

TECHNICAL MANUAL

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

FOR

**BORING MACHINE, ENGINE CYLINDER
MODEL FL
(NSN 4910-00-223-9734)
(KWIWAY MANUFACTURING CO.)**

Technical Manual
No. 9-4910-638-14&P }

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 21 August 1981

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REPORTING OF ERRORS

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

NOTE

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

Manufactured by: **KWIK-WAY MANUFACTURING COMPANY**
500 57th Street
Marion, IA 52302

Procured under Contract No. DAAA09 76-C-6568

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

INSTRUCTIONS FOR REQUISITIONING PARTS

NOT IDENTIFIED BY NSN

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

- 1 - Manufacturer's Federal Supply Code Number - 11140
- 2 - Manufacturer's Part Number exactly as listed herein.
- 3 - Nomenclature exactly as listed herein, including dimensions, if necessary.
- 4 - Manufacturer's Model Number - "FL"
- 5 - Manufacturer's Serial Number (End Item)
- 6 - Any other information such as Type, Frame Number, and Electrical Characteristics, if applicable.
- 7 - If DD Form 1348 is used, fill in all blocks except 4,5, 6, and Remarks field in accordance with AR 725-50.

Complete Form as Follows:

- (a) In blocks 4, 5, 6, list manufacturer's Federal Supply Code Number -11140 followed by a colon and manufacturer's Part Number for the repair part.

- (b) Complete Remarks field as follows:
 Noun: (nomenclature of repair part)
 For: NSN: 4910-00-223-9734
 Manufacturer: Kwik-Way Manufacturing Company

Model: "FL"
 Serial: (of end item)

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

DESCRIPTION

Description of the model FL cylinder boring machine is as follows:
Capacity 3.1/2" thru 7-1/2", Length 18", Size 2.
Additional descriptive material will be found throughout the Manual.

OPERATION

Detailed operation instructions covering the model FL cylinder boring machine will be found in the manual, pages 3 thru 23.

REPAIR

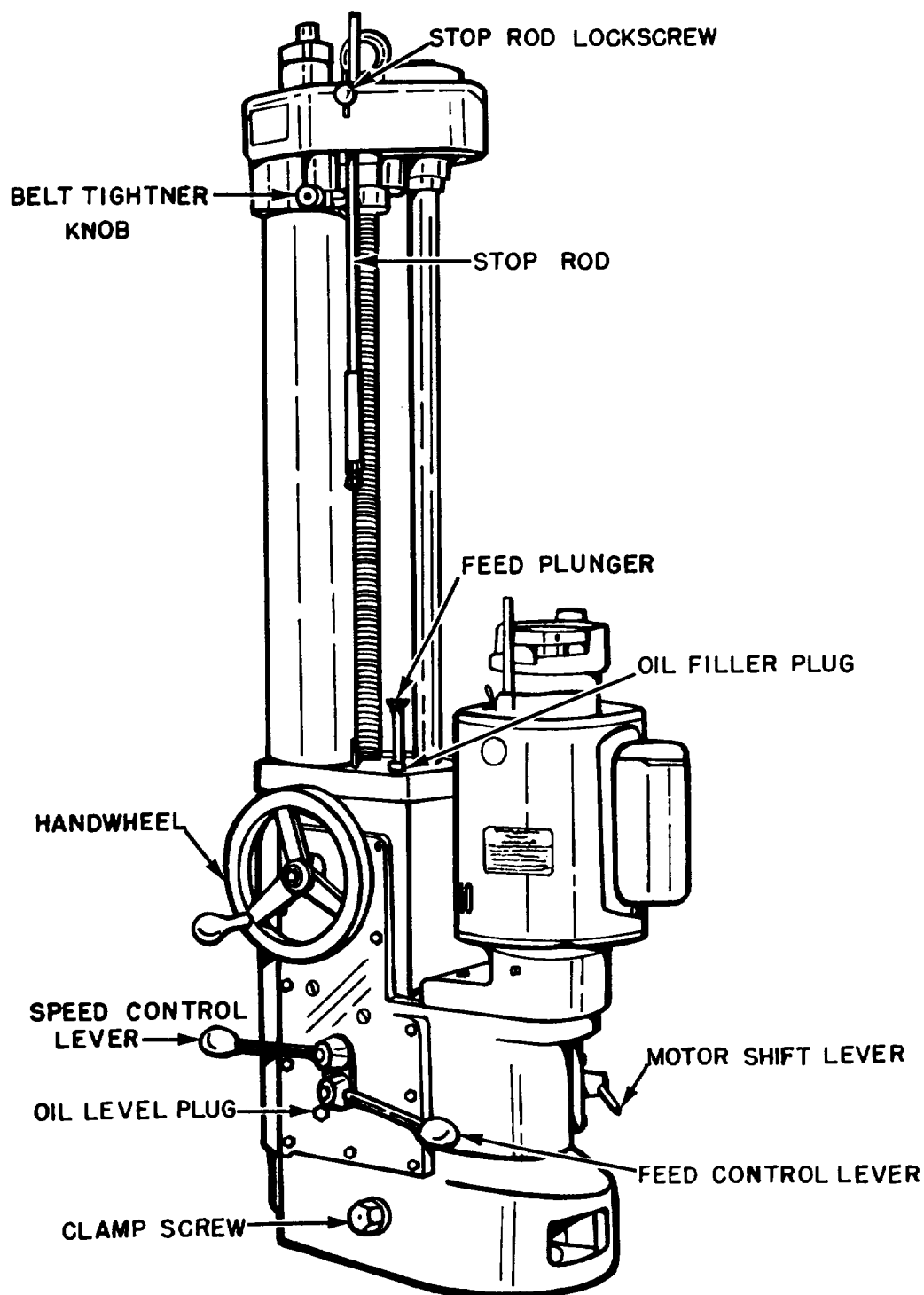
Normal maintenance procedure and detailed adjustment instructions are fully covered in the manual.

TROUBLESHOOTING

Detailed troubleshooting procedures are dealt with in the Manual in the last section on page 15 and on pages 16 thru 19 inclusive.

PARTS LIST

A complete listing of replacement parts will be found on pages 24 thru 53 in the manual laid out in an assembly orientated manner for easy and positive identification.



INSTRUCTIONS FOR OPERATING MODEL FL BORING MACHINE, ENGINE CYLINDER

RECEIPT FROM CARRIER

Inspect before unpacking. If there is damage or evidence of mishandling in transit, determine the extent of damage and notify the transit company immediately.

CLEAN MACHINE

Clean the machine thoroughly, removing all dust and grit collected in transit. The rust preventative used on the machine and all parts may be quickly removed with a cloth dampened in solvent. Clean bottom of machine base in like manner.

LUBRICATION

Before starting the machine, be sure to oil it properly, using a good grade of medium motor oil in all oil cups.

There is some oil in the main transmission.

To check oil level in the transmission, remove the oil filler plug just in front of the motor and the oil level plug just below the speed control lever. Pour SAE 30 oil in the upper hole until it runs out of the lower one. Then replace both plugs.

Oil the sleeve main bearing by putting a few drops of oil in the keyway, when the sleeve is in the UP position. This will saturate the lower felt which surrounds the sleeve at the bottom. Keep the upper felt saturated by putting oil around sleeve at top.

Oil the feedscrew and drive shaft occasionally.

CAUTION: DO NOT OVER LUBRICATE AND WIPE OFF ALL SURPLUS OIL TO PREVENT V-BELT SLIP.

MOTOR CURRENT

Be sure the motor is of the proper voltage and cycle for the current available. The motor nameplate will give this information.

INSTALLATION OF STOP ROD

Clean stop rod and remove round head machine screw in small end of rod. Insert through hole in belt guard as illustrated on page 2 and replace round head machine screw. Remove stop rod lock screw and brass plug from bag attached to stop rod. Insert plug, flat end first, into tapped hole in belt guard, screw in stop rod lock screw and adjust rod to desired length.

READ COMPLETELY BEFORE ATTEMPTING TO OPERATE MACHINE**SPEED AND FEED COMBINATIONS**

Speed Control Lever Position	Motor Shift Lever Position	Boring head R.P.M.	Travel Inches/Min. Feed Plunger Position			
			1	2	3	4
Up	Down	83	.127	.249	.393	.564
Up	Up	142	.217	.426	.670	.966
Down	Down	297	.455	.891	1.400	2.000
Down	Up	505	.772	1.515	2.380	3.380

OPERATING PROCEDURE

- 1 - Place speed control in neutral or horizontal position.
- 2 - Start motor.
- 3 - Move motor shift lever to selected position. (See table)
- 4 - Select feed plunger position. (See table)
- 5 - Move feed control lever to down position.
- 6 - Push speed control lever down or up. (See table)

Allow time for the feed plunger to engage. If the feedscrew does not turning, move the feed plunger slightly up or down to allow the engage.

NEVER MOVE FEED CONTROL LEVER TO UP POSITION WITHOUT FIRST DISENGAGING HANDWHEEL.

Pull handwheel out to disengage - push in to engage for hand feed.

When boring cylinders larger than 6-3/4", parallel bars (available as equipment) must be used. Centering fingers and boring tool must used during retraction so they will not strike the base of the. Remove centering fingers immediately after centering so that the remainder of the boring operation only the tool bit will be kept in the correct position.

BELT TENSION - On heavy rough boring cuts it will be necessary to turn tightener knob in a clockwise direction to increase tension on. On light finish cuts it may be necessary to release the tension the belt to eliminate any shadow patterns in the finished bore.

The stop rod is a device for measuring and controlling the travel of the boring head. However, it is not advisable to leave the machine unattended as it reaches the end of the boring stroke.

IMPORTANT

DO NOT ATTEMPT TO BORE WITH MACHINE WITHOUT FIRST CHECKING THE MICROMETER ;BY BORING IN A SCRAP CYLINDER. REFER TO INSTRUCTIONS ON SETTING AND ADJUSTING THE MICROMETER. DO ALL TEST BORING ON A SCRAP BLOCK UNTIL YOU ARE SATISFIED WITH RESULTS OBTAINED.

INSTALLATION OF ANCHORING DEVICE

The anchoring device is to be fastened into the cylinder next to the one to be bored. In the case of a four cylinder block, only two settings of the anchoring device are required, as number 1 and number 3 cylinders can be bored with anchoring device in number 2 cylinder, and number 2 and number 4 can be bored with the anchoring device in number 3 cylinder. A six or eight cylinder block required four settings of the anchoring device.

To install the anchoring device, proceed as follows:

Select the longest length of clamp which will freely enter the bore when in the position shown in figure 3. Then, if the shoulders A-A allow more than 1/16" endwise movement of the clamp, loosen the two adjusting screws (each one the same amount as nearly as possible by eye) until the endwise movement is between 1/32" and 1/16". Then fasten this clamp to the anchor body by means of the clamp pivot pin, in the position indicated in figure 2.

Turn the centering screws in if necessary (keeping each one as nearly central with the centering spider as possible by eye) until it will freely enter the cylinder and yet have but little side play in any direction. Select the proper combination of extension rods and coupling with the anchor clamp and body. Screw the assembly in or out until the approximate length is obtained.

The device is now ready to be put in place, but before inserting it, first examine the bottom of the cylinder bore to determine the best position on which to clamp. Whenever possible, we advise setting the clamp crosswise of the cylinder block, but if ribs or sloping walls interfere, use the nearest to a crosswise location which provides sufficient flat surface on which to hook the clamp.

CAUTION

THE CLAMP MUST NEVER BE HOOKED LENGTHWISE OF THE BLOCK IF THE CYLINDERS ARE SO CLOSE TOGETHER THAT ONE END OF THE CLAMP WOULD PROJECT BEYOND THE WALL OF THE CYLINDER TO BE BORED. In other words, the MOST IMPORTANT CAUTION to be observed in positioning the clamp is NEVER ALLOW THE CLAMP TO PROJECT TO A POSITION WHERE THE BORING TOOL COULD STRIKE IT. Second in importance is selecting as flat a place as possible at the bottom of the cylinder on which to hook the clamp.

Now, tilt the clamp on its pivot pin until the anchor will enter the cylinder and rotate to such a position as determined by examination described in the above two paragraphs. Then lower until the upper tilted end can be hooked against one side wall and pull up until the clamp engages both sides, as shown in figure 4. Pull up on the clamp nut and shake the clamp back and forth to make sure both shoulders (or adjusting screws) of the clamp are inside the cylinder. Continue to pull up on the clamp nut and at the same time, adjust length until the U-shaped anchor gage figure 1 can be slipped into place. Then, turn the clamp nut down almost tight against the gage. See figure 4. The device will now be in position, as shown by figure 2 or figure 4, and is ready for the machine to be slid over it. Turning one of the centering screws slightly will lock the assembly in the cylinder.

Push the machine over the open end of the anchor gage first, as this allows removal of the gage after the clamp nut engages the T-slot in the machine.

CAUTION IN CLAMPING

IN CLAMPING THE MACHINE TO THE BLOCK, ALWAYS USE THE SPECIAL WRENCH FURNISHED FOR THIS PURPOSE. THE CLAMPING DEVICE INSIDE THE BASE OF THE MACHINE HAS A POWERFUL LEVERAGE, AND ONLY A MEDIUM PULL ON THIS WRENCH IS NECESSARY TO POSITIVELY CLAMP THE BAR. A HEAVY PULL ON THIS WRENCH WILL CLAMP THE BAR TOO TIGHTLY AND CONSEQUENTLY DISTORT THE CYLINDER BLOCK, RESULTING IN OUT-OF-ROUND HOLES AFTER THE MACHINE HAS BEEN UNCLAMPED. OVER CLAMPING WILL, ALSO, FORCE THE CLAMP NUT, FORMING DEPRESSIONS IN THE T-SLOT OF THE ANCHOR CLAMP. THIS WILL EVENTUALLY CAUSE CENTERING TROUBLE AS THE CLAMP NUT WILL SLIP INTO THE DEPRESSIONS WHILE CLAMPING, MOVING THE MACHINE OFF CENTER AS FORCE IS APPLIED TO THE CLAMP.

ANCHORING DEVICE

Furnished with the anchoring device are different lengths of clamps, entering screws and anchor bolts. The capacities of these different parts are as follows:

ANCHOR CLAMP ASSEMBLIES

055-0462-20	Anchor Clamp Assembly	#2	Capacity	3-1/4" to 3-7/8" Diam.
055-0463-28	Anchor Clamp Assembly	#3	Capacity	3-7/8" to 4-1/2" Diam.
055-0464-25	Anchor Clamp Assembly	#4	Capacity	4-1/2" to 5-1/4" Diam.
055-0465-25	Anchor Clamp Assembly	#5	Capacity	5-1/4" to 6" Diam.
055-0466-22	Anchor Clamp Assembly	#6	Capacity	6" to 6-3/4" Diam.

CENTERING SCREWS

062-0456-04	Centering Screw - Short	Capacity	Up to 4" Diam.
062-0457-01	Centering Screw - Medium	Capacity	4" to 5-1/2" Diam.
053-0458-47	Centering Screw - Long	Capacity	5-1/2" to 7" Diam.

EXTENSION RODS

055-0472-43	Short Extension Rod	6-5/8" Long	Capacity	6-1/2" to 10"
055-0473-40	Medium Extension Rod	8-5/8" Long	Capacity	8-1/2" to 12"
053-0474-40	Long Extension Rod	10-5/8" Long	Capacity	10-1/2" to 14"

CAPACITY OF CENTERING FINGERS

The range of cylinder sizes covered by each set of centering fingers is as follows:

053-0361-55	Centering Finger #1 (Set of 3) 2-31/32" to 3-23/32"
053-0362-52	Centering Finger #2 (Set of 3) 3-23/32" to 4-1/2"
053-0363-50	Centering Finger #3 (Set of 3) 4-1/2" to 5-1/4"
053-0364-57	Centering Finger #4 (Set of 3) 5-1/4" to 6"
053-0365-54	Centering Finger #5 (Set of 3) 6" to 6-3/4"

CAUTION

Insert the pointed ends of the centering fingers in the boring head. Inserting the rounded ends in the boring head first will scratch and groove the centering cone and destroy the accuracy of the centering operation.

Capacity may be increased by adding special extras.

