OPERATION AND MAINTENANCE

(INCLUDING REPAIR PARTS)

of the

BROWN & SHARPE

Nos. 1, 2, 3 and 4

UNIVERSAL GRINDING MACHINES

B·S

Brown & Sharpe Mfg. Co.

Room 319 University Block
Syracuse, New York

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Phone 2-5917

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(Including Repair Parts)

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BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

Printed in U. S. A.

I1-117 IZ2-45

1M-12-44

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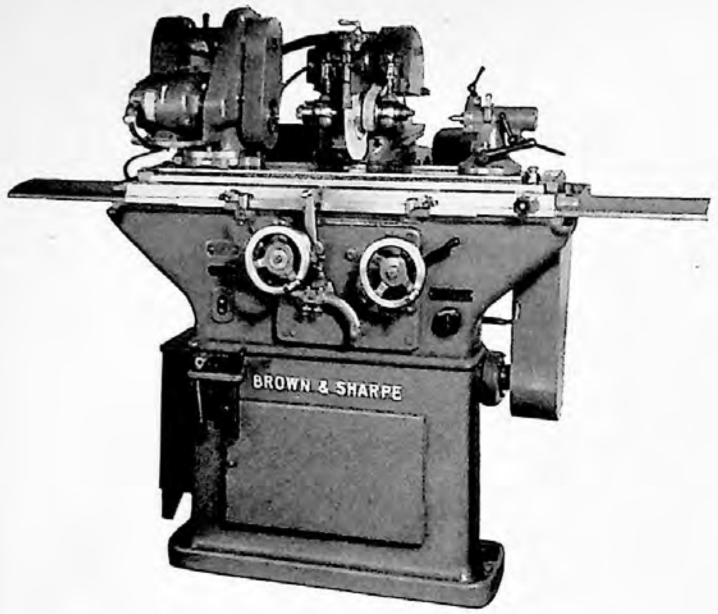
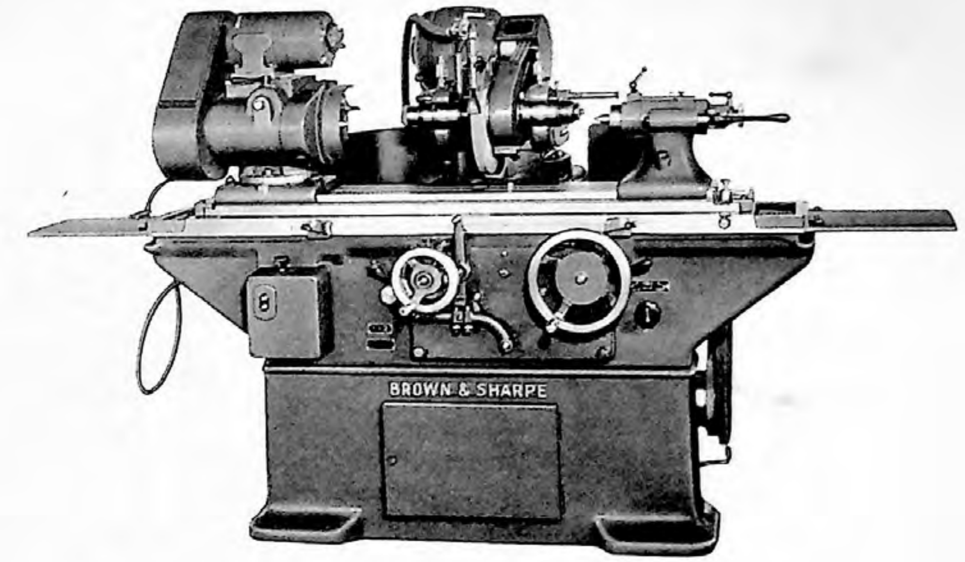
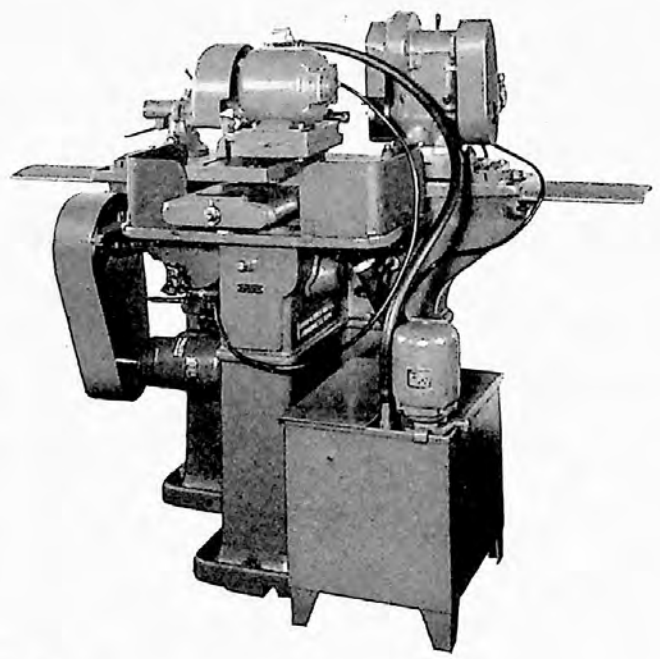


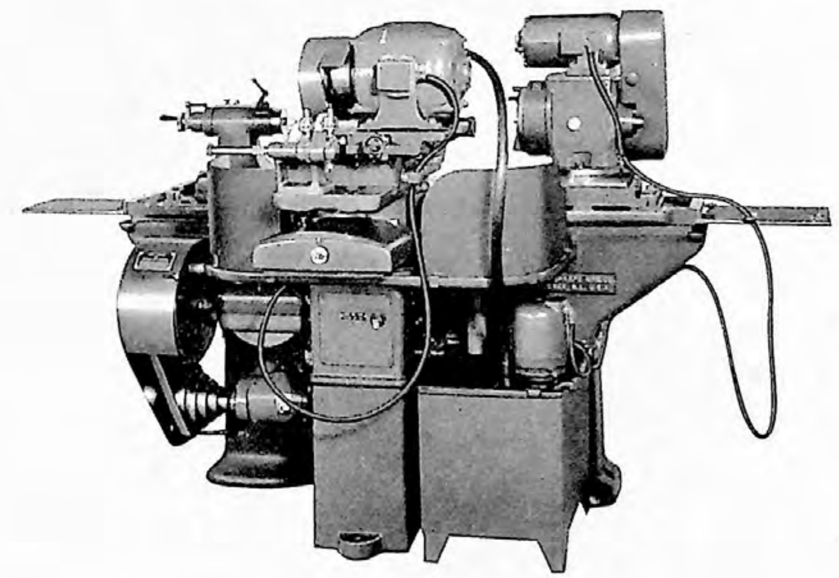


No. 1

— CAPACITY —

Length between centers	20″
Centers swing over table	10″ dia.
Centers swing over water guards	$8\frac{1}{2}$″ dia.

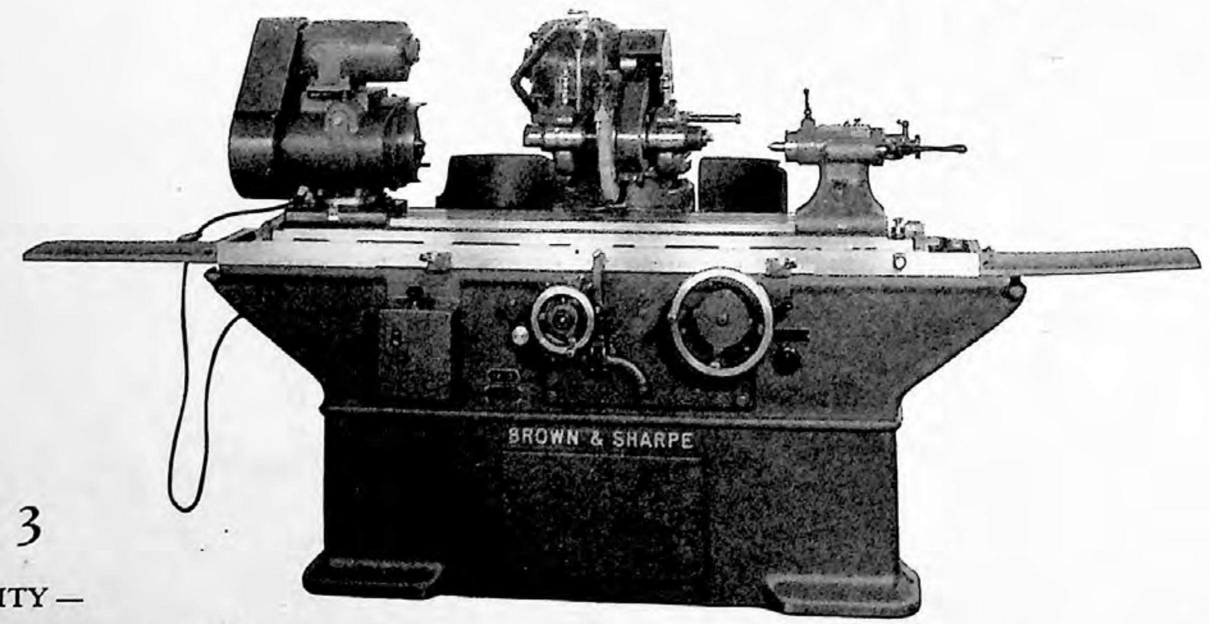




No. 2

— CAPACITY —

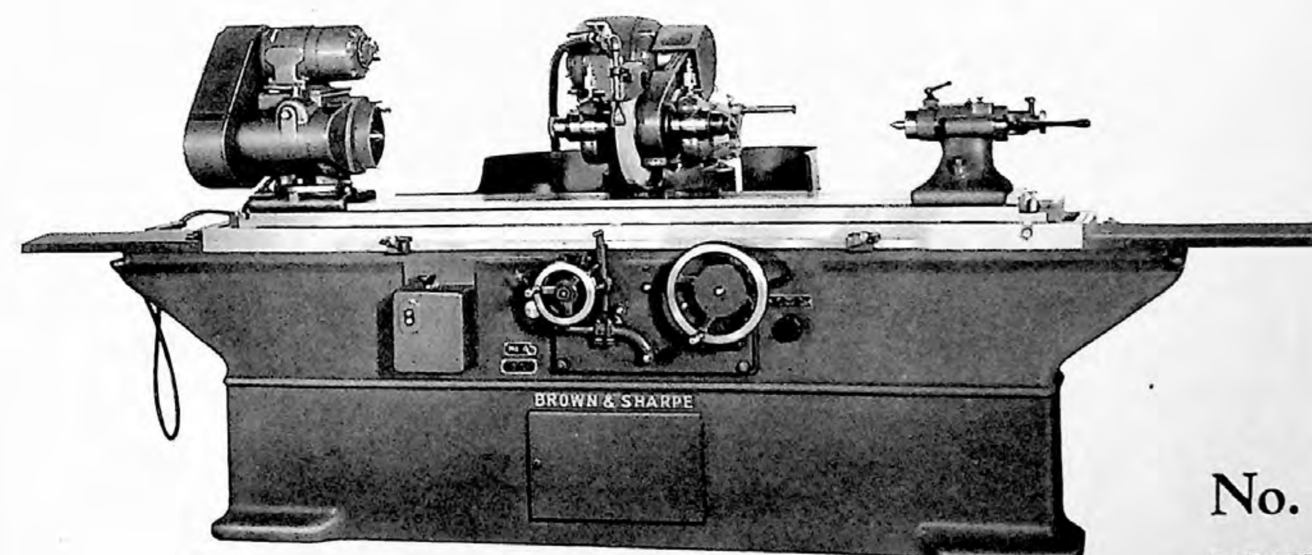
Length between centers	30″
Centers swing over table	14″ dia.
Centers swing over water guards	$12\frac{3}{4}$″ dia.



No. 3

— CAPACITY —

Length between centers	40″
Centers swing over table	14″ dia.
Centers swing over water guards	$12\frac{3}{4}$″ dia.



No. 4

— CAPACITY —

Length between centers	60″
Centers swing over table	14″ dia.
Centers swing over water guards	$12\frac{3}{4}$″ dia.

FOREWORD

Brown & Sharpe Universal Grinding Machines are designed to meet today's requirements in production and toolroom grinding. Unusually versatile, they are accurate, dependable and efficient for cylindrical, shoulder, combination cylindrical and shoulder, taper, internal, face, cutter and tool grinding. Furthermore, being universal, they handle the unusual jobs as easily as the common everyday jobs.

The purpose of this book is to give a thorough working knowledge of the Brown & Sharpe Nos. 1, 2, 3 and 4 Universal Grinding Machines. The book explains in detail each set-up adjustment and operating control. It tells how to select grinding wheels, and how to determine wheel speeds, work speeds and rates of table travel. Then, it illustrates and describes step by step how to set up a job in each of the six general classifications of grinding possible on these machines. This is followed by a discussion of possible grinding troubles and how to overcome them. A section on maintenance tells when and where to lubricate the machine, how to make mechanical adjustments and trace the electrical circuits. Finally, there is a repair parts section with the parts of the machines laid out in correct relationship to one another for easy identification and to make the construction of the machines more readily understood.

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PART I

PART II

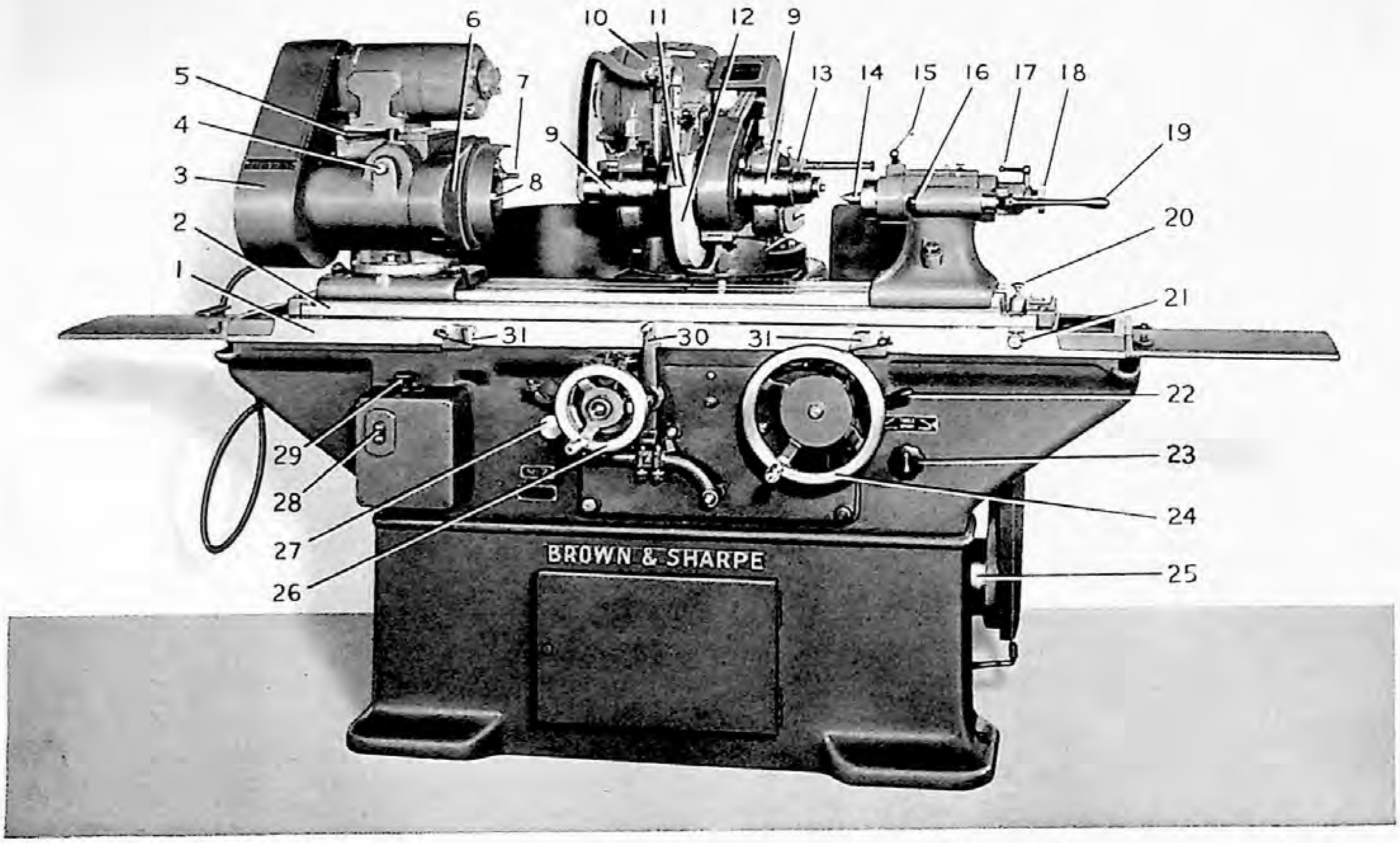
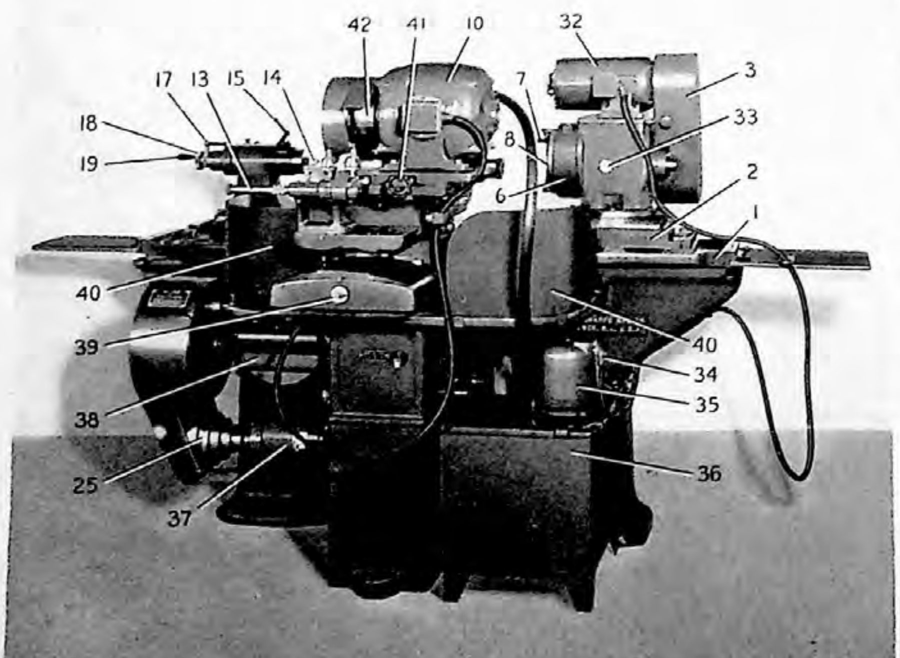


Fig. 1
Operating Controls and Principal Parts of the Nos. 2, 3 and 4 Universal Grinding Machines



1 Sliding Table
2 Swivel Table
3 Spindle Drive Belt Guard
4 Tension Adjustment
5 Belt Tension Release Lever
6 Headstock Spindle Belt Guard
7 Work Driving Pin
8 Headstock Center
9 Wheel Spindle Bushing
10 Wheel Spindle Motor
11 Coolant Nozzle
12 Grinding Wheel
13 Internal Grinding Fixture
14 Footstock Center
15 Diamond Tool Holder Clamp
16 Spring Pressure Adjusting Nut
17 Footstock Spindle Clamp
18 Spindle Adjusting Knob
19 Footstock Operating Lever
20 Swivel Table Locking Pin
21 Swivel Table Adjusting Nut and Scale
22 Table Feed Engagement Lever
23 Table Motor Selector Switch Knob
24 Table Handwheel
25 Lower Table Feed Cone Pulley
26 Cross Feed Handwheel
27 4:1 Ratio Cross Feed Engagement Knob
28 Main Push-Button Switch
29 Headstock Start-Stop and Jog Control
30 Table Reverse Lever
31 Table Reverse Dog
32 Headstock Motor
33 Spindle Lock for Dead Center Grinding
34 Coolant Pump Disconnect Plug
35 Motor Driven Centrifugal Coolant Pump
36 Coolant Tank
37 Two-Speed Gearhead Table Motor
38 Table Reversing Mechanism
39 Counterweight Adjusting Screw
40 Pan Water Guard
41 Motor Plate Adjusting Screw Knob
42 Internal Grinding Fixture Driving Pulley

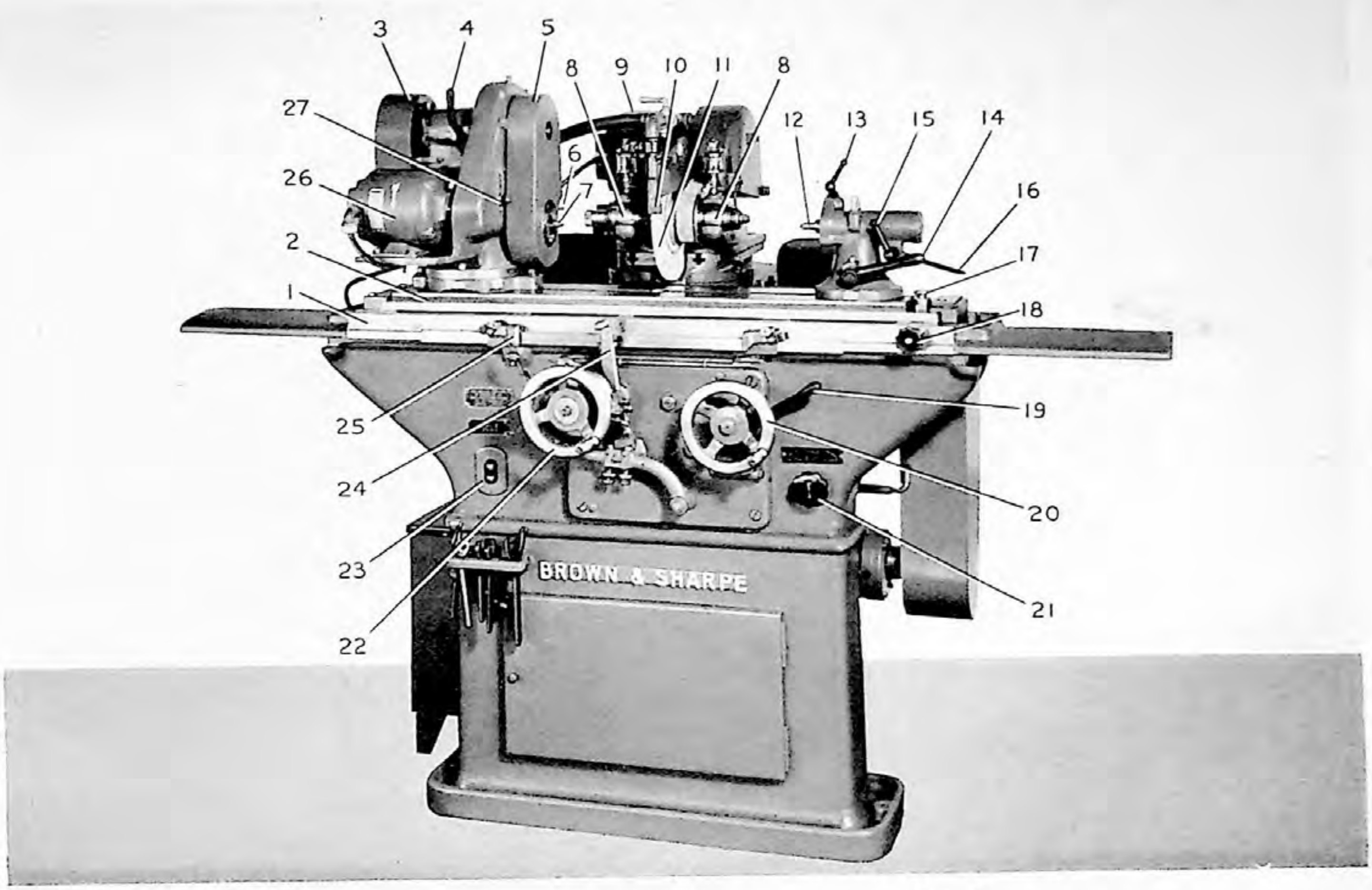
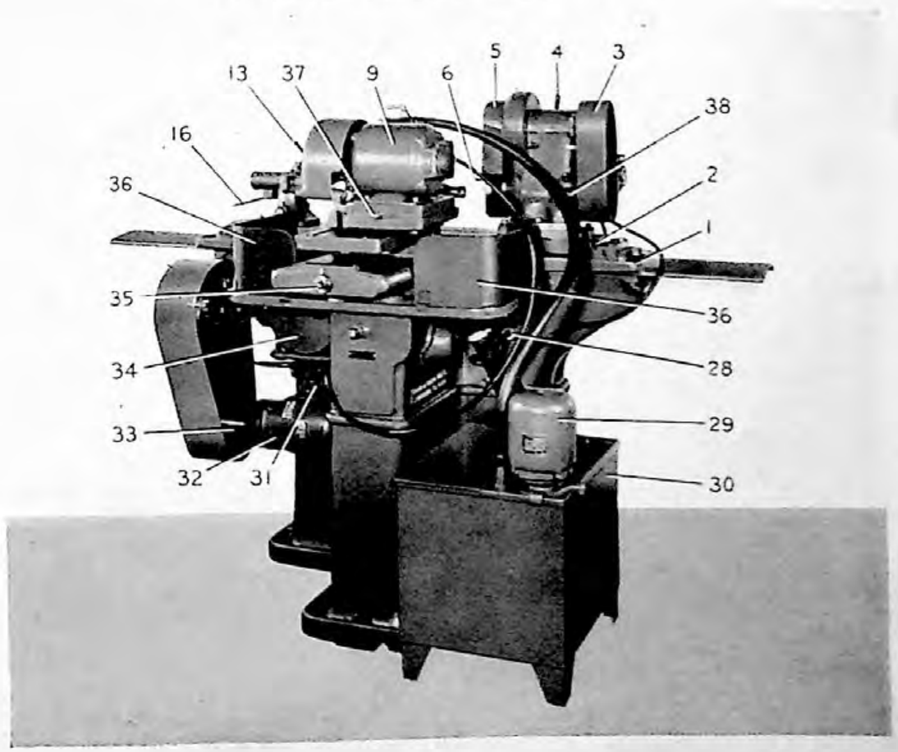
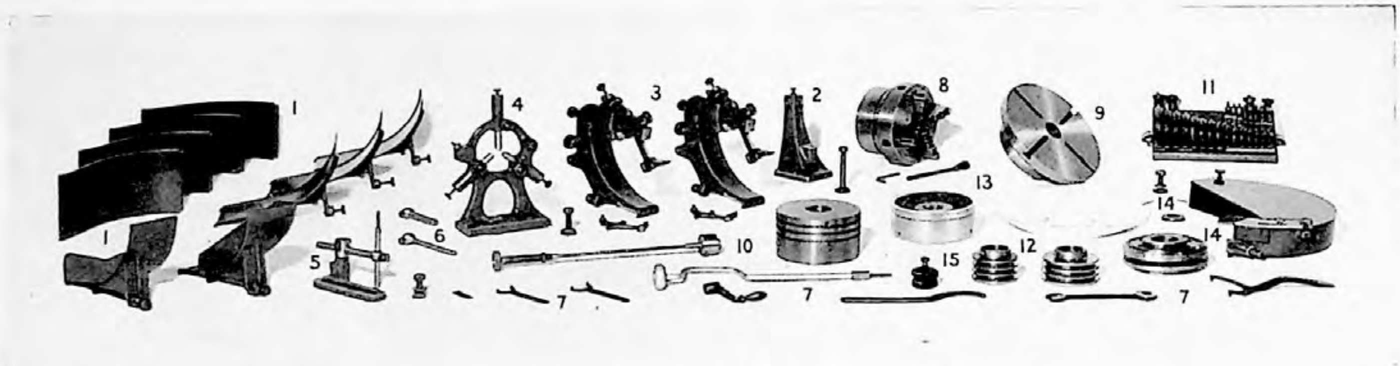


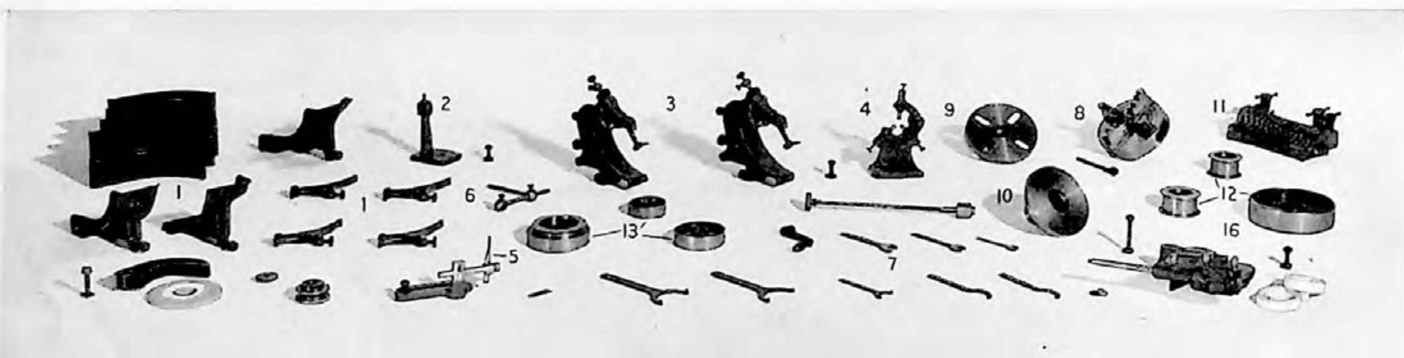
Fig. 2
Operating Controls and Principal Parts of the No. 1 Universal Grinding Machine

1 Sliding Table
2 Swivel Table
3 Revolving Spindle Drive Belt Guard
4 Headstock Operating Lever
5 Dead Center Drive Belt Guard
6 Work Driving Pin
7 Headstock Center
8 Wheel Spindle Bushing
9 Wheel Spindle Motor
10 Coolant Nozzle
11 Grinding Wheel
12 Footstock Center
13 Diamond Tool Holder Clamp
14 Footstock Clamp Lever
15 Footstock Operating Lever Clamp
16 Footstock Operating Lever
17 Swivel Table Locking Pin
18 Swivel Table Adjusting Knob
19 Table Feed Engagement Lever
20 Table Handwheel
21 Table Motor Selector Switch Knob
22 Cross Feed Handwheel
23 Main Push-Button Switch
24 Table Reverse Lever
25 Table Reverse Dog
26 Headstock Motor
27 Motor Idler Pulley Adjustment
28 Coolant Pump Disconnect Plug
29 Motor Driven Centrifugal Coolant Pump
30 Coolant Tank
31 Spindle Motor Reversing Switch
32 Two-Speed Gearhead Table Motor
33 Lower Table Feed Cone Pulley
34 Table Reversing Mechanism
35 Counterweight Adjusting Screw
36 Pan Water Guard
37 Motor Plate Adjusting Screw
38 Headstock Spindle Locking Pin





Standard Equipment Furnished with the Nos. 2, 3 and 4 Universal Grinding Machines.



Standard Equipment Furnished with the No. 1 Universal Grinding Machine.

1 Telescoping Water Guards and Brackets
2 Wheel Truing Fixture
3 Universal Back Rests and Adjustable Bronze Shoes
4 Center Rest
5 Tooth Rest, Holder and Bracket
6 Diamond Holders
7 Set of Wrenches
8 4-Jawed Independent Chuck
9 Face Plate
10 Face Chuck and Socket Rod
11 Set of Work Driving Dogs
12 Wheel Speed Change Pulleys or Sheaves
13 Headstock Speed Change Pulleys (No. 1 Machine)
Live Center Pulley (Nos. 2, 3 and 4 Machines)
14 Left-Hand Wheel, Guard and Sleeve
15 Wheel Puller (Nos. 2, 3 and 4 Machines only)
16 Internal Grinding Fixture (shown in position on Nos. 2, 3 and 4 Machines)

CHAPTER I

Set-up Adjustments and Operating Controls

This chapter explains how each set-up adjustment is made and the use of each operating control of the machine and its standard equipment.

The text is based on the Nos. 2, 3 and 4 Machines, which vary only in the length of work accommodated between centers. In certain instances the No. 1 Machine differs in design, and where these differences are important they are explained separately in narrow measure text.

Wheel Stand Assembly

Wheel Stand and Spindle. The wheel stand (Figs. 1 and 3) which supports the wheel spindle and wheel spindle motor is adjustable along the platen, to which it is secured by bolts in both platen T-slots. The right side of the stand should bear against the aligning strap which is fastened to the right side of the platen, when tightening the bolts. The stand is used most often in a forward position on the platen, but sometimes it must be moved back when grinding large diameters and when face grinding with the face chuck. This adjustment of the stand, together with the movement of the wheel stand slide by the cross feed mechanism, permits the center line of the spindle to range between $3\frac{1}{2}''$ and 19″ from the center line of the work.

On the No. 1 Machine (Figs. 2 and 4) alignment of the stand with the platen is secured by matching the finished surface on the left-hand side of the stand with a similar finished surface on the side of the platen. The adjustment of the stand, together with the movement of the wheel stand slide by the cross feed mechanism, permits the center line of the spindle to range between $2\frac{1}{4}''$ and 14″ from the center line of the work.

The wheel may be mounted between the bearings or at either end of the spindle. (Right-end mounting requires extra equipment—see pages 10 and 26).

The wheel positions on the No. 1 Machine are limited to left-end and between-bearings positions. Maximum diameter of wheel on left-end is 6″, and between-bearings, 10″.

The first step in mounting a wheel on the spindle is to remove the V-belt guard at the spindle by loosening the screw at the front of the dovetail guard support. The wheel guard, which is bolted to the stand by a single bolt in a T-slot in the stand, is removed next. Then the coolant system piping is swiveled out of the way. The piping can also be swiveled up and back out of the way when not in use.

The wheel spindle is held in the stand by the caps which fit over the spindle bushings. To remove the assembly from the stand, loosen the knurled nuts on the swing bolts and swing the caps back. Then pull the nuts forward so that they will catch in the caps and hold them up. Always exercise care in removing and handling the spindle assembly, as undue shock may cause serious damage. The spindle can now be removed for the purpose of mounting the wheel.

Remove the spindle guard on the left end of the spindle and slide off the left spindle bushing. To facilitate handling the spindle assembly, the spindle can be set vertically into the left-end spindle guard on a bench or other flat surface. Under ordinary conditions, this will support the assembly without further aid.

When mounting a grinding wheel on the sleeve, first lift the wheel with a support, such as the first

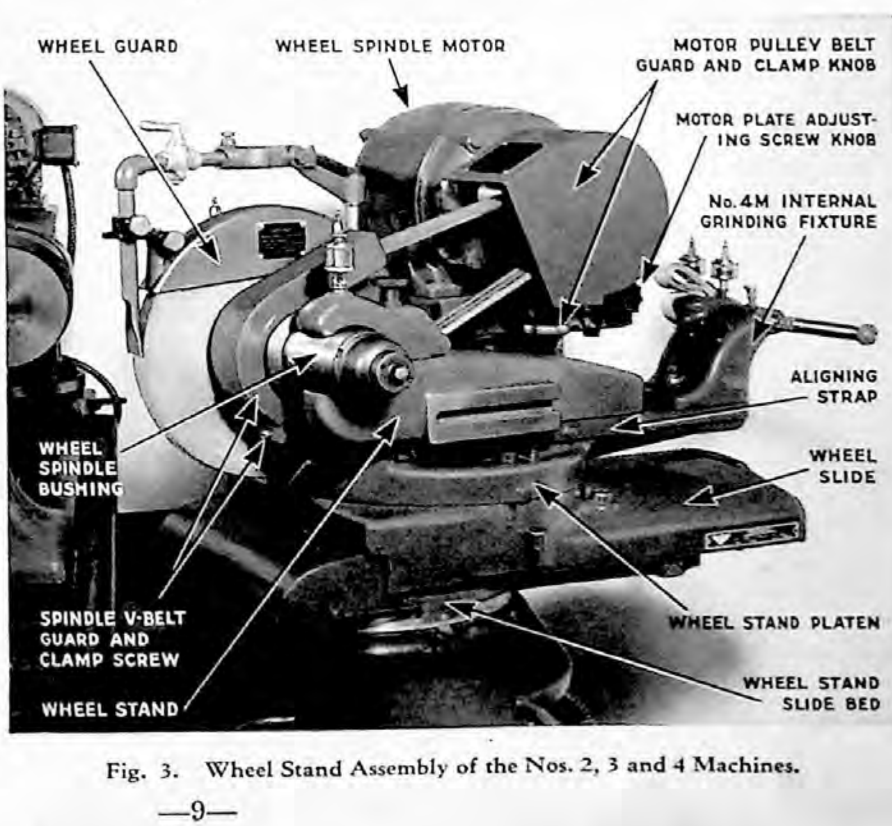


Fig. 3. Wheel Stand Assembly of the Nos. 2, 3 and 4 Machines.

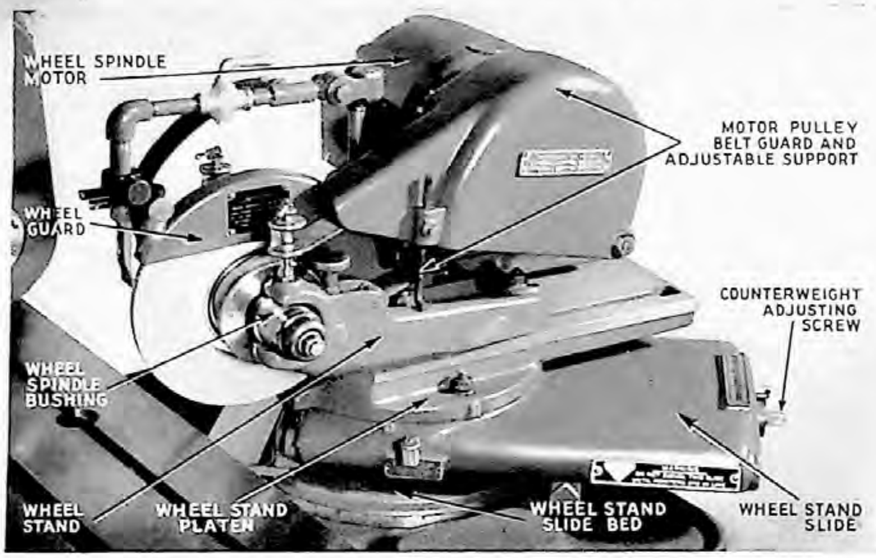


Fig. 4. Wheel Stand Assembly of the No. 1 Machine.

two fingers of one hand, and strike gently on the edge. The wheel should not be used if it does not ring clear. The wheel should slide onto the sleeve easily, but without play. A wheel that fits loosely cannot be centered accurately and will, therefore, run out of balance. If the fit is too tight, the wheel is liable to break. The rubber washers furnished should be used on each side of the wheel and the flange should be brought against the wheel and the set screws tightened to hold the wheel firmly in place.

On the No. 1 Machine, a wheel sleeve flange nut holds the flange firmly against the wheel. To take off the wheel sleeve flange, the center wheel sleeve nut must be removed.

Replace the left spindle bushing and guard. When the wheel is used between bearings, the spindle guard should always be screwed on in place of the sleeve at the left end of the spindle. The spindle assembly is now ready for remounting in the wheel stand. When replacing the assembly, make sure that the V-belts are in the proper grooves of the sheave and that the oil tube in each cap fits into the oil hole in the corresponding bushing before tightening the knurled nuts. The nuts should be just tight enough to prevent the bushings from turning and jumping. If they are too tight, the boxes will overheat.

Replace the V-belt guard and the wheel guard, and adjust the piping system if coolant is to be used. *Never* run a wheel without a guard.

Changes in spindle speed are obtained by changing the sheave on the spindle motor shaft. This is accomplished by loosening the nut which holds the sheave on the taper and using the wheel puller. (For wheel speeds available see Fig. 38 and table on page 29).

If the work requirements necessitate the use of the wheel on the left end of the spindle, the spindle and wheel are removed from the stand and the wheel dismounted from the sleeve.

In mounting the wheel on the left end (Fig. 5), the left-end wheel sleeve is used. The wheel and washers are mounted on the sleeve using the flange with balancing segments from the center sleeve and the assembly is held on the taper of the spindle end with the left-hand wheel sleeve nut. The left-end wheel guard is then fastened in place.

To mount a wheel sleeve at the right end of the spindle, additional equipment not regularly furnished with the machine must be used. These extras (Fig. 34) consist of a wheel guard, sheave and another wheel sleeve. After removing the spindle assembly from the stand, remove the flange, rubber washers, and wheel from the between-bearings sleeve and substitute the special sheave, using the same screws that were used to attach the flange. Mount the sleeve and wheel on the left end of the spindle and, turning the spindle end for end, replace it in the stand. The sleeve is now at the right end and the special sheave lines up with the motor sheave. Fasten the special wheel guard in place.

