shifts the table Pilot Valve (P). This diverts pressure to one end of the cross Seed control valve.

Interconnection permits transfer of pressure to the cross feed amount valve and results in a predetermined flow of oil to the upright cylinder.

The amount of upright movement at each table reversal is controlled by turning the Cross Feed Amount Knob (8) located on the right side of the machine. The Cross Feed Mode Knob (9) should be in the Grind position.

When the Cross Feed Mode Knob is set for Truing or Rapid Position, the table is mechanically interlocked to prevent movement.

<u>Caution</u>: Turn Table Throttle Lever to Off before calling for continuous upright movements.

Pressure Relief Valves: (Fig. 3E)

Pressure in the hydraulic system is controlled by two pressure relief valves which are adjusted and locked before the machine is shipped. The high pressure valve (A) is set for 120 psi (8.44 kp/cm²) and the low pressure valve (B) for 5 psi (.35 kp/cm^2).

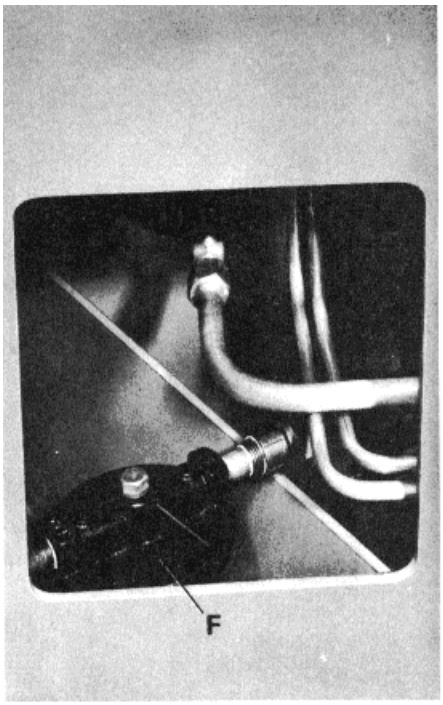
If, for any reason, these settings are disturbed, the valves can be easily reset. Check the high pressure valve by removing the 1/4 inch pipe plug (C) and attaching a pressure gage. The pressure should read 120 psi (8.44 kp/cm²) when the table throttle is opened to the point where the table is just about to start to creep.

The low pressure relief valve is similarly tested. The gage is attached at (D). It should read between 5 and 6 psi (.35 kp/cm² and .42 kp/cm²).

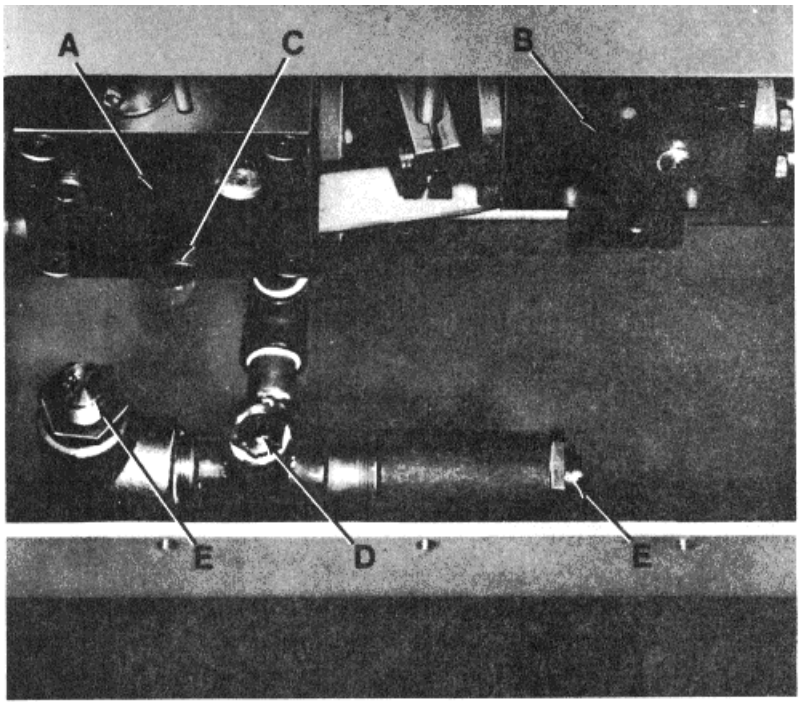
<u>Caution</u>: High pressure exceeding 120 psi (8.44 kp/cm^2) can overload the 1 hp pump motor. Low pressure readings below 5 psi (.35 kp/cm^2) indicate pressures too low for proper lubrication.

To change the pressure setting on either relief valve, loosen the check nut. Next, turn the adjusting screw (E) clockwise to increase pressure and counterclockwise to decrease it. Then tighten the check nut, making sure the adjusting screw doesn't turn with it.

After a low pressure adjustment is made, be sure to check the high pressure again, since this may have been affected. For this reason, it is suggested that two pressure gages be used. It is also recommended that the gages used do not out-range the above pressures by very much as this could result in inaccurate readings.



View thru access door.



Hydraulic compartment as viewed from above.

Fig. 3E

Hydraulic System Maintenance:

The reservoir for the hydraulic system should be filled with approximately 22 gallons (83.3 liters) of "combination hydraulic fluid and slide way lubricant" with a viscosity of 150 SUS (32 CST) at 1000 F (380 C), which complies with ASLE W-150 standards The oil, and the by-pass filter (F), Fig. 3E, should be changed annually (or even more frequently on machines in constant use).

The oil can be removed from the reservoir through a flexible tube connected to the pump discharge and emptying into a suitable container outside the machine. Remove the drain plug to get out all the oil at the bottom of the reservoir, and when it is empty, wipe it out with a lint-free rag saturated with solvent.

Oil that has been removed from the reservoir should not be reused unless it has been passed through a 25 micron filter.

After the oil change, run the pump for about an hour with the Table Throttle Lever in the Off position. This will distribute oil throughout the system and remove air from the hydraulic cylinders. When this run is completed, check the sight gage, and add more oil as necessary to bring it to Full level.

Valves sometimes become sticky due to gum deposits when a machine has been idle for a long time. If this happens, use one of the suitable solvents (available from several oil companies) and run it through the system for about four hours. Flush it out, and refill the system with fresh oil.

Lubrication System

In machines having power table feed, or both power table and cross feeds, the lubrication is supplied by tapping off the hydraulic system. This provides a pressure of 5 to 6 psi (.35 kp/cm² to .42 kp/cm²), which will force the oil through the meter unit for lubrication as called for.

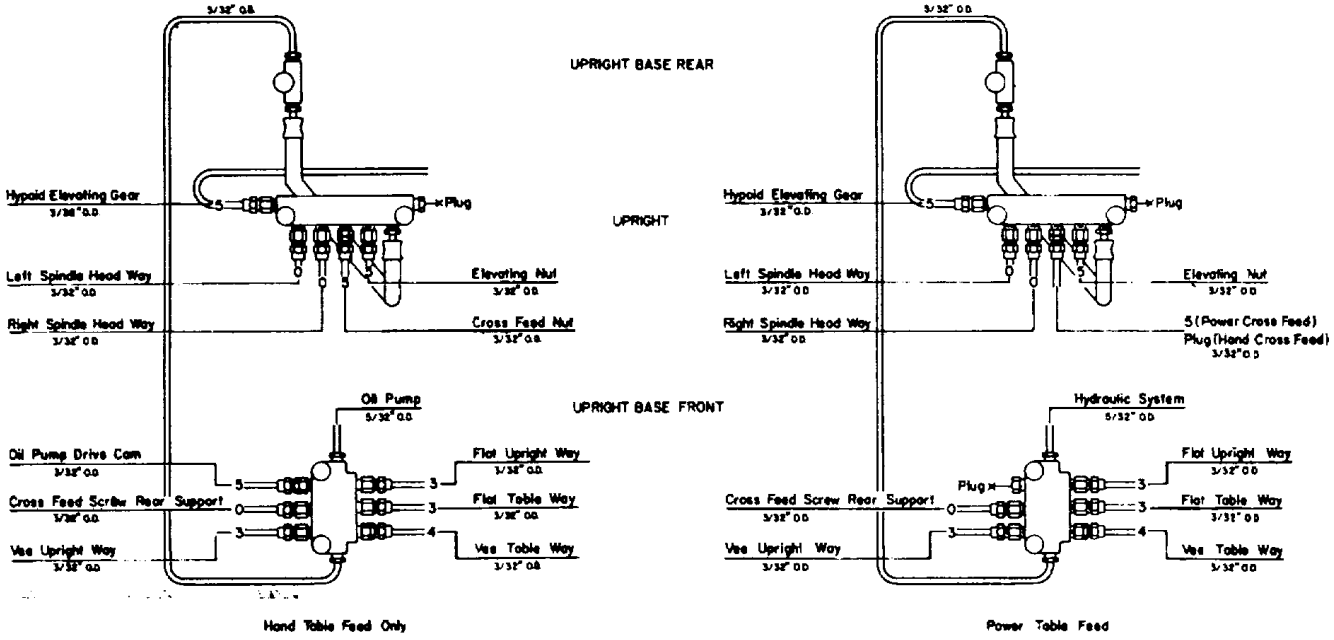


Fig. 4E. Lubrication Schematic

The oil drains back to the reservoir through a filter which is located inside a door on the left side of the machine. The filter has a 200 mesh stainless steel cartridge. This should be cleaned at least once a year and, if damaged, should be replaced. To remove the filter, loosen the large bolt at the top of the filter container and the container will drop down, exposing the filter cartridge.

In machines which have hand feed only, a lubrication pump is operated by the movement of the table handwheel. The filter at the intake of this pump should be cleaned annually (see Fig. 5E for instructions). The oil reservoir on these machines holds 6 gallons (22.7 liters) and should be filled with a high lubricity way oil which has a viscosity of 150 SUS (32 CST) at 100° F (38° C) and which complies with ASLE W-315 standards Fig. 5E. Lubrication pump in machine having hand feeds only.

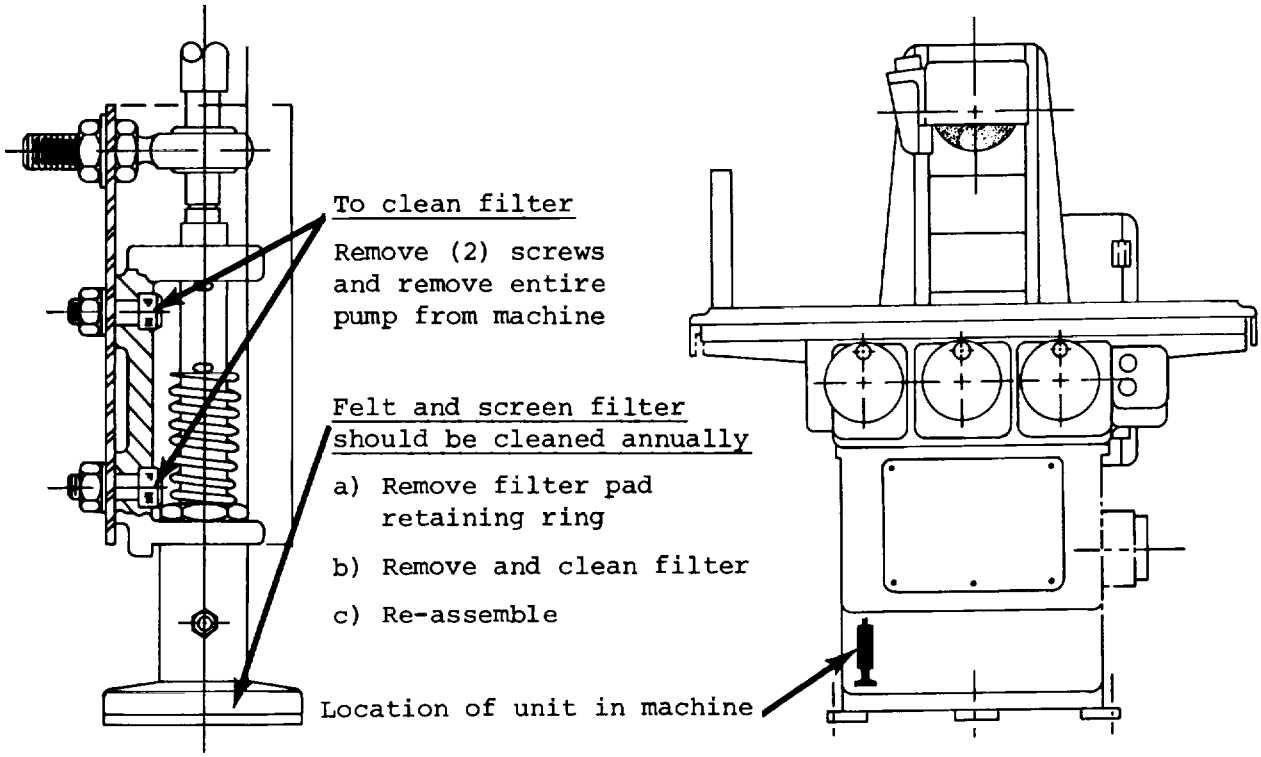


Fig. 5E. Lubrication pump in machine having hand feeds only.

Wheel Spindle

These machines are equipped with a super-precision antifriction bearing wheel spindle with either Oriflex or direct motor drive.

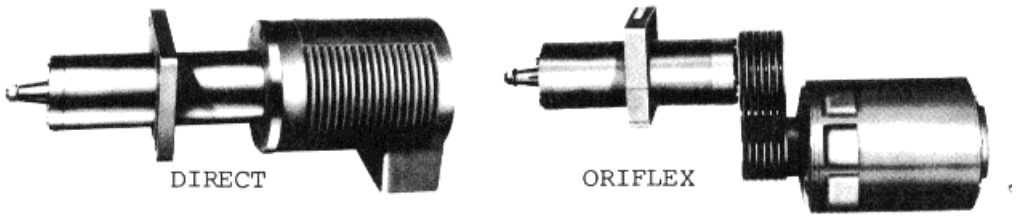


Fig. 6E. Wheel spindle drives.

Oriflex Drive:

This spindle is powered through six "O" rings from a 1 hp (.75 kw) motor. The wheel sleeve furnished takes wheels up to 8" (203 mm) diameter and 1/2" (12.7 mm) wide. A larger wheel sleeve available at extra cost, takes wheels up to 1" (25.4 mm) wide.

Direct Motor Drive:

Three different spindles of this type are available.

1. 1 1/2 hp (1.12 kw) 3600 rpm 60 cy 3000 rpm 50 cy
2. 2 hp (1.49 kw) 3600 rpm 60 cy 3000 rpm 50 cy These spindles will accomodate 7" (177.8 mm) dia. wheels.
3. 2 hp (1.49 kw) 1800 rpm 60 cy 1500 rpm 50 cy This spindle accomodates 12" (304.8 mm) wheels.

Spindle is High Precision Mechanism:

A grinding machine spindle has the same characteristics as a high precision instrument, and should be treated at all times with corresponding care. As an example of its accuracy, note that a variation of one hundred thousandth of an inch .00001" (.000254 mm) in a ground flat surface will be visible to the naked eye as a wheel mark.

Therefore, never hammer on the ends of the spindle, drop it on the floor or workbench, or otherwise subject it to force or impact.

If eventually a spindle should need repair or adjustment, we recommend that it be returned to Brown & Sharpe for reconditioning. Where machines are in continuous operation, it is advisable to keep a spare spindle on hand. It can be installed to keep the machine affected in production while the original spindle is being repaired.

See Section G Maintenance for instructions for removing and replacing a spindle.

618 and 818
Series II
Surface Grinding Machines

TYPICAL OPERATIONS

The operations shown in this Section are representative of the various types of work which can be performed on the 618 and 818 Surface Grinding Machines.

Some of the operations shown utilize various types of optional equipment which is listed and described in Section I.

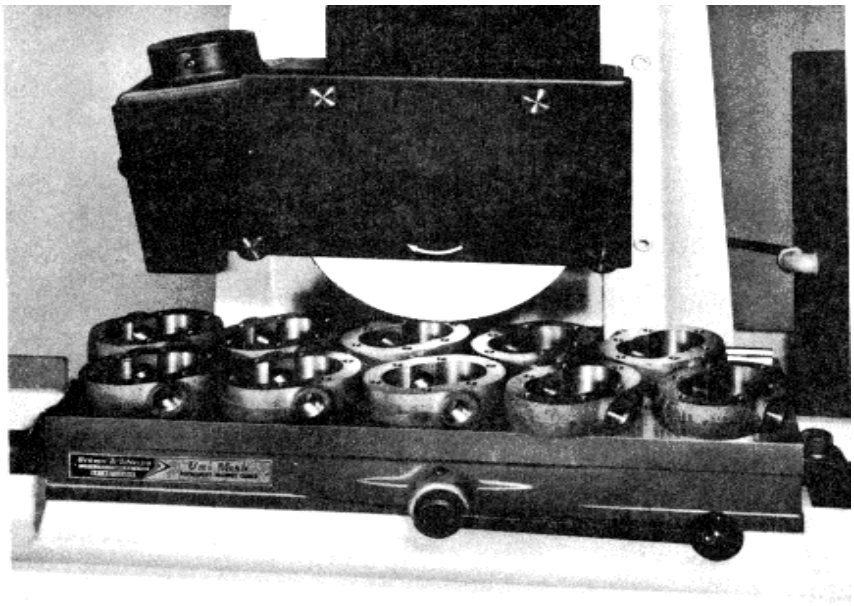


Fig. 1F. A representative production job, grinding the surfaces of ten pieces with one loading of the chuck.

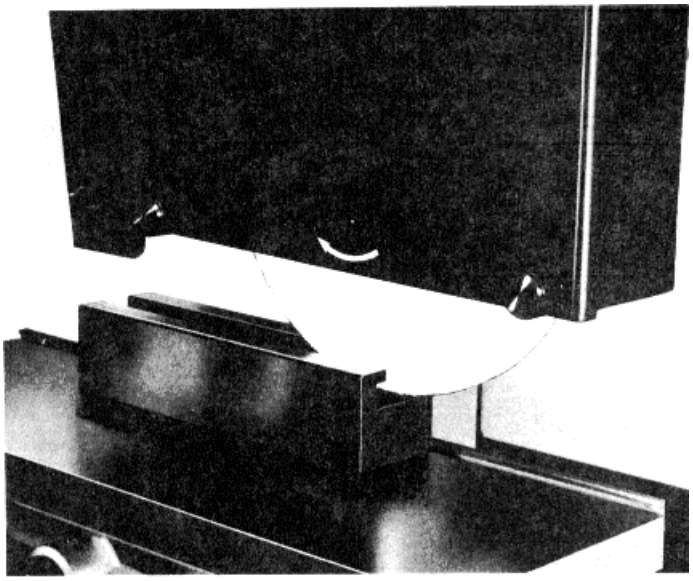


Fig. 2F. The table setting in fixed ways contributes immeasurably to slot and other forms of side wheel grinding.

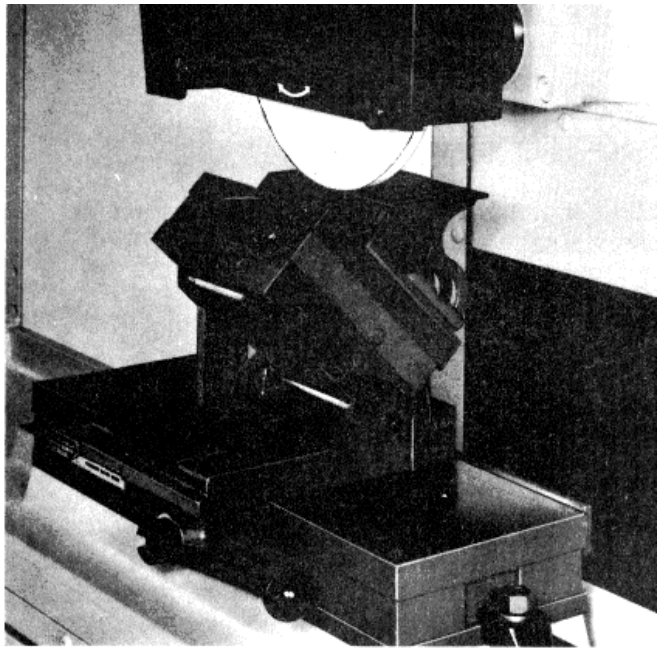
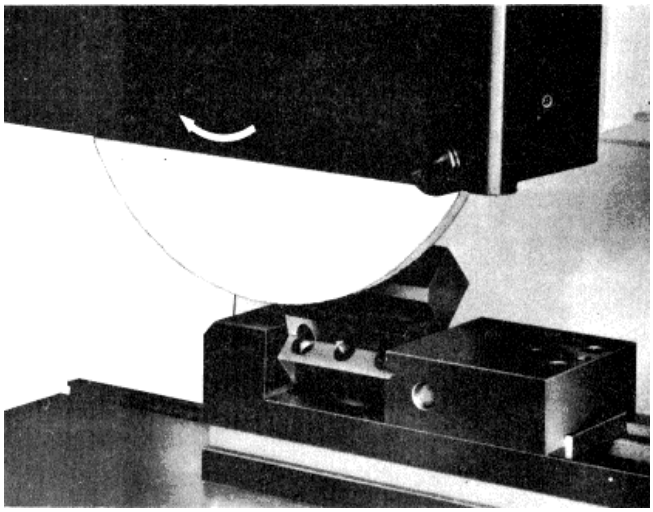


Fig. 3F. Machine has ample vertical capacity for tall jobs.

Fig. 4F. Grinding one side of a "V"



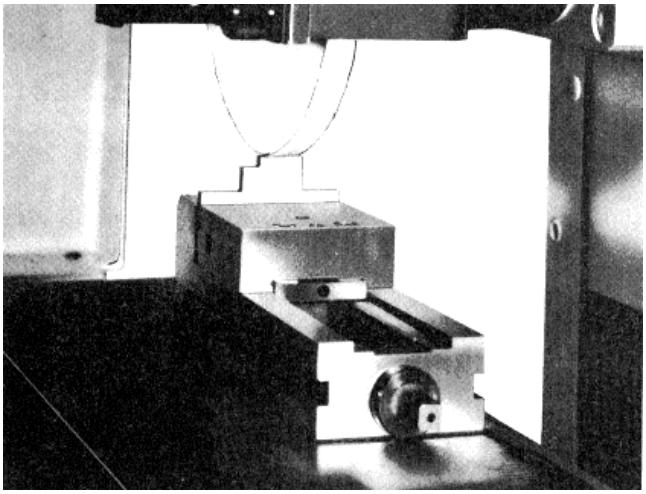


Fig. 5F. Grinding a series of steps

618 and 818
Series II
Surface Grinding Machines

MAINTENANCE

Direct Drive Spindle Unit

Removal from machine:

1. Remove wheel guard cover.
2. Remove wheel and wheel sleeve.
3. Remove wheel guard by loosening the two clamp screws on the rear extension of the guard and pulling forward.
4. Remove the rear upright cover.
5. Remove screw (A) at the lower right of the spindle front support (see Fig. 1G).
6. Remove the top set screws (B) in the front support.
7. Loosen spindle clamping screw (C).
8. Disconnect the motor cable.
9. Wrap the threads and taper, on the spindle, with several layers of tape to prevent damage during removal.

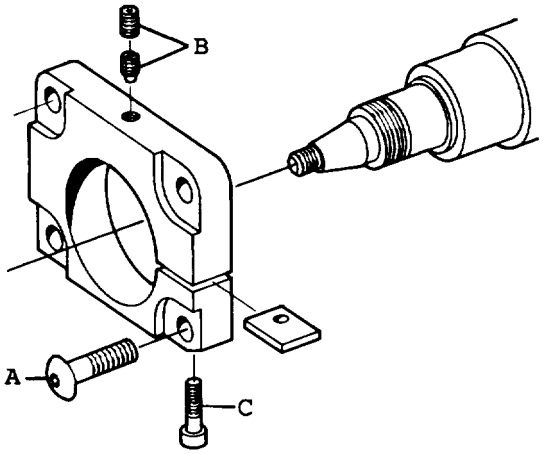


Fig. 1G. Direct drive spindle front support.

10. Draw the spindle unit out from the rear of the machine.

Replacement in machine:

1. Replace the spindle unit, inserting from rear of machine.
2. Connect motor cable.
3. Replace the top set screws (B) in the front support.
4. Tighten the spindle clamping screw (C) just enough to eliminate any looseness. Do not over-tighten.

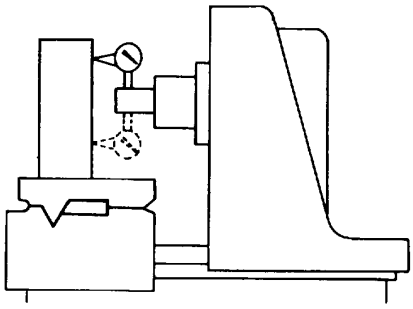


Fig. 2G. Top of table is square crosswise with sweep of spindle.

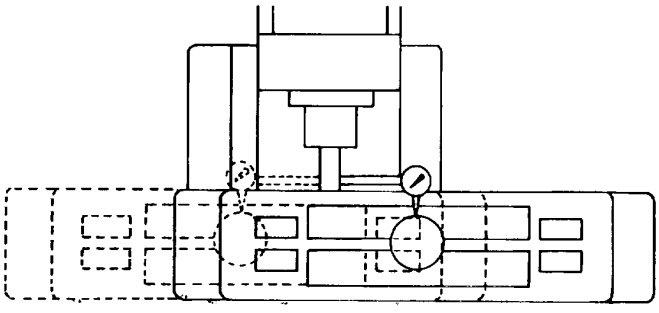


Fig. 3G. Wheel spindle is square with table ways.

5. Replace the lower right screw (A) in the spindle front support.
6. Check the spindle alignment (Figs. 2G and 3G): Align the spindle to the machine, if necessary, by shifting the front support. Using a Precision Square or Toolmaker's Cylindrical Square, indicate from the spindle nose and align the spindle vertically and horizontally within .001" (.025 mm) in a 5'" (127 mm) radius. For cross hatch slot grinding, the spindle needs closer alignment (within .0001).
7. Tighten the four screws on the face of the front support.
8. Replace the wheel guard and clamp.
9. Replace the wheel and wheel sleeve.
10. Replace the wheel guard front cover.
11. Jog spindle to be sure the wheel is rotating clockwise.
12. Replace the rear upright cover.

Oriflex Drive Spindle Unit

Removal from machine:

1. Remove wheel guard cover.
2. Remove wheel and wheel sleeve.
3. Remove wheel guard by loosening the two clamp screws on the rear extension of the guard and pulling forward.
4. Remove the upright rear cover.
5. Remove the screw that supports the lower sliding guards under the spindle head and lower the guards.
6. Remove the six "O" rings by rotating the spindle pulley and working the rings off. Do not loosen the motor, which has been aligned at the factory.
7. Remove the spindle pulley set screw locking screw and back off set screw (located in one of the grooves). Be careful not to lose the locking screw as it is essential to the balance of the pulley.
8. Remove the four spindle unit flange clamping screws.
9. Draw the spindle unit slowly out toward the front of the machine while holding the spindle pulley.
10. When the pulley slips off the spindle, remove it and withdraw the spindle completely from the machine.

Replacement in machine:

1. Clean the mating surfaces of the wheel head and the back of the spindle flange.
2. Insert the spindle into the wheel head enough to start the pulley onto it.
3. When the pulley is started, slide the spindle into the wheel head while guiding the pulley.
4. Replace the four screws in the spindle flange, finger tight.
5. Line up the face of the spindle pulley with the face of the motor pulley. A steel scale can be used for this purpose. Work through the opening exposed under the lower vertical guards. Correct alignment of the pulleys is essential to insure "O" ring service life.
6. With the pulley faces lined up, tighten the set screw in the spindle pulley. Replace the set screw lock screw.

7. Hang the six "0" rings over the motor pulley. Work the front ring over the pulleys until it is all the way forward. In like manner, work each remaining ring over the pulleys until it is in its proper groove in each pulley.
8. Replace the upright rear cover.
9. Align the spindle as described in step #6 (on page G2) under instructions for replacement of Direct Drive Spindle Unit in machine.

Spindle Head Gib Adjustment (see Fig. 4G)

Using the special gib adjustment wrench and T-handle Allen locking h furnished with the machine proceed as follows -

1. Remove the four plug buttons from the front of the upright straps.
2. Position the spindle head so that the adjusting screws are aligned with the holes in the upright straps.
3. Insert the adjusting wrench into the slot in the gib adjusting 7 screw.
4. Insert the Allen locking wrench through the hole in the adjusting wrench and into the locking screw.
5. Rotate the locking screw counterclockwise while preventing the adjusting screw from turning with the adjusting wrench. Loosen all four adjusting screws in this manner.
6. Adjust the gibs by turning the adjusting screws counterclock wise until they are snug, then turn them back slightly (less than 1/8 of a turn). While preventing the adjusting screws from turning with the adjusting wrench, lock them in position by turning the locking screws clockwise.
7. Check adjustment by raising and lowering the spindle head with the elevating handwheel. The head should move freely with no bind and no "hang-up".
8. Check for spindle "hang-up" by placing an indicator base on the upright base and indicating the spindle head. With the table running, feed the head down and check the response.
9. Replace the plug buttons in the upright straps.

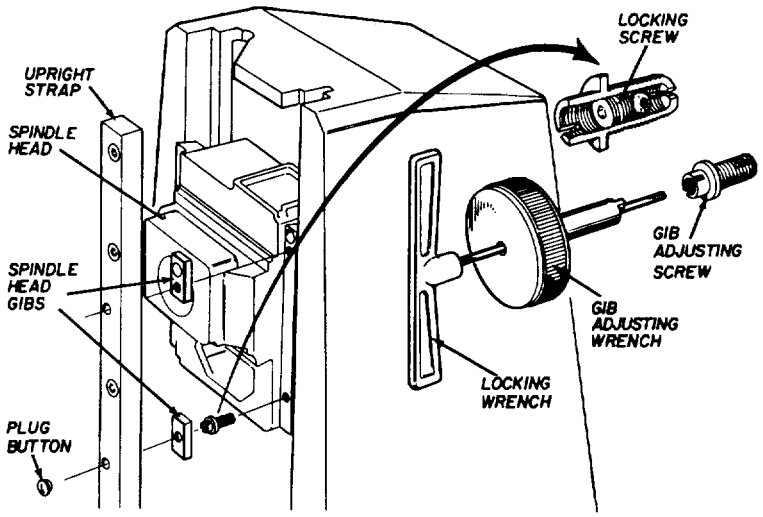


Fig. 4G. Spindle Head Gib Adjustment.

Changing the Table Drive Belt

1. Centralize the table.
2. Back off the belt tension locknut (A, Fig. 5G) at the right end of the table.
3. Loosen the belt tension screw (B).
4. Loosen the belt plate clamp screws (C) and release the belt.
5. Unclamp the belt at the left end of the table.
6. Tape the new belt to the old belt with the teeth facing in the same direction. Tape with approximately a 1 1/2" overlap.
7. Pull the opposite end of the old belt slowly so that the new belt will engage the belt sprocket and feed through properly.
8 Untape the old belt:
9. Clamp the new belt at the left end of the table.

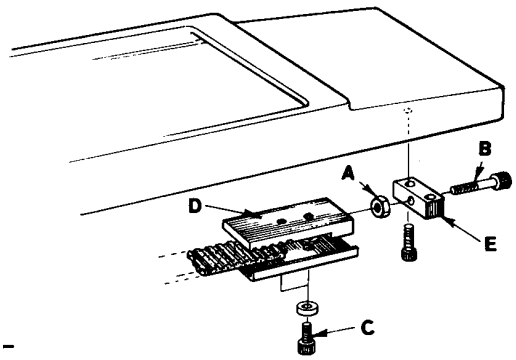


Fig. 5G. Construction at right end of table drive belt.

10. Clamp the belt to the belt tension block (D).
11. Adjust the belt tension to allow the screw (B) to move sideways in its support (E). Do not overtighten.
12. Rotate the handwheel to check sprocket engagement and proper table movement.
13. Lock belt tension adjusting screw (B) with locknut (A).

Adjustment of Bearings at Back End of Cross Feed Screw

1. Move upright to rear position and remove base ways guard at its lower rear.
2. Move upright to forward position.
3. Loosen socket head clamp screw in adjusting nut (see Fig. 6G).
4. Have cross feed handwheel held to prevent cross feed screw from turning. Grasp adjusting nut with thumb and forefinger and turn it clockwise until "metal to metal" contact is obtained. Then, using pin wrench in hole in adjusting nut, preload the bearings by tightening adjusting nut approximately 1/16" more as measured on the periphery of the nut.
5. Tighten socket head clamp screw in adjusting nut.
6. Replace base ways guard at rear of upright.

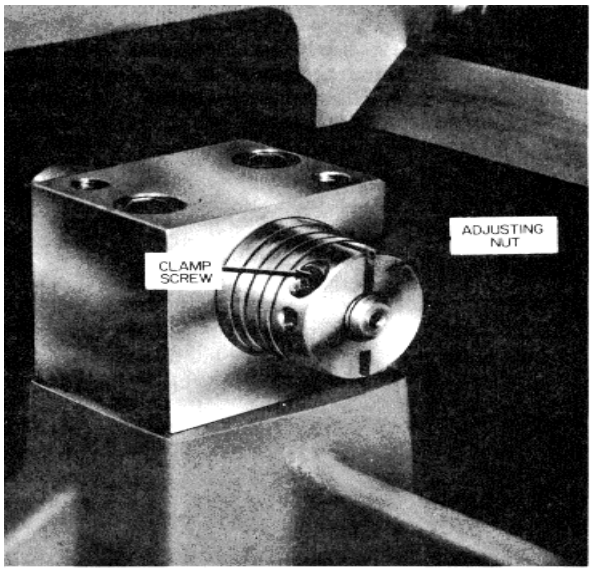
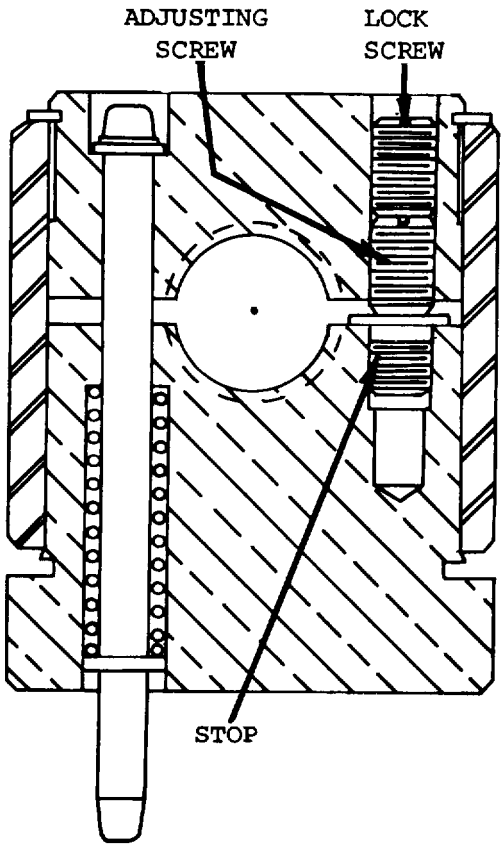


Fig. 6G. Adjustment of Bearings at Back End of Cross Feed Screw.

Adjusting the Power Cross Feed Nut

1. Remove upright rear cover.
2. Remove lock screw (see Fig. 7G).
3. Back off adjusting screw and then turn clockwise until the screw contacts the stop.
4. Check backlash.
5. Replace lock screw.
6. Replace upright rear cover.



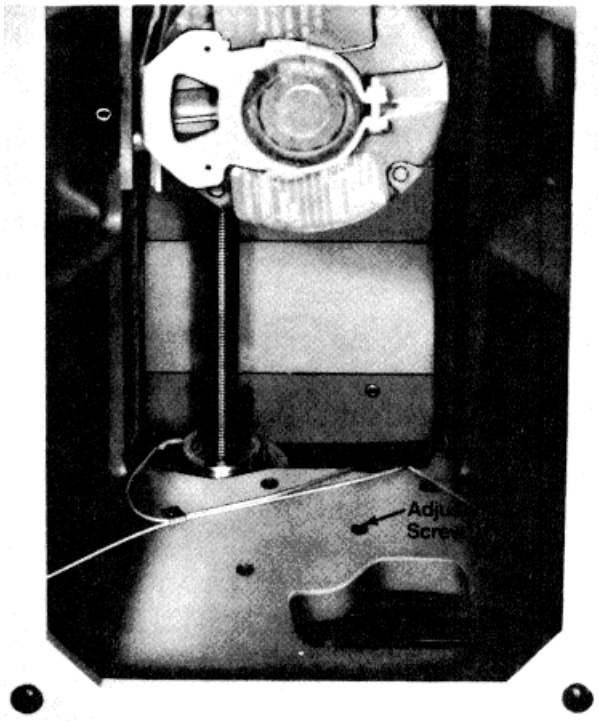


Fig. 7G. Location, and sectional drawing of power cross feed nut.

Elevating Screw and Nut

Every two years of normal usage, the elevating nut and screw should be checked for wear. If noticable wear is detected, both nut and screw should be replaced.

618 and 818
Series II
Surface Grinding Machines

TROUBLE SHOOTING GUIDE

Hydraulic pump motor heaters dropping out:
- Check 1. Voltage
  2. Motor connections
  3. High pressure
  4. Pump for damage
  5. Electric motor for damage

Low oil pressure:
- Check 1. Oil level
  2. Oil lines for leaks
  3. Relief valve malfunction
  4. Pump for damage
  5. Electric motor speed

Excessive lubrication:
- Check 1. Low pressure

No top table speed:
- Check 1. Throttle throw
  2. For oil leaks
  3. Relief valve malfunction (80# Min. PSI at Maximum Table Speed)
  4. Alignment of table throw-out piston shaft
  5. Lubrication on ways
  6. Is proper oil being used?

Table bounces:
- Purge cylinder of air (Page E6)
- Check 1. Lubrication of ways
  2. Piston rod for damage

Table slow on reversals:
- Check 1. Orifice plug under right hand cover of table valve
  2. Is spool of reversing valve free moving?
  3. Reaction of pilot valve spool to table reverse lever

Table does not move:
- Check 1. Piston rod nut
  2. Position of cross feed mode lever
  3. Machine pressures
  4. For sticky table ways - move table by hand
  5. Lubrication to table ways

Table handwheel spinning:

Check
1. Line to piston for leak
2. Alignment of piston and clutch
3. High pressure relief valve for malfunction

(High Pressure does not drop below 85-90 PSI at 100 RPM)

No cross feed movement:

Check
1. Table throttle - is it in pressure or table speed position?
2. Cross feed mode lever
3. Cross feed direction lever
4. Cross, feed amount valve - is it shut off?
5. Cross feed nut - is it disengaged?
6. All pistons in cross feed valve block for free movement

Cross feed bounce:

Purge cylinder to clear air.

Check
1. Lubrication of ways
2. Piston rod for damage

Large variation of pick - forward and back:

Check
1. Positioning of cross feed direction valve
2. Seal on piston rod
3. Piping for leak

Slow truing speed:

Check
1. Orifice in cross feed mode selector valve

Excess backlash in cross feed handwheel:

Check
1. Rear thrust bearings
2. Cross feed nut - adjust as necessary

Cross feed handwheel rumble:

Check
1. Cross feed screw - if not aligned, readjust at cross feed thrust bearings

Noisy spindle (with Oriflex drive):

Check
1. Pulley adjustment
2. Condition of the "0" rings
3. Motor alignment

Causes and Corrections of Common Grinding Errors

CHATTER

Indication	Cause	Correction
Chatter marks may take any of several forms and may be the result of any of causes listed.	Wheel out of balance.	Rebalance carefully on own mounting. Rebalance after truing operation. Run wheel without coolant to throw off excess water. When wheel is removed from machine, store on side to prevent water from settling at lower edge of wheel.
	Wheel out of round.	True before and after balancing. True sides to face.
	Wheel grading too hard.	Select softer grade, more open bond, or coarser grit.
	Dressing. close to wheel.	Use sharp diamond - rigidly held

SCRATCHING OF WORK

Indication	Cause	Correction
Narrow and deep regular marks.	Wheel too coarse.	Use finer grain size.
Wide, irregular marks of varying depth.	Wheel too soft.	Use harder grading.
Widely spaced spots on work. on wheel face.	Oil spots or glazed areas	Balance and true wheel. Avoid getting oil on wheel face.
Isolated deep marks.	Improper wheel dressing.	Use sharper dressing tools. Brush wheel after dressing, preferably with stiff bristle brush.
	Coarse grains or foreign matter in wheel face.	Dress out.
	Bond disintegrates, grain pulls out.	Coolant too strong for some organic bonds; decrease soda content.
Irregular marks.	Loose dirt.	Keep machine clean

SCRATCHING OF WORK - continued

Indication	Cause	Correction
Irregular marks of various lengths and widths: scratches usually "fishtail".	Dirty coolant.	Clean tank more frequently. Flush guard after dressing and when changing to finer wheels.
Deep, irregular marks.	Loose wheel flanges.	Tighten flanges, using blotters.
	Wheel too coarse or too soft.	Select finer grain size or harder grade wheel.
	Too much difference in grain size between roughing and finishing wheels.	Use finer roughing wheel or finish out better with roughing wheel.
	Dressing too coarse.	Less dresser penetration and slower dresser traverse.
	Improper cut from finishing wheel.	Start with high work and traverse speeds, to cut away previous wheel marks. Finish out with high work and slow traverse speeds, allowing wheel to spark out entirely.

WHEEL GRADING EFFECT

Indication	Cause	Correction
Lack of cut: glazing: some loading: burning of work: chatter.	Wheel too hard in effect.	Increase work and traverse speeds and wheel pressure (downfeeds). Decrease wheel diameter and width of wheel face. Open up wheel by sharper dressing. Use thinner coolant. Avoid gummy coolants. Use coarser grain size and softer grade.
Wheel marks: short wheel life: not holding cut.	Wheel too soft in effect.	Decrease work and traverse speeds and wheel pressure (downfeed). Increase wheel diameter and width of wheel face. Dress with slow traverse and slight penetration. Use heavier coolants.

WHEEL LOADING

Indication	Cause	Correction
Metal lodged on grains or in wheel pores.	Incorrect wheel.	Use coarser grain size, or more open bond, to provide chip clearance. Use more coolant.
	Faulty dressing.	Use sharper dresser. Dress faster. Clean wheel after dressing.
	Faulty coolant.	Use more, thinner and cleaner coolant.
	Faulty operation. feed.	Manipulate operation to soften effect of wheel. Use less down-

WHEEL GLAZING

Indication	Cause	Correction
Shiny appearance: slick feel. soften effect.	Improper wheel.	Use coarser grain size, softer grade. Manipulate operation to
	Improper dressing.	Keep wheel sharp with sharp dresser. Use faster dressing tool traverse. Use more dressing tool penetration.
	Faulty coolant.	Use less oily coolant. Use more coolant.
	Gummy coolant.	Increase soda content if water is hard. Do not use soluble oils in hard water.
	Faulty operation-	Use greater infeed.

INACCURACIES IN WORK

Indication	Cause	Correction
Work is not flat.	Improper dressing.	Make sure machine conditions are the same when dressing as when grinding.
	Expansion of work.	Reduce temperature of work by using more coolant and lighter cuts.

CHECKING OF WORK

Indication	Cause	Correction
Work shows check marks.	Improper wheel manipulation.	Prevent wheel from acting too hard. Do not force wheel into work. Use larger and more even flow of coolant.
BURNING OF WORK		
Indication	Cause	Correction
Work shows discoloration.	Improper wheel.	Use softer wheel or manipulate to get softer effect. Prevent glazing and loading. Use more coolant.
	Faulty operation.	Bring wheel to work more gradually. use less downfeed. Prevent stoppage of work while in contact with wheel.

WHEEL BREAKAGE

Indication	Correction
Radial break, three or more pieces.	Reduce wheel speed to rated speed. Correct improper mounting such as lack of blotters, tight arbors, uneven flange pressure or dirt between flanges and wheel. Prevent overheating due to lack of coolant. Prevent excessive wheel pressure on work. Do not allow wheel to become jammed on work.
Radial break, two pieces.	Prevent excessive side strain.
Irregular break.	Do not allow wheel to become jammed on work. Prevent blows on wheel. Do not use wheels that have been damaged in handling. Examine wheel before using. Sound wheel by tapping.
General.	Do not attempt to grind with a wheel that is too tight on the arbor, as wheel will break when started. Prevent excessive hammering action of wheel. Familiarize yourself with the provisions of the Safety Code governing use of grinding wheels, and observe the rules.

618 and 818
Series II
Surface Grinding Machines

OPTIONAL MECHANISMS AND EQUIPMENT

The wide selection of optional equipment for 618 and 818 available at extra cost, is described in the following pages. It includes supplementary mechanisms, attachments and accessories which extend capabilities and permit their adaptation to an unlimited variety of specialized requirements.

Dial-A-Size
(covered in separate booklet)

Power Down Feed Arrangement

This arrangement provides for fully adjustable Automatic control of the down feed when grinding slots and surfaces within the wheel width. Down feed occurs at each table reversal. The amount of this feed is in increments approximately .0002" (.005 mm). A positive stop permits termination of the feed at any depth to approximately .04" (1mm). This stop may be retracted to permit automatic down feeding over the entire range of the wheel slide.

The mechanism is designed so that the pawl is completely withdrawn from the tooth spaces of the ratchet wheel during each recovery stroke to avoid scraping the top of the teeth during recovery.

Index dial - This dial is used for fine adjustments. The handwheel can be set at zero at the positive stop position and readings made directly from the index dial. To get accurate readings, the wheel stop should bear against the right side of the positive stop. With the handwheel set at the positive stop, the index dial is turned back the desired amount. The mechanism will then feed down the amount selected.

If positioning will require many turns of the handwheel, pull out the downfeed adjustment pinion in the center of the index dial to disengage the handwheel. Turn the handwheel the required amount and push in the pinion.

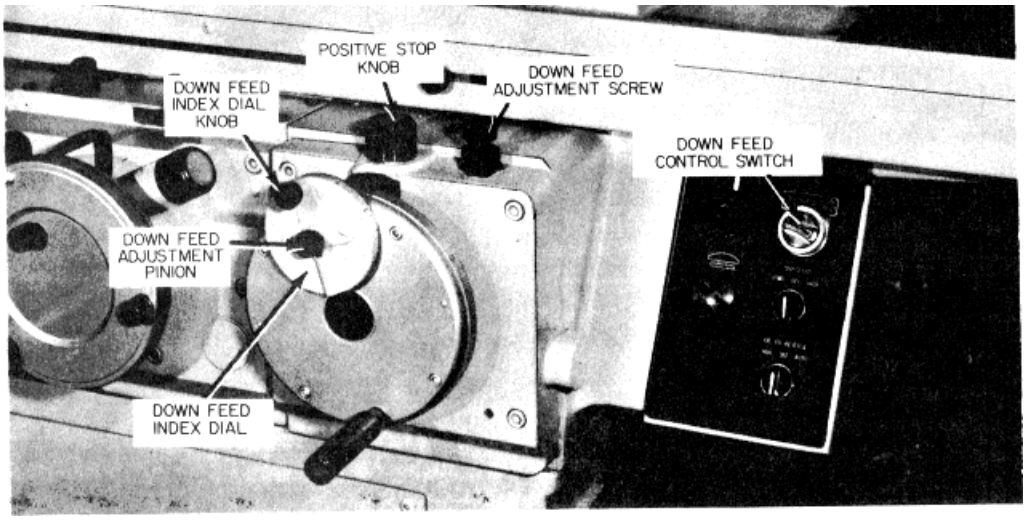


Fig. 1I. Power down feed arrangement.

Then make any necessary fine adjustments by turning the index dial.

Setting the positive stop A pin in the back of the elevating handwheel, located behind the index dial, comes in contact with the right hand side of the positive stop for the downfeed movement. The handwheel reading is then zero. To set the stopping point for the desired finished size of the work, proceed as follows:

1. With the other setup adjustments completed and the workpiece in place, use the handwheel for vertical adjustment until the grinding wheel just touches the work.
2. Pull out the downfeed adjustment pinion, freeing the handwheel. Turn the handwheel until the pin comes against the right hand side of the positive stop.

3. Re-engage the downfeed adjustment pinion. Check the size of the work, and make necessary adjustments with the downfeed index dial always working to the positive stop. The repeat accuracy will then be assured, under normal operating conditions.

Included in this arrangement is a friction device which keeps a drag on the handwheel. This device can adjusted for individual preference when the handwheel is used manually The adjustment is located below the handwheel. The device also prevent backlash of the handwheel when the ratchet is engaged.

The Power Downfeed Arrangement provides the advantages of automatic downfeed, and also permits manual operation. The positive stop can be adjusted for the desired size and the mechanism operated manually rather than waiting for the automatic down feed at table reversals.

Vertical Rapid Positioning Arrangement

Powered by a 1/4 hp (.187 kw) motor, this arrangement permits rapid vertical positioning at the rate of 40 ipm (1 m/min). A brake-type motor is used for fast stop. Control pushbuttons are located at the control station at the right of the machine.

Positioning by power requires, first, pushing the control knob located between the elevating and cross feed handwheels, then pressing the proper pushbutton to move the wheel up or down. The wheel travels as long as the button is pressed. The full travel range is 14 3/4" (375 mm). The elevating handwheel must be disengaged to activate the vertical positioning control.

Automatic Cross Feed Reversing Arrangement

Available for machines with power cross feed, this arrangement provides a convenient means of automatic cross feed reversal. Reversal continues until the cycle is stopped by the operator. The set of adjustable trip dogs is located on the right side of the upright.

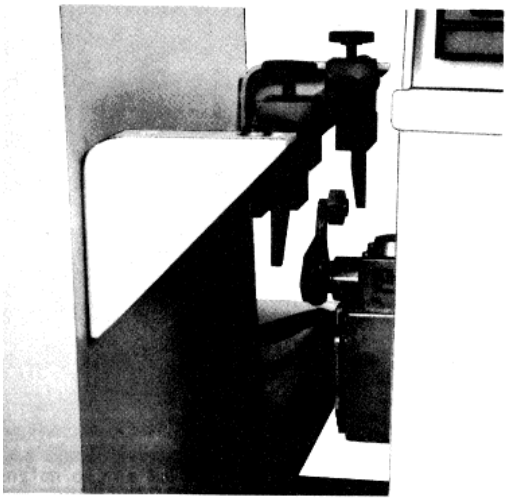


Fig. 2I. Automatic cross feed reversing arrangement.

The controls are located at the control station at the right front of the machine. Return to hand cross feed operation can be made by switching the Selector control to the Manual position.

Vertical Position Indicator

This Indicator greatly reduces setup time by permitting rapid, accurate vertical positioning of the grinding wheel. This eliminates the time consuming task of "feeling" for the workpiece. The Indicator is adjustable over the entire vertical range of the grinding wheel.

Wheel position is indicated by a dial indicator precisely adjusted with a micrometer. Position is easily observed by noting the dial indicator reading.

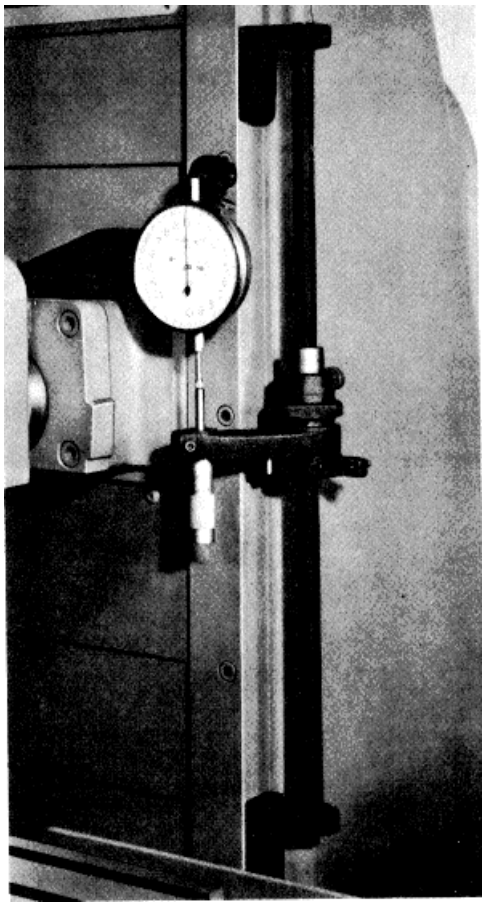


Fig. 3I. Vertical position Indicator.

Separate Control for Spindle Motor

This arrangement provides for independent control of spindle power and table power by use of the two position selector knob furnished with it. In one position, the spindle can be stopped without shutting down the hydraulic system. This provides a “dead wheel" for safety during setup, and the table can still be positioned by power. The other position of the selector provides normal, simultaneous operation of both spindle and hydraulic system motors.