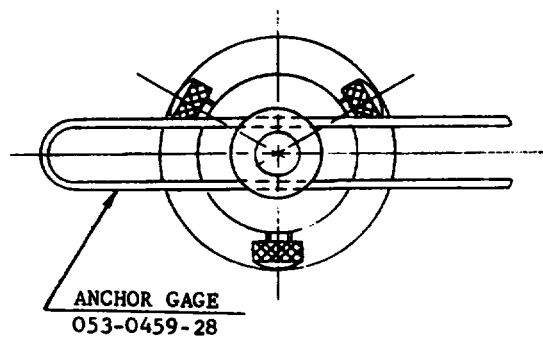


Figure 1.

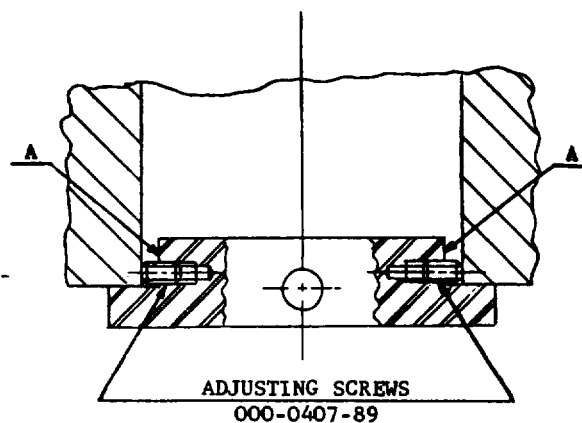


Figure 3.

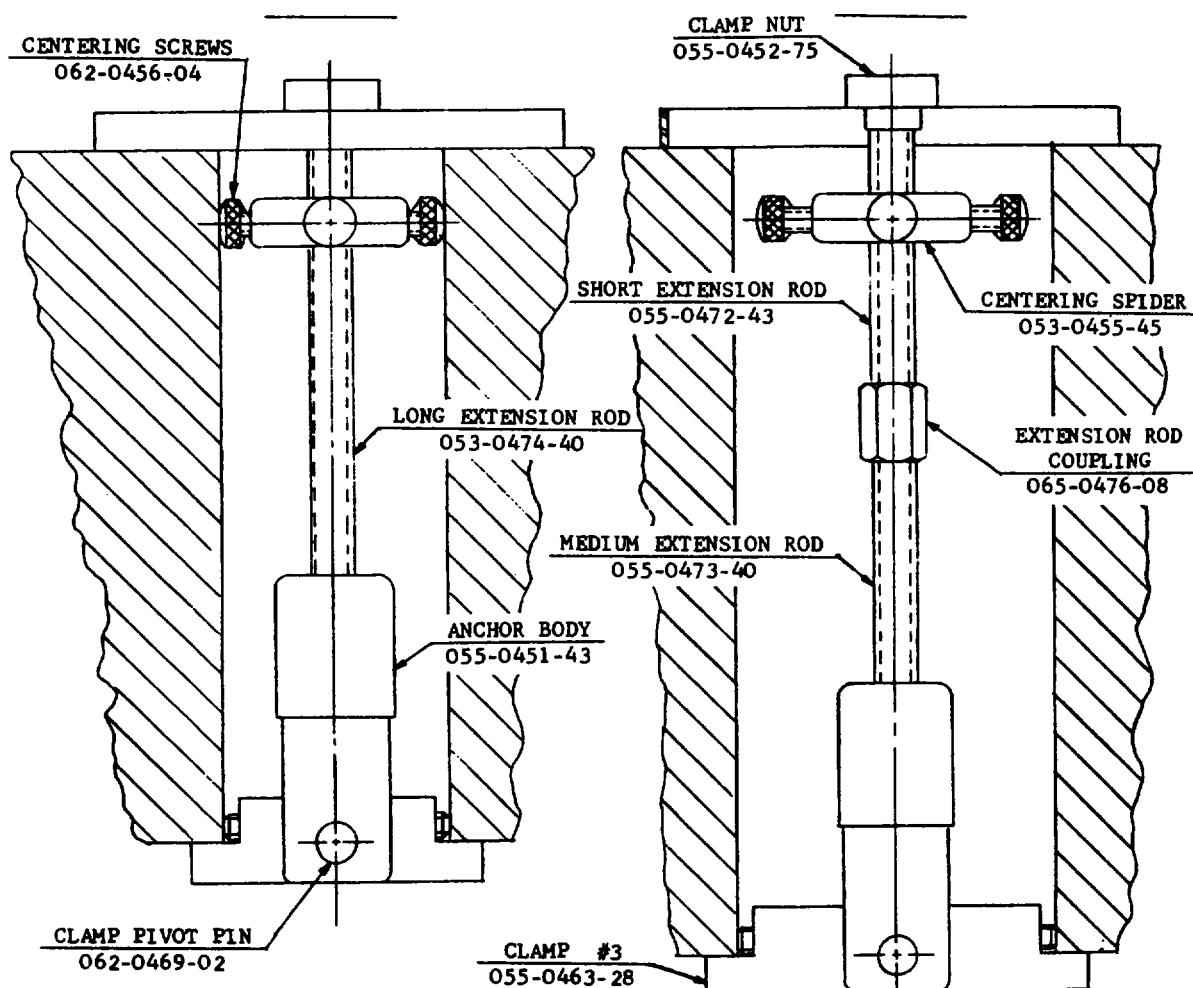


Figure 2.

Figure 4.

OPERATION PROCEDURE

CYLINDER BLOCK PREPARATION

Remove all studs.
Clean carbon and oil from top of block.
File top of block to remove burrs.
Make all cylinders for largest worn diameter.

INSTALLING ANCHOR BOLT

Select the proper length clamp, anchor bolt and centering screws -
See page 6.
Locate and adjust anchoring device in hole - See figures 2 and 3.
Adjust anchor bolt head down against anchor gage - See figures 1, 2 and 4.

CENTERING AND CLAMPING

Wipe machine base clean.
Place machine in position over anchor bolt and remove anchor gage.
Select proper centering fingers and insert in head - See page 7.
Move feed control lever to neutral position.
Lower sleeve to desired position for centering - using handwheel.
Tighten centering handwheel, at extreme top of bar, until fingers are tight against the cylinder wall
Swing base of machine on block to center on anchor bolt.
Clamp machine to block by using hex head screw on side of base.
Use wrench furnished - a longer wrench will clamp too tight.
Loosen centering handwheel. Disengage handwheel. Start motor and move
Feed control lever to UP position - thus raising bar out of cylinder.

ROUGH BORE

Lap roughing R tool - See pages 10 and 11.
Set micrometer to rough bore size desired - See page 14.
Set tool holder spring plunger - See page 14.
Insert R tool holder in head.
Set tool with micrometer and lock in place - See page 14.
Remove micrometer.
Lower sleeve manually until tool is slightly above top of block.
Disengage handwheel.
Set stop rod according to bore length.
Move feed control lever to DOWN position. Set feed plunger and motor Shift lever. Engage speed control lever according to speed desired. speed and feed table - page 4.
Lap finishing F tool while machine rough bores - See page 12.
When machine stops at bottom of cylinder, be sure handwheel is disengaged.
Raise feed control lever thus returning the sleeve to original position.

FINISH BORE

Remove roughing tool and install finishing F tool. Set micrometer to desired finished size and proceed as before.
When bore is completed, turn the knurled handwheel at top of the drive shaft so that index mark the nut below the centering handwheel is to the front of the machine. This prevents tool bit marking cylinder. Disengage handwheel.
Move feed control lever to retract sleeve. Unclamp machine - move to next hole and proceed in same manner.

CAUTION

Always clean out micrometer hole with brush before inserting micrometer.

The tool bits used are tipped with tungsten carbide. TUNGSTEN CARBIDE IS AN EXTREMELY HARD AND BRITTLE SUBSTANCE AND MUST, THEREFORE, BE HANDLED WITH GREAT CARE AT ALL TIMES.

Figures 5 and 8 show the tool bit (greatly enlarged) in the roughing and finishing operations of boring as seen when looking directly toward the tool

Both these figures show the three different angles which are lapped on the end tool bit. These are numbers 1, 2 and 3.

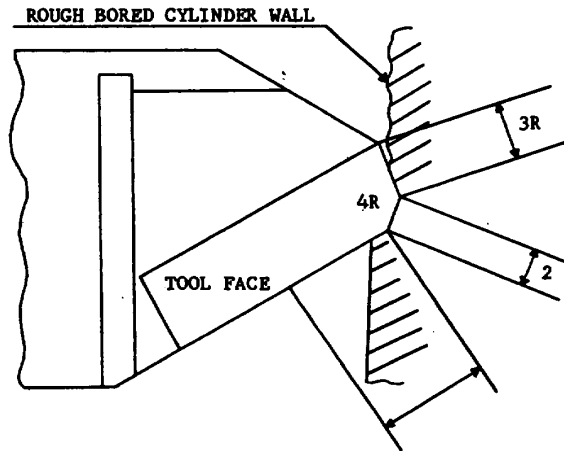


FIGURE 5.
ROUGH BORING TOOL BIT
IN CUTTING POSITION

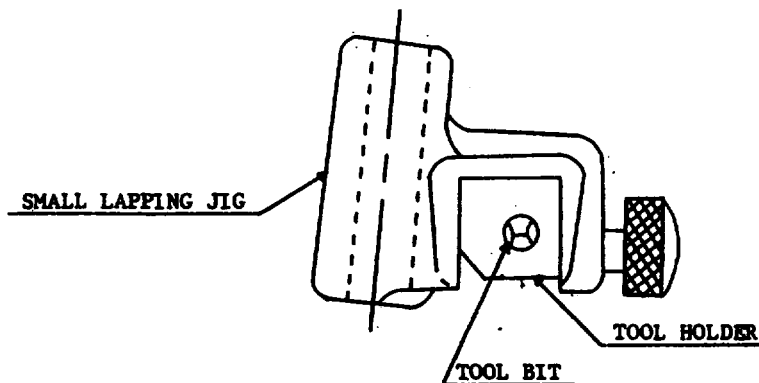


FIGURE 6.
LAPPING JIG FOR LAPPING ROUGH BORING
TOOL BIT IN POSITION 4R

LAPPING THE ROUGHING TOOL

On the roughing tool, figure 5, a part of portion 1 and all of portion 2 remove the metal in boring and are, therefore, the parts of the tool that wear must be reconditioned. The lapping operations will be as follows:

- 1 - The first operation is to lap the tool face, figure 5, by using the small lapping jig shown in figure 6. Lap only until you have removed all built-up material from the face of the tool.
- 2 - Then place the tool holder in the large lapping jig as shown in figure 7 and set the swivel casting that holds the tool to position 1 as illustrated. Lap in this position until portion 1, figure 5, is smooth.
- 3 - Shift swivel casting to position 2, figure 7, and lap portion 2, Figure 5, until portion 2 is in good condition.
- 4 - Shift to position 3R, figure 7, and lap portion 3R, figure 5, until 2 has the proper width. For roughing tool, this width should be eight thousandths for the average size bore.

Under ordinary conditions, the roughing tool will bore six cylinders without relapping. There are exceptions, however, when the tool should be lapped more often, due to hard material or large and long bores. Examine the tool after each hole to check its condition. A sharp free-cutting tool requires less power maintains consistent hole size so time spent in touching up the tool will improve results.

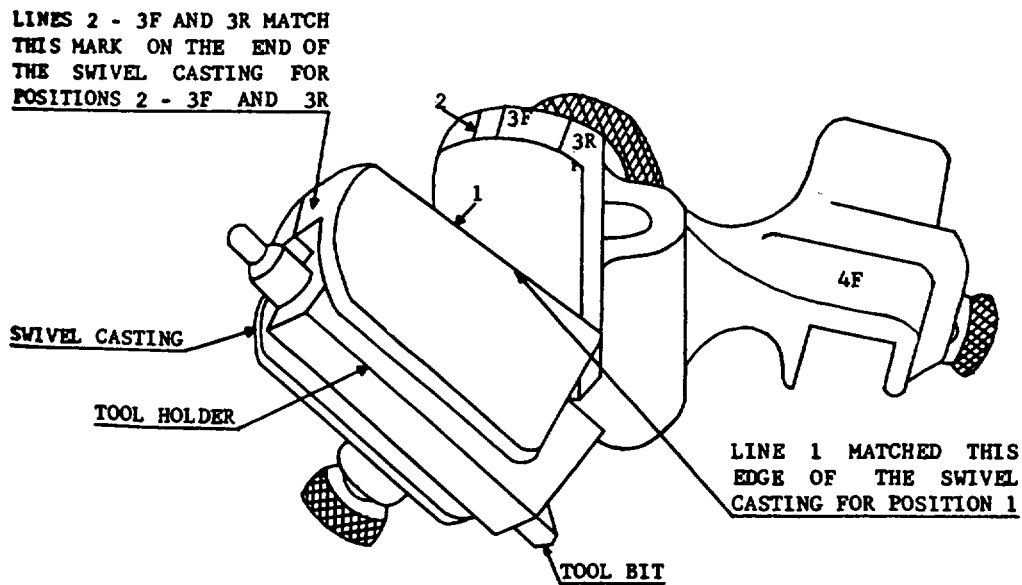


FIGURE 7.
LARGE LAPPING JIG SHOWING THE DIFFERENT
POSITIONS FOR LAPPING THE TOOL

LAPPING THE FINISHING TOOL

On the finishing tool, figure 8, portion-2 is the part that produces the finish cut. The condition of portion 2, therefore, determines the final finish. The finishing tool bit is lapped only in the large jig and in positions 4F, 1, 2, and 3F.

- 1 - The first operation is to lap the tool face, figure 8, with the tool in position 4F of the large lapping jig. Lap only until you have removed all built up material from the face of the tool.
- 2 - Then place the tool holder in the large lapping jig as shown in figure 7 and set the swivel casting which holds the tool to position 1 as illustrated. Lap in this position until portion 1, figure 8, is smooth.
- 3 - Shift the swivel casting to position 2 and lap portion 2 until it is smooth.
- 4 - Then shift to position 3F and lap portion 3F until 2 has the proper width. This should be from .020" to .050", depending on the bore size, as explained on Page 13 under Most Important Part of the Tool .
- 5 - Lap the finishing tool as outlined above, AFTER EVERY HOLE.

To fully understand the purpose of each lapping operation, carefully study the d views of the tool, at the same time holding one of the tools in your position shown in these views.

FINISH BORED CYLINDER WALL

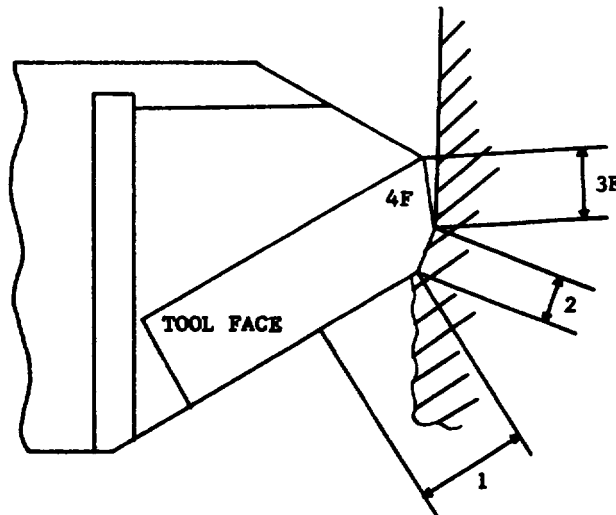


FIGURE 8.
FINISH BORING TOOL BIT IN
CUTTING POSITION

MOST IMPORTANT PART OF THE TOOL

The portion 2 is by far the most important part of the tool and its width and condition will determine absolutely the quality of cylinder wall finish left by the tool in boring. The following rules apply to this part of the tool and, if observed, will provide the best results possible.

- 1 - Portion 2 is widened by lapping operation number 2 and narrowed by either 1 or 3 (F or R) preferably 3, because it is faster.
- 2 - Widening portion 2 improves the finish but at the same time, increases the tendency of the tool to chatter. The width of portion 2 **MUST, THEREFORE, BE WATCHED CAREFULLY.**
- 3 - The correct width of portion 2 depends on the diameter of cylinder to be bored. For holes up to 3-1/4", the width of F tool should be about .040". For holes larger than 3-1/4" (and longer than 9") it will be necessary to reduce this width somewhat, the amount depending on the tendency to chatter at the bottom of the hole. For the largest holes, the width should be about .020".