It is convenient to have a separate sleeve for each wheel that is to be used on the end of the spindle. This will eliminate the necessity of dis-

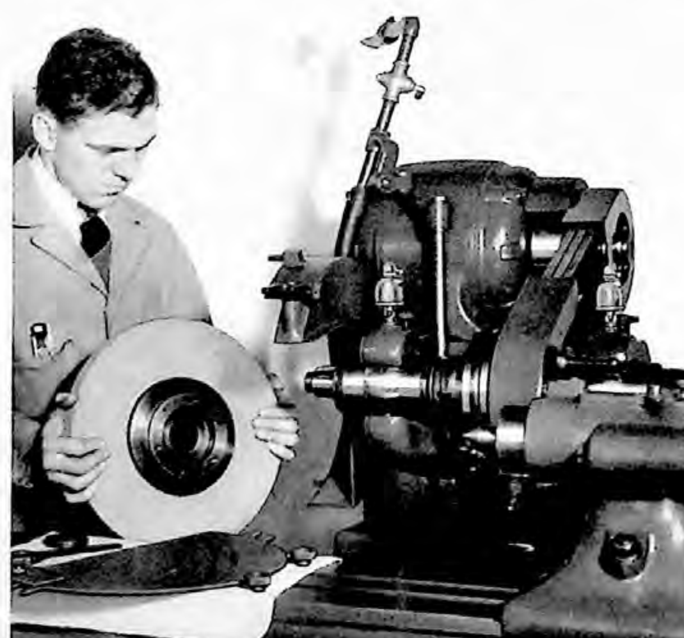


Fig. 5. Mounting a Wheel and Wheel Sleeve on the Left End of the Spindle of Nos. 2, 3 and 4 Machines.

mounting and mounting wheels each time a change is wanted.

The spindle driving motor is attached to a plate adjustable along the stand to regulate the tension in the driving belts. Adjustments are made by a screw knob directly connected at the rear of the motor plate. Turning the screw right-hand tightens the belt, while turning it left-hand relieves the tension. Before making this adjustment, it is first necessary to loosen the bolts underneath which fasten the plate to the stand. The tension of V-belts should be such that all belts will pull, yet none will be very tight or have much slack. (See page 44).

To relieve the belt tension on the No. 1 Machine, it is necessary to turn the motor adjusting screw counterclockwise, and push the motor plate forward.

Balancing the Grinding Wheel. It is essential that the wheel run perfectly true and without vibration. Two balancing segments are provided on the wheel sleeve flange, 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 true the wheel (see page 20).

2. Remove the V-belt pulley and using a suitable balancing arbor and balancing ways, let the wheel come to rest and mark the low point to locate the heavy side (see Fig. 6).

Fig. 6. Balancing the wheel.

3. Loosen the segment locking screws and slide the segments around to a trial position, locating the segments 90° each side of the heavy point. Clamp the segments and let the wheel come to rest.

4. Move both segments up a trifle away from the heavy point and again let the wheel come to rest. Repeat this adjustment as necessary, remembering at all times to keep both segments located an equal distance from the heavy point.

The wheel is in balance when it will remain at rest in all positions on the balancing ways.

The wheel sleeve flange on the No. 1 Machine does not have the balancing segments.

The Internal Grinding Fixture. A No. 4M Internal Grinding Fixture (Fig. 7), which runs at 15,000 R.P.M., is standard equipment and will grind holes up to 6" long and from $1\frac{1}{8}$" diameter up.

The fixture is held in place on the rear of the platen by a single bolt, which allows it to be swiveled slightly. It is usually left mounted with belt removed from motor pulley, when not in use, for the operator's convenience. To bring the fixture into operating position, the platen is swung half way around (180°). Guide lines (for matching) on the side of the platen and slide help in the alignment. Drive is by flat belt from the driving pulley on the motor shaft. Flat belts should be run tight but not stretched.

A No. 03M Internal Grinding Fixture, which runs at 15,700 R.P.M. is standard equipment with the No. 1 Machine. It will grind holes up to $5\frac{1}{4}$" long and from $\frac{3}{4}$" diameter up.

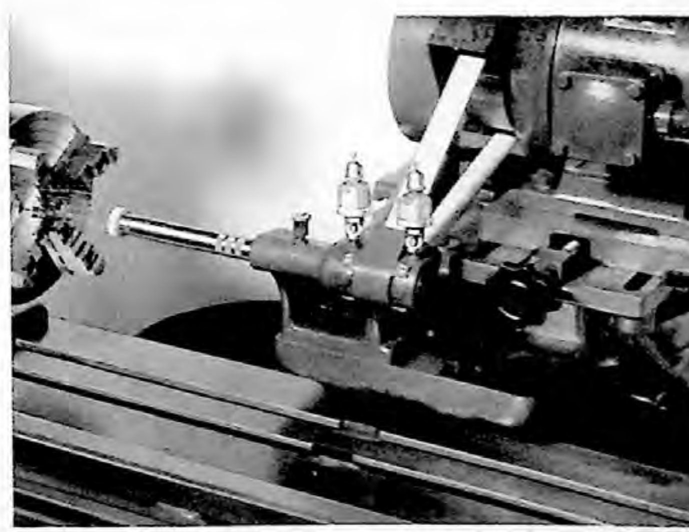


Fig. 7. No. 4M Internal Grinding Fixture in Grinding Position on the Platen of Nos. 2, 3 and 4 Machines.

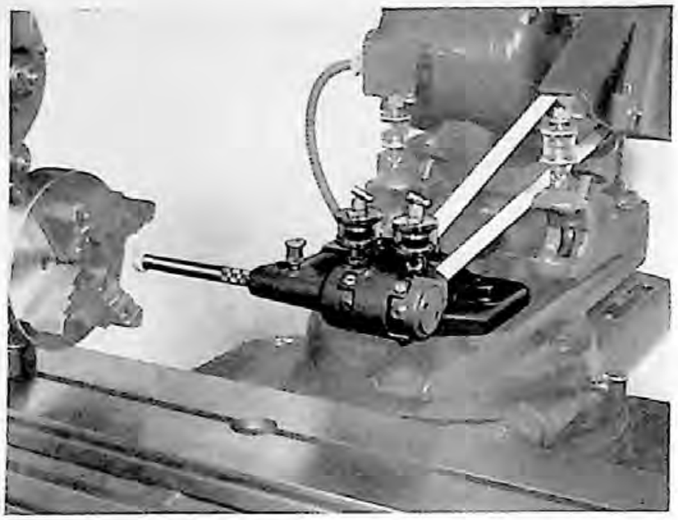


Fig. 8. No. 03M Internal Grinding Fixture in Grinding Position on the Platen of a No. 1 Machine.

The spindle assembly is removed and the wheel stand moved back to accommodate the fixture. Two bolts in the platen T-slots hold the fixture in place. One bolt hole in the fixture is elongated to permit the unit to be swiveled slightly.

The spindle driving pulley on the motor is removed to put on the spindle driving pulley for the Internal Grinding Fixture. This is done by taking off the nut which holds the pulley on the tapered sleeve.

It is necessary to change the direction of rotation of the motor when changing from external to internal grinding, or vice versa. This is controlled through a switch at the rear of the machine.

Similar fixtures and also ball bearing type fixtures having other speeds and capacities are available at extra cost.

Wheel Stand Platen. The platen (Figs. 3 and 4), which supports the wheel stand, is clamped to the wheel stand slide below by two bolts, one on either side. It can be set parallel to the slide by matching the guide lines on the side, or it can be swiveled to any angle with the slide.

Wheel Stand Slide. The wheel stand slide (Figs. 3 and 4) supports the platen, wheel stand, wheel spindle assembly and spindle driving motor unit. It is rack and pinion driven by the cross feed mechanism, with a maximum transverse movement of 6".

The maximum movement on the No. 1 Machine is 5 $^{5}/_{16}$".

Movement of the slide toward the work is resisted by a counterweight to compensate for backlash in the slide. Since external grinding is done on the front of the wheel and internal grinding on the rear, it is necessary to change the direction of the counterweight pull when changing from external to internal grinding and back again. This is done by turning the square-end shaft protruding from the rear of the slide. When changing from external to internal grinding, turn the shaft clockwise as much as it will go. Turn it counterclockwise as much as it will go when changing from internal to external grinding.

Wheel Stand Slide Bed. The bed (Figs. 3 and 4) provides ways (or bearing surfaces) for the wheel stand slide, and can be swiveled to 90° either side of zero—a scale graduated in half-degrees giving angular settings. When the bed ways are at right angles to the sliding table ways the reading is zero. Before swiveling the bed, move the slide, if necessary, until the pointer on the side of the wheel slide is directly above that on the wheel stand slide bed. This will balance the whole unit and make it easier to turn. The bed is clamped in position by two bolts, the nuts for which are underneath the projecting pan of the machine bed.

On the No. 1 Machine the scale is graduated in degrees to 90° either side of zero.

Headstock

This self-contained unit can be moved longitudinally along the swivel table and is clamped in position by two bolts, one either side of the base. It is aligned by the front lip of the base which bears for its entire length on the front edge of the table.

Start-stop and jog control is by means of a knob on the top of the main motor switch control box at the left front of the machine bed (Fig. 9). Turning the knob to the right starts the headstock motor, and hence the spindle, while turning to the left stops the motor. A spring-operated brake integral with the motor stops the work rotation quickly. The brake is released electrically when power is applied to the motor. Depressing the knob operates the jog control. The coolant system pump starts and stops with the headstock motor. The spindle is mounted in preloaded super-precision ball bearings at the front and preloaded super-precision roller bearings at the rear.

The work speeds are 65, 90, 125, 180, 255 and 360 R.P.M. — when powered with 60-cycle current — and the changes are obtained by shifting the position of a single V-belt on 6-step cone pulleys (Fig. 51). Drive is from the $^{1}/_{4}$ H.P. motor, mounted on top of the unit to an intermediate shaft in the front of the headstock, and then by flat belt to a work driving unit mounted directly on the 2" diameter — $4^{1}/_{2}$ — N.C., L.H. threaded spindle nose. Each of the work driving units furnished — dead center drive pulley, live center drive pulley, face plate, face chuck and 4-jawed chuck — has an integral driving pulley (Fig. 11).

A quarter turn of the belt tension release lever changes the position of the intermediate shaft suffi-

Fig. 9.
Right — Headstock Arrangement on the Nos. 2, 3 and 4 Machines.

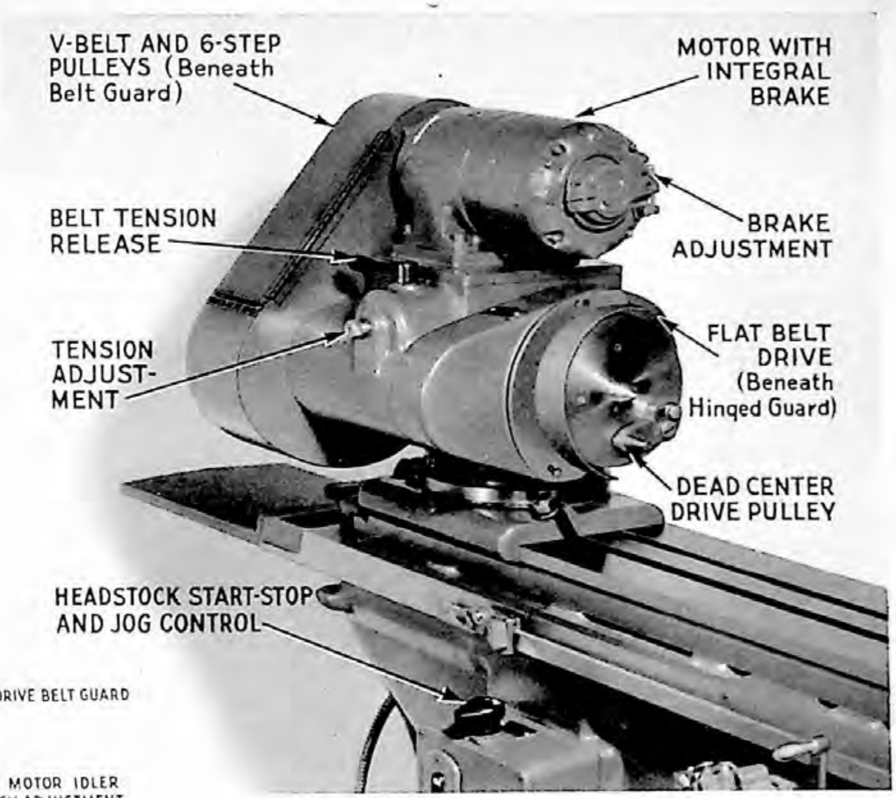
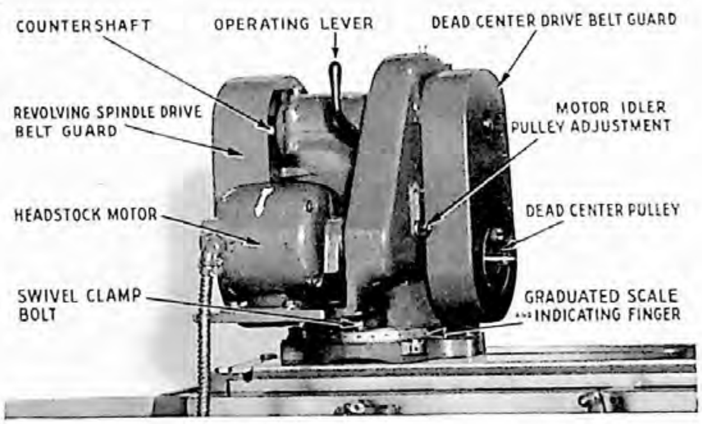


Fig. 10.
Below—Headstock of the No. 1 Machine.



ciently to slack-off the driving belts, thus facilitating changes of work speed and of work driving unit, as well as permitting manual movement of the spindle when truing-up work mounted on one of the chucks or on the face plate.

On the No. 1 Machine, the headstock (Fig. 10) is aligned with the footstock by the keys on the bottom of the base which fit into the table T-slot. The spindle has a No. 6 B&S taper center hole and the threads on the right end are 1½" in diameter, 6–N.C., R.H., and the scale is graduated by degrees to 100° each side of zero. The operating and braking is controlled by a single operating lever. With the operating lever of the headstock in the right of its three positions, the motor drive is connected to the countershaft. Moving the lever to the left position applies the brake which stops the shaft quickly, if in motion, and holds it from turning until the lever is moved back again.

Dead Center Grinding. To set-up for this type of grinding, the belt tension should be released and the V-belt moved to the step on the cone pulleys which will give the desired work speed. (The chart (Fig. 40) and the speed plate on the headstock belt guard will aid in this selection.) Place the dead center pulley on the threaded nose of the spindle and adjust the flat belt; then tighten the release lever.

In order to hold the spindle and center stationary when dead center grinding, the locking plunger at the rear of the headstock is seated in a slot in the spindle.

On the No. 1 Machine, the belt drive from the countershaft at the top of the unit should run to a dead center pulley at the right end of the spindle. Change pulleys for the countershaft and dead center pulleys for the spindle provide for several different work speeds. (For work speeds and belting diagrams see page 30 and Figs. 39 and 41.) The larger dead center pulley is attached to the smaller pulley by a radially-positioned set screw, and can be slipped on or off as needed. The smaller pulley is always in use when dead center grinding either as a pulley or as a support for the larger pulley. The idler pulley and stud are held in position against the pull of the belt by tightening the nut on the end of the stud. The belt should have no slack, but neither should it be stretched.

In order to prevent the spindle and center from turning when dead center grinding, a locking pin located at the left rear of the spindle is pushed into a drilled hole in the inner side of the pulley.

When the larger dead center pulley is not used, the ring-shaped belt guard should be attached to the main belt guard on the right end of the unit.

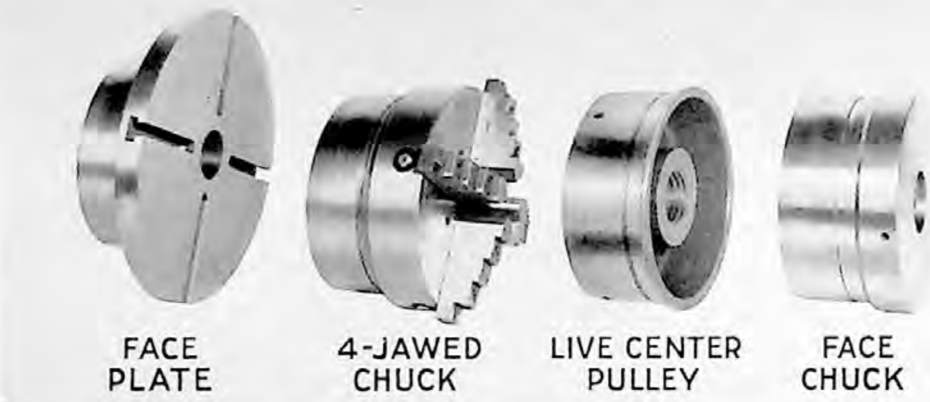


Fig. 11. Work Driving Units on Nos. 2, 3 and 4 Machines. Note that Both of the Chucks and the Face Plate Have Integral Pulleys.

Revolving Spindle Grinding. When using the live center pulley, the face plate, or one of the chucks furnished (Fig. 11), the dead center pulley is removed from the threaded spindle nose by loosening the unit with the spanner wrench furnished, and is replaced with the desired work driving unit. Lock the spindle with the locking plunger at the rear to facilitate removing or mounting the work driver. The locking plunger is then withdrawn to allow the spindle to revolve. The same work speeds are available, through the 6-step cone pulleys, for revolving spindle as for dead center grinding.

When the face chuck is used, the socket rod is inserted from the rear of the spindle and the thrust screw is tightened. The face chuck socket is then placed in the chuck and threaded to the socket rod, a pin in the socket and the keyway in the chuck preventing the unit from turning. The split bushing, which carries the work, is then expanded by a tapered screw threaded into the socket. In operation, the work is put on the bushing, the screw is turned to expand the bushing, and the knurled knob on the socket rod is operated to draw the work piece firmly against the plate. The end of the bushing should be below the surface of the work in order to clear the grinding wheel.

On the No. 1 Machine, the three largest dead center pulleys are also used as spindle change pulleys, being attached to the smallest spindle pulley in the same way they are attached to the smallest dead center pulley.

Footstock

Like the headstock, this unit can be moved longitudinally along the swivel table, and is clamped in position by a single bolt in the center of the base (Fig. 12). To assure alignment with the headstock, the front lip of the base should bear for its entire length on the front edge of the table. The center has a longitudinal adjustment of 1 1/16" by means of the knurled knob at the right end of the unit, and an included lever movement of 15/16".

The operating lever at the right is used to retract the center from the work. The movement is resisted by a spring which holds a plunger against the lever just in front of the pivot, and its pressure is adjusted by means of the nut at its left end. The pressure of the spring should be made great enough to hold the center firmly in the work but not so great that it springs the work piece or prevents it from turning easily. Holding the center in the work by spring pressure allows for expansion of the work due to heating while grinding, and automatically compensates for variations in length of pieces.

The spindle clamp in back of the knurled knob can be used to hold the center away from the work while setting up. Occasionally, on very heavy work, when it is feared that the maximum spring pressure is not enough to hold the center in the work, the clamp can be used to prevent movement of the center after it has been seated in the work. This latter practice, however, should be used with caution, as expansion of the work due to heating might damage the footstock spindle or the work piece.

The spindle has a No. 9 B&S taper hole. The center has a 60° point and can be driven from the

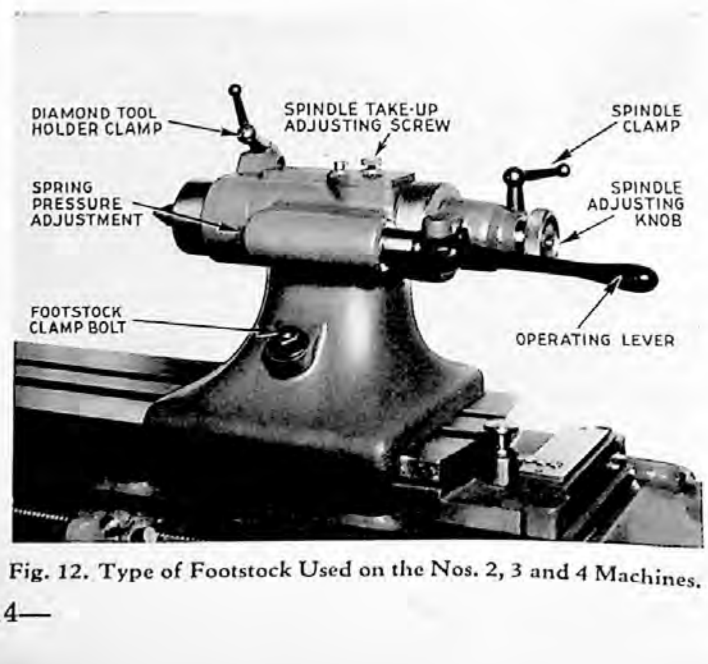


Fig. 12. Type of Footstock Used on the Nos. 2, 3 and 4 Machines.

spindle by a knockout rod inserted through the right end. The bracket and clamp at the left end are for the diamond tool holder usually used in truing the wheel.

The footstock on the No. 1 Machine (Fig. 13) is clamped by a lever in the center of the base, and is aligned with the headstock by the keys on the bottom of the base, which fit into the table T-slot. The center, which has a No. 6 B&S taper, can be locked in a fixed position by tightening the operating lever clamp located on the same stud as the lever.

When the operating lever is pressed down to its extreme low position, it moves the center nearly one-half inch. The movement is resisted by a spring between the right end of the spindle and the footstock nut on the right end of the footstock body.

A storage reservoir and oiler, for applying oil to the center points during operation, are located at the top of the footstock unit, to the right of the Diamond Tool Holder Clamp.

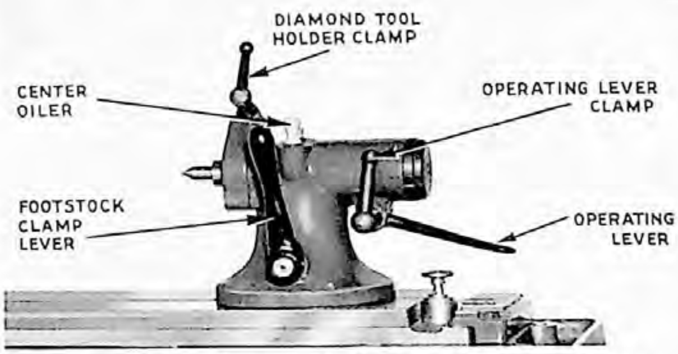


Fig. 13. Type of Footstock Used on the No. 1 Machine.

Swivel Table

The swivel table (Fig. 14) pivots about a central stud and is clamped to the sliding table by a clamp bracket and two bolts at each end.

A plate on the right-hand clamp bracket has three graduated scales for setting the table at an angle to grind slight tapers. The inner scale gives the taper in degrees and reads half the included angle by 5-minute graduations; the middle scale gives the taper in inches per foot and reads the included angle by sixteenths-of-an-inch graduations; and the outer scale gives the taper in percent and reads the included angle by half-percent graduations. See table at right. Steeper tapers are obtained through settings of the wheel stand assembly.

To facilitate setting the table at an angle, there is both a coarse and fine adjustment. The coarse adjustment is obtained by lifting the locking pin next to the scale pointer, turning it at right angles so that it will stay up, and pushing the table to its approximate working position. Then, after turning the pin and letting it down into one of the notches in the plate beneath, fine adjustment is obtained by turning the nut at the forward end of the plate.

Some slight adjustment in the table setting may be necessary after testing the first piece in a job. To facilitate this, the hub of the nut has a number of evenly spaced lines on its periphery, and there is a single line on the top surface of the plate. When turning the nut to make the adjustment, the number of lines on the nut which pass the line on the plate are noted. If, for instance, the adjustment turns out to be twice what it should have been, the nut is turned back through half as many lines to get the correct setting.

In addition to the angular T-slot for clamping the headstock and footstock, the table has a 3/4" vertical T-slot for locating and clamping any attachments which may be used.

The table of the No. 1 Machine has a vertical T-slot 9/16" wide.

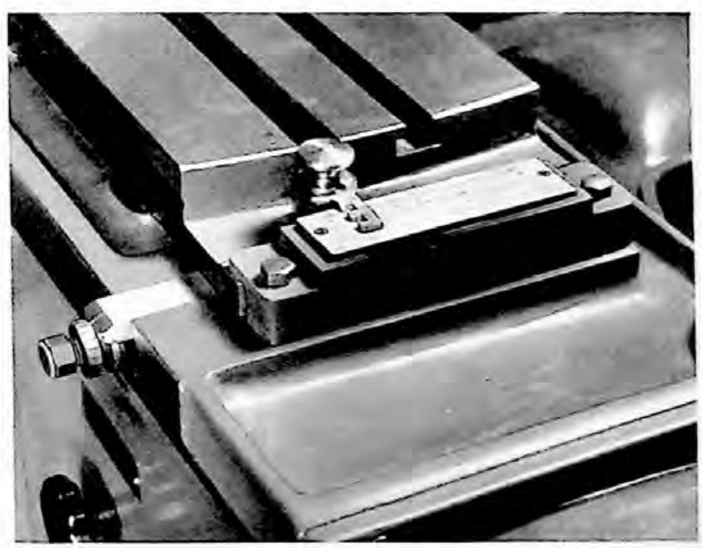


Fig. 14. Swivel Table Scale, Locking Pin, Index Finger, Adjusting Nut and Right-Hand Clamp Bracket on the Nos. 2, 3 and 4 Machines.

Graduations and Range of Table Scales for Grinding Slight Tapers

Number of Machine	Inner Scale, Degrees. 5-Minute Graduations		Middle Scale, Inches Per Ft. 1/16 Inch Graduations		Outer Scale, Percent. 1/2 Percent Graduations	
	Forward of Zero	Rear of Zero	Forward of Zero	Rear of Zero	Forward of Zero	Rear of Zero
1	1	7	1/2	3	5	25
2	1	8	1/2	3 1/2	5	30
3	1	8	1/2	3 1/2	5	29
4	1	6	1/2	2 1/2	5	21

Sliding Table

The table is driven through a rack and pinion, either by hand or by power. When driven by power, adjustable dogs act to stop the table and reverse it automatically at the end of each stroke.

For hand table travel, pull out the lever at the right edge of the handwheel (Fig. 15). This engages the handwheel and disengages the power feed. As a precautionary measure, turn the table motor switch knob at the right of the handwheel to *stop* so that, if the lever should be accidentally pushed in, the table will not become power driven. Turning the handwheel counterclockwise moves the table to the left, while turning it clockwise moves the table to the right. One revolution moves the table 0.82".

On the No. 1 Machine, one revolution moves the table 1.15".

The lever with the handle at the right edge of the cross feed handwheel reverses the table automatically when contacted by one of the dogs, or when operated by hand while the table is being power driven.

Before running the power table travel, it is advisable to set the table reverse dogs to prevent any mishap. To set a table dog (Fig. 16), lift the pawl in back of the knurled check nut and adjusting screw, and slide the unit to its approximate working position. Engage the pawl with the rack.

For power table travel, first make sure that the lever at the edge of the handwheel is in the *out* or hand travel position and then change the position of the belt on the cone pulleys at the right rear of the machine to give the rate of table travel desired. See Fig. 17, and also the rates of table travel listed on page 31. Next, turn the table

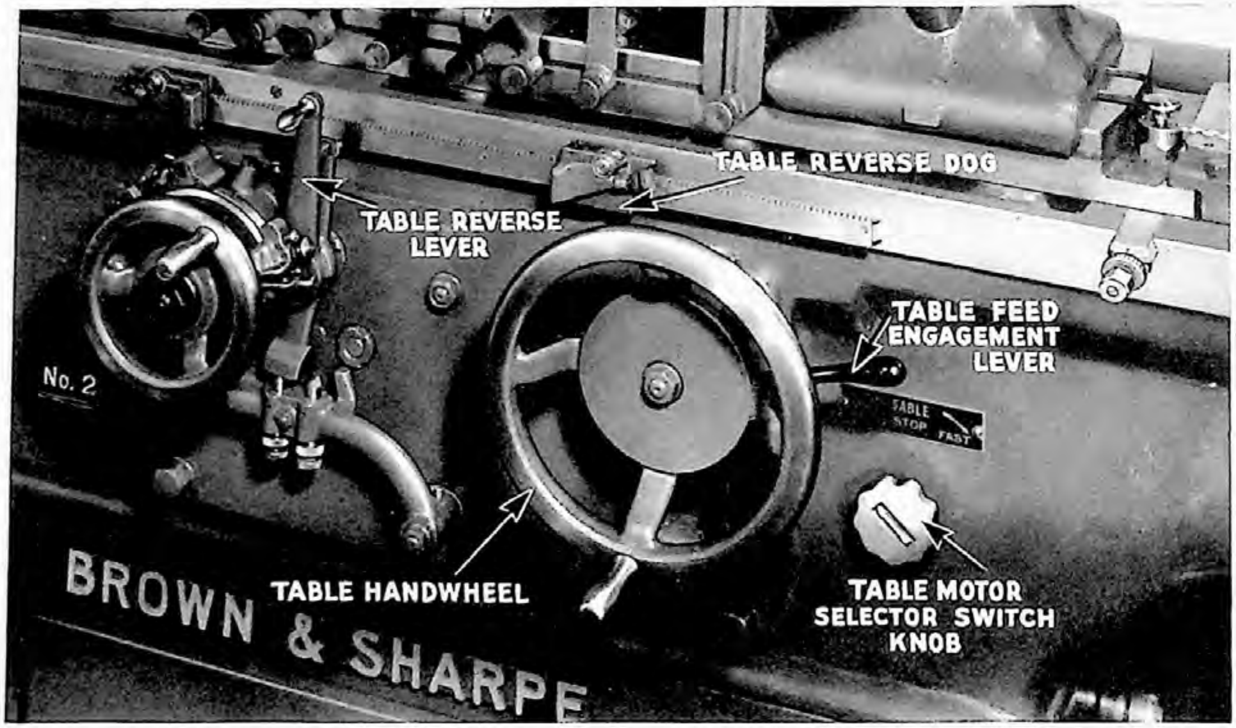


Fig. 15. Sliding Table Set-up Adjustments and Operating Controls of the Nos. 2, 3 and 4 Machines.

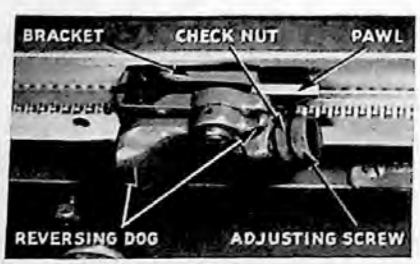


Fig. 16. Right-hand Table Reverse Dog.

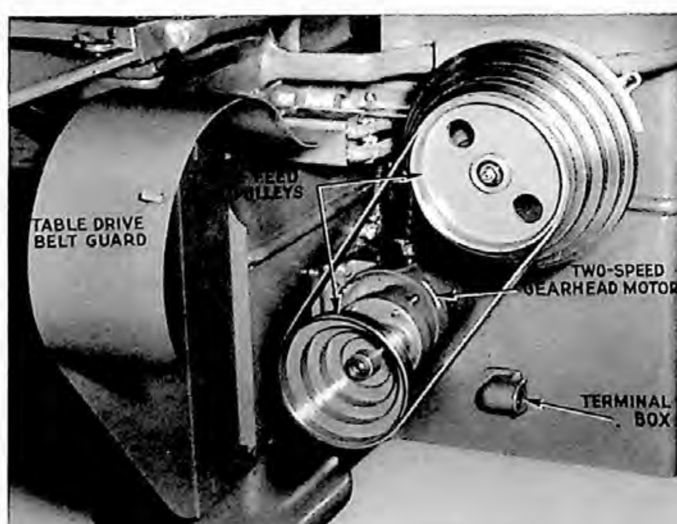


Fig. 17. Drive for Power Table Travel on the Nos. 2, 3 and 4 Machines (Belt Guard Opened).

motor switch knob either to the left or right, depending upon whether the table motor should run at its slow or fast speed. Press the main push button at the front of the machine bed. To start the table, push in the lever at the edge of the handwheel. To stop the table, it is only necessary to pull out the lever. The table can then be moved by hand until power feed is needed again.

While the table is being traversed by power, set the dog to its exact working position by turning the adjusting screw. Lock the screw in position with the check nut. When grinding to a shoulder the dogs can be depended upon to stop or reverse the table accurately each time. When grinding to the end of a piece, allow the wheel to run about one-quarter of its width off the work before stopping or reversing the table. To run the table beyond a dog, push down that part of the dog which projects above the knurled nut and screw. This will raise the rest of the dog away from the screw enough to clear the levers in its path. If the table should be accidentally run past its driving pinion, it can be pushed back in mesh again by hand.

Cross Feed

This mechanism can be operated (1) manually to move the wheel both to and from the work and (2) automatically, when external grinding, to feed the wheel toward the work as the table traverses.

Turning the handwheel (Fig. 18) counterclockwise feeds the grinding wheel toward the work when external grinding, and away from the work when internal grinding. One complete revolution of the handwheel gives the wheel slide a transverse movement of .0375". If the 4:1 ratio engagement knob at the left of the handwheel is pulled out, a movement four times greater, or .150" is obtained.

The No. 1 Machine is not equipped with the coarse hand feed (4:1 ratio).

The notches on the dial are so spaced that whenever the handwheel is turned to feed the wheel into the work, and the dial is moved only the distance from one notch to the next, the wheel is moved just enough to change the diameter of the work one quarter-thousandth of an inch. Every fourth notch is marked, representing a thousandth of an inch on the work diameter, and every fifth mark is numbered, thereby making the dial easy to read.

Manual Cross Feed. To feed the wheel manually when external grinding either with the table traversing or when plunge cutting, release the pawl (Fig. 18) from contact with the dial and slide the positive stop locking pin back in its bracket. With the wheel and work rotating and with the table traversing, unless it is a plunge cut, feed the wheel by hand. After the wheel has first ground the work for its entire length and has sparked out, stop the table and the work with the wheel at the footstock end of the work. Do not run the wheel back from the work. Measure the diameter of the

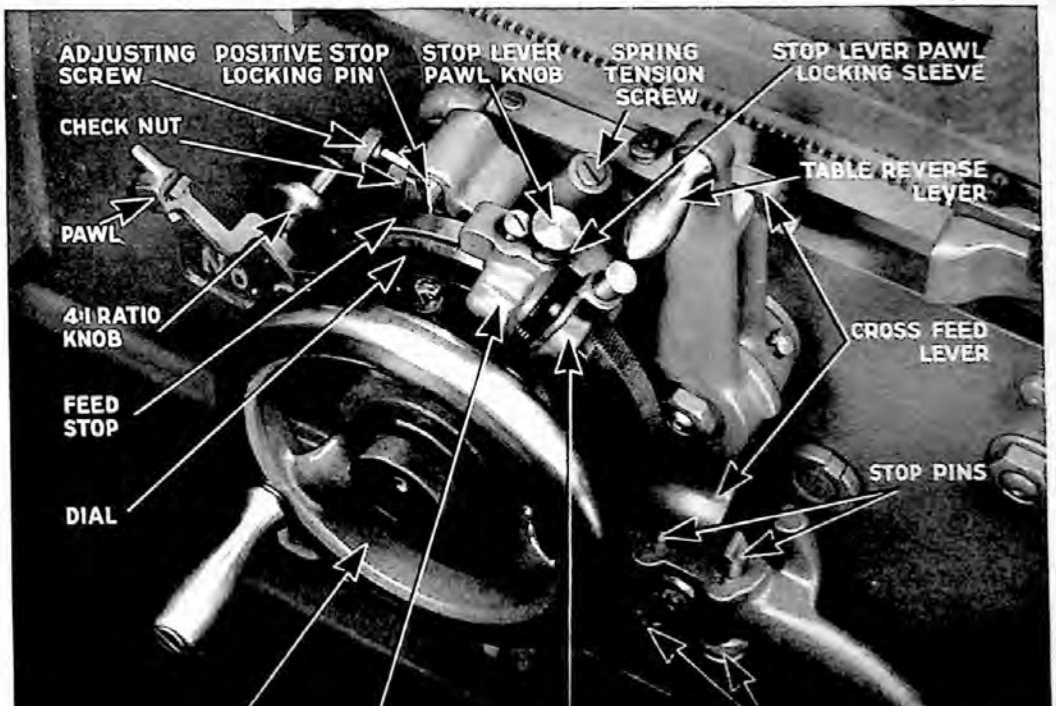


Fig. 18. Cross Feed Adjustments and Operating Controls of the Nos. 2, 3 and 4 Machines.

work, and determine the number of quarter-thousandths on the diameter yet to be removed.

Slide the pin forward in its bracket and, by lifting the knob on the stop lever, move the stop lever and the adjusting lever counterclockwise until the stop lever contacts the pin. Pinch the two levers together nearly as many times as there are quarter-thousandths yet to be ground from the work diameter. Each time the levers are pinched, they are moved clockwise one notch. Start the work rotating and the table traversing again, unless it is a plunge cut, and feed the wheel in until the stop lever contacts the pin. Run the wheel back from the work this time and stop the table and the work with the wheel at the footstock end of the work.

The work should now be close to the correct size. Measure the work, determine the number of quarter-thousandths on the diameter yet to be removed, and pinch the levers once for each remaining quarter-thousandth. Grind the work again, but as the wheel contacts the work, pull out the pin since it was pushed back in its bracket when the wheel was run back. When the stop lever contacts the pin, the work should be to size. Run the wheel back and stop the table and work with the wheel at the footstock end of the work. Give a final check to the work diameter.

If no adjustment to the levers is needed, lock the levers in position by turning the knurled locking sleeve below the knob on the stop lever so that it comes under the head of the screw to the left.

As each succeeding piece is ground, all that should be done is to feed the wheel in by hand until the work is nearly to size. Then, slide the pin out of its bracket and continue turning the handwheel until the stop lever is brought up against the pin. Allow the work pieces to spark out alike and each piece will be ground to the same diameter.

Because of the tension or *wind-up* created in the various parts when operating the heavy wheel slide unit through the cross feed mechanism, there is a slight tendency occasionally to *creep-in* when sizing to a positive stop. The locking pin bracket compensates for or relieves this condition. Variation of the amount of *relief* is made by means of the knurled screw and check nut, which control the amount of travel in the bracket spring.

In operation, the stop lever of the cross feed mechanism is brought against the positive stop locking pin by the counterclockwise feed movement of the handwheel. The counterclockwise movement is continued against the spring pressure of the locking pin bracket until the positive stop is reached. Then allow the spring pressure to move the handwheel back.

For internal grinding, first turn the counterweight adjusting screw to its proper position. Since internal grinding is done on the back side of the hole, turning the handwheel counterclockwise will move the wheel away from the work, and turning it clockwise will move the wheel toward the work. To feed the grinding wheel manually, release the pawl from contact with the dial and slide the positive stop pin back in its bracket. The pin is not used in internal grinding, because of the change in direction of rotation of the cross feed handwheel. It can, however, serve as a guide to approximate the finish-position for succeeding pieces.

Automatic Cross Feed. To feed the wheel automatically when external grinding with the table traversing, release the pawl (Fig. 18) from contact with the dial and slide the pin back in its bracket. With the wheel and work rotating and with the table traversing, feed the wheel by hand. After the wheel has first ground the work for its entire length and has sparked out, stop the table.

Place the pawl in contact with the dial again. Raise the knob on the stop lever and move that lever and the adjusting lever counterclockwise until the feed stop is under the pawl, lifting the pawl to let the feed stop pass. With the pawl resting on the feed stop, start the table again and pinch the levers together as many times as it is necessary to move the feed stop from under the pawl so that the pawl will engage a notch on the dial at a reversal of the table, and then ride up on the feed stop again. Stop the work and table with the wheel at the footstock end of the work.

Measure the diameter of the work and determine the number of quarter-thousandths inches on the diameter yet to be removed. Then pinch the levers once for each quarter-thousandth, or lift the knob on the stop lever and set the feed stop by means of the scale on the side of the dial. When the feed stop is at the proper setting, lock it there by turning the knurled locking sleeve below the latch so that the sleeve comes under the head of the screw to the left.