Extra Vertical Capacity Parts

These parts increase the vertical capacity of the machine by 4" (1000mm). This increases the height of work ground to 19 1/2" (495 ram) with a 7 " (177 mm) wheel. This modification is built into the machine at the factory when specified.

Wet Grinding Attachment

With the Wet Grinding Attachment, coolant is supplied to the wheel through a nozzle and flexible tubing from a 1/8 hp (.09 kw) motor-driven centrifugal pump mounted in the supply tank.

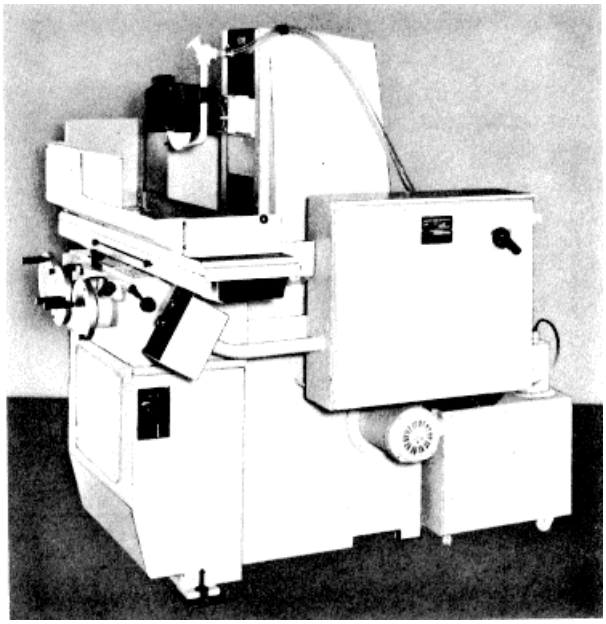


Fig. 4I. Wet Grinding Attachment

A valve adjacent to the nozzle controls the rate of flow, and an adjustable splash guard, mounted on the opposite side, deflects the coolant.

The machine table is surrounded by guards that protect both the machine and operator from coolant spray. Coolant collects in the table channels and is delivered to a trough in the bed at the rear of the table. It is then discharged into troughs at the side of the upright base and returns to the supply tank through a flexible hose. The 30 gal. (113.56 liter) floor type tank is of welded steel and is fitted with casters. Re movable baffles provide for efficient settling.

The pump motor connects to the back of the electrical cabinet and is started and stopped with the machine Start-Stop pushbuttons.

Mist Coolant Arrangement

This arrangement combines compressed air with coolant to develop a mist that evaporates on contact with the work, cooling as it evaporates, and provides full-time visibility of the work.

A solenoid valve connected to the machine's electrical circuit synchronizes the start of the mist stream with the start of the machine.

Precision control of the mist is provided by a needle valve on the jet. This valve permits accurate adjustment from a very fine mist to a heavy spray. There is never any flooding or "sputtering". The mist is generated at the end tip of the jet. There is no condensation in tubes, and no dripping or spurting of coolant when starting or stopping.

Exhaust Attachment

This attachment removes grit and dust-laden air from the region of the grinding operation by suction and separates out foreign matter, leaving the air well cleaned.

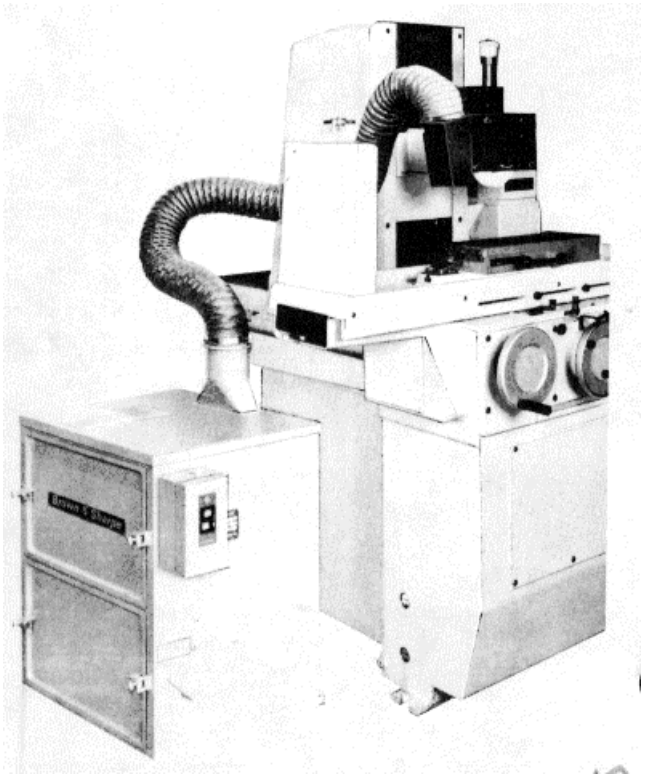


Fig. 5I. Exhaust Attachment.

A 3/4 hp (.56 kw) motor-driven fan is mounted on the clean air side of the unit. Dust-laden air, up to 420 cfm (11.89 cu. m/m), drawn through a flexible hose from an exhaust nozzle attached to the wheel guard, must pass through the filters before it reaches the fan. This prevents fan loading and excessive wear, and saves the time and cost of repairs.

Grit, dust and other particles exhausted from the work area are deposited in the base of the collection chamber or stopped by the filters. The fabric filtering area totals 30 square feet (2.787 square meters), providing an exceptionally high collection efficiency for particles of all sizes. This efficiency is up to 99.75% for particles as small as 1.0 micron.

Most of the dust and larger particles settle directly in the pullout dust drawer. The fine dust which collects on the outside of the fabric filters is easily dislodged by operating the filter shaker lever.

The attachment has a 4" (101.6 mm) inlet and a capacity of 420 cfm (11.89 cu. m/m) at a velocity of 4823 fpm (1470 m/m). Floor space required is 19 5/16" x 22 3/8" (490.5 mm x 568.3 mm) and the cabinet height is 26 11/16" (677.9 mm).

Optional equipment for Exhaust Attachment:

Independently Supported Hose Assembly - Available at extra cost in place of standard hose and nozzle regularly furnished for attachment to wheel guard. Suspension brace holds hose in operating position. Intake end is fitted with air scoop which can be readily positioned next to wheel for efficient collection of dust and grit.

Exhaust Silencer - For conditions where the utmost in silent operation is required, this supplementary silencer is available at extra cost. It fits over the air stream outlet and does not increase floor space requirements.

High Speed Surface Grinding Attachment

Slots and other surfaces which do not permit the use of a wheel of large diameter can be rapidly and economically ground with this attachment. The attachment is readily applied to the machine, and drives small grinding wheels at the necessary high surface speeds.

The attachment spindle runs at 15,000 rpm when driven from a machine spindle having Oriflex drive, and at 18,000 rpm when driven from a direct drive spindle (running at 3600 rpm).

The attachment fits on the machine spindle housing, and can be used in practically any angular position around the spindle. With the attachment spindle in the lowest position, the maximum vertical distance between center of attachment spindle and top of machine table is 12" (305 mm).

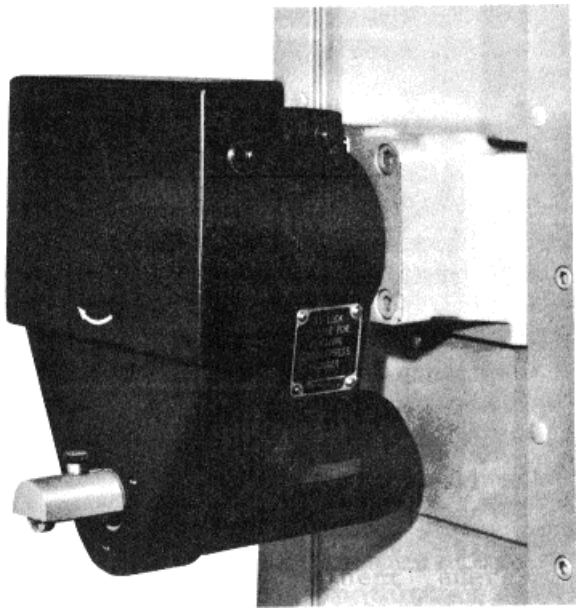


Fig. 6I. High Speed Surface Grinding Attachment.

The spindle is mounted on two pairs of super-precision ball bearings and is driven from a pulley mounted on the machine spindle. Belt tension adjustment is by means of an eccentric sleeve in the attachment body.

In changing wheels or arbors, a spring-loaded plunger in front of the attachment body above the spindle can be pushed in to hold the spindle from rotating. The spindle hole and arbor shank must be perfectly clean before the arbor is inserted, and the arbor must be seated firmly in the spindle. All arbors used have a left-hand thread. A cold arbor should never be placed in a warm spindle, since, when the arbor expands (or the spindle cools and contracts); the taper fit will be so tight that removal of the arbor will be difficult.

Wheel arbors and grinding wheels are furnished at extra cost. Stock sizes are listed or page I6. The exact ing limits and fine finish demanded of this equipment require extreme accuracy in the taper fit between spindle and wheel arbor.

Arbor Number	Grinding wheel size diam. x thick. x hole		Distance, rear face of grinding wheel to end of Attachment	
	Inches	mm	Inches	mm
2103*	1/2 x 1/4 x 3/32	12.7 x 6.35 x 2.38	13/16	20.64
2105*	1/2 x 1/4 x 3/32	12.7 x 6.35 x 2.38	1 3/16	30.16
2107*	1/2 x 1/4 x 3/32	12.7 x 6.35 x 2.38	1 9/16	37.69
2109	7/8 x 1/4 x 1/4	22.22 x 6.35 x 6.35	1 3/4	44.9
2111	1 1/4 x 3/8 x 5/8	31.75 x 9.53 x 15T88	1 3/4	44.9

* Used with No. 2125 Collet, furnished at extra cost

Therefore, we strongly recommend that all wheel arbors be furnished by us to assure the utmost in precision and finish.

Power Truing Arrangement Over-the-Wheel

This arrangement, mounted directly over the wheel, greatly reduces the time and effort required for wheel dressing. It provides a smooth, powered traverse of the diamond, at uniform speed, across any grinding wheel up to 1" (25 mm) in width.

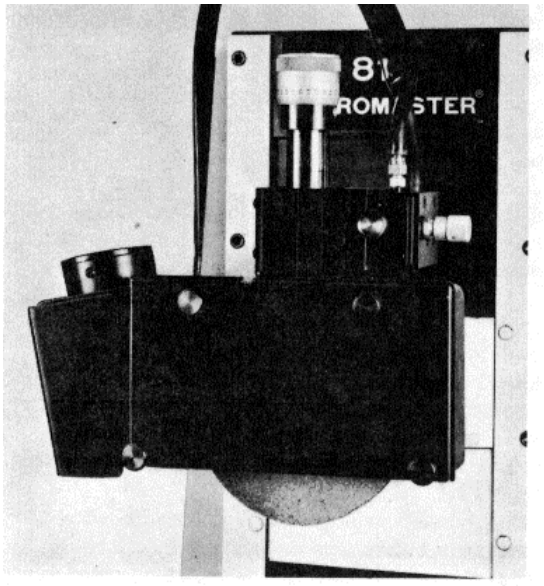


Fig. 7I. Over-The-Wheel Power Truing Attachment.

The traverse is hydraulically actuated by pushbutton, and the truing rate is adjustable from 2 to 20 ipm (50 to 500 mm/min). The total radial feed adjustment is 3" (76 mm), with 1" (25 mm) of this movement provided by the feed screw, which permits micrometer adjustment in increments of .0001" (.0025 mm).

The diamond (approximately 1 carat) in a mounting is available at extra cost.

Over-the-Wheel Manual Truing Arrangement

With this arrangement, wheel dressing for the majority of routine jobs becomes a simple operation, saving many of the steps necessary in other methods of truing. The diamond is held in a traversing ram mounted above the wheel, which is operated manually with the lever on the right side. It will true wheels up to 1" (25 mm) wide. The diamond has a total vertical feed adjustment of 3" (76 mm). One inch (25 mm) of this is provided by the feed screw, which permits micrometer adjustments in increments of .0001" (.0025 mm).

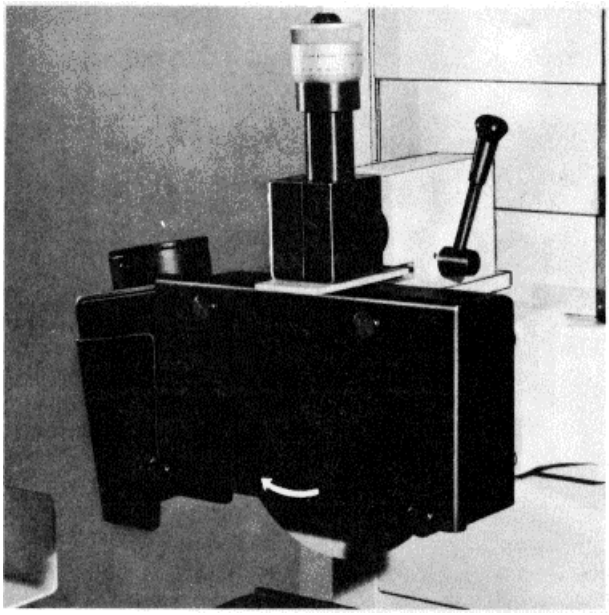


Fig. 8I. Over-The-Wheel Manual Truing Attachment.

The diamond is traversed across the wheel by use of the lever. A pull moves the diamond forward and a push retracts it. The truing speed is controlled by the operator; the slower the lever movement, the finer the truing cut.

In using this arrangement, it is essential that the stroke of the ram is parallel with the table. This is checked as follows:

1. True the wheel from the table and grind a test block.

2. Stop the table and true the wheel with the over-the-wheel truing arrangement.

3. Feed the rotating wheel down slowly until it contacts the work, then "read" the witness marks on the surface of the work. (See Fig. 9I).

4. If the wheel makes a full width cut, the ram stroke is parallel to the table. If the wheel cut is stronger at the front or back, adjust the ram stroke to correct it.

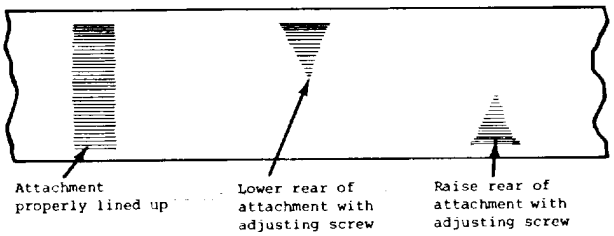


Fig. 9I. Wheel marks on surface of test block.

After the initial check and adjustment, wheel truing is fast and accurate. The diamond is fed down by turning the micrometer dial, then passed across the wheel. After the wheel is trued, it is lowered an amount equal to the truing cut, as indicated on the dial. This brings the surface of the wheel into the same position relative to the work surface as it was before truing.

The diamond (approximately 1 carat) in a mounting is available at extra cost.

Radius and Angle Wheel Truing Attachment

This attachment provides a ready means of forming wheels with accurate convex or concave outlines up to 1" (25.4 mm) in radius and face angles up to 900 (1.57'radians) either side of zero, and permits forming combinations of radial and angular shapes.

The base of the attachment carries a swivel platen upon which is mounted a slide which can be moved horizontally by handwheel. A gib and adjusting screw provide means of compensating for wear in the slide. The base is keyed for accurate alignment.

To form concave or convex outlines, clamp the diamond tool (diamond not furnished) in the upright parallel to the slide as shown in Fig. 10I, locating the diamond point by means of the diamond tool setting gage (turned upward 1800 (3.14 radians) from the position shown).

Adjust the slide by handwheel to the desired radius as shown by the scale on the side, setting the slide to the right of center to form a convex shape on the wheel and to the left of center to form a concave shape. Tighten the clamping screw on the back of the slide (not visible in illustration) to lock the adjustment, and pass the diamond across the wheel by swiveling the attachment on its base.

To true a wheel to an angle, swivel the slide to the desired setting as indicated in degrees by the scale on the base and tighten the clamp screw in front of the base.

Clamp the diamond tool in the upright at right angles to the slide and pass the diamond across the wheel by running the slide back and forth by handwheel.

In either case, to obtain the desired shape adjust the height of the spindle head to bring the center of the spindle horizontal with the diamond point.

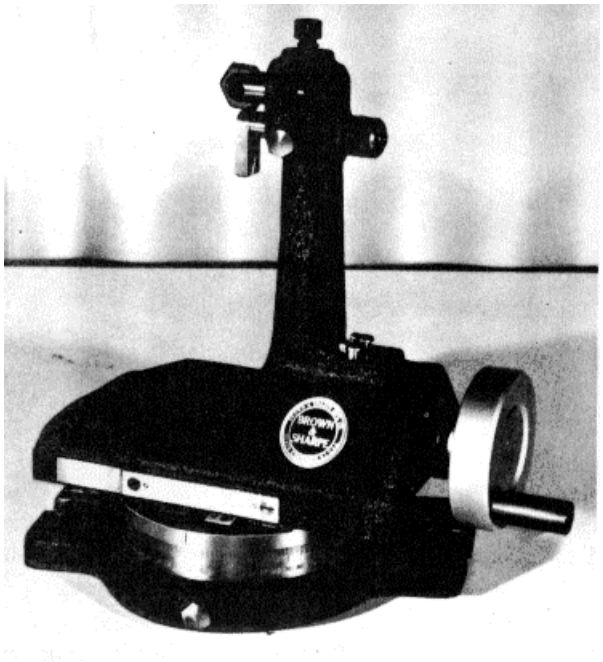


Fig. 10I. Radius and Angle Wheel Truing Attachment. The slide is clamped at the required radius, the diamond tool is set by the gage just below it and the slide is swiveled to form the wheel.

Continuous Radius and Tangent Wheel Truing Attachment

This attachment is designed to form, with one continuous movement of the diamond, accurate radii on grinding wheels with accurate tangents at either or both sides of the radii. The forms possible are described below:

Convex form on wheel:

A - Radii up to 1/2" (12.7 mm) can be used when forming convex shape on wheel.

B - Tangent at front of wheel can be in any direction from parallel to the side of the wheel to 1100 (1.92 radians) away from the side.

C - Tangent at rear of wheel can be in any direction from parallel to the side of the wheel to 1100 (1.92 radians) away from the side.

D - Included angle of tangents can be from 0 to 1800 (3.14 radians).

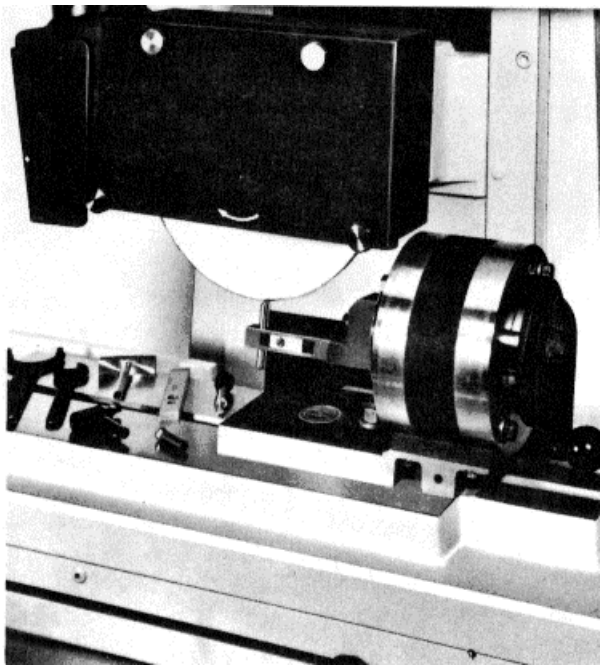


Fig. 12I. Continuous Radius and Tangent Wheel Truing Attachment.

Concave form on wheel:

A - Radii from 1/32" (.79 mm) to 1" (25.4 mm) can be used when forming concave shape on wheel.

B - Tangent at front of wheel can be in any direction from 70° to 180° (1.22 to 3.14 radians) away from the side of the wheel.

C - Tangent at rear of wheel can be in any direction from 70° to 180° (1.22 to 3.14 radians) away from the side of the wheel.

D - Included angle of tangents with radius of 3/8" (9.52 mm) or less can be from 0° to 180° (3.14 radians). With radius over 3/8", the included angle of tangents can be from 90° to 180° (1.57 to 3.14 radians).

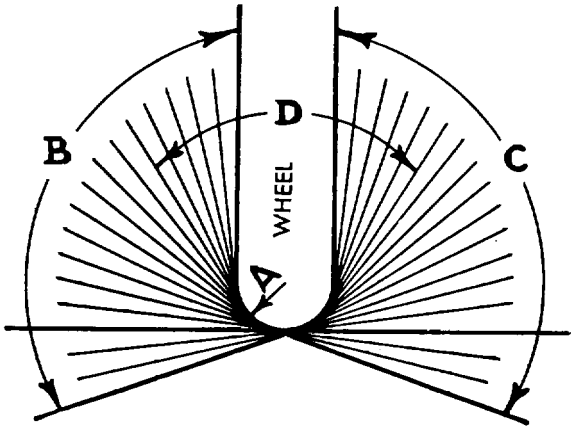


Fig. 13I. Convex form on wheel.

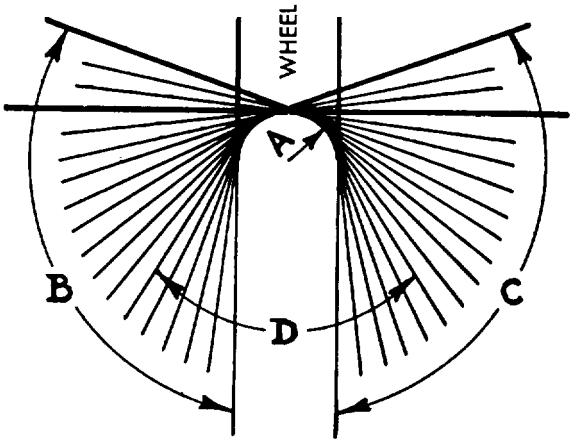


Fig. 14F. Concave form on wheel.

The angles of tangents are independent of each other. On a concave shape having a radius over 3/8" (9.52 mm), the included angle must be 90° (1.57 radians) or more. Concave radii less than 5/32" (3.97 mm), and all concave radii 3/8" (9.52 mm) or 1 less having the included angle of the tangents less than 90° (1.57 radians) require diamond tool holders other than the one furnished. (These diamond tools should be the same or similar to the "HC Series" as made by the Wheel Truing Tool Co. of Detroit, Mich.).

The attachment is firmly clamped to the machine table by a single T-bolt. Accurate alignment is assured by two reversible tongues for T-slots 1/2" or 9/16" (12.7 or 14.29 mm) wide These tongues are easily removed when the attachment is to be used on a magnetic chuck.

When truing a convex form, the angle of the tangent at the front of the wheel is controlled by the angular setting of the adjustable plate at the left side of the attachment body; the angle of the tangent at the back of the wheel is controlled by the setting of the plate at the right of the body.

When truing a concave form, the left-hand plate controls the rear tangent and the right-hand plate the front tangent. Verniers on the plate and matching scales on the attachment body facilitate the setting. Two clamp nuts on each plate maintain the angular setting. A gage is provided, which, used in conjunction with a micrometer, permits setting the diamond to form an accurate radius on the grinding wheel.

After the attachment is properly set, the diamond is brought into contact with the grinding wheel and the wheel is accurately formed to the desired shape by turning the easily operated crank at the right. Detailed operating instructions are furnished with the attachment.

This attachment is not recommended for use where coolant may enter its bearings.

Illuminated Dust Guard

This unit fits over the dust guard regularly furnished on the left end of the machine table. Two 6-watt fluorescent tubes mounted behind frosted safety glass provide an excellent bright background for such jobs as form grinding, etc.

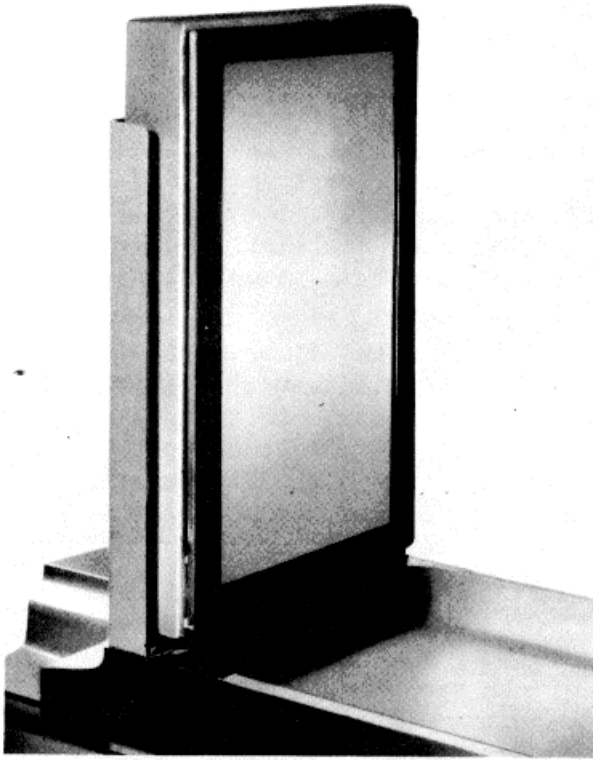


Fig. 16I. Illuminated Dust Guard.

Isolation Mountings

This set of three mounts eliminates the need for expensive machine foundations where external vibrations are a problem. A machine set on these mountings is isolated from external vibrations such as those present when a machine is located on an upper floor of a multistory building, or located near vibration-causing machinery.

The use of the Mountings, raises the machines approximately 3/4" (19 m off the floor.

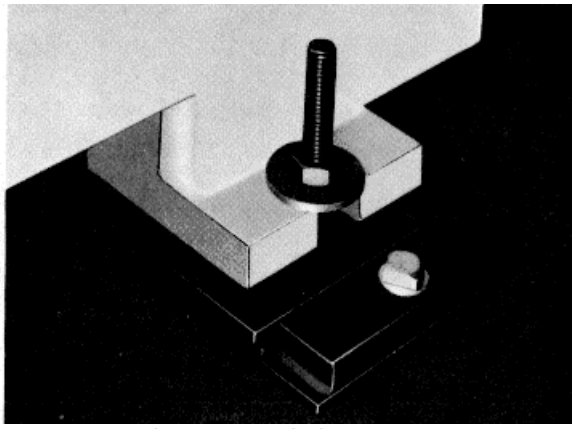


Fig. 17I. Isolation Mount.

Fine Cross Feed Knob

For maximum, precise control of cross feed operations. Wide space graduations permit easy reading of changes in .0001" (.001 mm) increments. This arrangement is couple to the Cross Feed Handwheel. Non- reflecting, black finish.

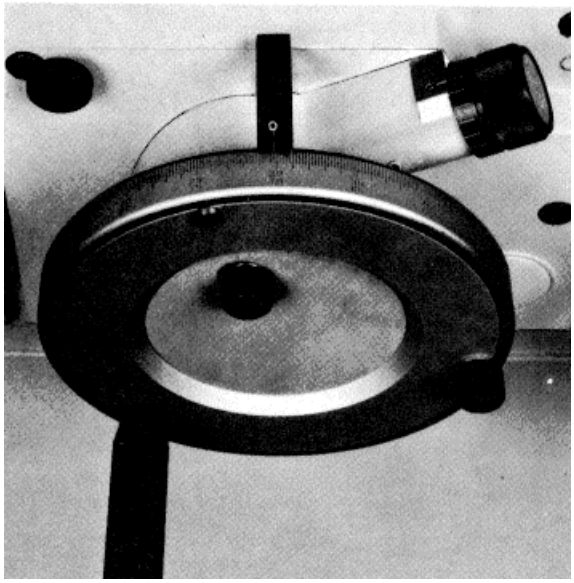


Fig. 15I. Fine Cross Feed Knob

English/Metric Handwheel

This Dual-Dial Handwheel (Fig. 8D) has two graduated dials (inner dial Metric, outer dial English) which respond to movement of the handwheel with independent rotation ratios. Separate "O" index marks are provided for each dial. A knurled knob on the face of the handwheel permits both dials to be disengaged and either dial set to "Zero."

English/Metric Handwheels are available for both Vertical and Cross-feed ant replace the standard English-reading, single dial handwheels. Dual-Dial units may be retrofitted to some machines in the field (information on application).

Fine feed Dual-Knobs, reading .000”/0.002 mm, are available for use with the Dual-Dial Handwheels. The fine feed knob is engaged by turning a knurled knob at the center of the handwheel.

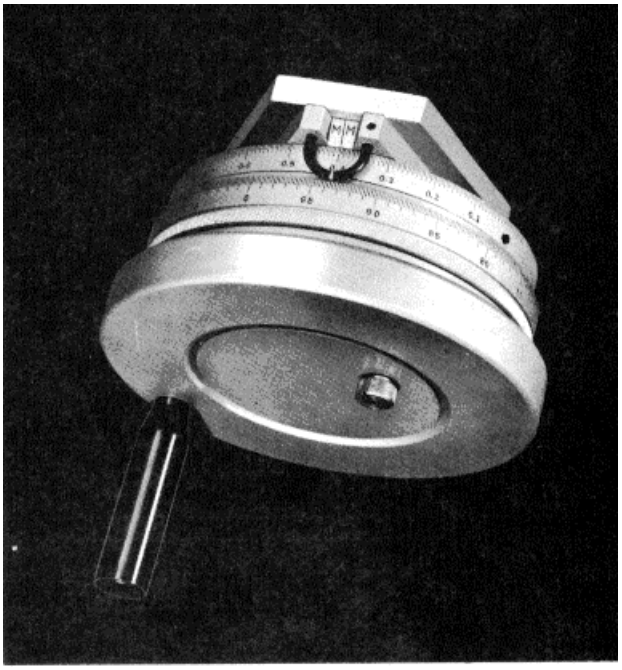


Fig. 8D. English/Metric Handwheel.

Wheel Sleeve, Balancing Type

This wheel sleeve facilitates correcting an out-of-balance condition of the wheel, should one occur. Two balancing segments are provided on the sleeve and are adjusted as follows to balance the wheel:

1. With the wheel mounted on the wheel-sleeve, set and clamp the two balancing segments 180° apart. Then place the wheel and sleeve on the machine and true the wheel.

2. Remove the wheel and sleeve from the machine and using a suitable balancing arbor and ways, let the wheel come to rest and mark the low point to locate the heavy side.

3. Loosen the segment locking screws and slide the segments around to a trial position, locating both segments above the horizontal and at the same distance each side of the mark on the heavy side. Then clamp the segments and let the wheel come to rest.

4. Repeat the adjustment as necessary until the wheel is in balance, remembering at all times to keep the segments located the same distance each side of the mark on the heavy side. If the wheel comes to rest with the mark at the bottom, move the segments farther up; and if it comes to rest with the segments at the bottom, move the segments in the other direction. The wheel is in balance when it will remain at rest in all positions on the balancing ways.

Fig. 24D. Wheel Sleeve, Balancing Type.

Work Positioning Table

For monitored positioning of the workpiece. Speeds and simplifies precise transverse adjustment for slot grinding, rack teeth and broach teeth grinding, and for grinding splines, keyways, tool and die sections, etc. Adjustable dial indicator has range of 1" (25 mm) with .0001" (.002 mm) graduations.

Features engineered for precision performance include accurately ground lead screw, hardened and grout dovetail ways, and patented nondistorting table top lock. Provides gal block stage. Accommodates Magnetic Chucks up to 6" x 12" (152 mm x 304

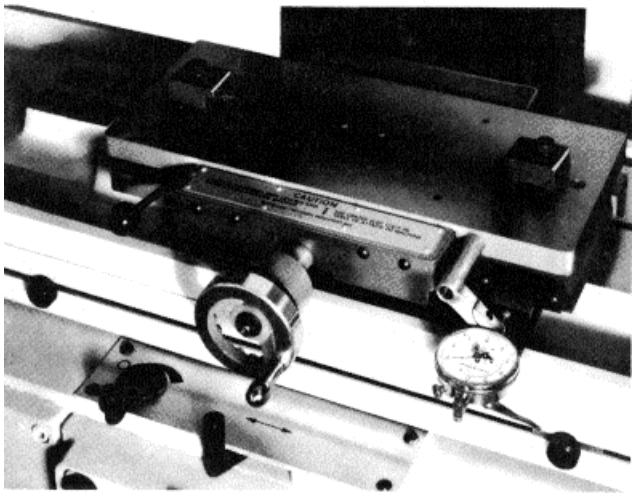


Fig. 18I. Work Positioning Table.

Variable Spindle Speed Arrangement

Permits constant control of surface speed by compensation for change as wear reduces diameter of grinding wheel. Allows adjustment of spindle speed up 6000 sfm (1829m/min) for maximum efficiency on different materials. Speed be easily read on the indicator provide A safety interlock prevents overspeeding of wheels. Solid state, plug-in module J1C, NEMA 12 enclosure.

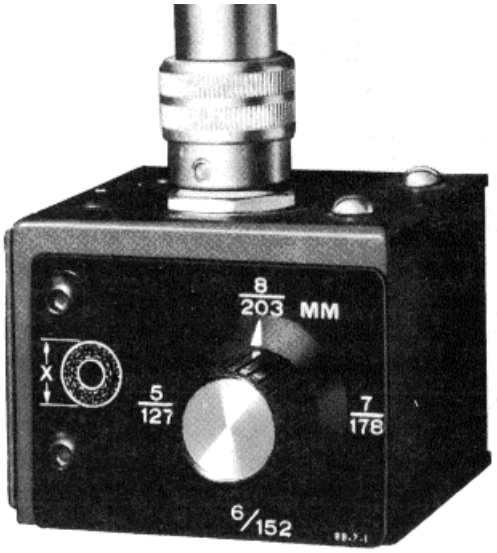


Fig. 25D. Safety interlock at rear wheel guard prevents overspeeding of grinding wheels.

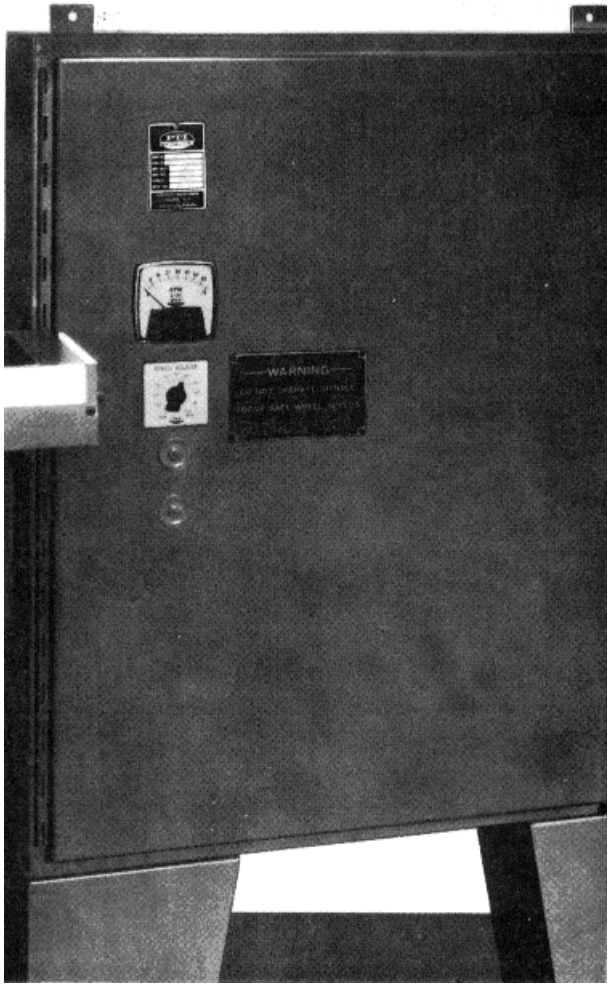


Fig. 26D. Wheel speed selected 1 knob on front of freestanding cabin

4 3/4 Inch Index Centers

These Index Centers permit accurate indexing of the more common circular divisions and facilitate the grinding of taps, reamers, formed cutters and similar work. The Center are clamped in position by T-bolts and are aligned by tongues which fit the table T-slots.

A spring-loaded locking pin on an adjustable arm, together with six rows of holes in the face of the combined index plate and worm wheel, provide for indexing all divisions from 2 to 14 and all even-numbered divisions from 18 to 28. The index plate can be turned by the worm, or the worm can be thrown out of mesh and the index plate turned by hand. To disengage the worm, loosen the adjacent clamp screw and swing the worm downward.

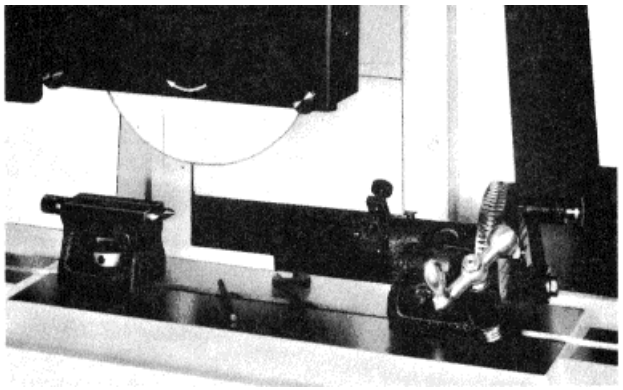


Fig. 19I. 4 3/4 Inch Index Centers.

In using the Index Centers for sharpening formed cutters or similar work having radial tooth faces, first turn the cross feed handwheel to bring the face of the grinding wheel in line with the centers. Then, with the work mounted between centers, disengage the index pin and turn the worm to feed the face of a tooth into the grinding wheel, feeding the work small amount and running the table back and forth by hand in successive steps until that tooth is properly sharpened. Next, loosen the index pin arm, insert the pin in a hole in the proper circle and securely clamp the arm.

In sharpening the rest of the teeth, where a considerable amount of stock is to be removed from each tooth face, feed the work to the grinding wheel by means of the worm to take the necessary number of successive cuts on each face until the index pin enters the proper hole. In case the grinding wheel requires dressing before all the teeth are sharpened, readjust the position of the grinding face of the wheel relative to the index centers after dressing the wheel. Moving the spindle slide upright to bring the grinding wheel into contact with the face of the last tooth ground is generally sufficient. After sharpening the remainder of the teeth, a final adjustment of the spindle slide upright may be necessary for required accuracy, after which a light finishing cut all around will compensate for errors due to wheel wear.

The Centers as furnished swing work up to 4 3/4" (120 mm) diameter. Used with raising blocks (available at extra cost), they will swing work up to 8 1/4" (210 mm) diameter. The reversible tongues fit T-slots 1/2" or 9/16" (12.7 mm. or 14.29 mm) wide.

Precision Grinding Vise

This vise is ruggedly designed to hold work rigidly for close-tolerance operations. All work contact ing surfaces are precision ground. A unique jaw cam prevents uplift of workpiece under pressure. Sides and jaws are square and parallel within .0002" (.005 mm). The jaw opening takes work up to 4" (101 mm). The jaws are 2 1/2" (63 mm) wide and 1" (25 mm) deep.

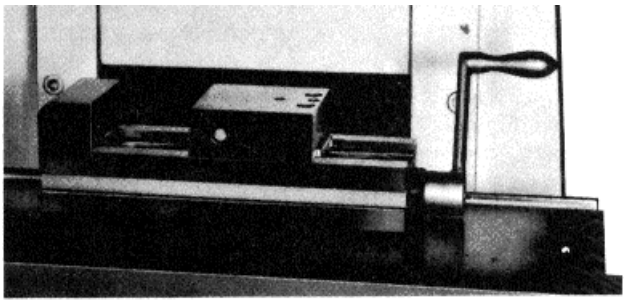


Fig. 23I. Precision Grinding Vise

Magnetic Chucks

The rectangular model Permanent Magnet Chucks provide a quick, easy means of holding a variety of ferrous work for surface grinding. A 1800 (3.14 radians) movement of the control lever turns the chuck on or off. Since the Chuck does not use electric current, it can be left turned on for as long as necessary without heating. Wiring, switches, generators, etc., are not required. The special alloy magnets retain their holding power indefinitely. These Chucks are available in two types:

"Wide pole" Magnetic Chucks are the type most commonly used. For grinding where the tolerance is over .0003" (.0076 mm) and where large and thick parts predominate, this type will prove satisfactory. Auxiliary top plates are available for holding smaller work.

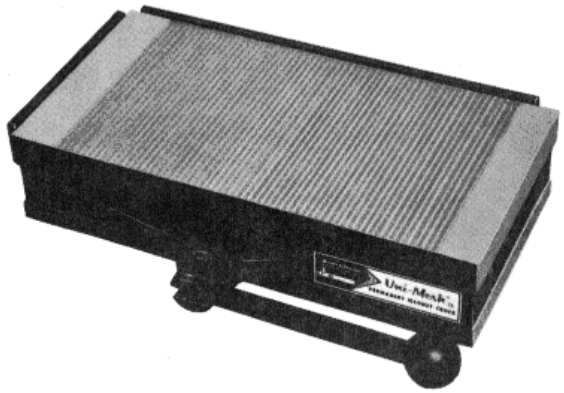


Fig. 20I. Permanent Magnet Chuck.

The Micro-Mesh Permanent Magnet Chucks are designed for high precision performance in grinding parts that are small or thin to tolerances of .0003" (.01 mm) or less. Their closely spaced poles serve equally well for holding larger, thicker parts.

The rectangular Permanent Magnet Chucks available are as follows:

Chuck No.	Working Surface, inches	(mm)	Height of Chuck, inches	(mm)	Shipping Weight, lbs.	(kg)
510-6	5 x 10	(125 x 250)	2.6	(65)	32	(14)
510-7	5 x 10	(125 x 250)	2.6	(65)	32	(14)
512-6	5 x 12	(125 x 300)	2.6	(65)	38	(17)
612-6	6 x 12	(150 x 300)	2.6	(65)	46	(21)
614-6	6 x 14	(150 x 350)	2.6	(65)	53	(24)
618-6	6 x 18	(150 x 450)	2.6	(65)	69	(31)
618-7	6 x 18	(150 x 450)	2.6	(65)	69	(31)
818-6	8 x 18	(200 x 450)	2.6	(65)	92	(41)

Nos. ending - 6 have Unimesh top plates with .165" (4.2 mm) pole spacing.
Nos. ending - 7 have Micro-Mesh top plates with .030" (.8 mm) pole spacing.

For highest accuracy in grinding work parallel, the top surface of the Chuck should be ground each time it is mounted on the machine. The Chuck should be turned On so that it will hold magnetically to the table surface. Only a minimum amount of metal should be removed, usually about .0002" (.005 mm).

If the machine is equipped for it, wet grinding is preferable when using a Magnetic Chuck. The coolant reduces the possibility of distortion in the top plate which might be caused by the heat from grinding.

Two removable stop plates are furnished with each chuck, one for the back and one for the left-hand end, which can be adjusted vertically to suit the work.

Electromagnetic Chucks can also be furnished together with a rectifier and neutrofier. Descriptive information will be sent on request.

Neutrofier

Neutrofiers are used to overcome problems encountered by shops where the work is predominantly ferrous metal parts. They successfully neutralize both swarf and workpiece to assure the finest finish. The Neutrofiers available are free-standing and self-contained.

5" and 10" Sine Plates
Simple and Compound

These Sine Plates offer, at surprisingly low cost, reliable means for establishing precise angles for surface grinding, and for tool-making and inspection purposes as well. With an overall accuracy within .0002" (.005 mm), they give gage block accurace to angular settings.

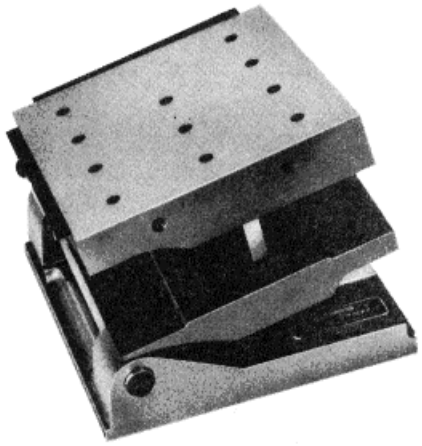


Fig. 21I. Compound Sine Plate.

Specifications for Simple and Compound Sine Plates

Size	Type	Working surface, inches	Working surface, (mm)	Height, set at 0° inches	Height, set at 0° (mm)
5"	Simple	3 1/2 x 6	(9 X 152)	1 15/16	(49)
10"	Simple	6 x 11	(152 X 279)	2 9/16	(65)
5"	Compound	6 x 6	(152 X 152)	3 3/16	(81)
10"	Compound	6 x 11	(152 X 279)	3 9/16	(90)

Made of normalized steel, case hardened and seasoned, they have a glass-like finish on bottom, top and sides. They are furnished with a side plate and end plate, held in place by knurled-head screws. The top plate has tapped holes in its sides, ends and top for the application of clamps or other holding devices.

Both Simple and Compound Sine Plates are available. The Compound Plate (Fig. 21I) is ideal for grinding compound angles. The lower hinge on the Compound Plate can be furnished on the opposite end to that illustrated at no extra cost.

5" and 10" Perma-Sines
Permanent Magnet Sine Plates -
Simple and Compound

Perma-Sines offer all the capabilities of the Sine Plates described above plus the added advantage of a Permanent Magnet working surface. Their overall accuracy is within .0002" (.065 mm).

No clamps or special holding fixtures are required. Magnetic holding power is turned on or off by the movement of a lever. The closely spaced poles in the magnetic plate are ideal for holding small or thin work.

These Sine Plates are made of steel, case hardened and seasoned, and have glass-like finish on bottom, top and sides. A side plate and an end plate are furnished, held in place by knurled-head screws.

Both simple and compound Perma-Sines are available. The compound model (illustrated) is particularly suited to grinding complex angles. The lower hinge on the compound plate can be furnished on opposite end to that illustrated at no extra cost.

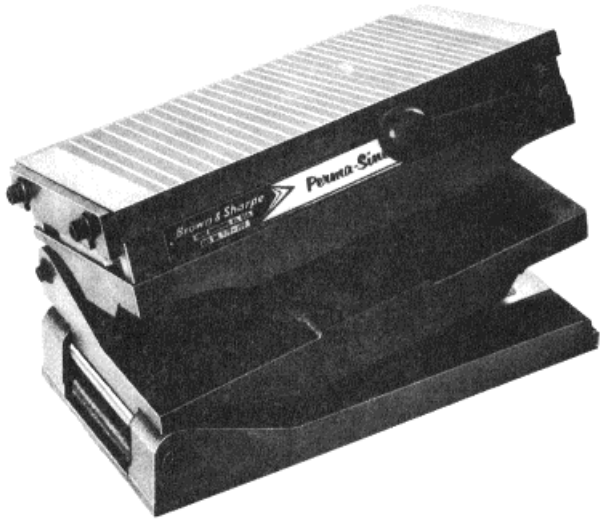


Fig. 22I. Compound Perma-Sine.

Specifications for Simple and Compound Perma-Sines.

Size	Type	Working Surface, inches	Working Surface, (mm)	Height, set at 0° inches	Height, set at 0° (mm)
5"	Simple	6 x 6	(152 X 152)	3 29/32	(99)
10"	Simple	6 x 12	(152 X 305)	4	(102)
5"	Compound	6 x 6	(152 X 152)	4 7/8	(124)
10"	Compound	6 x 12	(152 X 305)	5 3/8	(137)

OPERATION & MAINTENANCE OF DIAL-A-SIZE

AUTOMATIC CYCLE CONTROL FOR 618 & 818

SERIES SURFACE GRINDING MACHINES

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Appendix A - Signal Glossary Schematic Location Chart

Appendix B - Dial-A-Size Sequence in Automatic Mode

Appendix C - Dial-A-Size Sequence in Manual Mode

DIAL-A-SIZE OPERATING INSTRUCTIONS

To operate the Surface Grinder with a "Dial-A-Size" automatic control attached, the following operating instructions should be implemented. All control switches and lights discussed herein are identified on the machine control panel.

1.1 MANUAL OPERATION

1.1.1 WHEEL RETRACT (Auto-Manual Switch in Manual Position)

In the manual mode, the vertical feed may be rapidly moved up by depressing Wheel Retract. The head moves only while the button is held in. Up feed will travel at a rate of approximately *two hundred eighty(280) millimeters per minute in metric mode and approximately *ten (10) inches per minute in inch mode. The millimeter (mm) - inch switch must be placed in the appropriate position prior to any operation.

1.1.2 WHEEL ADVANCE (Auto-Manual Switch in Manual Position)

Continuous down feed motion may be obtained by operating the Down Feed switch. A counterclockwise rotation of the switch to Rapid will cause the Down Feed to move at approximately *two hundred eighty (280) millimeters per minute in metric mode and about *ten inches per minute in inch mode. A clockwise rotation of the downfeed switch to slow will cause a continuous Down Feed at the rate of approximately thirty three millimeters (1.3 inches) per minute. The head moves only while the switch is held to the appropriate position.

1.1.3 JOG (Manual-Auto Switch in Manual Mode)

In manual mode, a down feed increment of between 0.0001 inches to 0.0099 inches when the mm-inch switch is set to inch, or of between 0.002 millimeters to 0.099 millimeters when the mm-inch switch is set to mm may be attained with each depression of the Jog button.

Caution! Before depressing the Jog button for an incremental down feed, each coarse feed thumbwheel switch on the control station must be preset to the feed increment desired.

1.1.4 DISPLAY - WHEEL SURFACE LOCATION

In the upper right hand portion of the machine mounted on the top of the electrical cabinet, an illuminated six digit display is observed when electrical power is "on." When the electrical power is initially applied to the Surface Grinder, the six digit display will indicate spurious information. This must be corrected by; (1) Determining the grinding wheel surface distance above the table work surface, (2) Placing this measurement data on the six position thumbwheel switches at the

*These rates are quoted for a fully automatic system. They will be fifty percent (50%) lower on a semi-automatic system.

upper right of the control panel, and (3) Depressing the Wheel Position preset orange button at the center-right of the control panel. The above operator sequence must be precisely followed. The display will now indicate the position of the wheel surface with respect to the grinder work surface. Disregarding grinding wheel wear, the display will now always precisely indicate the up-down locations of the grinding wheel surface providing that the vertical travel is not inhibited by an overload or electrical power shut down.

1.1.5 UP - DOWN COMPENSATION

On the control panel to the lower right of center, an Up Compensation and Down Compensation pushbutton respectively are located. These buttons are utilized to correct for grinding wheel wear and long term machine deviations. Each depression of either pushbutton will cause the electronic system to compensate the appropriate vertical position of the grinding wheel by 0.000078 inches.

1.1.6 CROSSFEED, FORWARD - OFF - BACKWARD

In the grinding mode, the Crossfeed switch, when in the forward position, will cause the vertical upright to move forward a preset increment with each table reversal. The switch in the backward position will cause a similar backward movement of the upright. In the off position, no forward or backward motion will occur when the table reverses if the manual auto switch is in the manual mode.

The Crossfeed switch is also used for continuous cross feed and wheel dressing from the machine table when the crossfeed selector, located at the right side of the 618 and 818 machines and the left side of the 824 and larger machines, is set in the appropriate position.

1.1.7 INCH - METRIC SWITCH

The Dial-A-Size system is designed to work with either Metric or English measuring standards. Prior to any operation, therefore, the Inch-mm switch must be set to the desired measurement standard.

1.2 AUTOMATIC OPERATION

Before the Surface Grinder is set up for automatic operation, the machine should be "warmed up" for at least one half an hour with the table running at medium to high speed and the table dogs set far apart for long table travel.

With a work piece mounted on the table and the grinding wheel retracted high enough to clear the work piece, and with the manual-auto switch placed in manual mode, the following procedure is suggested for programming an automatic operation:

1.2.1 While the table is operating, bring the wheel down to the top of the work piece with the manual downfeed and jog controls until a measurable flat surface is ground on the sample item. The measurement obtained must be dialed into the six digit thumb wheel switch followed by a depression of the Wheel Position preset pushbutton. This action must be taken while the grinding wheel is held in the measured position and, for safety's sake, after the table is stopped and the table work surface is positioned to the extreme right of the normal work position.

1.2.2. With the table parked at the right side as in Paragraph 1.2.1, the position to which the grinding wheel should retract after the automatic grind cycle should nor be placed in the six digit feed limit thumbwheel switch.

The retract position thumbwheel switch should now be depressed. Caution! It is recommended that the retract position be at least five thousandths of an inch higher than the largest rough size of any of the pieces to be ground by the automatic cycle.

1.2.3. If the Surface Grinder is equipped with a high speed approach feature, the related information must be programmed. It is recommended that the grinding wheel be programmed to rapidly downfeed from its retract position to a point no less than one thousandth (.0010) of an inch above and no higher than 0.0700 of an inch above the largest size of the rough piece to be ground. If this dimension is placed in the six digit feed limit thumbwheel switch followed by a depression of the Rapid Approach Limit pushbutton, the grinder is set to automatically stop its rapid approach precisely above the work piece per the discussion in paragraph 1.2.7.2 a.