Careful examination of the tool before lapping will show a gray line along portion 2. This is the wear that takes place on this keen edge after it has bored a hole. In lapping, you must remove this gray line in order to restore the **KEEN CUTTING EDGE** which is of vital importance in getting a good finish. The keenness of the edge of portion 2 is especially important.

MISCELLANEOUS SUGGESTIONS ON LAPPING

In all lapping operations, lower the jig very carefully to the lapping disc. **IF THE TOOL IS DROPPED ON THE DISC, BOTH TOOL AND DISC ARE SUBJECT TO DAMAGE.**

To get the best results in lapping, oscillate the tool with a short, quick movement. Never lap any more than is necessary. To facilitate lapping operations, keep the steel filed away from the tungsten carbide, similar to a new tool.

The lapping at positions 2 and 3 should be done toward the center of the disc. The lapping at positions 1 and 4 should be toward the edge.

CARE OF THE DISC

Keep the felt wick in the lapping disc guard saturated with a good grade of light motor oil (or special lapping disc oil). If the disc is used dry, the tungsten carbide pulls the diamond powder out of the disc and will shorten its life. The free use of oil on the disc will not only improve the results, but greatly prolongs disc life. Occasionally the lapping disc will become gummed up and appear dull. Cleaning with solvent will improve its cutting quality. Do not press felt wick down tight against the lapping disc as too much pressure will serve as a brake and reduce the usable power of the motor.

SETTING THE TOOL IN THE BORING HEAD

Determine the size to bore and set the micrometer. Each graduation of the micrometer body, or one revolution of the thimble, represents fifty thousandths.

For the roughing cut, the micrometer should be set two thousandths smaller the desired finished size. Two thousandths is the proper amount for finish cut. After setting the micrometer, lock it with the micrometer lock screw. Loosen the plunger lock screw and place the R tool holder along the micrometer spindle as shown in figure 9. Move the plunger until the length of the tool, tip of tool to tip of plunger, is approximately $\frac{1}{2}$ inch longer than the extended length of the micrometer stem.

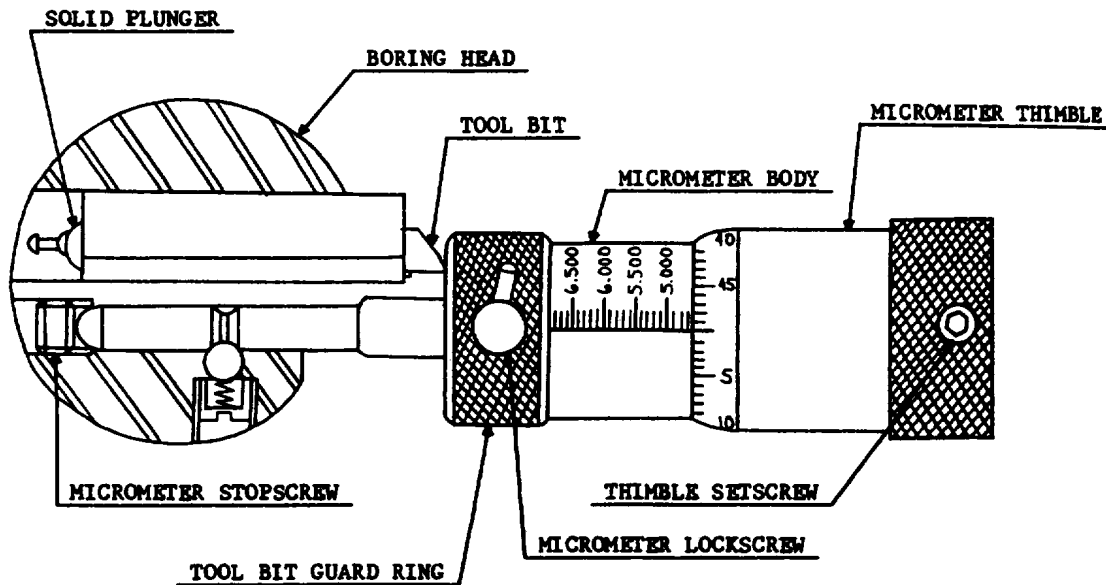


FIGURE 9.
SETTING THE TOOL IN THE BORING HEAD

CAUTION

UNLESS THE PLUNGER IS PROPERLY SET, IT WILL BE IMPOSSIBLE TO MAINTAIN UNIFORMITY SIZES

Figure 9 shows the tool holder in the boring head ready to be locked in position. The small spring plunger is partly compressed, thus pushing the tool holder and tool bit out against the face of the micrometer body with a light spring pressure.

- 1 - Before inserting micrometer spindle in boring head, clean hole with bristle brush furnished.
- 2 - Insert the tool holder in the boring head. Turn guard ring on micrometer to the left (to protect tool bit and micrometer), insert the micrometer spindle in boring head and push it in until it clicks into place.
- 3 - Turn the tool bit guard ring back to the right, allowing the tool bit point to gently contact the micrometer face. DO NOT rotate micrometer while tool is in contact with the face; scratches will affect setting size.
- 4 - Lock the tool holder in place, remove micrometer.

NOTE

For best uniformity of tool setting, use the same part of the mike face in contact with the tool bit for all settings. This is easily done by keeping the micrometer lock screw in the same position each time.

CAUTION

When removing the tool holder from the boring head, have one hand on the tool to prevent its flying out.

The finishing tool is set in the boring head in exactly the same way, after resetting the micrometer for the desired finished size.

IMPORTANT

Be sure the setting of the boring machine micrometer corresponds with the inside micrometer used in measuring the cylinders. If necessary to reset the tool setting micrometer, proceed in the following manner:

First set the boring tool with the tool setting micrometer to take a light cut and lock the knurled thumbscrew to retain the micrometer setting. Bore about an inch down, then measure the hole with the inside micrometer.

Second, loosen the setscrew in the hub of the thimble of the tool setting mike, the thimble to correspond with the measured size of the hole, and lock the setscrew.

Third after thus adjusting the micrometer thimble, set the micrometer to a size 5 or 10 thousandths larger, bore again and recheck.

If further adjustment is necessary, reset the thimble and check again. Repeat the two micrometers read alike.

MICROMETER SPINDLE LOCK ADJUSTMENT

In setting the boring tool for size, the micrometer is automatically held against a stop in the boring head by spring pressure on a ball which enters a groove in the micrometer spindle. The spring pressure on the ball is adjustable by means of a setscrew in the side of the boring head. See Figure 9.

In setting the tool holder in the boring head, the spring pressure on the ball must overcome the spring pressure of the plunger in the tool holder so as to hold tool holder in the proper position while being locked in the boring head. The spring pressure in the tool holder will vary according to the position of the plunger in the tool holder.

If the setscrew for adjusting the pressure on the ball is backed out too far, it is possible the end of the micrometer spindle will not be held against the stop in the back of the head. This will cause the machine to bore oversize at times and make it impossible to secure uniformity of bore sizes.

Whenever difficulty is encountered in sizes or uniformity of bore sizes, this adjustment should be checked. The setscrew should be screwed in until it stops, and then be backed out one-half turn. There should be a distinct click when the ball enters the groove of the micrometer spindle and thrusts the end of the spindle against the stop in the boring head.

This machine is equipped with a special adjustable micrometer stopscrew in the back of the boring head. See page 14, figure 9. This stopscrew **SHOULD NOT BE MOVED** to correct micrometer setting and adjusting as moving it in any way will require a readjustment of the micrometer as discussed in a preceding paragraph, page 15 under heading **IMPORTANT**.

The preceding paragraph explained the principle of the ball and spring pressure applied to the groove in the micrometer stem. This special stopscrew is adjusted so the ball that applies pressure to the groove in the micrometer stem just breaks over the edge of the groove and holds the micrometer tight against this stopscrew. If at any time it is necessary to change micrometers or if the micrometer screw develops end play in the boring head, this screw can be reset to position the ball properly at the edge of the groove on the stem so the micrometer will snap into the boring head and be held firmly without end play. Whenever a readjustment of this screw is necessary, it is extremely important that the bar be set up on a scrap block and the micrometer again be reset as explained in the paragraph under the heading **IMPORTANT** - page 15.

ADJUSTING THE BORING SLEEVE MAIN BEARING

An improper adjustment of the main sleeve bearing on the cylinder boring machine may cause trouble in the operation of the machine. This adjustment should be checked frequently. The adjusting of the sleeve bearing is a delicate operation and too much stress cannot be laid upon it. The most important thing to keep in mind in making this adjustment is that in order maintain the maximum bearing area on the sleeve, you must have a good fit on the adjustable bearing at the extreme top and extreme bottom of the bearing area. If you have a good adjustment on the two center screws of the split bearing and the top and bottom screws are not clamping the bearing down against the sleeve, the sleeve will not be properly stabilized in the bearing and chatter, size variation and out-of-round trouble will develop in the bore.

The cylinder boring machine sleeve bearings are properly adjusted when they leave the factory, but due to vibration and handling in shipment, there is no assurance that the sleeve will be properly adjusted when the machine is uncrated. Due to the importance of this adjustment, the machine should be readjusted before being put in service.

Four sets of adjusting screws are provided for this bearing, four large clamping screws and four smaller locking screws.

The adjustment is made by setting each set of screws separately beginning with the center adjusting screws and then the upper and lower screws.

First loosen all four setscrews. Tighten the center clamping screws while moving the handwheel back and forth until a drag is felt on the handwheel. Tighten the lockscrews of this set until it leaves a slight drag on the handwheel as the sleeve is moved down. Should this adjustment leave no drag or too great a drag after tightening the lockscrews, loosen the lockscrews and reset the clamp screw. Over tightening of the lockscrews will distort the bearing and cause uneven wear.

THE ADJUSTMENT AT THE BOTTOM OF THE BEARING AND THE ADJUSTMENT AT THE TOP OF THE BEARING IS THE MOST IMPORTANT AND SHOULD BE MADE PROPERLY.

Adjust the top and bottom screws in the same manner. The drag on the handwheel should be increased after locking each of these screws to insure that there is a good bearing on the top and bottom bearing areas of the sleeve. There should be a very definite drag on the handwheel as the sleeve is lowered manually by cranking.

It is extremely important that the sleeve bearing adjustment be properly made when the bar is new and it is necessary that you have this additional amount of drag on the sleeve during the break-in period. If this adjustment is carefully made, and maintained during the first few months of operation, it will be possible to then maintain hole size, eliminate chatter and out-of-roundness for long periods of time without sleeve adjustment.

PROTECT THE BASE OF THE MACHINE Upon its accuracy depends the accuracy of the boring operation. Do not set the machine on a rough or hard surface. Always set the machine on a soft piece of wood or cardboard.

TROUBLESHOOTING AND SERVICE TIPS

THE BORING TOOL

The tool bits used in this machine are tungsten carbide and are extremely hard and brittle. The tool should never be lowered until it strikes the top of the cylinder to be bored and it should never be allowed to snap out against the face of the micrometer. Rough handling in this manner may not show evidence of cracking at the time, but as soon as the tool is put in service, a chip will fall out due to this rough handling.

If the belts on the machine become worn or oil soaked and have a tendency to slip, you will, also, find that tool bit breakage is a problem. The feedscrew in the machine is gear driven direct from the motor and if the belt slips under heavy cut, the feedscrew will continue to feed the tool. This extreme pressure will snap off the end of the carbide.

Extreme overloading of the machine will, also, break the carbide tip because, if the cut is so heavy that the machine stalls while cutting, the spring back caused by shutting off the motor or taking the machine out of gear will snap the end from the carbide tip.

CHATTER

Chatter trouble may develop during the boring operation due to several different causes and a listing might possibly help you to locate the cause should this trouble occur.

- 1 - Sleeve bearing adjustment too loose.
- 2 - Boring tool needs lapping or sharpening.
- 3 - Width of number 2 face on boring tool too wide.
- 4 - Tool bit not locked securely in tool holder.
- 5 - Top of engine block not smooth, giving a poor clamping surface for the base of the machine.

OUT-OF-ROUND CYLINDERS

You may find that after boring a cylinder, removing the boring bar and checking the cylinder with an inside micrometer, the bore does not check round. If this out-of-roundness shows up through the whole length of the bore, it probably is due to overclamping of the cylinder boring machine, which has distorted the block. When the cylinder boring machine clamp is released, the cylinder will return to its original position giving an out-of-round bore.

If the out-of-round condition in the bore checks excessively at the bottom and is not apparent in the top of the bore, this trouble is caused by an improper sleeve bearing adjustment which allows the tool to bore out-of-round when it is boring at a position with the sleeve farthest extended from the base. It is sometimes difficult to determine if this variation is all out-of-roundness or part taper and part out-of-roundness.

When this condition exists at the bottom of a hole, it is important that you first check the sleeve bearing adjustment to eliminate the possibility of any out-of-roundness.

VARIATIONS IN BORE SIZE

A variation in size from one cylinder to the next can quite often be the fault of the operator, although he is not conscious of causing this effect. Due to the fact that the tool holder of the machine is spring loaded and the micrometer is held against the stop plug in the boring head with spring pressure, it is very important that the operator remove his hand from the micrometer while setting the tool. Force applied to the micrometer in any way while the tool is being set and locked in place will affect bore size.

Another cause of variations in bore size may be due to using a roughing tool that has worn down until there is very little carbide left; then using a new finishing tool to make the finish cut. The great variation in position of the boring point from a worn out roughing tool to a new finishing tool will change the centerline of the cutting face sufficiently to give a variation in bore size. Because of this, it is advisable to use both roughing and finishing tools with a comparable carbide in each tool.

Variation in bore size can, also, be caused by a loose thread in the micrometer. The end play on the micrometer stem between the thread and the thimble can be adjusted to remove this condition.

Variation in bore size can, also, be caused by the micrometer spindle not being held firmly against the backstop with the ball in the micrometer's stem groove. The tension on this ball can be readjusted and you should check to see that the stopscrew is locked securely in place. Please refer to micrometer spindle lock adjustment on page 16.

Variation in bore size will, also, be quite evident if the operator has scratched the face of the micrometer by rotating it while the tool was in contact with this face. If such a condition does exist and does cause trouble, it is recommended that the micrometer be returned to the factory relapping of the micrometer face.

As mentioned in a previous paragraph, it is advisable to insert the micrometer with the thumb lockscrew up each time that the tool is set. Although the face of the micrometer is checked very carefully and extreme accuracy is maintained between the micrometer stem and the micrometer face, you will find that more accurate settings will be made if the micrometer is inserted with the thumbscrew up each time the tool is set. The tool being set will be in contact with the same portion of the micrometer face.

THE COUNTERBORING

The special counterboring tool bit, due to the small amount of cutting done by it will require much less lapping than the regular boring tool bit. A counterboring lapping jig is available and is recommended, but if very little counterboring is done, the tool may be lapped freehand on the lapping disc. When lapping freehand, it is important that you maintain the relief angles that were originally ground on the tool, but this is not too difficult if care is exercised in placing the tool on the disc and holding the tool steady during the lapping operation.

When lapping the tool in the special counterboring lapping jig, the jig and tool should be positioned and checked on the lapping disc before the motor tuned on. It is extremely important that you lap the tool so you will retain the relief behind the cutting edge. The counterboring lapping jig can be used for lapping the face of the tool that is down in the counterbore also, the front or lead face of the tool. You might find, however that you prefer putting the tool holder in the 4F position of the large swivel head lapping jig and lapping the lead edge with a slight negative angle. The negative angle on the lead edge will keep the tool from digging in while you are hand feeding for a counterbore and enable the to feed the bar more smoothly by hand.

In ordering a counterboring tool for this machine specify:
062-1074-05 Counterboring Tool Bit

In ordering special counterboring lapping jig specify:
062-0581-53 Lapping Jig for Counterboring Tool Assembly

BORING CLOSED CYLINDERS

There are many applications where the operator finds it necessary to bore to the bottom of the closed cylinder. In this type of boring, it is necessary that an offset boring tool be used so that it will extend below the bottom of the boring head. This tool must be used in special offset tool holder.

In an emergency, standard tool bits can be lapped in the offset tool holder in such a way that they can be used for offset boring, but it is advisable to order special offset boring tools that have been ground for that particular purpose.

When putting an offset tool or standard boring tool in the offset tool holder, you will find it necessary to file the shank of the tool so it will conform with the angles on the tool holder.