Start the work rotating and the table traversing again. Set the amount of projection of each of the adjustable stop pins, which are located below the cross feed lever, by adjusting the bushings and check nuts on each of them. This regulates the amount of movement of the pawl at each reversal of the table and, consequently, the amount of feed of the grinding wheel. The left stop governs the feed when the wheel is at the left end of the work, and the right stop governs the feed when the wheel is at the right end. Each stop can be set so that the pawl will move the dial through any number of notches from one to sixteen at each reversal of the table, thus giving wheel feed varying by quarter-thousandths inches between .00025 and .004 inches per reversal. Each stop also can be set so that the pawl will engage the dial only at alternate reversals, thereby permitting wheel feed only when the wheel is at one end of the work—either right or left end.

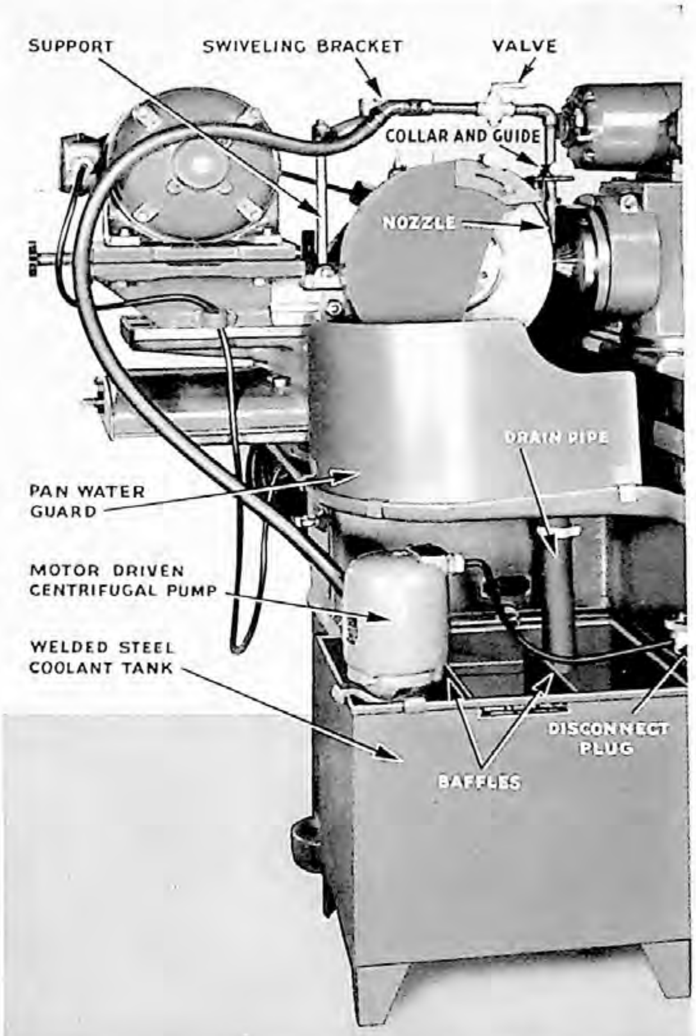


Fig. 19. Coolant System on the Nos. 2, 3 and 4 Machines.

The work should now be ground to size automatically. The pawl will engage the dial each time the table reverses until the feed stop comes under it, but as the wheel will show a cut even after the cross feed is thrown out, allow the cut to continue until it sparks the same as when the first measurement of the diameter was taken. Release the pawl from contact with the dial and run the wheel away from the work. Stop the table and work when the wheel is at the footstock end of the work. Measure the diameter and correct the setting of the feed stop, if necessary.

Replace the finished piece with one to be ground, start the work and table again, and run the wheel in until it touches the work. Engage the pawl with the dial and the new piece will be ground automatically to the correct size. As each piece is finished, repeat only this last step.

Coolant System

Coolant should be used whenever possible, as it serves to carry off the frictional heat developed by the wheel cutting the work. Unless this heat is carried off by the coolant or dissipated in some other way, the temperature of the work may rise until the work is distorted enough through expansion to result in the work being ground inaccurately. The work also may be burned, thus changing the physical properties of the piece. In addition, the coolant aids in keeping the surface of the wheel clean and free-cutting by washing from it loose particles of metal and abrasive.

The coolant pump motor (Fig. 19) is controlled by the main push button at the front of the machine bed. Use as much coolant as possible, controlling the flow by the valve above the nozzle. Place the nozzle so that the coolant will flow where the wheel contacts the work. Use enough water guards along the swivel table to fill the gap between the headstock and the footstock, and use the pan water guard at either side of the wheel stand, if possible. When coolant is not needed, disconnect the motor through the electrical disconnect plug, otherwise the pump will run whenever the wheel spindle does.

Any one of the better grades of commercial coolant compounds added to water should prove satisfactory as a coolant. The coolant tank has a capacity of 18 gallons, and should be cleaned and the coolant renewed every week or so. The pump and the baffles in the tank which aid settling can be removed easily when cleaning the tank. A

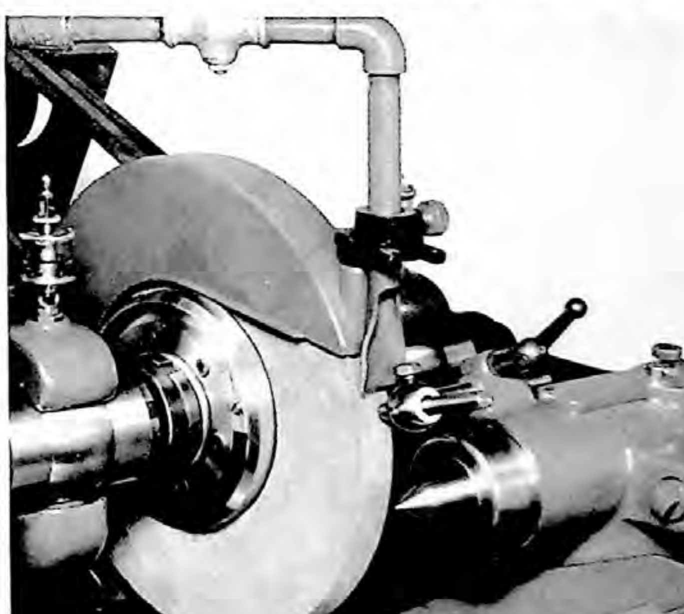


Fig. 20. Truing the Face of a Straight Wheel with the Diamond Tool Mounted on the Footstock of Nos. 2, 3 and 4 Machines.

Castered Base for the tank (additional equipment furnished at extra cost) is handy for moving the tank to a convenient place for emptying and cleaning. All parts of the machine contacted by the coolant, including the insides of the wheel guards, also should be cleaned at the same time.

Wheel Truing and Dressing

In order that a grinding wheel may give its most satisfactory service, it must run true both on the periphery and on the sides. To produce a good finish, while maintaining a satisfactory production rate, and also to assure economy of operation and safety for the operator, it must be neither dull nor glazed, but sharp.

The wheel is first trued to meet these conditions during setting-up operations any time after the swivel table and the wheel stand unit have been set in operating position. Subsequent truing or dressing is done whenever needed.

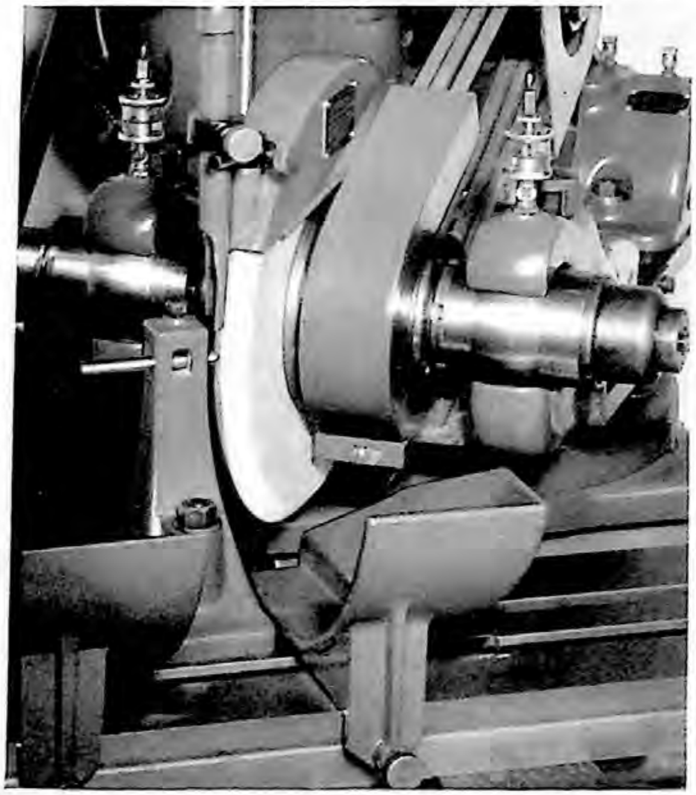


Fig. 21. Truing a Bevel on a Straight Wheel with the Diamond Tool Mounted in the Wheel Truing Fixture on Nos. 2, 3 and 4 Machines.

Truing is best accomplished with a diamond which is usually attached to the footstock (Fig. 20) by clamping the tool holder in the bracket on the left end.

The diamond should contact the wheel at a slight downward angle to prevent gouging. It is not necessary, when the tool is attached to the footstock, to remove the work from the centers in order to true the wheel. Just hold the right table dog so that it clears the levers in its path as the table is moved to the left to bring the tool up to the wheel. Pass the diamond across the wheel by traversing the table by power at a slow rate. Reverse the table by hand.

If the footstock mounting cannot be used conveniently, the diamond is held in the wheel truing fixture (Fig. 21) clamped to the swivel table by a bolt in the vertical T-slot. This table-type fixture is particularly adapted to truing a bevel on the wheel. For this type of truing, the wheel is passed across the diamond by turning the cross feed handwheel, and the diamond is fed toward the wheel by moving the table, or vice versa if the wheel is dressed parallel with the table ways.

Whether the diamond is mounted on the footstock or in the table fixture, run the wheel at operating speed when truing, and take a cut no more than .001" deep. Pass the diamond across the wheel, or pass the wheel by the diamond, as the case may be, at a uniform rate, running off the sides at the end of each stroke. Be sure the diamond is well clamped and is no farther from the support than is necessary. Since the diamond will wear, it is advisable to turn the tool every day or two to present new cutting points to the wheel. Dress the wheel when the need first becomes apparent, because once a wheel gets off balance or dull or glazed, it will get worse rapidly.

Use coolant when truing or dressing. It will keep the diamond cool, clean the wheel and keep the dust out of the air.

Except for the initial truing when setting up, the wheel is usually dressed just before taking a finishing cut when it is most important that the wheel give the best finish to the work. Sometimes, as a matter of economy, all the pieces in a job are rough ground and then, after dressing the wheel, all are finish ground. The sides of a wheel usually will be true enough as received from the manufacturer and will not need further truing.

When internal grinding, the back of the wheel should be trued with the diamond in the wheel truing fixture. Sometimes the wheel can be dressed satisfactorily by hand with a carborundum stick. After dressing by hand, however, watch the wheel spark as it grinds the work. If the sparks come only from the leading or trailing edge, true the wheel again.

For cutter grinding, the wheel should be dressed so that the part of the wheel in contact with the work will be about 1/32" wide and the rest of the face will taper back out of contact.

Universal Back Rest

The importance of the use of back rests cannot be emphasized too strongly, for on them, to a large extent, depends the accuracy obtained in external cylindrical grinding. Back rests should be used as supports between centers whenever the work is liable to chatter or spring. Even a relatively short piece, undergoing a heavy cut at rapid table travel tends to chatter, as does work with keyways or splines in the surface being ground. Long, slender work is liable to spring due to its own weight and might bend to the pressure of the wheel while grinding.

The number of rests used varies with the length and the diameter of the work. Usually one rest for every 6 to 10 diameters in length of work will prove satisfactory. For example, a piece 1" in

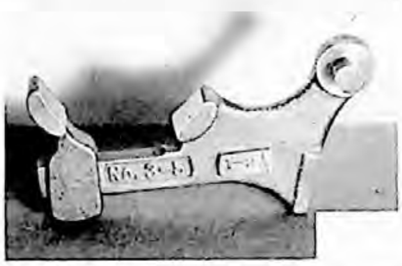


Fig. 22. Left. Adjustable Shoe.

Fig. 23. Right. Solid Shoe.

diameter and 30" long would require from 2 to 4 rests. Ordinarily, a rest would not be needed for work less than 6 diameters in length.

Both solid and adjustable bronze shoes are used. Adjustable shoes (Fig. 22) are furnished with the machine and can be adjusted easily and quickly to any diameter of work within their capacity and are intended for use in rapid commercial grinding involving a large variety in sizes of work. Shoes furnished as regular equipment take diameters from 1" to 4".

Shoes furnished with the No. 1 Machine take diameters from 1" to 2½".

Solid shoes (Fig. 23) are available as additional equipment at extra cost, and are recommended for all work requiring a fine degree of accuracy, and for jobs where a large volume of work of one diameter is to be done. Solid shoes should be used for all work less than 1" in diameter and for shafts with keyways or splines in the surface to be ground.

Set the back rest in position (Fig. 24) and tighten the stand clamp screws. Select the proper size shoe for the diameter to be ground, and place the shoe trunnions in the V-cuts of the shoe support. (If an adjustable shoe is used, set the shoe to size by fitting it to a sample of the work.)

The horizontal movement of the shoe is controlled by the lever adjusting screw. The spring adjusting nut regulates the resistance of the adjusting spring against the outward pressure of the work. If the movement of the lever adjusting screw becomes too free, the clamp screws on the right side of the lever can be adjusted to correct this condition.

The vertical adjustment of the shoe is controlled by the shoe adjusting screw at the top of the unit. The spring adjusting screw threads into the shoe support and regulates the resistance of the spring against the downward pressure of the work. Release the clamp screw in the clamp collar when moving the shoe adjusting screw.

To proceed with setting up, relieve the pressure in both springs, turn the shoe adjusting screw so that the shoe hangs free, pull the shoe support back and loosen the lever adjusting screw. Then, with a work piece between centers, push the shoe support forward with one hand and raise the shoe with the other until the shoe fits the work. Turn the lever adjusting screw until it touches the stand and turn the shoe adjusting screw until it touches the shoe. Produce a light pressure in both springs, being careful that the combined pressures will be sufficient only to keep the work from chattering or springing.

Grind the piece, regulating the shoe adjusting screw and the lever adjusting screw to keep the shoe in contact with the work. As the work nears size, measure the diameter after each cut and compare with the diameter at the other rests, if any are used. Deviations in diameter are corrected by the lever adjusting screw. When the piece is finished, the shoe should be in proper contact with

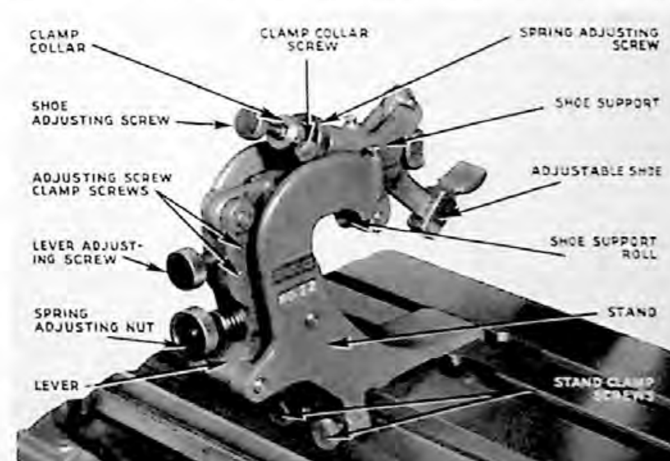


Fig. 24. Principal Parts of a No. 22 Universal Back Rest used on Nos. 2, 3 and 4 Machines. An Adjustable Bronze Shoe is shown in Operating Position.

the work, the sliding nut inside the shoe support should be seated, the lever adjusting screw should be in contact with the stand, and there should still

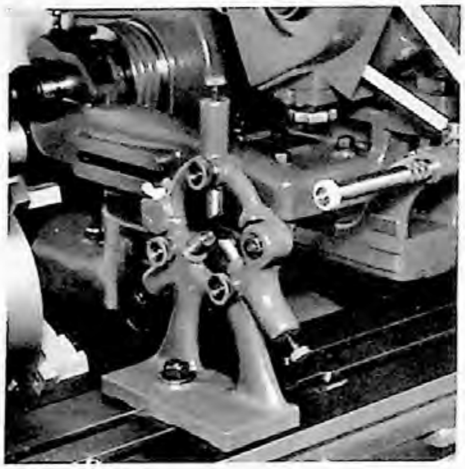


Fig. 25.
Above—Center Rest Mounted on Nos. 2, 3 and 4 Machines.

Right—Center Rest Used on the No. 1 Machine.

be pressure in the springs. Tighten the clamp screw before proceeding with the next work piece.

Placing subsequent pieces between centers will compress both springs which will then hold the shoe against the work for support, maintaining a constant pressure until the work is to size. Any wear in the shoe can be compensated for by regulating the shoe adjusting screw. Variations in work diameter can be compensated for with the lever adjusting screw.

By following this general outline and with a reasonable amount of practice, the operator will become skillful in the handling of the universal back rest.

Center Rest

The center rest (Fig. 25) is an adjustable positive support for the work, used chiefly whenever the footstock cannot be used and the work is too long to be held entirely by a chuck. It is used commonly when grinding long pieces internally, when grinding points on the end of long pieces, and when face grinding pieces with long shanks. Sometimes, however, it is used even though the footstock also is used, in preference to a back rest. Such a case would be when grinding a long cylindrical piece of work for only part of its length, with the surface being ground required to be concentric with another surface. The latter surface would then be supported in the rest.

When setting up for a job, attach the rest to the swivel table by a bolt in the vertical T-slot. Loosen the wing nut and let the hinged shoe support swing down. Adjust the shoes by loosening the knurled nuts on the side and turning the knurled screws at the end until the piece is adequately supported if grinding on centers, or is in line with the footstock center if grinding from the support of the center rest only.

On the No. 1 Machine, loosen the nut on the hinge bolt and swing the shoe support forward.

Tooth Rests and Bracket

A tooth rest clamped in its holder and held in the bracket (Fig. 26), is used to support and locate the teeth of cutters while they are being ground. The bracket is bolted to the swivel table, and the tooth rest is adjusted so that it is perpendicular to the tooth being supported and resists the force of the wheel as it cuts. It is preferable to have the rest support the tooth that is being ground, and that the rest should be directly in front of the wheel, clearing the latter by not more than 1/32". The height of the rest should be such that the tooth will be from $\frac{1}{8}$" to $\frac{3}{8}$", depending upon the work diameter, below the center line of the wheel to produce a clearance angle on the tooth.

Two tooth rests are furnished, one narrower than the other for thin cutters.

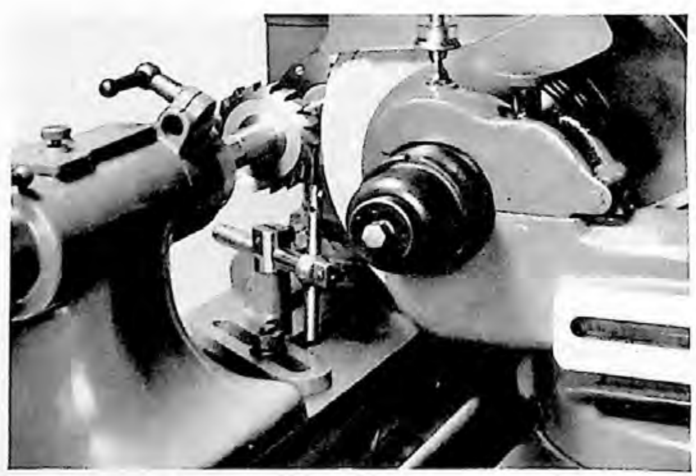


Fig. 26. Tooth Rest, Holder and Bracket in Position.

CHAPTER II

Additional Equipment (Furnished at Extra Cost)

Additional equipment furnished at extra cost for use with these machines includes Internal Grinding Fixtures, Internal Grinding Fixtures (Ball Bearing Type), Universal Back Rests and Bronze Shoes, Radius Wheel Truing Attachment, Universal Head, Bushings for holding Cutters with Milling Machine Standard Taper Shanks, Equipment for Right-Hand Wheel Mounting, No. 9R Rotary Model Magnetic Chuck (Permanent-Magnet Type) and Chuck Adapter Pulley, Castered Base for use with Coolant Tank, and No. 350 Spring Chuck and No. 11G Spring Collets.

Internal Grinding Fixtures

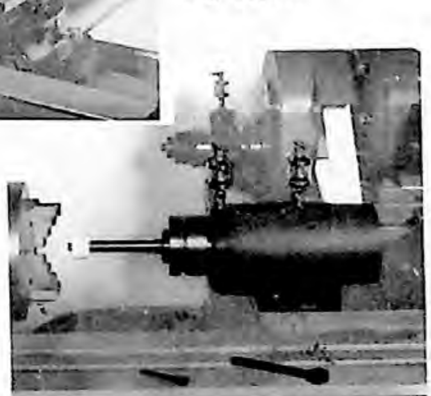
In addition to the Internal Grinding Fixture furnished with each machine (see pages 11 and 12) there are available at extra cost a number of sizes which provide a range from 1/4" minimum diameter of hole and 1 1/2" maximum length of hole to 1 7/8" minimum diameter of hole and 8" maximum length. These fixtures, which are numbered 1M, 2M, 3M, 4M and 5M, have spindle speeds ranging between 22,500 and 10,300 R.P.M.

The 01M, 02M, 03M and 04M, which are used on the No. 1 Machine, have spindle speeds between 22,500 and 15,000 R.P.M., and provide a range from 1/4" minimum diameter and 1 1/2" maximum length of hole to 1 1/8" minimum diameter and 6" maximum length.

Also available are the Nos. 30, 40 and 42 Fixtures (Ball Bearing Type) (Fig. 27), which are intended primarily for hole-grinding on a production basis and consequently are of very sturdy construction. They are of the removable-unit-type spindle unit design, with the spindle mounted in precision ball bearings, and have speeds of 27,000, 18,000 and 12,000 R.P.M. respectively. A number of sizes of Wheel Arbors and Wheels are stocked to provide a wide working range.

Fig. 27. Internal Grinding Fixtures (Ball Bearing Type).

Above—No. 30 Fixture on the No. 1 Machine.



Right—No. 42 Fixture on the Nos. 2, 3 and 4 Machines.

Universal Back Rests and Bronze Shoes

Although two Universal Back Rests with Adjustable Bronze Shoes are furnished with each machine (see pages 20 and 21), it is often desirable to have extra rests on hand together with a reserve stock of both adjustable and solid bronze shoes to accommodate a variety of work. Consequently, we regularly stock back rests and a full range of sizes of bronze shoes.

Radius Wheel Truing Attachment

For Use on Nos. 2, 3 and 4 Machines

This attachment (Fig. 28) is additional equipment furnished at extra cost, and is used to form and true convex and concave outlines of any radius up to 2" on wheels for grinding formed rolls, cylindrical work having fillets and rounds on shoulders, and similar work.

Fig. 28. Radius Wheel Truing Attachment.

The unit is attached to the swivel table by two bolts which pass through the base and fit in the vertical T-slot of the table. After loosening a screw in the middle of the lower right side of the attachment slide, the slide can be adjusted along the swivel by turning the knurled knob at the end. A scale on the left side of the slide indicates the radius formed or trued for any setting of the slide. The scale is graduated each side of zero to 2" by 64ths of an inch. A reading on the forward half of the scale indicates a convex radius on the wheel and, hence, a concave radius on the work. A reading on the rear half indicates the opposite. The slide should be clamped to the swivel again after a setting has been made.

To set the diamond, loosen the nut at the side of the gage and slide the gage forward as far as it will go. Then turn it so that the flat forward end comes up in front of the diamond. Loosen the nut at the top of the upright and slide the diamond tool forward until the diamond touches the flat end of the gage. Clamp the tool. Return the gage to its former position and tighten the nut at its side.

Universal Head

The Universal Head (Fig. 29) is additional equipment furnished at extra cost on all machines, and provides means for holding many forms of milling cutters, reamers and similar tools in accurate position while being ground.

Cutters can be held in three different ways, depending upon their construction. Cutters with arbor holes are mounted on stepped collars on the sliding shell (Fig. 30). Each stepped collar is protected by a recessed collar and the rest of the shell is filled with plain collars, if needed. A nut on the end of the shell holds everything in place. The shell slides on the cutter bar (also called stop dog rod) which passes through a sleeve which forms the pivot of the jaw. Cutters with 1", 1 1/16", 1⅛", 1¼", 1½", 1¾" and 2" holes can be accommodated with the regular stepped collars. Cutters with ⅞" holes are held on the sliding shell direct, while cutters with ¾" holes slide on the cutter bar without the use of a sliding shell.

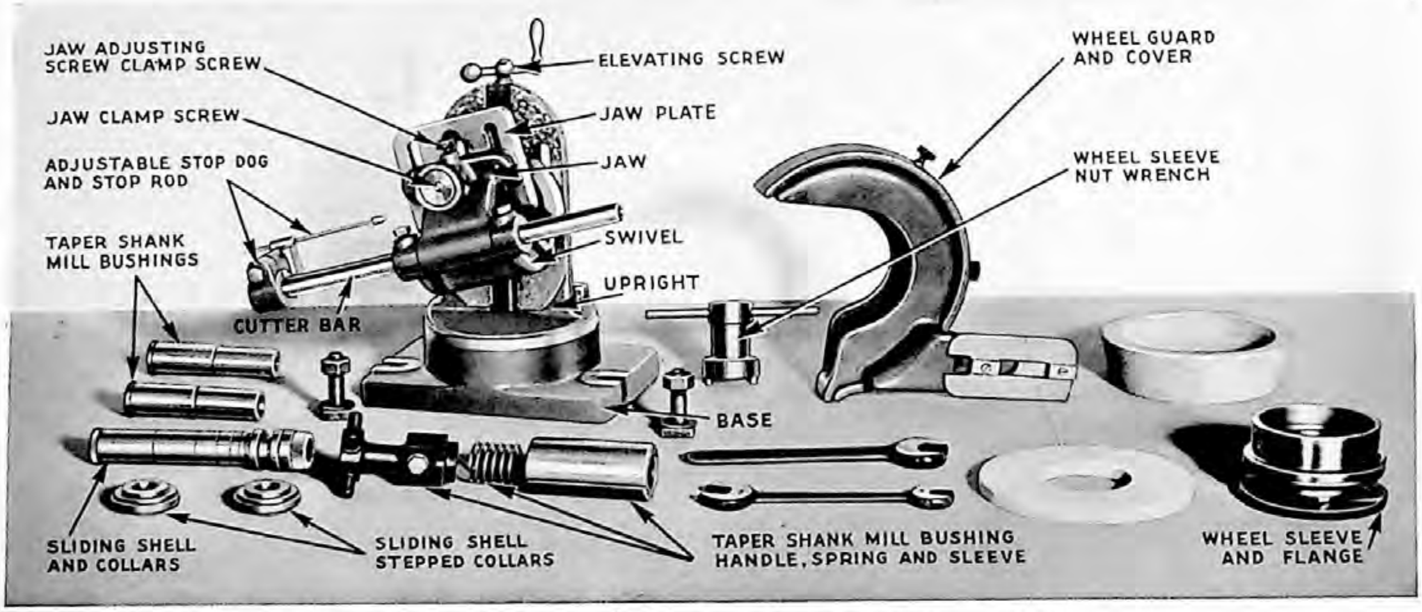


Fig. 29. The Universal Head and Equipment. The Wheel Sleeve and Flange are Omitted when the Universal Head is Furnished for Use on the No. 1 Machine.

Two bolts fasten the base of the unit to the swivel table. Both the upright and the swivel head may be positioned angularly in both the horizontal and vertical planes. The upright is graduated in degrees to 180° both sides of zero, while the swivel head is graduated in degrees to 90° both sides of zero. The swivel head also has a vertical adjustment of 4" by the crank at the top of the upright. The head bolts to the upright, while the latter bolts to the base.

The slotted jaw plate is adjustable to fit whatever is held in the swivel. Of the three knurled screws at the top of the jaw, the largest clamps the jaw to the swivel, while the one on top serves as a clamp screw for the third through which the jaw clamp screw passes. The third screw is adjusted to limit the movement of the jaw when being clamped so that the jaw plate will not exert excessive clamping pressure.

A taper shank cutter is held in a taper shank mill bushing and inserted in the right-hand end of the taper shank mill bushing sleeve. The spring is placed in the counterbored end of the mill bushing sleeve and over the small diameter of the mill bushing. Then the handle is attached to the small end of the bushing, compressing the spring; and the assembly is clamped in the swivel (Fig. 31). The pressure of the spring on the handle holds the bushing in the sleeve, while the handle is used to turn the bushing and cutter in the sleeve. The regular bushings accommodate shanks with Nos. 7 and 9 B&S tapers. Bushings for shanks with Nos. 10, 20 and 30 Milling Machine Standard tapers (Fig. 33) are also available.

Cutters with integral arbors or cutters mounted on arbors can be clamped with the swivel direct (Fig. 32). The adjustable stop dog and stop rod mounted on the end of the cutter bar serve to locate all duplicate pieces alike.

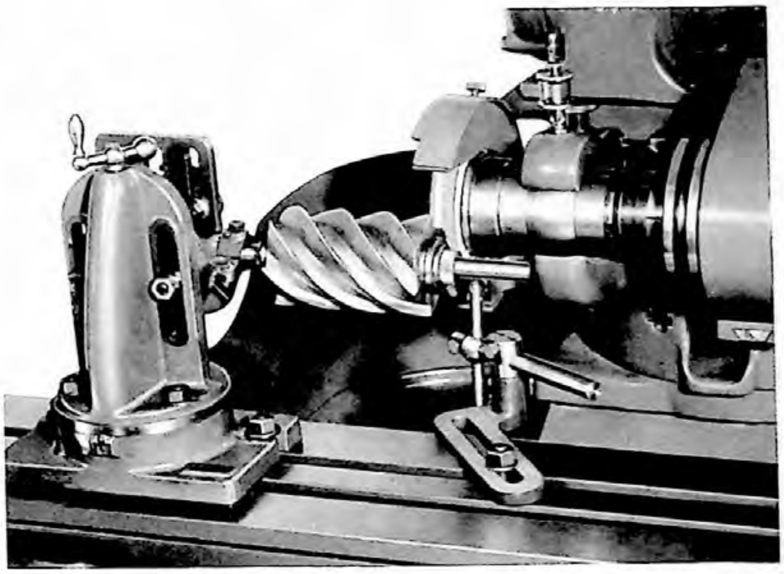
Work up to 18" in diameter will swing over the table, while light work up to 26" in diameter can be swung off the rear of the table.

A straight wheel and a cup wheel, a wheel guard, and a wheel sleeve are included with the equipment. The wheels, which are comparatively small in diameter to avoid interference with teeth not being ground, are mounted on the left end of the spindle to avoid interference between the head and the machine.

Work up to 16" in diameter will swing over the table, while light work up to 24" in diameter can be swung off the rear of the table on the No. 1 Machine.

The Universal Head, for use with the No. 1 Machine, is not furnished with a wheel sleeve and flange since the machine itself is regularly equipped with these units.

Fig. 30.
Right—Sharpening a Helical Plain Milling Cutter on a Universal Head. The Cutter is Mounted on Stepped Collars on the Sliding Shell and is Carried by the Cutter Bar.



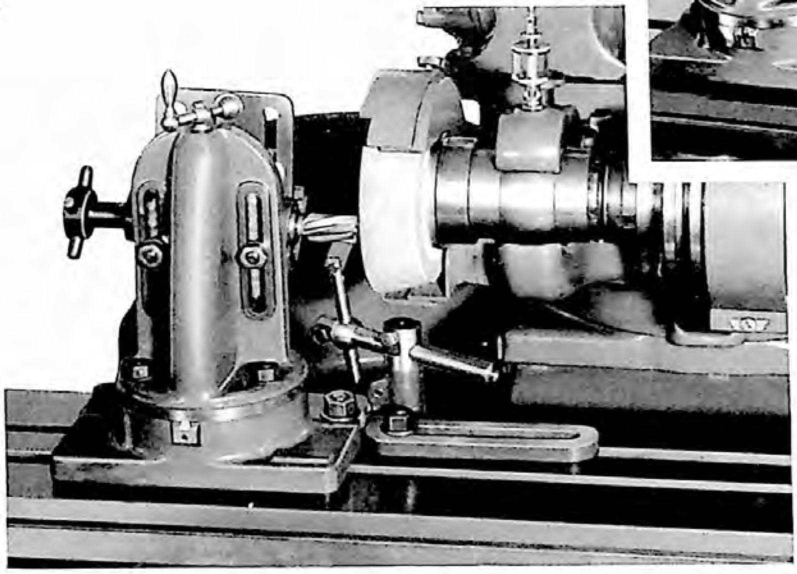
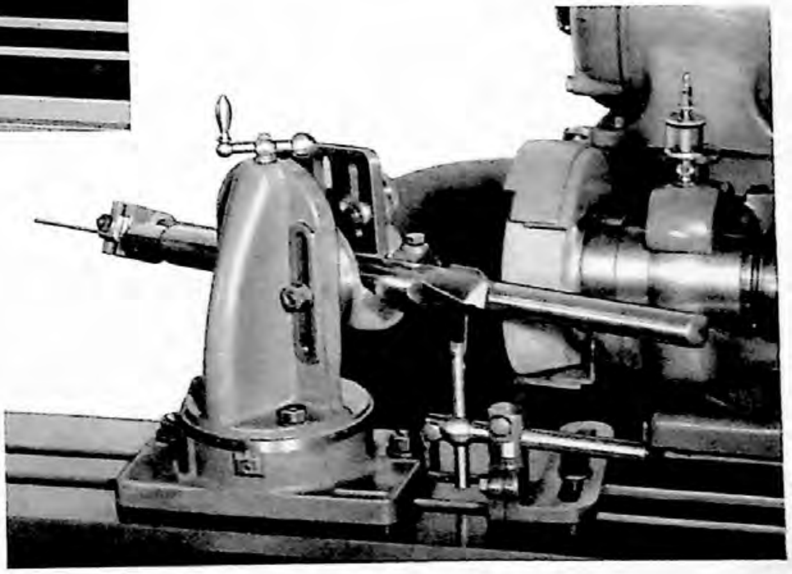


Fig. 31.
Left—Sharpening the End Teeth of a Spiral End Mill on a Universal Head. A Taper Shank Mill Bushing, Handle, Spring and Sleeve are Used.

Fig. 32.
Right—Sharpening a Four-Lipped Drill on a Universal Head. The Drill is Held by its own Shank in the Swivel.



Bushings for Holding Cutters with Standard Taper Shanks

Three bushings (Fig. 33) are available either separately or as a complete set, at extra cost, for use with the Universal Head. Cutters having Nos. 10, 20 or 30 Milling Machine Standard taper shanks are conveniently held for sharpening by means of these bushings.

Fig. 33. Bushings for Holding Cutters with Standard Taper Shanks.

Equipment for Right-Hand Wheel Mounting

For Use on Nos. 2, 3 and 4 Machines

This supplementary equipment (Fig. 34) available at extra cost, provides a means of grinding shoulders when interferences between the wheel stand and the footstock prevent grinding with the wheel in the between-bearings position. The equipment consists of a special spindle sheave, wheel guard, and wheel sleeve, and is used in conjunction with the regular wheel spindle which is turned end for end in the wheel stand.

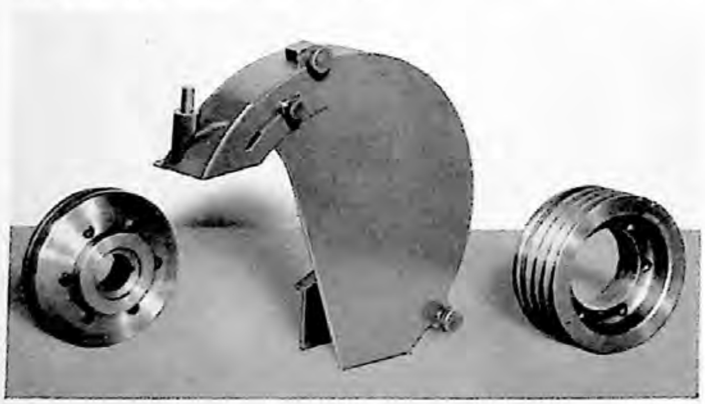


Fig. 34. Equipment for Right-Hand Wheel Mounting.

No. 9R Rotary Model Magnetic Chuck (Permanent-Magnet Type) and Chuck Adapter Pulley

For Use on Nos. 2, 3 and 4 Machines

This chuck and adapter pulley (Fig. 35) are additional equipment furnished at extra cost, and are sold only in the United States of America and its Territories and in Canada. They provide a simple and convenient means for holding ferrous work, especially pieces which cannot be supported or driven easily or at all by other equipment.

The chuck adapter pulley mounts on the back of the chuck for use on the headstock spindle. A detachable T-handle wrench, inserted in either one of two sockets on opposite sides of the chuck, is used to turn the chuck on or off. A half revolution of the handle turns the chuck completely on, but the amount of holding power can be regulated by turning the handle only part way. This is advantageous when centering work on the chuck as the holding power can be made enough to hold the work on the chuck but not enough to prevent sliding the work sideways to center it. The chuck should always be turned on fully, however, when rotating, to obtain maximum holding power and also because only when turned on full-power is its mechanism in balance. Leaving the chuck turned on for indefinite periods will not harm it, nor will the use of coolant harm it.

Fig. 35. No. 9R Rotary Model Magnetic Chuck (Permanent-Magnet Type), and Chuck Adapter Pulley in Position on the Headstock of a No. 2 Machine.

A steel bushing 7/16″ long, inserted at the center of the chuck face, is tapped full length with ¼″—28 N.F.—2, R.H. threads. This is for attaching locating buttons that may be made up for particular jobs for centering the work. The face is 9″ in diameter, and the magnetic surface is 7″ in diameter. In certain classes of work, it may be advisable to grind the face of the chuck with the chuck in position on the spindle to assure the face being at a right angle with the spindle. Be sure that the chuck is turned on when doing this.

The chuck should not be subjected to excessive heat, shocks or blows, and the face should be kept free from pits, scratches or burrs. Refinish the surface, if needed.

By unscrewing the adapter pulley from the back of the chuck, the latter can be used for bench work. The rim of the chuck is cut away in two places so that the chuck may be clamped to the bench.

Castered Base

For Use with Coolant Tank

The heavy steel castered base or dolly (Fig. 36) available at extra cost provides a ready means of moving the coolant tank to a convenient place for emptying and cleaning. It is equipped with ball bearing swiveled casters and fits into the corners formed by the feet of the tank. Sufficient height is provided to raise the feet from the floor to permit free movement.

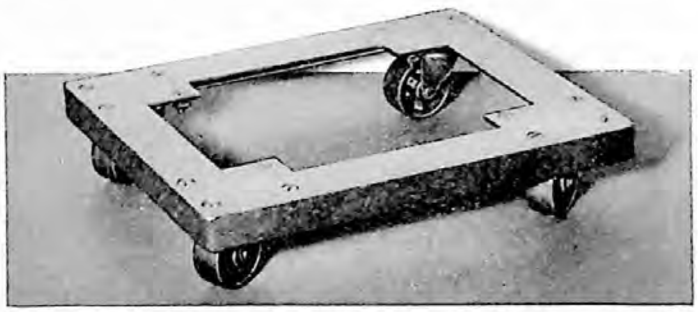


Fig. 36. Castered Base for Use with the Coolant Tank.

No. 350 Spring Chuck and No. 11G Spring Collets

For Use on No. 1 Machine

The chuck and collet (Fig. 37) are additional equipment furnished separately at extra cost, and provide means for holding long thin rods, needles for needle valves, and similar round parts which are to be ground at or near one end, and which cannot be supported or driven easily by other equipment.

The left-hand member of the chuck threads on the headstock spindle and is tightened with a face spanner wrench furnished with the chuck. The right-hand member carries the collet and is adjustable with relation to the left-hand member, so that work can be accurately centered. Turning the knurled nut right-hand closes the collet on the work, which can extend back through the headstock spindle.

A different collet is required for nearly every diameter of work. Collet sizes range from 1/16" to 15/32" by 64ths; ½" to ⅝" by 32nds, and include 11/16", ¾" and 13/16". The collets are changed by removing the knurled nut.