1.2.4 If the system is equipped with a Coarse Feed-Fine Feed automatic capability, this must also be programmed. In automatic cycle, whenever the grinding wheel rapidly approaches and stops at the top of the piece, thenceforth incremental downfeeds will commence with each table reversal. At some point above the final size, it may be desired to decrease the incremental feed steps to obtain a finer finish. If the coarse feed size limit is dialed into the six digit Feed Limit Thumbwheel followed by a depression of the Coarse Feed Limit Switch, a coarse feed to fine feed conversion will occur as defined in paragraph 1.2.7.2 b.

1.2.5 After, and only after, the functions of Paragraph 1.2.1 through 1.2.4 are programmed, the final size of the work piece must be entered into the Six Digit Feed Limit Thumbwheel Switch and remain in evidence during the remainder of automatic operations.

1.2.6 Before automatic operations may commence, three additional Thumbwheel switches must be preset as follows:

1) The left and right Coarse Feed Increment Switches (Left Switch only on the Semi-automatic System)
2) the Fine Feed Increment Switch
3) the Spark Out Switch

In addition, the slot-surface grind switch must also be positioned for either slot or surface grind mode. In surface mode, the crossfeed switch must be in the off position.

1.2.7 If an automatic program has been carefully entered into the system according to the steps in Paragraph 1.2.1 through 1.2.7, the Dial-A-Size system is prepared for automatic operation as follows:

1.2.7.1 Rotate the auto-manual switch from manual to auto. The grinding wheel will rise to the retract position. If the table is running prior to this action, it will move to the extreme right past the reversing dog and park.

1.2.7.2 After the appropriate work piece is placed on the table work surface, start the table by moving the table throttle lever

to the "Off" and then to the "On" position. Subsequently depress the Cycle Start button and the following steps will automatically be pursued by the Dial-A-Size system:

a) While the table is reversing the grinding wheel will rapidly downfeed to the rapid approach limit above the work piece and stop. The subsequent table reversals **and each reversal thereafter will cause an incremental downfeed per the value in the appropriate Coarse Feed Thumbwheel Switch until the work piece has reached its coarse feed limit size.

b) When the coarse feed limit size has been reached, the downfeed will change from a Coarse Feed to a Fine Feed value indicated on the Fine Feed Thumbwheel Switch for each table reversal.**

c) As the table reversals** continue, the final size of the work piece will be reached as indicated on the six digit Feed Limit Thumbwheel Switch. At this point any further fine or coarse feed increments will be inhibited, On the subsequent table reversal**, a downfeed of 0.000078 inches (2 microns) will be commanded by the system.

1.2.8 At the conclusion of the coarse and fine feed and the last pass of 0.000078 inch actions discussed in paragraph 1.2.7, the automatic system will suspend all down feed action and allow the table to reverse** for a spark out operation as many times as indicated in the spark out thumbwheel switch.

1.2.9 After the last spark out pass, a command to retract the grinding wheel is generated. The grinding wheel then retracts to the position programmed in Paragraph 1.2.2. During the retract motion, the table will automatically move to the extreme right and park if the park feature is installed.

**This statement refers to slot grind mode. If the Slot-Surface mode switch is positioned in surface mode, substitute the words crossfeed reversal(s) for table reversal(s).

1.3 OTHER OPERATIONAL FEATURES

1.3.1 DISPLAY DECIMAL POINT

When the system is in metric mode, the decimal point on the digital display and on the feed limit six digit switch appears between the third and fourth digits from the left. In English or Inch Mode, the decimal point appears between the second and third digits from the left.

1.3.2 INCH-METRIC VERTICAL FEED RATE

The vertical feed speed is approximately 2 percent higher in metric mode than in English (inch) mode. This differential is a result of the arithmetic conversion required when operations are in English (inch) mode.

1.3.3 VERTICAL FEED DRIVE MOTOR

The vertical feed is moved by a stepping (pulsed) motor. Each pulse to the motor will cause the feed to move up or down 0.000078 inches (.002mm). Therefore, for each pulse to the stepping motor when the system is in metric mode, the Digital Display and vertical feed will indicate 0.002 mm of movement. When the system is in the English (inch) mode, for each 100 pulses to the vertical feed motor, the vertical feed and digital display will indicate 0.0078 inches of movement.

1.3.4 PRESET INTERLOCKS

Preset interlocks are provided within the Dial-A-Size System. If, during the programming of an automatic sequence, any of the four preset pushbuttons is not depressed for an appropriate measurement, the automatic cycle will lock up after the manual-auto switch is moved to auto mode, and, at the same time the pushbutton that was overlooked will illuminate. To correct this error, move the auto-manual switch back to manual and enter a proper measurement with the pushbutton which was previously indicating the oversight. Follow the instructions of Paragraphs 1.2.1 through 1.2.5. Automatic operation is now prepared per the instructions of Paragraph 1.2.7.

1.3.5 AUTOMATIC STOP CONTROL

The stepping motor in this system must always be started and stopped at a pulse repetition rate of less than 300 pulses per second. The Dial-A-Size accomplishes this task automatically under both manual and automatic modes of operation. For example, an operator may have preset a retract position of 3.5000 inches in automatic mode and actually see the vertical travel retract to 3.5125 inches. There is no need to worry, since the Dial-A-Size recognized a stop command when it reached 3.5000 inches, but the system required 0.0125 inches more to slow down to a pulse rate of less than 300 pulses per second before stopping. Be assured that the 3.5125 inch measurement is recorded and accounted for in subsequent operations of the Dial-A-Size System.

1.3.6 RAPID APPROACH OPERATION

On machines with the automatic rapid approach feature, it is advisable that, when the operator grinds his measurable surface per Paragraph 1.2.1, the amount of stock removed from the work piece not exceed 0.0600 inches or be less than 0.0100 inches. This procedure will provide reasonable assurance that the wheel will not be excessively stressed by an oversized piece during the automatic approach and yet provide a minimum operation time for each automatic cycle.

1.3.7 UPPER FEED LIMIT

If, under any operating circumstances, the vertical feed is caused to travel to the upper feed limit, an automatic stop will occur. The operator must place the auto-manual switch in the manual position before he may actuate the Down Feed Switch to bring the wheel down from the upper limit. Attention! If the high speed down feed is actuated after the Up Limit is reached, the feed will proceed down at the rate of approximately 1.5 inches per minute (37.5 mm per minute). This will occur for about 0.5 inches of travel. After one-half inch of travel the operator may release the high speed Down Switch and immediately reactivate it to obtain a true high speed down feed rate of travel.

1.3.8 AUTOMATIC RETRACT CONTROL

Caution! If the Dial-A-Size system has been operating in automatic mode and the operator switches back to manual mode, he may not place the manual auto-switch back to automatic without placing a new program into the four preset switches per the instructions of Paragraphs 1.2.1 through 1.2.6. If the operator fails to do this, and he inadvertently moves the auto-manual switch from manual to auto, the vertical feed will up feed and most likely travel to the Up Feed Limit looking for a Retract Position Command which does not exist. It is advisable that, before reprogramming, that the operator depress the Up Feed Switch for at least a fraction of a second to take the system out of auto mode as a frame of reference for the next program.

DIAL-A-SIZE ELECTRONIC ALIGNMENT PROCEDURE

2.1 EQUIPMENT REQUIRED

a) Oscilloscope with 50 ms time base and 0.1 milliwatt per cm horizontal deflection scale and 10:1 high impedance amplifier probe.
b) Fine point (jeweler's), 1/16 wide maximum, screwdriver
c) Sixteen pin test clip for 16 and 14 pin electronic IC modules

2.2 SYSTEM ALIGNMENT

2.2.1 Oscillator frequency - The 16 pin test clip must be placed on the IC module EE1 on the main electronic assembly. The oscilloscope amplifier and external synchronization input shall be attached to terminal EE1-10. The inch-metric switch shall be placed in metric mode. The oscilloscope must be set for .5 bolt/cm vertical deflection and 1 millisecond/cm time base, The oscilloscope should then be synchronized as either the Up or Down vertical switches on the Dial-A-Size are activated.

2.2.1.1 Low frequency is the first adjustment to be made. Counter-clockwise rotation of potentiometer R5 (location CH1) decreases frequency. Adjust R5 until successive pulses on the oscilloscope 1.0 millisecond time base occur at 3.5 millisecond intervals. This adjustment is made as the Down Feed switch is held in the right hand rotated position. This adjustment provides a low frequency of 280 pulses per second.

2.2.1.2 The High Frequency adjustment is made by activating the Up or Down High Speed Feed controls and concurrently by monitoring the EE1-10 terminal with the oscilloscope as the R7 potentiometer (Location CJ1) is adjusted. R7 should be adjusted until pulses occur at 0.43 *millisecond intervals on the 0.1 millisecond oscilloscope time base.

2.2.2 Down Ramp Adjustment - With the auto manual switch set to manual and the inch-metric switch in inch mode, preset the wheel position, the Rapid Down Position, and course feed limit position switches with a 00.0000 value in the Six Digit Feed Limit switch. Preset the Retract Position with a value 01.0000 inches high. Move the auto manual switch to auto and wait to see where the up travel of the feed terminates. The UP travel termination should indicate between 01.0085 to 01.0095 inches. If not, adjust the R1A potentiometer (Location CC1) until this value range is attained. After this adjustment, recheck the high frequency and retrim per Paragraph 2.2.1 as required.

*This frequency for 618 series should be changed to 0.55 milliseconds for 824 series grinders.

2.2.3 Up Ramp Adjustment - With the oscilloscope synchronized on the frequency signal of terminal EE1-10, set the scope at 0.1v/ division vertical deflection and 50 millisecond per division time base. While successively operating the Up or Down high speed travel switches, the voltage signal on the scope should rise from 0.0 volts to about 0.3 volts maximum in from 190 to 250 milliseconds at terminal FE15. Adjust potentiometer R3 (Location CF1) until this rise time is reached. Following this adjustment recheck the high and low frequencies and readjust as required per Paragraph 2.2.1.

DIAL-A-SIZE TROUBLESHOOTING HINTS

The following possible problems and related troubleshooting hints are presented to assist personnel in the maintenance and repair of the Dial-A-Size system. The hints are selected in a manner which should allow a person to isolate most problems to repairable sub-assemblies of minimal cost and size in an expedient manner.

For clarification, all electronic assemblies mentioned in this section are referenced by physical location in Figure 3-1.

Before attempting to repair any defect in the Dial-A-Size system, all cable connections to all electronic panels should be examined for proper location and tightness of fit. Also, the serviceman should verify that the proper AC Voltage is connected to the Grinding Machine.

A. Twelve Volt Power Supply Light Extinguished-No Voltage

1) Check for 115 volts, 60 hertz at the screw terminals of the +12 volt power supply.

2) If 115 volts is available, check the power supply fuse. If the fuse is blown, correct the short circuit, if any, and replace the ½ ampere fuse.

3) If items 1 and 2 above are in order, unplug the Power Supply, Part #23-6907, and replace.

B. Manual Power Down Switch will not activate Down Feed when depressed

1) Check the Auto-Manual switch. It must be in the Manual position for manual power down operations.

2) Check for +12 volt power. If there is no power, the digital display will not move and it will show spurious numbers. Restore power per paragraph A if +12 volts is not available.

3) If +12 volts is available at the power supply, measure the terminal EA31 on the main electronic panel for +12 volts while the Power Down switch is activated in either low or high speed mode. If EA31 exhibits 12 volts, replace electronic assembly 23-6902.* Align the new Assembly per Section 2.0. If +12 volts is not evident at EA31, check for loose connections at the Power Down switch and at terminals G5 and B3 on the back of the Control Station Assembly.

C. Manual Power Up does not Operate

1) Check 12 volt supply Part #23-6907. Restore voltage per 3.1 if voltage is not available.

2) Measure for +12 volts at terminal D23 with Up Switch depressed. If +12 volts is present, replace 23-6902 electronic assembly. If D23 does not present 12 volts, check for loose connections or disconnects on the Up Switch and at terminals H3 and B1 on the rear of the control station.

D. Manual Power Up and/or Manual Power Down Switches start Feed Motion, but Motion Continues when Switches are Released

1) Check terminal FF24 on the 23-6902* Electronic Assembly with a voltmeter. If voltage is greater than 1.0 volts as Power Down or Up switches are activated, realign system per the alignment procedures of Section 2.0. If the oscillator continues to operate when the Up or Down Switches are off, replace electronic assembly 23-6902* and align the new assembly per Section 2.0.

2) If the motor will still not stop when the manual switches are released, check the appropriate switch for bad contacts and/or loose connections. Check the interconnecting cable between the DL1 location of the main electronic assembly and the B1 location on the rear of the Control Station.

E. The Feed Increment During Automatic Mode does not Operate at Each Table Reversal

1) Check the permanent magnet air gap adjustment on the throttle valve arm. The magnet is on the arm extension within the hydraulic compartment. The air gap between the magnet face and each solid state (Hall effect) switch face should be no more than 0.062 inches and no less than 0.020 inches.

2) Insure that the Auto-Manual Switch is in Auto Mode.

3) Make certain that the Surface-Slot Grind Switch is in Slot Grind Mode.

4) If either the left or right down feed increment does not occur, and the respective incremental thumbwheel switch indicates a value, and the proper down-feed increments occur in Surface Grind Mode, replace the defective solid state switch (Part #405-678).

5) If none of the above suggestions prove fruitful, check the cable connections between connector B1 on the rear of the control station and DL1 on the main electronic control panel.

6) If each of the above fails to solve the problem, replace the electronic control assembly, 23-6902* and align according to Section 2.0.

F. Increment Feed will not Operate in Automatic Surface Grind Mode at Crossfeed Reversal

1) Check to see if Surface-Slot Grind Switch is in "Surface" Mode.

2) Make certain that the manual "Forward-Backward" crossfeed switch is placed in the "off" position.

3) Check that the Auto-Manual switch is positioned in Auto Mode.

4) Verify that the crossfeed dogs are in the proper position and adequately tightened by means of the Crossfeed Dog Thumbscrews.

5) If the Upright does not reverse, determine that the forward and backward crossfeed solenoids within the hydraulic compartment are operating. If either solenoid is sticking or binding, replace the defective unit. Before replacing and solenoid, however, determine that the crossfeed reversal switch and contacts at the top, rear of the Electrical Equipment Cabinet are tight and in workable order.

6) If all of the above prove to be in satisfactory order, replace Module El, Part #23-6928, at the rear of the Switch Control Station.

7) If all else fails, replace the main electronic panel assembly and align per Section 2.0.

G. High Speed Approach in Auto Mode continued to Feed Down to Final Size After Cycle Start Switch is Initiated. (Applicable to fully automatic systems with Part #23-6902 only)

1) Determine that the cable connections between DK6 on the main electronic assembly and A6 on the rear of the control station are properly located and firmly in place. Determine that jumpers are solidly connected from EJ27 to EJ23 and from EJ33 to EJ29 on the main electronic panel.

2) If all of the above do not solve the problem, carefully align the system per Section 2.0.

3) If none of the above is satisfactory, replace the 23-6902 assembly and align the replacement per Section 2.0.

H. Table Will Not Park at Right at End of Automatic Cycle

1) See Detail "A" of the illustration. The red light on the Table Load Position Driver in location 3 should be illuminated when the table is parked. If the light is not glowing, check the driver fuse after main power has been turned off. Replace if defective.

2) Check the Table Park limit switch at the right, rear side of the table for loose mechanical and electrical connections.

3) Determine that cable connector DL1 at the electronic panel and the cable connector B5 on the rear of the pushbutton station are properly positioned and tightly connected.

4) Check for twelve volts on wire #47 at the Table Park Switch. This voltage is conducted between cable connectors FK9 (contact FL9) on the main electronic panel and K17 (contact K19) at the rear of the pushbutton control station. These connectors should be checked for good, firm contact.

5) If all the above prove adequate and the problem still exists, unplug the table load position driver at the third position of assembly 23-6962 and replace.

6) If trouble still persists, replace the main electronic assembly and align the new assembly per Section 2.0.

I. Table Will Not Start After the Table Throttle Lever is Positioned "Off" and then "On"

1) Check the Table Start-top Solenoid Driver Lamp Position 5 on Part #23-6962 for illumination. If lamp is extinguished, inspect the fuse on the driver, and, if it is open, check for a short at the table start-stop solenoid. If no short is evident, replace the fuse.

2) If the above fuse is not blown, replace the solenoid driver with a new Part #23-6966-1.

3) If table is still inoperative, check for a defective switch and loose connections and mechanical mounting adjustments for the throttle valve switch mounted under the operator's panel just below the throttle lever.

4) Check for +12 volts at terminal FC17 on the rear of the Push Button Control Station when the throttle valve switch is in the "on" position. If +12 volts is missing, check the cable connection FK1 on the main electronic panel and its other end at K17 on the rear of the push button station.

5) If all the above fail, replace the main electronic assembly and realign per Section 2.0.

J. Automatic Retract Will Not Occur After Final Size is Reached in Auto Mode

1) Check for correct and good quality cable connections at DK17 on the main electronic assembly and B17 at the rear of the pushbutton control station.

2) Check the connector at the rear of the Spark Out Thumbwheel Switch for firm emplacement and broken wires. Check the thumbwheel switch common terminal for +12 volts along with terminal H43 on the Control Station Terminal Panel.

3) If all of the above are to no avail, replace the main electronic assembly and align per Section 2.0.

K. An Automatic Retract will not Occur When Switching From Manual to Auto

1) If the present wheel position is the same as that which was programmed for the automatic retract location, little or no movement will occur, and all is probably well.

2) If one or more of the preset pushbuttons has not been programmed while in manual mode, the auto mode will be inhibited after the Manual-Auto switch is moved to Auto. To rectify this problem, the programming procedures according to Section 1.2 must be carefully implemented.

3) Check to make certain the vertical travel has not been locked out by the "Up Limit" switch at the upward limit of feed travel.

4) If proper procedures have been followed and Automatic Up Feed does not occur, a ground signal should appear at terminal ED7 on the main electronic control panel. If a ground connection is not available, check continuity of circuitry from ED7 through FL3 on the main

electronic panel to the Up Limit Switch at the top of the Machine Upright.

5) If all of the above is to no avail, replace Part #23-6902* and align the new assembly per Section 2.0.

L. No Manual Incremental Feed When the Jog Button is Depressed

1) Check coarse feed thumbwheel switches. A jog will not occur if the coarse feed thumbwheels set for zero feed.

2) Check cable connector DK1 on main electronic assembly and cable connector Al on the rear of the control station for good contact.

3) Check the Resistor-Capacitor Module at Terminals D7 and C7 on rear of the control station for looseness of assembly.

4) Check the connections on the back of the Jog Switch for tightness and broken connections.

5) As a last resort, change the main electronic assembly and align it per Section 2.0.

*On fully automatic systems, the main electronic assembly part # is 23-6902. In semi-automatic systems, substitute 23-6943 for 6902.

SECTION

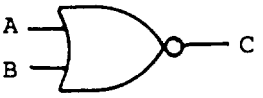
4

DETAILED ELECTRONIC CIRCUIT DESCRIPTION

4.1 ELEMENTS OF DIGITAL LOGIC

To understand the symbols on the logic diagrams of the "Dial-A-Size" system, the following instructions are presented:

4.1.1 The following symbol represents a NOR Gate circuit:

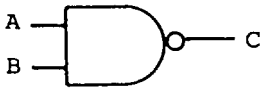


A Positive voltage on Line A or a positive voltage on Line B Will cause Line C to present a ground or zero volt signal. In other words, if A = 12V or B = 12V, then C =0V. This can be expressed as $A + B = \overline{C}$. The plus sign represents the word OR and a - over any letter means the terminal represented by the letter is at ground potential. If A is at ground potential and B is also at zero volts, then C will be positive 12V. Therefore:

$$\overline{A} \cdot \overline{B} = C$$

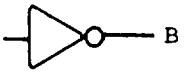
The dot between A and B represents the word AND.

4.1.2 A NAND Gate Circuit is shown by:



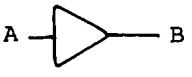
If A is positive 12 volts and simultaneously B is +12V, then C = 0V or $A \cdot B = \overline{C}$. Also for a NAND circuit $\overline{A} + \overline{B} = C$; if A or B is at 0 volts, C will be =12V.

4.1.3 An Inverter circuit is shown as:



If A is +12V, B must be ground or $A = \overline{B}$, $\overline{B} = A$.

4.1.4 A non-inverting amplifier is represented by:



A = B or A is +12V when B is +12V.

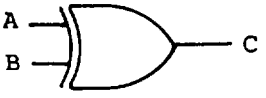
4.1.5 An OR circuit is:

$A + B = C$
$\overline{A}\,\overline{B} = \overline{C}$

4.1.6 An AND circuit is:

$A\,B = C$
$\overline{A} + \overline{B} = \overline{C}$

4.1.7 An exclusive OR circuit is shown as:

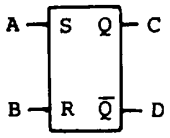


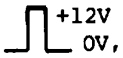
which means that only A or only B may be high if the output signal C is

to be high.

$$A\,\overline{B} + \overline{A}\,B = C$$
$$\overline{A}\,\overline{B} + A\,B = C$$

4.1.8 A Flip Flop circuit is shown by:





If signal line A presents a pulse s :he Q or C output will rise to +12V and the $\overline{Q}$ terminal or D output line will drop from +12V to ground potential. If a positive pulse appears on line B thereafter, the output C will go to ground and line D will rise to +12V. The Flip Flop is said to be “set” when the Q terminal is at high voltage and “reset” when the Q terminal is at low voltage.

4.1.9 Binary and Binary Coded Decimal Numbers are presented by circuits in the Dial-A-Size system.

4.1.9.1 The Binary number 1010 equals the decimal number 10. To determine this fact examine the following table.

Binary Index / Dec. Value	2^5	2^4	2^3	2^2	2^1	2^0	Decimal Value Summation
10	0	0	1	0	1	0	$2^3 + 2^1 = 10$
1	0	0	0	0	0	1	$2^0 = 1$
3	0	0	0	0	1	1	$2^0 + 2^1 = 3$
63	1	1	1	1	1	1	$2^5+2^4+2^3+2^2+2^1+2^0 = 63$

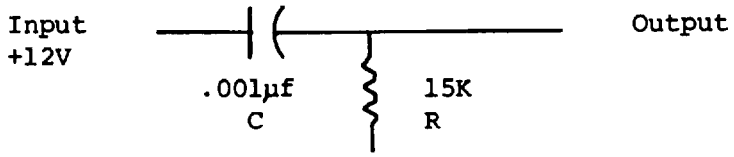
4.1.9.2 The Binary Coded Decimal number 1001 0001 is equivalent to the decimal number 91. See the following table for verification.

Binary Index / Decimal #	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	Explanation
91	0	0	0	0	1	0	0	1	0	0	0	1	
279	0	0	1	0	0	1	1	1	1	0	0	1	$1001_2 = 9,0001_2 = 1_{10}$
999	1	0	0	1	1	0	0	1	1	0	0	1	therefore:
11	0	0	0	0	0	0	0	1	0	0	0	1	$1001\ 0001_2 = 91_{10}$
111	0	0	0	1	0	0	0	1	0	0	0	1	
321	0	0	1	1	0	0	1	0	0	0	0	1	

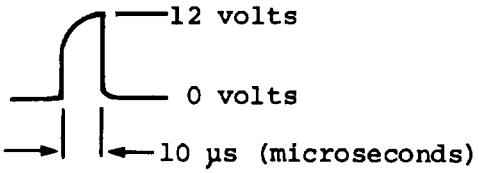
4.2 R-C TIME CONSTANT CIRCUITS

4.2.1 PULSE GENERATOR (differentiator circuit)

The following circuit is used frequently in the Dial-A-Size system:

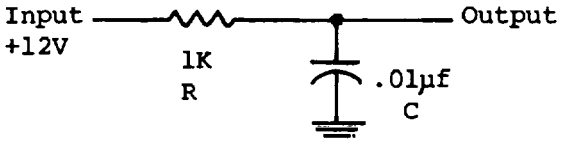


If a constant +12 volt signal is suddenly applied to the input, the Capacitor C will charge up to +12V. As C is charging, current is passing from ground through the Resistor R, the Capacitor C and on to the 12 volt supply. The current through the resistor develops a voltage across the resistor which appears at the output terminal as the capacitor becomes fully charged, current ceases to flow, and the voltage at the output terminal drops to zero. The signal appearing at the output, therefore, after voltage is initially applied to the input appears as follows:

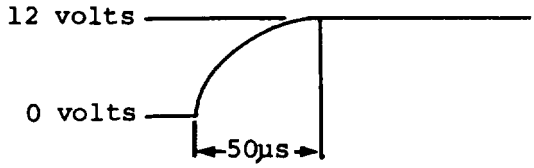


4.2.2 DELAY CIRCUIT (Integrator)

In the Dial-A-Size, the following circuit is occasionally seen:



If +12 volt is applied at the input, the output voltage will not immediately present the input signal. Rather, the output voltage will e somewhat slowly to the +12 volt value. This rise time delay is caused by the Resistor R and Capacitor C. The output will not reach volt until the Capacitor C receives a full 12 volt charge. The put voltage signal will appear as follows after +12 volts is applied the input:



4.3 DETAILED DIAL-A-SIZE CIRCUIT DISCUSSION

The following discussions refer to circuits which appear on electrical schematic 23-99990-5069 and 23-99990-5070. Each schematic consists of four (4) sheets. Either schematic may be used with the following description:

4.3.1 ELECTRICAL POWER SUPPLIES

4.3.1.1 +12 Volt Power

The Dial-A-Size electronic system operates from a power source of +12 volts. A twelve volt power supply in the upper left corner of the electronic assembly within the electrical equipment cabinet is this source. The current supplied by the 12 volt source is about 0.2 amperes.

4.3.1.2 5 Volt Power

The Display Module mounted on top of the electrical cabinet receives 115 volt, 60 hertz power from the main transformer. This AC voltage is converted to +5 volts within the display module. This 5 volt source is transmitted to terminal AK 7 at the left top of the electronic panel assembly. The use of this +5 volts will be discussed later in paragraph 4.3.6.

4.3.2 MANUAL FEED DOWN

With the Auto-Manual switch in the manual position, a rotation of the Power Down (11SS) switch to the left will allow continuous feed down at high speed. By releasing this switch handle, downfeed will stop.

After rotating the Power Down (11SS) switch in Section 10C, Sheet 1, Dwg. #23-9990-5069, a voltage appears at EA26-6 NAND gate. The AM signal is a high voltage during manual mode, therefore, EA26-4 is now at low potential. EA26-4 signal reaches Inverter DH43-7 whose output, DH43-6 goes high. The DH43-6 high signal sets Flip Flop EA10-1 (MP, Manual Power) output. EA10-2 ($\overline{MP}$) reset output goes low causing FC31-11 NAND gate (Section 13C, Sheet 1) output to go high. The high voltage on FC31-11 charges Capacitor C21 causing a positive pulse at the DG036 resistor terminal which also appears at NOR Gate DH26-5 in Section 13D, Sheet 1 of the drawing. A high pulse on DH26-5 causes DH26-1 to provide a low pulse to DH43-3 inverter. As a result DH43-2 provides a positive "I" pulse (Section 14D, Sheet 1) which appears at the IC Flip Flop AA34-6 set terminal in Section 2C of Sheet 2. Index Control Signal $\overline{IC}$ is now high at AA34-1 and IC is high at AA34-2. A high $\overline{IC}$ signal is now available at CD28 which turns on the Oscillator causing the vertical drive motor to operate. The Oscillator is discussed later in paragraph 4.3.3.

As $\overline{MP}$ (EA10-2) drops low, this signal appears at EC9-4 NAND (Section 11D, Sheet 1). This low signal on EC9-4 forms a high at EC9-6 to set the DN (down) Flip Flop DH18-6 (Section 13D, Sheet 1). This Flip Flop, when it is set, directs the Oscillator to drive the Feed Motor in the down direction.

When the 11SS handle is released, the EA10-6 signal goes low and appears at DH10-3 NOR Gate in Section 11C, Sheet 1. DH10-6 goes high

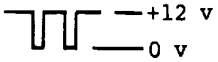
causing EA10-4 to reset the MP Flip Flop making EA10-2 ($\overline{MP}$) terminal high. A high EA10-2 ($\overline{MP}$) causes a positive pulse at DG039 ($\overline{MP-1}$) in Section 12C, Sheet 1. $\overline{MP-1}$ pulse appears at the DH10-8 NOR Gate in Section 12B, Sheet 3. $\overline{MP-1}$ pulse generates a negative pulse at DH10-9 NOR Gate output which forces a positive pulse from the FC23-10 NAND output. This pulse appears at the FE23-6 set input of the DNR (downramp) Flip Flop. The DNR signal causes the Oscillator to slow down preparatory to stopping (See AG34-4, Section 3C, Sheet 2). $\overline{DNR}$ (at FE23-2, Q DNR Flip Flop output) is now low at DD17-5 in Section 6A Sheet 2. Terminals 2, 3 are also low and terminal 4 of DD17 NOR Gate reaches a low voltage after the Oscillator reaches low frequency (to be explained in paragraph 4.3.3). Simultaneous low signals of DD17-2, 3, 4 and 5 cause a high at DD17-1 and the ST Flip Flop, FE23-8 to set. FE23-13 high creates and ST (stop pulse) at EH047 in Section 7A, Sheet 2.

The ST pulse appears at CJ9-6 NAND Gate (Section 13D, Sheet 1) along with a high AM Signal at CJ9-5 to reset the DN (DH18-4) Flip Flop, and at AG26-13 NAND Gate (Section 1D, Sheet 2) to reset the IC Flip Flop (AA34-4) which, in turn, shuts down the Oscillator by causing the IC signal (AA34-2) appearing at the base of transistor Q3 (CB39) to go high.

A low speed downfeed occurs if the Power Down, 11SS, switch is rotated clockwise (Section 4B). This causes a ground signal at NAND AG26-2; a high at AG26-3 (Section 3C); a low at AG34-1 NOR; a high at EC33-2 inverter (Section 3C); and thus a conduction of transistor Q4 to force low frequency. ST will not occur until 11SS is released to set DNR Flip Flop FE23-6 per the discussions in the fifth paragraph of this section.

4.3.3 OSCILLATOR OPERATION (Section 5B, Sheet 2)

4.3.3.1 The pulse generating Oscillator is the relaxation type built around the Q1, 2N2646, Unijunction transistor (Section 6B, Sheet 2). Whenever the emitter, terminal CD23, of Q1 is allowed to rise to about 0.7 volts through Capacitor C2, the unijunction will fire, provide a voltage pulse at CC24, and discharge C2. This action continuously repeats itself as long as this positive signal appears at CD23 and pulses will appear at CC24 and also at the base of transistor Q2, terminal CA38 (Section 6C, Sheet 2). Q2 amplifies the pulses which appear as negative spikes



at CA39, the collector of Q2. These negative pulses are transmitted to the counters FG3 and FG12 in Section 3E, Sheet 2 to be discussed later. The frequency of the Oscillator is controlled by C2 and the resistance (R6 & R5) connected between its terminal, CA30, and +12V. R5 is a 100K resistive potentimeter. The R5 resistance can be reduced by placing resistance in parallel with it and this reduction will cause the Oscillator to increase frequency. This technique is used in the Dial-A-Size for ramping up to high frequency. The Q5 transistor in Section 4B, Sheet 2, is switched on to place Resistors R7 and R3 in parallel with R5 to increase frequency. To switch on Q5, the voltage of Q5's emitter (CB27) must rise. Therefore Capacitor C1, 150 uf, is allowed to charge by shutting off Transistor Q4, (Section 4B, Sheet 2) which normally maintains C1's, CA26 and therefore CB37 terminals close to ground potential. To shut off Q4, an f signal (+12V) as discussed in 4.3.2 is presented to AE35-12 NAND Gate (Section 3B, Sheet 2).

A high $\overline{F =}$ at AE35-13 of the same NAND allows AE35-11 output to go low. This low signal appears at NOR AG34-2, which, along with lows on terminals 3,4, and 5 causes NOR output AG34-1 to rise to +12V. This high voltage is inverted at EC33-2 (Section 3C) causing a low voltage to appear at CE9 (Section 3B). This signal at CE9 shuts off Transistor Q4 allowing the 150 µf Capacitor C1 to charge and raise the frequency of the Oscillator.

4.3.3.2 Ramp Up -

Whenever the frequency of the Oscillator increases, it must increase gradually so as not to stall the vertical feed motor. To ramp the frequency upward gradually, Potentiometer R5 has been placed between the top of Capacitor C1 and 12V. By increasing R3, C1 charges at a slower rate and the Oscillator will rise to its high frequency at a slower rate. A decrease of R3 causes the Oscillator to rise to high frequency at a faster rate after turn on.

4.3.3.3 Ramp Down -

Before the Oscillator is turned off (by resetting IC Flip Flop AA34-1), it must be ramped down to low frequency (about 250 p.p.s) in order that the motor will not coast beyond the stop point. To cause the Oscillator to slow down in manual mode, the Transistor Q4 is turned on by the DNR (FE23-6, Section 13B, Sheet 3) Flip Flop as follows:

a) Either $\overline{MP - 1}$ or PU-1 signals set FE23-6.
b) The resulting high DNR signal appears at AG34-4 (Section 3C, Sheet 2) causing AG34-1 to rise to +12 volts.
c) AG34-1 signal is inverted by EC33-1.
d) The high EC33-1 signal appears at the CA41 base of Transistor Q4, thus turning on Transistor Q4 (Section 4B, Sheet 2).
e) Q4 conducting allows Capacitor C1 to gradually discharge through Potentiometer R1A (Section 4C). As C1 discharges, Transistor Q5 gradually shuts down causing the impedance in series with Capacitor C2 (Section 6B) to increase and the frequency of the Oscillator to decrease. Increasing R1A causes the down ramp to decrease its rate of change and vice versa. The down ramp should be set at about 150 milliseconds per the alignment instructions of Section 2.0.

4.3.3.4 Stop -

In manual mode the Oscillator, if allowed, will automatically stop itself whenever it reaches low frequency as follows:

1) As the Q5 Transistor shuts down, its base voltage at CB36 (Section 4B, Sheet 2) recedes to less than 6V (from about +11V). This voltage appears at the output of the Q8 emitter follower at FG22 (Section 4A, Sheet 2) and also at the base of Q9 (FH23) (Section 4A). Whenever the FH23 terminal falls below 6V, which is less than the 6 volts appearing at the emitters FH24 and FA27, Transistor Q9 will begin to conduct and cause a voltage to appear at the FH22 collector of Q9. This positive voltage turns on Q11 at FG28 (Section 5A). The collector FH22 of Q11 drops toward ground and causes the

output of DD17-1 NOR to rise and set the ST-Stop Flip Flop FE23-13. The high voltage on FE23-13 causes an ST pulse to appear at EH47 (Section 7A) per paragraph 3.2.1. This ST pulse appears at NAND AG26-13 (Section 1D) to reset IC Flip Flop AA34-4 and stop the Oscillator by cutting off Transistor Q3 (Section 5D) with a high IC signal at CD28.

4.3.4 MANUAL FEED UP

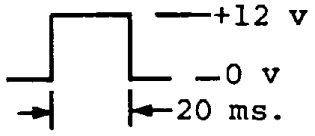
To cause the vertical feed to move up at high speed in manual mode the Power Up switch (2PB, Section 10B, Sheet 1) is depressed. This causes a positive pulse at the top of resistor R39, D26. This pulse is inverted at the output of NOR EA1-10 and inverted again at the output of NOR EC1-10 to set the Up Flip Flop EA10-8 (Section B12, Sheet 1). The positive signal at EA10-8 is formed into a pulse at DG013 (R23) (Section 15D) which also appears at DH26-5 NOR. The output at DH26-1 NOR (Section 13D) is a negative pulse which is again inverted at Inverter DH43-2 to produce an Index (1) pulse to start the Oscillator. The Oscillator passes pulses to the inch-metric control for Feed Motor Up motion. (See paragraph 4.3.5.)

4.3.5 INCH-METRIC CONTROL

Whenever the Oscillator is on, it presents its pulses (23 kilohertz high speed, 2700 hertz low speed) to two digital counters, FG3 and FG12 (Sections 3E, 4E, Sheet 2). These negative pulses enter the binary counters through terminals 5 and 15 of each counter.

4.3.5.1 Motor Pulses -

Counter FG12 presents the sum of its counts at terminals 6(2^0), 11(2^1), 14(2^2), and 2(2^3). This sum is continuously presented to NAND Gate FE7-2, 3, 4-5 and NAND Gate FE7-9, 10, 11, 12 in Section 2G, Sheet 2. The output of FE7-1 will drop from 12V to 0V whenever the counter reaches a sum of 11. The output of FE7-13 drops to zero each time the FG12 counter sums a count of 10. If the Inch Metric switch is in the MM position (Section 2H, Sheet 2), FE7-13 low signals will cause NOR Gate CG9-10 to present positive pulses to NOR DH10-13 and thus negative pulses at NOR output DH10-10 (Section 3G). Therefore, the Oscillator frequency is divided by 10 before it reaches the motor. In Inch mode, the low output pulses of NAND FE7-1 reach NOR DH01-10 (Section 3G) after each eleventh (11th) pulse from the Oscillator. All Inch-Metric pulses from DH10-10 are inverted by EA43-12 Inverter and are passed through NOR EE1-4 and NOR EE1-10 (Section 4G, Sheet 2) where they are shaped to be about 20 milliseconds wide. These shaped pulses from EE1-10 reach AND Gates EE9-1 +12 v and EE9-11. If a down feed is commanded, the DN (from DH18-2 FF, Section 12D, Sheet 1) along with a low Up signal at EE1-2. EE1-3, therefore becomes high. This high signal appears at AND Gate EE9-13. As long as EE9-13 (Section 2F) is high any positive motor pulses at EE9-1 will appear at AND output EE9-2 and also turn on Transistor Q7 by presenting positive pulses to terminal CC19 (Section 3F, Sheet 1). The inverted (negative) pulses at the Q7 collector (CD18) are passed to the motor driver amplifier via FL2.



Each time the motor is pulsed, the pulse signal from FB21 (Section 4G, Sheet 1) resets counter FG12-1 to zero via EC33-15 (Section 6E) and EC9-9. The zero preset inputs to the counter are presented at pins 3, 4, 12, and 13 of FG12.

When the system is in Inch mode, the FG12 counter is preset after each eleventh pulse from the Oscillator. In Metric mode, FG12 is preset after each tenth pulse from the Oscillator.

The Inch-Metric switch in Section 4H, Sheet 2 illuminates the appropriate decimal point on the digital display and six digit thumbwheel switch by switching ground to L9 or K9 respectively.

4.3.5.2 Master Counter and Display Pulses -

The sum of the Oscillator pulses are also stored in counter FG3 as mentioned before. This sum appears at terminals 6, 11, 14 and 2 of FG3 as binary code (review Section 3.1.9.1). This four-bit binary code appears at NAND Gate FC7-2, 3, 4 and 5 and NAND Gate FC7-9, 10, 11 and 12 in Section 2H of Sheet 1. If the number 1110 (decimal 14) is allowed to accumulate in FG3 counter, the output of NAND FC7-1 goes low and reaches NOR CG9-2. If CG9-1 NOR input is also low (System in Inch mode), NOR output CG9-3 (Section 3H, Sheet 1) will become high and pass to DD1-8 NOR Gate. DD1-10 (Section 4H) goes low which causes the inputs 5 and 15 to the BB9 (10-4) state of the Master counter to recognize a count. If the feed is in the down feed mode (DN low at DH18-2, Section 12D), the Master counter stages BB-9, BD9, BF9, BH9, CA9, and CC9 will respectively see a DN low signal on pin 10 to cause the Master counter to decrement for each count. If the Down Flip Flop is ever reset, DN signal will go high and the Master counter will increment for each pulse received.

Each low pulse signal from DD1-10 (Section 4H, Sheet 1) appears as a high at Inverter DD41-10 causing a pulse at terminal FB15 (Section 5H). The pulse at FB15 resets counter FG3-1 (Section 3D, Sheet 2).

In Metric mode each fifth pulse causes NAND FC7-13 to go low and thus pulse the Master counter and ultimately reset counter FG3.

In Inch mode, every fourteenth pulse reaches the Master counter. In Metric mode every fifth pulse reaches the Master counter.

A low signal on pin 9 of Master counter stages BB9, BD9, BF9, BH9, CA9 and CC9 causes each stage to count in BCD mode. Therefore, each stage presents a four-bit BCD code at pins 6, 11, 14 and 2 as a sum. The six-four bit codes appear at the respective display buffer inputs CE25, CE34, CG25 and CG34 in Section 11D, Sheet 2. The display buffers convert 0-12 Volt signals to 0-5 Volt signals. The 0-5 Volt signals are compatible with the display unit at the top of the equipment cabinet.

4.3.6 DIGITAL DISPLAY OPERATION

The Master counter presents Binary Coded Decimal (BCD) signals from the terminals 6, 11, 14 and 2 of counter positions BB9, BD9, BF9, BH9, CA9 and CC9 respectively in Section H, Sheet 1 to the display buffers CE25, CE34 and CG34 in Section 12D, Sheet 2. The display buffers convert all 12 volt signals to 5 volt signals required by the display assembly, part #405-660 mounted in a box on top of the electrical equipment cabinet. These 5 volt, BCD codes are transported to the display unit through the connector AK1 and AK9 at the left top of the main electronic panel. The 5 volt power supply in the display assembly presents 5 volts to the above buffers through pin AK7. The display unit receives its primary power from the 115 volts, 60 hertz machine supply.

4.3.7 MANUAL INCREMENTAL FEED (JOG)

When the Jog switch, 21PB, is depressed a positive pulse appears at terminal DK7 (Section 10D, Sheet 1). If a feed value other than zero is in the coarse feed thumbwheel switches, terminal CE43-8 of the NAND Gate along with the CE43-1 positive pulse from DK7 will allow NAND CE43-9 to go low (ED46 at CE43-2 is always high when the system is in manual mode). A low signal on CE43-9 causes NAND EC9-6 (Section 11D) to go high and set the DN Flip Flop, DH18-1, to command a down motion. The low CE43-9 signal pulse becomes positive at Inverter EC33-12 (Section 12D, Sheet 1) and creates an Index (I) pulse at DH43-2 (Section 14D) which sets the IC Flip Flop, AA34-1 (Section 2C, sheet 2) to start the Oscillator. The Oscillator pulses are reduced in frequency per the description in paragraph 4.3.5.2 and appear at terminal FA15 (Section 4H, Sheet 1) as pulse monitor indications. These pulses appear at NAND CA 1-2, 3 in Section 1C of Sheet 1. If the coarse feed switches are not set to zero, NAND CA1-4 (Section 1C, Sheet 1) is high and $\overline{IC}$ at CA1-5 is high. Therefore all positive, pulse monitor signals will cause NAND CA1-1 to go negative and appear at NOR AG18-6 (Section 2E, Sheet 1). $\overline{MP}$ and DN signals at CJ17-13 and 12 respectively are now high causing CJ17-11 (Section ID) to be low and appear at NOR AG18-5. With simultaneous low signals at AG18-5 and 6, the output of NOR AG18-4 will be high pulses which appear at counter inputs AC1-5, 15 (Section 2D) and AG1-5, 15 (Section 2B). Counters AC1-10 and AE1-10 terminals are low causing these counters to always count down. Counters AG1-10 and AJ1-10 terminals are always high causing these counters to always count up (increment).

The counters AC1 and AE1 (Section 3D, Sheet 1) are preset by $\overline{IC}$ at AC26 (Section IE) as are counters AG1 and AJ1. AG1 and AJ1 presets are always zero because of the ground signal on terminals 4, 12, 13 and 3 of each counter. Terminals 4, 12, 13 and 3 of counters AC1 and AE1 are preset to the value in the coarse feed thumbwheel switches. The thumbwheel signals appear at AE10 AND Gate and AJ10 AND Gate terminals 2,3, 9 and 10 (Section 3E) respectively or the like terminals of AND Gates BB1 and BD1 (Section 7E, Sheet 1). AND Gates AJ10 and AE10 preset counters AC1 and AE1 if AE10-13, 5, 6 and 12 and AJ10-13, 5, 6 and 12 receive a high signal from NOR EC25-10 (Section 5G, Sheet 1). Conversely, BB1-13, 5, 6 and 12 and BD1-13, 5, 6 and 12 will feed data to the counters AC1 and AE1 if they are receiving a high signal from NOR DF1-9 (Section 8F). EC25-10 will be high if the table has just completed a left reversal. DF1-9 will be high if the table has just completed a right hand reversal.

In a Jog operation, the Oscillator starts and immediately ramps up in frequency toward high speed. As pulses appear at the AC1 and AE1 counters, (Section 3E, Sheet 1) they count down and their outputs are presented to Exclusive ORs AA18-12, AC18-13, AC18-9, AC18-6 and AC18-2 in Section 5C, Sheet 1. At the same time counters AG1 and AJ1 (Section 3B, Sheet 1) are counting up and their outputs arepresented to alternate terminals of the same Exclusive Ors. When both the Up and the DN counters accumulate identical values, both inputs to NAND AG26-8 and 9 (Section 6C) become high and AG26-10 becomes low. A positive pulse at ED18 results which sets the Ramp control Flip Flop AA34-13 (Section 8C, Sheet 1). A low $\overline{RC}$ at AA34-12 appears at NAND AG26-1 (Section 3B, Sheet 2) to force the Oscillator to ramp down to low speed in preparation for a stop command. As the Oscillator continues toward a low frequency speed, counters AC1 and AE1 continue down counting pulses until they reach a zero value. The NOR Gates CJ25-13 and CJ25-1, P and Q terminals (Section 5D, Sheet 1), both go high and appear at NAND Gate CG44-12 and 9 terminals (Section 1B, Sheet 2) causing the IC Flip Flop AA34-1 to reset and stop the Oscillator. A down feed pick according to the value in either the right or left coarse feed thumbwheel switches has, therefore, been completed.

4.3.8 PRESET OPERATIONS AND INTERLOCKS

To operate the system in Automatic mode certain preset information must be entered in various system memory banks (see paragraph 1.2 of the Operating Instructions) as follows:

4.3.8.1 Retract Position Preset -

When switch 18PB (Section 11A, Sheet 3) is depressed, NOR Gate EC1-6 transits from +12 volt to ground potential. Since this must be done in Manual mode, HM signal on EC1-5 is also low. Therefore, EC1-4 NOR output goes high to force the retract memory modules' AJ26, BC26 and BF26 pin 15 terminals to be high and cause these memory modules to accept the six digit feed limit thumbwheel switch data on their respective 1, 2, 3, 4, 5, 6, 7 and 8 input terminals. The output terminals 16, 17, 18, 19, 20, 21, 22 and 23 will present zero volts each as long as pin 9 on AJ26, BC26 and BF26 respectively remains low. If the Up Flip Flop is ever set (EA10-13 high), whatever has been stored in these memory modules will appear at the respective output terminals 16 through 23.

4.3.8.2 Preset Rapid Approach to Pick Location -

The Rapid approach memory data is stored in modules FA39, FD39 and FG39 (Sections 3H, 5H and 8H, Sheet 3). When the preset switch 27PB (Section 10H) is activated, a low voltage appears at NOR FA31-5 (Section 10H) causing pins 15 of FA39, and FG39 to become high and force these modules to accept the data in the six digit thumbwheel switch at the respective 1 through 8 terminals. The high signal on NOR EC1-4 will also set interlock Flip Flop EE17-8 (Section 11E, Sheet 3). The 16 through 23 terminals of these memory blocks will present no output data until NOR Gate FA31-3 (Section 10H, Sheet 3) becomes high. FA31-3 will go high only when the High Speed Down (HD) and Down Flip Flops are simultaneously set.

4.3.8.3 Preset Coarse Feed to Fine Feed Crossover Location -

When in Manual mode (HM low) and the switch 28PB (Section 2A Sheet 3) is activated, a low voltage appears at NOR Gate DF1-13 causing its output DF1-10 to go high. This high voltage forces memory modules BF39, BC39 and AJ39 (Section 2, Sheet 3) to accept the six digit thumbwheel data through the respective 1 through 8 terminals. DF1-10 at high potential will also set interlock Flip Flop, EE17-6.

The output terminals 16 through 23 in the AJ39, BC39 and BF39 memory modules will show no data until High Speed Down (HD) Flip Flop, FE31-1 (Section 14D, Sheet 1) is reset accompanied by a set Down Flip Flop, DH18-13 (Section 12D, Sheet 1), which causes Nor Gate FA31-10 (Section 2H, Sheet 3) to present a high voltage to pins 9 of AJ39, BC39, and BF39 memory modules.

4.3.8.4 Preset Master Counter and High Speed Down Auto Approach Counter -

When switch 17PB (Section 4H, Sheet 1) is depressed Nor Gate DD1-2 goes low (Section 5H) and output DD1-3 goes high to preset the Master counter modules BB9, BD9, BF9, BH9, CA9 and CC9 to whatever value that is residing in the thumbwheel switch. A high DD1-3 (SWP) signal (Section 5G, Sheet 1) also presets binary counter CJ33, DH1, and DH34 to zero. A high DD1-3 also sets the interlock Flip Flop EE25-6 (Section 11D, Sheet 3).

4.3.8.5 Interlock Control -

If all the preset buttons have been depressed, the NAND EA18-9, 10, 11 and 12 inputs (Section 14H, Sheet 3) will all be high and EA18-13 will be low. NOR AE18-13 (Section 15H, Sheet 3) will therefore be low and, when the auto-manual switch is moved to auto, AE18-12 (AM signal) will be low. NOR AE18-11, with both inputs low, will go high to allow the operation of NAND Gate DF25-13 (Section 11C, Sheet 1) by the cycle start switch (in auto mode!). If any of the four interlock Flip Flops (i,e. EE17-1, EE17-8, EE25-6 or FE31-8) is not reset as the result of a preset oversight, the NAND Gate EA18-13 (Section 14G, Sheet 3) will not go low and a cycle start can not be initiated in automatic mode, because NAND Gate DF25-13 (Section 11D, Sheet 1) cannot be enabled with a low signal on DF25-10.

If any of the EE17-1, EE17-13, EE25-1 or FE31-13 Flip Flops in Section 12 of Sheet 3 are not set, the respective Q side of any reset Flip Flop will be high. Any high Q will appear at the input of an EG17 Inverter. For example: assume a high on EG17-9 (Section 12C, Sheet 3). If terminal 8 of EG17 is at ground, then EG17-10 will be at ground potential and force the rapid advance pushbutton lamp to illuminate. The lamp will glow only if pin 8 of EG17 is at ground potential. Pin 8 of EG17 will be at ground potential only when the auto-manual switch is in auto mode (see terminal DL3 in Section 1G, Sheet 1).

4.3.9 MANUAL FEED COMPENSATION

To compensate for grinding wheel wear or general accuracy drift within

the grinding system, Up Compensation switch, 16PB, and Down Compensation switch, 26PB, are provided (see Section 10A, Sheet 2).

When 16 PB is depressed, a high voltage appears at NOR EG1-12 _ (Section 12A, Sheet 2) forcing DG1-10 low. This low signal appears at EG1-1 causing NOR EG1-9 to become high (Signal CU). CU high appears at AND Gate EE9-6 (Section 3F). When the high voltage appears at EG1-12, it also appears at EC25-1 NOR Gate (Section 12A) to cause a positive pulse (CO) at EC25-6. The CO pulse appears at AND Gate terminal EE9-8 and, when EE9-6 is made high by CU, the pulse will show at EE9-9 output. This Up pulse will then cause the Transistor Q6 (Section 3F, Sheet 2) collector to momentarily pulse to ground and cause the down feed motor to feed Up by 0.002 mm.

When the Down Compensation switch, 26PB (Section 10A), is depressed a similar action takes place. The only difference being that a CD and CO signal set forces a positive pulse to appear at EE9-3 AND Gate output (Section 3F, Sheet 2). This pulse forces a negative pulse at the CD18 collector terminal of Q7 (Section 3F) to move the stepping motor in the Down direction by 0.002 mm.

4.3.10 TABLE THROTTLE VALVE OPERATION

On the front left of the surface grinder, a table throttle lever is located. Beneath the panel under this lever is a cam operated double contact switch. When the throttle lever is moved from off to on, a 12 volt pulse appears at Flip Flop EE25-8 (Section 12B, Sheet 4). EE25-13 sets to +12 volts and causes NAND FA23-6 (Section 11B) to go high. FA23-6 high forces NAND FA23-10 to go low and be inverted to a +12 volt signal at EA43-15 (Section 11B). If the true grind switch on the throttle switch panel is in the "Grind" position, the EA43-15 high signal will pass through the now closed, second contact of the throttle valve switch and turn on Valve Driver #1. Valve driver activates CR-1 Relay. The normally open CR1 contact (Section 10C, Sheet 4) now closes and energizes the table start solenoid. At the same time the normally closed CR1 contact opens to deenergize the handwheel clutch solenoid (the CR relay is on the 824 series machines only).