It is usually better to remove this metal before dressing the tool so the upper end of the tool will not interfere with the setting of the tool holder in the boring head.

LAPPING THE OFFSET BORING TOOL

#1, #2 and #3 faces on the tool bit are lapped with the large swivel lapping jig that is used for lapping standard boring tools. Set the number one position the same for both roughing and finishing.

The #3F position is set for lapping the finishing tool on the same line indicated on the swivel head jig, but in lapping the roughing tool, you will find it is not possible to go back as far as the #3R position without removing a good bit of the soft metal. Move the swivel head jig around about half way between the 3F and 3R position and then check the tool on the disc so you can maintain the original angle that was ground on the tool. This position normally will come about half between the 3F and 3R position. The #2 position is then lapped on the line indicated on the swivel head jig and the width of the #2 on a roughing tool should be held to a fine line, approximately .005 to .008 while the width of the #2 on the finishing tool can be increased to .030 to .040 in width.

Since the purpose of using the offset boring tool is to bore to the very bottom of a closed cylinder, it is important that you no more than just touch the end of the tool to the disc when you are lapping the #1 face. Should this #1 face become too wide, it will leave a fillet in the bottom of the counterbore. If you want to narrow the #1 face or want the tool so it will cut a counterbore with sharp corners, move the swivel head jig around until the tool holder is parallel with the top of the jig, check the tool on the disc to see it is flat, then lap this face until the #1 position has been removed or narrowed down satisfactorily for your particular boring operation.

The #4 face on the roughing tool is lapped with the special jig for offset boring tools. When using this jig, it is important to check to see that you have a positive relief on this face of the offset boring tool so that as the roughing tool, it will peel the metal off rather than scrape or plow it off. The #4 face on the finishing tool can be lapped in the #4F position on the large swivel head lapping jig.

When ordering offset boring tools for this machine specify:

062-1258-02	Offset Tool Bit
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The offset boring tool does require special tool holders and when ordering specify:

062-1030-00	Offset Tool Holder - Short
	Or
062-1031-08	Offset Tool Holder - Long

When ordering lapping jig for offset tools specify:

051-0455-13	Lapping Jig Assembly - Offset
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INSTRUCTIONS FOR LAPPING STANDARD TOOL BITS IN OFFSET BORING TOOL HOLDER

Either standard tool bits or special offset tool bits may be used in the offset tool holder. When it is necessary to bore to the very bottom of a closed cylinder, the special offset tool bit is recommended.

Insert the standard tool bit in the offset tool holder far enough so that it extends above the top of the tool holder. File off the top of the tool so it is flush with the top of the tool holder. It may not be necessary to file away this metal, but it is usually better to remove some of it before dressing the tool so the upper end of the tool bit will not interfere with the setting of the tool holder in the boring head.

Put the offset tool holder in the swivel lapping jig and set the swivel head so the tool holder is approximately parallel with the top of the lapping disc. Lap this face of the tool until the end or cutting edge of the tool has been relieved back to the full width of the carboloy insert. Swivel the jig assembly around to the #3F position and lap the 3F position on the tool bit until it forms a sharp line with the first position lapped. It is recommended that the backing metal be removed with a file that this softer metal will not be dressed into the lapping disc. There is a considerable amount of lapping necessary in the 3F position and removing the backing metal with a file will materially reduce the length of time necessary for dressing this position. Swivel the lapping jig head around to the #1 position and lap the tool on the #1 face just enough to dress off the sharp line. Then swivel to the #2 position and lap the face to the required width which, of course, in the case of the roughing cutting tool should be held from 5 to 10 thousandths in width. The #4 position is dressed using the special lapping fixture for offset boring tool.

The preceding instructions are for lapping the roughing cutting tool, but if finishing cutting tool is desired, the same procedure would be followed with the exception of the #2 position which would be dressed slightly wider.

ONE PASS BORING

Many operators prefer to dress a tool in such a way they can produce a desirable finish while taking out .030 to .040. You will find you can produce a very excellent finish on a cut as heavy as this if the tool is properly dressed for one-pass boring. The following dressing procedure is recommended.

It is best to start with a roughing tool if you want to lap a one-pass tool because the one-pass tool should have the #4R position lapped on the front of the tool. The #1 position is lapped as indicated on the swivel head lapping jig, the #3F position lapped as indicated on the jig and the #2 position lapped as indicated on the jig, but about the same width as you normally would lap the #2 position on a finishing tool. What you actually have then is a combination between the roughing tool and the finishing tool. On larger bores or long bores where chatter is a problem, it is recommended that you lap the #2 position about 1/16 inch toward the #3F mark and #3F position about 1/16 inch toward the #3R. Lapping the tool in this way will move the #2 and #3F position back slightly so the tool will be freer cutting and, therefore, will not have as much tendency to chatter. Lapping the #2 and #3F with this 1/16 inch relief will enable you to make the #2 considerably wider. See figure 7, page -11-.

The above lapping procedure, also, is a definite advantage when boring the extremely hard sleeves because the #3F position will give the cutting edge more support as the tool wears and will cut down on a tendency to lose size as the tool wears.

PLATE I

1	053-0101-48	Base	1 - Req'd.
2	053-0103-42	Motor Base	1 - Req'd.
3	000-7000-29	1/4 x 1 Dowel Pin	2 - Req'd.
4	000-1740-09	1/2 x 13 x 1/16 Felt Strip	1 - Req'd.
5	000-0505-39	3/8-24 x 7/8 Flat Point Socket Setscrew	4 - Req'd.
6	000-0170-78	3/8-24 x 1 Socket Head Capscrew	4 - Req'd.
7	000-6000-32	Dust Guard	1 - Req'd.
8	000-0212-96	1/4-20 x 5/8 Round Head Machine Screw	2 - Req'd.
9	053-0169-01	Felt Retainer	1 - Req'd.
10	000-0222-76	8-32 x 1/2 Flat Head Machine Screw	3 - Req'd.
11	000-1702-59	3-1/2 x 3 x 1/4 Felt Washer	1 - Req'd.
12	053-0102-02	Base Plug	1 - Req'd.
13	000-1602-10	Bearing	4 - Req'd.
14	000-2001-15	End Plate Gasket	1 - Req'd.
15	053-0134-06	Lower Bearing End Plate	1 - Req'd.
16	000-0100-14	1/4-20 x 1/2 Hex Head Capscrew	3 - Req'd.
17	053-0126-04	Countershaft Bearing Plug - Lower	1 - Req'd.
18	053-0117-05	Lower Bearing Spacer	1 - Req'd.
20	000-1800-17	Compression Spring	1 - Req'd.
21	062-0116-02	Bearing Cap	1 - Req'd.
22	000-0212-96	1/4-20 x 5/8 Round Head Machine Screw	2 - Req'd.
23	053-0427-08	Clamp Locating Arm	1 - Req'd.
24	065-0428-43	Locating Arm Pivot	2 - Req'd.
25	062-0422-06	Clamp Lever	2 - Req'd.
26	062-0421-41	Main Clamp Casting	1 - Req'd.
27	062-0423-89	Clamp Nut - Rear	1 - Req'd.
28	062-0423-03	Clamp Nut - Front	1 - Req'd.
29	062-0424-00	Clamp Screw	1 - Req'd.
30	000-2001-07	Clutch Plate Gasket	1 - Req'd.
31	000-0212-96	1/4-20 x 5/8 Round Head Machine Screw	3 - Req'd.
32	000-2001-23	Gear Case Cover Gasket	1 - Req'd.
33	000-2000-93	Gasket	1 - Req'd.
34	053-0118-02	Counter Shaft Bearing Spacer - Upper	1 - Req'd.
35	053-0103-93	Motor Base Screw	2 - Req'd.
36	053-0101-80	Bearing Nut	1 - Req'd.
37	000-1602-10	Bearing	2 - Req'd.
38	000-0100-65	1/4-20 x 1-1/4 Hex Head Capscrew	1 - Req'd.

PLATE I

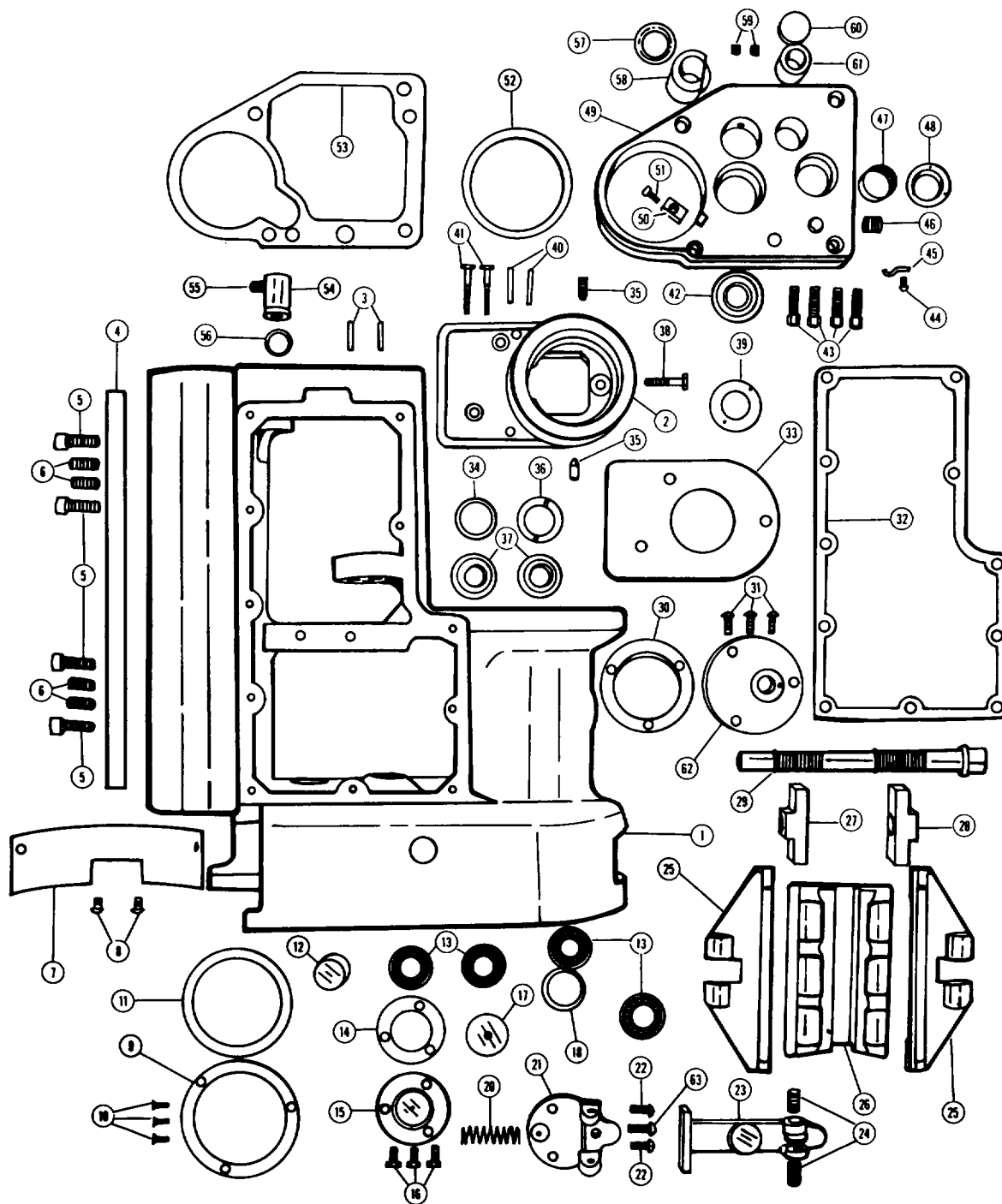


PLATE I

39	053-0248-07	Locknut.....	1 - Req'd.
40	000-7000-37	1/4 x 1-1/4 Dowel Pin	2 - Req'd.
41	000-0101-20	1/4-20 x 1-1/2 Hex Head Capscrew	2 - Req'd.
42	000-1603-77	Ball Bearing.....	1 - Req'd.
43	000-0168-10	5/16-18 x 1-1/4 Socket Head Capscrew	4 - Req'd.
44	000-0347-54	10-24 x 3/8 Round Head Machine Screw N. P.....	1 - Req'd.
45	000-1242-22	Hold Down Clip.....	1 - Req'd.
46	000-1540-32	1/4-18 Headless Pipe Plug.....	1 - Req'd.
47	000-1620-43	Needle Bearing.....	1 - Req'd.
48	000-2200-60	Oil Sea.....	1 - Req'd.
49	053-0162-43	Casting Base Cover	1 - Req'd.
50	053-0184-08	Boring Sleeve Key.....	1 - Req'd.
51	000-0162-68	10-24 x 3/8 Socket Head Capscrew.....	1 - Req'd.
52	000-1702-59	3-1/2 x 3 x 1/4 Felt Washer	1 - Req'd.
53	000-2001-31	Cover Gasket	1 - Req'd.
54	053-0183-00	Return Rod Holder	1 - Req'd.
55	053-0181-22	Return Pin	1 - Req'd.
56	000-2301-38	O Ring	1 - Req'd.
57	000-2200-51	Oil Seal.....	1 - Req'd.
58	053-0292-05	Feed Countershaft Bearing - Upper	1 - Req'd.
59	000-0487-63	5/16-18 x 5/16 Cup Point Socket Setscrew.....	2 - Req'd.
60	053-0203-48	Countershaft Bearing Plug.....	1 - Req'd.
61	053-0204-02	Countershaft Bearing - Upper	1 - Req'd.
62	053-0128-09	Clutch Plate.....	1 - Req'd.
63	000-0213-00	1/4-20 x 3/4 Round Head Machine Screw.....	1 - Req'd.