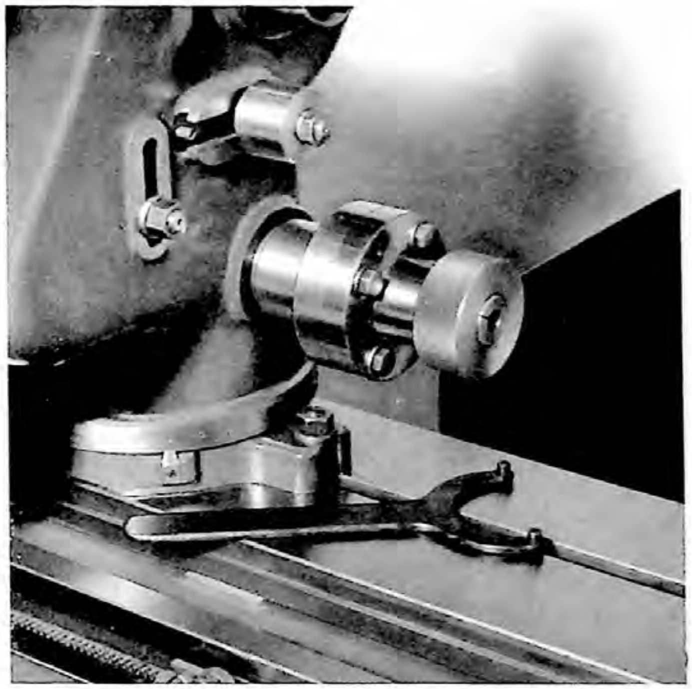


Fig. 37. No. 350 Spring Chuck and No. 11G Spring Collet in Position on the Headstock of a No. 1 Machine.

With the work in place in a collet, line up the zero lines on the right- and left-hand members and make the adjacent surfaces at the line flush. Due to this adjustment, the work should rotate concentrically, but to check, start the work rotating and test for concentricity with a dial test indicator. If adjustment is necessary, loosen the four bolts and relocate the right-hand member accordingly. No further adjustment should be necessary, but it is advisable to check new pieces for run-out from time to time during the course of a job.

CHAPTER III

Grinding Wheels and How to Select Them

Grinding wheels are made of crushed abrasive or cutting grit, held together by a substance known as the bond.

Abrasives. The most common abrasives are aluminum oxide and silicon carbide.

Aluminum oxide crystals are tough but not particularly hard, hence are used in grinding materials of high tensile strength such as alloy and high-speed steels. They are known by the trade names Borolon, Aloxite, Alundum and others.

Silicon carbide crystals are very hard and quite brittle, hence are used in grinding easily-penetrated materials such as copper, rubber and celluloid, and hard materials of low tensile strength such as cast iron and cast bronze. They are good for obtaining a mirror finish on work, and are known by the trade names Electrolon, Carborundum, Crystolon and others.

Grain. The size of the particles of abrasive in a wheel is referred to by the term *grain.* A 36 grain wheel, for example, is one made of abrasive that will just pass through a 36 mesh screen; that is, a screen having 36 meshes or openings per linear inch.

Several sizes of abrasive are often combined to produce a compact wheel of special characteristics. Such a wheel is called a *combination.*

The grains commonly used for cylindrical and internal grinding vary from 24 to 60, and for cutter grinding, from 46 to 60. For rough grinding, when the finish is not important, coarse grain wheels are used. When the finish is more important or the surface to be ground is narrow and requires a sharp edge, fine grain wheels are used. Combination wheels usually cut fast yet leave a good finish.

Bonds. Differences in bond impart varied characteristics to wheels.

A vitrified clay bond is the most common bond used. Wheels of this type are usually preferred for general production and toolroom grinding. They are unaffected by heat and cold, water and oils, and have many other advantages. They are usually not so strong, however, as wheels of other bonds and have practically no elasticity. Consequently, it is not advisable to attempt a heavy side cut with these wheels.

Silicate wheels, as a rule, cut smoothly and with little heat and are adapted to work requiring a delicate edge, such as a cutter or tool.

Shellac forms a strong bond and very thin wheels made with it are safe. These wheels have considerable elasticity which is of advantage on certain types of work. Shellac wheels produce a smooth finish and deep side cuts can be taken.

Rubber forms a bond of great strength and wheels bonded with this material are used to cut grooves and for similar work.

Grade. Wheels from which the grit is torn readily are known as soft bond or soft grade wheels, while those that retain the grit well are called hard bond or hard grade. The term *grade,* therefore, refers to the breakdown resistance of the wheel, not to the hardness of the abrasive.

Two things affect the grade of a wheel; the bonding material and the size of the grains. Comparing two wheels of the same bond, but of different grains, the wheel with the finer grain will be the harder. Also, in general, the faster a wheel runs, the harder it will act.

In general, hard grade wheels are used in grinding soft steel, annealed carbon steel and similar metals. Medium grade wheels are used on such metals as brass and bronze. Soft grade wheels are used on the very hard metals and cast iron. A softer grade wheel, however, would be used on a job if it were to be ground without coolant than if coolant were to be used. Also, the more contact between work and wheel the softer the grade should be.

When selecting wheels for a particular job, determine carefully what the abrasive, grain, bond and grade should be. Wheel manufacturers publish literature which will be of particular help in selecting grinding wheels of their own make.

Grinding Wheels Regularly Furnished with Brown & Sharpe Universal Grinding Machines

NOS. 2, 3 AND 4 MACHINES

Shape of Wheel	Number of Wheel		Dimensions
	B&S	Manufacturer's	
Straight	224	Norton—1936 Comb.-DL	14" Dia. x 1" Thick x 5" Hole
Flaring Cup	255	Norton—3880-18BE	14" Dia. x ⅜" Wall x 1½" Thick x 5" Hole
Straight (Fine Grain)	33	Norton—38120-J	1¼" Dia. x ⅜" Thick x ⅝" Hole
Straight (Medium Grain)	34	Norton—3846-K	1¼" Dia. x ⅜" Thick x ⅝" Hole
Straight*	256	Norton—3860-I	8" Dia. x ½" Thick x 3" Hole
Cup*	257	Norton—3860-J	8" Dia. x 2" Thick x 3" Hole

NO. 1 MACHINE

Shape of Wheel	Number of Wheel		Dimensions
	B&S	Manufacturer's	
Straight	116	Norton—60-DK	6" Dia. x ½" Thick x 2" Hole
Straight	185	Norton—1936 Comb.-L5BE	10" Dia. x ½" Thick x 3" Hole
Straight (Fine Grain)	16	Norton—38120-J	⅞" Dia. x ¼" Thick x ¼" Hole
Straight (Medium Grain)	17	Norton—3846-K	⅞" Dia. x ¼" Thick x ¼" Hole
Straight*	116	Norton—60-DK	6" Dia. x ½" Thick x 2" Hole
Cup*	168	Norton—3860-J	7" Dia. x 2" Thick x 2" Hole

*Included with Universal Head which is furnished at extra cost.

CHAPTER IV

How to Determine Wheel Speed, Work Speed and Rate of Table Travel; Six Representative Set-ups Illustrated and Described; Possible Grinding Troubles and Probable Causes.

The purpose of this chapter is to explain in enough detail how to set up several representative jobs so that it will be fairly easy to set up any job within the scope of the machines. It tells how to determine wheel and work speeds and rate of table travel, how to set up the machine, and what the operation procedure is after the machine is set up. Then there is a section which discusses grinding troubles sometimes encountered and what to do to overcome them.

Wheel Speed, Work Speed and Rate of Table Travel

There are certain general rules which can be followed to determine approximately the wheel and work speeds and rate of table travel for any given job. After the machine is set up, however, needed adjustments in the speeds or rate due to factors peculiar to the job may become necessary.

Wheel Speed. A new wheel should be run as close as possible to the maximum wheel speed, marked in R.P.M. on the wheel, without exceeding that speed. As the wheel wears down through use, however, the wheel speed must be increased to maintain the correct surface speed. To determine what the wheel speed should be at any time, substitute the proper values in the following formula:

$$N = \frac{3.82\,S}{D}$$

N = Wheel speed; number of revolutions per minute (R.P.M.) at which wheel should be run to give correct surface speed.

S = Surface speed of the wheel, correct for the wheel and job, in feet per minute.

D = Diameter of wheel in inches.

The correct surface speed of a wheel depends upon the grade of the wheel and upon the type of grinding to be done. When grinding with vitrified or silicate bonded wheels, the value for "S" ranges as follows:

Cylindrical grinding ......5500-6500 Ft. per Min.
Face grinding ....5000-6000 Ft. per Min.
Internal grinding ....2000-6000 Ft. per Min.
Cutter grinding ....4000-5000 Ft. per Min.

The values for wheels with organic bonds (shellac, rubber, etc.) range from $\frac{1}{4}$ to 1/3 higher than these figures. Soft grade wheels should run at speeds in the lower end of each range, medium grade wheels in the middle and hard grade wheels in the upper.

Use the spindle driving pulley or sheave which will give the wheel speed nearest the value of "N" found by the formula, so long as it does not exceed the maximum allowable speed for the wheel. The table of wheel speeds below gives the wheel speeds available on the machines and the diameters of the pulleys or sheaves used to obtain those speeds.

WHEEL SPEEDS*

NOS. 2, 3 and 4 MACHINES		NO. 1 MACHINE	
Driving Pulley Diameter, Inches	Wheel Speed, R.P.M.	Driving Pulley Diameter, Inches	Wheel Speed, R.P.M.
$3\frac{1}{8}$	1500	$2\frac{21}{64}$	2444
4	1960	$2\frac{23}{32}$	2850
$4\frac{13}{16}$	2410	$3\frac{13}{32}$	3560

*These wheel speeds apply to machines powered with 60-cycle current.

To facilitate finding the best wheel speed for a job, see Fig. 38. An example in the use of the

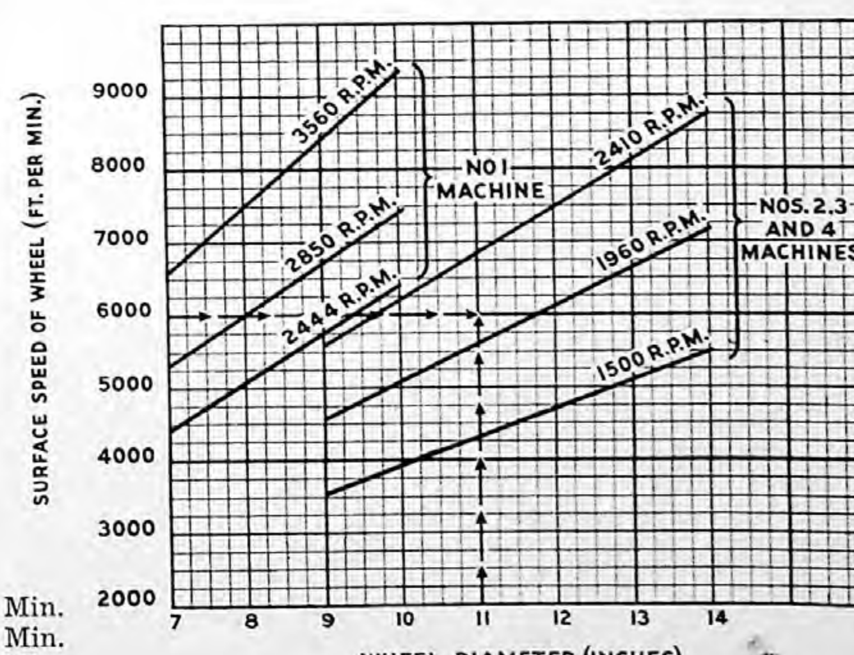


Fig. 38. Chart of Wheel Speeds for Various Wheel Diameters.

chart follows. Let us say that the job is to be done on a No. 2 Machine, that the wheel diameter is 11 inches and that the wheel should run at a surface speed of about 6000 feet per minute. The chart shows that if the wheel runs at 1960 R.P.M. the surface speed will be about 5600 feet per minute, and if it runs at 2410 R.P.M., the surface speed will be about 6900 feet per minute. The spindle, therefore, should be driven at 1960 R.P.M., as 5600 feet per minute is nearer 6000 than is 6900.

When a wheel is of such size that the correct surface speed cannot be reached fairly closely, try another wheel.

Work Speed. For most materials the work should turn with a surface speed of about 50 feet per minute for external grinding and 100 feet per minute for internal grinding. To find the revolutions per minute at which the work should be run to give these surface speeds, use the following formulas:

$$n = \frac{191}{d} \text{ for external grinding}$$

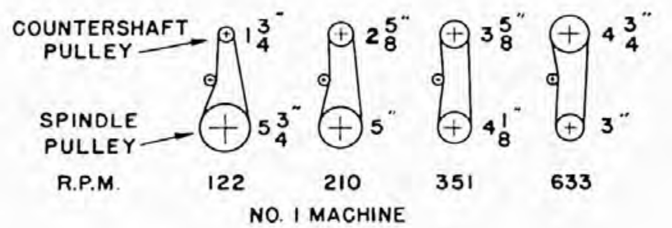
$$n = \frac{382}{d} \text{ for internal grinding}$$

n = Work speed; number of revolutions per minute (R.P.M.) at which work should run to give correct surface speed.

d = Diameter of work or hole, in inches.

When grinding shoulders and tapers and when face grinding, "d" has a value equal to the average diameter of the work piece.

Set up the headstock so as to get the work speed nearest the value found for "n". See the belting diagrams (Fig. 39) and the charts (Figs. 40 and 41) which will facilitate finding the best work speed for a job. The charts are used in the same manner as the wheel speed chart (Fig. 38) on page 29.



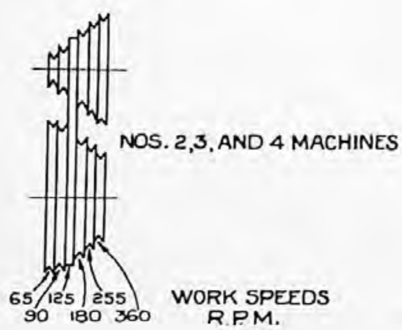


Fig. 39. Work Speeds and Belting Diagrams.

The diagrams, above and at left, show headstock pulley and belt arrangements to obtain work speeds given. The pulley diameters are in inches and the work speeds are in R.P.M. The arrangements shown are for dead center grinding. Similar arrangements are used for revolving spindle grinding.

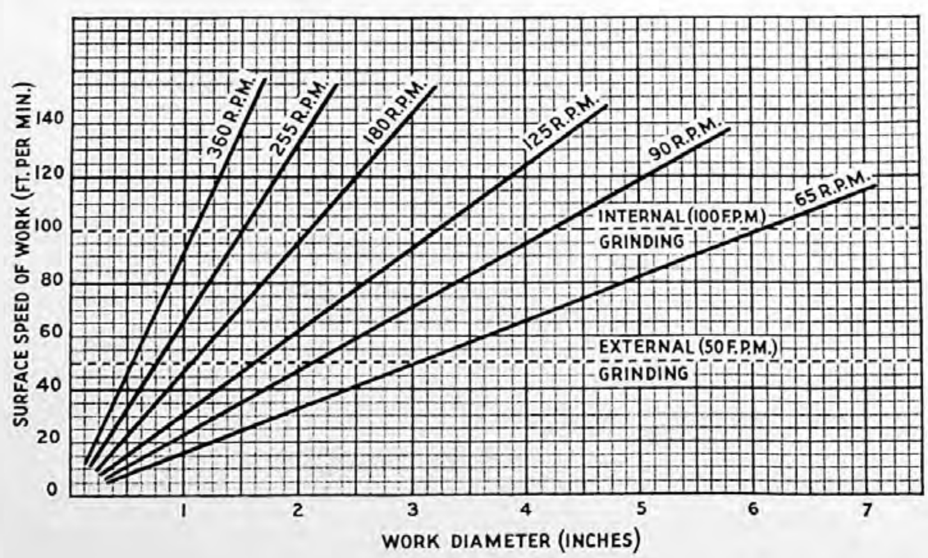
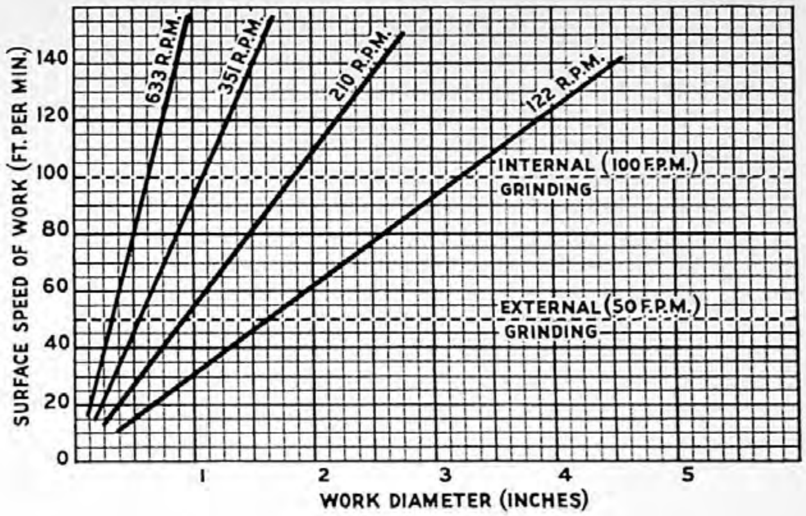


Fig. 40. Chart of Work Speeds for Various Work Diameters on Nos. 2, 3 and 4 Machines.

Fig. 41. Chart of Work Speeds for Various Work Diameters on No. 1 Machine.



Rate of Table Travel. For roughing operations on most materials the rate of table travel should be about 2/3 the width of the wheel per revolution of the work, and about 1/3 for finishing operations. The rates, therefore, for these machines can be expressed as follows:

External roughing—about .6" per revolution
External finishing—about .3" per revolution
Internal roughing—about .2" per revolution
Internal finishing—about .1" per revolution

To determine the rate of table travel in inches per minute for any given job, choose the proper constant and multiply it by the work speed.

Change the table driving cone pulley belt and set the motor at *slow* or *fast* according to the table below to give the nearest available rate of table travel.

Adjustments. After running the job for a while, if the wheel becomes glazed from loading up with work particles and produces a rough finish or heats the work unduly, slow down the wheel or speed up the work. If the wheel crumbles and does not size the work accurately and produces a rough finish, speed up the wheel or slow down the work.

When finish grinding, run the table at a slower rate if a still better finish is wanted.

RATES OF TABLE TRAVEL*

NOS. 2, 3 AND 4 MACHINES			NO. 1 MACHINE		
Motor Cone Pulley	Travel in Inches Per Min.		Motor Cone Pulley	Travel in Inches Per Min.	
	Fast	Slow		Fast	Slow
Smallest Step	11½	3	Smallest Step	16½	4
Second Step	19	5	Second Step	28	7
Third Step	30	7½	Third Step	41½	10
Fourth Step	42	10½	Largest Step	58½	14½
Largest Step	60½	15			

*These rates apply to machines powered with 60-cycle current.

Six Representative Set-ups Illustrated and Described

These set-ups have been chosen as most representative of the six main types of grinding possible on these machines; that is, cylindrical, shoulder, taper, internal, face, and cutter grinding.

In setting up any job, be careful to use the correct method, correct wheel, the proper wheel and work speeds and rate of table travel. Make all settings and adjustments carefully. Check all belt tensions. Use all guards needed for wheel, spindle belts and coolant. Check the entire oiling system to make sure all moving parts are sufficiently lubricated. Be sure that the centers are true and that the center holes in the work are clean and well oiled. Warm up both the machine and the wheel spindle to running temperature before starting to grind.

Each step in the set-ups is stated simply and briefly. For a more complete explanation of any particular step, see the section in Chapter I which deals with the point in question. The illustration for each set-up shows the machine as if in operation. To make the illustrations as clear as possible, coolant is not shown although its use may be indicated.

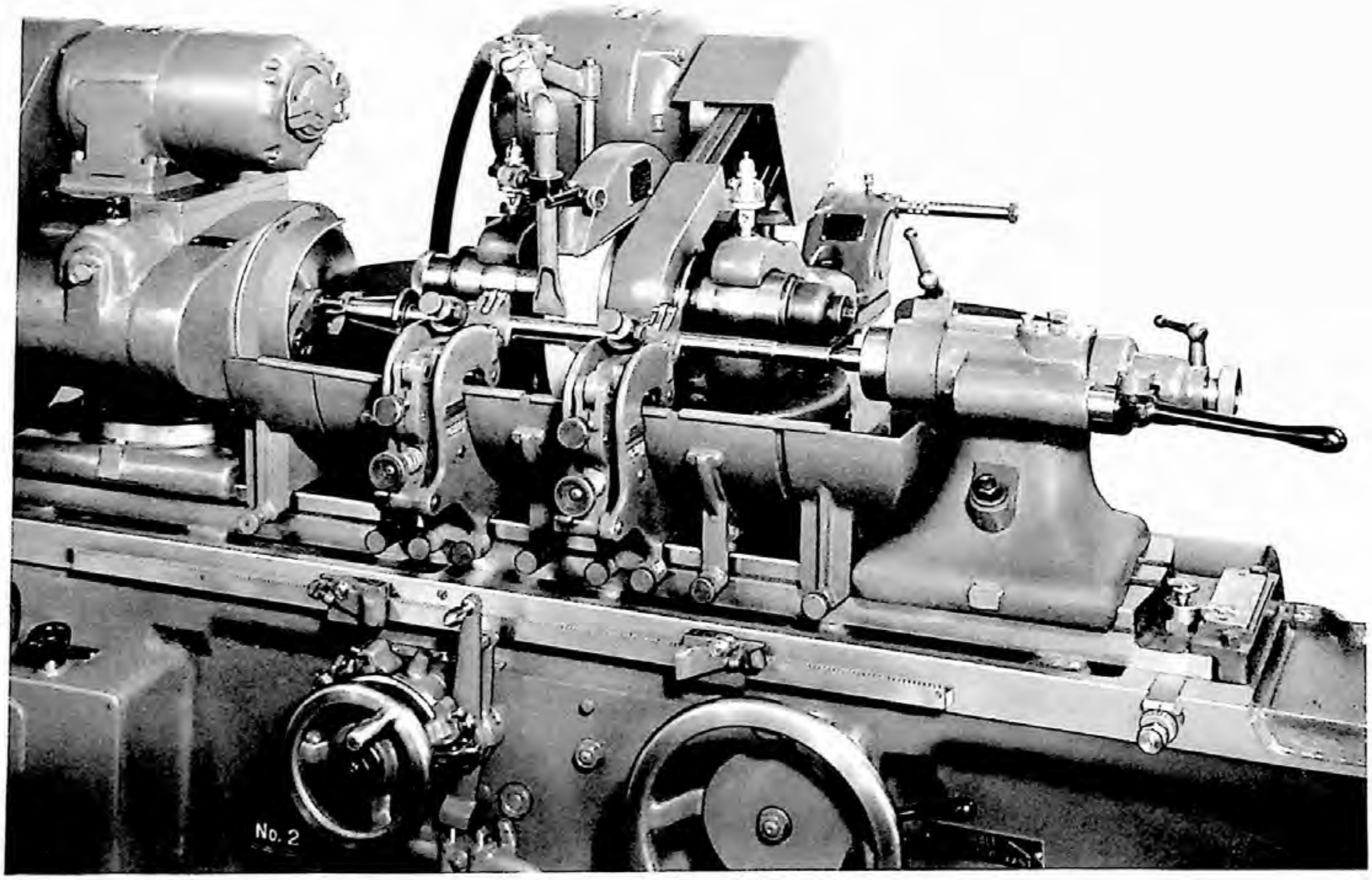


Fig. 42. Set-up for Cylindrical Grinding. The No. 2 Machine is Shown.

Cylindrical Grinding

The sample piece as shown in the illustration (Fig. 42) is long, cylindrical, and of two diameters—one end being smaller than the rest. The longer and larger section is to be ground. The steps in setting up the job are as follows:

1. Set the wheel stand platen parallel with the slide and set the bed at zero degrees so that the spindle will be parallel with the table and the bed will be at right angles to it. Check the direction of the counterweight pull on the slide so that it is correct for external grinding.
2. Mount a straight wheel between bearings. Determine what the wheel speed should be and change the spindle driving pulley or sheave accordingly. Check the belt tension.

On the No. 1 Machine, snap the motor direction switch to *External Grinding*.

3. Run the wheel slide forward and back with the cross feed handwheel to make sure that the wheel stand is located on the platen so that the wheel will come forward enough to grind yet go back far enough to clear the work when truing or dressing and changing pieces.
4. Set the swivel table at zero. Final adjustments for perfect parallelism are made with the swivel table adjusting knob after a trial cut has been made.
5. Arrange the headstock for dead center grinding, using the correct pulleys for the work speed needed, and set the unit at zero degrees so that it will be parallel with the table.
6. Attach the correct driving dog to the left end of the work and, holding that end of the work on the headstock center, slide the footstock along the table until it supports the other end of the work. The spring in the footstock should be compressed a little. While still holding the work, move the footstock center with the operating lever to make sure that the center can clear the work. Clamp the footstock to the table, and adjust the tension on the spring so that the center will be held firmly in the work, but no more so than is necessary.
7. Pull out the table control lever at the edge of the table handwheel to disengage the power feed mechanism. Determine the rate of table travel, change the belt on the cone pulley, and set the table motor control knob accordingly.
8. Hook the bronze shoes on the back rests and attach the latter to the table, letting the shoes hang clear of the work. If adjustable shoes are used, they should first be fitted to the work.
9. Adjust the coolant piping and nozzle. Attach table water guards and pan water guards.
10. Start the wheel rotating, and true with the diamond mounted on the footstock.
11. Adjust the table dogs for length of table stroke.
12. Start the work rotating, turn on the coolant, and start the table traversing. Adjust the automatic cross feed mechanism and the back rests while grinding the first piece.

When a piece is finished, release the pawl from the feed stop of the cross feed mechanism and run the wheel back. Then shut off the coolant, stop the table and the work and change to a new piece. To grind the new piece, set the table and work in operation again. Turn on the coolant. Run the wheel in until it touches the work, and engage the pawl with the dial.

During the course of the job, dress the wheel when needed, and occasionally check the diameter of the work at each back rest for consistency.

Notes:

a) When a job requires that a shoulder on the piece should come close to the wheel at the end of a stroke, the table dog which reverses the table at that end should be checked for position before each new piece is started. Variations in the sizes of center holes and in the distances from shoulders to ends, make this check advisable.

b) If a shaft is to be ground the same diameter for its entire length, it is necessary to do the job in two separate, complete operations. First the shaft is ground almost up to the driving dog. Then it is turned end for end, the driving dog being changed accordingly, and the remaining portion ground. Since the latter portion is short and close to the footstock, its diameter can be easily made to match that of the first portion. When there is more than one piece in a job, do the first operation on all the pieces before changing the set-up for the second operation.

c) When plunge cutting, practically the same set-up procedure is followed, exceptions being made only to steps 7, 8, 11 and 12. Power table travel is used only for wheel truing and back rests are used only if the cut is near the middle of a long piece. Also, manual cross feed is used.

d) When using the Radius Wheel Truing Attachment, adjust the coolant piping and nozzle after finishing step 7. Then remove the work from the centers and bolt the attachment to the table. Form the wheel, removing the attachment from the table when finished. Return the work to the centers and proceed with the rest of the steps. Since the coolant piping and nozzle have already been adjusted, it will only be necessary to attach the table and pan water guards in step 9. When dressing the wheel during the course of the job, do it between pieces, removing the back rests and water guards from the table, as necessary, to make room for the attachment.

e) While the machine will swing work of much greater diameters, the maximum diameter of work recommended for efficient external grinding is about $3\frac{5}{8}$".

On the No. 1 Machine, the maximum diameter recommended is about 2".

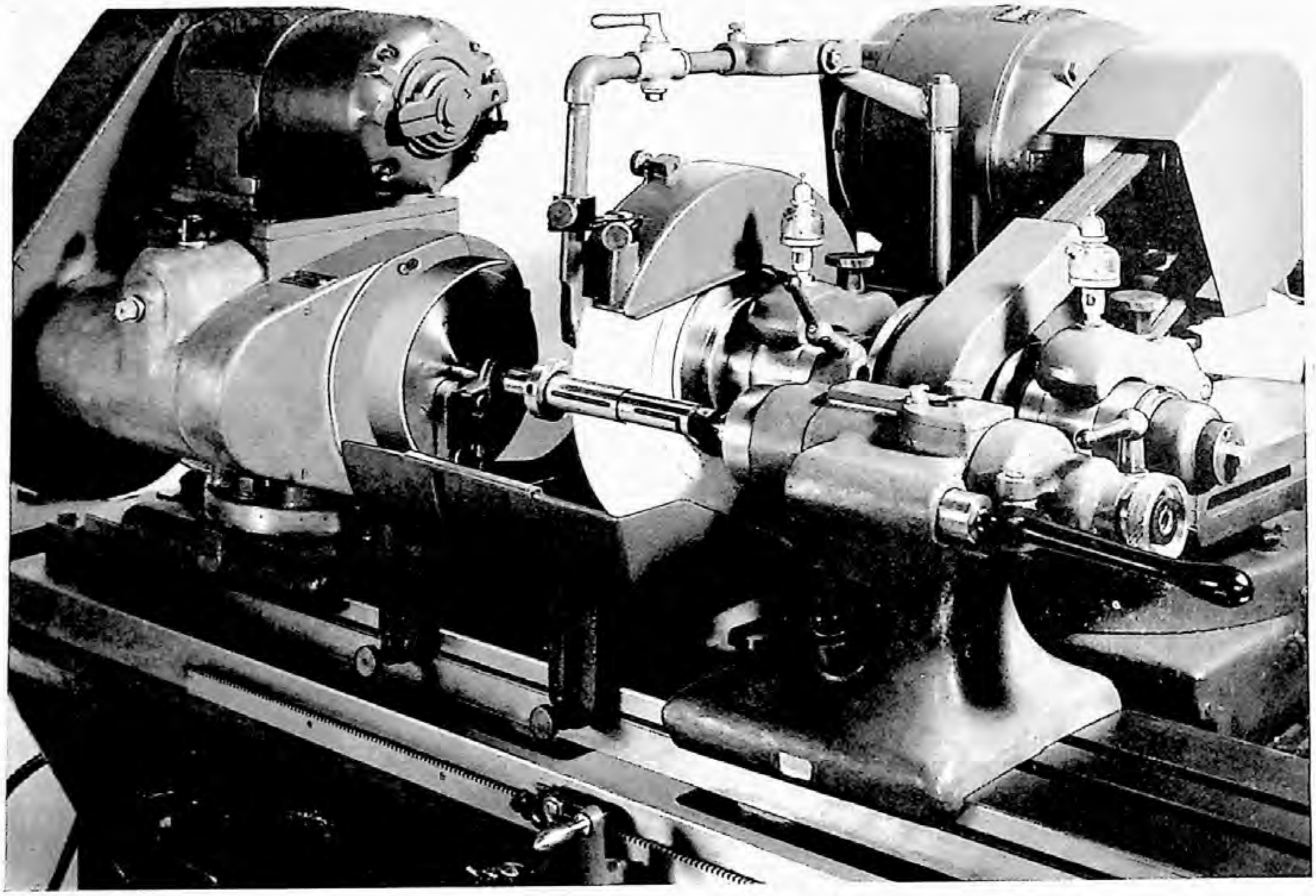


Fig. 43. Set-up for Shoulder Grinding. The No. 2 Machine is Shown.

Shoulder Grinding

It is often necessary that the side of a shoulder on a cylindrical piece such as the one illustrated (Fig. 43) should be ground square with the axis of the piece. Following are the steps taken in setting up the job.

1. Mount a flaring cup wheel, particularly suited for this type of work, on the left end of the spindle, and arrange the entire wheel stand assembly, headstock, footstock and swivel table as if for cylindrical grinding.
2. Arrange for manual cross feed and table feed.
3. Adjust the coolant piping and nozzle.
4. Start the wheel rotating, and true the wheel. For ordinary shop work the wheel may be trued with a carborundum stick, but a quality finish may require truing the wheel with the diamond mounted in the wheel truing fixture bolted to the table. Remove the fixture when finished.
5. Attach table water guards and the pan water guards.
6. Start the work rotating and turn on the coolant. Run the wheel in toward the work while moving the shoulder of the piece toward the wheel until the leading corner of the wheel is in the recess between the shoulder and the cylindrical surface next to it. Then move the table to the right until the work contacts the wheel. Do not move the wheel forward and back while grinding, because the cup wheel generates the flat surface at the point of contact. After the shoulder has been ground, move the work to the left again while running the wheel back to clear the work. Stop the work and shut off the coolant. Change to a new piece and repeat this step.

When dressing the wheel during the course of the job, do it between pieces, removing water guards from the table, as necessary, to make room for the fixture.

Notes:

a) To grind the side of a shoulder square with the axis of the piece and obtain a particularly good finish, a straight full-size wheel is used, mounted between bearings. The wheel stand platen is turned right-hand to bring the spindle to as near 45° with the work as possible without causing interference between the wheel stand and the footstock.

The wheel is trued with the diamond mounted in the wheel truing fixture on the table. First, the face is trued while running the table back and forth. Then, the diamond is turned 90° to be parallel with the table and the left side of the wheel is trued square with the face by running the wheel stand slide forward and back with the cross feed handwheel. The widths of the trued faces of the wheel are made about equal.

If the side of the shoulder of the work piece is wider than the side of the wheel, the wheel is moved forward and back while grinding.

When there is interference between the wheel stand and the footstock, with the wheel mounted in the between-bearings position, the Equipment for Right-Hand Wheel Mounting facilitates handling the work (see Fig. 34, and Fig. 44 below). The spindle can be set at 45° with the work, and wheels of reduced diameters may be used.

b) Frequently, a shoulder grinding operation and a cylindrical grinding operation on the same piece can be handled in one setting of the machine. The machine is set up with the spindle at an angle with the work and the wheel trued as stated in the preceding note. The wheel may be mounted in the between-bearings position or on the right end of the spindle using the Equipment for Right-Hand Wheel Mounting (Fig. 44 below).

The cylindrical grinding operation is performed with the parallel face of the wheel in the usual manner. Then with the table and cross feed manually controlled, the side of the shoulder is ground with the perpendicular face of the wheel. Both operations are performed before removing the piece from the centers.

c) The two operations mentioned in the preceding note can be performed with the spindle set parallel with the work and using a straight wheel, if the side of the shoulder is quite narrow and a particularly good finish is not required. The side of the wheel is trued square with the face. When the cylindrical grinding operation has been completed, the shoulder is brought up against the wheel until ground. The wheel need not be moved forward and back.

d) It is advisable always to grind a shoulder with the wheel pressure in the direction of the headstock so that the spring in the footstock will not have to take the thrust.

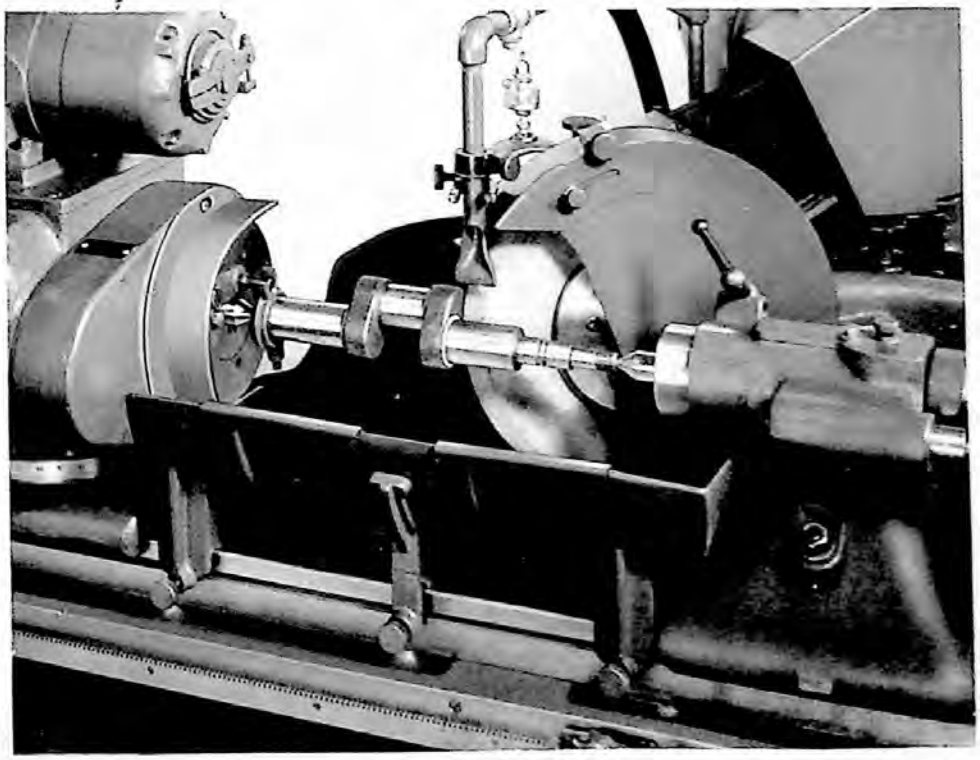


Fig. 44. Grinding a Diameter and a Shoulder of a Small Crankshaft at One Setting of the Machine, Using the Equipment for Right-Hand Wheel Mounting. (See notes (a) and (b) above.)

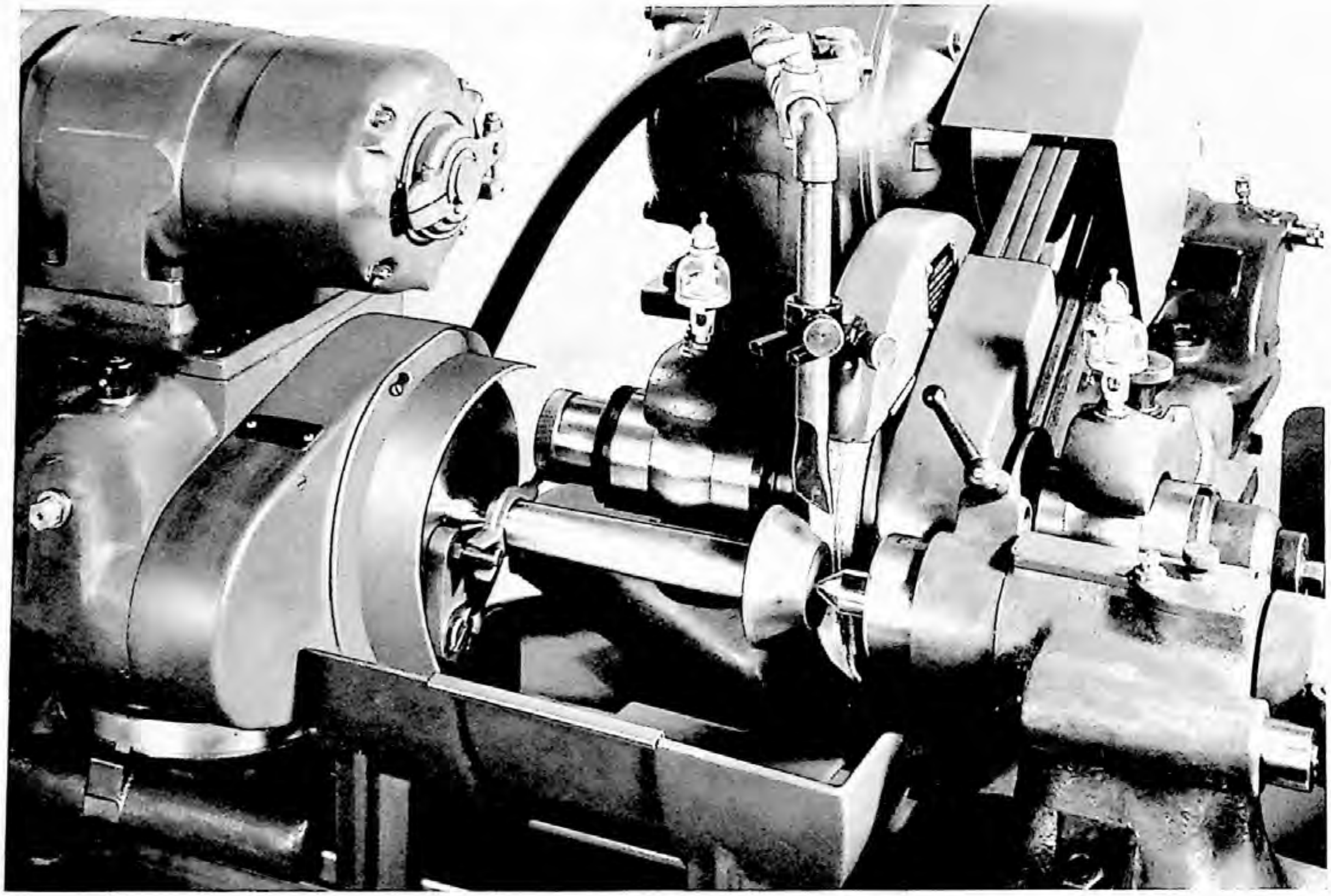


Fig. 45. Set-up for External Taper Grinding. The No. 2 Machine is Shown.

External Taper Grinding

Accurate tapers of any degree are easily ground. The sample piece (Fig. 45) is a bullnose lathe center, and it is required to grind the 60° included angle of the nose. These are the steps to follow in setting up the job.