4.3.11 MASTER RESET

Whenever the main, AC, power switch is operated, the +12 volt power supply is activated. This voltage appears at CH19 (Section 2G, Sheet 1) after a delay of about 1 second. This voltage signal ultimately is shaped into a 12 volt pulse, about 100 milliseconds wide, which appears as a Master Reset (MR) signal at terminal CH21 (Section 2G, Sheet 1). This MR signal resets ever Flip Flop in the system so that each Flip Flop Q terminal is at ground and each Q terminal is at a +12 volt potential.

4.3.12 AUTOMATIC CYCLE

The following details of Automatic circuit operations are predicated on the fact that an automatic cycle has been programmed per the instructions in the Operator Manual, paragraph 1.2.

A. Automatic Retract

After the automatic program has been placed in the system per

paragraph 1.2, a movement of the auto-manual switch to auto will cause a ground potential to appear at DK5 (Section 1F, Sheet 1) and ultimately NOR Gate AE18-8 (Section 11A, Sheet 1). As a result, a positive pulse occurs at DG23 and thus at NOR Gate EA1-13. NOR Gate EC1-10 therefore presents a positive pulse to set EA10-8 Flip F Flop (Section 12B, Sheet 1). The Up Flip Flop, being set, generates a pulse at DG13 (Section 15D) which eventually causes an I pulse at DH43-2 (Section 14D) to start the Oscillator. The Master counter at Section H accumulates each pulse signal. The respective Master counter 6, 11, 14 and 2 terminals presents accumulated data to the respective 2, 5, 8 and 12 terminals of the Exclusive OR Gates CA18, BH18, BF18, BD18, BB18 and AJ18 in Section 2, Sheet 4.

Terminals 1, 3, 5 and 7 of the respective AND Gates CB43, BJ43, AG43, AE43, AC43 and AA43 are primed by a high voltage ($\overline{GF}$) on the respective pins 14 to receive data from the appropriate EE36 through EE42, EE44 through EE50, EF 37 through EF41 and EF45 through EF49 memory busses in Section 9, Sheet 3. The retract limit binary coded decimal number is resident on these buss lines, because a positive Up command appears on terminals 9 of Retract Memories BC26, BF26 and AJ26 and forces data stored in memory to appear on the buss lines. This memory data appears at terminals 1, 6, 9 and 13 of Exclusive OR Gates CA18, BH18, BF18, BD18, BB18, and AJ18 respectively and is continuously compared with the data being generated by the Master counter. When an equality of numbers becomes evident as the grinding wheel retracts, the outputs of NOR Gates DB1-1, DB1-13, DB9-1, DB9-13, DB41-6, DB41-10 and DD1-11 (Section 3, Sheet 4) all become high simultaneously. These high voltages influence a low voltage at NAND Gate output DF25-1 (Section 6B). This low signal appears at NOR Gate EA1-5 (Section 7C, Sheet 4) along with a low DN at EA1-3 and a low AM at EA1-5 which causes EA1-6 to become high. This high signal creates a positive pulse, Up = signal, at NOR Gate DD9-4 (Section 9C, Sheet 4). The Up = Command appears at NAND Gate CG44-5 forcing a negative pulse at CG44-1 which is inverted at NAND FC23-10 to set the Down Ramp Flip Flop FE23-1 (Section 13B, Sheet 3). The high FE23-1 (DNR) signal forces the Oscillator to slow down and stop as described in paragraph 4.3.3.4.

B. Cycle Start and Rapid Advance

To start an automatic cycle, after the program has been entered and the manual-auto switch has been set to auto, the Cycle Start button must be depressed. Then a positive pulse is created at NAND Gate DF25-11 (Section 11D, Sheet 1). HM at DF25-9 is high in auto mode and DLO at DF25-13 is also high. Therefore, DF25-13 will go low and appear low at NAND EC9-5 (Section 11D) and at NOR AC34-12 (Section 13D). The resulting high pulse at EC9-6 sets the DH18-5 Down Flip Flop and the high pulse at AC34-11 sets the High Speed Down (HD) Flip Flop FE31-6 (Section 13D). When DN (DH18-2 at Section 12D) becomes low, it forces an Index (I) pulse out of DH43-2 (Section 14D) to start the Oscillator and the motor feed in the down direction.

Since HD and DM are now both low, the output of NOR Gate FA31-3 (Section 9H, Sheet 3) is high and forces memory modules FA39, FD39, and FG39 (Section H, Sheet 3) to present their data to the memory buss through their respective output pins 16 through 23. This memory data reaches the comparators (Exclusive ORs) CA18, BH18, BF18, BD18,

BB18 and AJ18, (Section 2, Sheet 4) and is continually compared with data from the Master counter. When an equality occurs, the NOR Gate Outputs DB1-1 DB1-13, DB9-1, DB9-13, DB17-1 and DB17-13, in combination, force the output of -NOR Gate DD17-13 (Section 5B, Sheet 4) high which in turn generates a positive D = pulse at NOR Gate DD9-10 (Section 7A, Sheet 4). The D = pulse appears at NOR EG9-2 (Section 2A, Sheet 2) which causes the IC Flip Flop, AA34-4, to reset and stop the Oscillator. D = also reset the HD Flip Flop FE31-4 (Section 14D, Sheet 1).

The D = signal shall not stop the Oscillator before it reaches low speed. This paragraph discloses how this low speed is determined. During programming in manual mode, the Master counter is preset to a value which is within tenths of a thousandth of the rough size of the item to be ground. This preset signal (DD1-3 in Section 5G of Sheet 1) also presets the binary counters CJ33, DH1 and DH34 (Section 7B, Sheet 1) to zero. Each time the Master counter BD9 stage accumulates one hundred pulses, a signal (carryout) originates at BD7 (Section 7H, Sheet 1). This negative pulse appears at CJ33-5 terminal (Section 5B). Thus the binary counter (High Speed Rapid Approach Counter) CJ33', DH1 and DH34 accumulates each 100 steps stored by the Master counter. This High Speed Rapid Approach Counter counts up when the grinding wheel retracts and counts down when the grinding wheel -approaches the work piece. During rapid approach in automatic mode, after the cycle start button is depressed, the counter will count down, and, at any time that the binary count in CJ33, DH1 and DH34 reaches 700 or less, the output of NAND Gate DB25-13 (Section 8A, Sheet 1) goes low, since CJ33-2, DH-2, 6, 11 and 14 and DH34-2, 6, 11 and 14 reach a binary zero value (0 volts). The low DB25-13 signal appears at NAND Gate FC23-13 causing the DNR Flip Flop FE23-6 to set. The resultant DNR high signal appears at NOR Gate AG34-4 to force the Oscillator to ramp down to low speed in preparation for a D = command to stop.

C. Coarse Feed Pick in Auto Mode

The solid state switches, 1LS and 2LS, govern incremental feed in slot grind mode after the completion of the Rapid Approach described in Section B. These switches are located in the hydraulic chamber below the manual table reversing lever.

The crossfeed switches, 3LSA and 3LSB, located on the upper rear of the electrical cabinet, control incremental feeds in auto mode during surface grind operations.

The respective switches mentioned above cause the Flip Flop configuration of two NOR Gates, EC1-1 and EC1-12 in Section 11G of Sheet 1, to provide positive pulses at FB9 or FB13 (Section 11G) depending on the table or crossfeed reversal direction. These pulses are inverted at NOR AA26-10 (Section 10G) and are identified as LS signals. The LS signals appear as negative pulses at DH26-9 NOR Gate (Section 11E, Sheet 1) which set Flip Flop DH18-8. DH18-13 creates a positive pulse at DH43-2. The I pulse starts the Oscillator and causes a feed increment in identically the same manner as the Jog button described in paragraph 4.3.7.

D. Coarse Feed to Fine Feed Transition

After each table or crossfeed reversal during automatic mode (following the completion of High Speed Downfeed), a feed increment occurs. This increment is accumulated by the Master counter. As the Master count approaches the numeric value stored in the coarse to fine feed crossover memory AJ39, BC39 and BF39, the information at Exclusive ORs CA18, BH18, BF18, BD18 from memory will compare with the related digit locations of the Master counter much sooner than the 10-4 and 10-3 digit positions. When this occurs, the input 2, 3, 4 and 5 of the DB25 NAND Gate (Section 4H, Sheet 4) are high. Therefore, the NOR Gate input DB33-3 will be low. DB33-2 and DB33-5 are also low presently.

When the count in the Master counter contains a count 11 higher than that on the memory buss, the outputs of NOR Gates DB41-6 and DB41-10 are high. DD33-4 is then low, which causes a positive pulse at DG17 (Section 4G, Sheet 4) and thus a negative pulse at DB33-4 (Section 5G, Sheet 4). Since all other terminals on the NOR Gate are already low, the negative pulse at DB33-5 causes DB33-1 to pulse positively to set Flip Flop DD25-6 (Section 6G, Sheet 4). The resulting high F = signal will immediately cause the Oscillator to revert to low speed during the remainder of the automatic sequences in constant anticipation of a D = command to stop. The $\overline{F=}$ low (0 volt signal) speed command appears at NAND Gate AE35-13 (Section 2B, Sheet 2) to slow down the Oscillator.

Ultimately, all digits in the Master counter will equate to the information on the memory busses and the output of NOR Gate DD1-11 (Section 4B, Sheet 4) will become high to force the output of DF25-1 NAND Gate low. This low signal appears at NOR DF1-5 (Section 6B, Sheet 4) to set GF Flip Flop DD25-8 (Section 7B). Also when all digits compare the output of NOR DD17-13 (Section 5A, Sheet 4) rises to about 14V to generate at D = pulse to stop the Oscillator preparatory to a change from coarse to fine feed increments.

When the GF (DD25-8) Flip Flop is set, all memory units are ignored and the high GF signal (DD25-13) to pins 9 of the AND Gates CB43, BJ43, AG43, AE43, AC43 and AA43 (Section 1, Sheet 4) causes the information in the six digit thumbwheel switch appearing at the pins 2, 4, 6, and 13 of the above, respective Gates to be compared with the sum in the Master counter.

The $\overline{\text{GF}}$ signal, now at about ground potential, turns off AND Gates BB1, BD1, AE10 and AJ10 to discourage coarse feed increments. However, $\overline{\text{GF}}$ at NOR AE18-5 (Section 4F, Sheet 1), forces a high signal at pins 5, 6, 12 and 13 of NAND Gates AJ10. This action allows the incremental down feed to be controlled by data stored within the Fine Feed Thumbwheel switch.

E. Spark Out Control

When the Fine Feed increments ($\overline{\text{GF}}$ Flip Flop Set) decrease the sum in the Master counter to a value equivalent to the number in the six digit thumbwheel switch, the comparator section will issue another D = signal from NOR Gate DD9-10. This D = appears at NAND Gate FC31-9 (FC3-8, F =, is still high per paragraph 4.3.12D). The output FC31-10

(Section 10H, Sheet 4) and FG30-12 Inverter output becomes high to set Flip Flop EC44-6 (Section 11H, Sheet 4). EC44-2 becomes low and appears at NOR AC34-2. The next incremental feed signal LS appears at AC34-1 to produce a DSO signal at NOR output AC34-3. At this time cycle start is inhibited by $\overline{DLO}$ (EC44-2, Section 11H) which is at about ground voltage, and appears at NAND DF25-12 (Section 11C, Sheet 1). Also, DSO sets Flip Flop EC44-8 (Section 12H, Sheet 4) to inhibit any further incremental feeds by sending a low signal from Inverter CJ9-3 (Section 12H, Sheet 4) which appears at NOR AG18-1 (Section 11E, Sheet 1) to inhibit successive LS pulses from passing through NOR Gate DH26-9 (Section 11E, Sheet 1).

The most recent LS pulse has provided an I pulse from DH43-2 (Section 14D, Sheet 1) and has started the Oscillator. The very first negative Oscillator pulse that reaches the motor from CD18 (Q7 Collector) (Section 3F, Sheet 2) also appears at NOR Gate DD1-6 (Section 12G, Sheet 4). Since DD1-5 is also low, the output of NOR DD1-4 creates a positive pulse, DS, at EH26 (Section 13G, Sheet 4). After one pulse reaches the down feed motor, the DS signal appears at: 1) NOR Gate EG9-1 (Section 2A, Sheet 2) to reset the IC Flip Flop and thus stop the Oscillator and 2) at NOR Gate CJ41-3 (Section 12D, Sheet 1) to reset the Down Flip Flop, DH18-4 (Section 12D, Sheet 1). The above action has caused the Down Feed to move 0.000078 inches after the final size of the work piece has been reached. This last pass of one pulse helps to compensate for any stress, backlash, etc. which has been built up in the down feed mechanism.

Prior to any of the above electronic actions, a spark out thumbwheel switch has been feeding a BCD digit to terminals 3, 4, 12 and 13 of the DF43 (Section 11E, Sheet 4) sparkout counter. After the Flip Flop EC44-13 has been set, each LS signal will appear at NOR Gate EA34-2 and generate a positive pulse at EA34-1 (Section 13H, Sheet 4). These positive pulses will reach counter DF43-5, 15 terminals, (Section 11E, Sheet 4) and, since terminal 9 is at ground, the counter will count down for each pulse. When the output terminals 2, 6, 11, and 14 of the DF43 spark out counter simultaneously decrement to ground potential, the output of NOR Gate EA34-13 becomes high. Following this high signal, which appears at NAND Gate EA26-12 (Section 13 E, Sheet 4), the next LS (table reversal feed signal) will cause a negative pulse at EA26-11 (SO). SO causes the table to park and appears as SO (Section 13E, Sheet 4) at Inverter DH43-10 as a positive pulse. This positive pulse arrives at NOR Gate EA1-11 (Section 11B, Sheet 1) to set the Up Flip Flop EA10-13, start the Oscillator, and force an up feed to the retract position (described in paragraph 4.3.12A).

F. Table Park Circuit

Whenever the sparkout command, SO, provides a negative pulse, that pulse appears at NAND Gate FC23-1 (Section 13D, Sheet 4). The resultant positive signal at FC23-9 appears at FC23-3 to force NAND output FC23-6 negative. The negative signal is inverted at EA43-10 inverter output (Section 12C, Sheet 4). The positive signal turns on Table Load Position Solenoid Driver #3 (See Figure 4-1). This activates a solenoid which allows the table to bypass the right hand reversal dog and drift to the extreme right travel position. As the table reaches the right hand side it activates a Table Park Limit

Switch, 4LS (Section 12B, Sheet 4). Switch 4LS introduces a ground signal to NAND FA23-3 which, in turn, forces FA23-6 output high. This +12 volt signal appears at NAND FA23-11 to cause the output of Inverter EA43-15 (Section 10B, Sheet 4) to go high. EA43-15, now high, deactivates the table start driver to kill hydraulic pressure to the table reversal system. If the throttle valve is turned "off" and then "on", a positive pulse at FD17 (Section 13B, Sheet 4) will set Flip Flop EE25-8 which turns on the table start solenoid and turns off the Table Load Position solenoid.

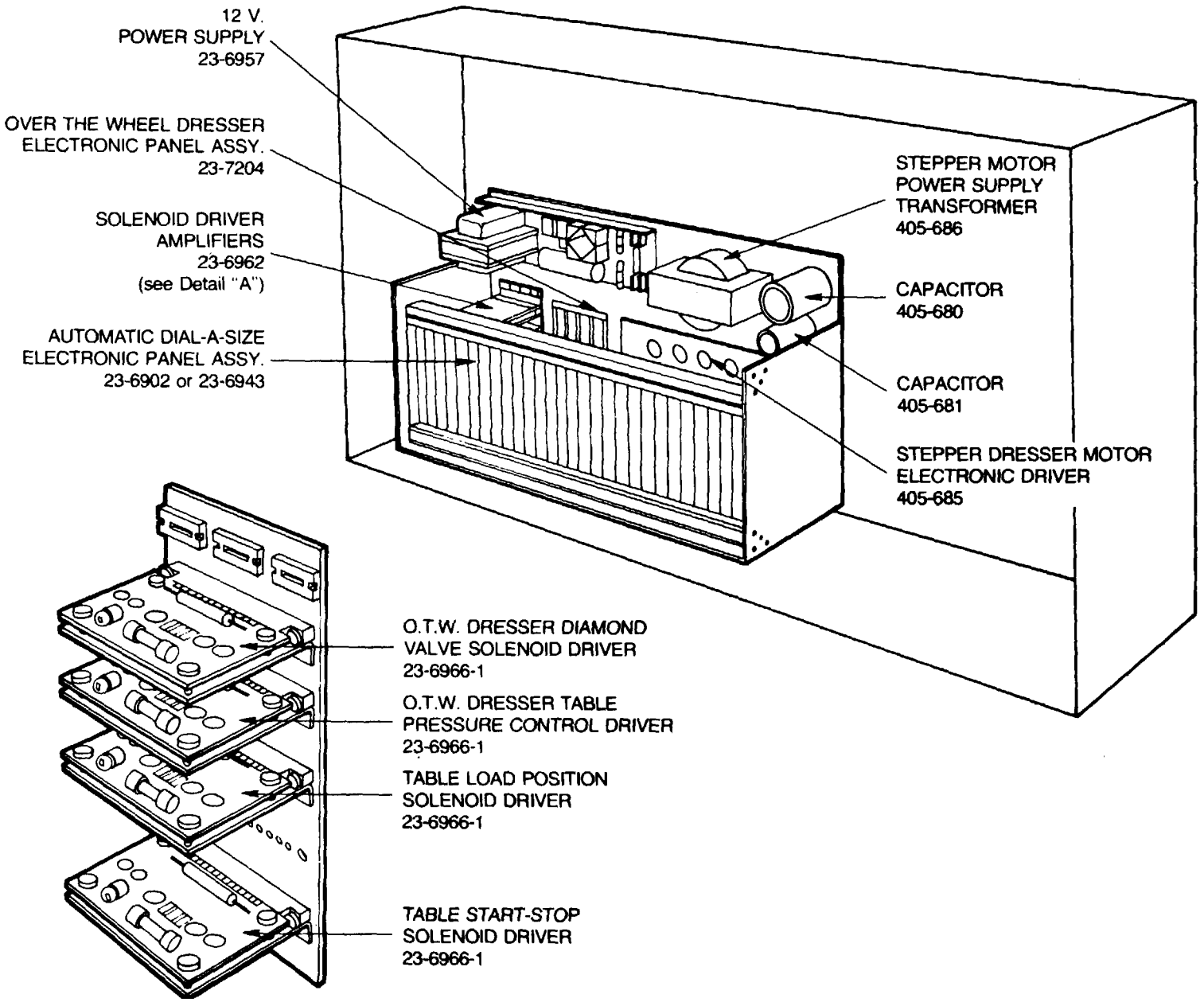
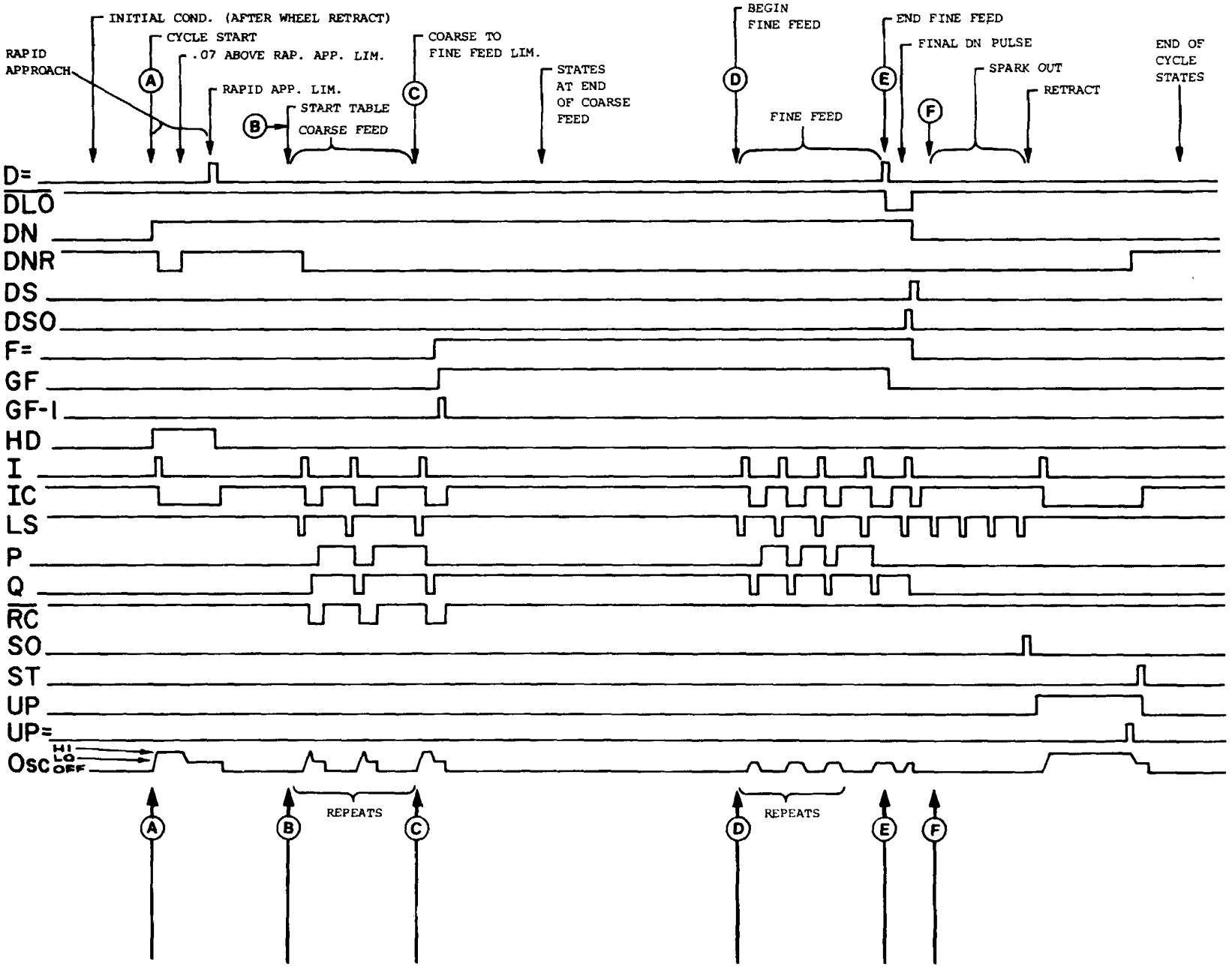


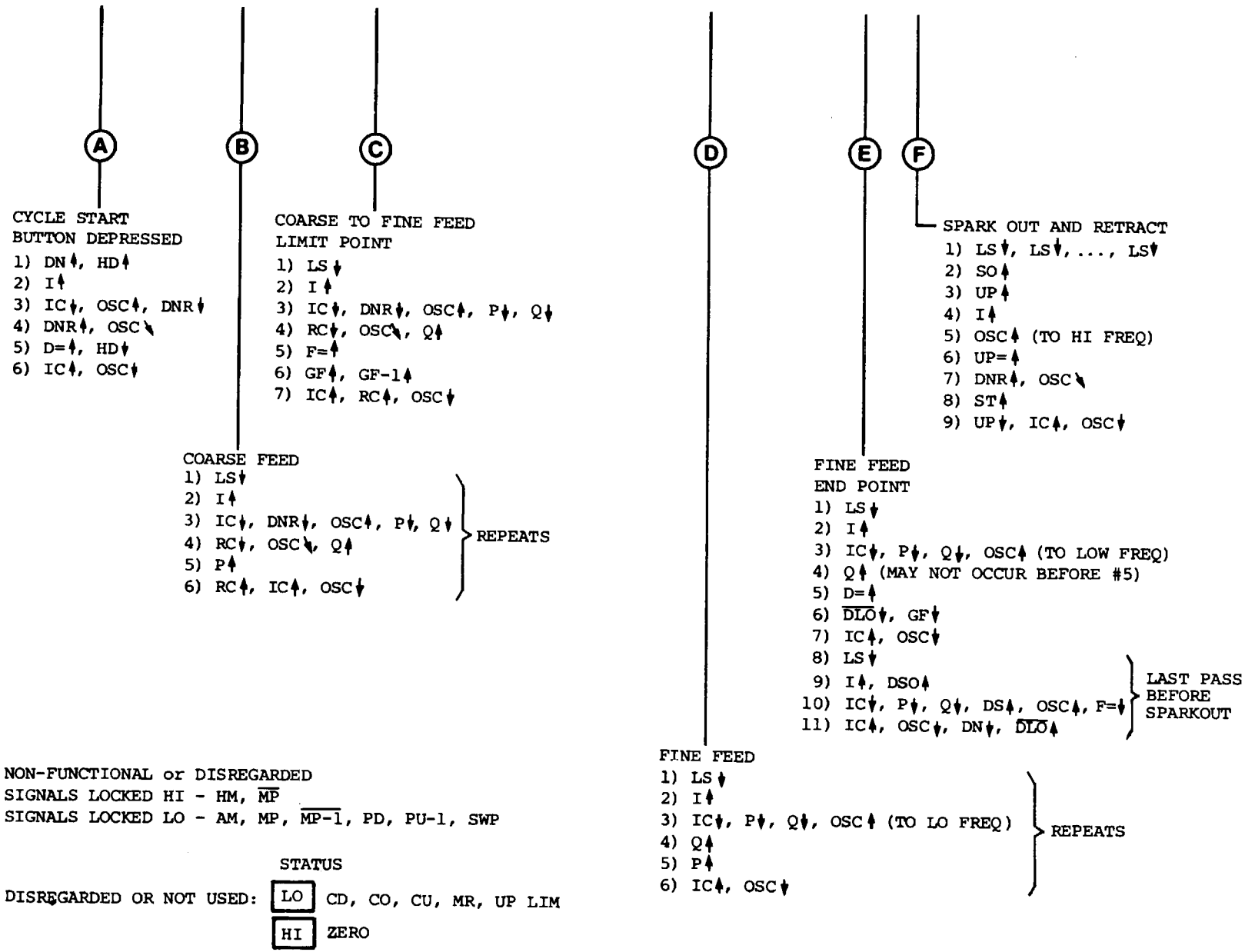
Figure 4-1. Location of Electronic Assemblies.

APPENDIX "A"
Signal Glossary Schematic Location Chart
(This chart is applicable to schematics 23-99990-5069 and 23-99990-5070

Mnemonic Code	Description	Signal Origin		Signal Destinations									
		Terminal	Location	Terminal	Location	Terminal	Location	Terminal	Location	Terminal	Location	Terminal	Location
AM	Automatic Mode	DK5	1-1F	EA26-5	1-10C	EA34-4	4-13H	AE18-8	1-11A	DD17-10	4-5B	DB41-2	2-3B
AM	Automatic Mode			EG1-4	4-4H	EA1-4	4-7C	CJ9-5	1-13D	AE18-12	3-14G		
CD	Compensate Down	EG1-10	2-12A	EG1-1	2-12A	EE9-5	2-3F						
CO	Compensate Output	EC25-6	2-13A	EC25-8	2-12A	EE9-8	2-3F	EE9-4	2-3F				
$\overline{CO}$	CO Complement	EC25-9	2-12A	EC21	2-12A								
CU	Compensate Up	EG1-9	2-12A	EG1-13	2-12A	EE9-6	2-3F						
D=	Down Equal	DD9-10	4-7A	DD9-13	4-5A	DD25-10	4-7B	EG9-2	2-2A	FE31-4	1-13D	FC31-9	4-10H
$\overline{D=}$	D= Complement	DD9-11	4-SB	EG032	4-5B								
$\overline{DLO}$	Down Lockout Complement	EC44-2	4-11H	CG44-11	2-1B	AC34-2	4-11H	DF25-12	1-11C				
DN	Down Control	DH18-1	1-12D	EE1-12	2-4F	CJ17-12	1-1D	AC34-13	1-13D	EA1-3	4-7C	AG26-6	2-1C
$\overline{DN}$	DN Complement	DH18-2	1-12D	FA31-8	3-2H	EE1-1	2-2F	DH26-12	1-11E	CJ17-2	2-11B	FA31-1	3-10H
$\overline{DN}$	DN Complement			DB41-1	2-3B			CJ9-8	4-12H	FK0l7	1-3H		
$\overline{DNR}$	Down Ramp Control	FE23-1	3-13B	AG34-4	2-3C								
$\overline{DNR}$	DNR Complement	FE23-2	3-13B	CG44-10	2-1B	DD17-S	2-6A						
DS	Down Stop	EH026	4-13G	CJ41-3	1-12D	EG9-1	2-2A						
DSO	Delay Spark Out	AC34-3	4-11H	EC44-8	4-12H								
F=	Begin Fine Feed Cycle	DD25-1	4-6G	AC34-6	2-3A	FC31-8	4-10H						
$\overline{F=}$	F = Complement	DD25-2	4-6G	DF1-3	4-6B	CJ17-8	1-7C	AE35-13	2-3C				
GF	Begin Fine Feed Pick	DD25-13	4-8B	FC20	4-8B	EJ21	4-1H	AC34-5	2-3B				
$\overline{GF}$	GF Complement	DD25-12	4-7B	FC31-6	4-4A	EJ017	4-1H	AE18-5	1-4F	EJ011	1-8E		
GF-1	Fine Feed Pulse	FD020	4-8B	AA26-3	2-1C								
HD	High Speed Down	FE31-1	1-14D	EJ27	1-14D								
$\overline{HD}$	HD Complement	FE31-2	1-14D	EJ33	1-14D								
HM	High Auto Signal	EC33-4	1-1E	FA31-6	3-10H	DF25-5	4-6B	EC1-5	3-10A	DF1-12	3-1A	DD1-1	1-5G
HM	High Auto Signal			DF25-9	1-11D	FC23-4	4-13C	FC23-2	4-13D	FA31-13	1-12C	AG26-5	2-1B
HM	High Auto Signal			CG44-4	3-11B	AE35-8	2-2B						
I	Index Pulse	DH43-2	1-14D	AA34-6	2-2D	FE23-10	2-6A	DF43-1	4-12F	FE23-4	3-12B		
IC	Index Control	AA34-2	2-2C	CD28	2-6C	FK10	2-2C						
$\overline{IC}$	IC Complement	AA34-1	2-2D	CA1-5	1-2C	AC26	1-1E	AE35-12	2-3C				
LS	Table Limit Signal	FL12	1-9F	EA34-5	4-13H	DH26-9	1-11E	AC34-1	4-11H				
$\overline{MP}$	Manual Power Complement	EA10-2	1-12C	FC31-13	1-13C	EC9-4	1-11D	DF37	1-12C	CJ17-13	1-1D		
$\overline{MP-1}$	Manual Pwr Reset Pulse	DG039	1-12C	DH10-8	3-12B								
MR	Master Reset	CH21	1-3G	EC44-3	4-11H	DD25-11	4-7B	DD25-3	4-6G	EE17-3	3-11F	FE31-11	3-11C
MR	Master Reset			FE23-3	3-13B	FE23-11	2-7A		EE25-11	4-12A	EE25-3	3-11D	
MR	Master Reset			EC44-11	4-12H	AA34-11	1-8C	FK19	2-2C	FE31-3	1-14D	EA10-11	1-12B
MR	Master Reset			EA10-3	1-12C	DH18-3	1-12D	DH18-11	1-12E	EE17-11	3-11E		
P	Pick Complete	CJ25-1	1-6D	CG44-12	2-1B	DH10-5	1-11C						
PD	Power Down	DH43-6	1-11C	EA10-6	1-11C	DH10-3	1-11C	D17-2	2-6A	EA1-1	1-6F		
PU-1	Power Up Stop Pulse	EH46	1-11A	DH10-1	3-12B								
Q	Pick Complete	CJ25-13	1-6D	CG44-9	2-1B	DH10-4	1-11C						
$\overline{RC}$	Ramp Control Complement	AA34-12	1-8C	AG26-1	2-3B								
So	Spark Out	DH43-10	4-13E	EC44-10	4-12A	EA1-11	1-11B						
$\overline{SO}$	SO Complement	EA26-11	4-13E	FC23-1	4-13D	EC9-8	2-6E	CE43-4	2-3D				
ST	Stop Oscillator	EH047	2-7A	EA10-10	1-12B	CJ9-6	1-13D	AG26-13	2-1C				
SWP	Set Wheel Position	DD1-3	1-5G	CJ33-1	1-6B	DH1-1	1-7B	DH34-1	1-8B	EE25-6	3-11E		
UP	Power Up	EA10-13	1-12B	DFI5	1-15C	DF1-4	4-6B	AJ26-9	3-5B	BC26-9	3-7B	BF26-9	3-9B
UP	Power Up			EE1-2	2-2F	CG44-3	3-11B	DD9-9	4-6A	EG1-5	4-4H	FK22	
UP	Power Up			EA34-3	4-13H	EA1-2	1-6F						
UP=	UP Equal	DD9-4	4-9C	DD9-2	4-7C	CG44-5	3-11B						
$\overline{UP=}$	UP Complement	DD9-3	4-7C	DF11	4-7C								
$\overline{UP}$	UP Complement	EA10-12	1-12B	EE1-13	2-4F	CJ17-1	2-2-11B						
ZERO	Zero Suppression	CJ17-4	1-1C	CA1-4	1-1C	CE43-8	1-11D	EG9-8	1-10E				
UP LIMIT		FL3	1-12B	EC1-8	1-12B								

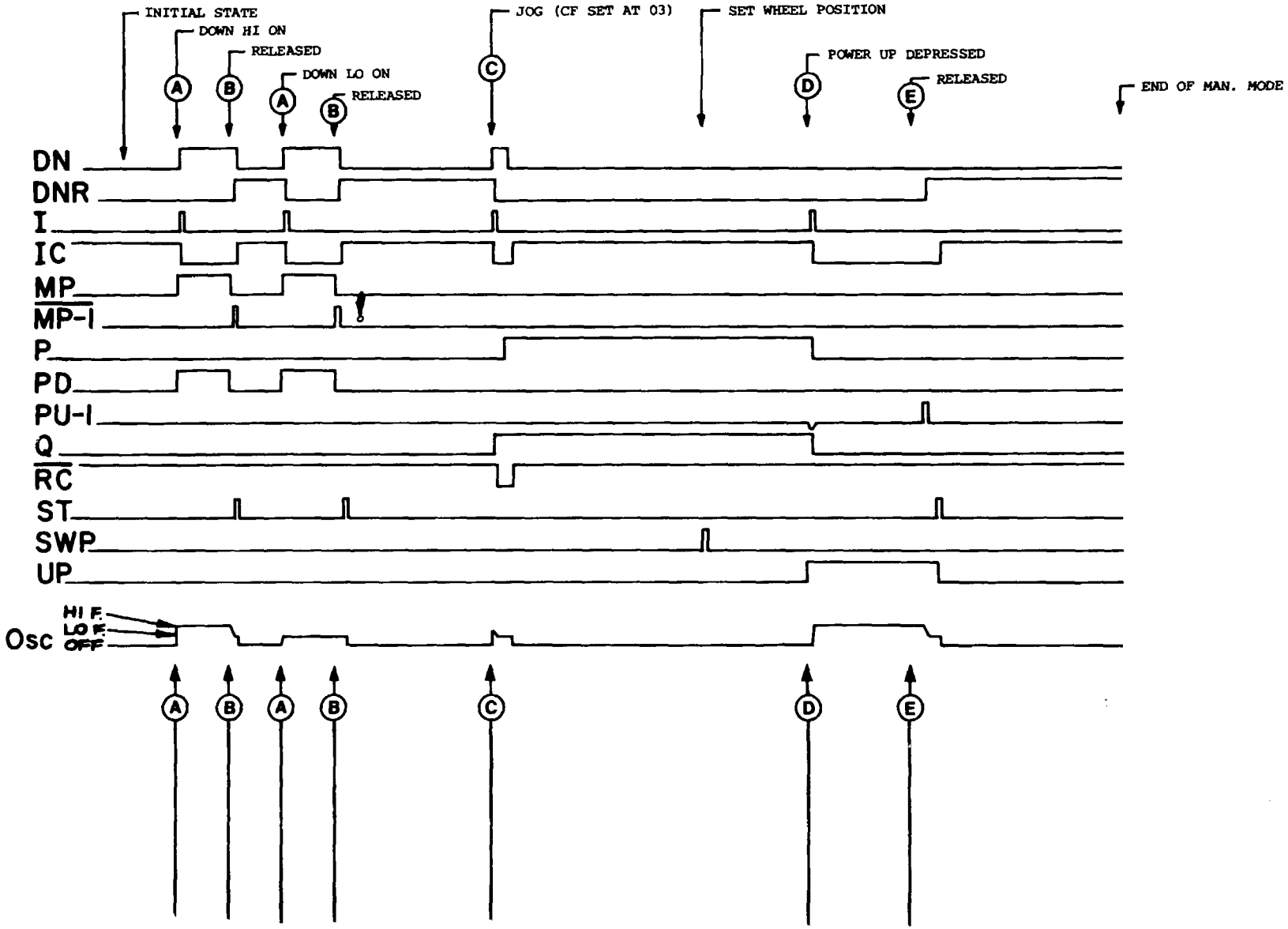
APPENDIX "B"

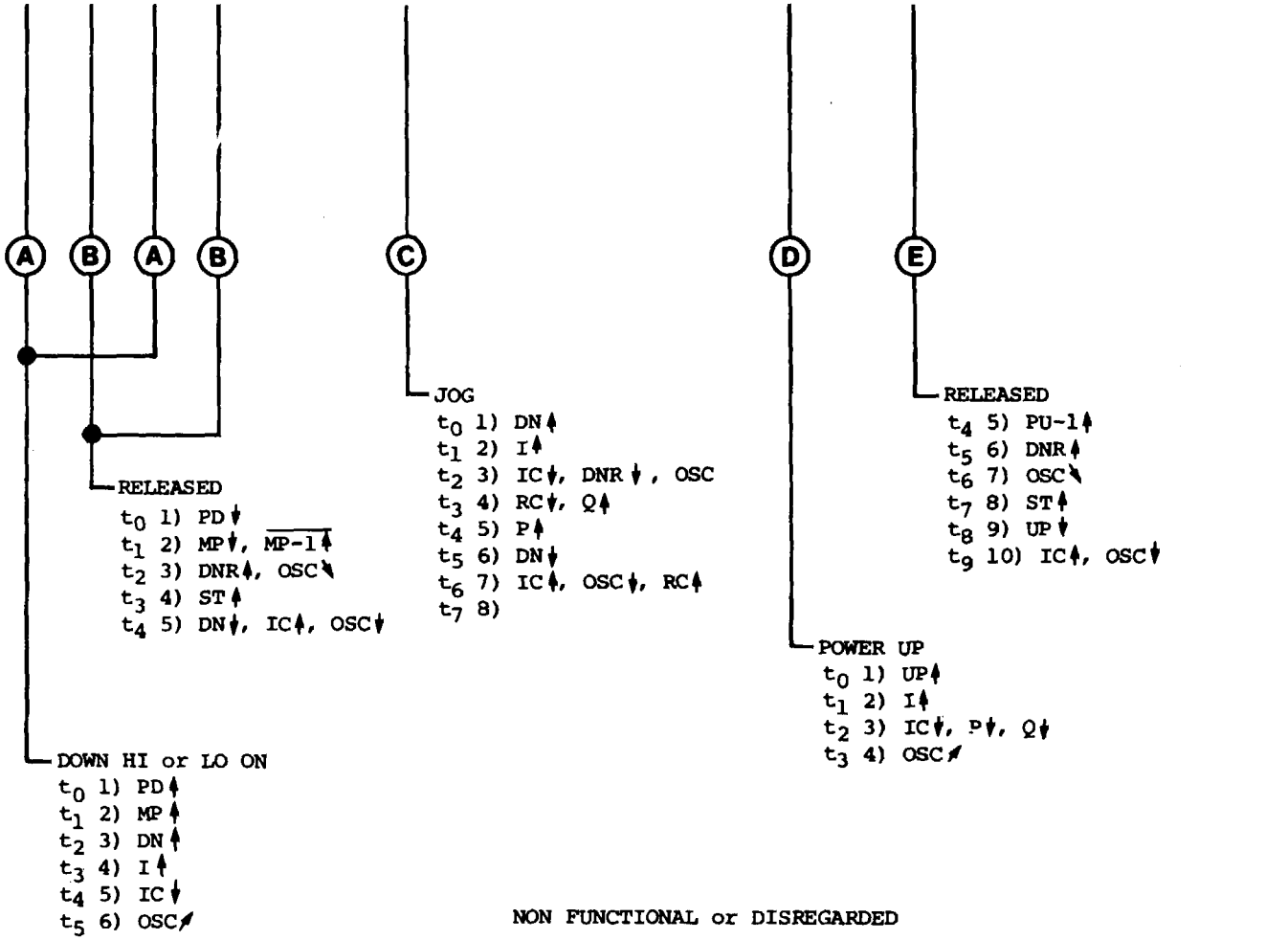

INITIAL COND. (AFTER WHEEL RETRACT)
CYCLE START
.07 ABOVE RAP. APP. LIM.
RAPID APP. LIM.
START TABLE
COARSE FEED
COARSE TO FINE FEED LIM.
STATES AT END OF COARSE FEED
BEGIN FINE FEED
FINE FEED
END FINE FEED
FINAL DN PULSE
SPARK OUT
RETRACT
END OF CYCLE STATES
RAPID APPROACH
A
B
C
D
E
F
D=
DLO
DN
DNR
DS
DSO
F=
GF
GF-I
HD
I
IC
LS
P
Q
RC
SO
ST
UP
UP=
Osc
HI
LO
OFF
REPEATS
REPEATS



DIAL-SIZE SEQUENCE IN AUTOMATIC MODE

APPENDIX "C"


INITIAL STATE
DOWN HI ON
RELEASED
DOWN LO ON
RELEASED
JOG (CF SET AT 03)
SET WHEEL POSITION
POWER UP DEPRESSED
RELEASED
END OF MAN. MODE
A
B
A
B
C
D
E
DN
DNR
I
IC
MP
MP-I
P
PD
PU-I
Q
RC
ST
SWP
UP
Osc
HI F.
LO F.
OFF
A
B
A
B
C
D
E



NON FUNCTIONAL or DISREGARDED

SIGNALS LOCKED HI - AM, $\overline{D=}$, $\overline{DLO}$, $\overline{F=}$, $\overline{GF}$, $\overline{HD}$, $\overline{UP=}$

SIGNALS LOCKED LO - D=, DS, DSO, F=, GF, GF-1, HD, HM, UP=

STATUS

DISREGARDED or NOT USED [LO] - CD, CO, CU, MR, UP LIM.

[HI] - ZERO [PULSING] - LS

DIAL-A-SIZE SEQUENCE IN MANUAL MODE

PARTS LIST FOR THE 618 & 818 SERIES

SURFACE GRINDING MACHINES

1

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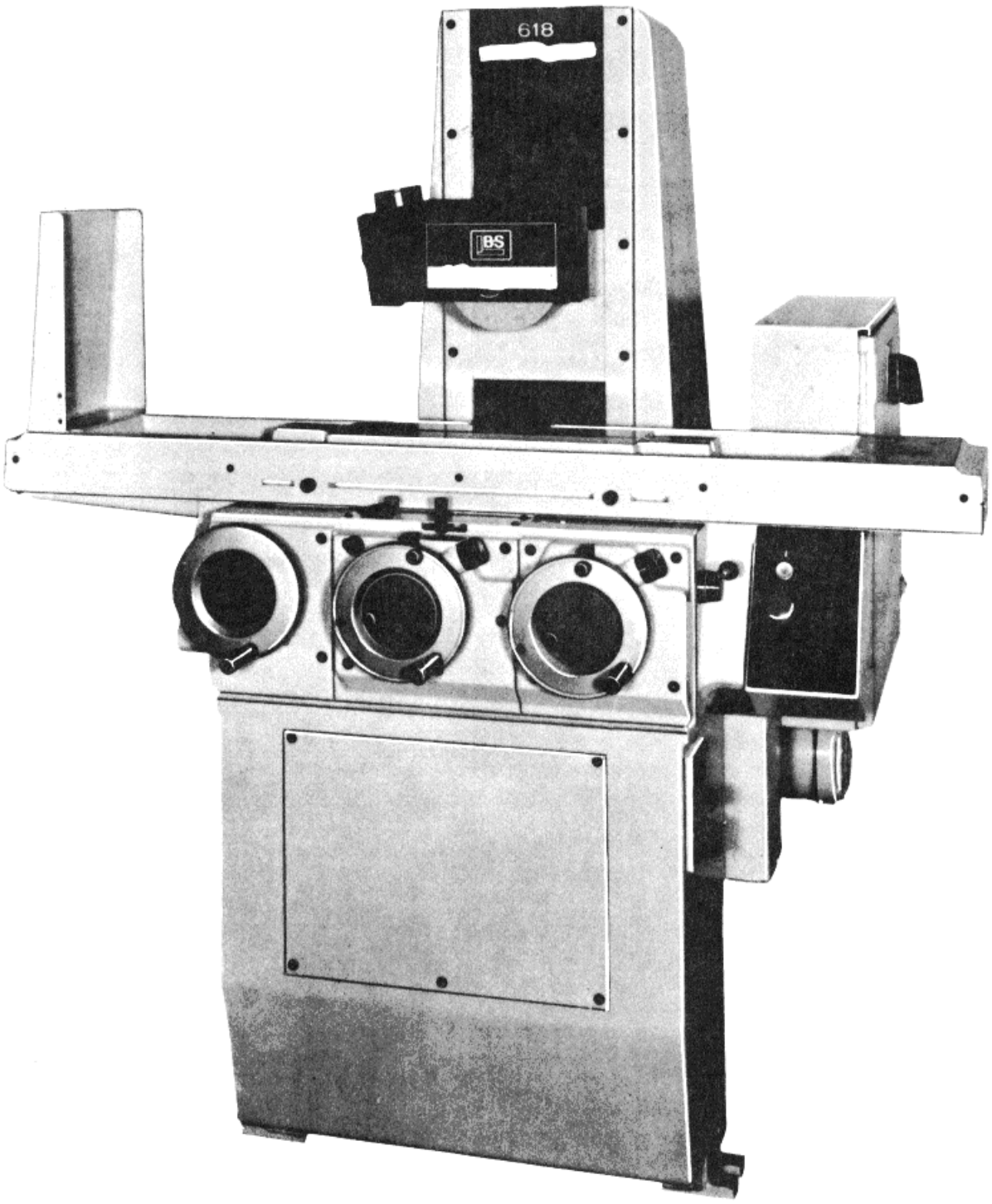
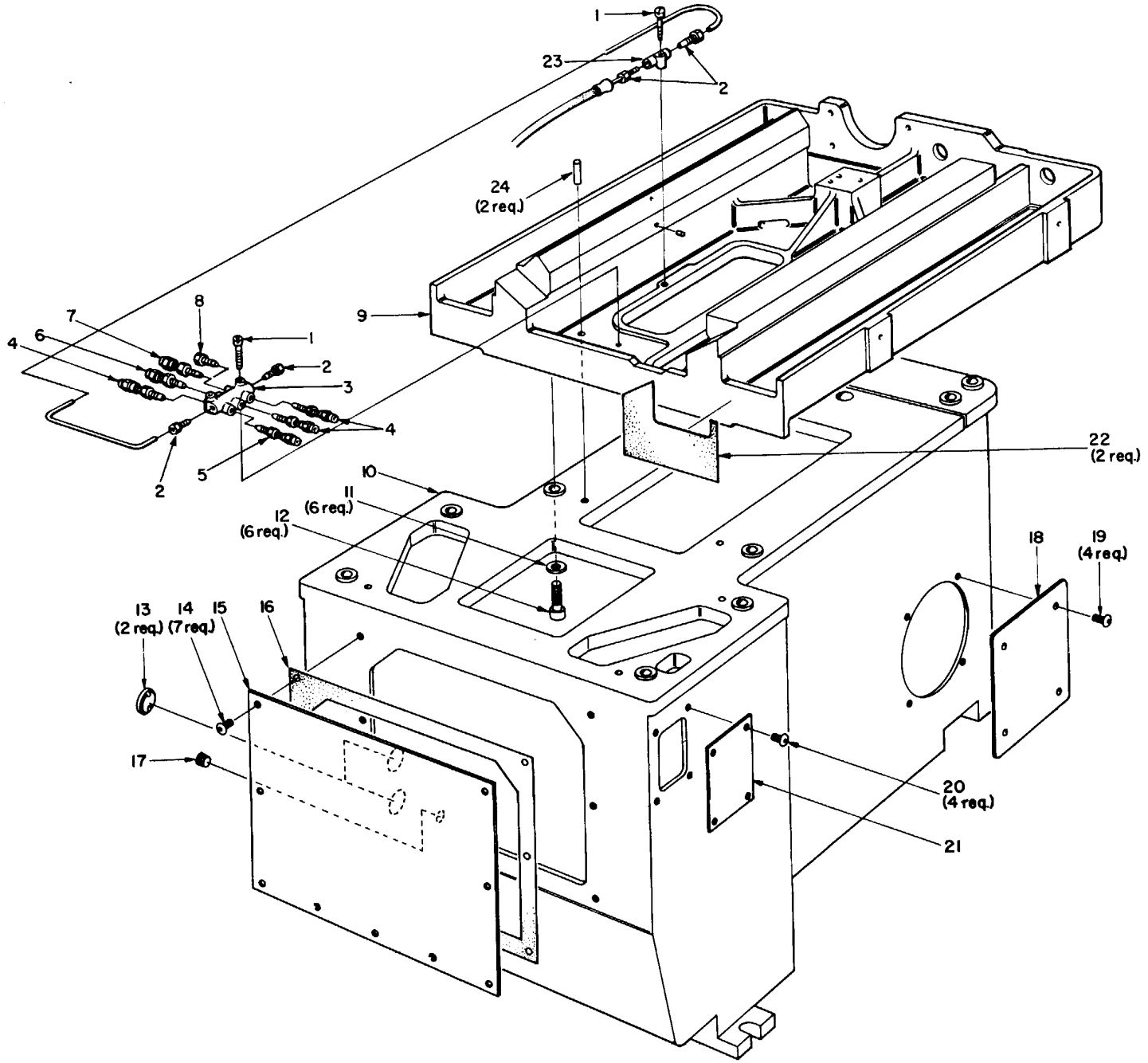
ELECTRICAL COMPONENTS

Not all electrical components are shown in this book.

Always give all data shown on manufacturer’s plate when ordering electrical components.