PLATE I

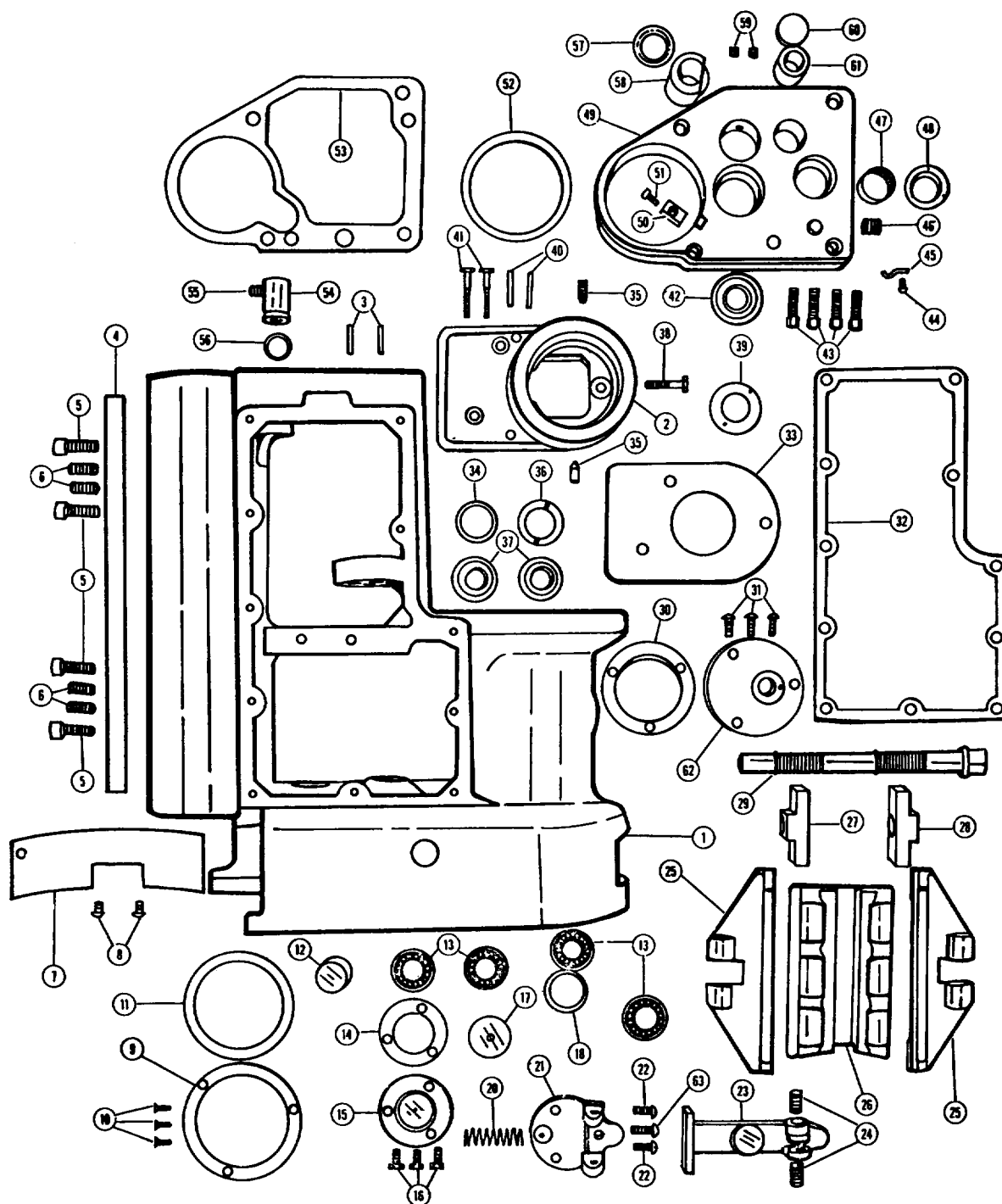


PLATE II

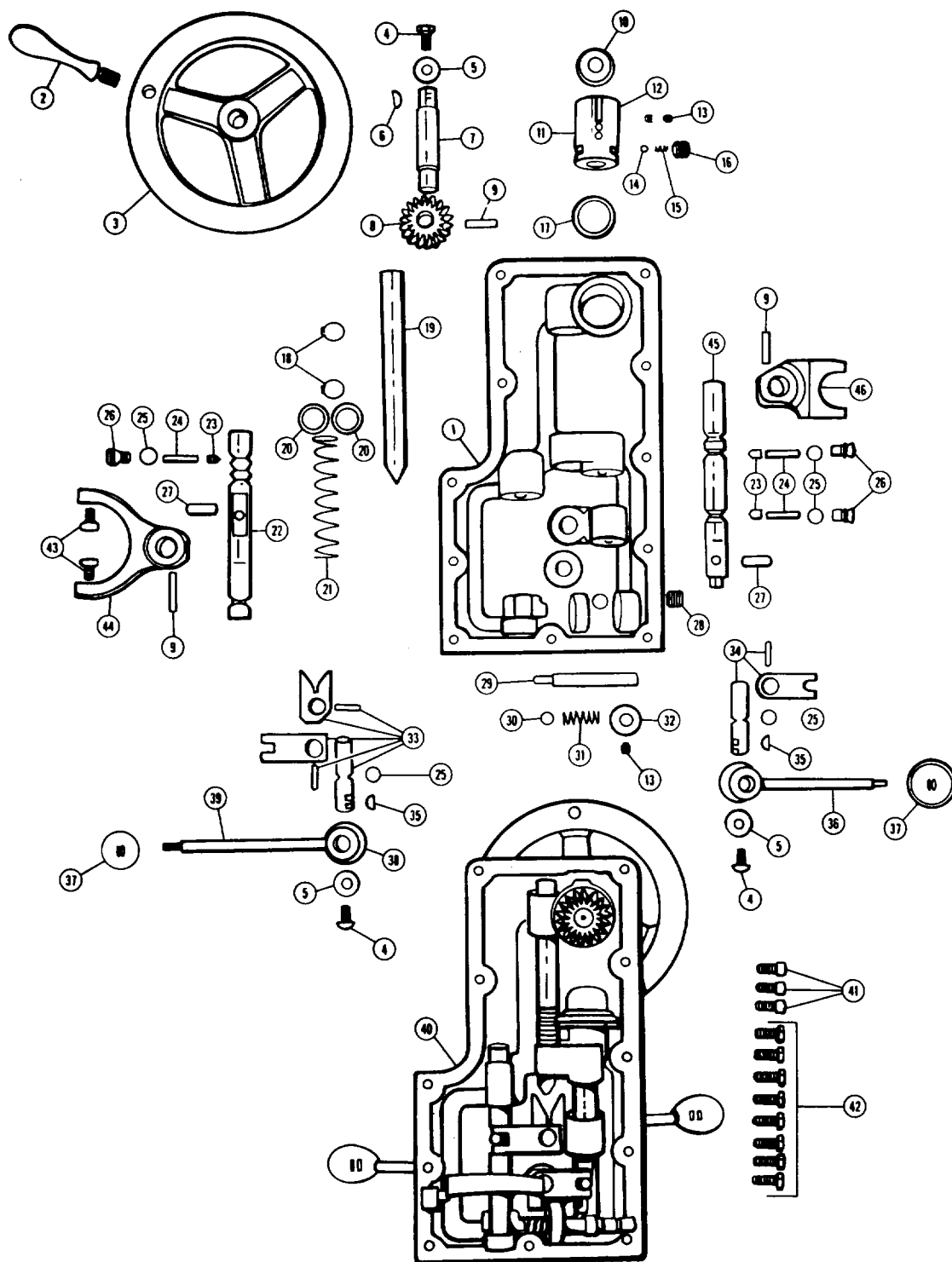


PLATE II

1	053-0146-07	Gear Case Cover	1 - Req'd.
2	062-0245-00	Handwheel Handle	1 - Req'd.
3	053-0208-01	Feed Handwheel	1 - Req'd.
4	000-0100-14	1/4-20 x 1/2 Hex Head Capscrew	3 - Req'd.
5	000-1180-52	Washer Z. P	3 - Req'd.
6	000-7300-33	#3 Woodruff Key	1 - Req'd.
7	053-0206-07	Handwheel Shaft	1 - Req'd.
8	053-0213-01	Handwheel Shaft Bevel Gear	1 - Req'd.
9	000-7200-20	#2 x 1 Taper Pin	3 - Req'd.
10	000-2200-43	Oil Seal	1 - Req'd.
11	053-0201-00	Handwheel Shaft Bearing	1 - Req'd.
12	000-0520-19	1/4-20 x 1/4 Socket Half Dog Setscrew	1 - Req'd.
13	000-0485-18	1/4-20 x 1/4 Socket Cup Point Setscrew	2 - Req'd.
14	000-2100-64	1/4 Steel Ball	1 - Req'd.
15	000-1802-20	Compression Spring	1 - Req'd.
16	053-0202-08	Ball Holder	1 - Req'd.
17	000-2301-38	O Ring	1 - Req'd.
18	000-1832-61	Snap Ring	2 - Req'd.
19	053-0170-02	Drive Clutch Release Plunger	1 - Req'd.
20	000-2004-50	#15 Fiber Washer 7/8 x 5/8 x 1/32	2 - Req'd.
21	000-1803-51	Compression Spring	1 - Req'd.
22	053-0159-05	Drive Shaft Shift Rod	1 - Req'd.
23	053-0148-01	Plunger	3 - Req'd.
24	000-1805-72	Compression Spring	3 - Req'd.
25	000-2300-03	O Ring	5 - Req'd.
26	053-0165-02	Plunger Holder	3 - Req'd.
27	000-7100-91	5/16 x 7/8 Type 4 Groove Pin	2 - Req'd.
28	000-1540-32	1/4-18 Headless Pipe Plug	1 - Req'd.
29	053-0154-09	Return Shaft Lock Rod	1 - Req'd.
30	000-1832-53	Snap Ring	1 - Req'd.
31	000-1803-60	Compression Spring	1 - Req'd.
32	053-0153-01	Lock Rod Collar	1 - Req'd.
33	053-0151-15	Feed Stop Lever Assembly	1 - Req'd.
34	053-0155-14	Feed Gear Shift Arm Assembly	1 - Req'd.
35	000-7300-25	#2 Woodruff Key	2 - Req'd.
36	053-0152-04	Feed Clutch Shaft Lever	1 - Req'd.
37	000-4500-22	5/16-18 Ball	2 - Req'd.

PLATE II

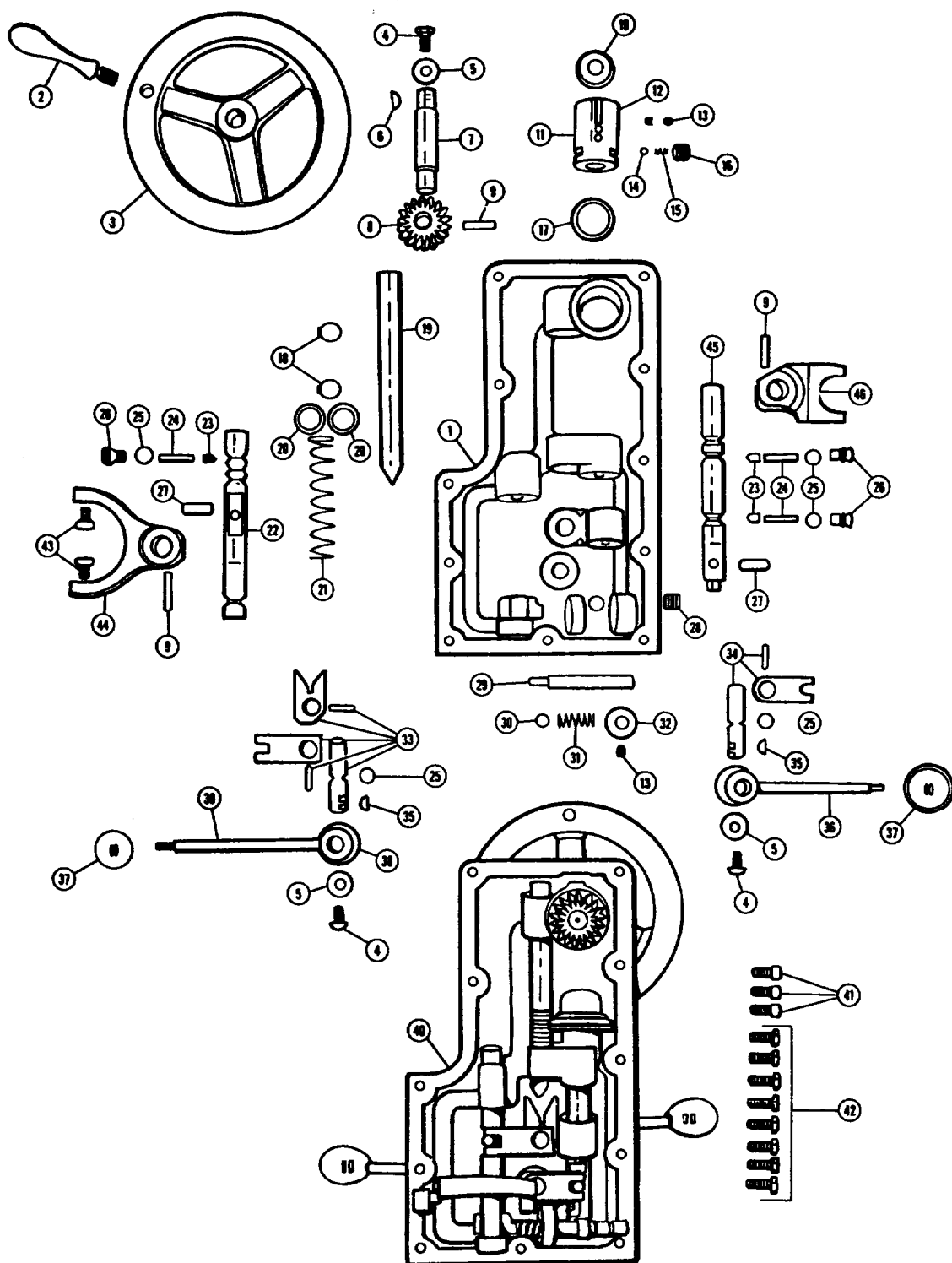


PLATE II

38	053-0149-09	Drive Clutch Shaft Collar	2 - Req'd.
39	053-0147-04	Drive Clutch Shaft Lever	1 - Req'd.
40	053-0200-11	Gear Case Cover Assembly.....	1 - Req'd.
41	000-0165-27	1/4-20 x 5/8 Socket Head Capscrew.....	3 - Req'd.
42	000-0100-30	1/4-20 x 3/4 Hex Head Capscrew	8 - Req'd.
43	025-0221-06	Clutch Shifter Finger.....	2 - Req'd.
44	053-0143-05	Clutch Yoke	1 - Req'd.
45	053-0150-00	Feed Gear Shift Rod	1 - Req'd.
46	053-0156-03	Feed Clutch Yoke.....	1 - Req'd.