1. Arrange the entire wheel stand assembly, headstock, footstock and swivel table as if for cylindrical grinding except for setting the wheel stand platen and the wheel stand slide. Since the reading on the wheel stand slide scale is zero degrees when the slide is at right angles with the table ways, set the slide to the angle which is the complement of half the included angle of the taper. In this case, half the included angle is 30°, and the slide, therefore, is set at 90° less 30°, or 60°; thus bringing the slide to the same angle with the table as the taper to be ground. Next turn the platen so that the spindle is as nearly parallel with the slide as possible without interference between the spindle and the footstock. The more nearly parallel the spindle and slide are, the easier it will be to form the wheel.
2. Arrange for manual cross feed and table feed.
3. Adjust the coolant piping and nozzle.
4. Mount the diamond in the wheel truing fixture bolted to the table. Start the wheel rotating and true the face of the wheel parallel with the slide. Remove the fixture when finished.
5. Attach table water guards.
6. Start the work rotating and turn on the coolant. The piece is then ground by moving the wheel back and forth across the work by turning the cross feed handwheel, while the work is moved toward the wheel by moving the table to the right. When the piece is finished, run the table to the left to clear the work from the wheel, stop the work from rotating and shut off the coolant. Change to a new piece and repeat this step.

When dressing the wheel during the course of the job, do it between pieces, removing water guards from the table, as necessary to make room for the fixture.

Notes:

a) When grinding a slight taper, (Fig. 46) the machine is set up entirely as if for cylindrical grinding except that the swivel table is set at the required angle for the taper to be ground. The machine is operated during the course of the job just as if it were doing a cylindrical grinding job.

b) A steep taper for which the wheel stand platen and slide must be set, and a slight taper for which the swivel table is set, can both be ground on the same piece at one setting of the machine. The slide is set at the angle which is the complement of the difference between half of the included angle of one taper and half the included angle of the other. For example: if half the included angle of the steep taper is 25° and half the included angle of the slight taper is 5°, the difference between them is 20° and the slide, therefore, would be set at 90° less 20°, or 70°.

With the platen, slide and swivel table set properly, the face of the wheel is trued for grinding the slight taper by moving the table back and forth. The side of the wheel is trued at an angle with the face for grinding the steep taper by moving the wheel slide back and forth. The diamond is held in the wheel truing fixture for both truings.

First, the slight taper is ground, and then, without removing the piece from the centers, the steep taper is ground.

c) Grinding the face of a bevel gear blank, or grinding a taper on any similar piece, can usually be accomplished satisfactorily by holding the piece in the 4-jawed chuck on the headstock. If the taper is slight, the headstock is set at zero degrees and the swivel table is set at the proper angle. If the taper is steep, the headstock is set at the proper angle and the swivel table is set at zero. In either case, the operation is otherwise handled like a cylindrical grinding job.

d) To grind a center point on the end of a cylindrical piece, support the piece with the headstock center and the center rest. Arrange the headstock for revolving spindle grinding with the face plate. Tie the dog on the work to the face plate with strips of rawhide to transmit the drive and to hold the work on the center. The swivel table should be set at zero degrees, and the wheel spindle should be parallel to the table with a straight wheel mounted on the left end. The wheel stand slide, however, should be set to the angle which is the complement of half the included angle of the point. True the wheel with the diamond mounted in the wheel truing fixture on the table by running the wheel back and forth with the cross feed handwheel.

e) It is advisable always to grind a taper with the wheel pressure in the direction of the headstock so that the spring in the footstock will not have to take the thrust.

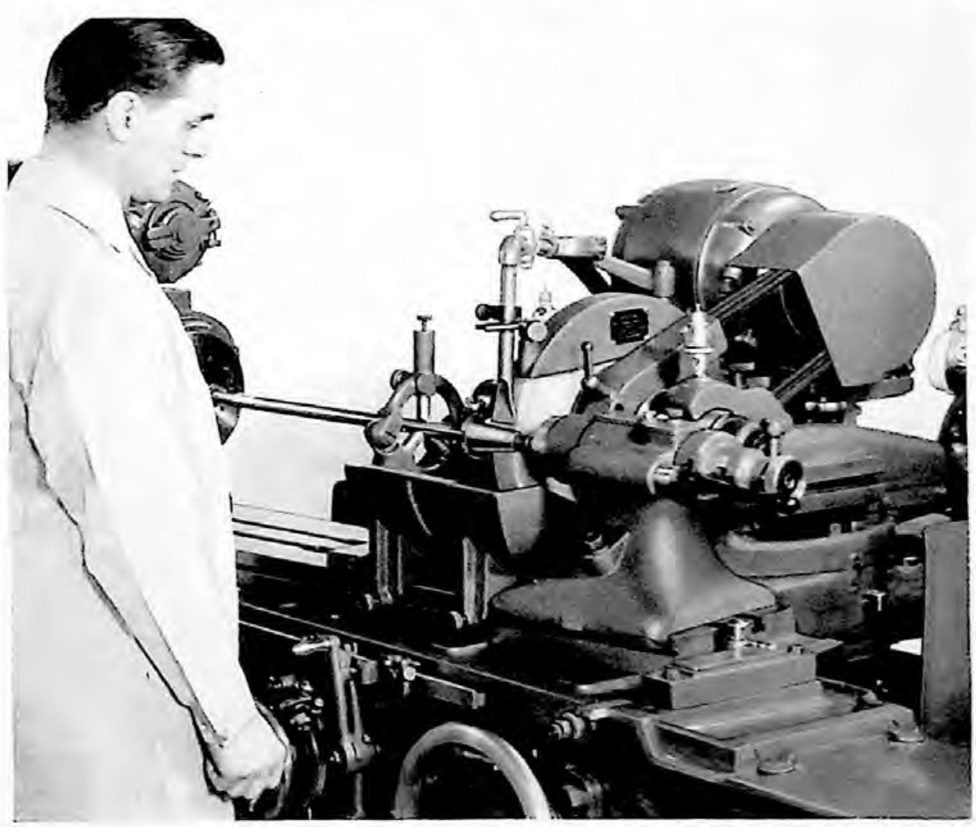


Fig. 46. In This Set-up the Taper is Being Ground with the Wheel Spindle Parallel to the Table Ways and the Swivel Table set at the Proper Angle to give the Degree of Taper Required.

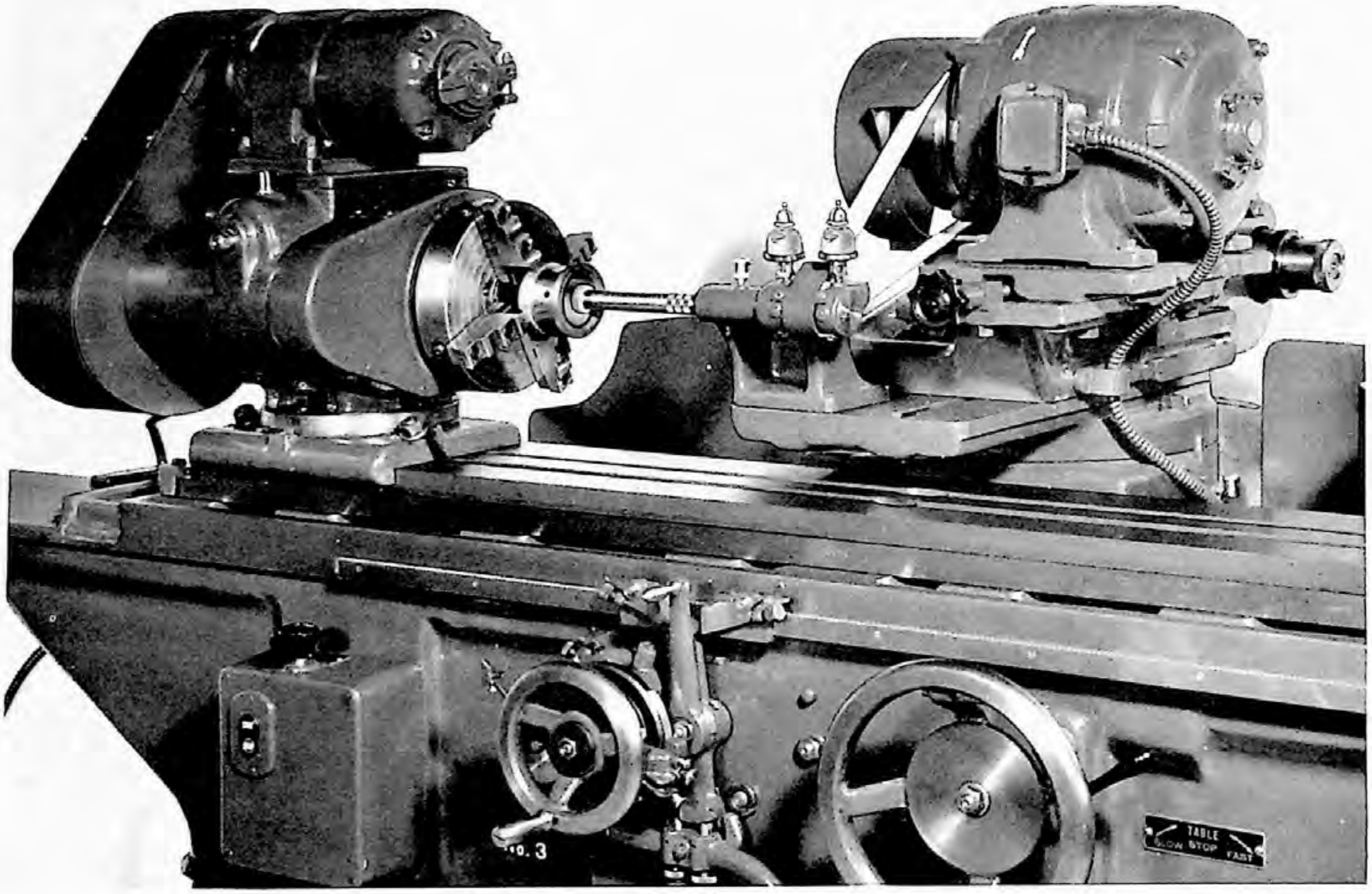


Fig. 47. Set-up for Internal Grinding. The No. 3 Machine is Shown.

Internal Grinding

Straight and tapered holes, both open and blind, can be ground. The sample (Fig. 47), however, has a straight hole running through the piece. The steps are:

1. Remove the V-belts from the sheave on the wheel spindle motor, and put the belt for the Internal Grinding Fixture on the flat pulley. Adjust the tension of the belt.
2. Set the wheel stand slide at zero degrees and turn the platen completely around to bring the fixture in operating position, matching the guide lines on the slide to assure correct alignment of the platen and slide.
3. Change the direction of the counterweight pull on the slide so that it is correct for internal grinding.
4. Set the swivel table at zero.
5. Arrange the headstock for revolving spindle grinding with the 4-jawed chuck, using the correct pulleys for the work speed needed. Set the headstock at zero degrees.
6. With the work held in the chuck, adjust the jaws so that the work will run true, using a dial test indicator to test for run-out.
7. Arrange for power table travel at the rate needed.
8. Adjust the table dogs so that the work will pass partly off, but not entirely off the wheel at the end of each stroke.
9. Arrange for manual cross feed.
10. Mount the diamond in the wheel truing fixture bolted to the table. Start the wheel rotating and true the back side of the wheel, not the front.
11. Start the work rotating. Run the wheel into the hole by hand. Then engage power table travel and feed the wheel by hand so as to grind on the back of the hole. When the piece is finished, disengage power table travel and run the wheel out of the work by hand. Stop the work, change to a new piece and repeat this step.

When changing pieces, loosen only two jaws of the chuck. This will help locate each new piece easily. It is best, however, to check each new piece for run-out with the dial test indicator. When dressing the wheel during the course of the job, do it between pieces.

On the No. 1 Machine, the wheel stand unit is set up somewhat differently. Slide the wheel stand back on the platen and remove the spindle. Replace the spindle driving pulley on the motor with the Internal Grinding Fixture driving pulley. Attach the fixture to the front of the platen and, with the belt on the pulleys, adjust the tension in the belt. Snap the spindle motor direction switch to *Internal Grinding*. Set the platen parallel with the slide and set the bed at zero degrees. Change the direction of counterweight pull on the slide so that it is correct for internal grinding.

Notes:

a) Long pieces must be supported at the outer end by the center rest. If the inner end is solid, it should be supported by the headstock center and the piece should be driven by a dog laced to the face plate. However, if the inner end has no center hole, or is not solid, it should be supported and driven by the 4-jawed chuck.

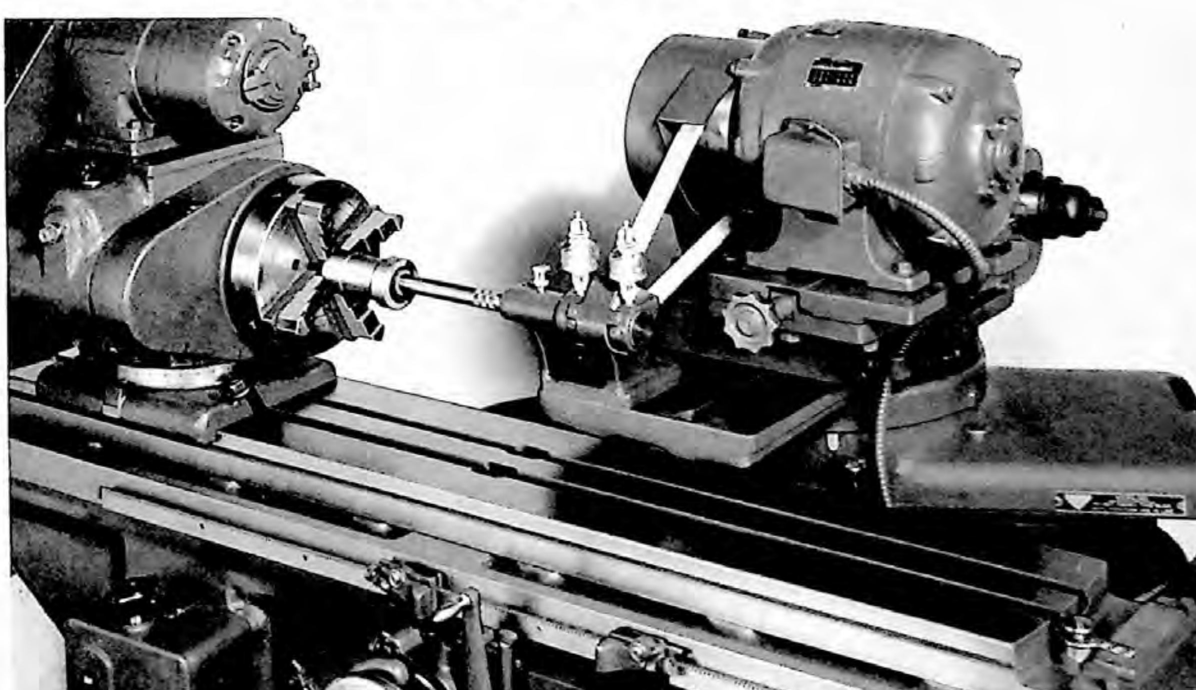
b) Tapered holes are ground by setting the wheel stand platen and wheel stand slide in much the same manner as for grinding external tapers.

c) A straight hole and a tapered seat can often be ground in one setting of the machine, (Fig. 48) but in two separate operations. The wheel stand platen is set so that the fixture spindle is parallel to the table ways and the wheel stand slide is set parallel to the back of the tapered hole. The major portion of the wheel is dressed parallel to the table ways for the straight hole, and the leading edge is dressed parallel to the slide ways for the tapered hole. The straight hole is ground by using power table travel and the wheel feed is by hand through the cross feed mechanism. The tapered hole is ground by manual cross slide movement and the grinding wheel is fed by a slight table movement.

d) While work of larger diameters can be handled, the maximum diameter of hole recommended for efficient internal grinding is about 7″.

On the No. 1 Machine, the maximum diameter recommended for efficient internal grinding is about 3¾″.

Fig. 48. Grinding a Straight Hole and Tapered Seat at One Setting on a No. 2 Machine.



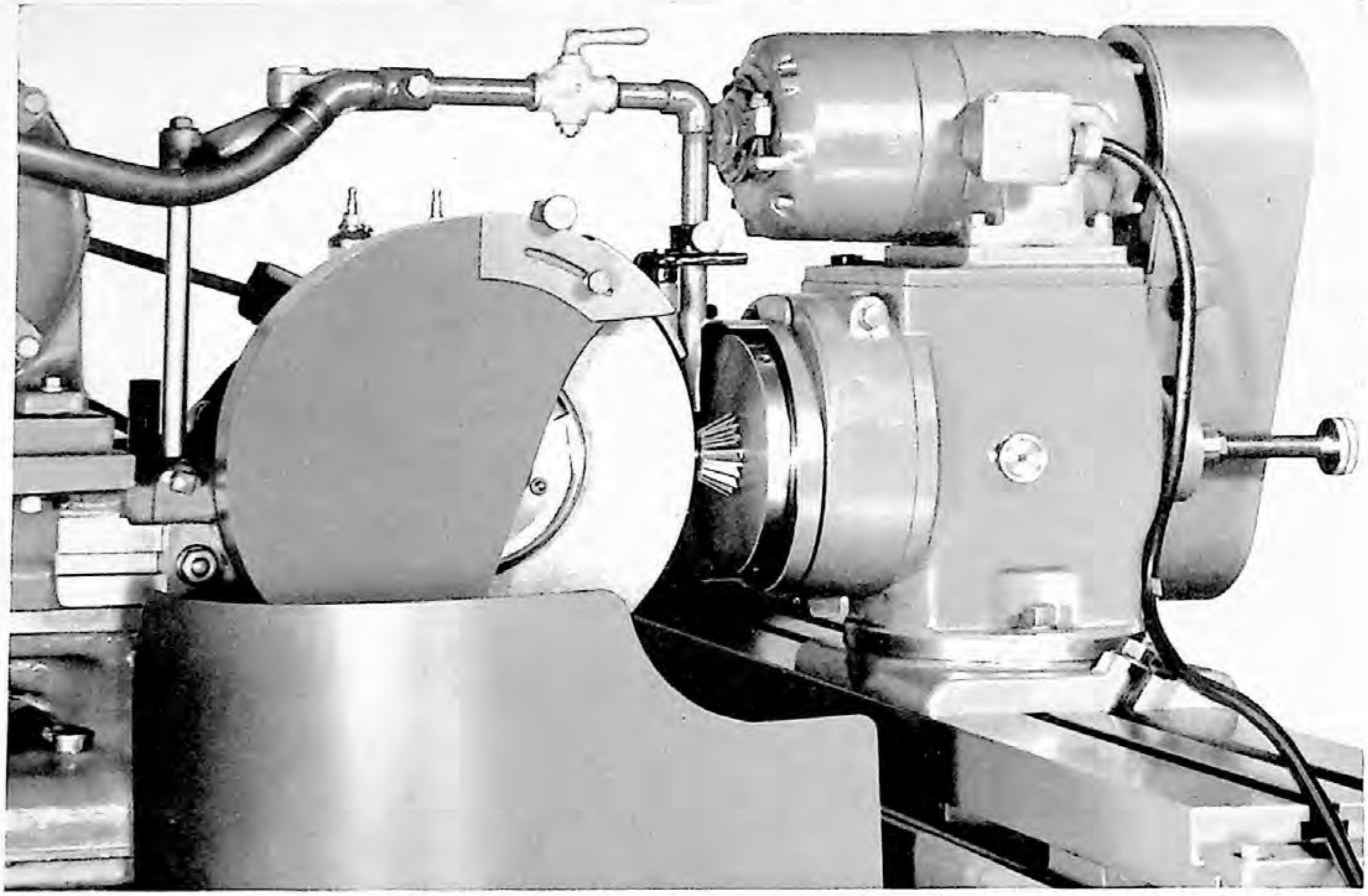


Fig. 49. Set-up for Face Grinding. The No. 2 Machine is Shown.

Face Grinding

A common example of face grinding is the finishing of the sides of a part (Fig. 49). The steps to be taken in setting up a machine for this type of work follow:

1. Arrange the entire wheel stand assembly as if for cylindrical grinding except for mounting a straight wheel on the left end of the spindle.
2. Set the swivel table at zero.
3. Prepare the headstock for revolving spindle grinding with the face chuck, using the correct pulleys for the work speed needed. Set the headstock at right angles to the table. Place a piece of work in the chuck.
4. Arrange for power table travel at the rate needed and set the table dogs. The surface being ground should move in opposite direction to the wheel at their point of contact.
5. Adjust the coolant piping and nozzle to the correct position and attach the pan water guards.
6. Start the wheel rotating, and true with the diamond mounted in the wheel truing fixture bolted to the table in permanent position for the job.
7. Start the work rotating, turn on the coolant, and start the table traversing. Adjust the automatic cross feed mechanism while grinding the first piece.

When a piece is finished, release the pawl from the feed stop of the cross feed mechanism and run the wheel back. Then shut off the coolant, stop the table and the work, and change to a new piece. To grind the new piece, set the table and work in operation again. Turn on the coolant. Run the wheel in until it touches the work, and engage the pawl with the dial.

Notes:

a) Saws and similar cutters often require sides that taper in slightly for side clearance in sawing or cutting. Setting the headstock at slightly less than 90° with the table will provide for this.

b) Face grinding the outer end of a piece with a straight shank can best be done by supporting the piece with the center rest and headstock center, and grinding the end of the piece as if it were a shoulder. The piece would be driven and held on the center by a dog laced to the face plate with rawhide.

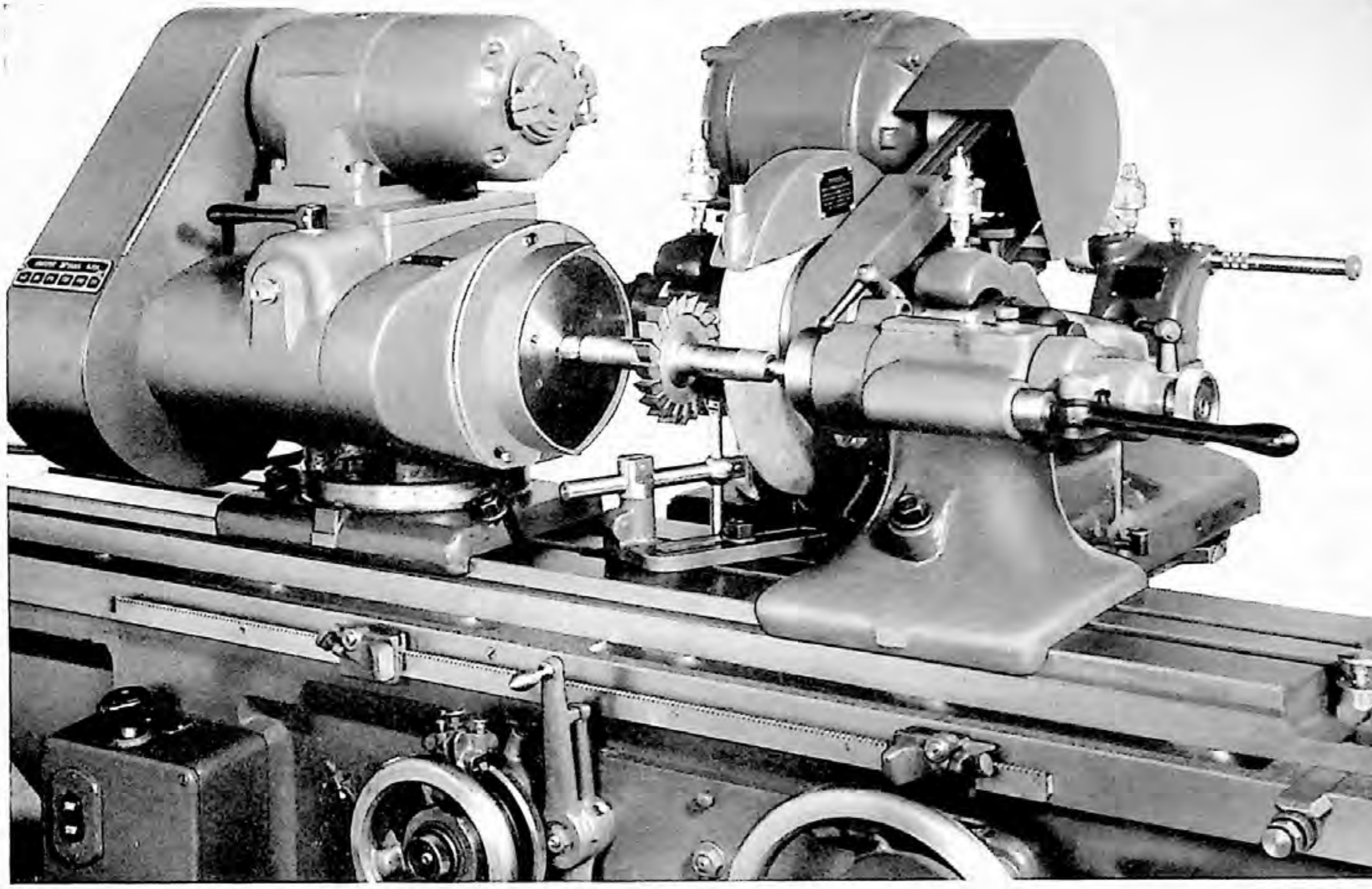


Fig. 50. Set-up for Cutter Sharpening. The No. 2 Machine is Shown.

Cutter Sharpening

A cutter having straight teeth without taper is ground while supported by the centers either direct or when mounted on a mandrel. The work shown in Fig. 50 is a plain milling cutter mounted on a mandrel. The steps in setting-up are:

1. Arrange the entire wheel stand assembly as if for cylindrical grinding, making sure, however, that the wheel used is small enough to avoid interference with the tooth next to the one being ground.
2. Set the swivel table at zero.
3. With the headstock center in place, set the headstock at zero degrees.
4. Locate and adjust the footstock so that it will support the mandrel.
5. Arrange for manual table travel and cross feed.
6. Bolt the tooth rest bracket to the table and adjust the tooth rest.
7. True the face of the wheel so that the part of the wheel in contact with the work will be about 1/32″ wide and the rest of the face will taper back out of contact.
8. To sharpen the first tooth, hold it down on the tooth rest and run the table back and forth, feeding the wheel in until the tooth has been sharpened. Take no cut deeper than .002″ and finish off by letting the wheel spark out completely. Set the stop lever of the cross feed mechanism against the pin and lock the lever. Run the wheel back and turn the cutter until the next tooth comes up from below and rests on the tooth rest. For the second tooth and each succeeding one, run the wheel until it touches the work, slide the pin forward and sharpen. Do not change the position of the stop lever. In this manner, each tooth is sharpened to the same diameter.

Dress the wheel only between cutters, otherwise not all teeth will be sharpened to the same diameter.

Note:

a) When using the Universal Head, the machine is set up in the same manner except that the wheel furnished with the Head is mounted on the left end of the spindle and the headstock and footstock are not used.

Possible Grinding Troubles and Probable Causes

Some troubles that might be encountered during the life of the machine are listed below, together with the most likely causes. Where explanation or instructions will prove helpful, the reader is referred to the portion of this book where the point in question is covered in detail.

When trouble develops, determine the cause immediately and remedy the condition without delay. This will not only maintain the quality of the work but in many cases will prevent a minor trouble from developing into a major one.

Work shows chatter finish

Grinding wheel out of balance (see page 11), or not clamped properly on wheel sleeve (page 9).

Grinding wheel dull, glazed or loaded; needs dressing (page 20).

Poor choice of wheel for the material being ground (see page 28).

Work not supported properly. Centers worn, or need lubrication. Not enough back rests used, or back rests not properly adjusted (see page 21).

Too high a work speed or rate of table travel.

Too heavy a cut (excessive cross feed).

Unbalanced work-piece (crankshaft, etc.) running at too high a speed, or running away from driving dog.

Worn or defective driving belt. Check headstock, spindle and table belts.

Spindle and wheel have not run long enough to be up to operating temperature.

End play or radial play in boxes of wheel spindle. (Also possibly in boxes of headstock spindle on No. 1 Machine).

Machine located on insufficiently rigid floor, or floor transmits vibration to machine (see page 45).

Scratches on work

Dirty coolant (see page 19).

Grinding wheel not trued properly. Truing diamond dull, cracked or broken, or not held rigidly in holder, or holder not clamped securely in truing fixture, or fixture not rigidly clamped in position, or footstock spindle not clamped. Too rapid table feed or too deep a cut in truing or dressing. (See page 20).

Too coarse a wheel.

Spiral marks on work

Point of truing diamond too high. True the wheel with the diamond point as near as possible to height of work centers.

Wheel burning the work

Not enough coolant used, or coolant not properly directed onto point of contact of wheel and work.

Grinding wheel dull, glazed or loaded; needs dressing (page 20).

Wheel too hard, or wheel speed too high, or work speed too low.

Excessive cross feed.

Work not ground parallel

Swivel table or headstock not set accurately at zero. Swivel table pivot ring may need adjusting (page 45).

Headstock or footstock not seated properly on table.

Centers not seated properly in spindle, or center points worn out of round.

Center holes in work dirty, or out of round, or do not fit centers well.

Radial play in footstock spindle. Spindle clamp not properly adjusted (see page 14).

(End play or radial play in boxes of headstock spindle on No. 1 Machine).

Back rests needed, or not properly adjusted (see page 21).

Wheel spindle runs too hot or stalls

Insufficient oil in spindle oilers, or wrong kind of oil (page 43).

Too heavy a cross feed, beyond capacity of machine.

Spindle driving belts too tight (page 44).

Spindle caps clamp the bushings too tightly.

Not enough oil clearance is left after rescraping bearings. If only right bearing runs too hot after end play adjustment has been made, adjustment is too tight (page 44).

CHAPTER V

Maintenance

Lubrication

Oil cups, oil holes and greasing stations are conveniently located for reaching all moving parts requiring lubrication. Use a good grade of **Spindle Oil** of 100 seconds S.U.V. at 100° F. for the spindle; and oil of 300 seconds S.U.V. at 100° F. or S.A.E. 20 elsewhere. A good grade of ball bearing grease is suggested for greasing stations. A mixture of oil with enough white lead to make a paste is satisfactory for use on the headstock and footstock centers.

Following are two lubrication diagrams which show the location of the oil cups, oil holes and greasing stations on the machines, and indicate when to service them under ordinary operating conditions. A machine which has not been run for some time will probably require more frequent attention for a while than the diagram calls for.

Notes:

a) The headstock spindle bearings are permanently sealed and should require no attention.

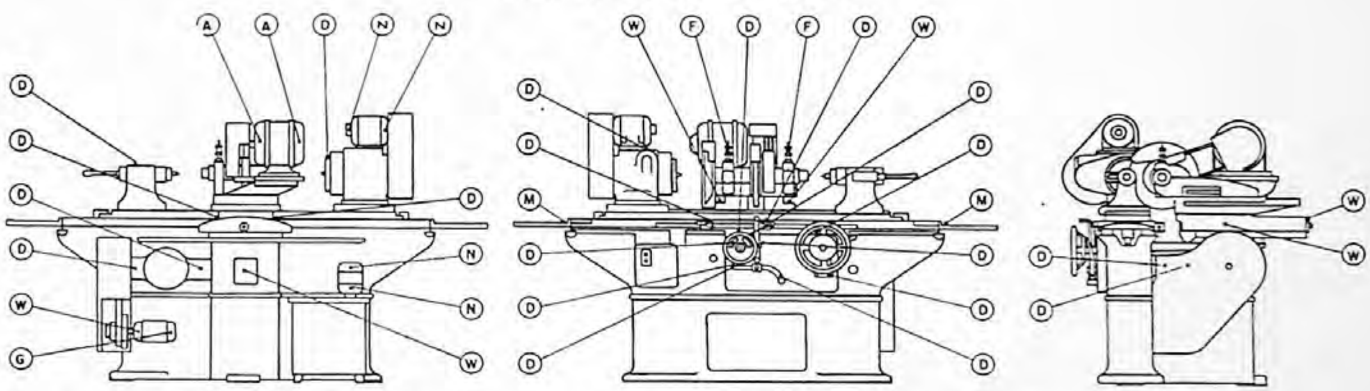
The bearings of the intermediate shaft should be inspected every three or four years and greased if necessary.

The motor bearings are permanently sealed and should require no attention.

b) Regulate both sight feed oilers for the wheel spindle, so that two drops of oil per minute will flow to each box.

c) Once a month, the used oil which has settled through the machine should be drained off through the outlet provided on the left side of the bed above the coolant tank. Do not let the oil drain into the coolant.

LUBRICATION DIAGRAM
Nos. 2, 3 and 4 Machines



A—Clean and grease annually (Ball Bearing Motors)
Good grade ball bearing grease

D—Oil daily—good grade machine oil of 300 seconds S.U.V. at 100°F

F—Fill when necessary
Good grade spindle oil of 100 seconds S.U.V. at 100°F

G—Clean and grease every two years (Ball Bearing Motors)
Good grade ball bearing grease

M—Inspect monthly—fill when necessary
Good grade machine oil of 300 seconds S.U.V. at 100°F

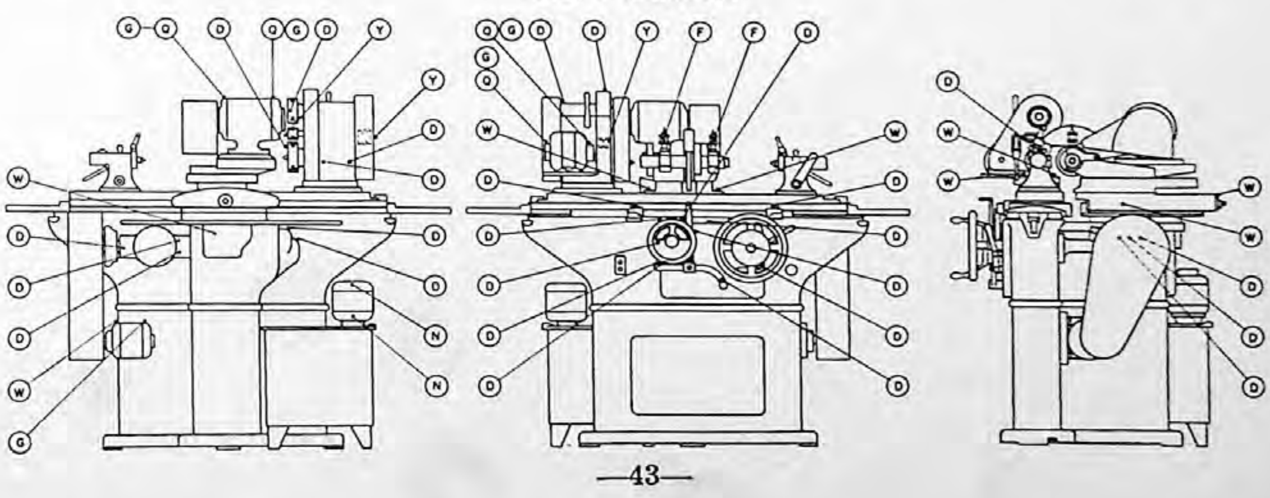
N—Bearings permanently sealed. Headstock bearings permanently sealed (Nos. 2, 3 and 4 machines)

Q—Inspect every six months (Sleeve Bearing Motors)
Good grade machine oil of 300 seconds S.U.V. at 100°F

W—Oil weekly—good grade machine oil of 650 seconds S.U.V. at 100°F

Y—Grease yearly — good grade ball bearing grease

No. 1 Machine



d) The entire oiling system should be flushed occasionally with kerosene, gasoline or naphtha to clean out all dirt and sludge.

e) Permanent stains on the machine can be prevented by wiping the machine once a week with a cloth soaked in kerosene, gasoline or naphtha.

Main Mechanical Adjustments

To avoid excessive or rapid wear, make adjustments when their need first becomes apparent. It is difficult to produce good work with a machine in need of adjustment.

Wheel Spindle

Excessive end play. The spindle should have from .003"-.005" end play when cold. If the play exceeds the maximum figure an adjustment may be necessary. The spindle should be run until heated to running temperature before any adjustment is made, and should then have an end play of about .001". To make an adjustment, loosen the spindle thrust nut plug at the extreme right end of the spindle and turn the spindle thrust nut to take up the play. Tighten the thrust nut plug after the proper adjustment has been made.

Radial play in spindle boxes. Usually only one box will need adjusting at a time, i. e., the one which does not run as warm as the other. Remove the spindle from the machine. First loosen the nut on the left end of the spindle box, and then tighten the nut on the right end. Replace the spindle in the machine and check the adjustment.

If further adjustment is needed, remove the spindle again, take both nuts off the box and drive the latter out of the bushing. The bushing unit can be removed from the left end of the spindle after taking off the wheel sleeve. The unit on the right end of the spindle can be removed after taking off the end play adjustment parts. Reduce the thickness of the two brass box liners slightly, and reassemble the spindle. Replace the spindle in the machine and check the adjustment. Further reduction of the liners may be necessary.

After making the adjustment for excessive end play or radial play in the boxes, the machine should be run to allow the spindle to heat to normal running temperature. The spindle bushings should be quite warm to touch but should not heat excessively when the spindle boxes are in good adjustment.

Tension in Spindle V-Belts. Do not use excessive tension in the spindle V-belts, as this is unnecessary and may cause serious damage to the machine.

When running, a V-belt wedges itself into the pulley grooves, resulting in a tightening on the driving side, and a noticeable slackening on the idle side. Therefore, it is best to leave V-belts as loose as possible and yet not have them slide. Before starting, it should be possible to grasp the two sides of a V-belt and readily draw them toward each other an appreciable distance without using extreme pressure (this effect varies with the center distance and size of the belt).

Use only matched sets of V-belts, adjusting for the tightest belt and regulating the tension as the belts work in, until all are driving evenly.

Cross Feed

Play in the worm shaft thrust bearings. This condition may affect the operation of the cross feed mechanism. To correct, first remove the cross feed handwheel unit. Remove the locking plate which holds the serrated nut in position in back of the cross feed dial and tighten the nut until the play is taken up. Replace the plate to lock the nut.

On the No. 1 Machine, remove the cover at the rear of the bed, and take out the cross feed bracket oil well after removing the three screws which clamp it to the bracket above. The serrated nut is tightened similarly by removing the locking plate and turning the nut until the play is taken up. Replace the plate, oil well and cover.

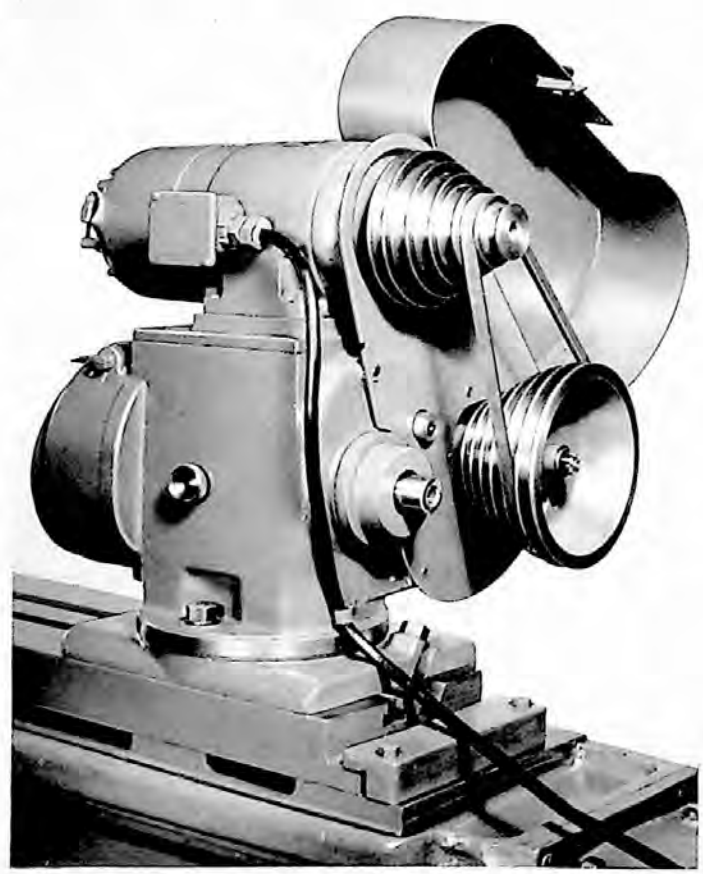


Fig. 51. Rear View of the Headstock of a No. 2 Machine with the Pulley Belt Guard Open to Show the Driving Belt and Sheaves.

Headstock

Truing the center point. Mount the live center pulley on the spindle nose, and place the center in the spindle. Set the swivel table at zero and the headstock at 30°, and grind the point. Flat the point to about 1/32″ after grinding.