FRONT VIEW


1
23
2
24
(2 req.)
9
8
7
6
4
1
2
3
4
5
2
22
(2 req.)
10
11
(6 req.)
12
(6 req.)
18
19
(4 req.)
13
(2 req.)
14
(7 req.)
15
16
17
20
(4 req.)
21

MACHINE BASE
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	92-5050-834	Screw (2 Req)
2	461-951	Compress Sleeve
	461-953	Compress Bushing
3	461-964	Junction Bar
4	461-3960	#3 Meter Unit
	461-918	Compress Nut
	461-919	Compress Bushing
5	461-3953	#4 Meter Unit
	461-918	Compress Nut
	461-919	Compress Bushing
6	961-3951	#0 Meter Unit
	461-918	Compress Nut
	461-919	Compress Bushing
7	461-21	#5 Meter Unit (hand feed machine only)
	461-918	Compress Nut
	461-919	Compress Bushing
8	461-974	Plug (power table only
9	234603	Upright Base
10	23-6600	Machine Base
11	92-2010-1608-28	Washer, 1/2" I.D. x 1 1/8" O.D. x 1/8"
12	92-5380-1644	Socket Head Screw, 1/2"-13 x 1 1/2"
13	461-911	Oil Level Window
14	92-5385-1016	Button Head Screw, 5/16"-18 x 1/2"
15	234778	Hydraulic Compartment Cover
16	234007	Cover Gasket
17	463-697	Pipe Plug
18	23-6606	Cover (machines without power table feed only)
19	92-5385-1216	Button Head Screw, 3/8"-16x 1/2"
20	92-5385-1016	Button Head Screw, 5/16"-18 x 1/2"
21	23-6641	Cover (machines without power cross feed only)
22	23-5513	Table Bed Gasket
23	461-97	Junction Bar
24	92-900-1236	Dowel

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE

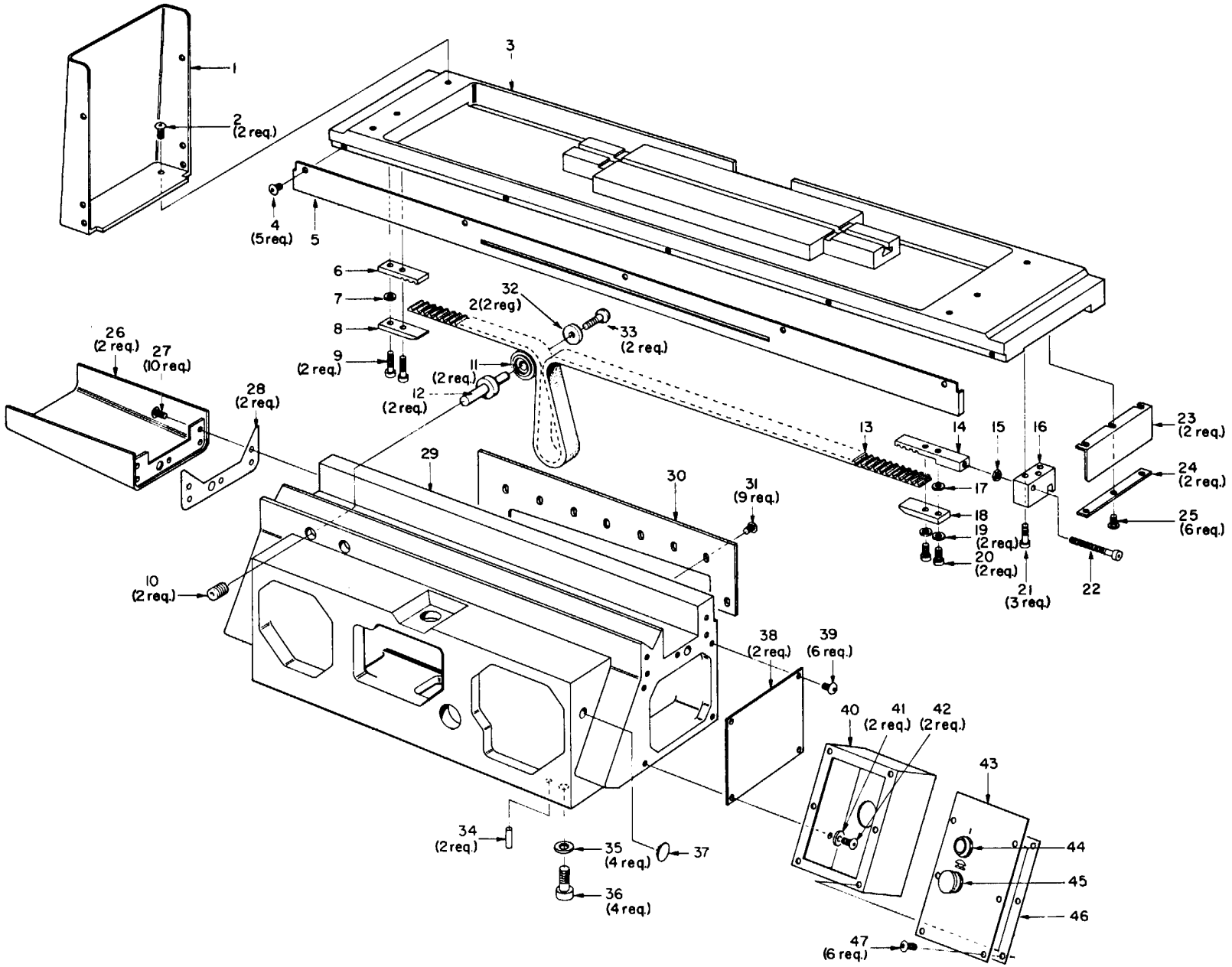

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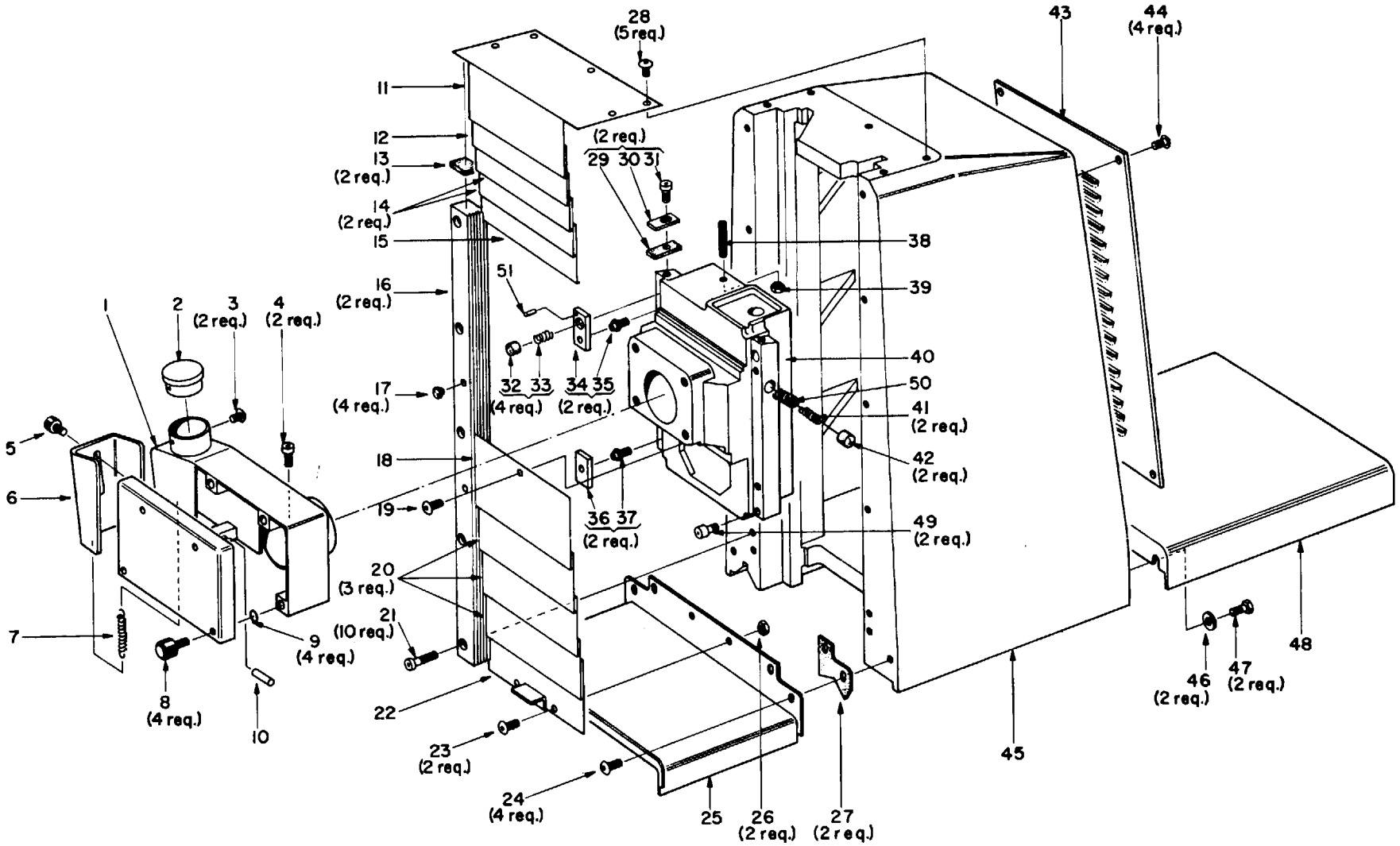
TABLE AND TABLE BED
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-4912	Splash Guard
2	92-53854320	Button Head Screw, 1/4"-20 x 5/8"
3	23-6784	Table (618 machines with hand table feed only)
	23-662	Table (618 machines with power table feed)
	23-6785	Table (818 machines with hand table feed only)
	23-6628	Table 1818 machines with power table feed)
4	92-5385-816	Button Head Screw, 1/4"-20 x 1/2"
5	23 1661	Table Front Guard
6	234827	Belt Support
7	92-2010-1202-24	Washer, 3/8" I.D. x 3/4" O.D. x 1/16"
8	234830	Belt Clamp
9	92-53801232	Socket Head Screw, 3/8"-16 x 1"
10	91-90-781	Plug
11	429-155	Roller
12	23-7418	Idler Pulley Shaft
13	442-76	Belt 23-666
14	234829	Belt Tension Plate
15	92-3015-1221	Nut, 38"16
16	23B2	Table Thrust Block
17	92-2010-1202- 24	Washer, 3/8" I.D. x 3/4" O.D. x 1/16"
18	234830	Belt Clamp
19	92-2010-1204-24	Washer, 3/8" I.D. x 3/4" O.D x 1/8"
20	92-5380-1224	Socket Head Screw, 3/8"-16 x 3/4"
21	92-5380-1236	Socket Head Screw, 3/8"-16 x 1 1/4"
22	92-5380-1260	Socket Head Screw, 3/8"-16 x 31/2"
23	234832	End Guard
24	23-4833	End Guard Strap
25	92-5385-816	Button Head Screw, 1/4"-20 x 1/2"
26	234834	Bed Extension
27	92-5385-820	Button Head Screw, 1/4" x 20 x 5/8"
28	23-5079	Bed Extension Gasket
29	23-6601	Table Bed
30	234836	Table Bed Guard (618 machines only)
		Table Bed Guard (818 machines only)
31	92-5385-816	Button Head Screw, 1/4" - 20 x 1/2"
32	92-2040-1204-32	Washer
33	92-5385-1232	Screw
34	924 1236	Dowel
35	92-2010-1604-34	Washer, 5/8" I.D. x 1 1/8" O.D x 1/8"'
36	92-5381-2048	Socket Head Screw, 5/8"-1 1 x 2"
37	479-90	Plug Button (machines with hand cross feed only)
38	23-4799	Bed End Plate
39	92-5385-816	Button Head Screw, 1/4"-20 x 1/2"
40	236512	Control Box
41	92-2040-802- 20	Washer
42	92-5385-828	Button Head Screw, 1/4"-20 x 7/8"
43	8842	Control Plate
44	412-343	Pushbutton Cap
	412-342	Pushbutton Operator
	412-346	Contact Block
45	412-345	Mushroom Pushbutton Cap
	412-344	Pushbutton Operator
	412-347	Contact Block
46	23-6511	Control Plate Gasket
47	925385-612	Button Head Screw, #10-32 x 3/8"

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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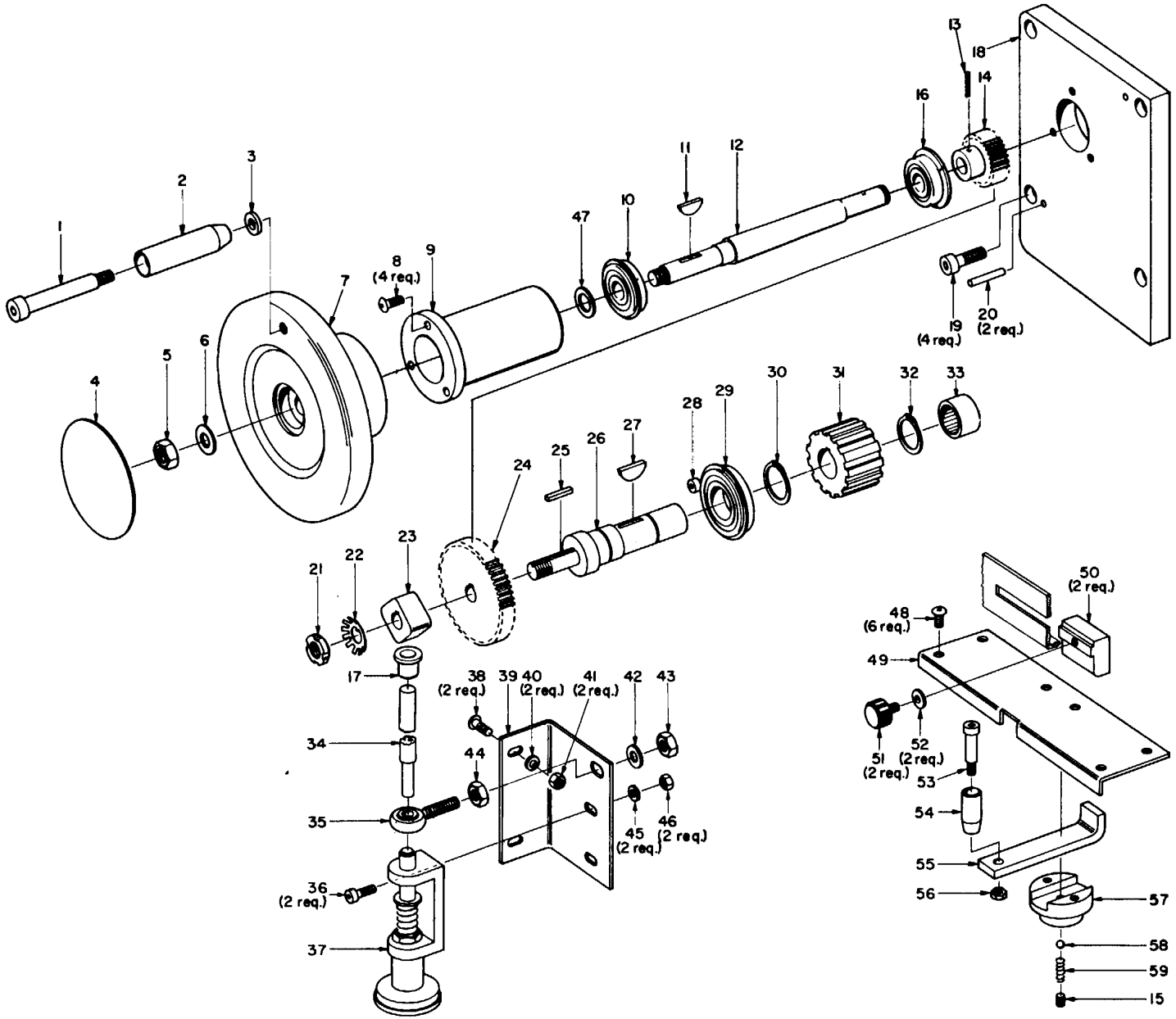
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-4721	Wheel Guard for 2" Wheel (includes 2 through 9)
2	23-6699	Exhaust Plug
3	92-5385-612	Button Head Screw, 10-32 x 318,
4	92-5380824	Socket Head Screw, 1/4"-20 x 3/4,'
5	8-5125-824	Thumb Screw
6	23-6700	Deflector
7	91-100-262	Spring
8	88-5125-1232	Thumb Screw
9	466-3601	O-ring
10	92-900-834	Pin (for 7 grinding wheels only)
11	234947	Elevating Screw Guard
12	23-5573	Elevating Screw Guard
13	2356087	Strap Filler
14	23-4709	Elevating Screw Guard
15	23-4710	Elevating Screw Guard
16	23-4719	Upright Strap
17	479-70	Plug Button
18	23-4711	Elevating Screw Guard
19	92-85-1012	Button Head Screw, 5/16" - 18 x 3/8,'
20	23-4709	Elevating Screw Guard
21	92-5380-1240	Socket Head Screw. 3/8"-16 x 1 1/2"'
22	23-4712	Elevating Screw Guard
23	92-5385-612	Button Head Screw, #10-32 x 3/8"
24	92-5385-1216	Button Head Screw, 3/8"-16 x1/2"
25	23-4946	Splash Guard
26	92-6010	Nut, #10-32
27	23-4941	Splash Guard Gasket
28	92-5385-1012	Button Head Screw, 5/16"-18 x 1/2"
29	23-4672	Felt Wiper
30	23-5225	Wiper Plate
31	92-538D-1024	Socket Head Screw, 5/16"-18 x 3/4"
32	23-6612	Stabilizer Button
33	47 703	Spring
34	23-6611	Spindle Head Gib
35	23-7278	Adjusting Screw
36	23-6610	Spindle Head Gib
37	23-7278	Adjusting Screw
38	92-5071-1049	Headless Set Screw, 5/16"-18x21/8'
39	92-6015-1012	Nut, 5/16"-18
40	23-4720	Spindle Head (618 machines only)
	236609	Spindle Head (818 machines only)
41	92-1000-2436-15	Spring
42	23-4956	Stabilizer Button
43	23-4715	Upright Rear Cover
44	92-5385-1216	Button Head Screw, 3/8"-16 x 1/2"
45	23-6022	Upright
46	92-2010-1204-32	Washer, 3/8" I.D. x 1" O.D x 1/8"
47	92-5385-1224	Hex Head Screw, 3/8"-16 x 3/4"
48	23-6012	Base Ways Guard
49	429-238	Roller
50	92-1000-1636-17	Spring
51	92-900-420	Pin

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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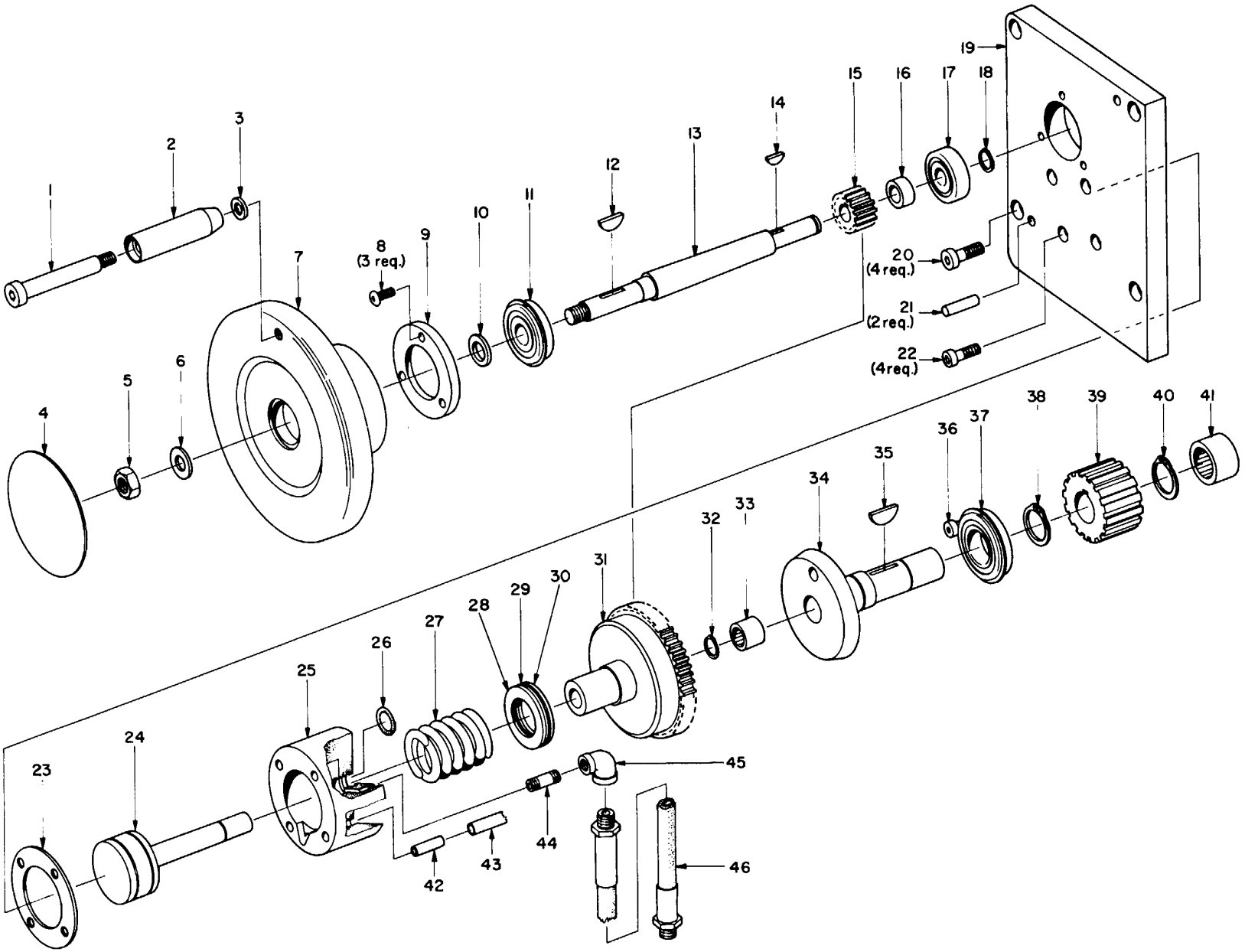
HAND TABLE FEED MECHANISM
AND LUBRICATING PUMP
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	472-1044	Shoulder Screw
2	88-5805-16	Handwheel Handle
3	23-7332	Washer, 3/8” I.D. x 5/8" O.D. x 1/8"
4	23-6676	Handwheel Insert
5	926015-1620	Nut, 1/2"-13
6	92-2010-1604-32	Washer, 1/2" I.D. x 1" O.D. x 1/8"
7	23-7057	Handwheel
8	92-5380-328	Button Head Screw, 1/4"-20 x 5/8"
9	23-7247	Bearing Retainer
10	437-15	Ball Bearing
11	92-980-628	Key
12	23-7248	Handwheel Shaft
13	92-902-1228	Pin
14	23-7252	Pinion, 2 7/8" Table Travel
	23-7250	Pinion, 2" Table Travel
	23-7254	Pinion, 3 1/2" Table Travel
15	472-229	Set Screw
16	437-15	Ball Bearing
17	421-875	Bronze Bearing
18	23-7260	Handwheel Bracket
19	92-5380-1232	Socket Head Screw, 3/8"-16 x 1,
20	92-900-1038	Pin
21	92-043-19	Lock Nut
22	92-2031-19	Lock Washer
23	234906	Pump Cam
24	23-7253	Gear, 2 7/8" Table Travel
	23-7251	Gear, 2" Table Travel
	23-7259	Gear, 3 1/2" Table Travel
25	92-970432	Key
26	234806	Table Drive Shaft
27	92-980-832	Key
28	92-5380816	Socket Head Screw, 1/4"-20x 1/2"
29	4374451	Ball Bearing
30	429-1476	Retaining Ring
31	23-4807	Belt Sprocket
32	429-1475	Retaining Ring
33	422-32	Needle Bearing
34	23-4909	Pump Operating Rod
35	429-129	Rod End Bearing
36	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"
37	461-180	Lubricating Pump
38	92-5385-824	Button Head Screw, 1/4" x 20 x 3/4"
39	23-4911	Pump Bracket
40	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"
41	926015-814	Nut, 1/4"-20
42	92-2010-1202-24	Washer, 3/8" 1.D. x3/4" O.D. x 1/16"
43	472-568	Nut
44	472-568	Nut
45	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"
46	926015814	Nut, 1/4"-20
47	23-7249	Washer, 5/8" I.D. x 1" O.D. x 1/16"
48	92-5385-816	Button Head Screw, 1/4"-20 x 1/2"
49	23-6663	Cover Plate
50	23-6680	Table Dog
51	23-6772	Thumb Screw
52	92-2040-802-20	Washer
53	472-1050	Shoulder Screw
54	88-5805-10	Stop Handle
55	23-662	Feed Stop
56	92-6015810	Nut, 1/4"-20
57	236681	Stop Retainer
58	429-1293	Steel Ball
59	92-1000620-22	Spring

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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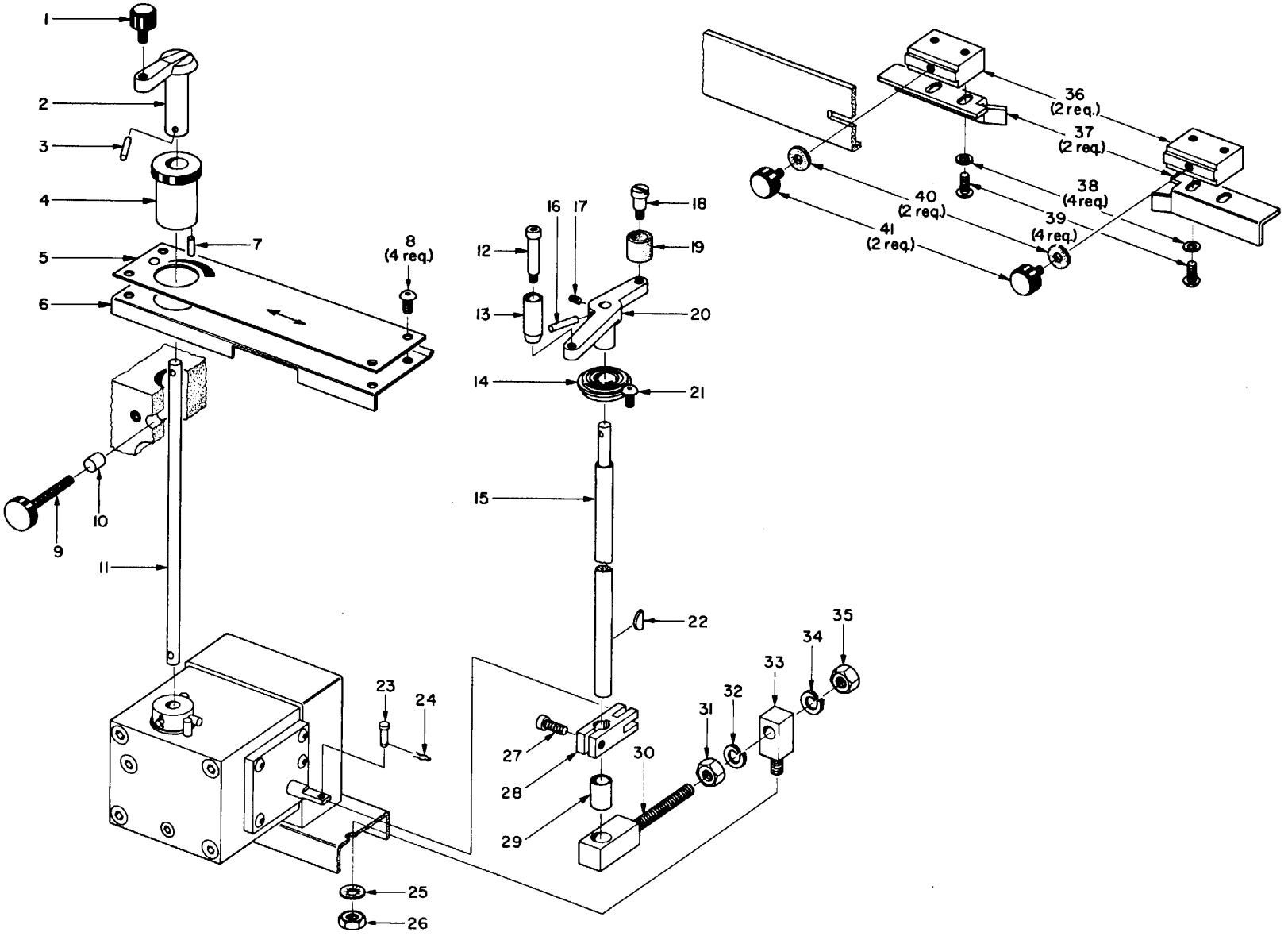
POWER TABLE FEED HANDWHEEL
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	472-1044	Shoulder Screw
2	88-5805-16	Handwheel Handle
3	23-7332	Washer, 3/8" I.D. x 5/8" O.D. x 1/8"
4	23-6676	Handwheel Insert
5	92-6015-1620	Nut, 1/2"-13
6	92-2010-1604-32	Washer, 1/2" I.D. x 1" O.D. x 1/8"
7	23-6634	Handwheel
8	92-5385-820	Button Head Screw, 1/4"-20 x 5/8"
9	23-6655	Bearing Retainer
10	92-2040-200432	Washer
11	437-1467	Ball Bearing
12	92-980-628	Key
13	234901	Handwheel Shaft
14	92-980-420	Key
15	23-6650	Pinion
16	23-6652	Pinion Spacer
17	434-7	Ball Bearing
18	429-45	Retaining Ring
19	23-6646	Handwheel Bracket
20	92-5380-1232	Socket Head Screw, 3/8"-16 x 1"
21	92-900-1034	Pin
22	92-5381-1032	Socket Head Screw, 5/16"-18 x 1"
23	23-6658	Cylinder Gasket
24	23-6649	Piston
25	23-6648	Handwheel Cylinder
26	466-3620	O-ring
27	236792	Clutch Spring
28	438-32	Thrust Bearing Race
29	438-7	Needle Thrust Bearing
30	438-32	Thrust Bearing Race
31	23-6639	Clutch and Gear
32	429-241	Retaining Ring
33	422-62	Needle Bearing
34	23-4804	Clutch Plate
35	92-980-832	Key
36	92-5380-816	Socket Head Screw, 1/4"-20 x 1/7’
37	437-4451	Ball Bearing
38	429-1476	Retaining Ring
39	23-4807	Belt Sprocket
40	429-1475	Retaining Ring
41	422-32	Needle Bearing
42	92-2450-1032	Tube
43	464-275	Plastic Tube (order in inches)
44	92-2440-432	Nipple, 1/8" N.P.T. x 1"
45	463-788	90” Reducing Elbow, 1/4" x 1/8”
46	463-46	Hose Assembly

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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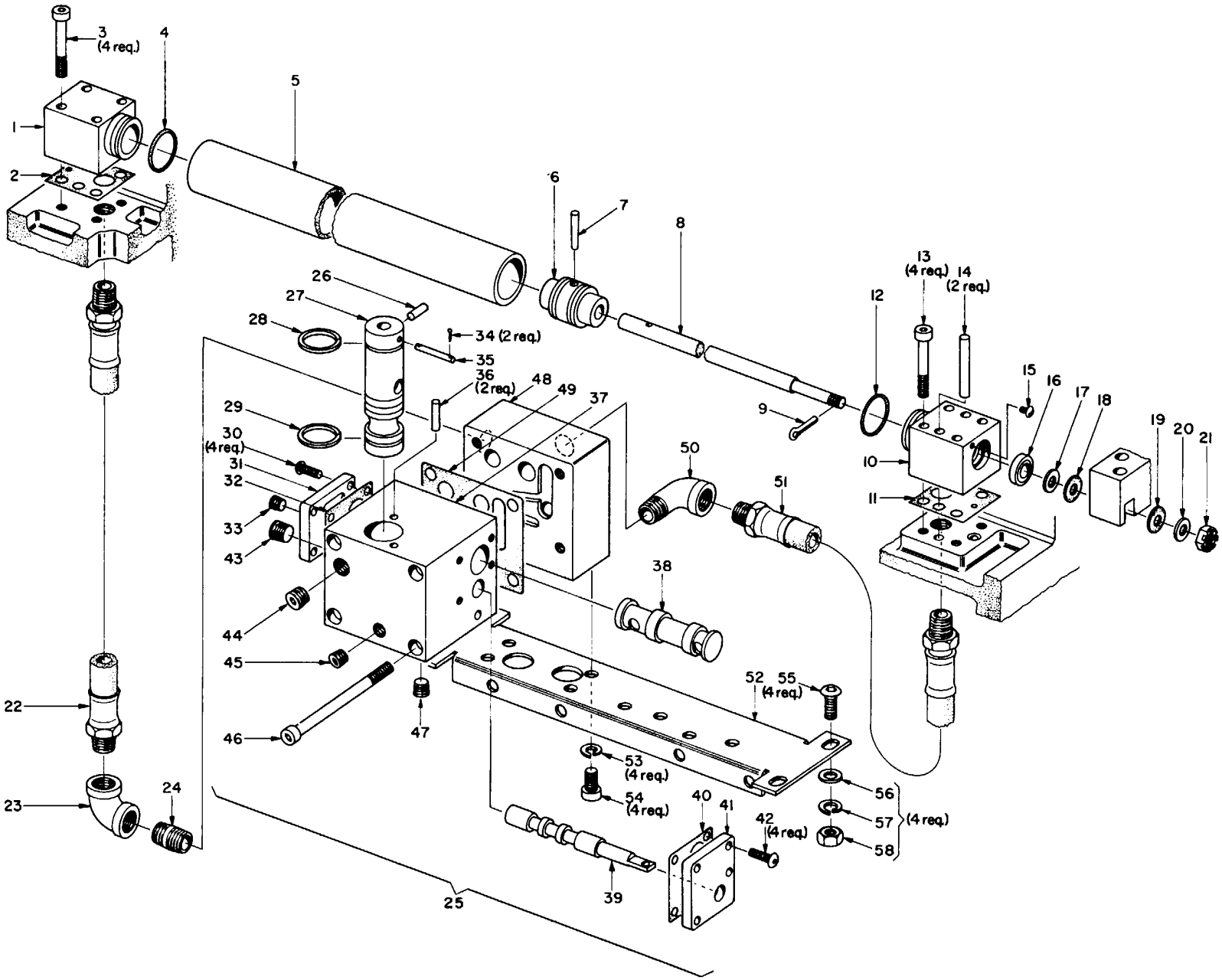
POWER TABLE FEED CONTROLS
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	88-5125-816	Knob
2	23-4814	Throttle Lever (includes 1)
3	92-900-628	Pin
4	234816	Throttle Adjusting Bushing (includes 7)
5	8841	Instruction Plate
6	23-6672	Throttle Lever Cover
7	92-90D-420	Pin
8	9235-816	Button Head Screw, 1/4"-20 x 1/2"
9	88-5128-850	Throttle Adjusting Screw
10	92-930-1312	Throttle Adjusting Shoe
11	234815	Throttle Shaft
12	472-1050	Shoulder Screw
13	88-5805-10	Handle
14	437-3	Ball Bearing
15	23-4819	Reversing Shaft
16	92-900-432	Pin
17	92-5390608	Cup Point Set Screw, #10-32 x 1/4”
18	92-5270-816	Shoulder Screw
19	23-6659	Contact Roller
20	23-4818	Reversing Lever (includes 12,13, 17,18, 19)
21	92-5385-816	Button Head Screw, 1/4"-20 x 1/2"
22	92-980420	Key
23	23-4821	Pin
24	472-199	Hair Cotter Pin
25	472-1040	Lockwasher
26	92-6015-1224	Nut, 3/8"-16
27	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"
28	23-4820	Lever
29	421-807	Bushing
30	23-4822	Support Block (includes 29)
31	92-6015-1224	Nut, 3/8"-16
32	92-2030-12	Lockwasher, 3/8"
33	23-6620	Support Block Pivot
34	92-2030-12	Lockwasher, 3/8"
35	92-6015-1224	Nut, 3/8"-16
36	23-4824	Table Dog Carrier
37	23-6788	Table Dog
38	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"
39	472-703	Screw
40	472-986	Nylon Washer
41	23-6772	Thumb Screw

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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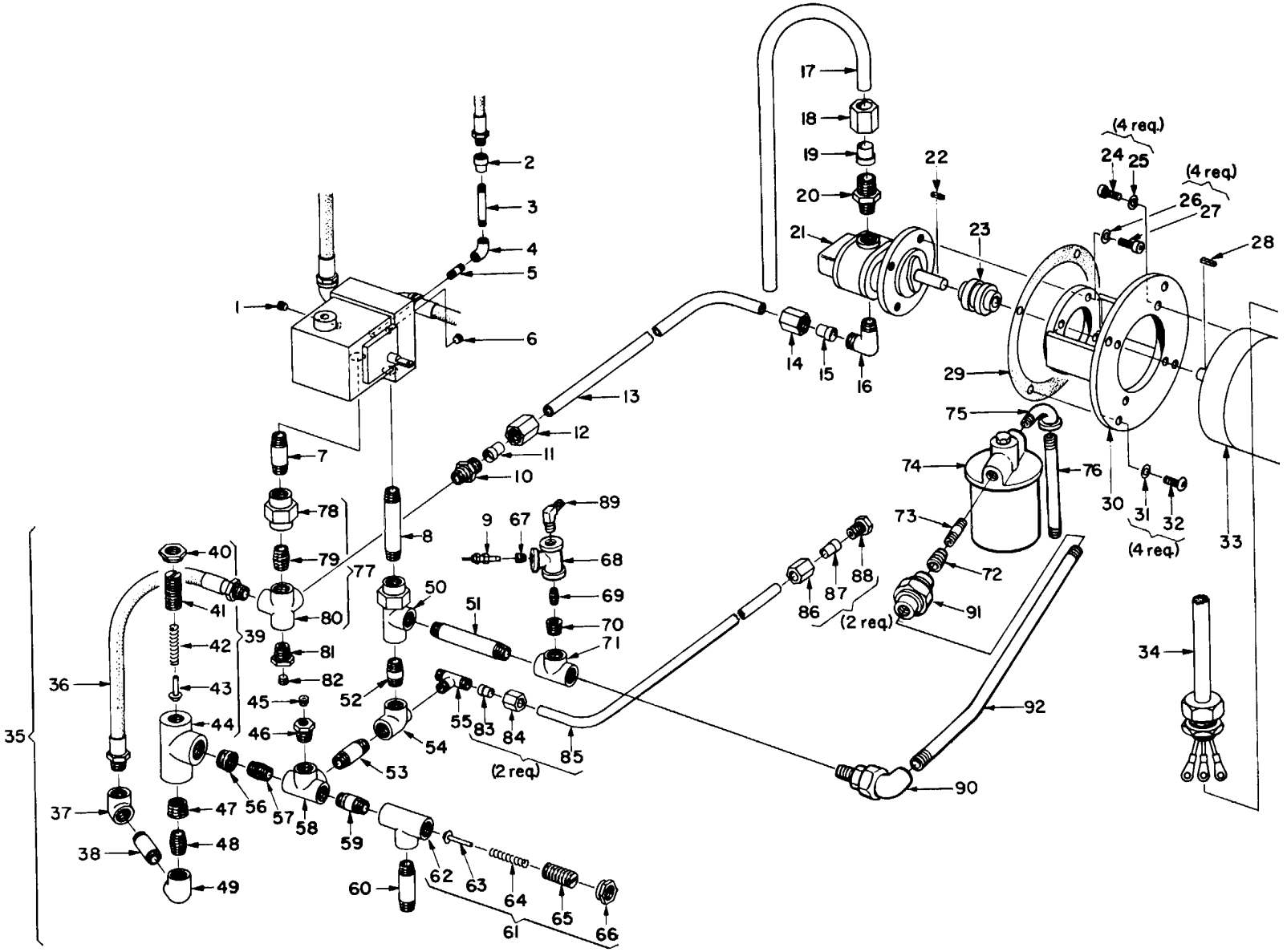
POWER TABLE FEED
CYLINDER AND VALVE
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-4795	Left Cylinder Head
2	23-4798	Cylinder Head Gasket
3	92-5381-1050	Socket Head Screw, 5/16"-18 x 2 1/4"
4	466-71	O-ring
5	23-4792	Cylinder
6	23-4793	Piston
7	92-890-322	Taper Pin
8	23-4794	Piston Rod
9	92-5990-632	Cotter Pin
10	23-4797	Right Cylinder Head
11	23-4798	Cylinder Heed Gasket
12	466-71	O-ring
13	92-5381-1050	Socket Head Screw, 5/16"-18 x 2 1/4"
14	92-900-1032	Pin
15	21-5418	Screw
16	466-3945	Oil Seal
17	92-2010-1202-24	Washer, 3/8"' I.D. x 3/4" O.D. x 1/16"
18	23-5184	Nylon Washer
19	23-5184	Nylon Washer
20	92-2010-1202-24	Washer, 3/8" I.D. x 3/4" O.D. x 1/16"
21	92-6013-12	Hex Slotted Nut, 3/8"-16
22	463-47	Hose Assembly
23	463-752	90° Pipe Elbow, 1/2" N.P.T.
24	92-2440-1648	Nipple, 1/2" N.P.T. x 2"
25	23-4957	Table Feed Valve (Includes 26 through 42)
26	92-900-820	Pin
27	23-4892	Throttle Piston
28	429-44	Retaining Ring
29	429-44	Retaining Ring
30	92-5385-824	Button Head Screw, 1/4"-20 x 3/4"
31	23-4898	Left Valve End Cover
32	23-4899	End Cover Gasket
33	463-698	Plug, 1/8" N.P.T.
34	92-5990-416	Cotter Pin
35	23-4878	Piston Pin
36	92-900-832	Pin
37	23-4888	Valve Body
38	23-4890	Control Piston
39	23-4891	Reversing Piston
40	23-4897	End Cover Gasket
41	23-4896	Right End Cover
42	92-5385-824	Button Head Screw, 1/4"-20 x 3/4’
43	463-697	Plug, 1/2" N.P.T.
44	463-697	Plug, 1/2" N.P.T.
45	463-696	Plug, 1/4" N.P.T.
46	472-3525	Screw
47	463-696	Plug, 1/4" N.P.T.
48	23-6615	Valve Subplate
49	23-4889	Valve Gasket
50	463-778	Street Elbow, 1/2" N.P.T.
51	463-48	Hose Assembly
52	23-6614	Valve Mounting Bracket
53	92-2030-12	Lockwasher, 3/8"
54	92-5380-1224	Socket Head Screw, 3/8"-16 x 3/4"
55	92-5385-1224	Button Head Screw, 3/8"-16 x 3/4"
56	23-3773	Adjustable Washer
57	92-2030-12	Lockwasher, 3/8"
58	92-6015-1214	Nut, 3/8"-16

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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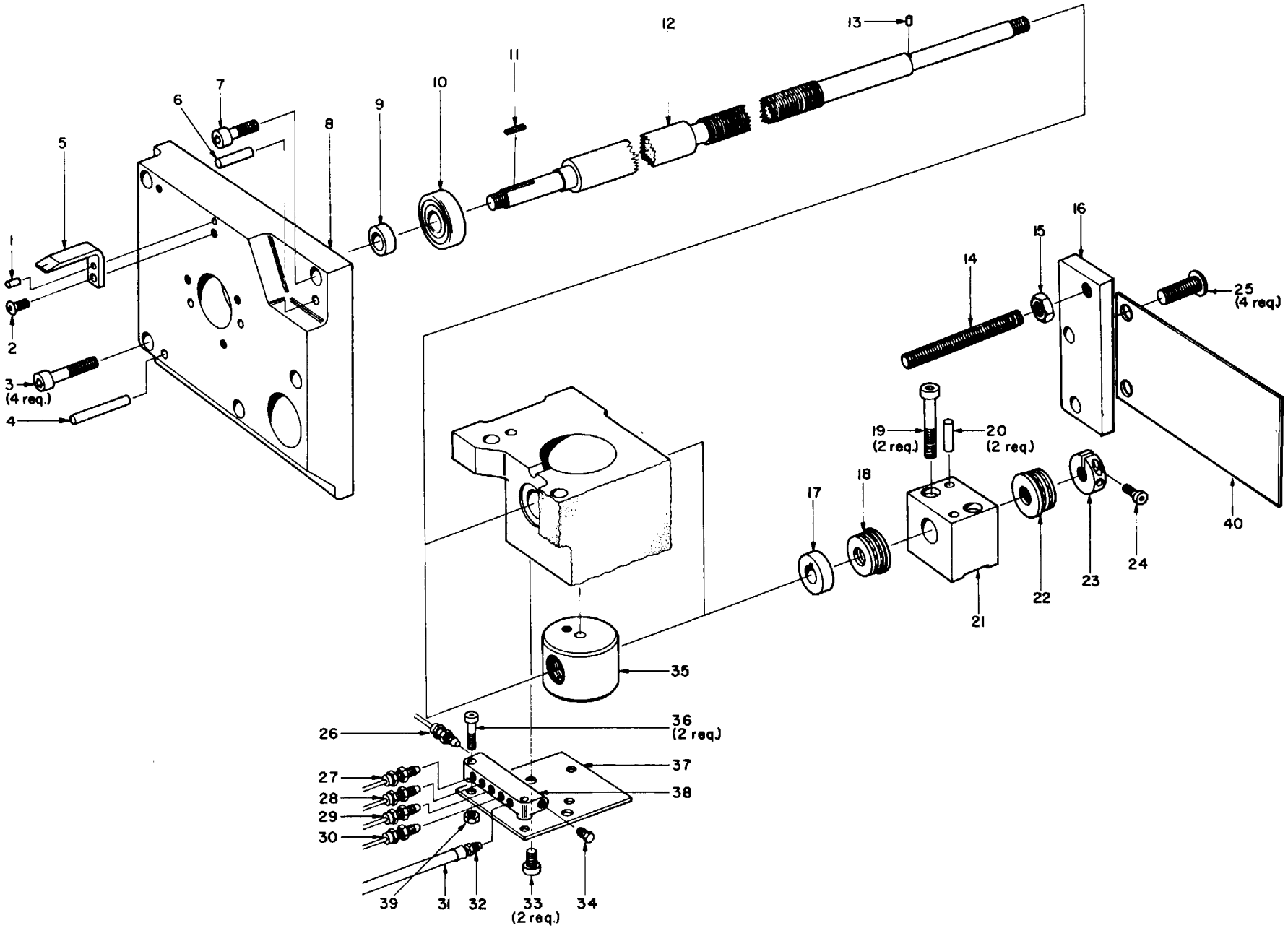
POWER TABLE FEED
HYDRAULIC SYSTEM

INDEX NO.	PART NO.	PART NAME
1	463-698	Pipe Plug, 1/8" N.P.T
2	463-3772	Reducer Coupling, 1/4" x 1/8" N.P.T
3	92-2440-456	Nipple, 1/8" N.P.T. x 3"
4	463-3771	90° Elbow, 1/8" N.P.T
5	92-2440-424	Nipple, 1/8" N.P.T. x 3/4"
6	463-698	Pipe Plug, 1/8" N.P.T
7	92-2440-1648	Nipple, 1/2" N.P.T. x 2"
8	92-2440-1664	Nipple, 1/2" N.P,T. x4"
9	461-3935	Adapter
	461-950	Compress Nut
	461-951	Sleeve
10	464-3680	Connector
11	464-670	Sleeve
12	464-672	Coupling Nut
13	464-130	Aluminum Tubing, 5/8" O.D. (order in inches)
14	464-672	Coupling Nut
15	464-670	Sleeve
16	464-3986	90° Elbow
17	464-131	Aluminum Tubing, 3/4" O.D. (order in inches)
18	464-678	Coupling Nut
19	464-674	Sleeve
20	464-3693	Connector
21	123-618-503	Rotary Gear Pump
22	92-970-624	Key
23	473-139	Flexible Coupling
24	92-5380-1232	Socket Head Screw, 3/8"-16 x 1"
25	92-2030-12	Lockwasher, 3/8" I.D.
26	92-2030-12	Lockwasher, 3/8" I.D.
27	92-5380-1232	Socket Head Screw, 3/8"-16 x 1"
28	92-970-624	Key
29	23-6605	Mounting Bracket Gasket
30	23-6604	Pump and Motor Mounting Bracket
31	92-2010-1202-24	Washer., 3/8" I.D. x 3/4" O.D. x 1/16"
32	92-5385-1232	Button Head Screw, 3/8"-16 x 1"
33	401-120	Motor
34	23-4928-3	Motor Cable, Complete
35	23-6582-1	Oil Filter Assembly (includes 37 through 76)
36	463-468	Hose Assembly
37	463-752	90° Elbow, 1/2" N.P.T
38	92-2440-1664	Nipple, 1/2" N.P.T. x 4"
39	23-4951	High Pressure Relief Valve (includes 40 through 44)
40	91-101-47	Check Nut
41	213-3-783	Adjusting Screw
42	92-1000-1656-13	Spring
43	213-3-786	Plunger
44	23-5083	Body
45	463-696	Pipe Plug, 1/4" N.P.T
46	463-787	Reducing Bushing, 1/2" x 1/4" N.P.T. 1672
47	463-3789	Reducing Bushing, 3/4" x 1/2" N.P.T.
48	92-2440-1634	Nipple, 1/2" N.P.T. x 1-1/8"
49	463-752	90° Elbow, 1/2" N.P.T.
50	463-49	Tee Female Union,. 1/2" N.P.T,
51	92-2440-1672	Nipple, 1/2" NP.T. x 5"
52	92-2440-1640	Nipple, 1/2" N.P.T. x 1-1/2"
53	92-2440-1652	Nipple, 1/2" N.P.T. x 2-1/2"
54	463-84	Reducing Tee, 1/2" x 1/4" x 1/2" N.P.T.
55	464-52	Tee
56	463-3789	Reducing Bushing, 3/4" x 1/2" N.P.T
57	92-2440-1634	Nipple, 1/2" N.P.T. x 1-1/8"
58	463-799	Side Outlet Tee, 1/2" N.P.T
59	92-2440-1640	Nipple, 1/2" N.P.T. x 1-112"
60	92-2440-1656	Nipple, 1/2" N.P.T. x 3"
61	23-4796	Low Pressure Relief Valve (includes 62 through 66)
62	213-9001-2201	Body
63	213-9001-2207	Plunger
64	92-1000-1652-17	Spring
65	213-3-783	Adjusting Screw
66	91-101-47	Check Nut
67	463-786	Reducing Bushing, 1/4" x 1/8" N.P.T.
68	463-764	Tee, 1/4" N.P.T.
69	92-2440-828	Nipple, 1/4" N.P.T. x 7/8"
70	463-365	Reducing Bushing, 1/2" x O 1/4" N.P.T.
71	463-759	Tee, 1/2" N.P.T.
72	463-3752	Reducing Bushing, 1/2' x 3/8" N.P.T.
73	92-2440-1236	Nipple, 3/8" N.P.T. x 1-1/4"
74	461-85	Oil Filter (filter cartridge obtainable separately)
75	463-27	Reducing Street Elbow, 1/2" x 3/8" N.P.T.
76	92-2440-1672	Nipple, 1/2" N.P.T. x 5"
77	23-6712	High Pressure Piping Assembly (includes 78, 79, 80)
78	463-3793	Female Union, 1/2" N.P.T.
79	92-2440-1634	Nipple, 1/2" N.PT. x 1-1/8"
80	463-799	Side Outlet Tee, 1/2" N.P.T.
81	463-787	Reducing Bushing, 1/2" x 1/4" N.P.T.
82	463-696	Pipe Plug, 1 /4" N.P.T.
83	464-628	Sleeve
84	464-629	Coupling Nut
85	464-126	Aluminum Tubing, 1/4" O.D. (order length in inches)
86	464-629	Coupling Nut
87	464-628	Sleeve
88	23-6796	Orifice
89	464-665	90° Adapter
90	463-779	1/2" Union Elbow
91	463-3793	1/2" Female Union
92	23-7211	Low Press. Filter Pipe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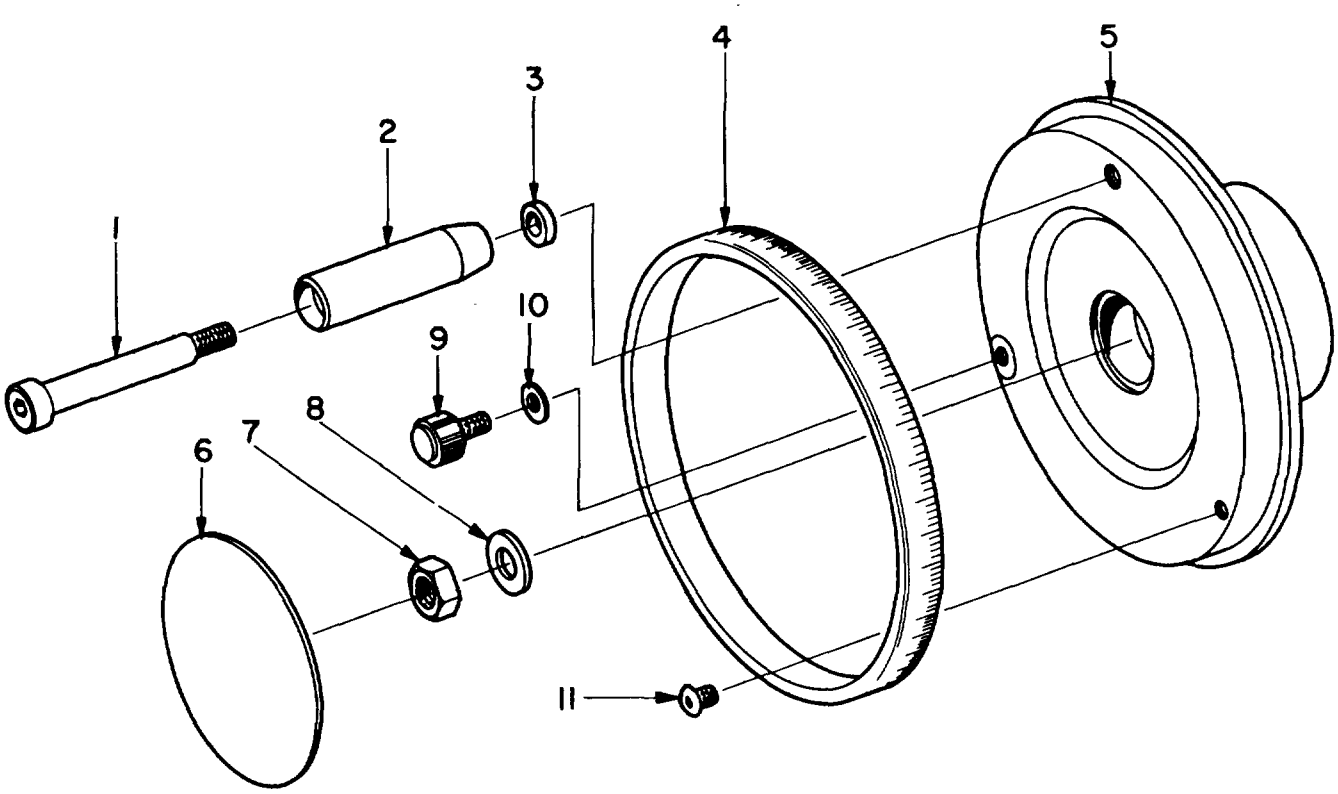
HAND CROSS FEED MECHANISM
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	92-900-614	Pin
2	92-5385-820	Button Head Screw, 1/4"-20 x 5/8"
3	92-5380-1248	Socket Head Screw, 3/8"-16 x 2"
4	92-900-1050	Pin
5	23-6657	Pointer
6	92-900-1038	Pin
7	92-5380-1236	Socket Head Screw, 3/8"-16 x 1 1/4"
8	23-4837	Handwheel Bracket
9	23-5052	Handwheel Spacer
10	434-1167	Ball Bearing
11	92-970-624	Key
12	23-4838	Cross Feed Screw, English (includes 13)
	23-5571	Cross Feed Screw, Metric (includes 13)
13	92-900-406	Pin
14	23-6627	Cross Feed Stop (618 machines only)
	23-6708	Cross Feed Stop (818 machines only)
15	92-6015-1620	Nut, 1/2"-13
16	23-7172	Mounting Plate
17	23-6218	Bearing Spacer
18	438-74	Thrust Ball Bearing
19	92-5380-1250	Socket Head Screw, 3/8"-16 x 2 1/4"
20	92-900-1032	Pin
21	23-6222	Cross Feed Screw Rear Support
22	438-74	Thrust Ball Bearing
23	23-6219	Nut (includes 24)
24	92-5380-624	Socket Head Screw, #10-32 x 3/4"
25	472-312	Button Head Screw
26	461-21	# 5 Meter Unit
	461-918	Compress Nut
	461-919	Sleeve
27	461-3951	#0 Meter Unit
	461-918	Compress Nut
	461-919	Sleeve
28	461-3951	#0 Meter Unit
	461-918	Compress Nut
	461-919	Sleeve
29	461-21	#5 Meter Unit
	461-918	Compress Nut
	461-919	Sleeve
30	461-21	#5 Meter Unit
	461-918	Compress Nut
	461-919	Sleeve
31	464-7	Hose Assembly
32	461-951	Compress Sleeve
	461-953	Compress Bushing
33	92-5380-1016	Socket Head Screw, 5/16"-18 x 1/2"
34	461-974	Plug
35	23-4949	Cross Feed Nut
36	92-5380-832	Socket Head Screw, 1/4"-20 x 1"'
37	23-4691	Junction Bar Mounting Plate
38	461-967	Junction Bar
39	92-6015-814	Nut, 1/4"-20
40	23-7173	Cover