PLATE III

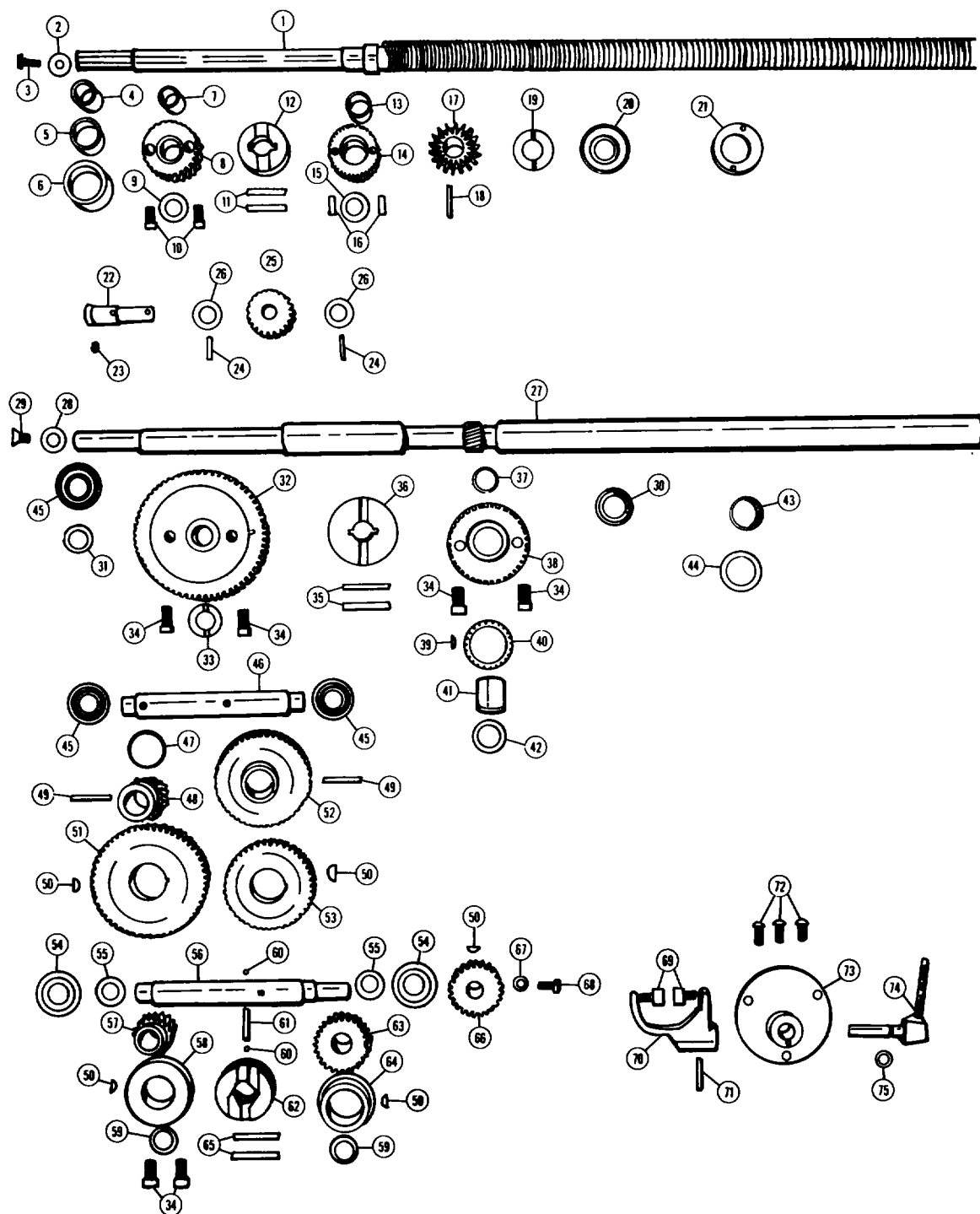


PLATE III

1	053-0241-06	Feedscrew	1 - Req'd.
2	053-0249-04	Feedscrew Washer	1 - Req'd.
3	000-0100-14	1/4-20 x 1/2 Hex Head Capscrew	1 - Req'd.
4	000-1620-94	Inner Race	1 - Req'd.
5	000-1621-08	Needle Bearing	1 - Req'd.
6	053-0245-05	Feedscrew Bushing	1 - Req'd.
7	053-0247-85	Bushing	1 - Req'd.
8	053-0247-00	Feedscrew Return Gear	1 - Req'd.
9	053-0243-00	Feedscrew Lower Thrust Washer	1 - Req'd.
10	053-0236-06	Return Gear Clutch Pin	2 - Req'd.
11	053-0239-08	Feedscrew Clutch Key	2 - Req'd.
12	053-0234-28	Feedscrew Shaft Clutch	1 - Req'd.
13	062-0246-86	Bushing	1 - Req'd.
14	053-0246-10	Feedscrew Return Gear Assembly	1 - Req'd.
15	053-0242-03	Feedscrew Upper Thrust Washer	1 - Req'd.
16	063-0235-07	Feed Gear Clutch Pin	2 - Req'd.
17	053-0251-02	Feedscrew Bevel Gear	1 - Req'd.
18	000-7200-20	#2 x 1 Taper Pin	1 - Req'd.
19	053-0244-08	Feedscrew Bearing Locknut	1 - Req'd.
20	000-1603-77	Ball Bearing	1 - Req'd.
21	053-0248-07	Locknut	1 - Req'd.
22	053-0238-43	Idler Gear Stud	1 - Req'd.
23	000-0487-63	5/16-18 x 5/16 Cup Point Socket Setscrew	1 - Req'd.
24	000-7200-11	#2 x 3/4 Taper Pin	2 - Req'd.
25	053-0237-46	Idler Gear	1 - Req'd.
26	053-0240-41	Stud Collar	2 - Req'd.
27	053-0131-55	Drive Shaft	1 - Req'd.
28	053-0132-01	Drive Shaft End Washer	1 - Req'd.
29	000-0235-07	5/16-18 x 5/16 Nyloc Flat Head Socket Capscrew	1 - Req'd.
30	000-1621-16	Needle Bearing	1 - Req'd.
31	053-0133-09	Lower Gear Spacer	1 - Req'd.
32	053-0136-94	Large Gear Assembly	1 - Req'd.
33	053-0138-05	Lower Thrust Washer	1 - Req'd.
34	053-0137-08	Clutch Pin	6 - Req'd.
35	053-0142-08	Clutch Key	2 - Req'd.
36	053-0141-00	Sliding Clutch	1 - Req'd.
37	000-9202-74	Oilless Bushing	1 - Req'd.

PLATE III

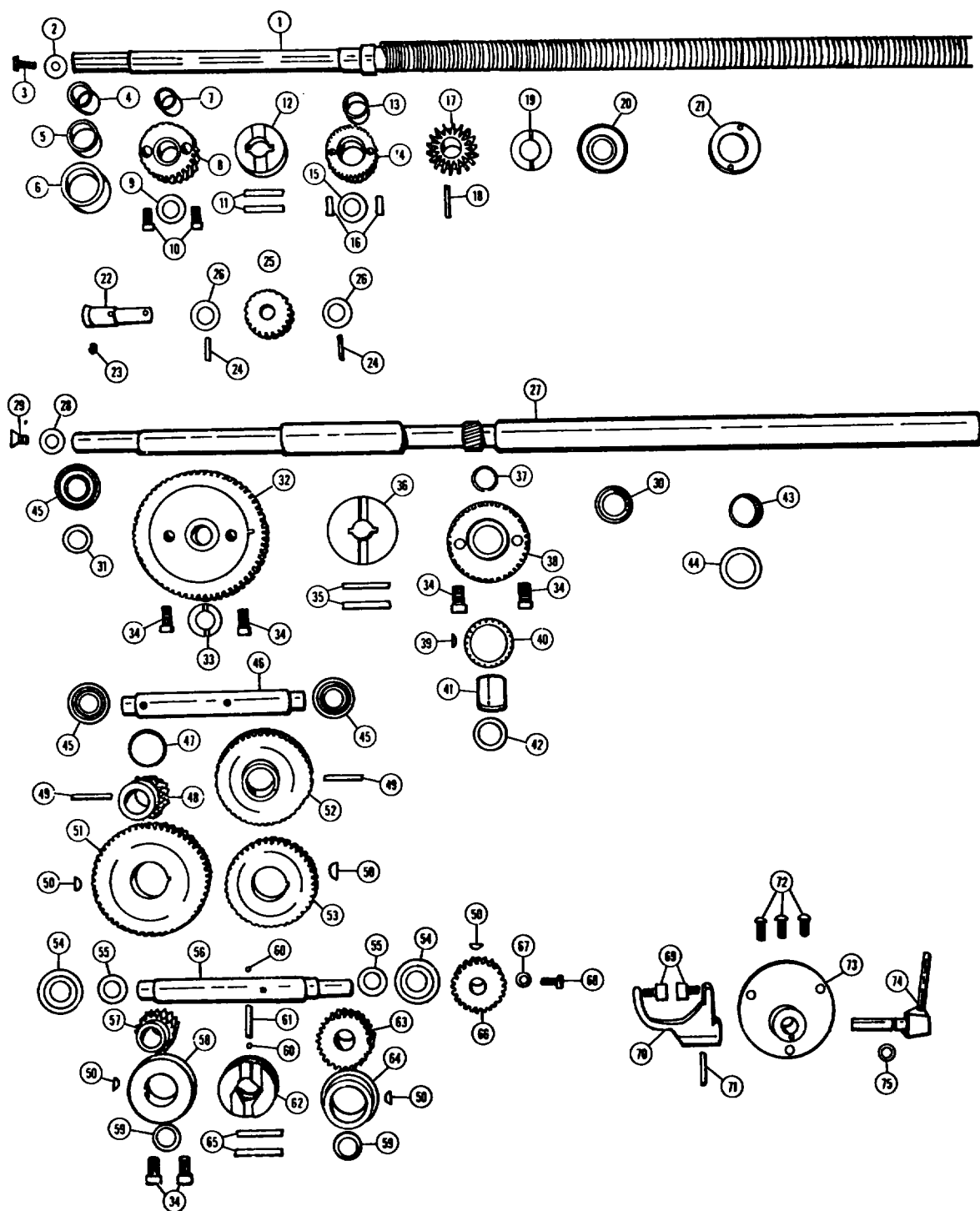


PLATE III

38	053-0135-03	Drive Shaft Small Gear.....	1 - Req'd.
39	000-7300-33	#3 Woodruff Key	1 - Req'd.
40	053-0140-03	Drive Shaft Return Gear.....	1 - Req'd.
41	000-9202-07	Oilless Bushing.....	1 - Req'd.
42	062-0139-07	Upper Thrust Washer	1 - Req'd.
43	000-1620-43	Needle Bearing.....	1 - Req'd.
44	000-2200-60	Oil Seal	1 - Req'd.
45	000-1602-10	Bearing	3 - Req'd.
46	053-0121-08	Countershaft.....	1 - Req'd.
47	000-1831-21	Spirolox Ring	1 - Req'd.
48	053-0125-07	Countershaft Driving Gear - Small	1 - Req'd.
49	000-7200-89	#3 x 1-1/4 Taper Pin.....	2 - Req'd.
50	000-7300-33	#3 Woodruff Key	5 - Req'd.
51	053-0123-02	Countershaft Driven Gear - Large.....	1 - Req'd.
52	053-0122-05	Countershaft Driven Gear - Small	1 - Req'd.
53	053-0124-00	Countershaft Driving Gear - Large	1 - Req'd.
54	000-1602-10	Bearing	2 - Req'd.
55	053-0114-03	Bearing Thrust Washer	2 - Req'd.
56	053-0109-03	Motor Driven Shaft Assembly.....	1 - Req'd.
57	053-0105-04	Motor Driven Shaft Gear - Small	1 - Req'd.
58	053-0115-00	Lower Clutch	1 - Req'd.
59	053-0111-01	Thrust Washer	2 - Req'd.
60	000-2100-48	3/16 Steel Ball	2 - Req'd.
61	000-1803-60	Compression Spring.....	1 - Req'd.
62	053-0112-25	Sliding Clutch - Small	1 - Req'd.
63	053-0104-07	Motor Driven Shaft Gear - Large.....	1 - Req'd.
64	053-0110-04	Upper Clutch	1 - Req'd.
65	053-0113-06	Clutch Key	2 - Req'd.
66	053-0107-41	Drive Shaft Driven Gear	1 - Req'd.
67	000-1145-02	1/4 Wrought Iron Washer Z. P.	1 - Req'd.
68	000-0100-14	1/4-20 x 1/2 Hex Head Capscrew	1 - Req'd.
69	053-0144-88	Clutch Finger	2 - Req'd.
70	053-0130-07	Clutch Yoke - Small.....	1 - Req'd.
71	000-7100-59	3/16 x 1 type 1 Groove Pin.....	1 - Req'd.
72	000-0212-96	1/4-20 x 5/8 Round Head Machine Screw.....	3 - Req'd.
73	053-0128-09	Clutch Plate	1 - Req'd.
74	053-0129-06	Clutch Yoke Shaft Assembly	1 - Req'd.
75	000-2300-49	O Ring	1 - Req'd.

PLATE IV

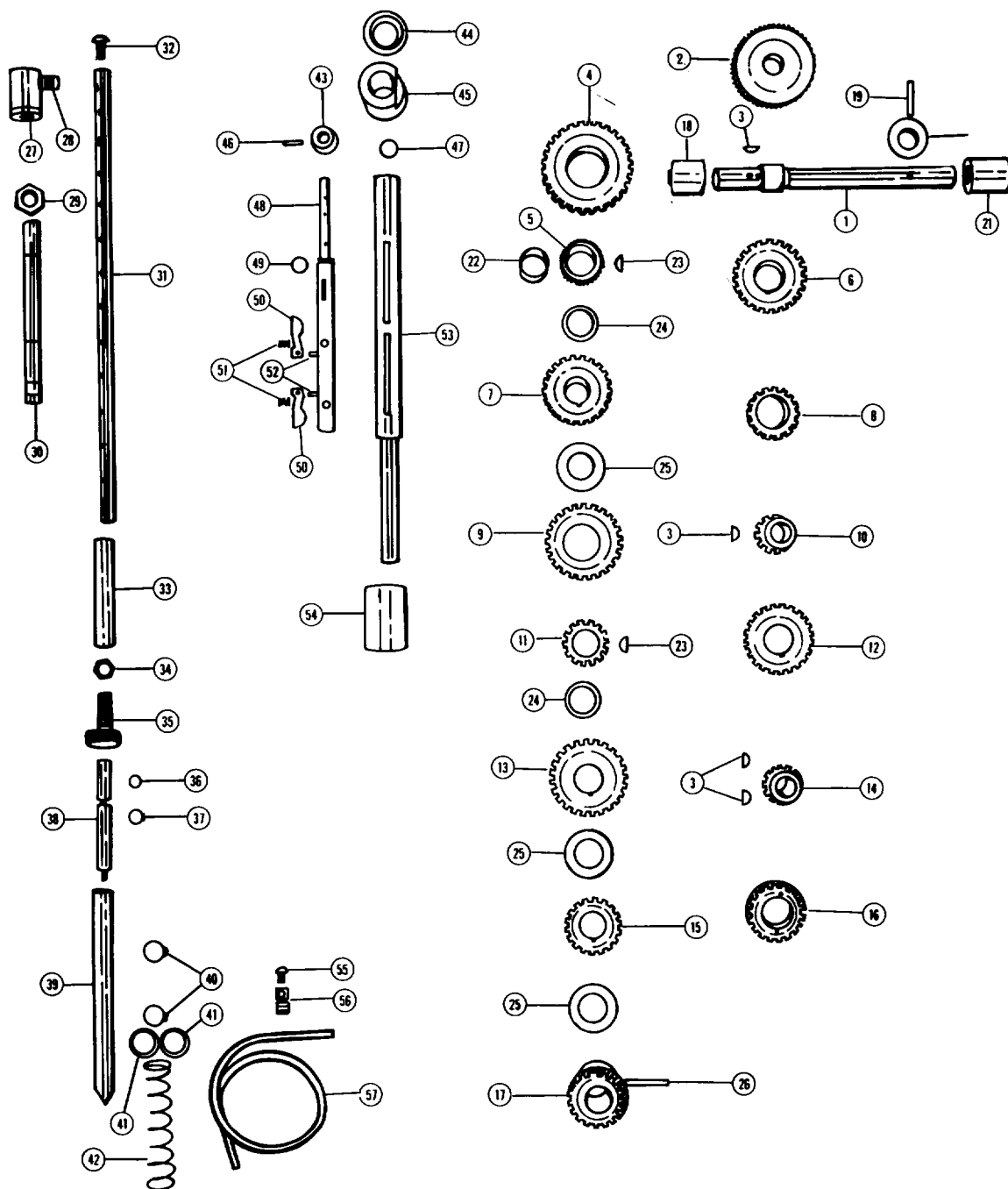


PLATE IV

1	053-0265-08	Feed Countershaft Gear	1 - Req'd.
2	053-0266-05	Feed Gear #2	1 - Req'd.
3	000-7300-33	#3 Woodruff Key	4 - Req'd.
4	053-0274-07	Feed Gear #4	1 - Req'd.
5	053-0275-04	Feed Gear #5	1 - Req'd.
6	053-0267-02	Feed Gear #6	1 - Req'd.
7	053-0277-09	Feed Gear #7	1 - Req'd.
8	053-0268-00	Feed Gear #8	1 - Req'd.
9	053-0279-03	Feed Gear #9	1 - Req'd.
10	053-0269-07	Feed Gear #10	1 - Req'd.
11	053-0281-01	Feed Gear #11	1 - Req'd.
12	053-0270-08	Feed Gear #12	1 - Req'd.
13	053-0283-06	Feed Gear #13	1 - Req'd.
14	053-0271-05	Feed Gear #14	1 - Req'd.
15	053-0285-00	Feed Gear #15	1 - Req'd.
16	053-0272-02	Feed Gear #16	1 - Req'd.
17	053-0287-05	Feed Gear #17	1 - Req'd.
18	053-0204-02	Countershaft Bearing Upper.....	1 - Req'd.
19	000-7200-20	#2 x 1 Taper Pin	1 - Req'd.
20	053-0273-00	Countershaft Collar	1 - Req'd.
21	053-0205-00	Countershaft Bearing - Lower	1 - Req'd.
22	053-0298-00	Feed Gear Bearing.....	1 - Req'd.
23	000-7300-17	#1 Woodruff Key	2 - Req'd.
24	053-0276-01	Feed Gear Spacer - Small	2 - Req'd.
25	071-0238-00	Feed Gear Spacer.....	3 - Req'd.
26	000-7200-38	#2 x 1-1/4 Taper Pin.....	1 - Req'd.
27	053-0183-00	Return Rod Holder	1 - Req'd.
28	053-0181-22	Return Pin	1 - Req'd.
29	000-1067-63	7/16-20 Hex Jam Nut Finished.....	1 - Req'd.
30	053-0182-03	Return Rod.....	1 - Req'd.
31	053-0175-68	Stop Rod	1 - Req'd.
32	000-0212-88	1/4-20 x 1/2 Round Head Machine Screw	1 - Req'd.
33	053-0176-06	Stop Rod End.....	1 - Req'd.
34	000-1045-15	3/8-16 Hex Jam Nut Finished.....	1 - Req'd.
35	053-0177-03	Stop Rod End Head	1 - Req'd.
36	000-2300-22	O Ring	1 - Req'd.
37	000-1832-53	Snap Ring.....	1 - Req'd.