Driving belt tension. Any stretch in the headstock driving belts which cannot be *taken up* by the belt tension release lever can be compensated for by changing the position of the intermediate shaft with the hexagonal-headed belt tension adjusting screw located just below the release lever on the front of the headstock.

The tension in the driving belt from the motor to the countershaft on the No. 1 Machine is controlled by an idler pulley, the stud and nut for which project from the right side of the headstock (Fig. 10). Raising the stud tightens the belt.

End play in spindle on the No. 1 Machine. First try tightening the nut on the left end of the spindle. If this does not accomplish the desired result, the spindle should be removed by taking the nut off the left end, and the thrust washer should be thinned by filing or grinding.

Motor Brake Adjustment. The integral motor brake has a small screw and check nut at the right rear of the unit by means of which adjustments for wear can be made. Tightening the screw compensates for wear in the stationary friction disk.

Countershaft brake and clutch on the No. 1 Machine. Remove the cover from the top of the headstock (Fig. 52). The brake is threaded into the brake bracket to the left of the clutch body on the countershaft. Loosen the screw at the front of the right end of the brake bracket, pull out the locking plunger at the top of the bracket, and turn the brake left-hand to compensate for wear in the brake. Allow the plunger to return into one of the holes in the brake and tighten the screw in the bracket again.

Wear in the driving pulley clutch which threads onto the pulley to the right of the clutch body can be compensated for in a similar manner. Loosen the screw which clamps the clutch to the pulley. Push the plunger, which is on the opposite side of the clutch from the screw, back through the hole in the pulley and into the clutch, and turn the clutch left-hand. Allow the plunger to return into one of the holes in the pulley and tighten the screw in the clutch.

Footstock

Truing the center point. Place the center in the headstock spindle and grind it as if it were the headstock center.

Radial play in spindle. The play is taken up by turning the small, vertical, knurled screw above the spindle right-hand.

On the No. 1 Machine, remove the vertical screw in back of the spindle and knock out the shim. Grind or file the shim slightly and replace it along with the screw.

Swivel Table

Play between the split ring, which surrounds the pivot, can be taken up by turning right-hand the screw in the middle of the front edge of the table just above the dog rack.

Internal Grinding Attachment

End play can be eliminated by turning the outer shell over the spindle right-hand until all the play is taken up. If there is also radial play in the spindle box, turn the shell still more so that the box, which is tapered on the outer surface, will be forced deeper into the tapered hole in the shell. This will make the hole in the box smaller and allow a better fit on the spindle. Back off the shell slightly, but not enough to allow end play.

Installing or Relocating the Machine

The machine should be located on a level and solid floor or foundation, free from heavy vibration. With the machine securely bolted in place, a spirit level should show the machine level both longitudinally and transversely.

If the machine is to be hoisted to change its location, pass a rope under the bed from the front at one end, up over the falls, down under the other end of the bed from the front, and up over the falls again. Then pass the rope down around the rear of the bed just below the pan beneath the wheel stand assembly, and up over the falls again

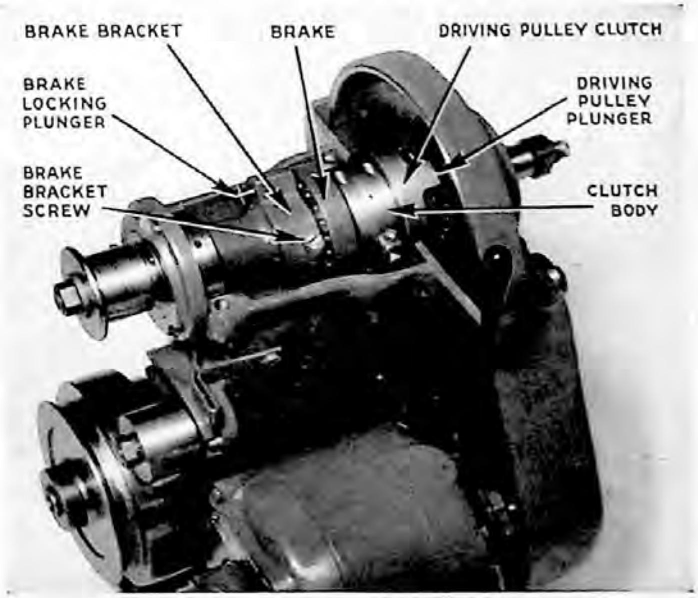


Fig. 52. Headstock of a No. 1 Machine with the Cover Removed to Show the Countershaft Assembly.

to join the loose end. Place wooden blocks between the rope and the machine wherever the rope is liable to damage some part of the machine. The Nos. 1, 2, 3 and 4 Machines weigh about 2900, 5500, 6800 and 7500 pounds respectively.

Electrical Circuit

The electrical circuit of the standard machine is connected with the power supply through the terminal box at the right rear of the base near the floor (Fig. 17). Means should be provided to ground the machine either through the conduit system, or to some suitable ground nearby, so that the machine will be grounded for safety at all times.

The main magnetic switch connecting the machine to the power supply, the headstock magnetic switch and the individual overload relays for each motor circuit are located in the covered compartment in the front of the machine base. Overload of any motor circuit automatically stops the entire machine. Each overload relay has an automatic reset.

In case of repeated overloads, change the individual overload relays from automatic to hand reset and determine which motor circuit is causing the trouble. Where Westinghouse Electric Company overload relays are used, this is done by taking the plungers and springs found inside the compartment and placing one of each in the hole provided for them in each relay (Fig. 53). Hold the relay contact out of the way as each plunger is inserted. Then start the machine and wait for it to be stopped by a relay tripping out. After the relay has had time to cool, push each plunger until one is found that clicks as it is pushed in. That one is the relay for the circuit with the overload. If overload relays appear O.K., press the transformer reset button. The wiring diagram sent with the machine will aid in further tracing of the trouble and in remedying it. The sample diagrams on page 47 are for 3-phase, 60-cycle installations.

General Electric overload relays are changed from automatic to hand reset by moving the wire loop of each relay to the position indicated on the relay itself.

If, at any time, it becomes necessary to disconnect any wires, be careful to replace them properly according to the wiring diagram sent with the machine, and the numbers on the terminals. Be careful not to run the motors longer than necessary if their direction is wrong. Switching two of the line wires at the line disconnect switch will reverse the direction of all the motors.

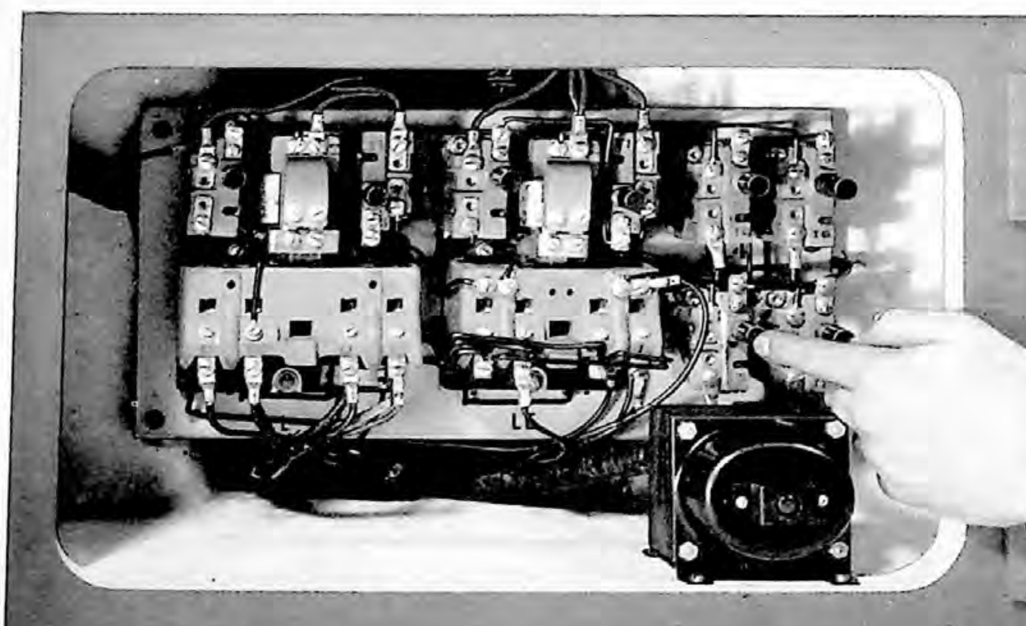
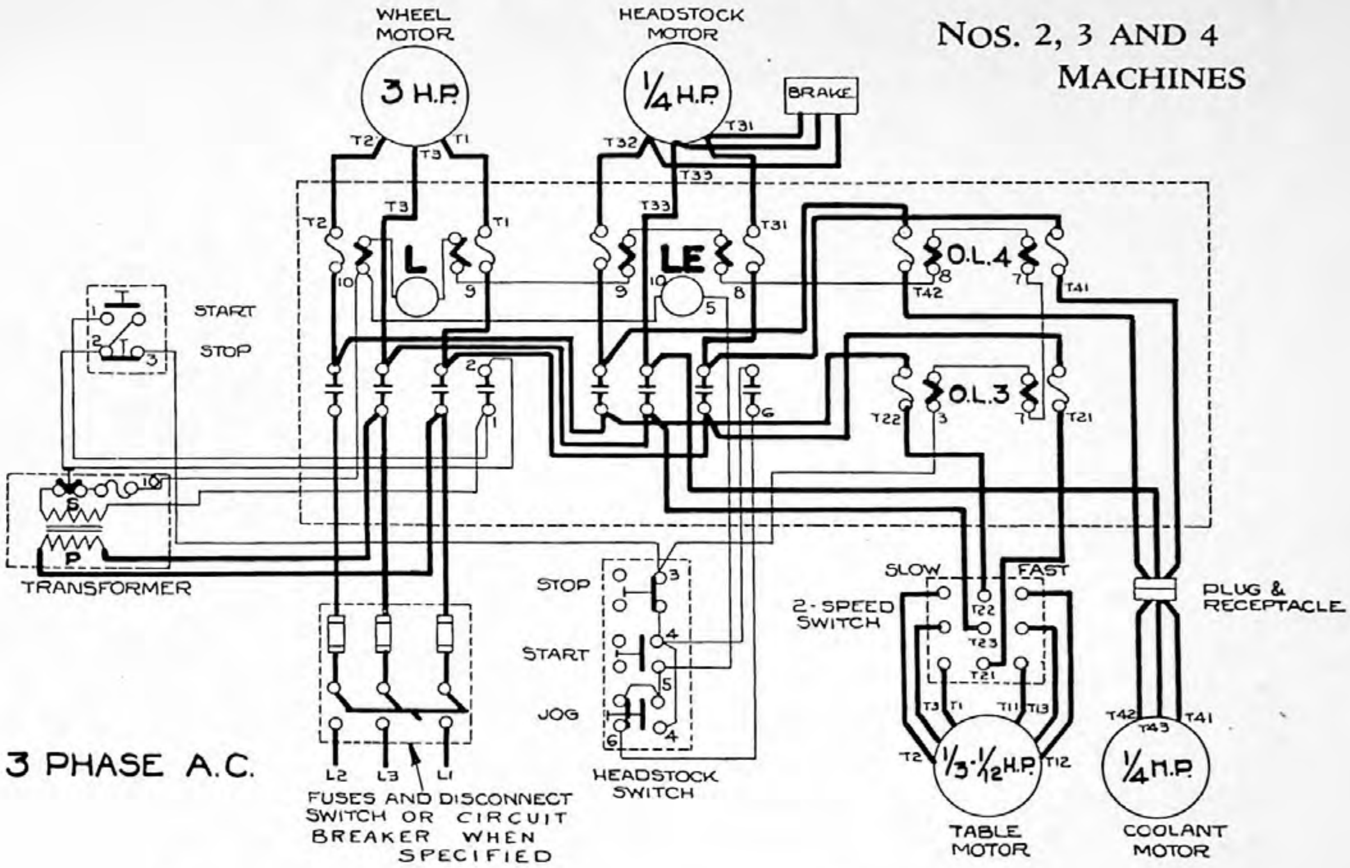


Fig. 53. Testing Individual Motor Relays to Determine which Motor Circuit is Overloaded. The Electrical Control Panel of a No. 2 Machine is Shown.

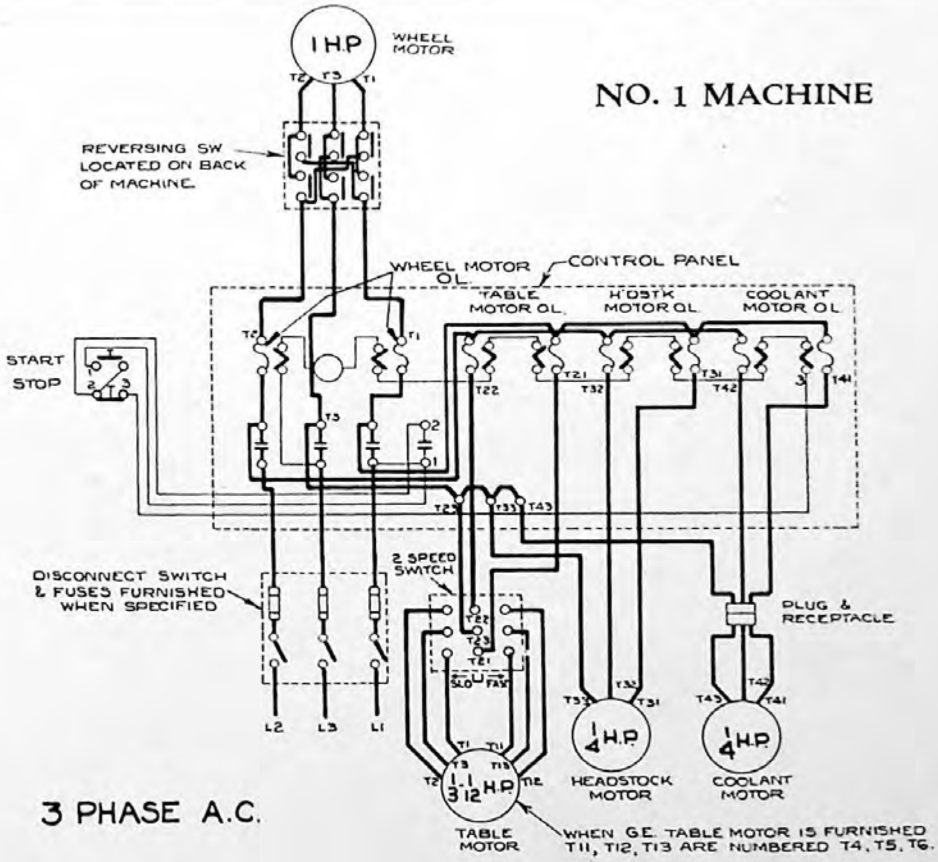
It is highly important in the efficient production of good work that the machine be kept clean, properly oiled and in good operating condition. Jobs should be set up correctly and carefully. Mechanical and electrical troubles should be remedied whenever they first become apparent. Refer to the repair part section of this book when stripping and assembling any unit, and for identifying parts when ordering replacements.

Nos. 2, 3 and 4 Machines

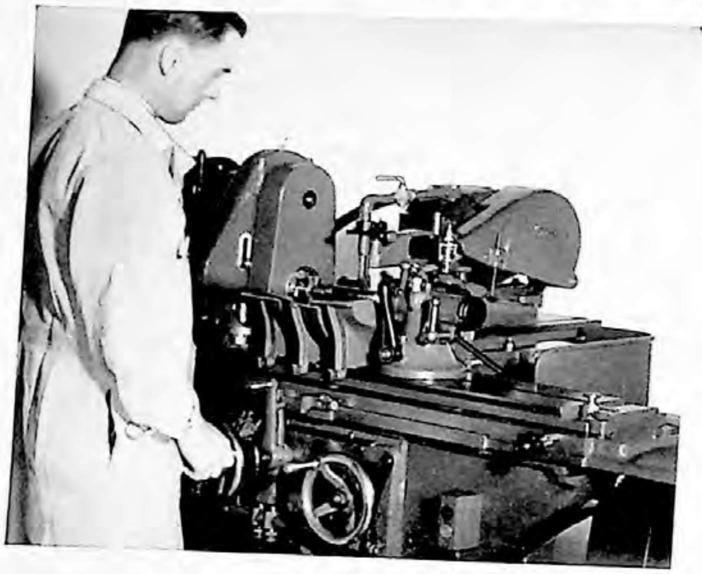


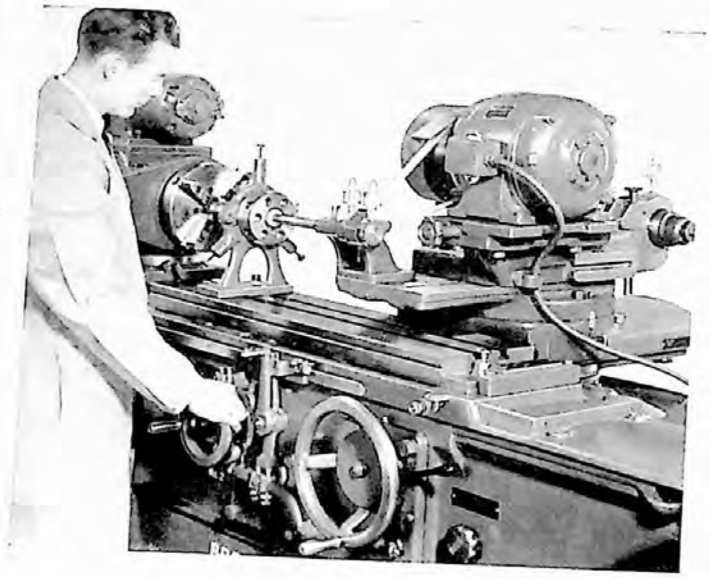
3 PHASE A.C.

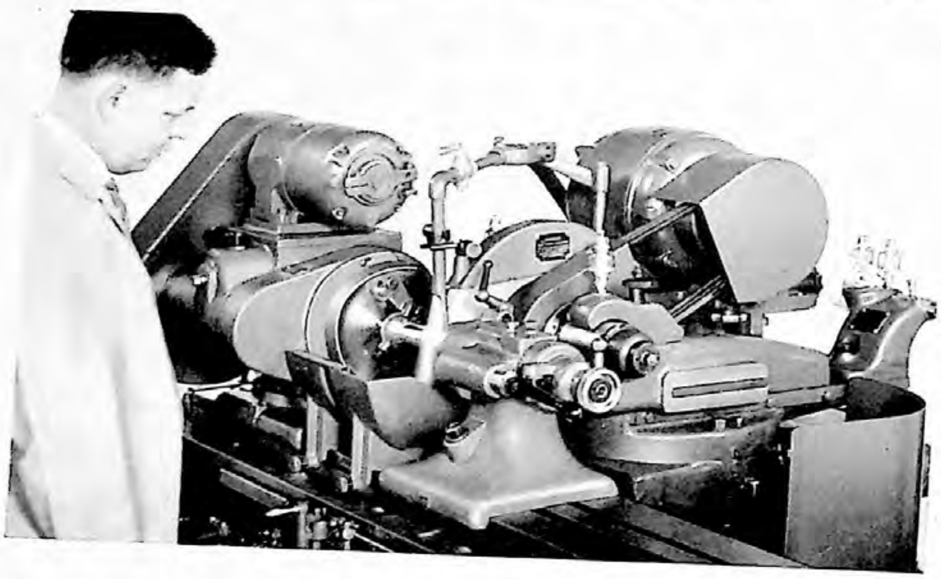
No. 1 Machine



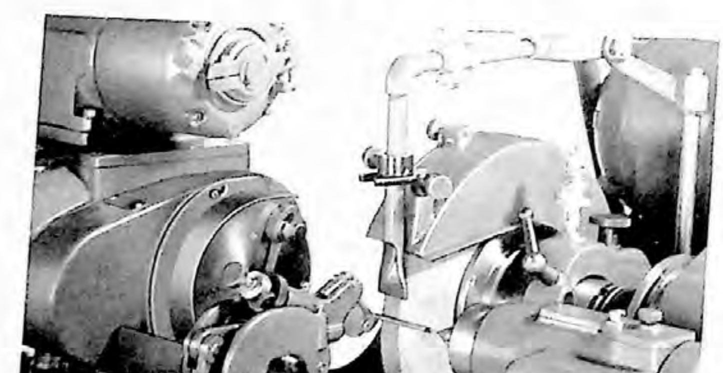
3 PHASE A.C.

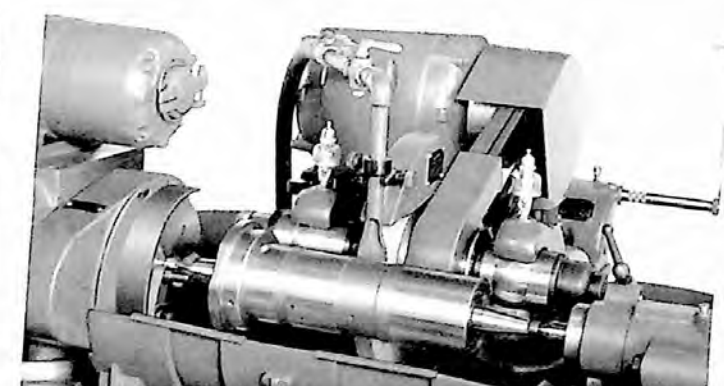






Typical Run-of-Shop Jobs, Illustrating the Ability of the Machines to Handle a Wide Variety of Toolroom and Production Grinding.





PART II

REPAIR PARTS

for

Nos. 1, 2, 3 and 4 UNIVERSAL GRINDING MACHINES

REPLACEMENT parts are listed and illustrated in this section of the book. To facilitate the identification of parts as well as stripping and assembling, the parts are shown separated and are arranged so far as possible in the same relative position as in the machines.

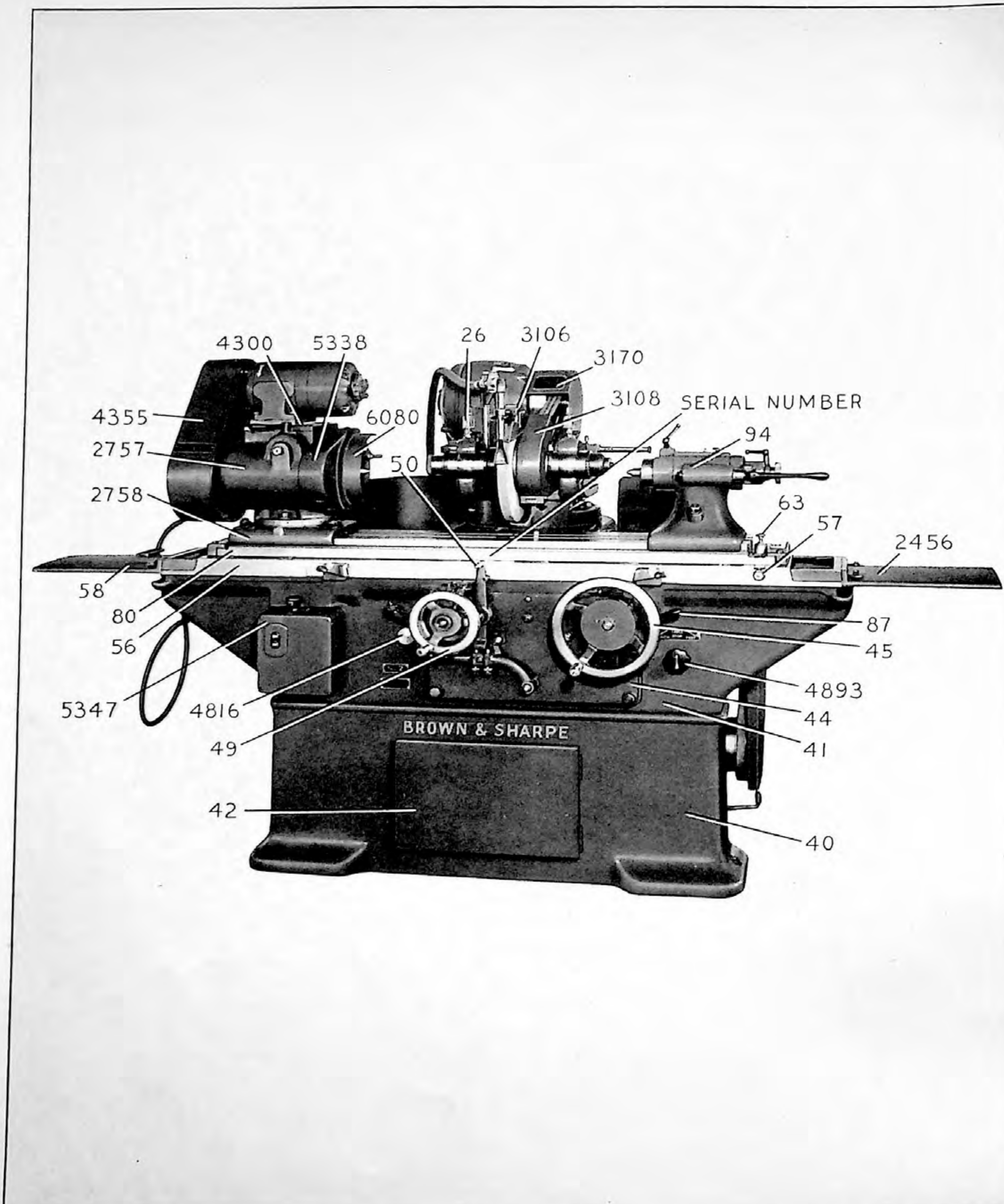
In some cases when a part is ordered, not only that part but one or more supplementary parts also may be sent. This is done when, from our experience, it is known to be advisable for a more satisfactory repair job.

When ordering repair parts it is essential that the size, style and serial number of the machine be stated in addition to the part number and name given in the following pages.

INDEX OF REPAIR PART GROUPS

IMPORTANT

Parts illustrated in this book are *finished* parts and are shown for identification purposes only. In some cases repair parts as furnished will require fitting and therefore may need to have holes drilled, shoulders squared or other machining in order to make them fit properly.



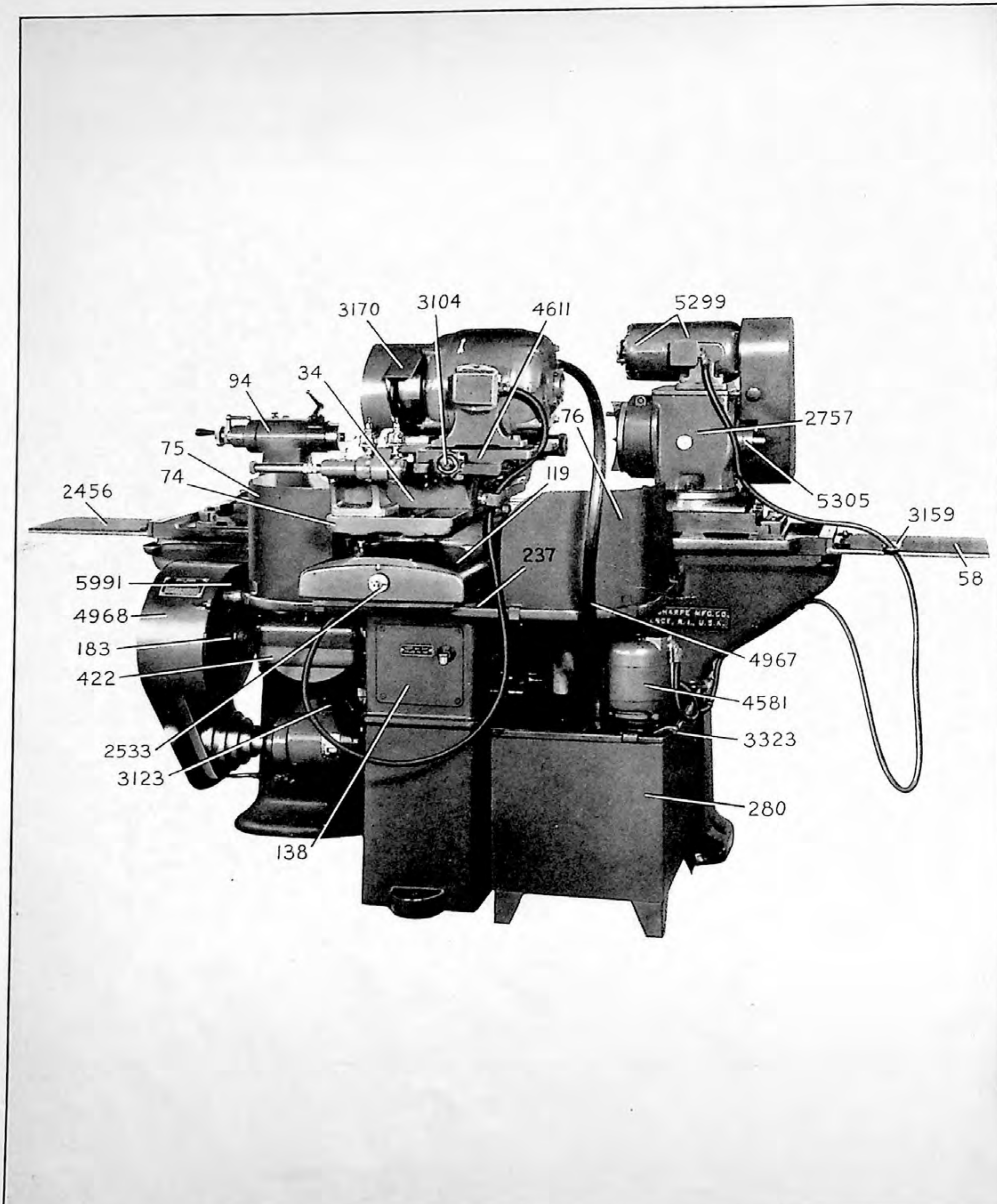
Front View
Nos. 2, 3 and 4 Machines
(No. 2 Machine Shown)

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Front View

Nos. 2, 3 and 4 Machines

26	Sight Feed Oiler
40	Base
41	Bed
42	Electrical Controls Cover
44	Bed Front Plate
45	Table Handwheel
49	Cross Feed Handwheel
50	Reverse Lever
56	Sliding Table
57	Swivel Table Adjusting Knob
58	Table Guard, Left
63	Swivel Table Locking Pin Knob
80	Swivel Table
87	Table Handwheel Throwout Lever
94	Footstock
2456	Table Guard, Right
2757	Headstock Body
2758	Headstock Base
3106	Wheel Guard
3108	Wheel Spindle V-Belt Pulley Guard
3170	Motor Pulley Belt Guard
4300	Headstock Motor Plate
4355	Motor Drive Belt Guard
4816	Cross Feed Change Gear Plunger Knob
4893	Table Motor Switch Operating Knob
5338	Headstock Spindle Belt Guard
5347	Headstock and Main Switch Compartment
6080	Splash Guard



Rear View
Nos. 2, 3 and 4 Machines
(No. 2 Machine Shown)

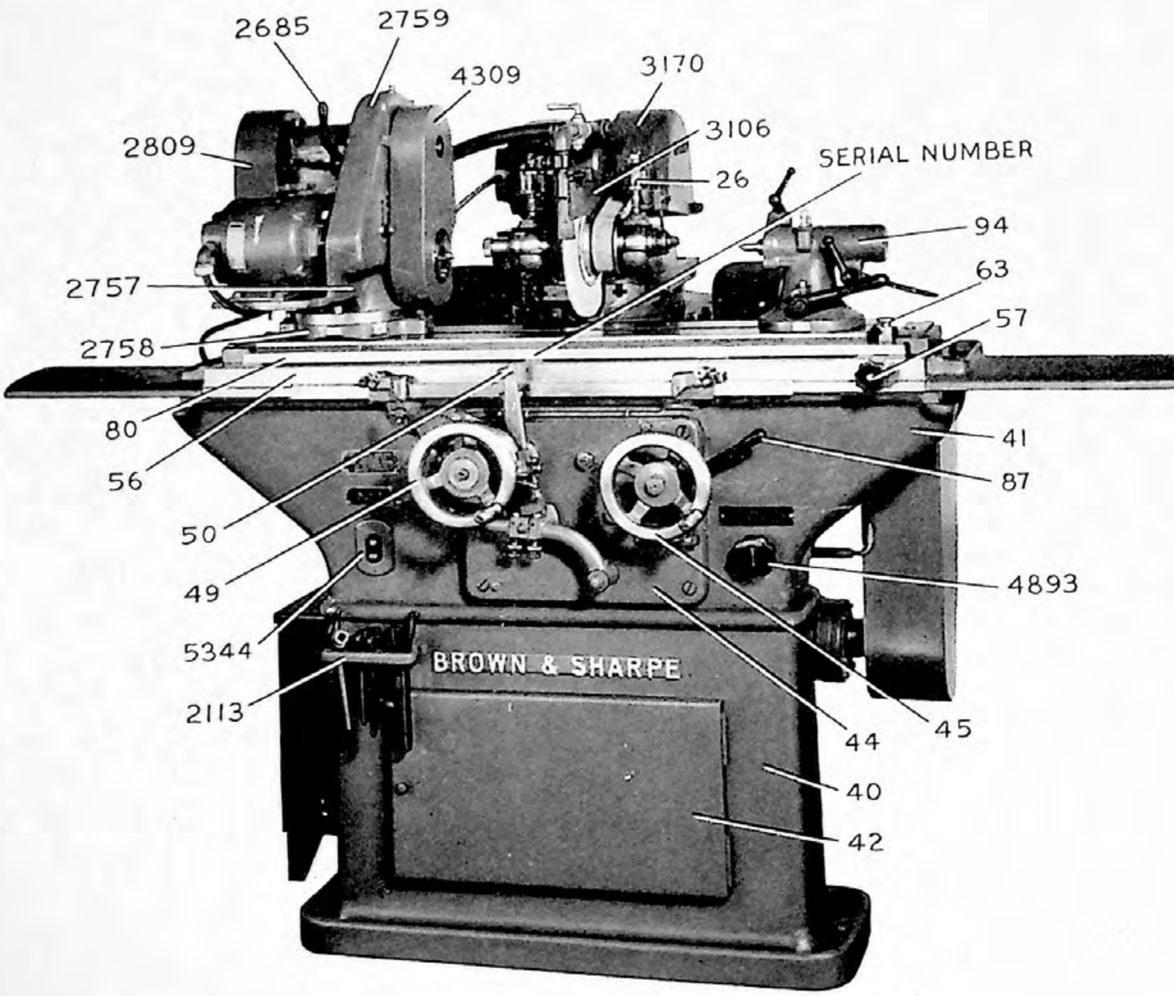
When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Rear View

Nos. 2, 3 and 4 Machines

34	Wheel Stand
58	Table Guard, Left
74	Wheel Stand Platen
75	Pan Water Guard, Right
76	Pan Water Guard, Left
94	Footstock
119	Wheel Stand Slide
138	Bed Cover
183	Clutch Shaft Bracket
237	Wheel Stand Slide Bed
280	Coolant Tank
422	Clutch Shaft Bracket Cover
2456	Table Guard, Right
2533	Counterweight Adjusting Screw
2757	Headstock Body
3104	Motor Adjusting Screw Knob
3123	Table Driving Motor Bracket
3159	Headstock Cable Guide
3170	Motor Pulley Belt Guard
3323	Coolant Pump Support
**4581	Motor Driven Centrifugal Pump
4611	Motor Support
4967	Coolant Hose
4968	Table Drive Belt Guard
5299	Headstock Motor and Motor Brake
5305	Spindle Rear Bearing Cover
5991	Table Drive Belt Guard Support

**See also, "Repair Parts for Brown & Sharpe Pumps".



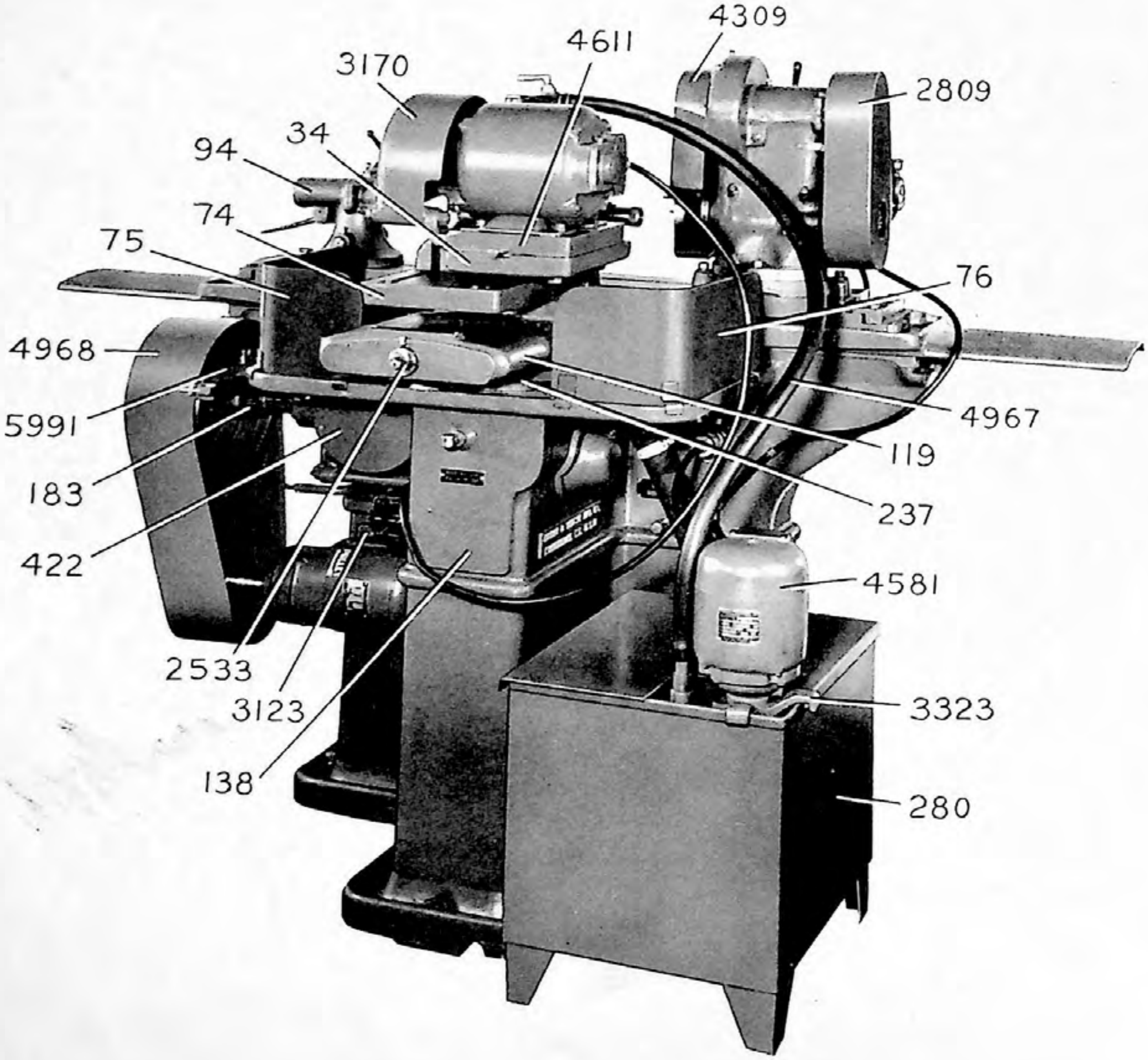
Front View
No. 1 Machine

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Front View

No. 1 Machine

26	Sight Feed Oiler
40	Base
41	Bed
42	Electrical Controls Cover
44	Bed Front Plate
45	Table Handwheel
49	Cross Feed Handwheel
50	Reverse Lever
56	Sliding Table
57	Swivel Table Adjusting Knob
63	Swivel Table Locking Pin Knob
80	Swivel Table
87	Table Handwheel Throwout Lever
94	Footstock
2113	Wrench Rack
2685	Clutch Fork Lever
2757	Headstock Body
2758	Headstock Base
2759	Headstock Cover
2809	Headstock Belt Guard, Left
3106	Wheel Guard
3170	Motor Pulley Belt Guard
4309	Headstock Belt Guard, Right
4893	Table Motor Switch Operating Knob
5344	Main Switch Push Button



Rear View

No. 1 Machine

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Rear View

No. 1 Machine

34	Wheel Stand
74	Wheel Stand Platen
75	Pan Water Guard, Right
76	Pan Water Guard, Left
94	Footstock
119	Wheel Stand Slide
138	Bed Cover
183	Clutch Shaft Bracket
237	Wheel Stand Slide Bed
280	Coolant Tank
422	Clutch Shaft Bracket Cover
2533	Counterweight Adjusting Screw
2809	Headstock Belt Guard, Left
3123	Table Driving Motor Bracket
3170	Motor Pulley Belt Guard
3323	Coolant Pump Support
4309	Headstock Belt Guard, Right
**4581	Motor Driven Centrifugal Pump
4611	Motor Support
4967	Coolant Hose
4968	Table Drive Belt Guard
5991	Table Drive Belt Guard Support

**See also, "Repair Parts for Brown & Sharpe Pumps".

Wheel Spindle

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Wheel Spindle

1	Wheel Spindle
2	Wheel Spindle Box, Left
3	Wheel Spindle Box, Right
§8	Wheel Sleeve, Center
10	Wheel Sleeve Nut, Center
*11	Center Wheel Sleeve Flange Nut
12	Wheel Sleeve Nut, Center
13	Wheel Spindle Thrust Washer
14	Wheel Sleeve, Left
15	Wheel Sleeve Flange
*16	Left-hand Wheel Sleeve Flange Nut
17	Left-hand Wheel Sleeve Nut
*18	Wheel Spindle Thrust Plate
20	Wheel Spindle Thrust Nut
21	Wheel Spindle Thrust Nut Plug
22	Spindle Box Spring
28	Grinding Wheel Packing Washer
372	Wheel Spindle Left Box Nut, Left
374	Wheel Spindle Bushing, Left
375	Wheel Spindle Bushing, Right
376	Wheel Spindle Left Box Nut, Right
377	Wheel Spindle Right Box Nut, Left
378	Wheel Spindle Right Box Nut, Right
379	Wheel Spindle Thrust Nut Washer
†382	Wheel Spindle Thrust Nut Bushing
2161	Wheel Spindle Guard
3877	Wheel Puller
§4110	Wheel Stand Motor Pulley (State Diameter)
†4569	Wheel Sleeve Flange Wrench
4843	Internal Grinding Driving Pulley
4844	Motor Pulley Clamp Nut
4845	Pin Wrench, $1\frac{1}{2}''$
†4846	Pin Wrench, $1\frac{3}{4}''$
4847	Wheel Sleeve Nut (Right) Wrench

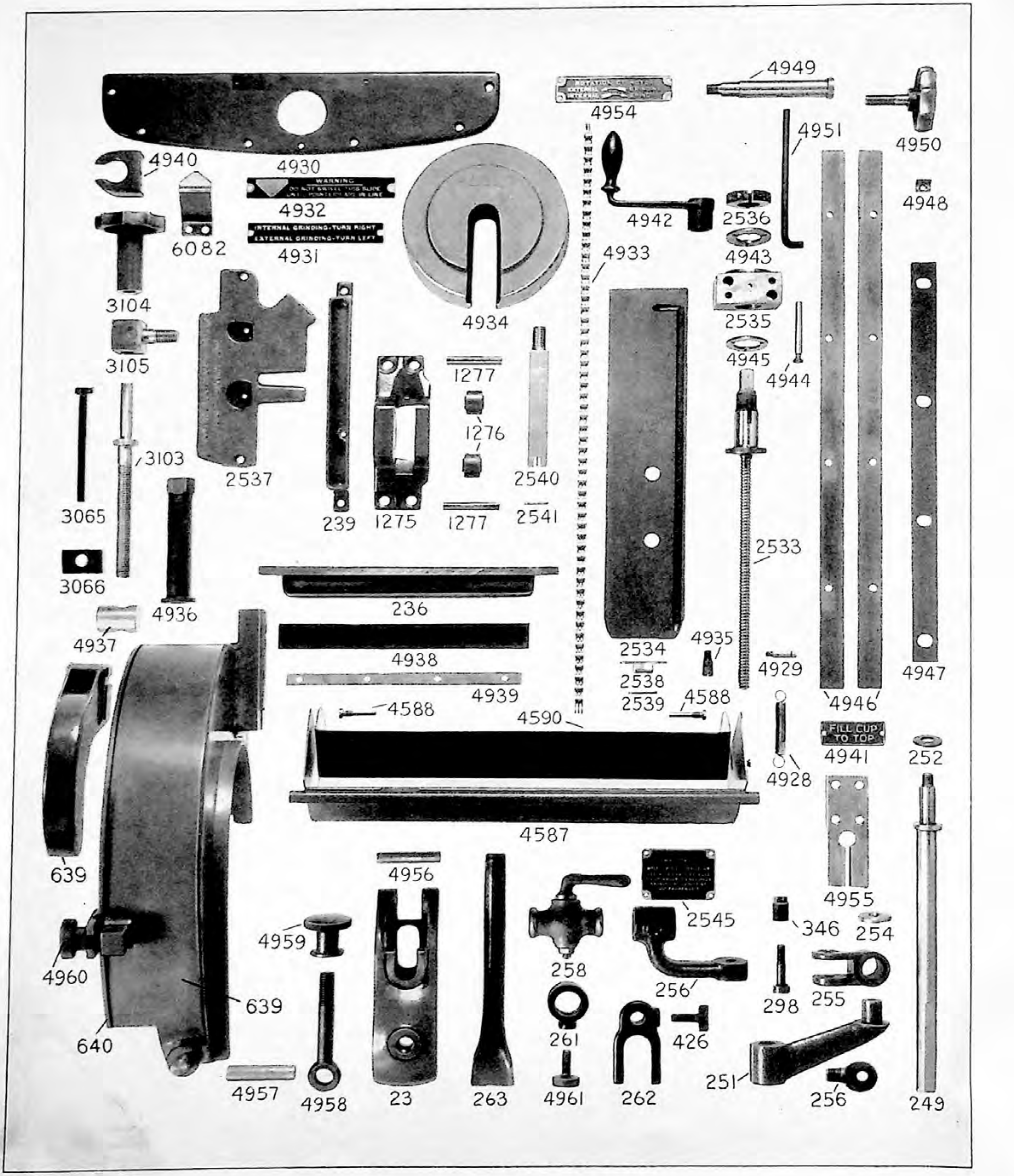
Belts
(Not illustrated)

**3213	Wheel Spindle Driving Belt

*No. 1 Machine only.
†Nos. 2, 3 and 4 Machines only.
§Flat Belt Drive on No. 1 Machine.