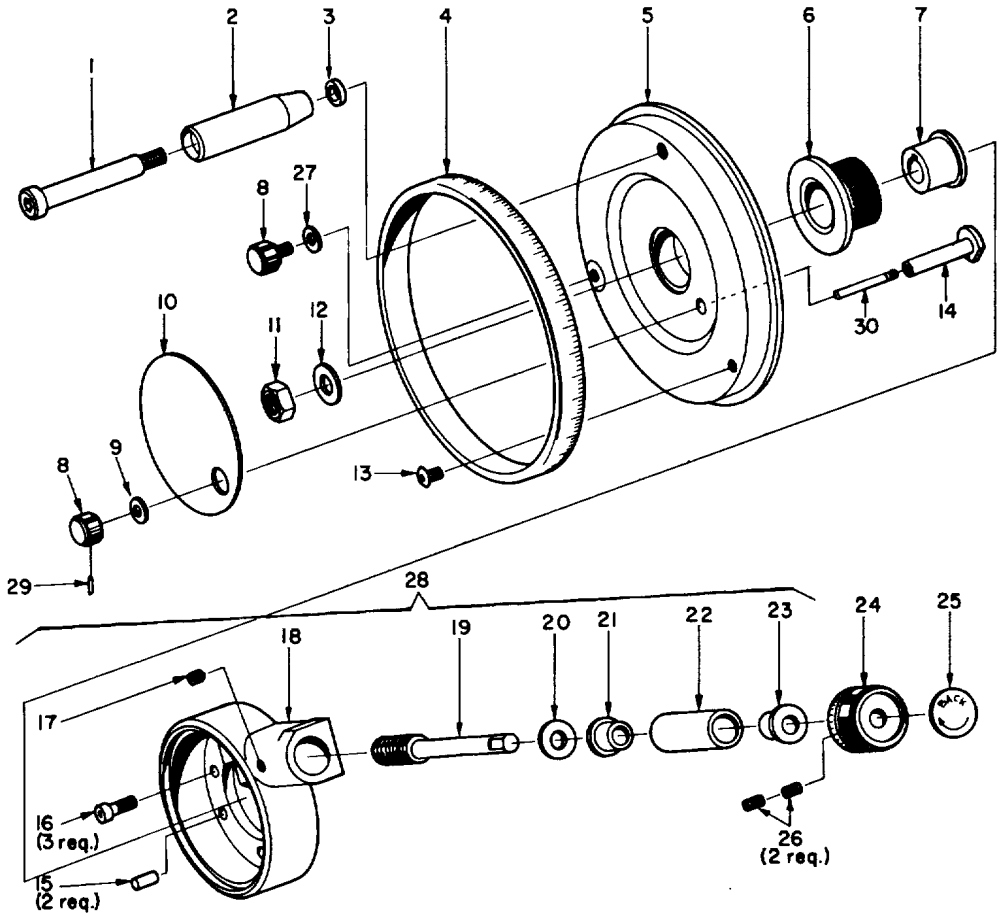
ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE



CROSS FEED HANDWHEEL
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	472-1044	Shoulder Screw
2	88-5805-16	Handwheel Handle
3	23-7332	Washer, 3/8" I.D. x 5/8" O.D. x 1/8"
4	23-6644	Cross Feed Indicator Ring, English
	23-6645	Cross Feed Indicator Ring, Metric
5	23-6635	Handwheel
6	23-6676	Handwheel Insert
7	92-6015-1620	Nut, 1/2"-13
8	92-2010-1604-32	Washer, 1/2" I.D. x 1" O.D. x 1/16"
9	88-5125-816	Clamp Knob
10	23-7333	Washer
11	92-5385-812	Button Head Screw, 1/4"-20 x 3/8"

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE

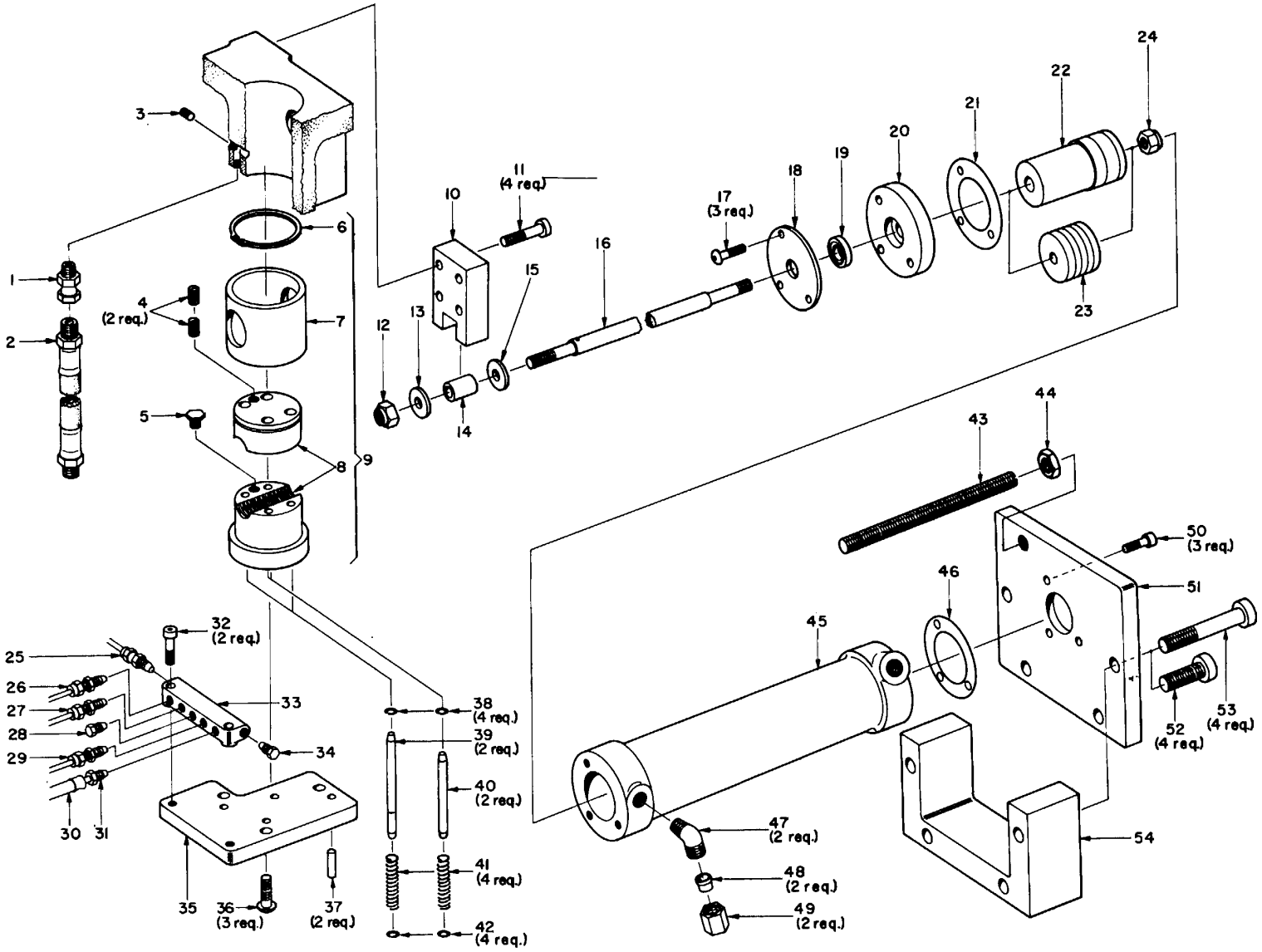


CROSS FEED AND VERTICAL FEED HANDWHEELS
WITH FINE FEED MECHANISM
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	472-1044	Shoulder Screw
2	88-5805-16	Handwheel Handle
3	23-7332	Washer, 3/8" I.D. x 518" O.D. x 1/8"
4	23-6644	Cross Feed Indicator Ring, English
	23-6645	Cross Feed Indicator Ring, Metric
	23-6642	Elevating Indicator Ring, English
	23-6643	Elevating Indicator Ring, Metric
5	23-6608	Handwheel
6	23-5051	Worm Gear
7	23-5010	Worm Gear Bushing
8	88-5725-6	Clamp Knob
9	472-1144	Washer
10	23-6677	Handwheel Insert
11	92-6015-1620	Nut, 1/2"-13
12	92-2010-1604-32	Washer, 1/2" I.D. x 1" O.D. x 1/16"
13	92-5385-812	Button Head Screw, 1/4"-20 x 3/8"
14	23-6656	Clamp Bolt (includes 8, 9 & 30)
15	92-900-820	Pin
16	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"

INDEX NO.	PART NO.	PART NAME
17	472-3553	Set Screw
18	23-6637	Handwheel Bracket Extension
19	23-6653	Worm
20	92-2010-1404-28	Washer, 7/16" I.D. x 7/8" O.D. x 1/8"
21	23-5351	Worm Bushing Spacer (includes 21 & 23)
22	23-5351	Worm Bushing Spacer (includes 21)
23	421-36	Worm Bushing
24	23-6668	Fine Cross Feed Dial, English
	23-6669	Fine Cross Feed Dial, Metric
	23-5046	Fine Elevating Dial. English
	23-5564	Fine Elevating Dial, Metric
25	23-6675	Dial Insert, Cross Feed
	23-6674	Dial Insert, Elevating
26	92-5390-608	Cup Point Set Screw, #10-32 x 1/4"
27	23-7333	Washer
28	23-6671	Handwheel Bracket Assembly (includes 17 thru 23)
29	92-902-420	Pin
30	23-7225	Clamp Stud

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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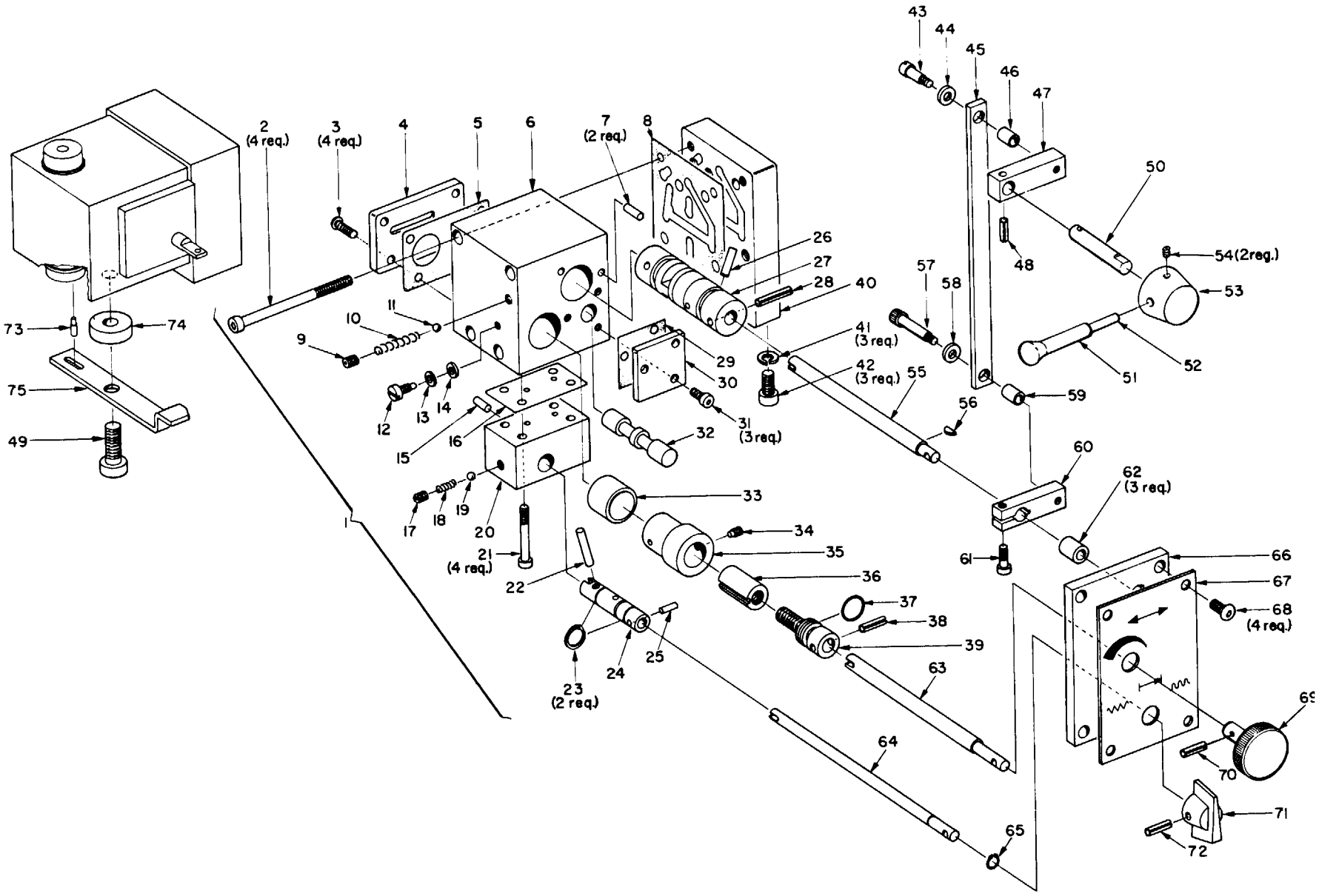
POWER CROSS FEED MECHANISM
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	463-284	Adapter Union
2	463-44	Hose Assembly
3	91-90-719	Plug
4	92-5071-1016	Headless Set Screw, 5/16"-18 x 1/2"
5	23-6629	Cross Feed Nut Stop
6	429-240	Retaining Ring
7	23-6624	Cross Feed Nut Sleeve
8	23-4865	Cross Feed Nut, English
	23-5567	Cross Feed Nut, Metric
9	23-6632	Complete Cross Feed Nut, English (includes 4 through 8, 38 through 42)
	23-6633	Complete Cross Feed Nut, Metric (includes 4 through 8, 38 through 42)
10	23-4862	Piston Rod Block
11	92-5050-1040	Fillister Head Screw, 5/16"-18 x 1 1/2"
12	472-582	Stop Nut
13	92-2010-1204-32	Washer, 3/8" I.D. x 1" O.D. x 1/8"
14	23-4791	Piston Rod Spacer
15	92-2010-1204-32	Washer, 3/8" I.D. 1" O.D. x 1/8"
16	23-4789	Piston Rod
17	92-5385-832	Button Head Screw, 1/4"-20 x 1"
18	23-4954	Cylinder Cap Cover
19	466-3945	Oil Seal
20	23-4790	Cylinder Cap
21	23-4786	Cylinder Gasket
22	23-6625	Piston (618 machines only)
23	23-4788	Piston (818 machines only)
24	472-582	Stop Nut
25	461-21	#5 Meter Unit
	461-918	Compress Nut
	461-919	Sleeve
26	461-3951	#0 Meter Unit
	461-21	#5 Meter Unit (Dial-A-Size only)
	461-918	Compress Nut
	461-919	Sleeve
27	461-3951	#0 Meter Unit
	461-21	#5 Meter Unit (Dial-A-Size only)
	461-918	Compress Nut
	461-919	Sleeve
28	461-974	Plug
29	461-21	#5 Meter Unit
	461-918	Compress Nut
	461-919	Sleeve
30	464-7	Hose Assembly
31	461-951	Compress Sleeve
	461-953	Compress Bush
32	92-5380-832	Socket Head Screw, 1/4"- 20 x 1"
33	461-967	Junction Bar
34	461-974	Plug
35	23-4907	Retaining Plate
36	92-5385-1032	Button Head Screw,
37	92-900-828	Pin
38	429-239	Retaining Ring
39	23-6631	Long Guide Pin
40	23-6630	Short Guide Pin
41	92-1000-1250-18	Spring
42	429-239	Retaining Ring
43	23-6627	Cross Feed Stop
44	92-6015-1620	Nut, 1/2"-13
45	23-4787	Cross Feed Cylinder
46	23-4786	Cylinder Gasket
47	464-651	45, Elbow
48	464-653	Sleeve
49	464-654	Nut
50	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"
51	23-4780	Cylinder Mounting Plate
52	92-5050-1632	Fillister Head Screw, 1/2"-13 x 1" (618 machines only)
53	92-5050-1656	Fillister Head Screw, 1/2"-13 x 1" (818 machines only)
54	23-6626	Mounting Plate Spacer (818 machines only)

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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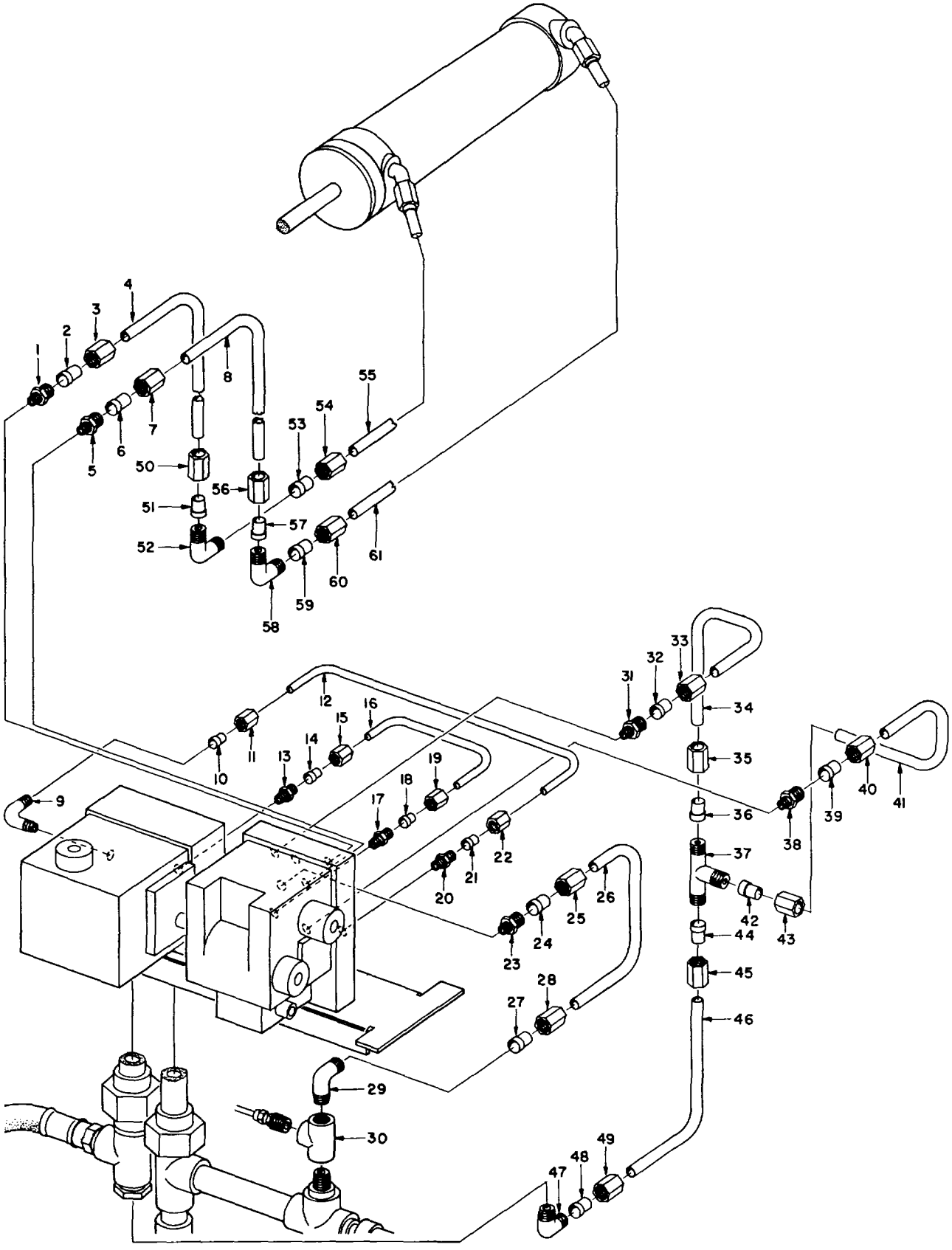
POWER CROSS FEED CONTROLS AND VALVES
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-4958	Cross Feed Valve (includes 3 through 39)
2	92-5381-1060	Socket Head Screw, 5/16"-18 x 3 1/2"
3	92-5385-824	Button Head Screw, 1/4"-20 x 3/4"
4	23-4880	Left Valve Cap
5	23-4881	Valve Cap Gasket
6	23-4875	Cross Feed Valve Body
7	92-900-824	Pin
8	23-4886	Valve Gasket
9	92-5390-1012	Cup Point Set Screw, 5/16"-18 x 3/8"
10	92-1000-840-19	Spring
11	429-1295	Steel Ball
12	92-5340-816-8	Screw
13	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"
14	472-817	Thread Seal Washer
15	92-900-824	Pin
16	23-4923	Valve Gasket
17	92-5390-1012	Cup Point Set Screw, 5/16"-18 x 3/8"
18	92-1000-816-20	Spring
19	429-1295	Steel Ball
20	23-4920	Rapid Positioning Valve Body
21	92-5380-844	Socket Head Screw, 1 /4"-20 x 1 3/4"
22	92-900-836	Pin
23	429-1496	Retaining Ring
24	23-4921	Valve Spool
25	92-902-1220	Roll Pin
26	92-900-834	Pin
27	23-4876	Valve Piston
28	92-902-1636	Roll Pin
29	23-4887	Valve Cap Gasket
30	23-4877	Right Valve Cap
31	472-540	Socket Head Screw
32	23-4879	Valve Piston
33	23-4883	Regulating Piston
34	92-5361-810-4	Set Screw
35	23-6617	Adjusting Nut Retainer
36	23-6618	Adjusting Nut
37	466-271	O-ring
38	92-902-1628	Roll Pin
39	23-6619	Regulator Screw Extension
40	23-6616	Valve Subplate
41	92-2030-12	Lockwasher
42	92-5080-1224	Socket Head Screw, 3/8"-16 x 3/4"
43	472-1109	Shoulder Screw
44	92-2040-1003-20	Washer
45	23-6664	Connecting Rod (includes 46 and 59)
46	421-118	Bronze Bushing
47	23-6665	Upper Clevis (incl 50 & 48)
48	92-902-824	Roll Pin
49	472-789	Self Locking Screw
50	23-7157	Pin
51	88-5855-12	Lever Handle
52	92-900-1232	Lever
53	23-7299	Lever Boss (includes 51 and 52)
54	472-229	Set Screw
55	23-4767	Directional Shaft
56	92-980-416	Key
57	472-1109	Shoulder Screw
58	92-2040-1003-20	Washer
59	421-118	Bronze Bushing
60	23-6670	Lower Clevis
61	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"
62	421-3809	Bronze Bushing
63	23-4771	Regulating Shaft
64	23-4925	Rapid Positioning Shaft
65	429-4485	Retaining Ring
66	23-6640	Aligning Plate (includes 62)
67	88-4-3	Rapid Positioning Plate
68	92-5385-1024	Button Head Screw, 5/16"-18x3/4"
69	23-7393	Knob, Cross Feed
70	92-902-824	Roll Pin
71	88-5865-12	Knob
72	92-902-824	Roll Pin
73	23-6104	Control Lever Pin
74	23-6103	Control Lever Collar
75	23-4926	Valve Control Lever

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE

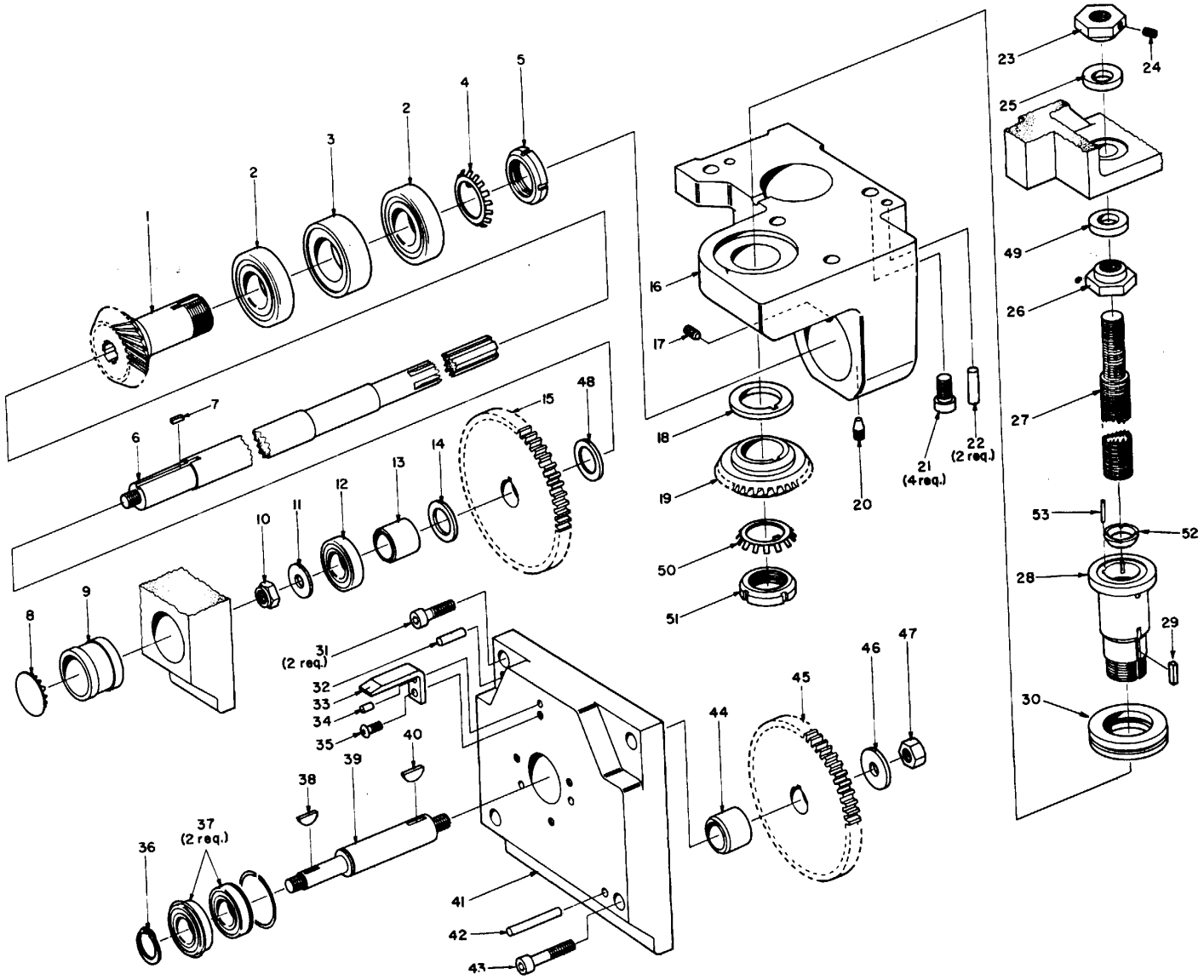


POWER CROSS FEED HYDRAULIC SYSTEM

POWER CROSS FEED HYDRAULIC SYSTEM
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	464-652	Connector
2	464-653	Sleeve
3	464-654	Coupling Nut
4	23-7136	Aluminum Tube, 3/8" O.D. (includes 2, 3, 50, 51)
5	464-652	Connector
6	464-653	Sleeve
7	464-654	Coupling Nut
8	23-7135	Aluminum Tube, 3/8" O.D. (includes 6, 7,56,57)
9	464-3	90° Elbow
10	464-628	Sleeve
11	464-629	Coupling Nut
12	23-7141	Aluminum Tube, 1/4" O.D. (includes 10, 11, 21, 22)
13	464-626	Connector
14	464-628	Sleeve
15	464-629	Coupling Nut
16	23-7140	Aluminum Tube, 1/4" O.D. (includes 14,15,18,19)
17	464-626	Connector
18	464-628	Sleeve
19	464-629	Coupling Nut
20	464-626	Connector
21	464-628	Sleeve
22	464-629	Coupling Nut
23	464-652	Connector
24	464-653	Sleeve
25	464-654	Coupling Nut
26	23-7133	Aluminum Tube, 3/8" O.D. (includes 24, 25, 27, 28)
27	464-653	Sleeve
25	464-654	Coupling Nut
29	464-655	90° Elbow
30	463-764	Tee, 1/4" N.P.T.
31	464-652	Connector
32	464-653	Sleeve
33	464-654	Coupling Nut
34	23-7137	Aluminum Tube, 3/8" O.D. (includes 32,33,35, 36)
35	464-654	Coupling Nut
36	464-653	Sleeve
37	464-661	Tee
38	464-652	Connector
39	464-653	Sleeve
40	454-654	Coupling Nut
41	23-7138	Aluminum Tube, 3/8" O.D. (includes 39, 40, 42, 43)
42	464-653	Sleeve
43	464-654	Coupling Nut
44	464-653	Sleeve
45	464-654	Coupling Nut
46	23-7139	Aluminum Tube, 3/8" O.D. (includes 44, 46,48, 49)
47	464-655	90° Elbow
48	464-653	Sleeve
49	464-654	Coupling Nut
50	464-654	Coupling Nut
51	464-653	Sleeve
52	464-111	90° Elbow
53	464-653	Sleeve
54	464-654	Coupling Nut
55	23-7144	Aluminum Tube
56	464-654	Coupling Nut
57	464-653	Sleeve
58	464-111	90° Elbow
59	464-653	Sleeve
60	464-654	Coupling Nut
61	23-7145	Aluminum Tube

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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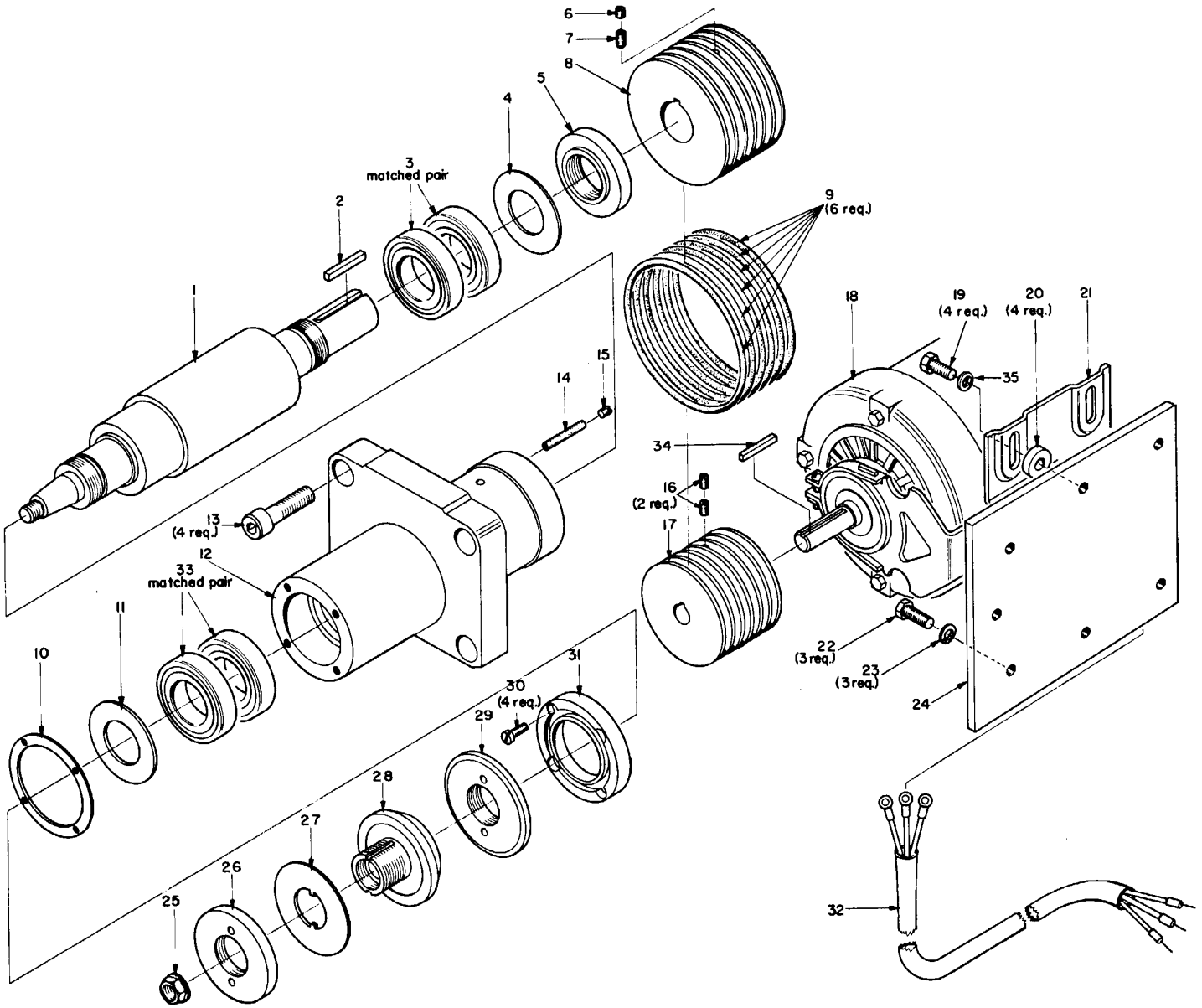
VERTICAL HAND FEED MECHANISM
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-6623	Screw Pinion
2	434-5	Ball Bearing
3	23-4861	Spacer
4	92-2031-38	Lock Washer
5	92-6043-38	Nut
6	23-4849	Elevating Driving Shaft
7	92-970-814	Key
8	479-206	Plug Button
9	23-8660	Bearing Spacer
10	472-588	Stop Nut
11	92-2040-1604-36	Washer
12	434-1164	Ball Bearing
13	23-4847	Collar
14	92-2010-3204-40	Washer, 1" I.D. x 1 1/2" O.D. x 1/8"
15	23-4848	Elevating Shaft Gear
16	23-4940	Feed Nut Bracket
17	92-5071-1016	Headless Set Screw, 5/16"-18 x 1/2"
18	23-6636	Nut Spacer
19	23-4939	Screw Gear
20	92-5370-1224	Set Screw
21	92-5380-1636	Socket Head Screw, 1/2"-13 x 1 1/4"
22	92-900-1238	Pin
23	23-6182	Clamp Nut
24	92-5390-808	Cup Point Set Screw, 1/4"-20 x 1/4"
25	92-2060-24	Washer
26	23-4718	Clamp Nut
27	23-4717	Elevating Screw, English
	23-5569	Elevating Screw, Metric
	23-7187	Elevating Screw, (Dial-A-Size only)
28	23-4735	Elevating Nut, English
	23-5565	Elevating Nut, Metric
29	92-970-624	Key
30	438-3	Thrust Ball Bearing
31	92-5380-1236	Socket Head Screw, 3/8"-16 x 1 1/4"
32	92-900-1038	Pin
33	23-6657	Pointer
34	92-900-614	Pin
35	92-5385-820	Button Head Screw, 1/4"-20 x 5/8"
36	429-1485	Retaining Ring
37	437-1471	Ball Bearing
38	92-980-624	Key
39	23-5049	Handwheel Shaft
40	92-980-828	Key
41	23-4840	Elevating Handwheel Bracket
42	92-900-1050	Pin
43	92-5380-1248	Socket Head Screw, 3/8"-16x 2'
44	23-5257	Bearing Retainer
45	23-5117	Elevating Handwheel Shaft Gear
46	92-2040-1604-40	Washer
47	472-599	Nut
48	92-2010-3204-40	Washer, 1" I.D. x 1 1/2" O.D. x 1/8"
49	92-2060-24	Washer
50	92-2031-38	Lock Washer
51	92-6043-38	Nut
52	23-7402	Safety Nut, English
	23-7403	Safety Nut, Metric
53	23-7401	Pin

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE


6
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matched pair
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(4 req.)
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33
matched pair
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(3 req.)
23
(3 req.)
24
31
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(4 req.)
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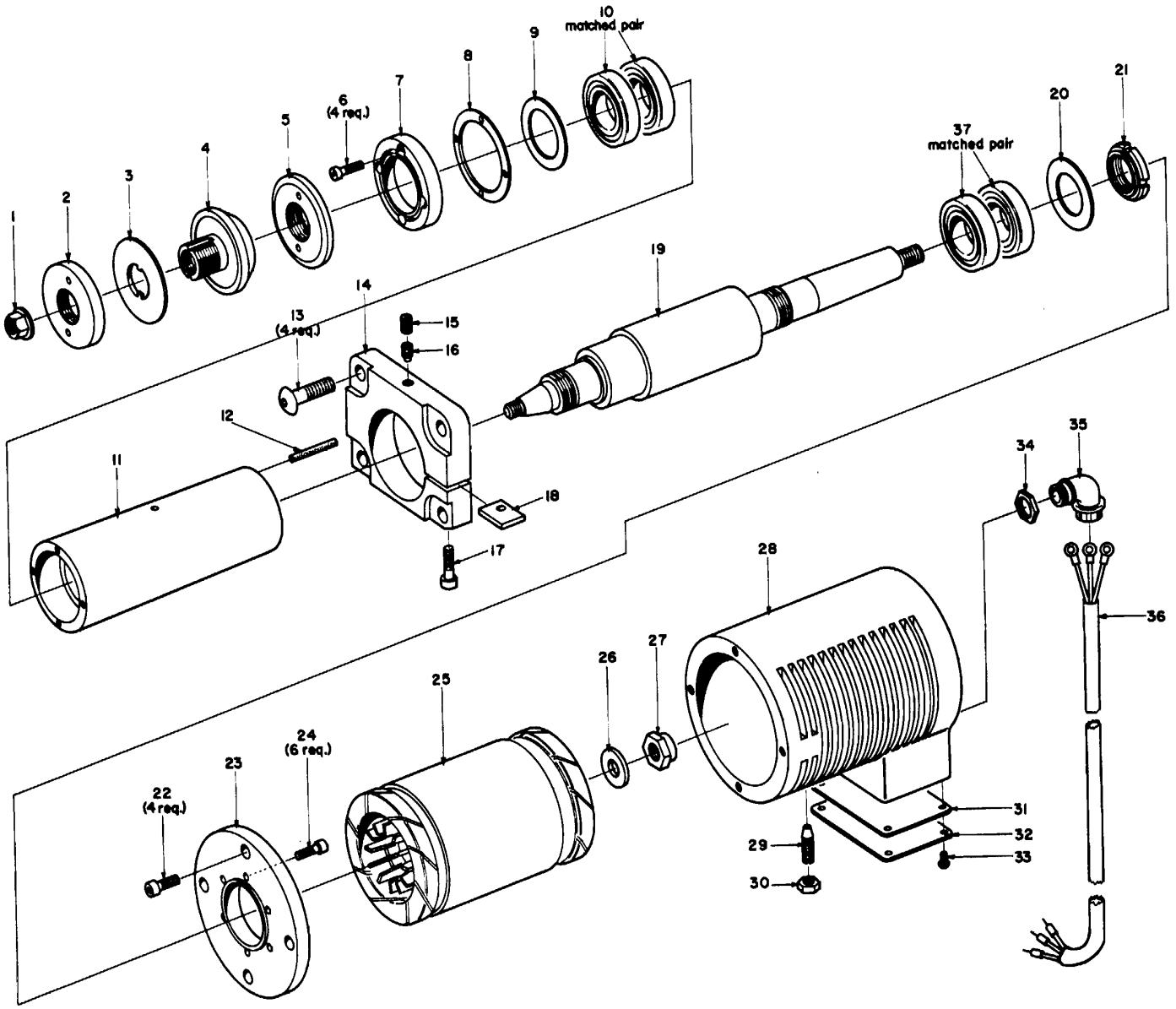
25
32

1 HP ORIFLEX DRIVE SPINDLE UNIT
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-4759	Spindle
2	92-970-638	Key
3	431-17	Ball Bearing
4	429-140	Friction Seal Washer
5	23-4763	Ball Bearing Retaining Nut
6	472-824	Locking Screw
7	92-5390-616	Cup Point Set Screw, . # 10-32 x 1/2"
8	23-4765	Spindle Pulley, 60 c/s (includes 6 & 7)
	23-5711	Spindle Pulley, 50 c/s (includes 6 & 7)
9	466-64	O-Ring
10	23-6613	Fitting Washer
11	429-1141	Friction Seal Washer
12	23-4761	Spindle Sleeve
13	93-5380-1636	Socket Head Screw, 1/2"-13 x 1 1/4"
14	466-178	Felt Wick
15	92-5071-810	Headless Set Screw, 1/4"-20 x 5/16"
16	472-347	Motor Pulley Set Screw
17	23-4727	Motor Pulley (includes 16)
18	401-2920	1 H.P. Motor
19	92-5035-1024	Hex Head Screw, 5/16"-18 x 3/4"
20	91-204-350	Motor Mounting Washer
21	21-5687	Motor Base
22	92-5035-1028	Hex Head Screw, 5/16"-18 x 7/8"
23	92-2030-10	Lock Washer
24	23-4726	Motor Mounting Plate, 60 c/s
	23-6622	Motor Mounting Plate, 50 c/s
25	23-4785	Spindle Nut
26	23-5119	Wheel Sleeve Nut
27	23-5120	Wheel Sleeve Washer
28	23-5118	Wheel Sleeve (includes 26 and 27)
29	23-4760	Ball Bearing Retaining Nut
30	92-5050-828	Fillister Head Screw, 1/4"-20 x 3/4"
31	23-4758	Spindle Bearing Dust Guard
32	23-4745	Motor Cable
33	431-17	Ball Bearing
34	92-970-638	Key
35	92-2010-1002-24	Washer

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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6 (4 req.)
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10 matched pair
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13 (4 req.)
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22 (4 req.)
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24 (6 req.)
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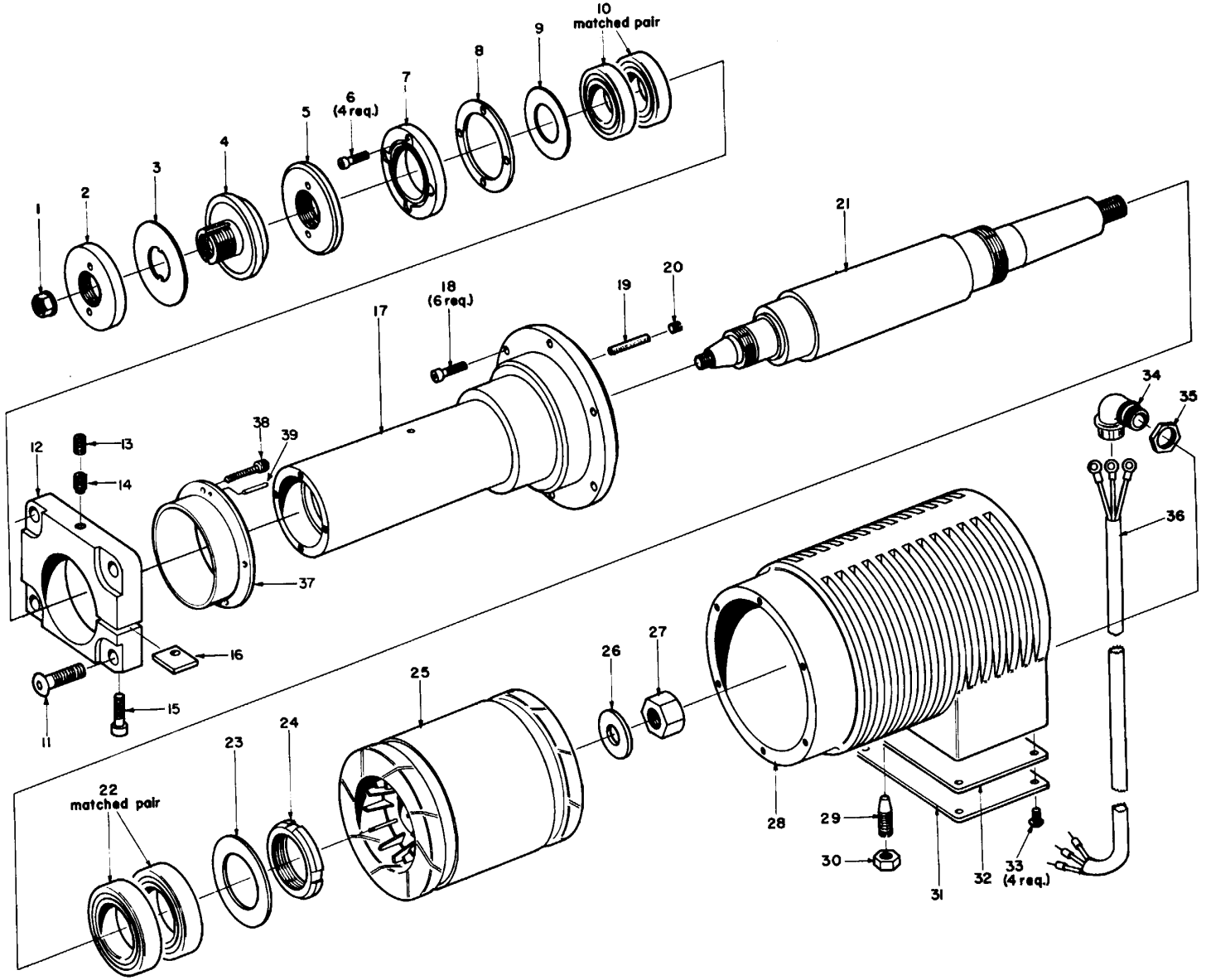
36
37 matched pair

1 ½ HP DIRECT DRIVE SPINDLE UNIT
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-4785	Spindle Nut
2	23-5119	Wheel Sleeve Nut
3	23-5120	Wheel Sleeve Washer
4	23-5118	Wheel Sleeve (includes 2 & 3) (618 only)
	23-6790	Wheel Sleeve (includes 2 & 3) (818 only)
5	23-4760	Ball Bearing Retaining Nut
6	92-5050-828	Fillister Had Screw, 1/4"-20 x 7/8"
7	23-4758	Spindle Bearing Dust Guard
8	23-6613	Baring Fitting Washer
9	429-1141	Friction Seal Washer
10	431-17	Bell Bearing
11	23-4985	Spindle Sleeve
12	466-178	Felt Wick
13	472-312	Button Head Socket Screw
14	23-5104	Spindle Sleeve Front Support (includes 17 and 18)
15	92-6390-1220	Cup Point Set Screw, 3/8"-16 x 5/8"
16	92-6361-1214-4	Front Support Set Screw
17	92-5381-1036	Socket Head Screw, 5/16"-18 x 1 1/4"
18	23-6989	Front Support Shim
19	23-4984	Spindle
20	421-40	Friction Seal Washer
21	23-5128	Ball Bearing Lock Nut
22	92-6381-1024	Socket Head Screw, 5/16"-18 x 3/4"
23	2349B9	Motor Housing Mounting Cap
24	92-5380-824	Socket Head Screw. 1/4"-20 x 3/4"
25	402-62	1 1/2 H.P. Motor
26	92-2010-2004-38	Spindle Washer
27	472-99	Elastic Stop Nut, 5/8"-18
28	23-4983	Motor Housing
29	92-5370-1238	Motor Housing Set Screw
30	92-6015-1221	Nut, 3/8"-16
31	23-4991	Motor Housing Cover Gasket
32	23-4990	Motor Housing Cover
33	92-5385-612	Button Head Screw, #10-32 x 3/8"
34	413-2117	Lock Nut
35	415-60	Connector
36	23-4745	Spindle Motor Cable
37	431-17	Ball Bearing