PLATE IV

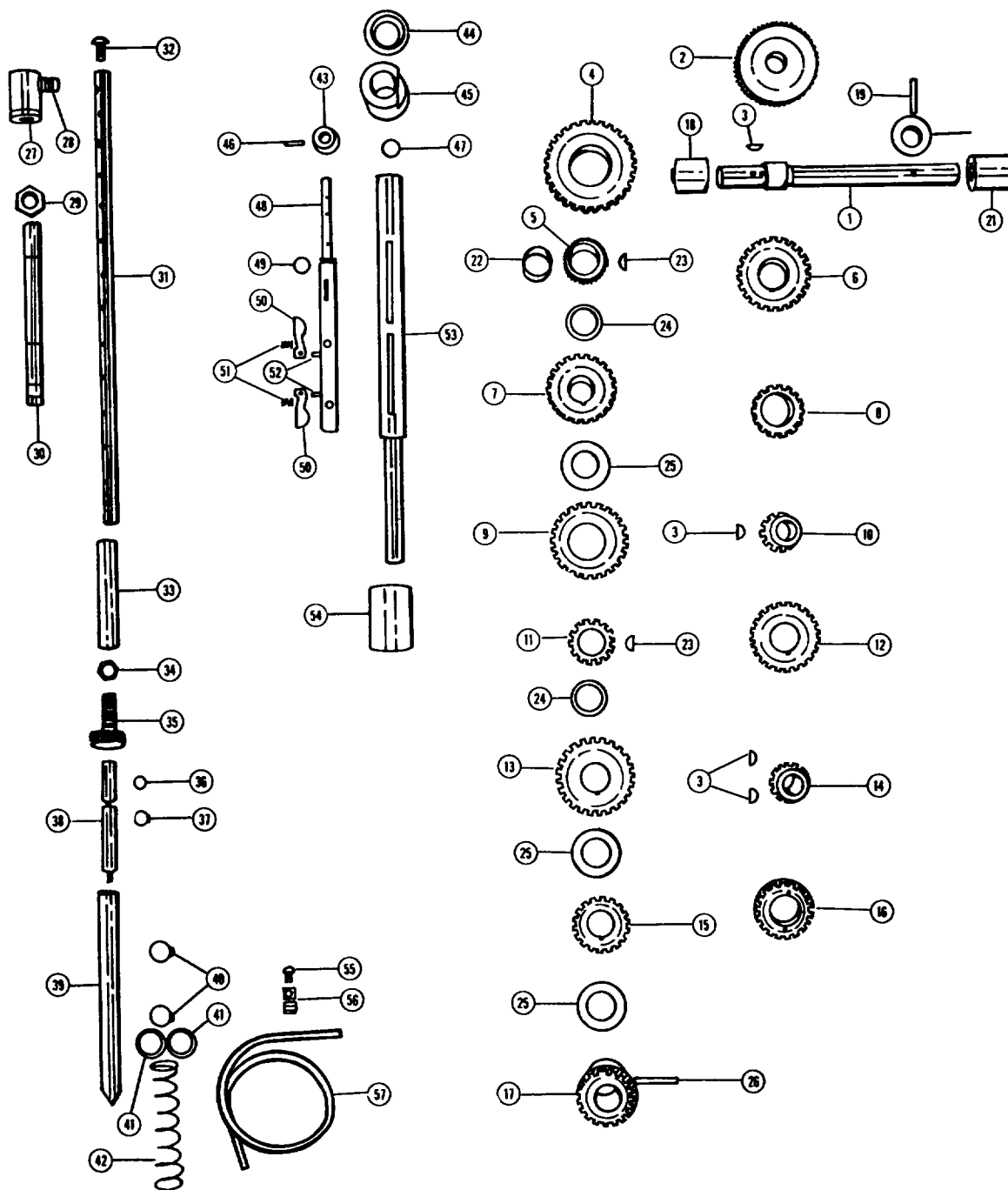


PLATE IV

38	053-0172-07	Clutch Release Plunger - Extension.....	1 - Req'd.
39	053-0170-02	Drive Clutch Release Plunger	1 - Req'd.
40	000-1832-61	Snap Ring.....	2 - Req'd.
41	000-2004-50	#15 Fiber Washer 7/8 x 5/8 x 1/32	2 - Req'd.
42	000-1803-51	Compression Spring.....	1 - Req'd.
43	053-0293-02	Sliding Shaft Knob C. P.....	1 - Req'd.
44	000-2200-51	Oil Seal.....	1 - Req'd.
45	053-0292-05	Feed Countershaft Bearing - Upper	1 - Req'd.
46	000-7204-96	1/8 x 1/2 Roll Pin	1 - Req'd.
47	000-1830-59	Spirolox Ring	1 - Req'd.
48	053-0290-43	Sliding Shaft	1 - Req'd.
49	000-2300-49	O Ring	1 - Req'd.
50	071-0237-45	Sliding Key.....	2 - Req'd.
51	000-1802-20	Compression Spring.....	2 - Req'd.
52	000-7101-13	Roll Pin	2 - Req'd.
53	053-0288-02	Feed Countershaft.....	1 - Req'd.
54	053-0291-08	Feed Countershaft Bearing - Lower	1 - Req'd.
55	000-0347-54	10-24 x 3/8 Round Head Machine Screw N. P.....	2 - Req'd.
56	000-1242-22	Hold Down Clip.....	2 - Req'd.
57	003-0002-49	Tubing Black 18" Long	1 - Req'd.

PLATE IV-A
053-0260-10 PUMP ASSEMBLY

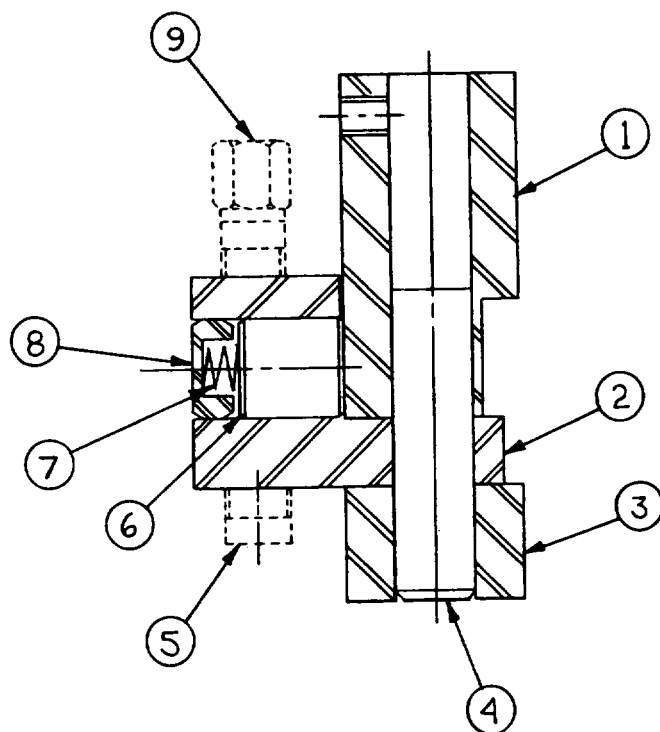


PLATE IV-A
053-0260-10 PUMP ASSEMBLY

1	053-0255-28	Cam.....	1 - Req'd.
2	053-0261-25	Pump Body.....	1 - Req'd.
3	053-0257-22	Spacer Collar.....	1 - Req'd.
4	000-7002-90	1/2 x 2 Dowel Pin	1 - Req'd.
5	057-0164-00	Check Valve	1 - Req'd.
6	053-0259-27	Plunger	1 - Req'd.
7	000-1823-62	Compression Spring (Cut To 1 Inch Long).....	1 - Req'd.
8	053-0258-20	Spring Retainer	1 - Req'd.
9	000-1561-75	63C 1/4 x 1/8 Ball Check Valve.....	1 - Req'd.

PLATE V

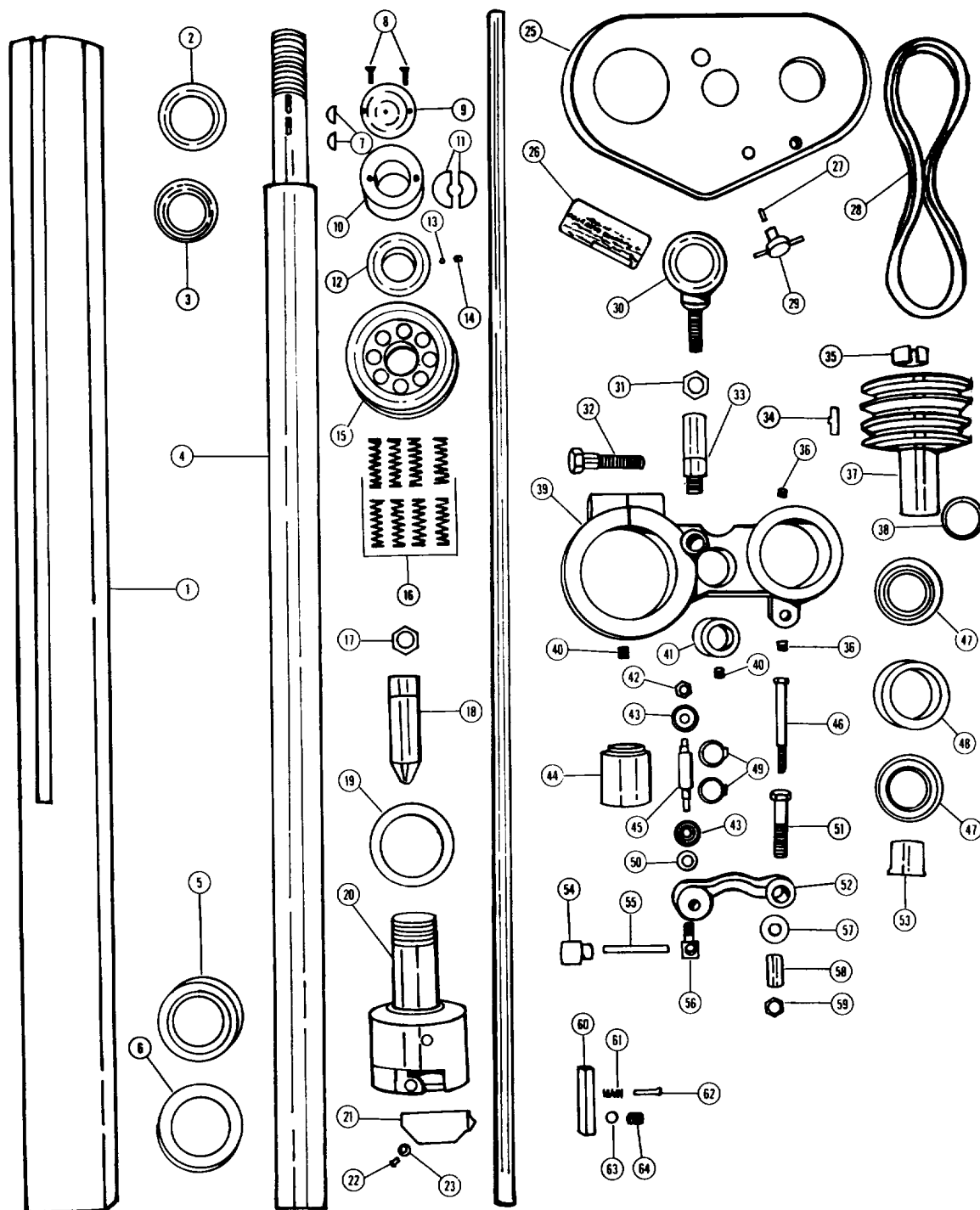


PLATE V

1	053-0301-06	Boring Sleeve	1 - Req'd.
2	053-0332-02	Upper Bearing Spacer.....	1 - Req'd.
3	000-1601-21	Bearing	1 - Req'd.
4	053-0311-02	Boring Spindle	1 - Req'd.
5	000-1604-20	Bearing	1 - Req'd.
6	053-0302-03	Lower Sleeve Insert.....	1 - Req'd.
7	000-7300-41	#5 Woodruff Key	2 - Req'd.
8	000-0220-20	6-32 x 3/8 Flat Head Machine Screw	2 - Req'd.
9	053-0357-28	Centering Rod Extension	1 - Req'd.
10	053-0356-04	Centering Handwheel.....	1 - Req'd.
11	053-0358-09	Centering Rod Collar.....	1 - Req'd.
12	053-0333-00	Spindle Pulley Nut.....	1 - Req'd.
13	000-6400-26	Lockscrew Plug	1 - Req'd.
14	000-0485-18	1/4-20 x 1/4 Socket Cup Point Setscrew	1 - Req'd.
15	053-0331-05	Spindle Pulley.....	1 - Req'd.
16	000-1801-73	Compression Spring.....	8 - Req'd.
17	053-0359-06	Centering Cone Nut.....	1 - Req'd.
18	053-0354-00	Centering Cone	1 - Req'd.
19	000-1702-16	2-11/16 x 2 x 3/16 SAE F-7 Felt	1 - Req'd.
20	053-0313-15	Boring Head Assembly.....	1 - Req'd.
21	055-0316-22	Hole Cover Assembly.....	1 - Req'd.
22	000-0202-65	6-32 x 1/4 Round Head Machine Screw Z. P.....	1 - Req'd.
23	000-1170-99	Curved Spring Washer	1 - Req'd.
24	053-0355-07	Centering Rod	1 - Req'd.
25	053-0337-41	Belt Guard	1 - Req'd.
26	000-6602-13	Nameplate	1 - Req'd.
27	081-0106-17	Brass Plug	1 - Req'd.
28	001-1902-37	V Belt (Matched set of 3).....	3 - Req'd.
29	062-0174-49	Lockscrew Pin	1 - Req'd.
30	000-0700-25	#3050 Eye Bolt (1/2-13) Z. P.....	1 - Req'd.
31	000-1047-60	1/2-13 Hex Finished Jam Nut.....	1 - Req'd.
32	000-0110-37	1/2-13 x 2 Hex Head Capscrew	1 - Req'd.
33	053-0335-04	Belt Guard Spacer.....	1 - Req'd.
34	062-0342-46	Pulley Drive Key	1 - Req'd.
35	053-0341-87	Pulley Bushing (14-FN-16).....	1 - Req'd.
36	000-0487-63	5/16-18 x 5/16 Cup Point Socket Setscrew	2 - Req'd.
37	053-0341-44	Drive Shaft Pulley.....	1 - Req'd.