**For No. 1 Machine—Smooth running, endless flat belt; $1\frac{1}{8}''$ wide; $32\frac{1}{8}''$ inside circumference.

**For Nos. 2, 3 and 4 Machines—Oil resistant "V" belt; "A" cross section ($\frac{1}{2}''$ wide x $\frac{11}{32}''$ thick); pitch length 52". These belts should be purchased in matched sets of three and should be tested for vibration.



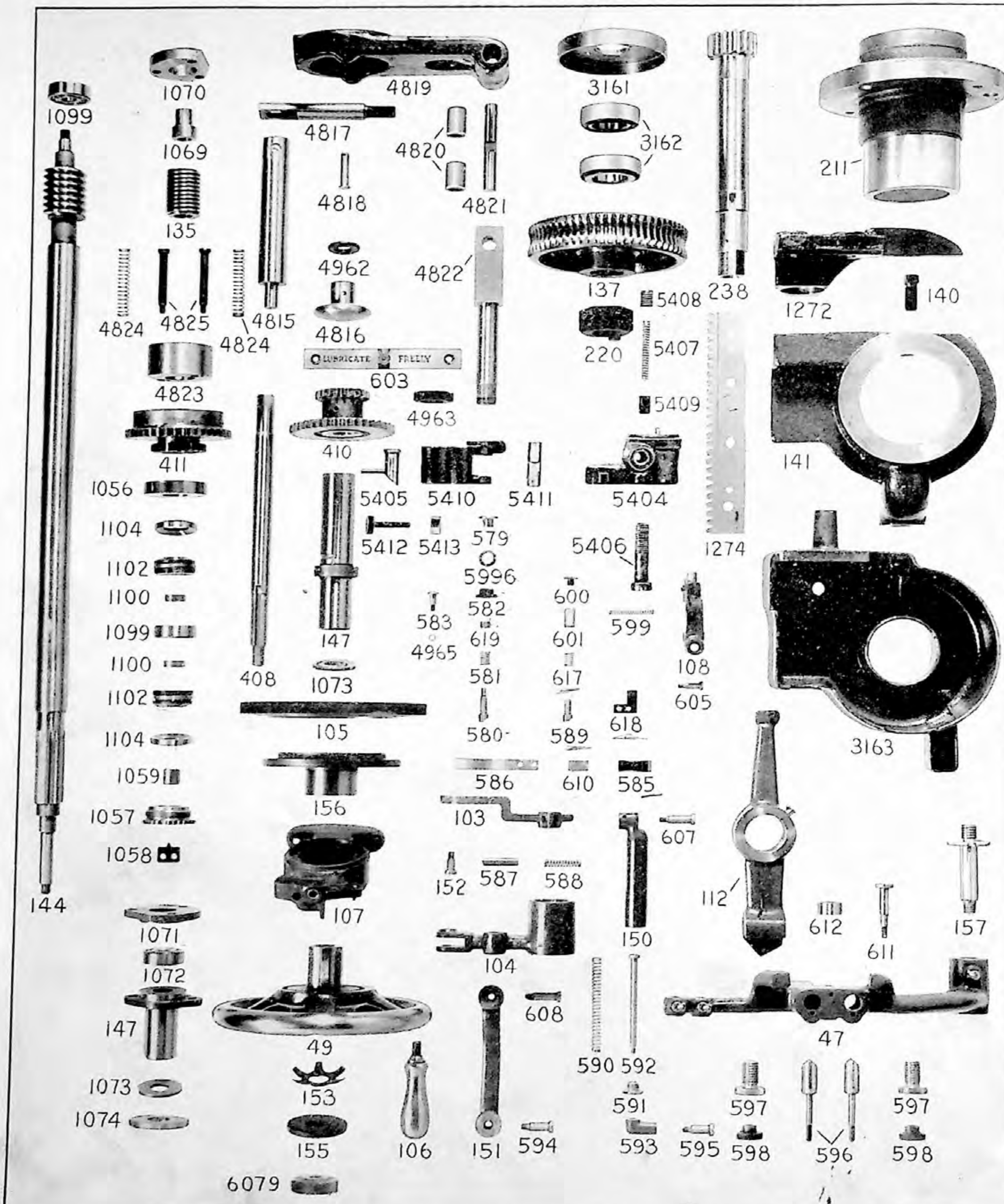
Wheel Stand and Coolant System

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Wheel Stand and Coolant System

23	Wheel Stand Cap
*236	Wheel Stand Slide Guard
239	Cross Feed Rack Pinion Oil Trough
249	Water Pipe Support
251	Water Pipe Bracket
252	Water Pipe Support Washer
254	Water Pipe Bracket Washer
255	Water Pipe Swivel
256	Water Pipe Hinge (Eye-bolt type shown is for No. 1 Machine; bracket type is for Nos. 2, 3 and 4)
258	Straight Shut-Off Valve
261	Nozzle Collar
262	Water Pipe Guide
263	Nozzle
298	Water Pipe Swivel Screw
*346	Water Pipe Swivel Clamp Nut
426	Set Screw
639	Wheel Guard, Left (Small guard shown is for No. 1 Machine; large guard is for Nos. 2, 3 and 4)
†640	Wheel Guard Cover
1275	Counterweight Roll Bracket
1276	Counterweight Roll
1277	Counterweight Roll Pin
2533	Counterweight Adjusting Screw
2534	Counterweight Adjusting Slide
2535	Counterweight Adjusting Screw Bearing
2536	Counterweight Adjusting Screw Nut
2537	Counterweight Oil Distributor
2538	Chain Bracket
2539	Counterweight Pin, Upper
2540	Counterweight Chain Stud
2541	Counterweight Pin, Lower
2545	Spindle Lubrication Notice Plate
*3065	Motor Adjustment Screw
*3066	Motor Bracket Adjustment Block
†3103	Motor Support Adjusting Screw
†3104	Motor Adjusting Screw Knob
†3105	Motor Adjusting Screw Bearing
†4587	Wheel Stand Slide Guard
†4588	Wheel Stand Bed Guard Stud
†4590	Wheel Stand Slide Bed Guard
†4928	Wheel Stand Slide Guard Spring
†4929	Slide Guard Spring Stud, Long
4930	Wheel Stand Slide End Plate
4931	Wheel Stand Slide Warning Plate
4932	Wheel Slide Instruction Plate
4933	Counterweight Chain
4934	Counterweight (State Upper, Intermediate or Lower)
†4935	Wheel Stand Slide Stop Screw
4936	Wheel Stand Clamp Nut
†4937	Motor Adjusting Screw Nut
*4938	Wheel Stand Slide Wiper Gasket
*4939	Wheel Stand Slide Wiper Clamp
†4940	Cable Guide
*4941	Wheel Slide Instruction Plate, Small
4942	Counterweight Adjusting Screw Crank
4943	Counterweight Adjusting Screw Washer, Outer
4944	Adjusting Screw Bearing Pin
4945	Counterweight Adjusting Screw Washer, Inner
†4946	Wheel Stand Slide Safety Strap
†4947	Wheel Stand Strap
4948	Slide Bed Index Finger
*4949	Belt Guard Clamp Bolt
†4950	Motor Pulley Belt Guard Stud
*4951	Belt Guard Support
*4954	Motor Rotation Instruction Plate
†4955	Spindle V-Belt Pulley Guard Bracket
4956	Wheel Stand Cap Swivel Pin
4957	Wheel Stand Cap Bolt Swivel Pin
4958	Wheel Stand Cap Bolt
4959	Wheel Stand Cap Bolt Nut
†4960	Wheel Guard Nut
4961	Nozzle Collar Screw
*6082	Wheel Stand Slide Index Finger

*No. 1 Machine only.
†Nos. 2, 3 and 4 Machines only.



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LUBRICATE FREELY
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6079

Cross Feed

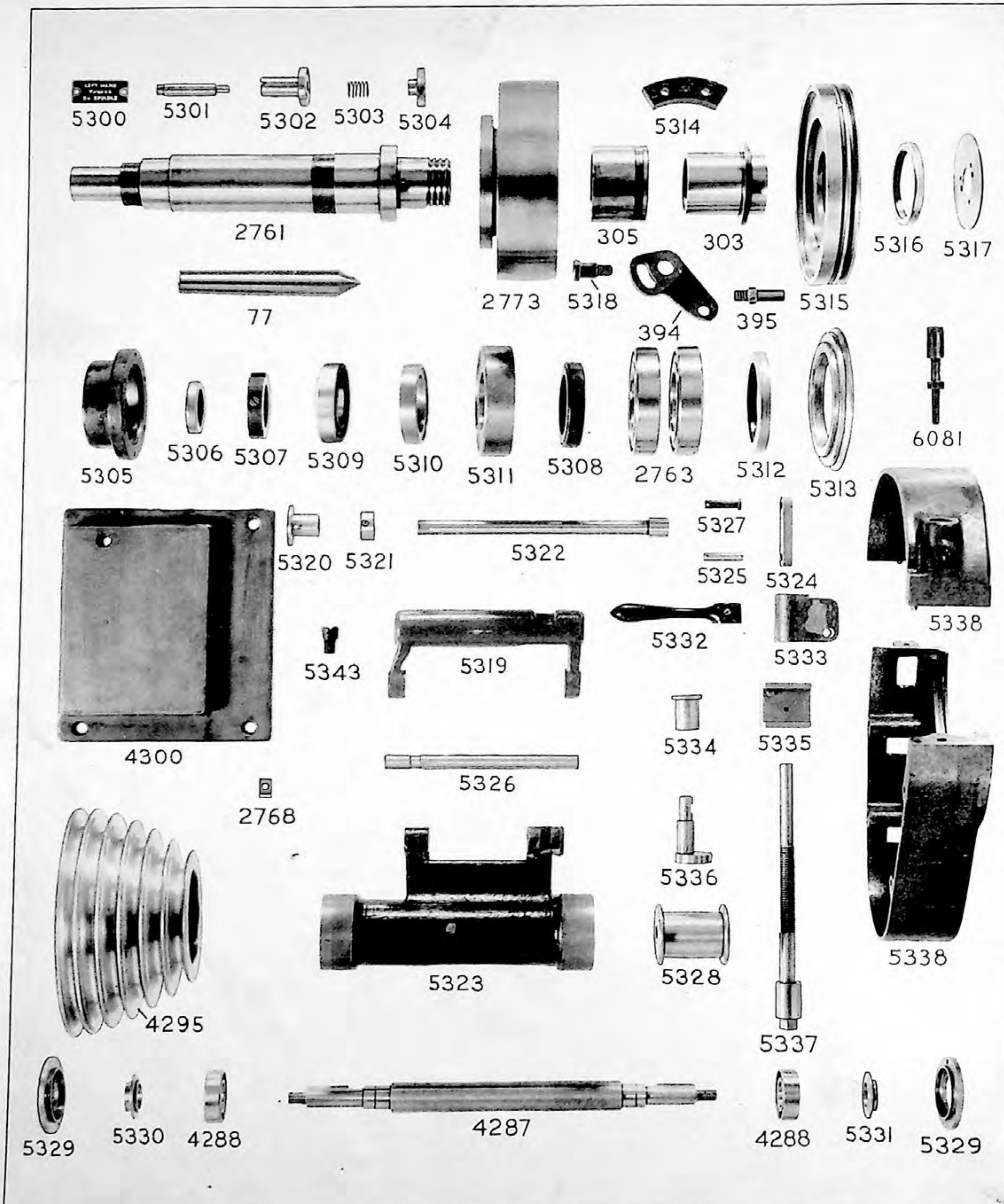
When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Cross Feed

47	Feed Roll Lever
49	Cross Feed Handwheel
103	Pawl
104	Pawl Lever
105	Cross Feed Dial
106	Cross Feed Handwheel Handle
107	Stop Lever
108	Adjusting Lever
112	Cross Feed Lever
*135	Cross Feed Worm
137	Cross Feed Worm Gear
140	Cross Feed Bracket Set Screw
141	Cross Feed Bracket
144	Worm Shaft
147	Worm Shaft Sleeve
150	Spring Case
151	Connecting Rod
152	Pawl Fulcrum Screw
153	Handwheel Spring
155	Cross Feed Handwheel Shaft Washer
156	Dial Body
157	Feed Roll Lever Stud
211	Cross Feed Rack Pinion Shaft Bearing
220	Cross Feed Rack Pinion Nut
238	Cross Feed Rack Pinion
†408	Cross Feed Handwheel Shaft
†410	Cross Feed Driving Gear
†411	Cross Feed Change Gear
579	Stop Lever Pawl Knob
580	Stop Lever Pawl
581	Stop Lever Pawl Spring
582	Stop Lever Pawl Locking Sleeve
583	Pawl Locking Sleeve Screw
585	Pawl Tooth
586	Pawl Feed Stop
587	Pawl Spring Pin
588	Pawl Lever Spring
589	Adjusting Lever Pawl
590	Spring Case Spring
591	Spring Pin Bushing
592	Spring Pin
593	Spring Pin Nut
594	Connecting Rod Screw
595	Spring Pin Nut Screw
596	Stop Pin
597	Stop Adjusting Bushing
598	Stop Pin Adjusting Nut
599	Stop Lever Spring
600	Adjusting Lever Pawl Oil Stop
601	Adjusting Lever Pawl Oil Bushing
603	Oil Well Plate
605	Adjusting Lever Fulcrum Screw
607	Spring Case Upper Screw
608	Connecting Rod Upper Screw
610	Pawl Tooth Shoe
611	Roll Stud
612	Roll
617	Adjusting Lever Spring
618	Plate
619	Stop Lever Pawl Bushing
†1056	Worm Shaft Bearing Cover
1057	Worm Shaft Bearing Nut
1058	Locking Plate
1059	Worm Shaft Bushing
*1069	Worm Shaft Spacer
*1070	Ball Bearing Retainer
*1071	Worm Shaft Ball Bearing Cap
*1072	Worm Shaft Ball Bearing, Front
1073	Worm Shaft Washer
*1074	Dial Body Washer
1099	Worm Shaft Ball Bearing
1100	Worm Shaft Spacing Collar
1102	Worm Shaft Radial Thrust Bearing
1104	Radial Thrust Washer
1272	Cross Feed Worm Shaft Bracket
1274	Cross Feed Rack
3161	Cross Feed Rack Pinion Collar
3162	Cross Feed Rack Pinion Bearing
3163	Cross Feed Bracket Oil Well
4815	Cross Feed Change Gear Plunger
†4816	Cross Feed Change Gear Plunger Knob
†4817	Change Gear Lever Stud
†4818	Change Gear Lever Stud Pin
†4819	Cross Feed Change Gear Lever
†4820	Change Gear Lever Bushing
†4821	Change Gear Lever Fulcrum Stud
†4822	Change Gear Lever Fulcrum
†4823	Worm Shaft Collar
†4824	Worm Shaft Collar Spring
†4825	Cross Feed Change Gear Screw
†4962	Cross Feed Change Gear Plunger Washer
†4963	Change Gear Lever Fulcrum Lock Nut
4965	Pawl Locking Sleeve Screw Lockwasher
5404	Locking Pin Bracket
5405	Locking Pin
5406	Locking Pin Bracket Screw
5407	Locking Pin Bracket Plunger Spring
5408	Spring Adjusting Screw
5409	Spring Plunger
5410	Locking Pin Swivel Bracket
5411	Swivel Bracket Pin
5412	Swivel Bracket Adjusting Screw
5413	Adjusting Screw Lock Nut
5996	Spring Washer
†6079	Cross Feed Handwheel Shaft Nut

*No. 1 Machine only.

†Nos. 2, 3 and 4 Machines only.



Headstock

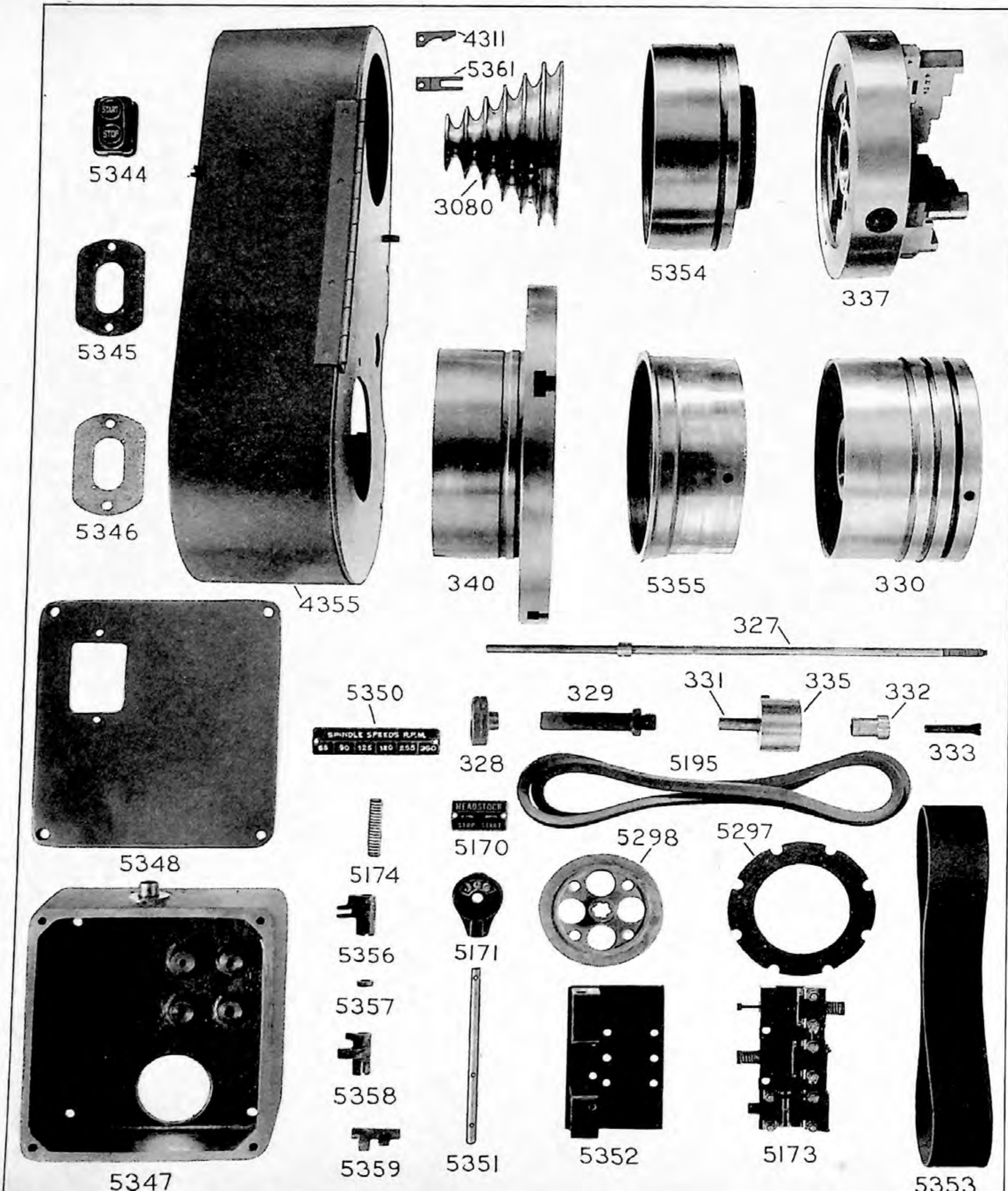
Nos. 2, 3 and 4 Machines

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Headstock

Nos. 2, 3 and 4 Machines

77	Headstock Center
303	Dead Center Pulley Bearing
305	Dead Center Pulley Bushing
394	Work Driving Arm
395	Work Driving Stud
2761	Headstock Spindle
2763	Spindle Ball Bearings, Front
2768	Headstock Index Finger
2773	Dead Center Pulley
4287	Intermediate Shaft
4288	Intermediate Shaft Ball Bearing
4295	Intermediate Shaft Sheave
4300	Headstock Motor Plate
5300	Spindle Thread Notice Plate
5301	Spindle Locking Plunger
5302	Spindle Locking Plunger Bushing
5303	Spindle Locking Plunger Spring
5304	Spindle Locking Plunger Knob
5305	Spindle Rear Bearing Cover
5306	Spindle Bearing Grease Seal, Rear
5307	Spindle Bearing Nut, Rear
5308	Spindle Bearing Nut, Front
5309	Spindle Roller Bearing, Rear
5310	Spindle Bearing Grease Retainer, Rear
5311	Spindle Bearing Grease Retainer, Front
5312	Spindle Bearing Grease Seal, Front
5313	Spindle Bearing Grease Seal Retainer (Front)
5314	Dead Center Driving Plate Counterweight
5315	Dead Center Grinding Driving Plate
5316	Dead Center Pulley Oil Seal
5317	Center Pulley Bearing Ring Flange
5318	Work Driving Arm Pivot
5319	Intermediate Shaft Tension Yoke
5320	Tension Yoke Pivot Bearing
5321	Tension Yoke Pivot Collar
5322	Tension Yoke Pivot
5323	Intermediate Shaft Tension Bracket
5324	Tension Bracket Link
5325	Tension Bracket Link Pin
5326	Tension Bracket Fulcrum Rod
5327	Intermediate Shaft Tension Bracket Pin
5328	Intermediate Shaft Pulley
5329	Intermediate Shaft Bearing Cap
5330	Intermediate Shaft Rear Bearing Oil Flinger
5331	Intermediate Shaft Front Bearing Oil Flinger
5332	Belt Tension Clamp Lever
5333	Belt Tension Nut
5334	Belt Tension Clamp Eccentric Bushing
5335	Belt Tension Clamp Block
5336	Belt Tension Clamp Eccentric
5337	Belt Tension Adjusting Screw
5338	Headstock Spindle Belt Guard (Specify Front or Rear)
5343	Headstock Base Locating Pin
6081	Belt Guard Clamp Screw



Headstock, Continued

Nos. 2, 3 and 4 Machines

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

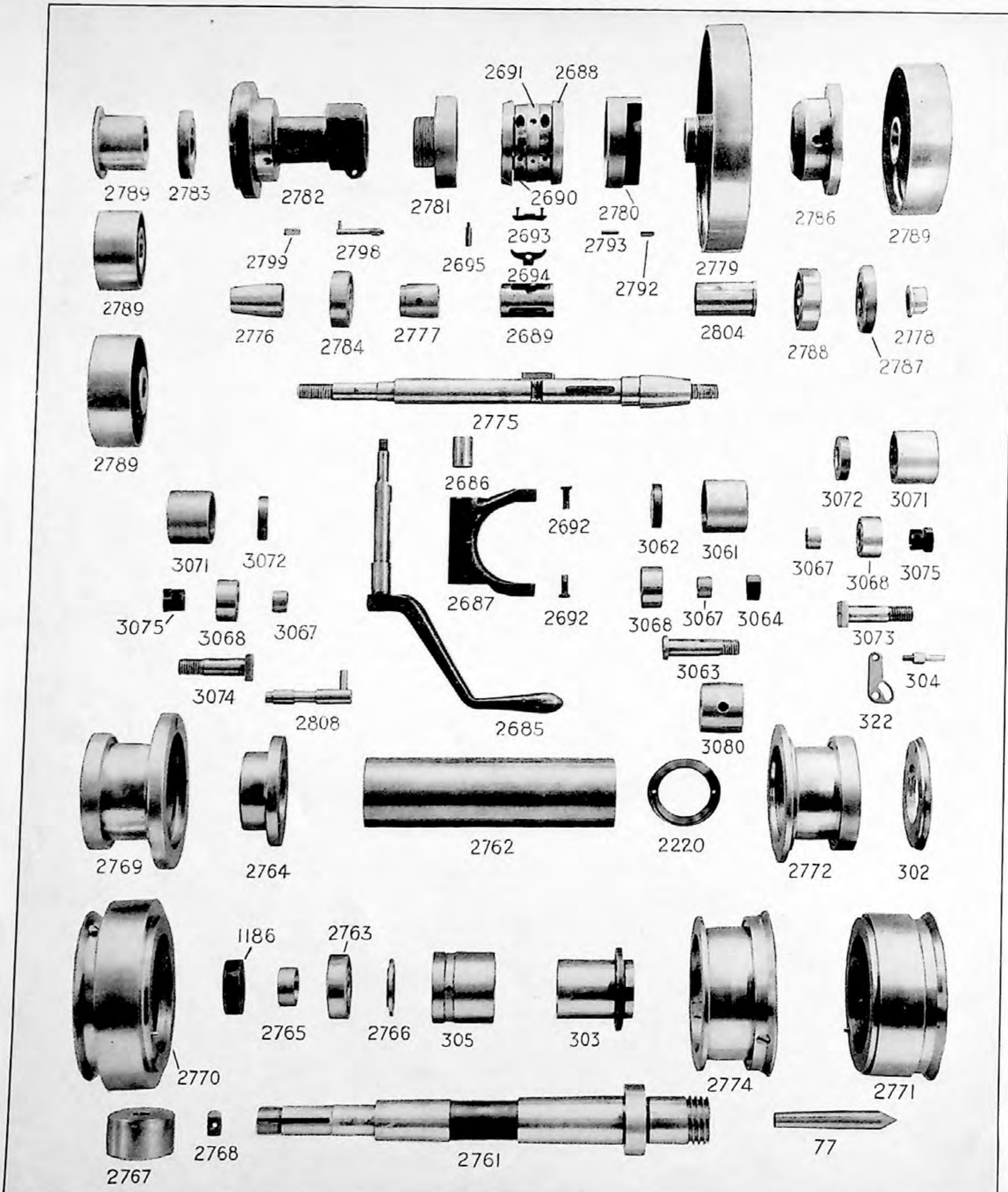
Headstock, Continued

Nos. 2, 3 and 4 Machines

327	Face Chuck Socket Rod
328	Fack Chuck Socket Rod Knob
329	Face Chuck Thrust Screw
330	Face Chuck
331	Face Chuck Socket
332	Face Chuck Bushing
333	Face Chuck Bushing Screw
335	Face Chuck Shell
337	Four-jaw Skinner Chuck
340	Face Plate
3080	Headstock Motor Sheave
4311	Belt Guard Catch
4355	Motor Drive Belt Guard
5170	Headstock Stop and Start Plate
5171	Headstock Control Knob
5173	Headstock Multiple Control Switch
5174	Headstock Switch Operating Rod Spring
*5195	Headstock Motor Sheave Belt
5297	Motor Brake Friction Disk (Stationary)
5298	Motor Brake Friction Disk (Rotating)
5344	Main Switch Push Button
5345	Push Button Cover
5346	Push Button Cover Gasket
5347	Headstock and Main Switch Compartment
5348	Headstock and Main Switch Compartment Cover
5350	Headstock Speed Plate (state cycle of Motor)
5351	Headstock Control Switch Operating Rod
5352	Multiple Control Switch Bracket
†5353	Headstock Spindle Belt
5354	Four-jaw Chuck Adapter Pulley
5355	Live Center
5356	Stop Switch Lever
5357	Multiple Control Switch Collar
5358	Starting Switch Lever
5359	End Stop Switch Lever
5361	Belt Guard Latch Block

* "V" belt; cross section ½″ x $\frac{11}{32}$″ x 40°; inside circumference 37″.

† Smooth running, oil-resistant, endless flat belt; 2″ wide; 30″ inside circumference.



Headstock
No. 1 Machine

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Headstock

No. 1 Machine

77	Headstock Center
302	Small Dead Center Pulley Flange
303	Dead Center Pulley Bearing
304	Work Driving Pin, Small
305	Dead Center Pulley Bushing
322	Work Driving Arm
1186	Spindle Nut
2220	Headstock Spindle Thrust Washer
2685	Clutch Fork Lever
2686	Clutch Fork Lever Sleeve
2687	Clutch Fork
2688	Clutch Body
2689	Clutch Body Bushing
2690	Clutch Sleeve
2691	Clutch Sleeve Ring
2692	Clutch Sleeve Ring Pin
2693	Clutch Shoe
2694	Clutch Lever
2695	Clutch Lever Fulcrum
2761	Headstock Spindle
2762	Headstock Spindle Bushing
2763	Headstock Spindle Ball Bearing
2764	Spindle Ball Bearing Container
2765	Spacing Collar
2766	Spindle Thrust Washer, Rear
2767	Headstock Body Pivot
2768	Headstock Index Finger
2769	Spindle Pulley, 3″ diameter
2770	Spindle Change Pulley, 5¾″ diameter
2771	Spindle Change Pulley, 5″ diameter
2772	Dead Center Pulley
2774	Spindle Change Pulley, 4⅛″ diameter
2775	Countershaft
2776	Countershaft Taper Sleeve
2777	Countershaft Collar
2778	Countershaft Nut, Right
2779	Countershaft Driving Pulley
2780	Countershaft Driving Pulley Clutch
2781	Countershaft Brake
2782	Countershaft Brake Bracket
2783	Countershaft Bearing (Left) Nut
2784	Countershaft Ball Bearing, Left
2786	Countershaft Ball Bearing (Front) Seat
2787	Countershaft Bearing (Right) Nut
2788	Countershaft Ball Bearing, Right
2789	Countershaft Change Pulley (State Diameter)
2792	Countershaft Driving Pulley Plunger
2793	Countershaft Driving Pulley Plunger Spring
2798	Countershaft Brake Locking Plunger
2799	Countershaft Brake Locking Plunger Spring
2804	Countershaft Driving Pulley Bushing
2808	Spindle Pulley Locking Pin
3061	Motor Idler Pulley
3062	Motor Idler Nut
3063	Motor Idler Pulley Stud
3064	Motor Idler Stud Nut
3067	Idler Pulley Stud Sleeve
3068	Idler Pulley Ball Bearing
3071	Change Pulley Idler Pulley
3072	Change Pulley Idler Nut
3073	Change Pulley Idler Stud, Right
3074	Change Pulley Idler Stud, Left
3075	Change Pulley Idler Stud Nut
3080	Headstock Motor Pulley

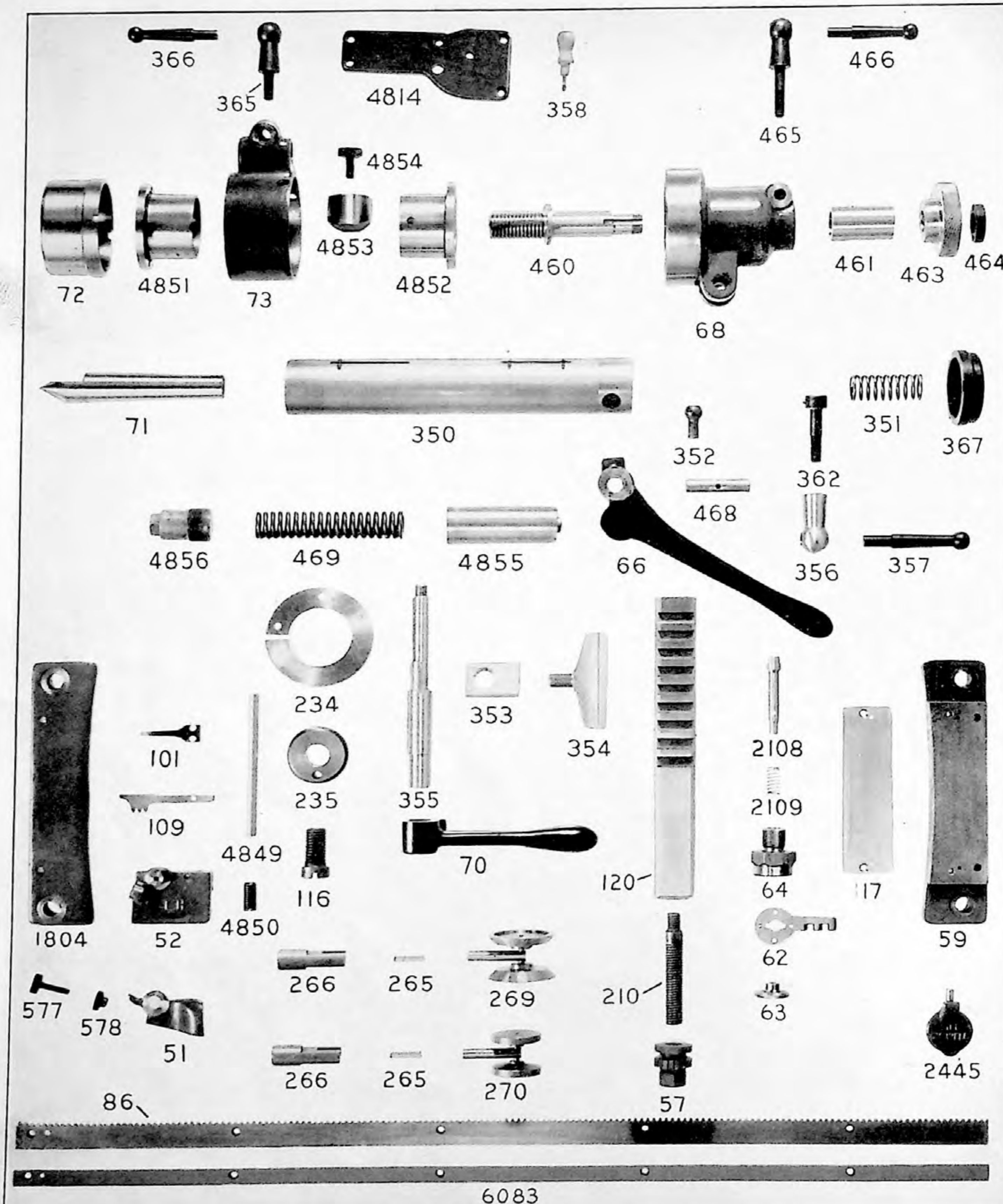
Belts

(Not illustrated)

*5195	Headstock Motor Drive Belt
†5353	Headstock Spindle Belt

* Smooth running, endless flat belt; 1⅛″ wide; inside circumference 32⅛″ for 60 cycle motor or 32¾″ for 50 cycle motor.

† Smooth running, oil-resistant, endless flat belt; 1⅛″ wide; inside circumference 27½″.