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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33 (4 req.)
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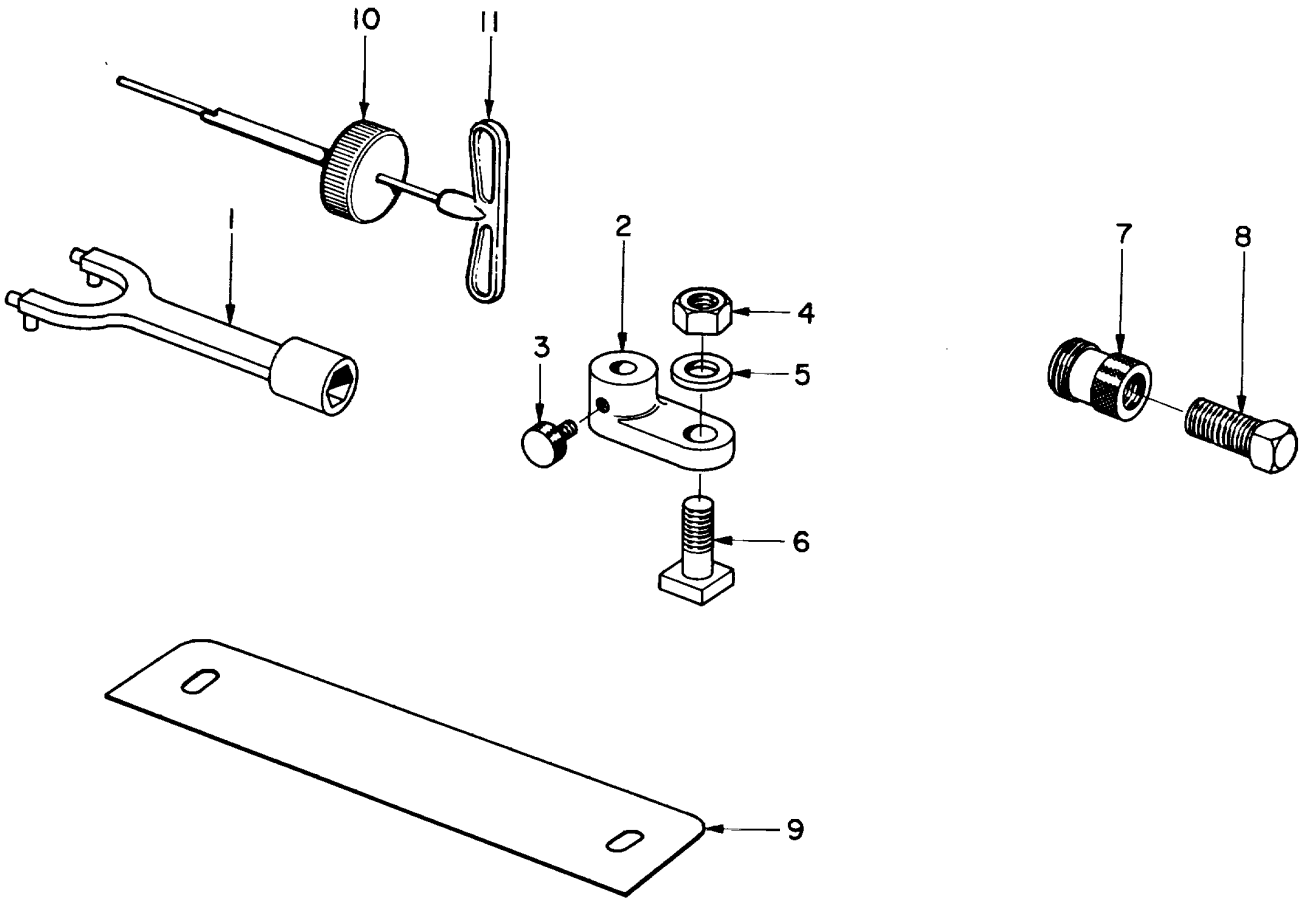
2 H.P., 3600 R.P.M., DIRECT DRIVE SPINDLE UNIT
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-4785	Spindle Nut
2	23-5119	Wheel Sleeve Nut
3	23-5120	Wheel Sleeve Washer
4	23-5118	Wheel Sleeve (includes 2 & 3) (618 only)
	23-6790	Wheel Sleeve (includes 2 & 3) (818 only)
5	23-4760	Ball Bearing Retaining Nut
6	92-5050-828	Fillister Head Screw, 1/4"-20 x 7/8'
7	23-4758	Spindle Bearing Dust Guard
8	23-6613	Fitting Washer
9	429-1141	Friction Seal Washer
10	431-17	Spindle Ball Bearing
11	472-312	Button Head Socket Screw
12	23-5104	Spindle Sleeve Front Support (includes 15 and 16)
13	92-5390-1220	Cup Point Set Screw, 3/8"-16 x 5/8"
14	92-5361-1214-4	Front Support Set Screw ,
15	92-5381-1036	Socket Head Screw, 5/16"-18x1 1/4"
16	23-6989	Neoprene Shim
17	23-6692	Spindle Sleeve
18	92-5380-832	Socket Head Screw, 1/4"-20 x 1"
19	466-169	Felt Wick
20	472-824	Set Screw, #10-32 x 1/4"
21	23-6651	Spindle
22	431-29	Spindle Ball Bearing
23	21-5731	Friction Seal Washer
24	472-353	Ball Bearing Lock Nut
25	402-169	2 H.P. Motor
26	92-2010-2404-44	Spindle Washer, 3/4" 1.D. x 1 3/4" O.D. x 1/8"
27	472-162	Elastic Stop Nut
28	23-6688	Motor Housing
29	92-5370-1238	Motor Housing Set Screw
30	92-6015-1221	Nut, 3/8"-16
31	23-6691	Motor Housing Cover
32	23-6690	Motor Housing Cover Gasket
33	92-5385-612	Button Head Screw, #1 0-32 x 3/8"
34	415-60	Connector
35	413-2117	Locknut
36	23-4745	Spindle Motor Cable
37	23-6678	Spindle Support (618 only)
38	92-5381-1036	Socket Head Screw, 5/16"-18 x 1 1/4"
39	92-900-832	Pin

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE

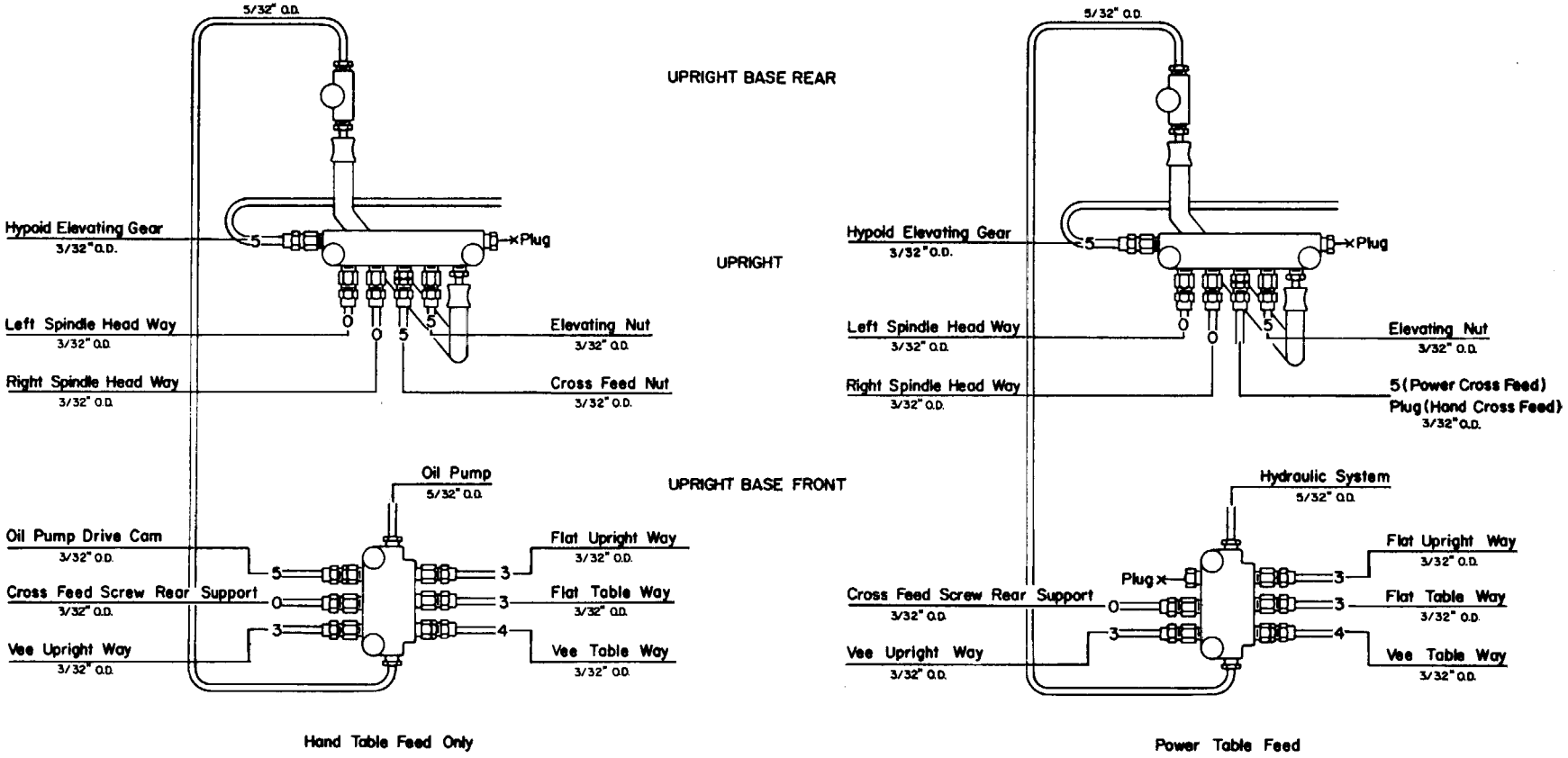


MISCELLANEOUS PARTS
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	471-6	Wheel Sleeve Wrench
2	23-4611	Wheel Truing Fixture (includes 3 through 6)
3	92-51 20-820	Screw
4	92-6015-1628	Nut, 1/2"-13
5	92-2040-1604-32	Washer
6	92-5020-1638	Tee-Bolt
7	25-1488	Wheel Sleeve Puller (includes 8)
8	92-5010-2040	Screw
9	23-6745	Splash Guard Gasket
10	23-7379	Gib Adj Screw Wrench (MC11)
11	471-34	Hex Tee Handle Wrench

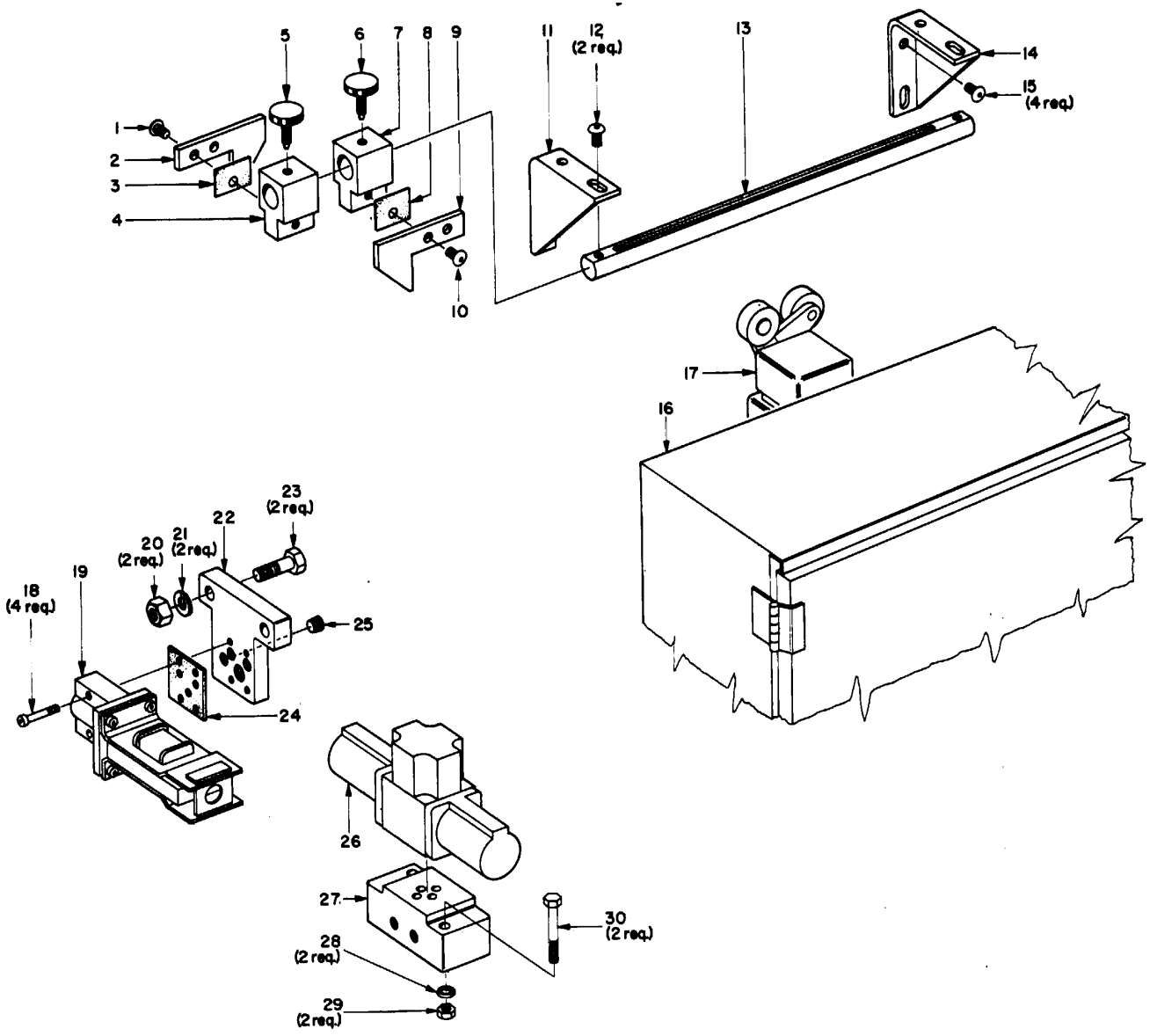
ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE

LUBRICATION SYSTEM DIAGRAM



When ordering new lubrication pipes, always give the length of pipe required, as well as the outside diameter. See the appropriate pages in this book for the pipe fittings.

The numbers at the junction-bar connections designate the numbers of the metering unit to which the pipes are to be fitted.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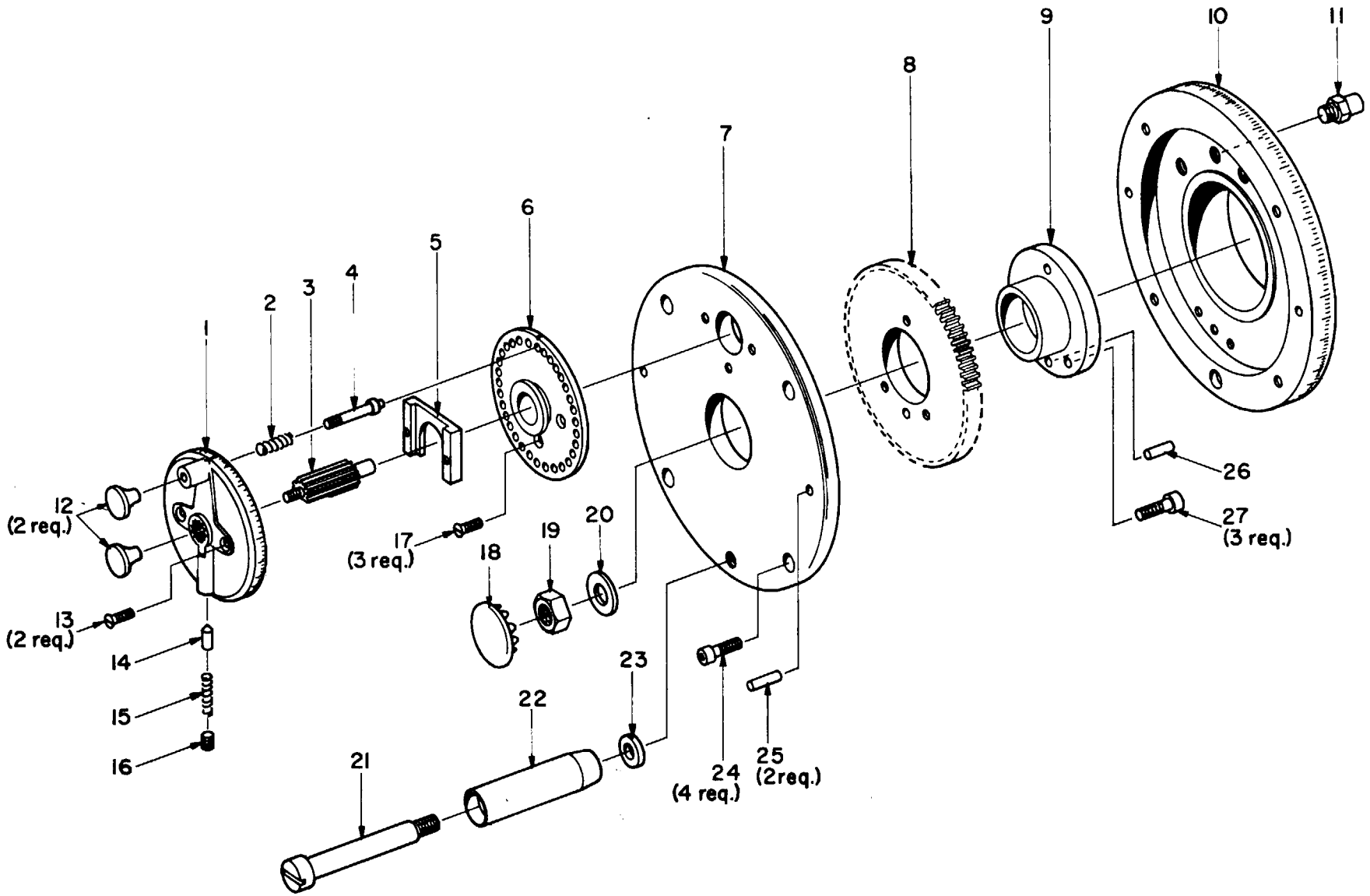
29 (2 req.)
30 (2 req.)

AUTOMATIC CROSS FEED REVERSING ARRANGEMENT
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	92-5385-816	Button Head Screw, 1/4”-20 x 1/2"
2	23-6826	Cross Feed Dog
3	23-6990	Dog Gasket
4	23-6827	Dog Mounting Block
5	23-5585	Thumb Screw
6	23-5585	Thumb Screw
7	23-6827	Dog Mounting Block
8	23-6990	Dog Gasket
9	23-6826	Cross Feed Dog
10	92-5385-820	Button Head Screw, 1/4”-20 x 1/2"
11	23-6828	Rail Mounting Bracket
12	92-5385-820	Button Head Screw, 1/4”-20 x 1/2"
13	23-6829	Dog Rail
14	23-6828	Rail Mounting Bracket
15	92-5385-816	Button Head Screw, 1/4”-20 x 1/2"
16	23-5751	Electrical Control Cabinet
17	412-369	Limit Switch
18	92-5380-632	Socket Head Screw, #10-32 x 1”
19	23-5617	Pilot Valve
20	92-6015-1214	Nut, 3/8” -16
21	92-2030-13	Lockwasher, 3/8”
22	23-5628	Valve Mounting Plate (includes 25)
23	92-5035-1236	Hex Head Screw, 3/8” -16 x 1 1/4”
24	23-5463	Gasket
25	463-698	Pipe Plug, 1/8” N.P.T.
26	411-410	Solenoid Valve
27	464-319	Sub Plate
28	92-2030-8	Lockwasher, 1/4”
29	92-6015-814	Nut, 1/4” -20
30	92-5035-848	Hex Head Screw, 1/4” -20 x 2”

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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(4 req.)
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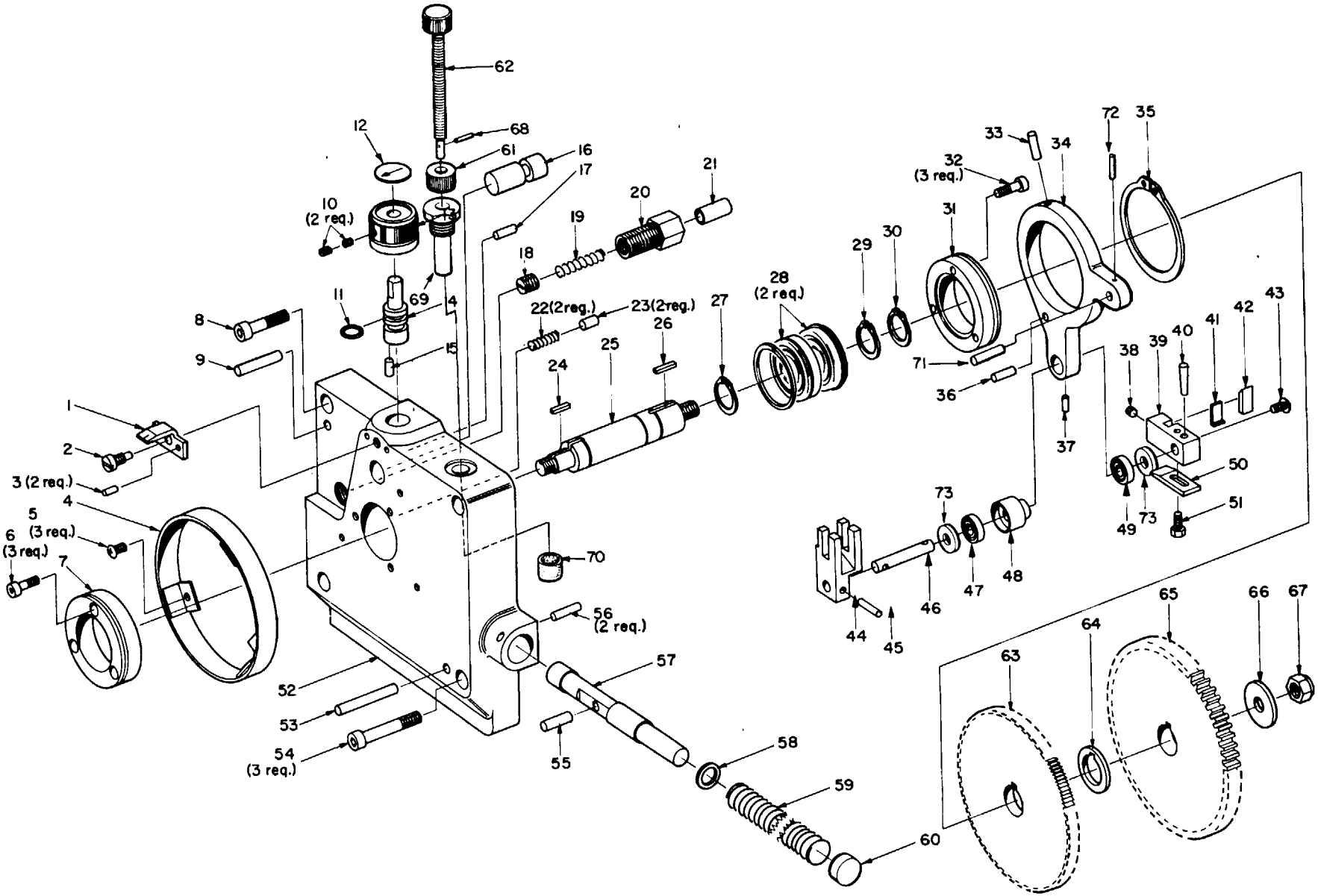
(2req.)
26
27
(3 req.)

POWER DOWN FEED ARRANGEMENT HANDWHEEL

PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-5035	Index Dial, English
	23-5840	Index Dial, Metric
2	92-1000-82423	Spring
3	23-5036	Adjusting Pinion
4	23-5523	Index Plunger
5	23-5522	Index Dial Clamp
6	23-5034	Index Plate
7	23-5038	Handwheel, Front Half
8	23-5040	Handwheel Gear
9	23-5039	Driving Sleeve
10	23-5037	Handwheel, Rear Half, English
	23-5839	Handwheel, Rear Half, Metric
11	23-5032	Handwheel Stop
12	479-140	Knob
13	92-5080-612	Flat Head Screw, #10-32 x 3/8,'
14	92-920-612	Locking Pin
15	92-1000-632-23	Spring
16	92-5390-808	Cup Point Set Screw, 1/4"-20 x 1/4" l
17	92-5081-616	Flat Head Screw, *10-32 x 1/2"
18	479-189	Plug Button
19	92-6015-1620	Nut, 1I2'-13
20	92-2010-1602-32	Washer, 1/2" I.D. x 1" O.D. x 1/16"
21	472-1044	Shoulder Screw
22	88-5805-16	Handwheel Handle
23	23-7332	Washer, 3/8" I.D. x 5/8" O.D. x 1/8,'
24	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"
25	92-900-624	Pin
26	92-900-620	Pin
27	92-5380616	Socket Head Screw, * 10-32 x 1/2"

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE


62
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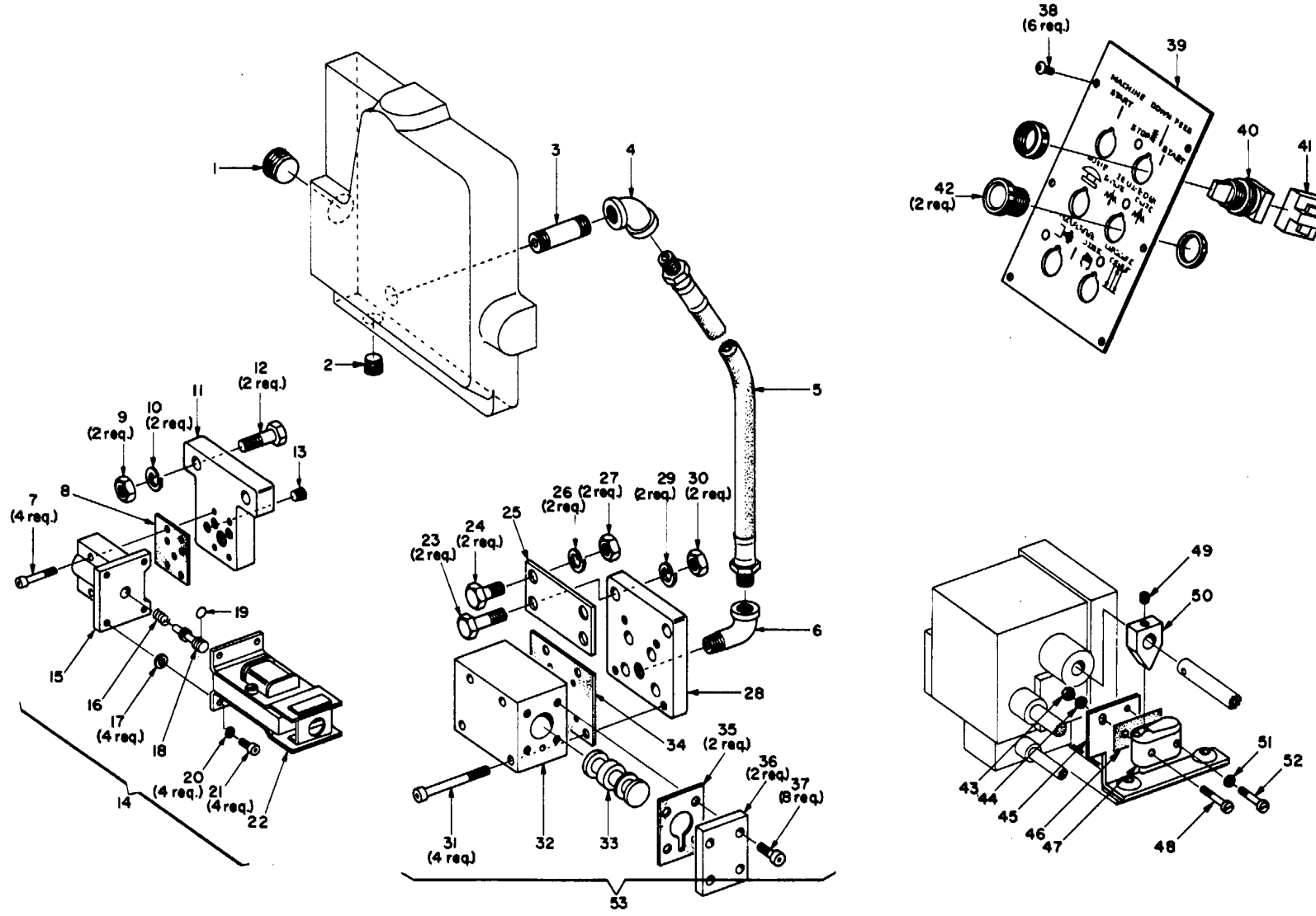
POWER DOWN FEED ARRANGEMENT HANDWHEEL BRACKET
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-4842	Pointer
2	92-5340-1020-8	Screw
3	92-900-612	Pin
4	23-6841	Handwheel Guard
5	92-5385-612	Button Head Screw, #10-32 x 3/8"
6	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"
7	23-5014	Bearing Retainer
8	92-5380-1240	Socket Head Screw, 3/8"-16 x 1-1/2"
9	92-900-1042	Pin
10	92-5390-608	Cup Point Set Screw, # 10-32 x 1/4"
11	466-609	O-ring
12	23-6820	Dial Insert
13	23-6819	Feed Selector Dial
14	23-6819	Feed Selector Shaft
15	472-1064	Pin
16	23-7092	Adjustable Handwheel Stop
17	472-3176	Pin
18	472-637	Tensioning Screw
19	92-1000-1240-16	Spring
20	23-5023	Brake Shoe Housing
21	23-5042	Brake Shoe
22	92-1000-832-19	Spring
23	92-900-1016	Pin
24	92-970-622	Key
25	23-4843	Handwheel Shaft
26	92-970-824	Key
27	429-1485	Retaining Ring
28	437-1471	Ball Bearing
29	429-242	Retaining Ring
30	429-1485	Retaining Ring
31	23-5014	Bearing Retainer
32	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"
33	472-3176	Pin
34	23-5013	Operating Lever (includes 37, 48)
35	429-50	Retaining Ring
36	472-3176	Pin
37	92-900-410	Pin
38	472-173	Set Screw
39	23-5015	Operating Lever Link
40	92-890-322	Taper Pin
41	22-5049	Pawl Tooth Side
42	22-5050	Pawl Tooth
43	472-360	Button Head Screw
44	23-6941	Piston Lever
45	92-900-632	Pin
46	23-7088	Piston Lever Pivot
47	432-1000	Ball Bearing
48	23-6942	Operating Pin Bearing
49	432-1000	Ball Bearing
50	23-6202	Pawl Retainer
51	472-873	Hex Head Screw
52	23-5012	Handwheel Bracket
53	92-900-1050	Pin
54	472-111	Socket Head Screw
55	472-1037	Pin
56	92-900-832	Pin
57	23-5017	Piston
58	92-2010-2002-28	Washer, 5/8" I.D. x 7/8' O.D. x 1/16"
59	23-5100	Spring
60	23-5018	Adjusting Screw Housing
61	23-6821	Adjusting Nut
62	23-7372	Adjusting Screw
63	23-6824	Ratchet, English
	23-5858	Ratchet, Metric
64	92-2120-3264-40	Spacer
65	23-5117	Handwheel Shaft Gear
66	92-2040-1604-40	Washer
67	472-599	Stop Nut
68	92-902-416	Roll Pin
69	23-7323	Adjusting Screw Insert
70	23-7324	Down Feed Stop
71	23-7022	Feed Adjusting Spot Pin
72	92-900-432	Pin
73	23-7184	Spacer

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE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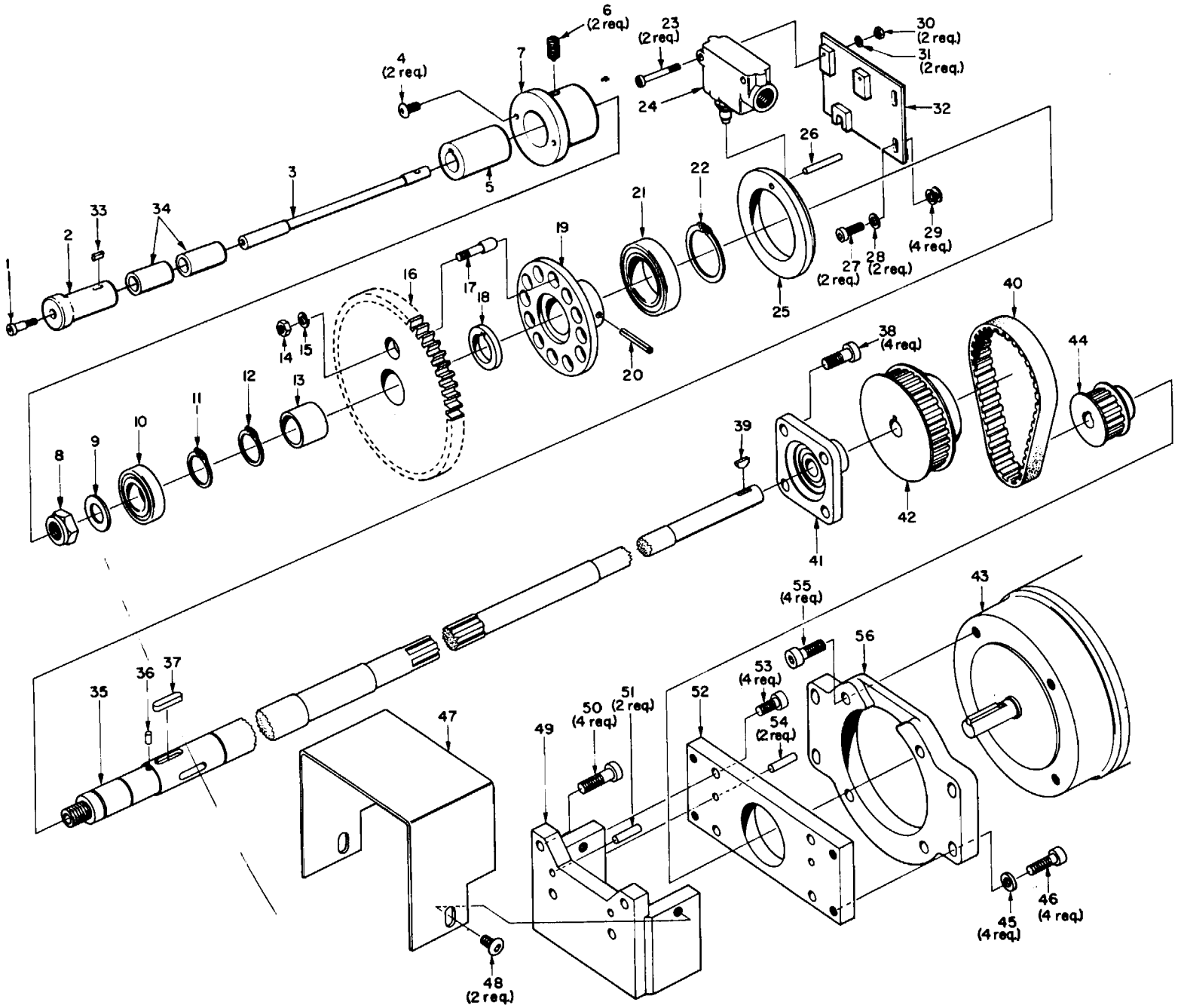
POWER DOWN FEED ARRANGEMENT CONTROLS AND VALVES
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	463-695	Hex Socket Pipe Plug, 3/4" N.P.T.
2	463-696	Hex Socket Pipe Plug, 1/4" N.P.T.
3	92-2440-848	Nipple, 1/4" N.P.T. x 2"
4	463-3796	45' Pipe Elbow, 1/4" N.P.T.
5	463-63	Downfeed Hose
6	463-6708	Street Elbow, 1/4" N.P.T.
7	92-53808-632	Socket Head Screw, #10.32 x 1"
8	23-5463	Valve Gasket
9	92-6015-1214	Nut, 318"-16
10	92-2030-12	Lockwasher, 3/8"
11	23-5628	Valve Mounting Plate
12	92-5035-1236	Hex Head Screw, 3/8"-16 x 1 1/4"
13	463-698	Hex Socket Pipe Plug, 1/8,' N.P.T.
14	23-5617	Pilot Valve (include" 15 through 22)
15	23-5462	Valve Body
16	23-5465	Spring
17	472-299	Washer
18	23-5464	Valve Piston
19	466-272	O-ring
20	92-2030-6	lockwasher, #10
21	92-5380-616	Socket Head Screw, #10-32 x 1/2"
22	411-82	Solenoid
23	92-5035-1236	Hex Hood Screw, 3/8"-16 x 11/4"
24	92-5035-1224	Hex Heed Screw, 3/8"-16 x 3/4"
25	23-6825	Mounting Plate
26	92-2030-12	lockwasher, 3/8"
27	92-015-1214	Nut, 3/8"-16
28	23-5625	Valve Mounting Plate
29	92-2030-12	Lockwasher, 3/8”
30	92-6015-1214	Nut, 3/8"-16
31	92-5380-852	Socket Hood Screw, 1/4"-20 x 2 1/2'
32	23-5620	Downfeed Valve Body
33	23-5622	Valve Piston
34	23-5621	Valve Gasket
35	23-5624	Valve Gasket
36	23-5823	Valve Cap
37	92-53804-824	Socket Head Screw, 1/4"-20 x 3/4"
38	92-5385-612	Button Head Screw, p10-32 x 3/8'
39	88-4-7	Control Plate
40	412-348	Selector Switch
41	412-346	Contact Block
42	412-452	Plug
43	472-578	Nut
44	472-92	Lockwasher
45	23-7095	Switch Mounting Bracket
46	415-89	Fabric Shield
47	412-370	Micro Switch
48	472-3504	Screw
49	92-5390-808	Cup Point Set Screw, 1/4"-20 x 1/4"
50	23-7096	Switch Dog
51	472-92	Lockwasher
52	472-189	Screw
53	23-7384	Down Food Valve Complete includes includes 28 & 31 thru 37)

ORDER BY PART NUMBER AND NAME, ALSO ONE SIZE STYLE AND SERIAL NUMBER OF MACHINE AND ATTACHMENT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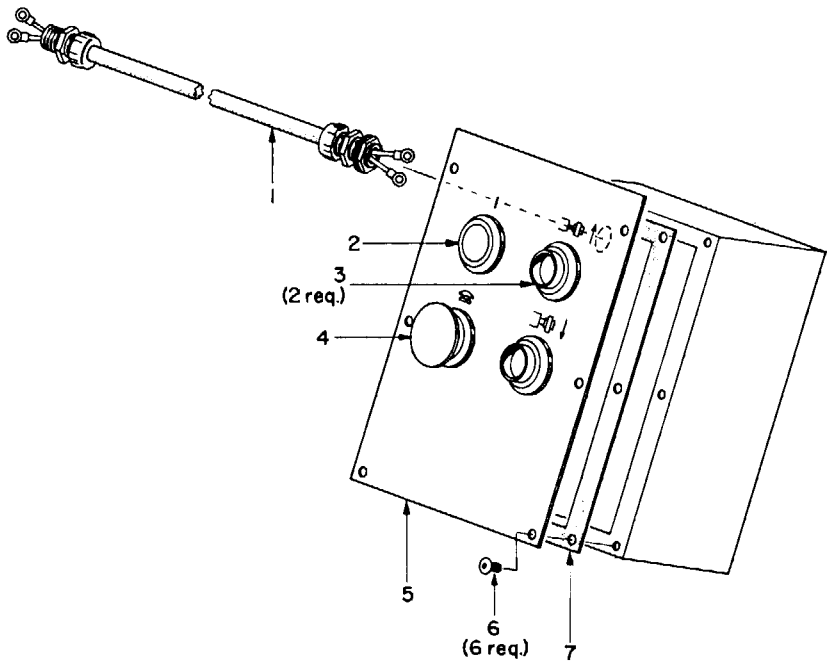
RAPID VERTICAL POSITIONING ARRANGEMENT
CLUTCH AND DRIVE

PARTS LIST

INDEX NO.	PART NO.	PART NAME	INDEX NO.	PART NO.	PART NAME
1	472-1080	Shoulder Screw	29	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"
2	23-7068	Pull Knob (includes 33 & 34)	30	92-6015-608	Nut, #10-32
3	234846	Clutch Control Rod	31	92-2030-6	Lockwasher, 010
4	472-703	Nylock Button Head Screw	32	23-6842	Switch Mounting Bracket
5	421-130	Oil Tight Bearing	33	23-7155	Key
6	419-837	Spring Plunger	34	421-802	Bronze Bushing
7	23-6839	Bearing Thrust Bushing includes 5)	35	23-5164	Drive Shaft includes 36)
8	472-1083	Lock Nut	36	92-900-306	Pin
9	92-2010-2002-36	Washer, 5/8" I.D. x 1 1/4" O.D. x 1/16”	37	23-6854	Key
10	4341164	Ball Bearing	38	92-5380-1232	Socket Head Screw, 3/8"-16 x 1"
11	428-1475	Retaining Ring	39	92-980-624	Key
12	428-1475	Retaining Ring	40	442-118	Driving Belt
13	421-123	Bushing	41	432-1	Flange Mounted Ball Bearing
14	9246015-814	Nut, 1/4"-20	42	473-181	Belt Pulley
15	92-2030-8	Lockwasher, 1/4"	43	401-130	Motor
16	23-6845	Gear (includes 13)	44	473-180	Belt Pulley
17	23-6838	Clutch Drive Pin	45	92-2010-1002-20	Washer, 5/16" I.D. x 5/8" O.D. x 1/16"
18	236847	Thrust Bearing	46	92-5380-1032	Socket Head Screw, 5/16"-18 x 1"
19	23-6843	Drive Clutch	47	23-5166	Belt Guard
20	472-1115	Pin	48	92-5385-1020	Button Head Screw, 5/16"-18 x 5/8'
21	432-1038	Ball Bearing	49	23-5165	Motor Mounting Bracket
22	429-4496	Retaining Ring	50	92-5380-1236	Socket Head Screw, 3/8"-16 x 1 1/4"
23	472-72	Socket Head Screw	51	92-900-832	Dowel
24	412-198	Interlocking Switch	52	23-6793	Motor Mounting Plate
25	234840	Cam Ring (includes 26)	53	92-5380-1024	Socket Head Screw, 5/16"-18 x 3/8"
26	92-9640	Pin	54	92-900-832	Dowel
27	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"	55	92-5380-1232	Socket Head Screw, 3/8"-16 x 1"
28	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"	56	23-6724	Motor Mounting Flange

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUM#BER OF MACHINE AND ATTACHMENT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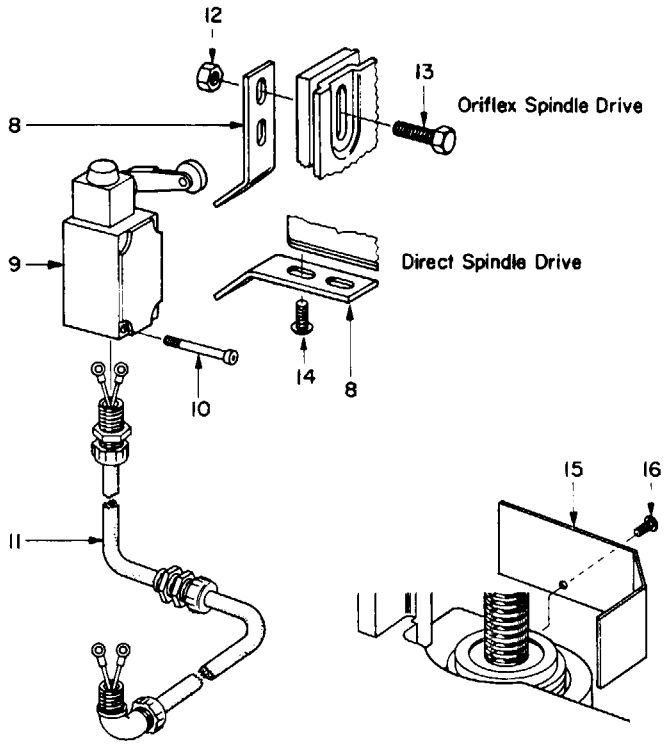
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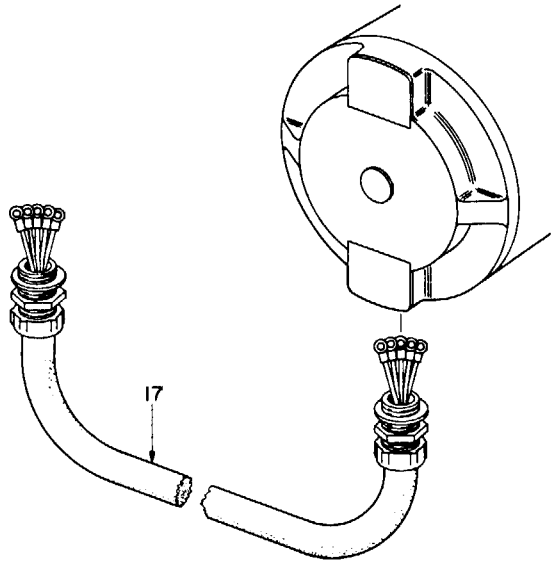
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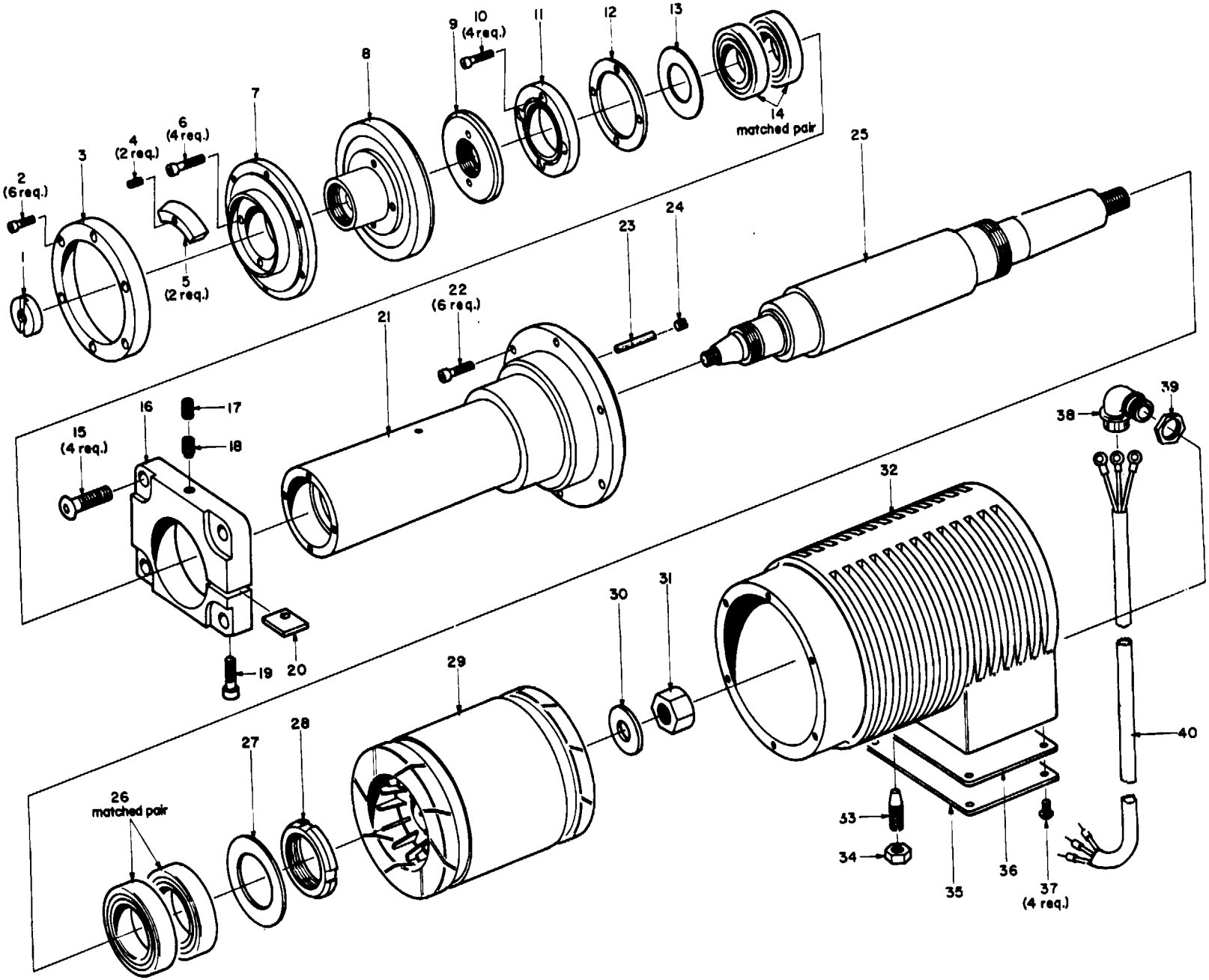
APID VERTICAL POSITIONING ARRANGEMENT
CABLES AND MISCELLANEOUS PARTS

INDEX NO.	PART NO.	PART NAME
1	23-6746	Interlocking Switch Cable
2	412-343	Pushbutton Cap
	412-342	Pushbutton Operator
	412-346	Contact Block, normally open
3	412-353	Pushbutton Operator
	412-346	Contact Block, normally open
	412-347	Contact Block, normally closed
4	412-345	Mushroom Pushbutton Cap
	412-344	Pushbutton Operator
	412-347	Contact Block, normally closed
5	88-4-5	Control Plate
6	92-5385-612	Button Head Screw. #10-32 x 3/8"
7	23-6511	Control Plate Gasket
8	23-5170	Limit Switch Cut-Off
9	412-60	Limit Switch
10	472-3552	Socket Head Screw
11	23-6730	Limit Switch Cable
12	92-6015-1012	Nut. 5/16"-18
13	92-5035-1036	Hex Head Screw, 5116"-18 x 1 1/4"
14	472-847	Button Head Screw
15	23-6090	Oil Splash Guard
16	92-5385-612	Button Head Screw, #10-32 x 3/8"
17	23-6725	Motor Cable Harness
	413-2150	Motor Cable Conduit and Fittings

ORDER BY PART NUMBER AND NMAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE AND ATTACHMENT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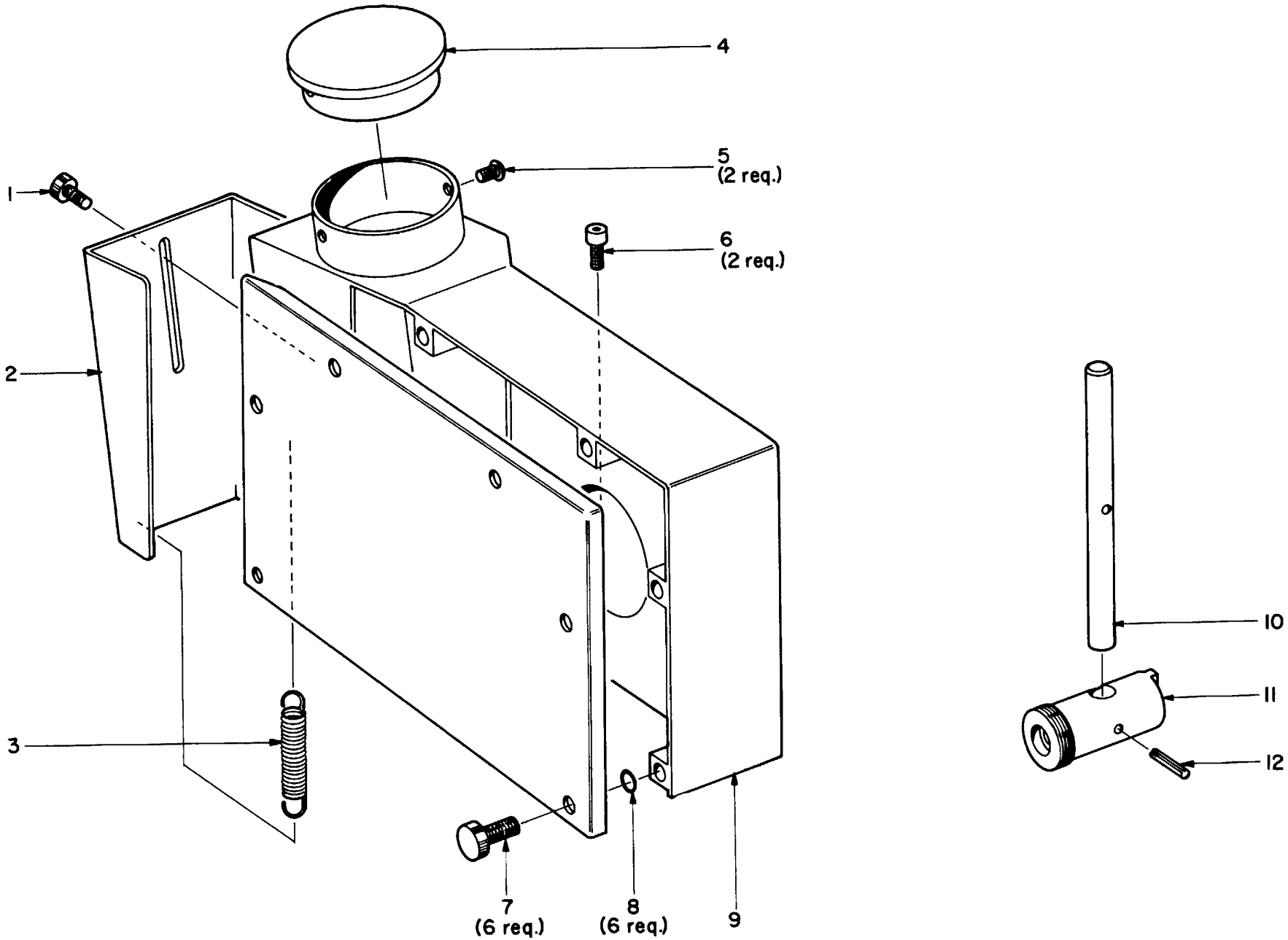
2 H.P., 1800 R.P.M., DIRECT DRIVE SPINDLE
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-6713	Spindle Nut
2	92-5380-624	Socket Head Screw, *10-32 x 3/4"
3	23-5254	Retaining Ring
4	92-5391-816	Oval Point Set Screw, 1/4"-20 x 1/2"
5	23-5253	Balancing Segment (includes 4)
6	92-5381-1040	Socket Head Screw, 5/16"-18 x 1 1/2", For 1/2" Grinding Wheel
	92-5381-1048	Socket Head Screw, 5/16"-18 x 2", For 1 " Grinding Wheel
7	23-5252	Wheel Sleeve Flange
8	23-6711	Wheel Sleeve
9	23-4760	Ball Bearing Retaining Nut
10	92-5050-828	Fillister Head Screw, 1/4"-20 x 7/8"
11	23-4758	Spindle Bearing Dust Guard
12	23-6613	Fitting Washer
13	429-1141	Friction Seal Washer
14	431-17	Ball Bearing
15	472-312	Button Head Socket Screw
16	23-5104	Spindle Sleeve Support (includes 19 and 20)
17	92-5390-1220	Cup Point Set Screw, 3/8"-16 x 5/8"
18	92-5361-1214-4	Set Screw
19	92-5381-1036	Socket Head Screw, 5/16"-18 x 1 1/4"
20	23-6989	Sleeve Support Shim
21	23-6692	Spindle Sleeve
22	92-5380-832	Socket Head Screw, 1/4"-20 x 1"
23	466-169	Felt Wick
24	472-254	Set Screw
25	23-6654	Spindle
26	431-29	Ball Bearing
27	21-5731	Friction Seal Washer
28	472-353	Ball Bearing Lock Nut
29	402-170	2 H.P. Motor
30	92-2010-2404-44	Washer, 3/4" 1.D. x 1 3/4" 0.D. x 1/8"
31	472-162	Elastic Stop Nut
32	23-6688	Motor Housing
33	92-5370-1238	Set Screw
34	92-6015-1221	Nut, 3/8"-16
35	23-6691	Motor Housing Cover
36	23-6690	Motor Housing Cover Gasket
37	92-5385-612	Button Head Screw, .10-32 x 3/8"
38	415-60	Connector
39	413-2117	Lock Nut
	23-4745	Motor Cable