Footstock and Table Parts

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Footstock and Table Parts

51	Table Dog (State Left or Right)
52	Table Dog Bracket (State Left or Right)
57	Swivel Table Adjusting Knob
59	Swivel Table Clamp, Right
62	Swivel Table Index Finger
63	Swivel Table Locking Pin Knob
64	Swivel Table Locking Pin Bushing
66	Footstock Lever
†68	Footstock Spring Guard
*70	Footstock Clamp Lever
71	Footstock Center
†72	Footstock Dust Guard
73	Diamond Tool Holder Support
86	Table Dog Rack
101	Table Dog Pawl Spring
109	Table Dog Pawl
116	Swivel Table Pivot Screw
117	Table Scale
120	Table Adjusting Plate
210	Swivel Table Adjusting Screw
234	Swivel Table Pivot Ring
235	Swivel Table Pivot
265	Oil Roll Spring
266	Oil Roll Bushing
269	Oil Roll, Rear
270	Oil Roll, Front
350	Footstock Spindle
*351	Footstock Spindle Spring
352	Footstock Lever Ball
*353	Footstock Clamp Bolt Nut
*354	Footstock Clamp Bolt
*355	Footstock Clamp
*356	Footstock Lever Clamp Bolt Nut
*357	Footstock Lever Clamp Bolt Handle
*358	Footstock Center Oiler
*362	Footstock Lever Clamp Bolt
365	Diamond Tool Holder Clamp Screw
366	Diamond Tool Holder Clamp Screw Handle
*367	Footstock Nut
†460	Footstock Spindle Adjusting Screw
†461	Footstock Spindle Adjusting Screw Bushing
†463	Footstock Spindle Adjusting Screw Knob
†464	Footstock Spindle Adjusting Screw Nut
†465	Footstock Spindle Clamp Screw
†466	Footstock Spindle Clamp Screw Handle
†468	Footstock Lever Fulcrum
†469	Footstock Plunger Spring
577	Table Dog Adjusting Screw
578	Table Dog Adjusting Screw Check Nut
1804	Swivel Table Clamp, Left
2108	Swivel Table Locking Pin
2109	Swivel Table Locking Pin Spring
†2445	Table Guard Oil Hole Cover
†4814	Footstock Oil Well Cover
4849	Swivel Table Pivot Clamp Screw Shoe
4850	Swivel Table Pivot Clamp Screw
†4851	Footstock Spindle Bushing, Front
†4852	Footstock Spindle Bushing, Right
†4853	Footstock Spindle Take-Up Plug
†4854	Footstock Spindle Take-Up Adjusting Screw
†4855	Footstock Lever Plunger
†4856	Footstock Spring Tension Adjusting Screw
†6083	Table Dog Rack Support

*No. 1 Machine only.
†Nos. 2, 3 and 4 Machines only.

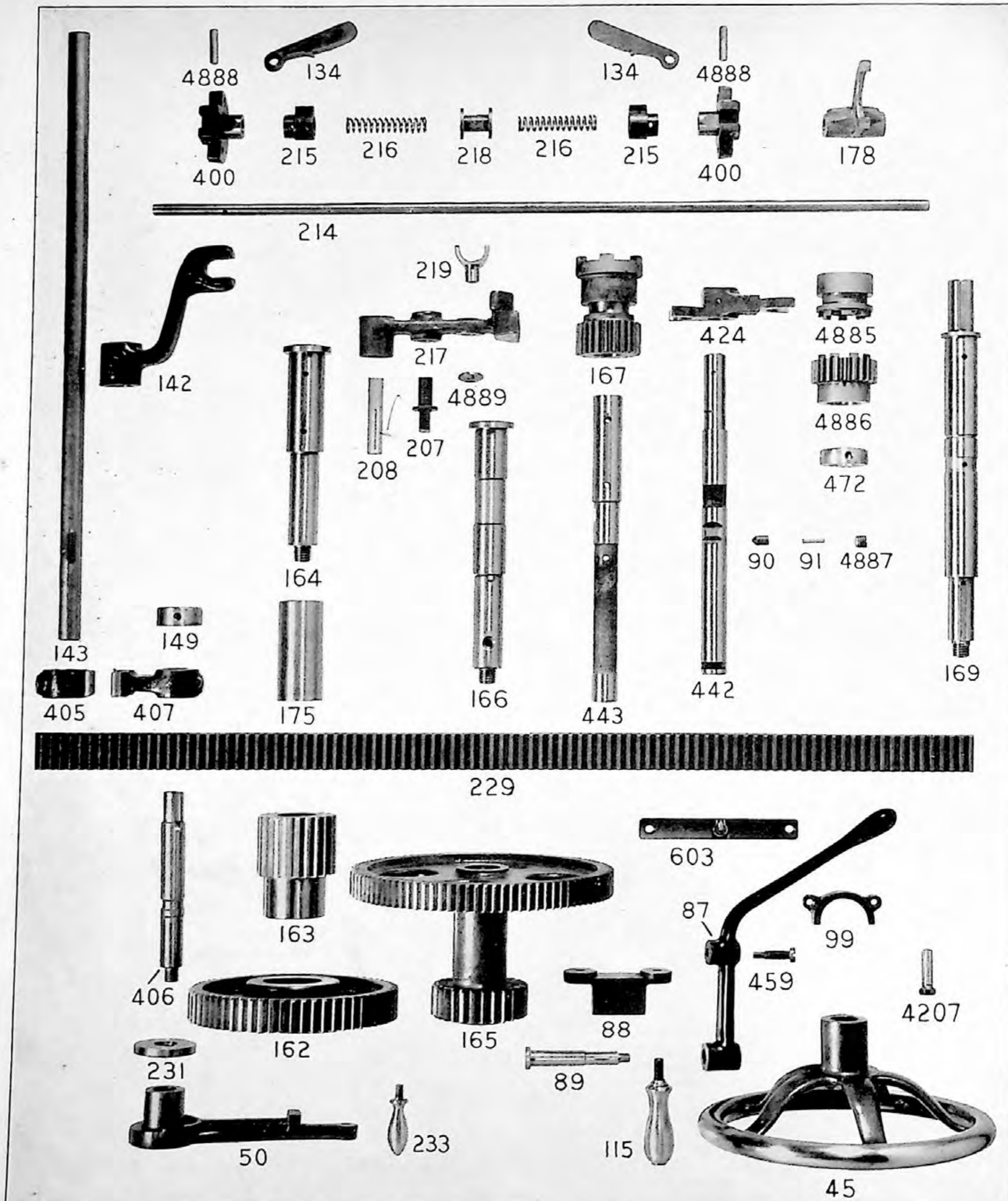


Table Drive and Table Reverse

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Table Drive and Table Reverse

45	Table Handwheel
50	Reverse Lever
87	Table Handwheel Throwout Lever
88	Table Handwheel Lever Pivot Bracket
89	Table Handwheel Lever Pivot
90	Table Feed Throwout Rod Plunger
91	Table Feed Throwout Rod Plunger Spring
99	Table Handwheel Dust Guard
115	Table Handwheel Handle
134	Locking Pawl
142	Reverse Operating Shaft Lever
143	Reverse Operating Shaft
*149	Reverse Lever Shaft Collar
162	Rack Pinion Sleeve Gear
163	Rack Pinion
164	Rack Pinion Stud
165	Feed Quill Gear
166	Feed Quill Gear Stud
*167	Table Feed Throwout Clutch
169	Table Handwheel Shaft
175	Rack Pinion Bushing
178	Feed Clutch Fork
*207	Cam Lever Stud
*208	Locking Pawl Bracket Pin
214	Clutch Rod
215	Locking Pawl Dog
216	Reversing Spring
*217	Clutch Cam Lever
218	Clutch Rod Sleeve
*219	Clutch Cam Lever Swivel Fork
229	Table Rack
231	Reverse Lever Shaft Washer
233	Table Feed Reverse Lever Handle
†400	Locking Pawl Bracket
†405	Small Reversing Sector
406	Reverse Lever Shaft
†407	Large Reversing Sector
424	Table Feed Throwout Fork
442	Table Feed Throwout Rod
†443	Feed Throwout Clutch Stud
459	Table Handwheel Throwout Lever Screw
*472	Handwheel Shaft Spacing Collar
603	Oil Well Plate
4207	Bed Front Plate Pin
†4885	Table Handwheel Shaft Clutch
†4886	Table Handwheel Shaft Pinion
4887	Table Feed Throwout Rod Plunger Screw
4888	Table Reverse Locking Pawl Fulcrum
*4889	Clutch Cam Lever Fork Washer

*No. 1 Machine only.
†Nos. 2, 3 and 4 Machines only.

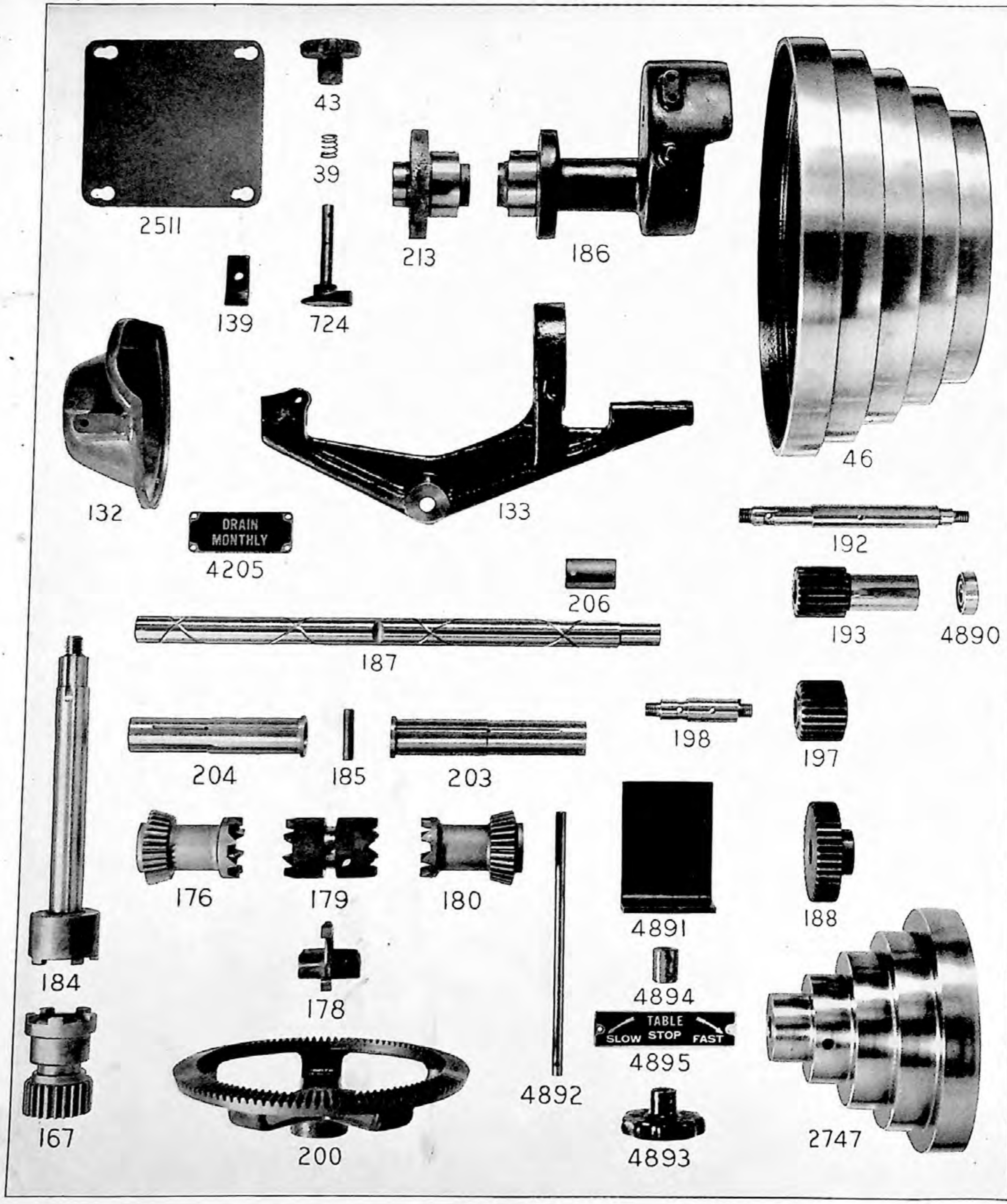


Table Power Feed

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Table Power Feed

39	Bed Door Latch Spring
43	Door Knob
46	Feed Driving Cone
*132	Pawl Bracket Cover
*133	Locking Pawl Bracket
139	Bed Door Anchor
*167	Table Feed Throwout Clutch
176	Feed Clutch Face, Left
178	Feed Clutch Fork
179	Table Feed Driving Clutch
180	Feed Clutch Face, Right
184	Feed Bevel Gear Shaft
185	Table Feed Driving Clutch Pin
*186	Clutch Bracket Bushing, Right
187	Clutch Gear Shaft
188	Clutch Shaft Gear
192	Feed Driving Cone Stud
193	Feed Cone Pinion
*197	Intermediate Gear
*198	Intermediate Gear Stud
200	Feed Bevel Gear
203	Clutch Face (Right) Bushing
204	Clutch Face (Left) Bushing
*206	Clutch Shaft Bushing
*213	Clutch Bracket Bushing, Left
724	Latch
2511	Base Opening Cover Plate
2747	Feed Driving Motor Cone Pulley
4205	Oil Drain Notice Plate
†4890	Feed Driving Cone Pulley Ball Bearing
4891	Table Motor Switch Bracket
4892	Switch Operating Rod
4893	Table Motor Switch Operating Knob
4894	Switch Operating Rod Coupling
4895	Table Motor Switch Plate

Belts
(Not illustrated)

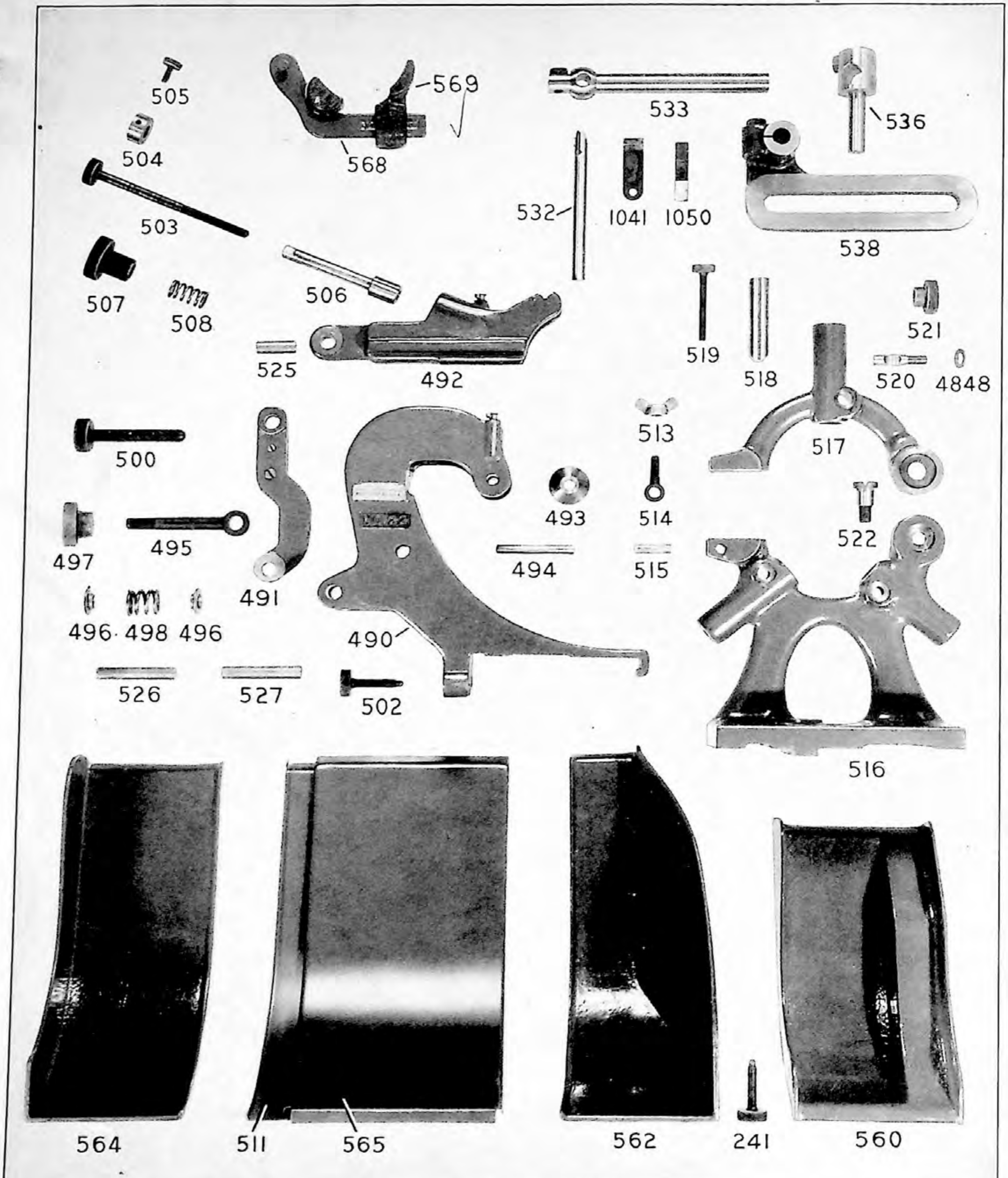
**3218	Table Driving Belt

*No. 1 Machine only.

†Nos. 2, 3 and 4 Machines only.

**For No. 1 Machine—Smooth running, endless flat belt; 1″ wide; inside circumference 49⅜″.

**For Nos. 2, 3 and 4 Machines—Smooth running flat belt with cemented lap; 1″ wide; inside circumference 59″.



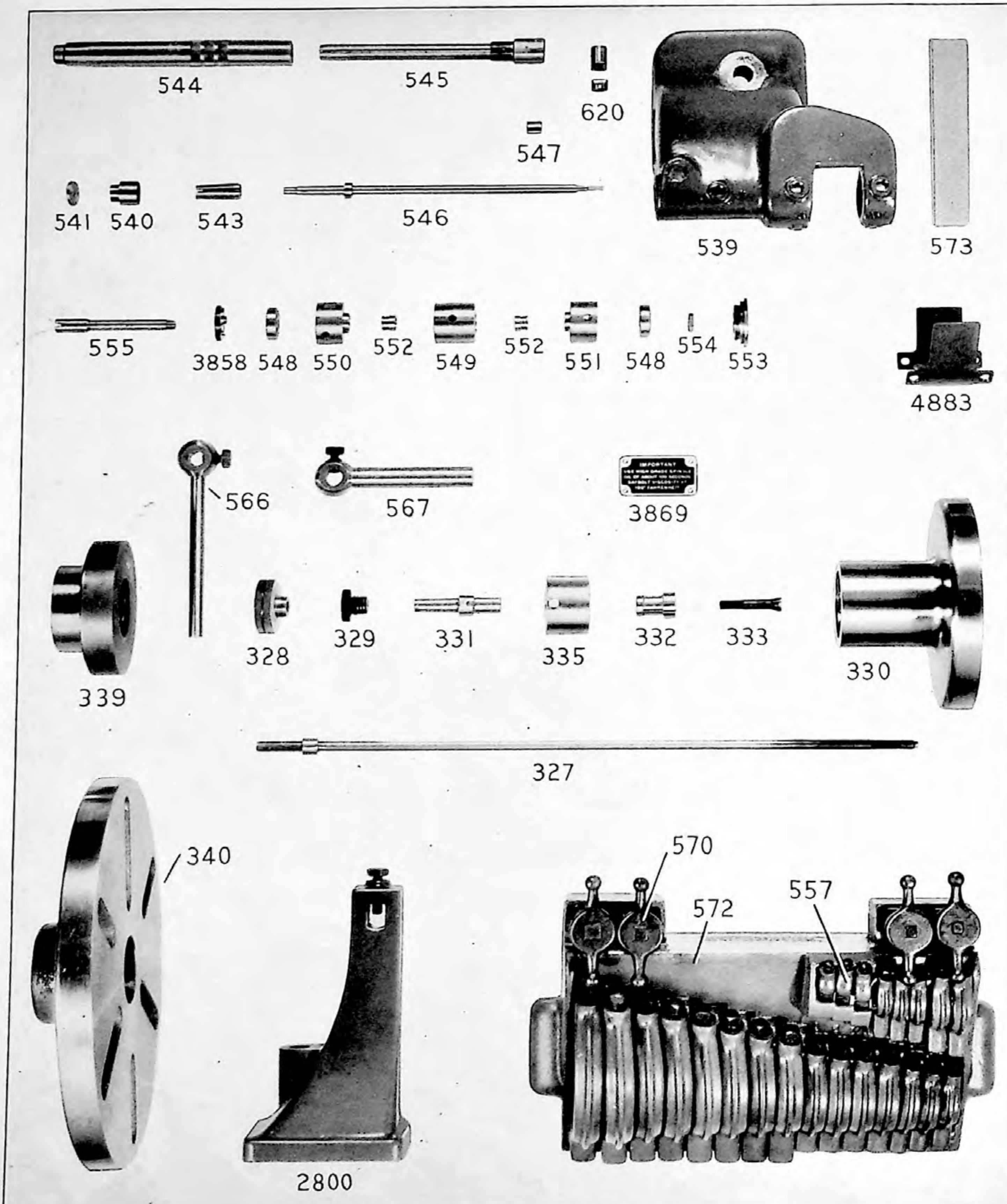
Universal Back Rest, Center Rest, Tooth Rests, Water Guards

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Universal Back Rest, Center Rest, Tooth Rests, Water Guards

241	Water Guard Clamp Screw
490	Stand
491	Lever
492	Shoe Support
493	Shoe Support Roll
494	Shoe Support Roll Pin
495	Lever Spring Bolt
496	Lever Spring Washer
497	Lever Spring Adjusting Nut
498	Lever Spring
500	Lever Adjusting Screw
502	Stand Clamp Screw
503	Shoe Adjusting Screw
504	Sliding Nut Clamp Collar
505	Sliding Nut Clamp Collar Screw
506	Sliding Nut
507	Small Spring Adjusting Screw
508	Sliding Nut Spring
511	Water Guard, Lower
513	Center Rest Clamp Bolt Nut
514	Center Rest Clamp Bolt
515	Center Rest Clamp Bolt Fulcrum
516	Center Rest Base
517	Center Rest Top
518	Center Rest Shoe
519	Center Rest Shoe Adjusting Screw
520	Center Rest Shoe Clamp Bolt
521	Center Rest Shoe Clamp Bolt Nut
522	Center Rest Hinge Bolt
525	Shoe Support Fulcrum
526	Lever Spring Bolt Fulcrum
527	Lever Fulcrum
532	Tooth Rest Holder
533	Tooth Rest Holder Support
536	Tooth Rest Swivel
538	Tooth Rest Bracket
*560	Water Guard (For Short Work)
562	Water Guard, Foot End
564	Water Guard, Head End
565	Water Guard, Upper
568	Adjustable Shoe Arm (State Size)
569	Adjustable Shoe, Lower (State Size)
1041	Tooth Rest, Angular
1050	Tooth Rest, Short
4848	Center Rest Clamp Bolt Washer

*No. 1 Machine only.



Internal Grinding Fixture, Face Chuck, Dog Tray, etc.

When ordering parts, state the serial number of Fixture, and size, style and serial number of the machine in addition to the part number and name.

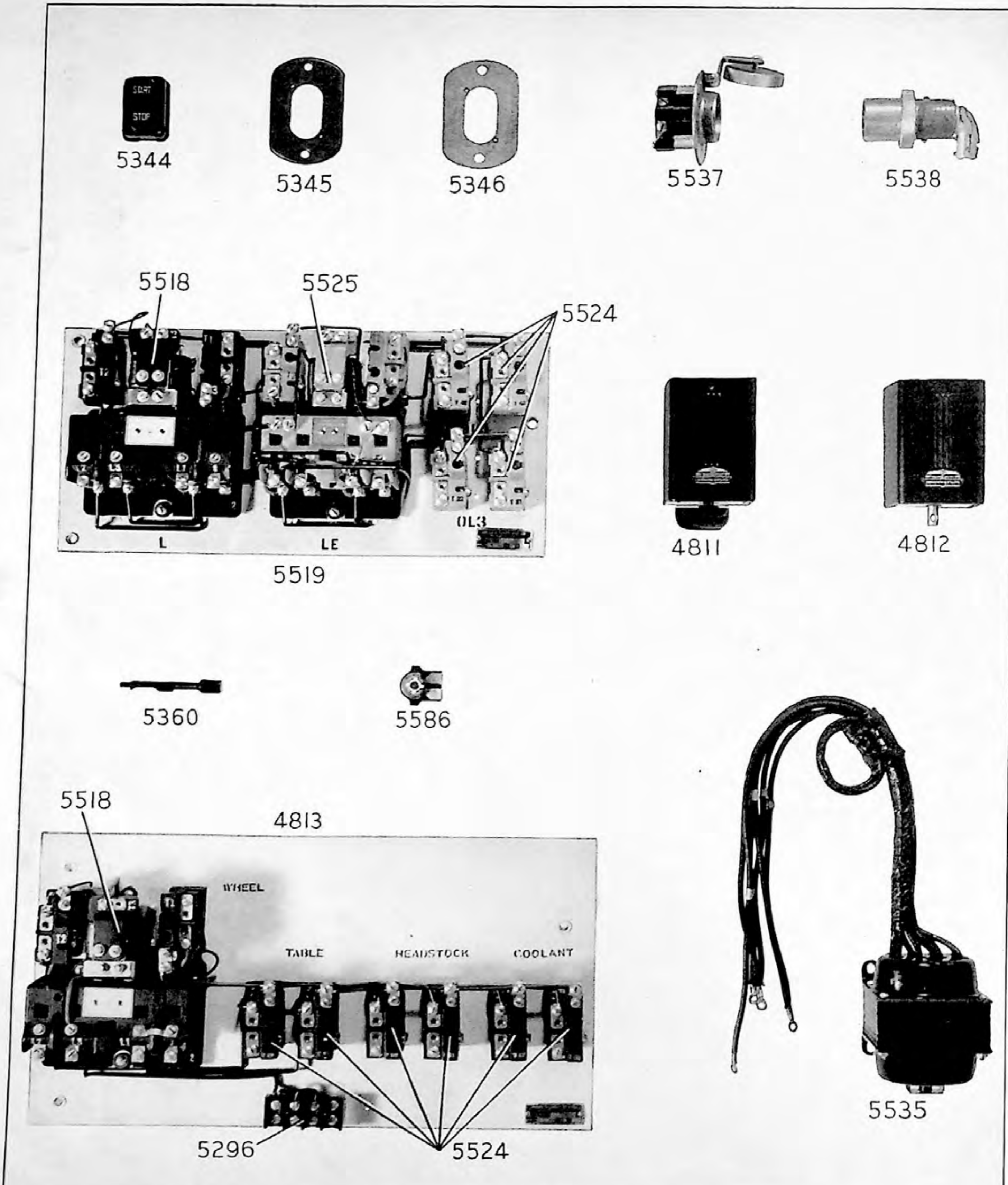
Internal Grinding Fixture

**539	Stand
540	Wheel Bushing
541	Wheel Spindle Washer
543	Wheel Spindle Box
544	Outer Shell
545	Inner Shell
546	Wheel Spindle
547	Wheel Spindle Bushing
548	Pulley Spindle Ball Bearing
549	Pulley
550	Bearing Case, Left
551	Bearing Case, Right
552	Pulley Spindle Sleeve
553	Bearing Case Cap
554	Spindle Nut
555	Pulley Spindle
573	Belt
620	Outer Shell Clamp Bushing
3858	Ball Bearing Clamp Nut
3869	Lubrication Notice Plate
4883	Belt Guard

Face Chuck, Dog Tray, etc.

*327	Face Chuck Socket Rod
*328	Face Chuck Rod Knob
*329	Face Chuck Thrust Screw
*330	Face Chuck
*331	Face Chuck Socket
*332	Face Chuck Bushing
*333	Face Chuck Bushing Screw
*335	Face Chuck Shell
*339	Four-Jaw Chuck Plate
*340	Face Plate
557	Work Driving Dog (State Size)
566	Diamond Tool Holder, Long
567	Diamond Tool Holder, Short
570	Socket Wrench (State Size)
572	Dog Tray
2800	Wheel Truing Fixture

*No. 1 Machine only (See page 66 for Nos. 2, 3 and 4 Machines)
**Serial number of fixture stamped on this part.



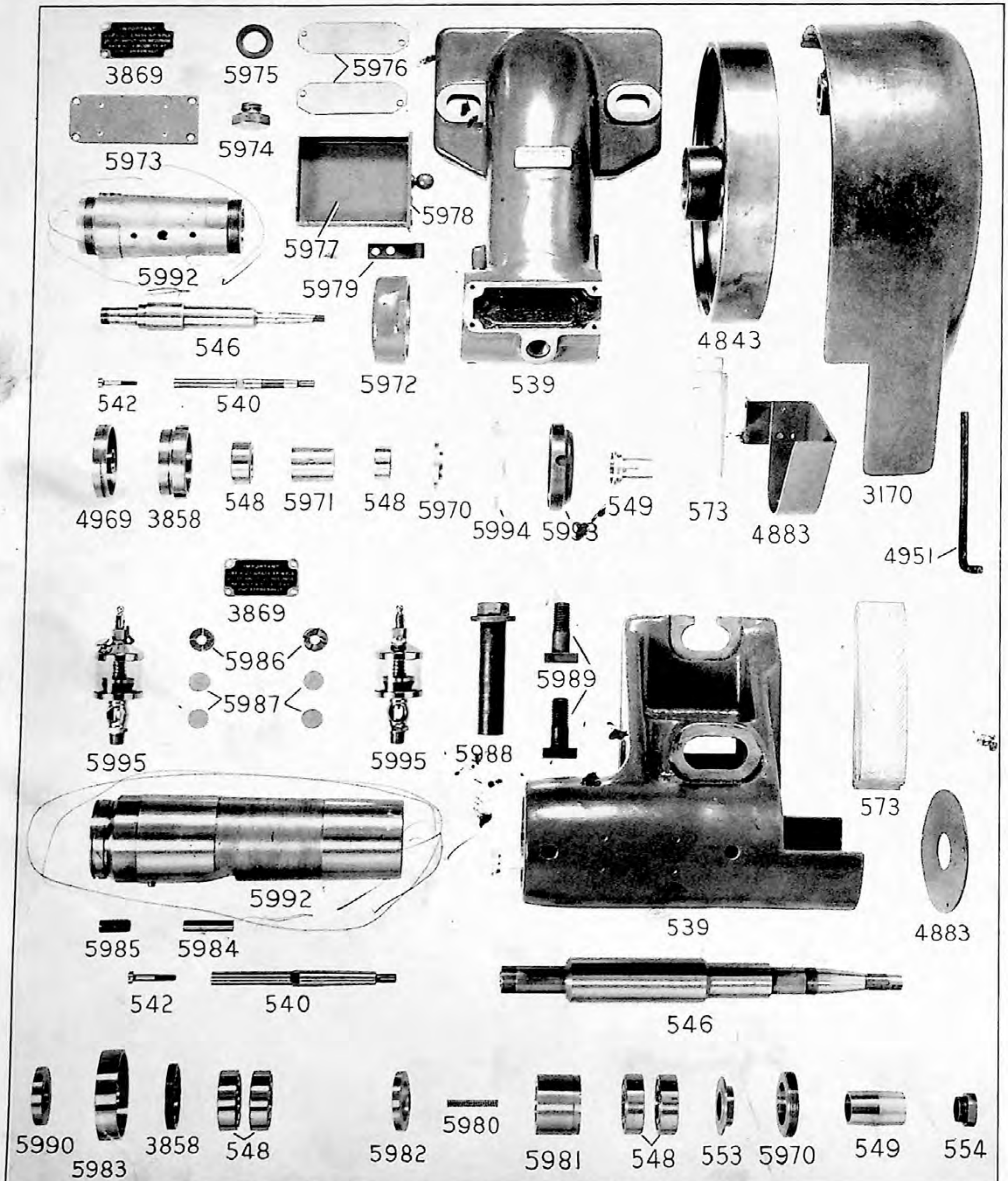
Electrical Units

When ordering parts, state the size, style and serial number of the machine in addition to the part number and name.

Electrical Units

*4811	Wheel Reversing Switch
4812	Table Two-Speed Switch
*4813	Main Control Panel (Less Thermal Relay Heaters)
5296	Terminal Block
5344	Main Switch Push Button
5345	Push Button Cover
5346	Push Button Cover Gasket
5360	Reset Rod
5518	Main Starter
†5519	Main Control Panel (Less Thermal Relay Heaters)
5524	Overload Relays
5525	Headstock Switch
†5535	Control Transformer
5537	Coolant Pump Receptacle
5538	Coolant Pump Plug
5586	Thermal Relay Heater (State Number stamped on heater)

*No. 1 Machine only.
†Nos. 2, 3 and 4 Machines only.



No. 30 Internal Grinding Fixture (Ball Bearing Type)
Nos. 40 and 42 Internal Grinding Fixtures (Ball Bearing Type)
Additional Equipment

When ordering parts, state the name and serial number of Fixture, and size, style and serial number of the machine in addition to the part number and name.

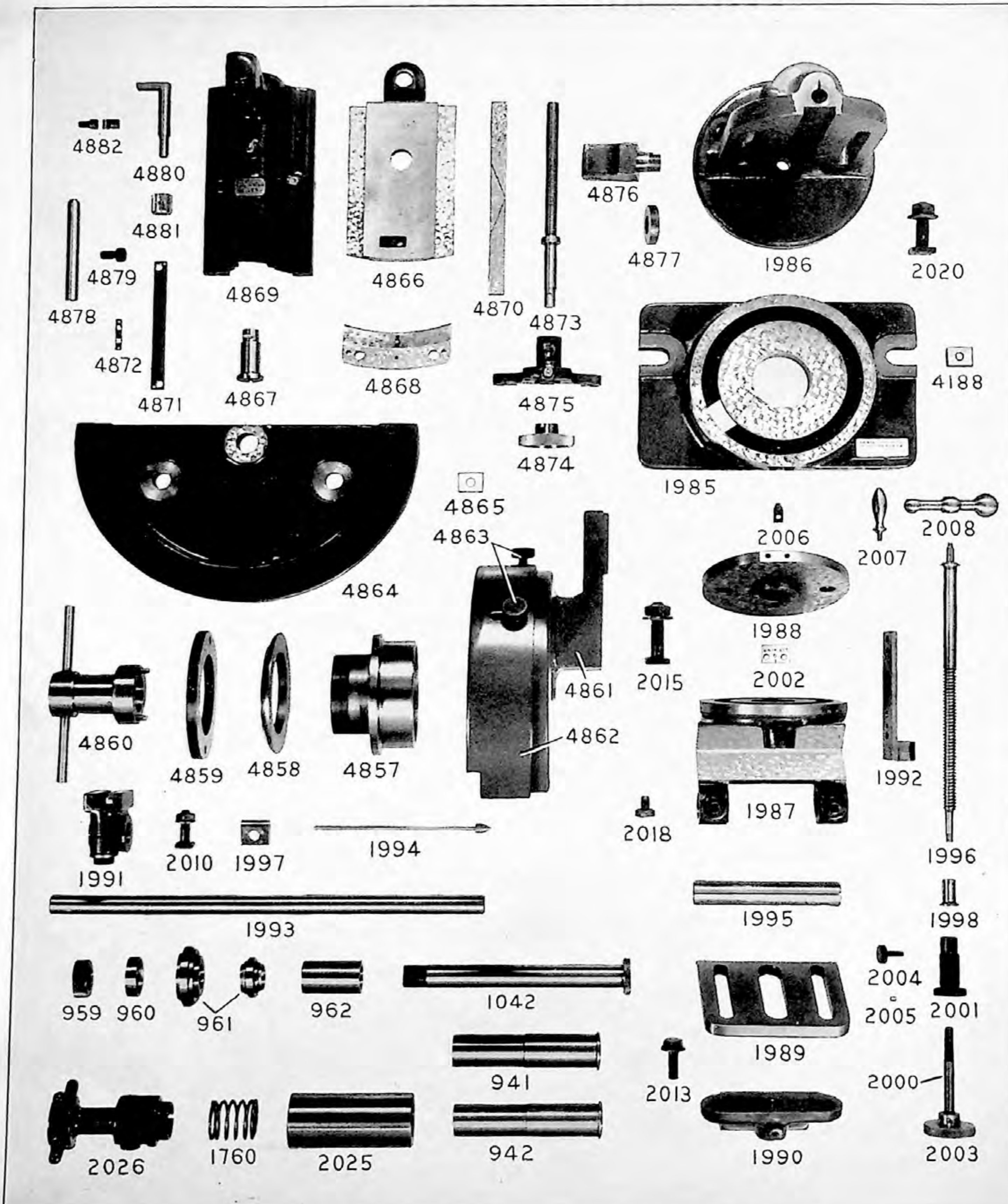
No. 30 Internal Grinding Fixture
Ball Bearing Type
Additional Equipment, No. 1 Machine

**539	Stand
540	Wheel Arbor (State Size)
542	Wheel Screw (State Arbor Size)
546	Wheel Spindle
548	Spindle Bearing (State Left or Right)
549	Spindle Pulley
573	Belt
3170	Wheel Stand Belt Guard
3858	Spindle Bearing Nut, Left
3869	Spindle Lubrication Notice Plate
4843	Wheel Stand Motor Pulley
4883	Internal Grinding Fixture Belt Guard
4951	Belt Guard Support
4969	Bearing Shield
5970	Bearing Cover
5971	Oil Dam Collar
5972	Stand Cap, Left
5973	Stand Cover
5974	Oil Reservoir Cap
5975	Oil Reservoir Cap Washer
5976	Breather Plate
5977	Oil Tray
5978	Oil Tray Plate
5979	Oil Tray Spring
5992	Spindle Bearing Sleeve
5993	Sleeve Nut, Right
5994	Sleeve Nut Gasket

Nos. 40 and 42 Internal Grinding Fixtures
Ball Bearing Type
Additional Equipment, Nos. 2, 3 and 4 Machines

**539	Stand
540	Wheel Arbor (State Size)
542	Wheel Screw (State Arbor Size)
546	Spindle
548	Spindle Bearing
549	Spindle Pulley
553	Bearing Thrust Nut, Rear
554	Spindle Pulley Clamp Nut
573	Belt
3858	Bearing Thrust Nut, Front
3869	Spindle Lubrication Notice Plate
4883	Belt Guard
5970	Spindle Dust Guard, Rear
5980	Bearing Thrust Spring
5981	Bearing Thrust Spring Holder
5982	Bearing Thrust Spring Washer
5983	Spindle Dust Guard, Front
5984	Clamp Shoe
5985	Spindle Sleeve Clamp Screw
5986	Spindle Sleeve Oil Screw
5987	Spindle Sleeve Oil Strainer
5988	Clamp Nut
5989	Stand Clamp Bolt
5990	Spindle Nut
5992	Spindle Sleeve
5995	Oil Cup

**Serial number of fixture stamped on this part.



Universal Head and Radius Wheel Truing Attachment
Additional Equipment

When ordering parts, state the name and serial number of Attachment, and size, style and serial number of the machine in addition to the part number and name.

Universal Head
Additional Equipment

941	Taper Shank Mill Bushing, No. 7 Taper
942	Taper Shank Mill Bushing, No. 9 Taper
959	Sliding Shell Collar Nut
960	Sliding Shell Collar, Recessed
961	Sliding Shell Step Collar (State Large or Small)
962	Sliding Shell Collar (State Length)
1042	Sliding Shell
1760	Mill Bushing Sleeve Spring
**1985	Universal Head Base
1986	Upright
1987	Swivel
1988	Swivel Plate
1989	Jaw Plate
1990	Jaw
1991	Stop Dog
1992	Nut
1993	Stop Dog Rod
1994	Stop Rod
1995	Sleeve
1996	Screw
1997	Stop Rod Clamp
1998	Screw Sleeve
2000	Clamp Screw
2001	Jaw Adjusting Screw
2002	Swivel Plate Index Finger
2003	Clamp Screw Knob
2004	Jaw Adjusting Screw Clamp Screw
2005	Jaw Adjusting Screw Clamp Screw Shoe
2006	Upright Index Finger
2007	Screw Crank Handle
2008	Screw Crank
2010	Stop Rod Clamp Bolt
2013	Jaw Plate Screw
2015	Swivel Bolt
2018	Stop Dog Rod Sleeve Screw
2020	Upright Bolt
2025	Taper Shank Mill Bushing Sleeve
2026	Taper Shank Mill Bushing Handle
4188	Base Tongue
4857	Offset Wheel Sleeve
4858	Offset Wheel Sleeve Flange
4859	Offset Wheel Sleeve Flange Nut
4860	Wheel Sleeve Wrench
4861	Wheel Guard
4862	Wheel Guard Cover
4863	Wheel Guard Cover Screw

Radius Wheel Truing Attachment
Additional Equipment, Nos. 2, 3 and 4 Machines

4864	Base
4865	Base Tongue
4866	Swivel
4867	Swivel Stud
4868	Swivel Gib
**4869	Slide
4870	Slide Gib
4871	Slide Scale
4872	Slide Plate
4873	Adjusting Screw
4874	Adjusting Screw Knob
4875	Adjusting Screw Bearing
4876	Adjusting Nut
4877	Adjusting Nut Clamp Nut
4878	Diamond Tool (State Whether With Diamond)
4879	Diamond Tool Clamp Screw
4880	Diamond Setting Gage
4881	Diamond Setting Gage Knob
4882	Diamond Setting Gage Clamp Bolt

**Serial number of equipment stamped on this part.