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE AND ATTACHMENT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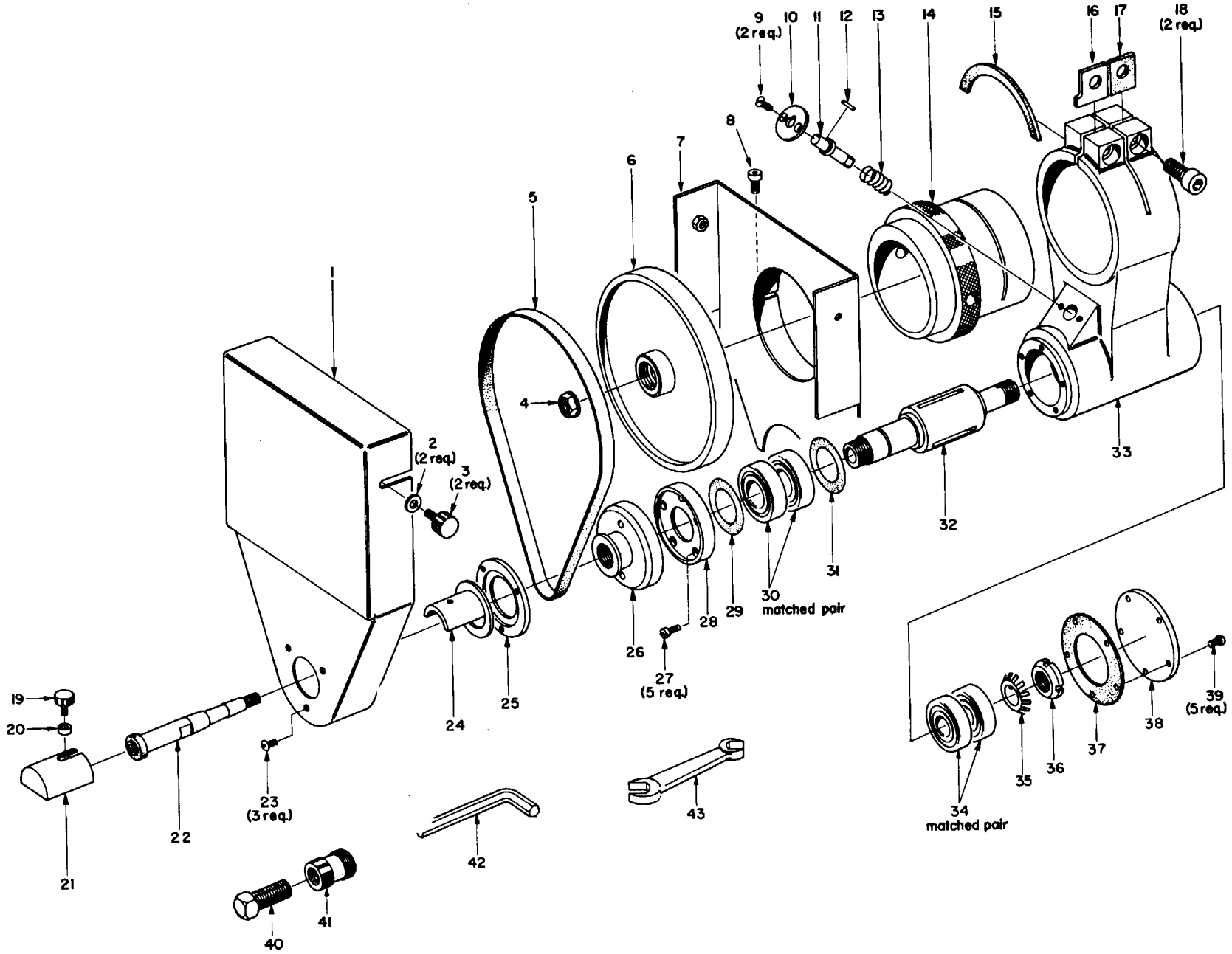
12" WHEEL EQUIPMENT
(See pages 52 and 53 for spindle and wheel sleeve parts)
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	88-5125-824	Knurled Thumb Screw
2	23-6704	Wheel Guard Deflector
3	23-6707	Spring
4	23-6706	Exhaust Cover
5	92-5385-612	Button Head Screw, #10-32 x 3/8"
6	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"
7	88-5125-1232	Knurled Thumb Screw
8	466-3601	O-ring
9	23-6703	Wheel Guard (includes 1 to 8)
10	26-644	Handle
11	26-573	Wheel Puller and Wrench (includes 10 and 12)
12	92-902-1236	Roll Pin, 3/16" x 1 1/4"

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE AND ATTACHMENT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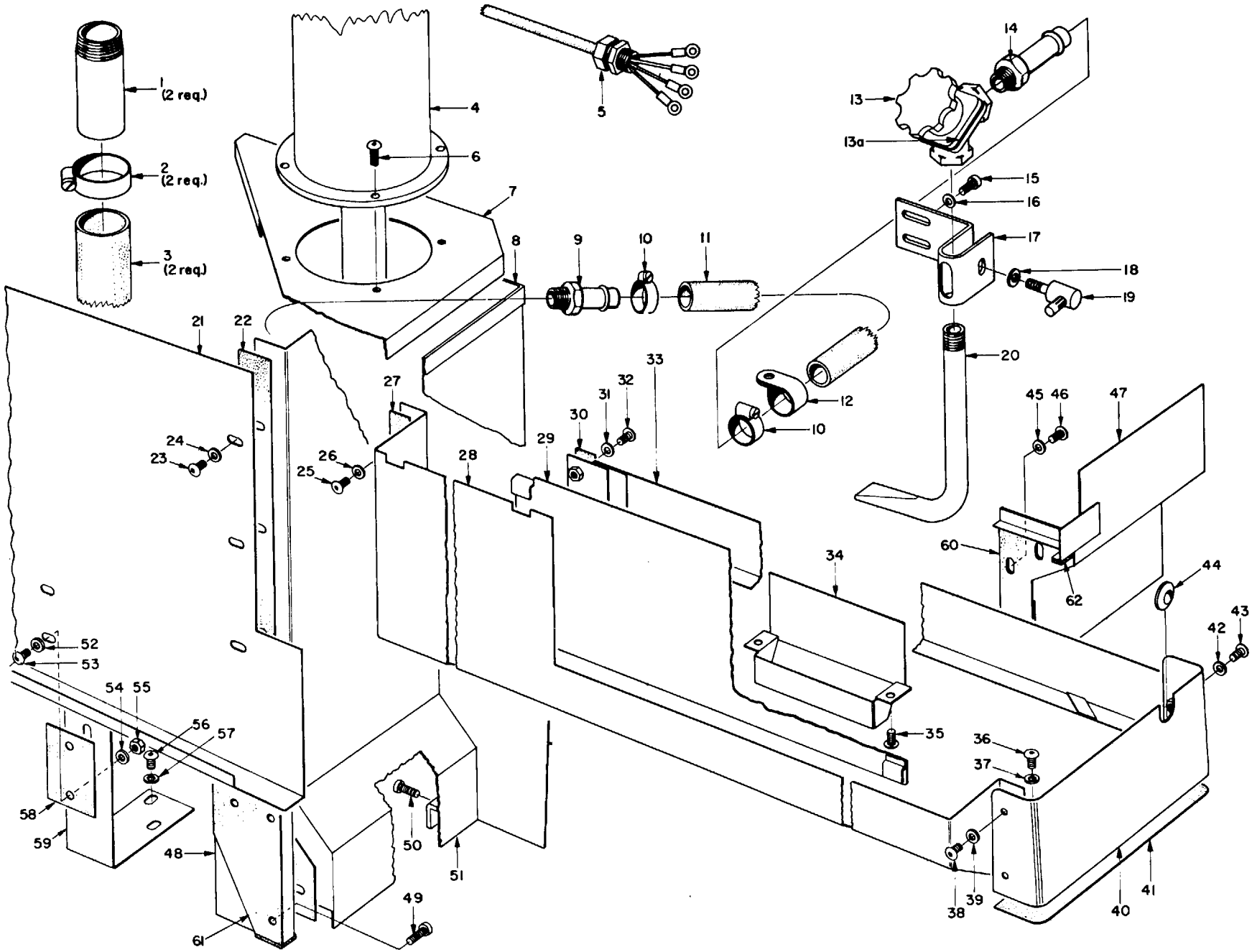
HIGH-SPEED SURFACE GRINDING ATTACHMENT
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-2576	Belt Guard
2	92-2010-802-20	Washer, 1/4" 1.D. x 5/8" 0D. x 1/16"
3	88-5125-824	Thumb Screw
4	23-4785	Nut
5	442-81	Belt
6	23-2665	Driving Pulley
7	23-5081	Belt Guard Support (includes 8)
8	92-5380-816	Socket Head Screw, 1/4"-20 x 1/2"
9	92-5080-616	Flat Head Screw, #10-32x 1/2"
10	23-2580	Locking Pin Guide
11	23-2579	Locking Pin (includes 12)
12	92-970-420	Key
13	91-100-401	Spring
14	23-2581	Belt Take-up Eccentric
15	442-64	Leather Shim
16	23-2578	Shim
17	442-67	Leather Shim
18	92-5380-1640	Socket Head Screw, 1/2"-13 x 1 1/2"
19	88-6128-616	Thumb Screw
20	91-215-15	Spacer
21	23-6875	Wheel Guard
22	-	Grinding Wheel and Arbor, not included with attachment. See 618 Specification Bulletin.
23	92-5385-612	Button Head Screw, 1/4"-20 x 1/2"
24	23-6874	Wheel Guard Support
25	23-6876	Wheel Guard Support Ring
26	23-2574	Spindle Pulley
27	92-5051-616	Fillister Head Screw, # 10-32 x 1/2"
28	23-2095	Front Bearing Retainer
29	429-1137	Friction Seal Washer
30	431-1050	Ball Bearing
31	429-1137	Friction Seal Washer
32	23-2573	Spindle
33	23-2572	Spindle Housing includes 15, 16,17, 18,38,39)
34	431-1051	Ball Bearing
35	92-2031-26	Lockwasher
36	92-6043-25	Nut
37	23-5097	Gasket
38	23-2575	Spindle Housing Cover
39	92-5051-616	Fillister Head Screw, #10-32 x 1/2"
40	92-5010-2040	Screw
41	25-1488	Wheel Sleeve Puller (includes 40)
42	471-427	Hex Key Wrench, 3/8"
43	471-410	Double End Wrench, 1/2" x 11/16"

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE AND ATTACHMENT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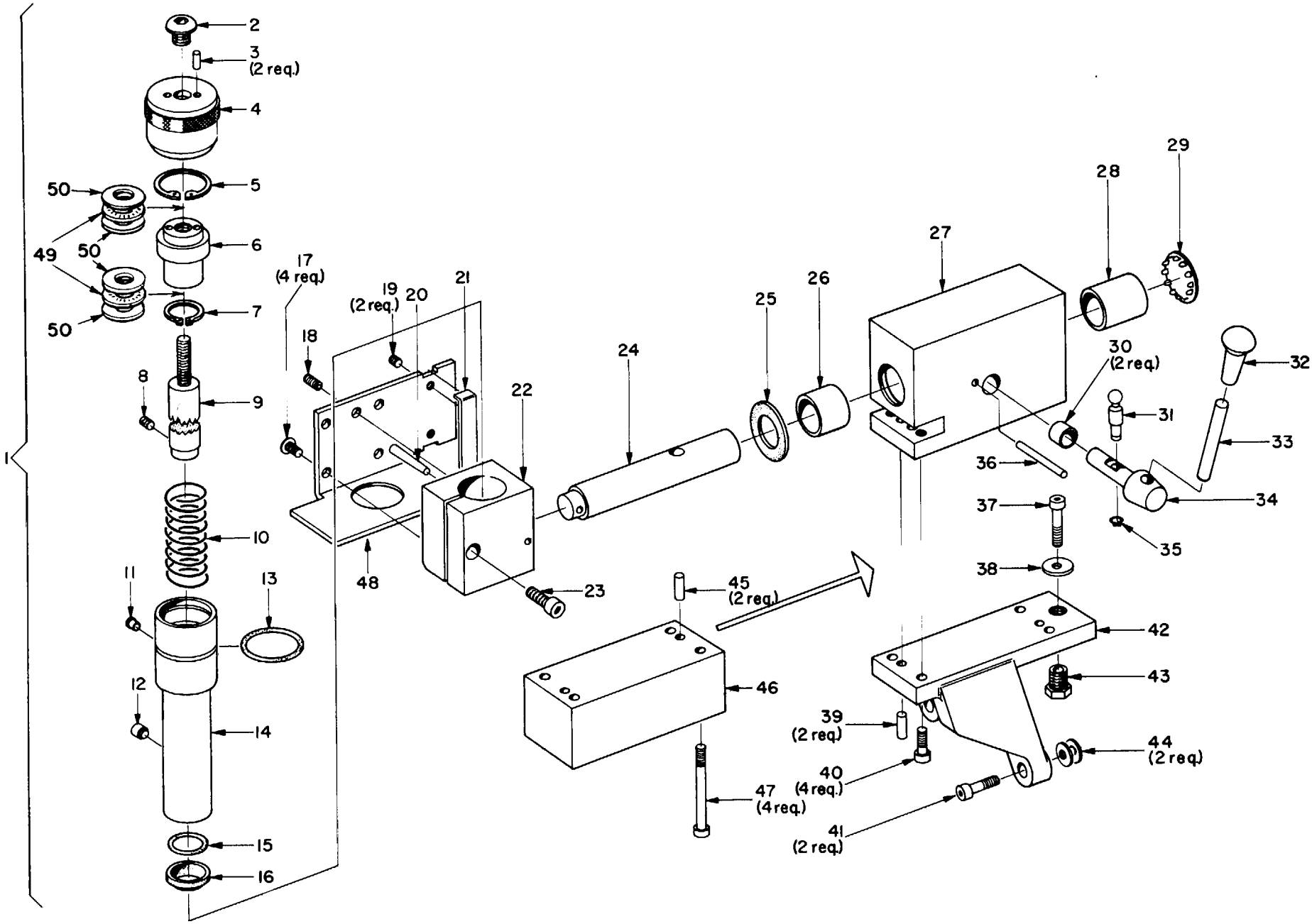
WET GRINDING ATTACHMENT
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	92-2440-3664	Hose Nipple
2	463-817	Hose Clamp
3	463-796	Hose
4	713-2529	Pump
5	23-2632	Pump Motor Cable
6	92-5385-824	Button Head Screw, 1/4"-20 x 3/4"
7	23-6721	Pump Mounting Bracket
8	23-6197	Coolant Tank
9	463-437	Hose Nipple
10	474-308	Hose Clamp
11	464-234	Hose
12	464-165	Hose Clip
13	463-178	Diaphragm Valve (diaphragm 13a obtainable separately)
14	463-437	Hose Nipple
15	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"
16	92-2040-802-20	Washer
17	23-6710	Nozzle Clamp Bracket
18	92-2040-1002-20	Washer
19	88-5746-1032	Clamp Screw
20	23-6096	Coolant Nozzle for 8" grinding wheel)
	23-6709	Coolant Nozzle (for 12" grinding wheel)
21	23-4914	Splash Guard Extension
22	23-6695	Splash Guard Gasket
23	92-5385-820	Button Head Screw, 1/4"-20 x 5/8"
24	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"
25	92-5385-816	Button Head Screw, 1/4"-20 x 1/2"
26	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"
27	23-6804	Splash Guard Gasket
28	23-4919	Front Splash Guard (includes 27)
	479-3177	1/16x 5/8 Gasket
29	23-4918	Splash Guard Gate
30	23-6803	Splash Guard Gasket
31	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"
32	92-5385-816	Button Head Screw, 1/4"-20 x 1/2"
33	23-4916	Rear Splash Guard
	479-83	3/16 x 5/8 Gasket
34	23-4835	Table Trough Guard
35	92-5385-812	Button Head Screw, 1/4"-20 x 3/8"
36	92-5385-1224	Button Head Screw, 3/8-16
37	92-2010-1202-24	Washer, 3/8"
38	92-5385-816	Button Head Screw, 1/4"-20 x 1/2"
39	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"
40	23-4913	Right Splash Guard
41	23-5192	Splash Guard Gasket
42	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"
43	92-5385-816	Button Head Screw, 1/4"-20 x 1/2"
44	479-713	Grommet
45	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"
46	92-5385-820	Button Head Screw, 1/4"-20 x 5/8"
47	23-5004	Rear Bed Splash Guard (includes 60)
48	23-6693	Splash Guard Filler Plate (includes 61)
49	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"
50	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"
51	23-4998	Bed Splash Guard (includes 50)
52	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16"
53	92-5385-820	Button Head Screw, 1/4"-20 x 5/8'
54	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16'
55	92-6015-814	Nut, 1/4"-20
56	92-5385-816	Button Head Screw, 1/4"-20 x 1/2"
57	92-2010-802-16	Washer, 1/4" I.D. x 1/2" O.D. x 1/16
58	23-7090	Gasket
59	23-7089	Bracket
60	23-5005	Gasket
61	23-6694	Gasket
62	479-3177	Neoprene Sponge (.08 ft)

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE AND ATTACHMENT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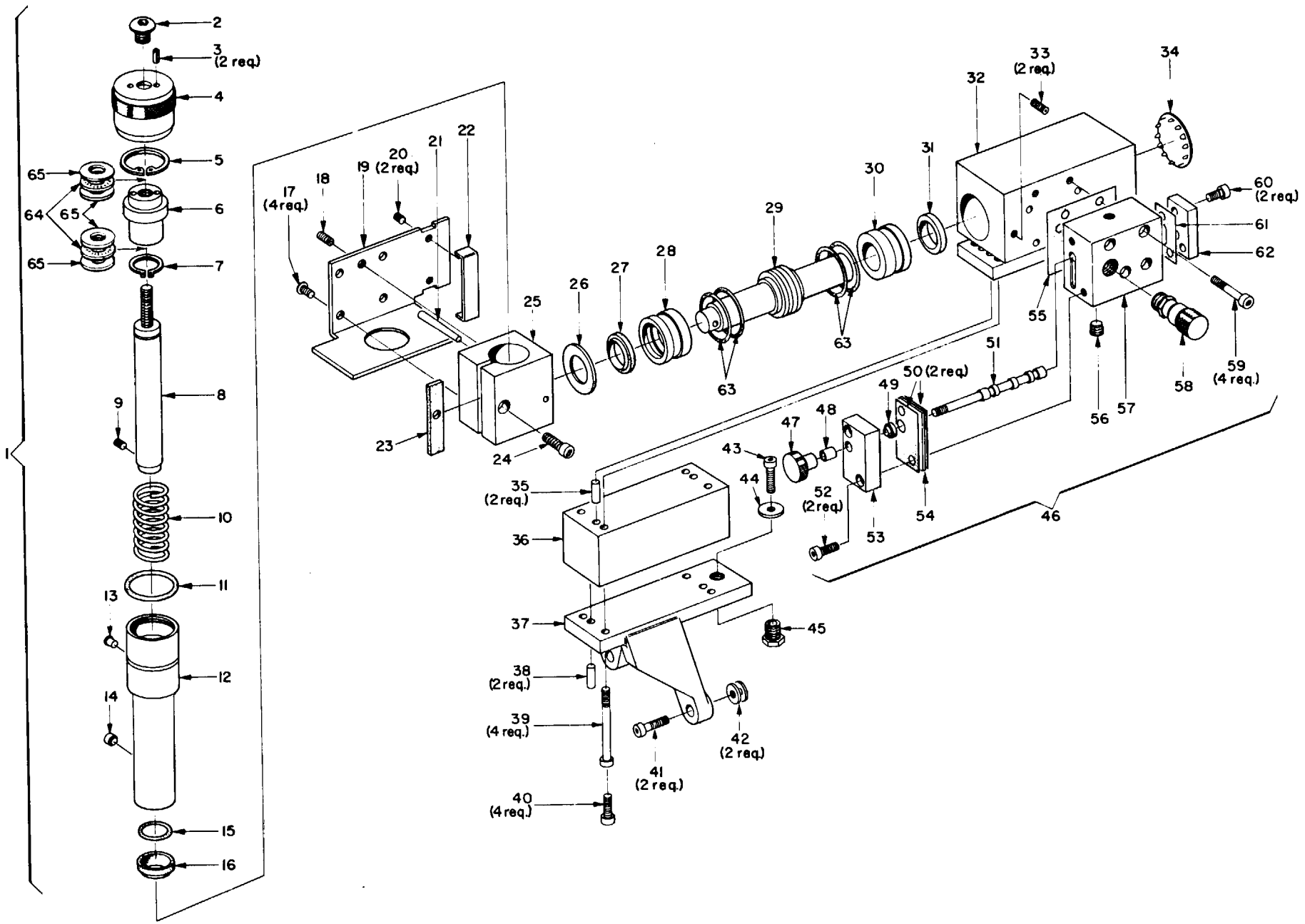
MANUAL OVER-THE-WHEEL STRAIGHT LINE DRESSER
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-3775	Diamond Tool Holder (includes2 through 16)
2	23-6732	Screw
3	92-900-316	Pin
4	99-299-150	Thimble
5	429-61	Retaining Ring
6	23-3758	Tool Holder Nut
7	429-4488	Retaining Ring
8	92-5390-808	Cup Point Set Screw, 1/4"-20 x 1/4"
9	23-3754	Tool Holder
10	23-6731	Spring
11	92-5650-8	Oil Cup
12	23-6411	Tool Holder Pin
13	466-214	0-ring
14	23-3755	Tool Holder Sleeve
15	466-3603	0-ring
16	466-396	Seal Guard
17	92-5385-816	Button Head Screw, 1/4"-20 x 1/2"
18	479-414	Ball Plunger
19	472-239	Screw
20	92-890-443	Tapered Pin
21	23-6743	Clamp Block Guide
22	23-6733	Clamp Block
23	92-5381-1032	Socket Head Cap Screw, 5/16"-18 x 1
24	23-6735	Piston
25	23-6741	Spacer
26	421-10	Bearing
27	23-6685	Dresser Block includes 26,28, 30)
28	421-11	Bearing
29	479-110	Plug Button
30	421-811	Bearing
31	23-6739	Piston Drive Stud
32	88-5855-12	Knob
33	92-900-1256	Pin
34	23-6738	Dresser Piston Lever (includes 32, 33)
35	429-14	Retaining Ring
36	92-900-648	Stop Pin
37	92-5380-836	Socket Head Screw, 1/4"-20 x 11/4"
38	92-2040-803-28	Washer
39	92-900-824	Dowel
40	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4" (for 8" wheel only)
41	92-5380-832	Socket Head Screw, 1/4"-20 x 1"
42	23-6683	Mounting Bracket
43	23-6742	Aligning Screw
44	472-1056	Spherical Washer
45	92-900-824	Dowel (for 12" wheel only)
46	23-6737	Riser Block (for 12" wheel only)
47	472-3522	Screw
48	23-6734	Guide Bracket
49	438-38	Thrust Bearing
50	438-50	Race

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE AND ATTACHMENT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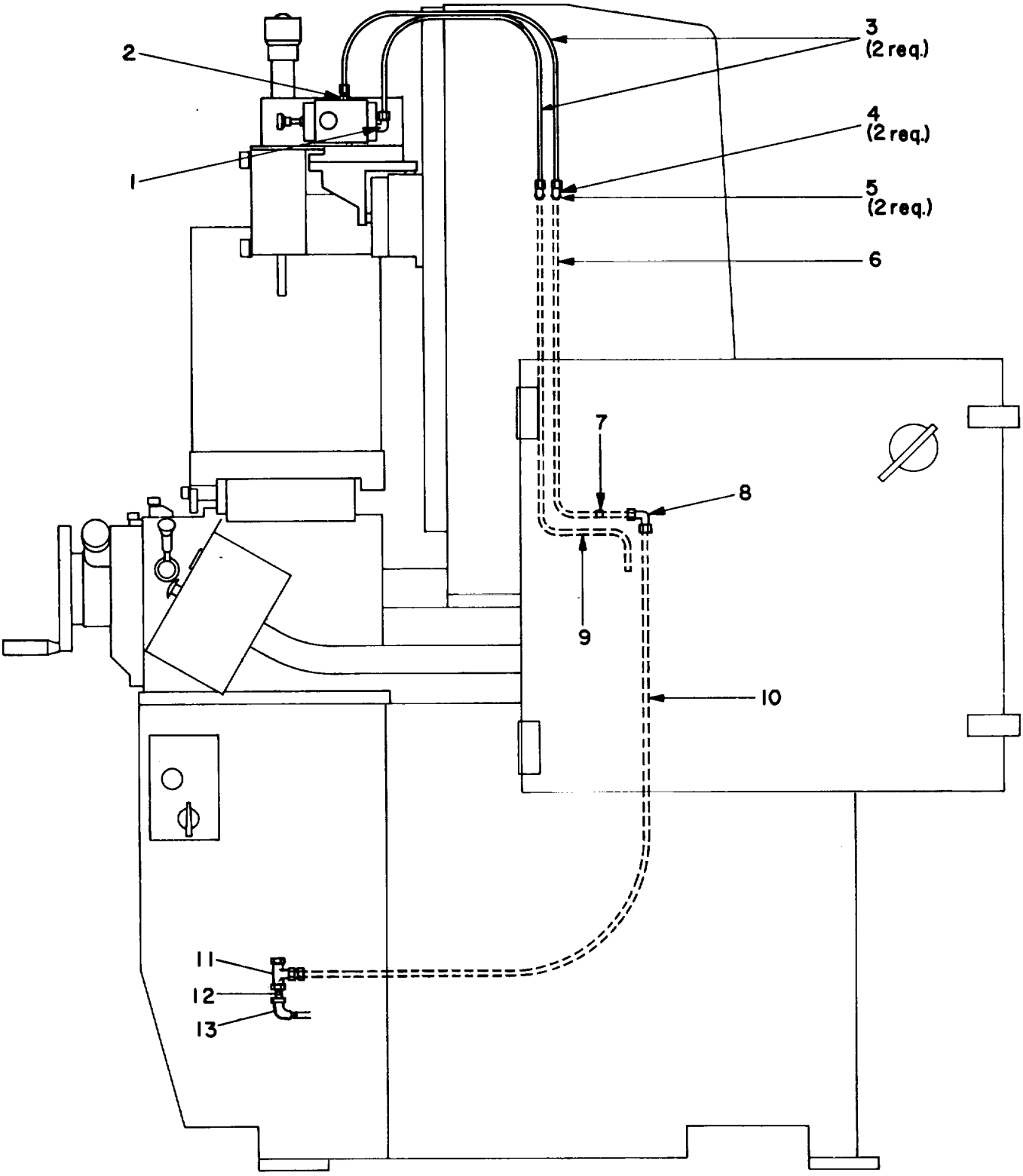
POWER OVER-THE-WHEEL STRAIGHT LINE DRESSER
PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-3775	Diamond Tool Holder (includes 2 through 16)
2	23-6732	Thimble Retaining Screw
3	92-902-416	Roll Pin
4	99-299-150	Thimble
5	429-61	Retaining Ring
6	23-3758	Adjusting Nut
7	429-4488	Retaining Ring
8	23-3754	Tool Holder
9	92-5390-808	Cup Point Set Screw
10	23-6731	Spring
11	466-214	O-ring
12	23-3755	Tool Holder Sleeve
13	92-5650-8	Oil Cup
14	23-6411	Tool Holder Pin
15	466-3603	0-ring
16	466-396	Seal Guard
17	92-5385-816	Button Head Screw, 1/4"-20 x 1/2"
18	479-553	Spring Plunger
19	23-6734	Guide Bracket
20	472-239	Screw
21	92-890-443	Tapered Pin
22	23-6743	Clamp Block Guide
23	479-123	Neoprene Shim
24	92-5381-1032	Socket Head Screw, 5/16"-18 x 1"
25	23-6733	Clamp Block
26	23-6741	Spacer
27	466-397	Rod Wiper
28	23-6740	Rod Wiper Cartridge
29	23-6736	Piston
30	23-6740	Rod Wiper Cartridge
31	466-397	Rod Wiper
32	23-6684	Power Feed Block
33	472-743	Set Screw
34	479-163	Plug Button
35	92-900-824	Dowel (for 12" grinding wheel only)
36	23-6737	Riser Block (for 12" grinding wheel only)
37	23-6683	Mounting Bracket
38	92-900-824	Dowel
39	472-3522	Socket Head Screw (for 12" grinding wheel only)
40	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4" (for 8" grinding wheel only)
41	92-5380-832	Socket Head Screw, 1/4"-20 x 1"
42	472-1056	Spherical Washer
43	92-5380-836	Socket Head Screw, 1/4"-20 x 1 1/4"
44	92-2040-803-28	Washer
45	23-6742	Aligning Screw
46	23-6179	Control Valve (includes 47 through 54, 56 through 58, 60 through 62)
47	88-5715-8	Knob
48	421-33	Bushing
49	466-278	Rod Wiper
50	23-6715	Gasket
51	23-6689	Valve Piston
52	92-5380-824	Socket Head Screw,
53	23-6714	Front End Cap
54	23-6716	Retaining Plate
55	23-6744	Gasket
56	463-323	Flush Type Pipe Plug, 1/8" NPTF
57	23-6679	Valve Body
58	467-39	Micrometer Regulator
59	92-5380-844	Socket Head Screw, 1/4"-20 x 1 3/4"
60	92-5380-816	Socket Head Screw, 1/4"-20 x 1/2"
61	23-6718	Gasket
62	23-6717	Rear End Cap
63	466-160	"O" Ring
64	438-38	Thrust Bearing
65	438-50	Race

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE AND ATTACHMENT



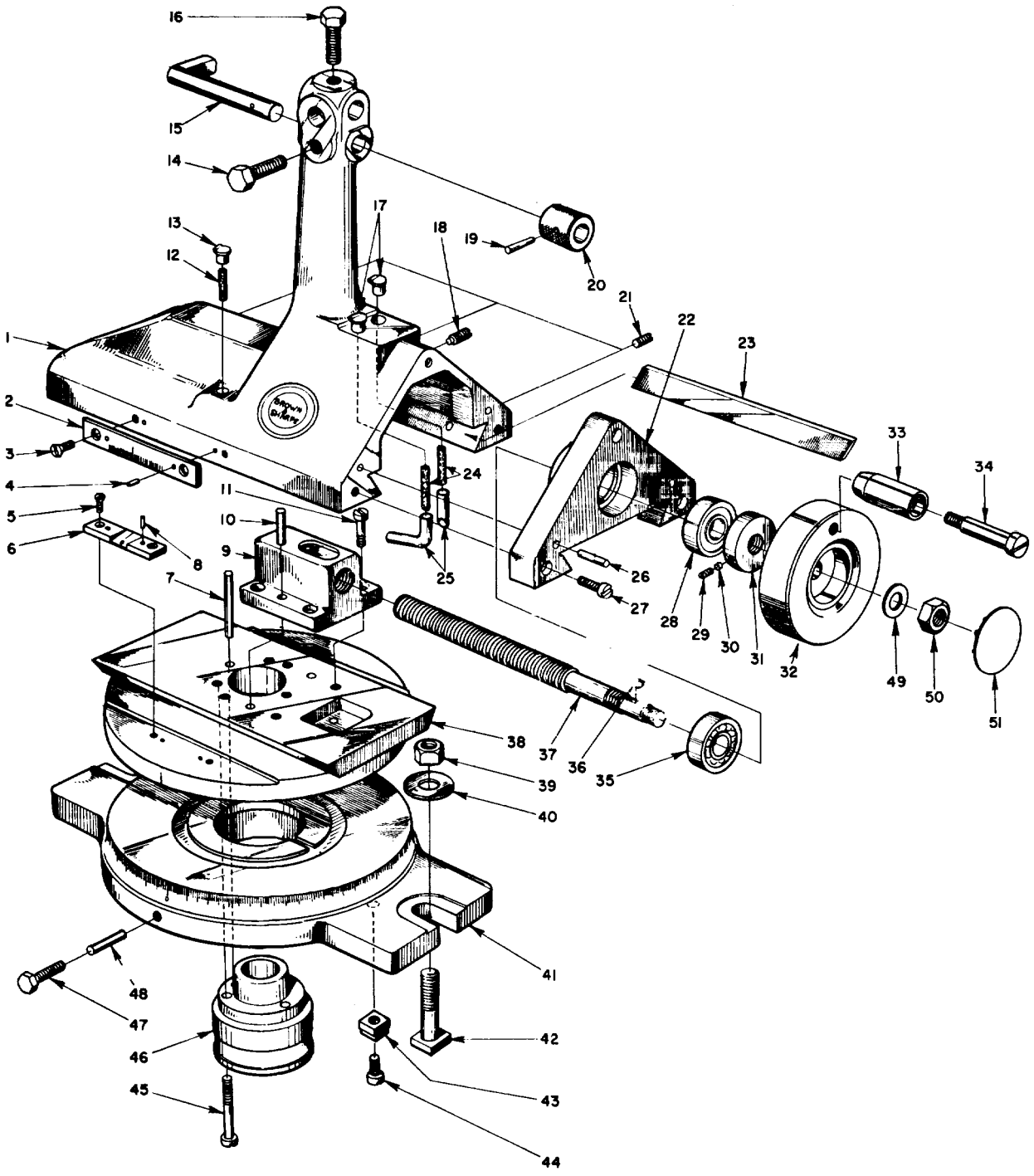
POWER OVER-THE-WHEEL
STRAIGHT LINE DRESSER PIPING

POWER OVER-THE-WHEEL
STRAIGHT LINE DRESSER PIPING

PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	464-631	Elbow
2	464-626	Connector
3	463-747	Hose Assembly
4	464-318	Swivel Nut Elbow
5	464-3662	Bulkhead Union
6	464-126	Tubing, 1/4" O.D. (order length in inches)
7	464-153	Tubing Clip
	92-5385-612	Button Head Screw, *6-32 x 3/8"
8	464-93	Connector
	464-628	Sleeve
	464-629	Nut
9	464-126	Tubing, 1/4" O.D. (order length in inches)
10	463-160	Hose Assembly
11	464-92	3/8 Outlet Tee
12	464-662	3/4-1/4 Tube Reducer
13	464-318	90° SW Nut EL 1/4 TU

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE AND ATTACHMENT



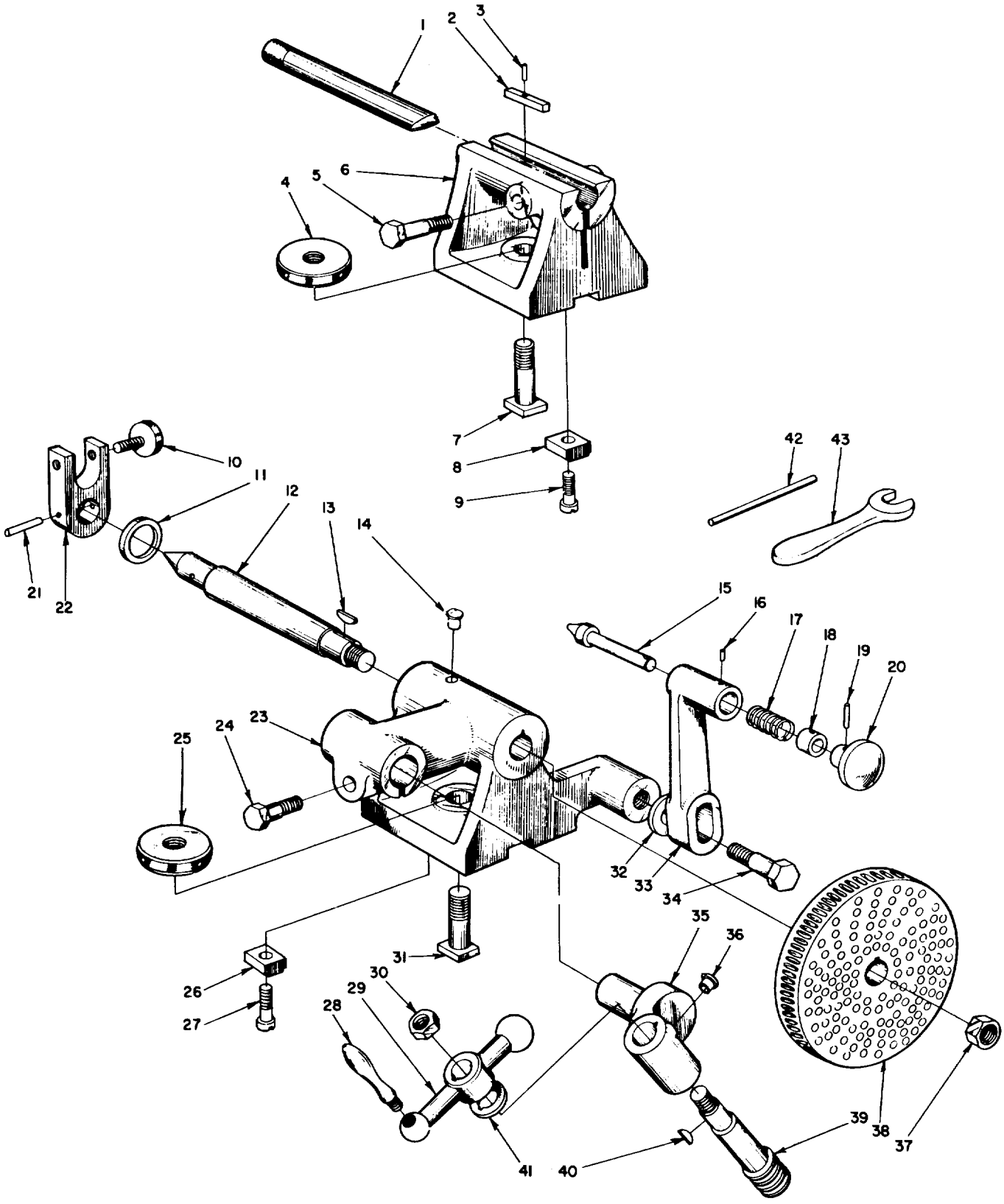
RADIUS AND ANGLE
WHEEL TRUING ATTACHMENT

RADIUS AND ANGLE
WHEEL TRUING ATTACHMENT

PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-3184	Slide (includes 22, 26, 27)
2	23-494	Slide Scale
3	92-81-612	Flat Head Screw
4	92-900-310	Dowel
5	92-81-508	Flat Head Screw
6	23-495	Slide Plate
7	92-900-840	Dowel
8	92-900-310	Dowel
9	23-918	Adjusting Nut
10	92-900-620	Dowel
11	92-50-724	Fillister Head Screw
12	466-175	Felt Wick
13	92-5550-6	Oil Cup
14	91-1-41	Clamp Screw
15	23-417	Diamond Setting Gage
16	91-141	Clamp Screw
17	92-5550-6	Oil Cup
18	92-360-1016-8	Teated Set Screw
19	92-890-240	Taper Pin
20	23-419	Diamond Setting Gage Knob
21	92-70-620	Set Screw
22	23-3185	Bearing Cap (includes 26, 27)
23	23-518	Slide Gib
24	466-169	Felt Wick
25	92-2450-638	Tubing
26	92-900-620	Dowel
27	92-50-724	Fillister Head Screw
28	433-1114	Ball Bearing
29	92-5391-608	Oval Point Set Screw, #10-32 x 1/4"
30	92-5930-504	Shoe
31	433-1114	Ball Bearing
32	23-4535	Handwheel
33	88-5805-10	Handle
34	472-1050	Shoulder Screw
35	433-1114	Ball Bearing
36	30-980-316	Key
37	23-3187	Adjusting Screw
38	23-521	Swivel
39	92-6015-1620	Nut, 1/2"-13
40	92-2040-1602	Washer
41	23-482	Base
42	92-6020-1640	Clamping Bolt
43	23-3490	Base Tongue
44	92-5051-820	Fillister Head Screw, 1/4"-20 x 5/8"
45	92-50-844	Fillister Head Screw
46	23-497	Swivel Pivot
47	92-5041-1024	Hex Head Screw
48	92-900-834	Shoe Pin
49	92-2010-1202-24	Washer, 3/8" I.D. x 3/4" O.D. x 1/16"
50	92-6015-1214	Nut, 3/8"-16
51	23-7056	Plug Button

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIE, STYLE AND SERIAL NUMBER OF MACHINE AND ATTACHMENT



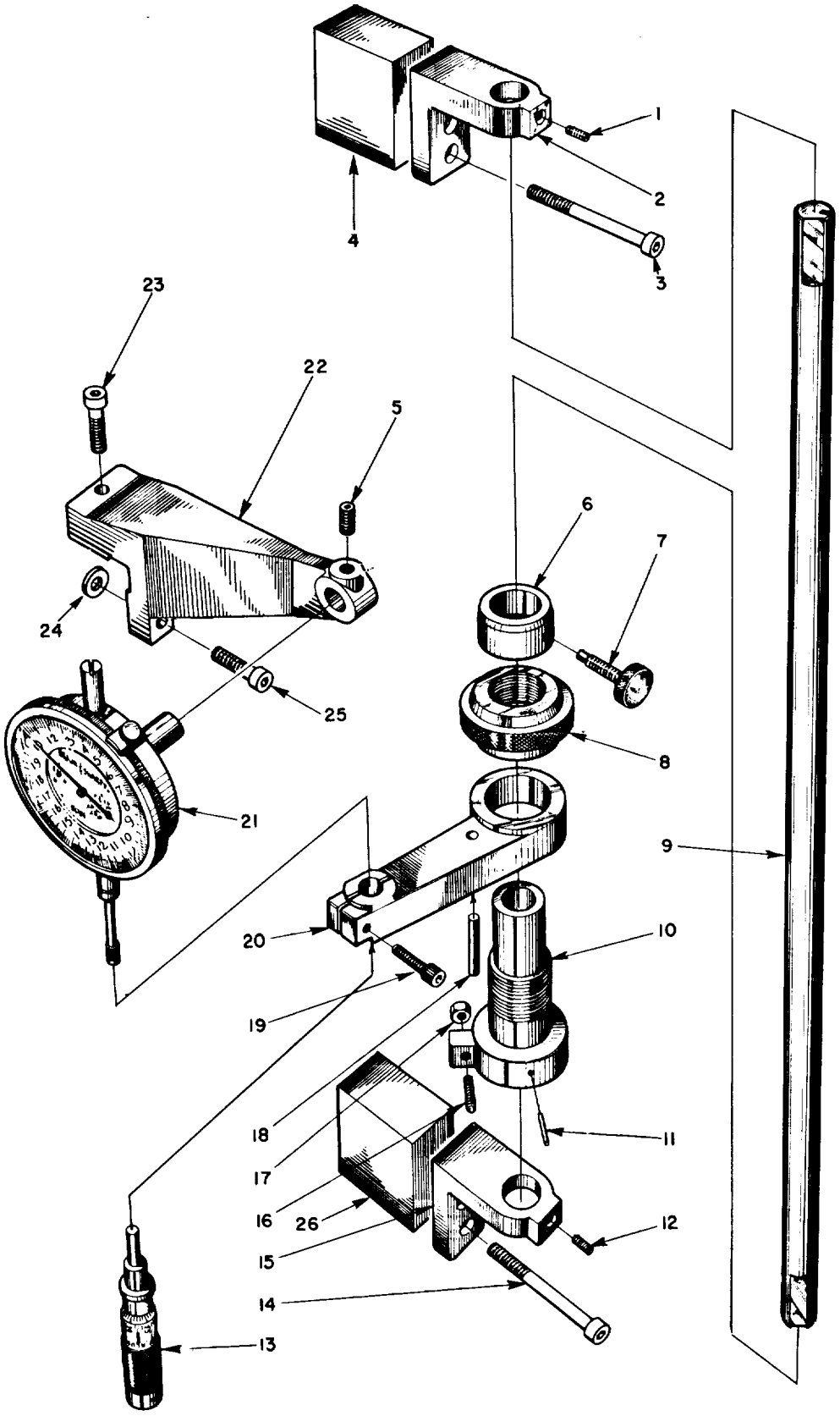
4 ¾ INCH INDEX CENTERS

4 ¾ -INCH INDEX CENTERS

PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-121	Footstock Center
2	92 -970-628	Footstock Key
3	92-900-312	Footstock Key Pin
4	25-3797	T-Clamp Nut
5	92-5035-1248	Hex Head Screw, 3/8"-16x22"
6	23-1691	Footstock, includes 8 and 9 (two of each)
7	92-5020-1640	Footstock T-Clomp Bolt
8	91-95-28	Footstock Tongue
9	92-5051-824	Slot Head Screw, 1/4 "-20x3/4"
10	92-5120-824	Headstock Center Driver Thumbscrew
11	91-201-211	Headstock Center Driver Washer
12	23-117	Headstock Center
13	92-980-420	Key
14	92-5550-6	Oil Cup
15	91-91-191	Index Pin
16	92-900-206	Pin
17	92-1000-1232-19	Index Spring
18	91-201-210	Stop Washer
19	92-900-316	Knob Pin
20	92-710-808	Knob
21	92-890-321	Toper Pin
22	23-120	Headstock Center Driver
23	23-1690	Headstock, includes 26 and 27(two of each)
24	92-5035-1236	Hex Head Screw, 3/8"-16x1 1/4"
25	25-3797	T-Clamp Nut
26	91-95-28	Headstock Tongue
27	92-5051-824	Slot Head Screw, 1/4" -20 x3/'4"
28	92-780-812	Index Worm Handle Extension
29	92-820-10	Index Worm Handle
30	92-6015-1012	Hex Nut, 5/16"-18
31	92-5020-1640	Headstock T-Clamp Bolt
32	92-2040-1404-28	Washer, 7/16" I.D.x7/8" O.D.x1/8"
33	23-227	Index Finger, includes 16 and 18
34	92-5035-1240	Hex Head Screw, 3/8"-16x1 1/2"
35	23-118	Index Worm Bearing
36	92-5550-6	Oil Cup
37	924010-1216	Hex Nut, 3/8"-16
38	23-605	Index Worm Wheel
39	23-116	Index Worm
40	92-980-316	Key
41	92-2044-1002-24	Index Worm Washer
42	91-90-68	T-Clamp Nut Pin Wrench
43	92-2500-18	Open End Wrench

ORDER BY PART NUMBER AND NAME, ALSO OIVE SRE, STYLE AND SERIAL NUMBER OF MACHINE AND ATTACHMENT



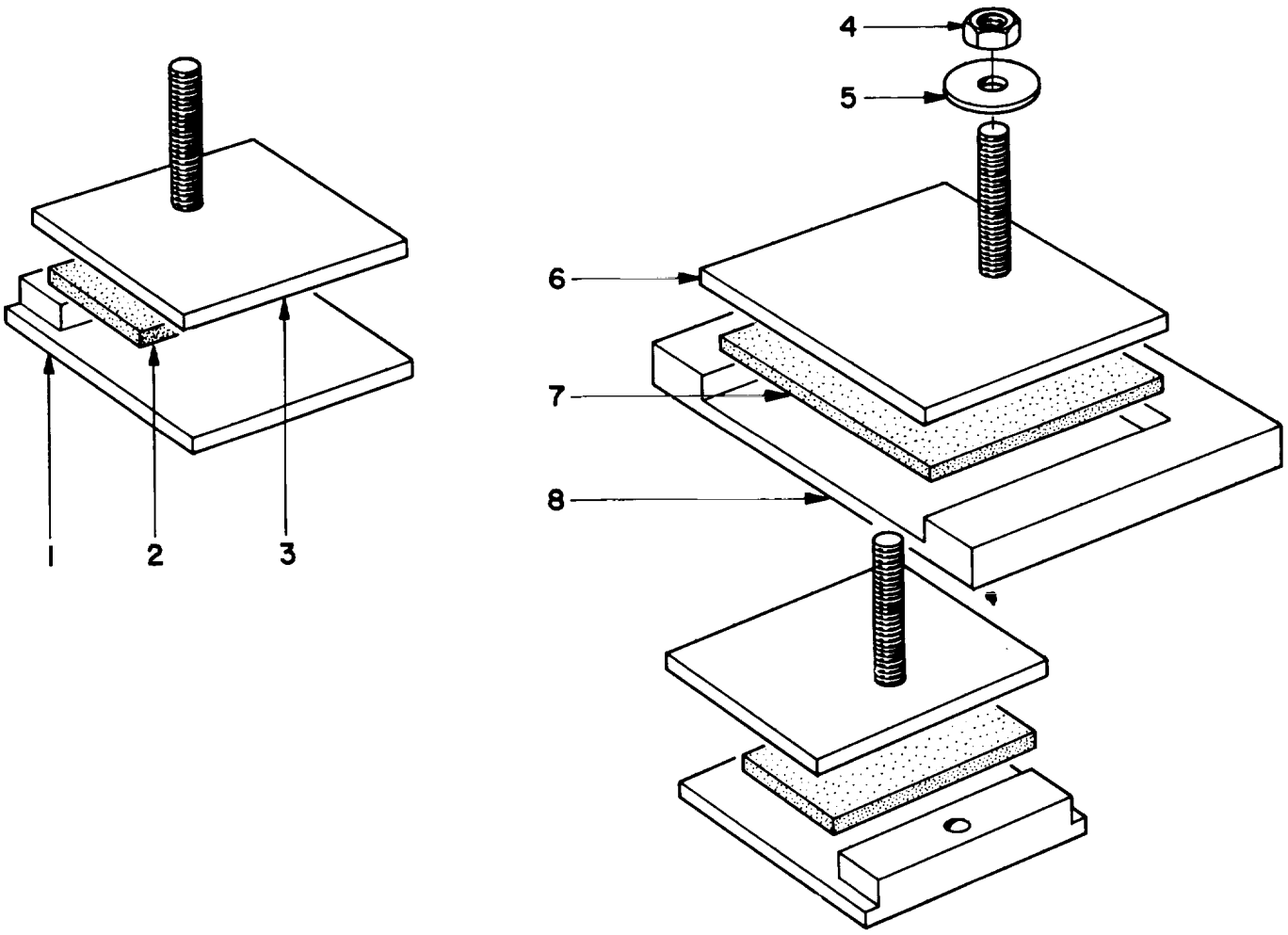
VERTICAL POSITION INDICATOR

VERTICAL POSITION INDICATOR

PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	92-5390-812	Cup Point Set Screw, 1/4"-20 x 3/8"
2	23-5579	Shaft Bracket
3	92-5380-852	Socket Head Screw, 1/4"-20 x 2 1/2"
4	23-6817	Bracket Mounting Block
5	92-5390-812	Cup Point Set Screw, 1/4"-20 x 3/8"
6	23-5584	Clearance Adjusting Washer
7	23-5585	Swivel Stop Clamp Screw
8	23-5583	Swivel Stop Nut
9	23-5582	Indicator Shaft
10	23-5580	Micrometer Head Swivel Stop
11	92-900-816	Dowel Pin
12	92-5390-812	Cup Point Set Screw, 1/4"-20 x 3/8"
13	599-298	Micrometer Head
14	92-5380-824	Socket Head Screw, 1/4"-20 x 3/4"
15	23-5579	Shaft Bracket
16	92-5390-624	Cup Point Set Screw, #10-32 x 3/4"
17	92-6015-608	Nut, #10-32
18	92-900-836	Dowel Pin
19	92-5380-624	Socket Head Screw, #10-32 x 3/4"
20	23-5581	Micrometer Head Swivel
21	479-199	Dial Indicator, #452
22	23-5845	Indicator Gage Bracket
23	92-5380-836	Socket Head Screw, 1/4"-20 x 1 1/4"
24	92-2040803-20	Washer
25	92-5380-836	Socket Head Screw, 1/4"-20 x 1 1/4"
26	23-68-17	Bracket Mounting Block

ORDER BY PART NUMBER AND NAME, ALSO GIVE SIZE, STYLE AND SERIAL NUMBER OF MACHINE AND ATTACHMENT



ISOLATION MOUNTINGS

PARTS LIST

INDEX NO.	PART NO.	PART NAME
1	23-5174	Base Plate
2	23-5175	Isomode Pad
3	23-5176	Top Plate
4	92-6015-1620	Nut, 1/2"-13
5	92-2040-1604-42	Washer
6	23-6170	Top Plate
7	23-6169	Base Plate Cushion
8	23-6171	Bay Plate

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