PLATE V

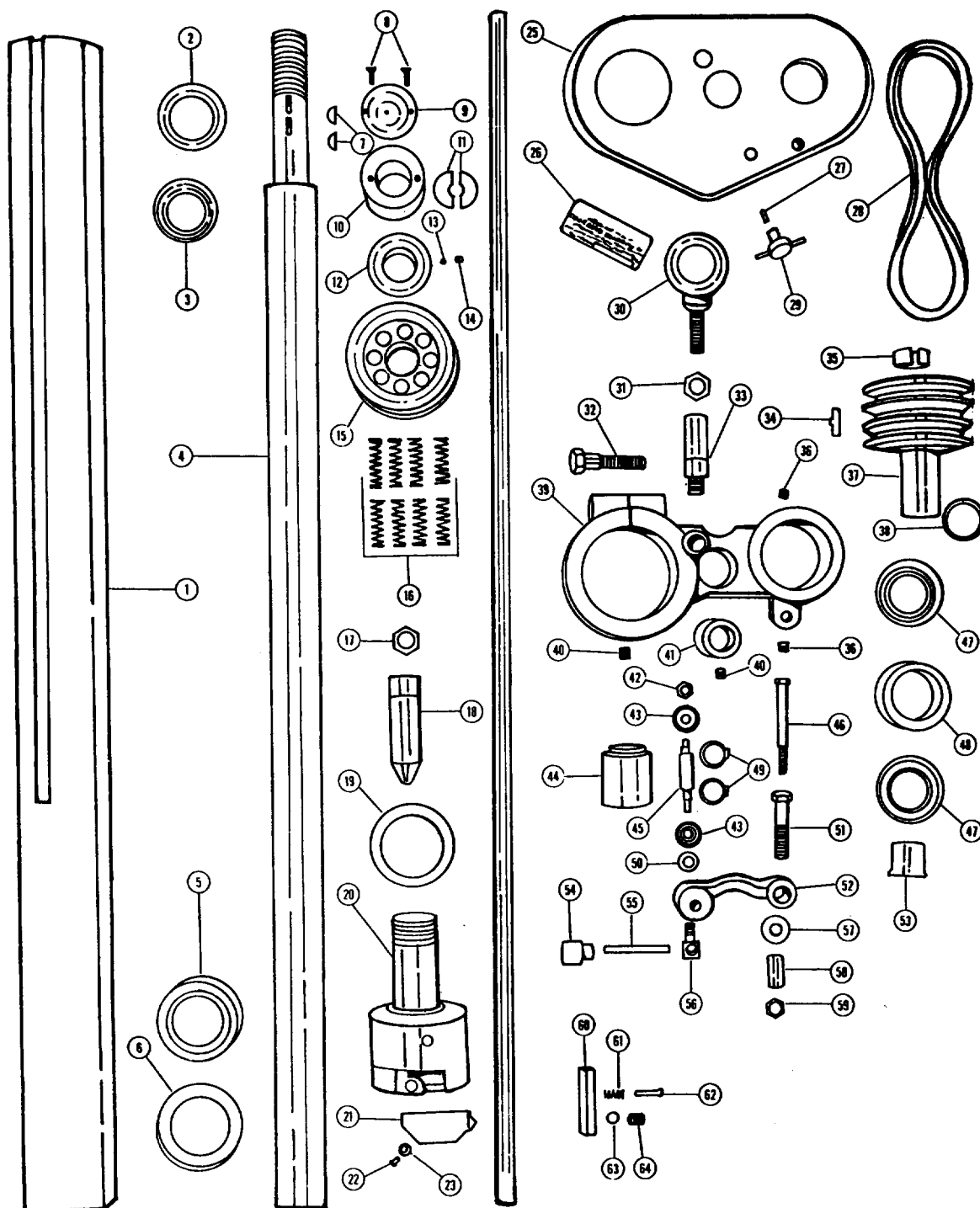


PLATE V

38	000-1831-30	Spirolox Ring	1 - Req'd.
39	053-0336-44	Pulley Bracket	1 - Req'd.
40	000-0490-34	3/8-16 x 3/8 Cup Point Socket Setscrew.....	2 - Req'd.
41	053-0346-40	Feed Nut.....	1 - Req'd.
42	000-1042-64	5/16-18 Hex Finish Jam Nut.....	1 - Req'd.
43	000-1605-55	Ball Bearing	2 - Req'd.
44	053-0373-21	Idler Pulley.....	1 - Req'd.
45	053-0374-02	Idler Pulley Shaft	1 - Req'd.
46	000-0113-80	1/4-20 x 3 Hex Head Capscrew Z. P.....	1 - Req'd.
47	000-1601-21	Bearing	2 - Req'd.
48	053-0343-06	Bearing Spacer.....	1 - Req'd.
49	000-1832-45	Ring.....	2 - Req'd.
50	062-0375-63	Pulley Pivot Washer	1 - Req'd.
51	022-0356-06	Capscrew	1 - Req'd.
52	053-0371-43	Idler Arm.....	1 - Req'd.
53	000-1690-30	Nylon Flanged Bushing 14-FN-16.....	1 - Req'd.
54	053-0380-00	Idler Arm Locknut	1 - Req'd.
55	053-0378-10	Locknut Stud	1 - Req'd.
56	053-0379-09	Idler Arm Stud	1 - Req'd.
57	000-1150-37	5/16 Wrought Iron Washer	1 - Req'd.
58	053-0372-08	Idler Arm.....	1 - Req'd.
59	000-1045-15	3/8-16 Hex Finish Jam Nut.....	1 - Req'd.
60	062-0324-48	Tool Holder Gib	1 - Req'd.
61	000-1802-38	Compression Spring.....	1 - Req'd.
62	000-0245-38	10-24 x 3/4 Fill. Head Machine Screw.....	1 - Req'd.
63	055-0328-40	Tool Lockscrew Plug	1 - Req'd.
64	000-0505-20	3/8-16 x 1/2 Flat Point Socket Setscrew	1 - Req'd.

PLATE VI

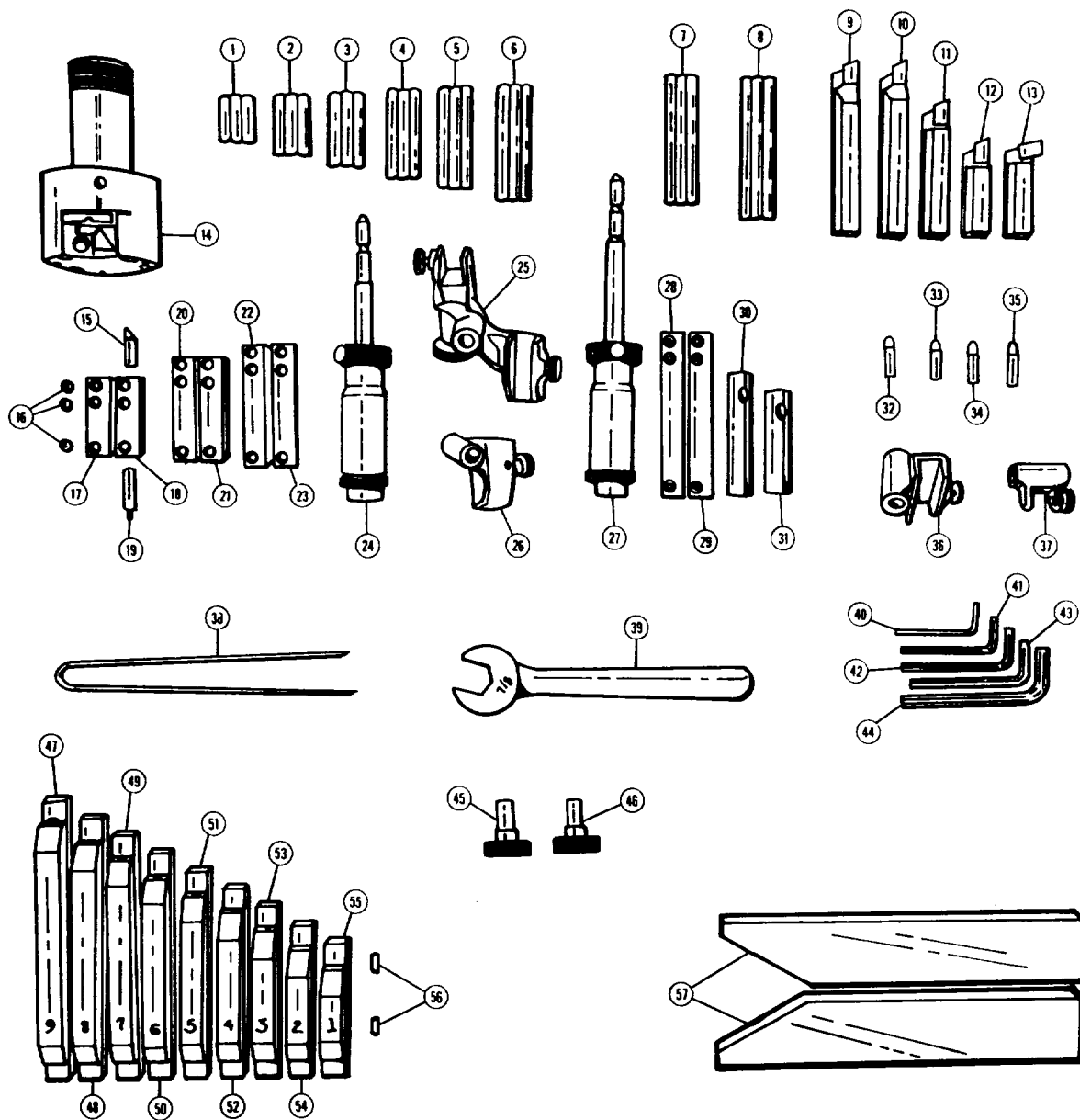


PLATE VI

1	053-0361-55	Centering Finger #1 (Set of 3).....	1 - Req'd.
2	053-0362-52	Centering Finger #2 (Set of 3).....	1 - Req'd.
3	053-0363-50	Centering Finger #3 (Set of 3).....	1 - Req'd.
4	053-0364-57	Centering Finger #4 (Set of 3).....	1 - Req'd.
5	053-0365-54	Centering Finger #5 (Set of 3).....	1 - Req'd.
6	053-0366-51	Centering Finger #6 (Set of 3).....	1 - Extra
7	053-0367-59	Centering Finger #7 (Set of 3).....	1 - Extra
8	053-0368-56	Centering Finger #8 (Set of 3).....	1 - Extra
9	053-1141-13	Heavy Duty Boring Tool - 4-3/4 Roughing.....	1 - Extra
10	053-1145-12	Heavy Duty Counter Boring Tool - 4-11/16.....	1 - Extra
11	062-1131-11	Heavy Duty Boring Tool - 3-5/8 Roughing.....	1 - Extra
12	062-1121-15	Heavy Duty Boring Tool - 2-9/16 Roughing.....	1 - Extra
13	053-1155-00	Special Offset Tool.....	1 - Extra
14	053-0313-15	Boring Head Assembly.....	1 - Req'd.
15	062-1071-03	Boring Tool - Roughing.....	2 - Req'd.
15	062-1072-00	Boring Tool - Finishing.....	2 - Req'd.
16	000-0590-21	F-318 V Tool Bit Screw.....	3 - Req'd.
17	062-1021-28	Tool Holder Assembly - 2-5/32 Roughing.....	1 - Req'd.
18	062-1021-36	Tool Holder Assembly - 2-5/32 Finishing.....	1 - Req'd.
19	062-0317-19	Plunger Holder Assembly.....	1 - Req'd.
20	062-1025-27	Tool Holder Assembly - 2-7/8 Roughing.....	1 - Req'd.
21	062-1025-35	Tool Holder Assembly - 2-7/8 Finishing.....	1 - Req'd.
22	062-1041-20	Tool Holder Assembly - 3-3/8 Roughing.....	1 - Req'd.
23	062-1042-28	Tool Holder Assembly - 3-3/8 Finishing.....	1 - Req'd.
24	053-0621-16	Standard Micrometer Assembly.....	1 - Req'd.
25	062-0540-18	Lapping Fixture Assembly.....	1 - Req'd.
26	062-0555-10	Lapping Fixture Assembly - Roughing.....	1 - Req'd.
27	053-0620-24	Micrometer Assembly 3-1/2 to 7-1/2.....	1 - Extra
28	053-1038-12	Tool Holder Assembly - 4-1/2 Roughing.....	1 - Extra
29	053-1039-10	Tool Holder Assembly - 4-1/2 Finishing.....	1 - Extra
30	062-1031-16	Offset Tool Holder Assembly 2-7/8.....	1 - Extra
31	062-1030-27	Offset Tool Holder Assembly 2-5/32.....	1 - Extra
32	062-1076-00	Chamfering Tool 600°.....	1 - Extra
33	062-1251-60	Offset Boring Tool - K11 - Single Pass.....	1 - Extra
34	062-1074-05	Counter Boring Tool.....	1 - Extra
35	062-1150-09	Boring Tool Bit For Track Rollers.....	1 - Extra
36	062-0551-11	Offset Lapping Tool Holder Assembly.....	1 - Extra

PLATE VI

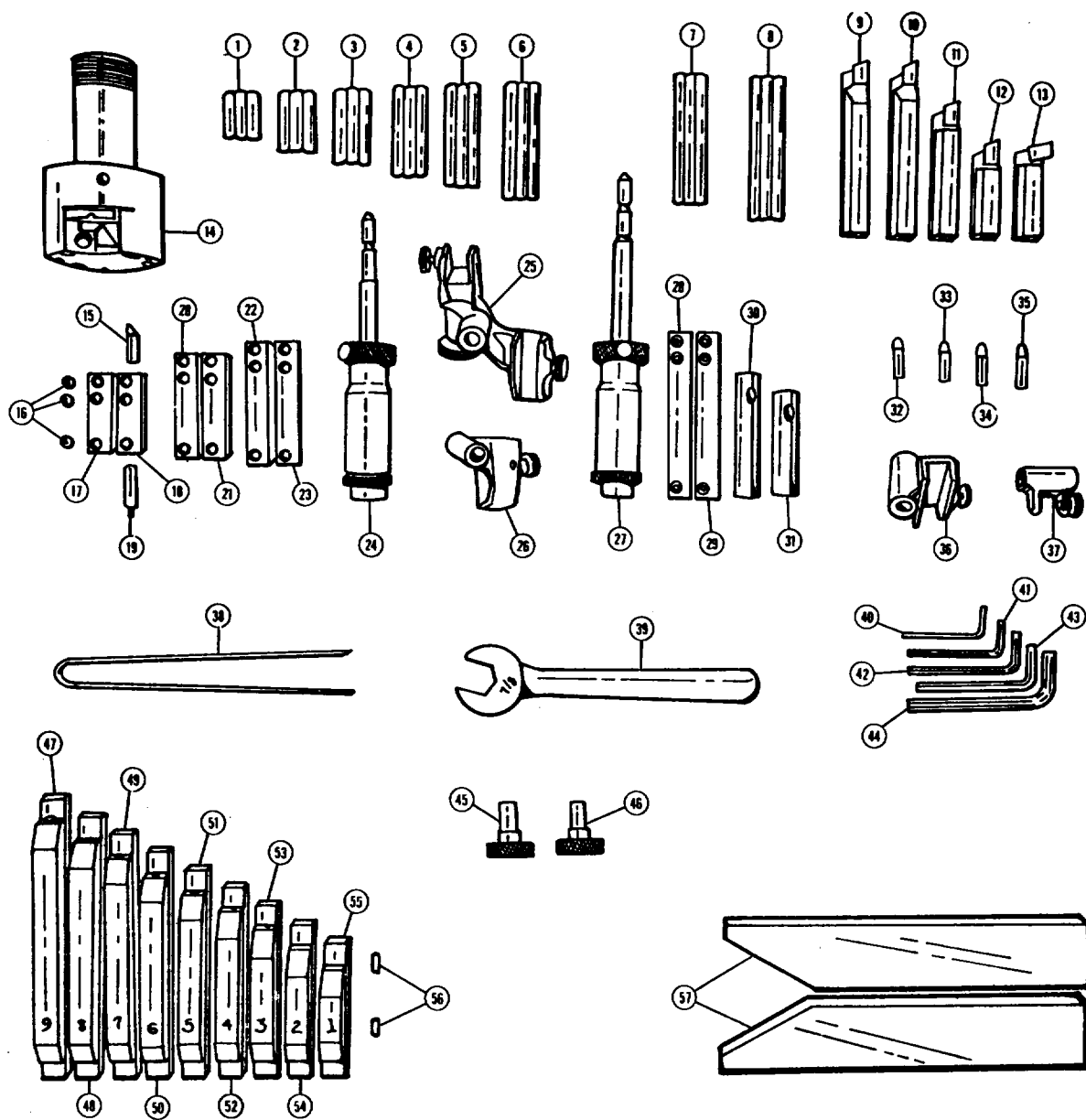


PLATE VI

37	062-0581-53	Lapping Fixture Assembly with Counterboring Tool.....	1 - Extra
38	053-0459-28	Anchor Gauge	1 - Req'd.
39	000-8800-19	#5 Engineers Wrench.....	1 - Req'd.
40	000-0600-54	1/8 Across Flats Hex Wrench	1 - Req'd.
41	000-0600-62	5/32 Across Flats Hex Wrench	1 - Req'd.
42	000-0600-70	3/16 Across Flats Hex Wrench	1 - Req'd.
43	000-0600-11	7/32 Across Flats Hex Wrench	1 - Req'd.
44	000-0600-20	5/16 Across Flats Socket Capscrew Wrench	1 - Req'd.
45	062-0452-64	1/2-13 Anchor Bolt.....	1 - Req'd.
46	062-0452-48	7/16-14 Anchor Bolt.....	1 - Req'd.
47	053-0469-08	Anchor Clamp #9.....	1 - Extra
48	053-0468-27	Anchor Clamp Assembly #8.....	1 - Extra
49	053-0467-20	Anchor Clamp Assembly #7.....	1 - Extra
50	053-0466-22	Anchor Clamp Assembly #6.....	1 - Req'd.
51	053-0465-25	Anchor Clamp Assembly #5.....	1 - Req'd.
52	055-0464-25	Anchor Clamp Assembly #4.....	1 - Req'd.
53	055-0463-28	Anchor Clamp Assembly #3.....	1 - Req'd.
54	055-0462-20	Anchor Clamp Assembly #2.....	1 - Req'd.
55	062-0461-04	Anchor Clamp #1.....	1 - Extra
56	000-0407-89	5/16-18 x 1/2 Headless Cup Point Setscrew.....	2 - Req'd.
57	053-0190-05	Spacer Plates	1 - Extra

NOTE: Items 17 - 18 - 20 - 21 - 22 - 23 - 28 - 29 - 30 - 31 Are Without Tools And Plunger Holder Assemblies.

PLATE VII

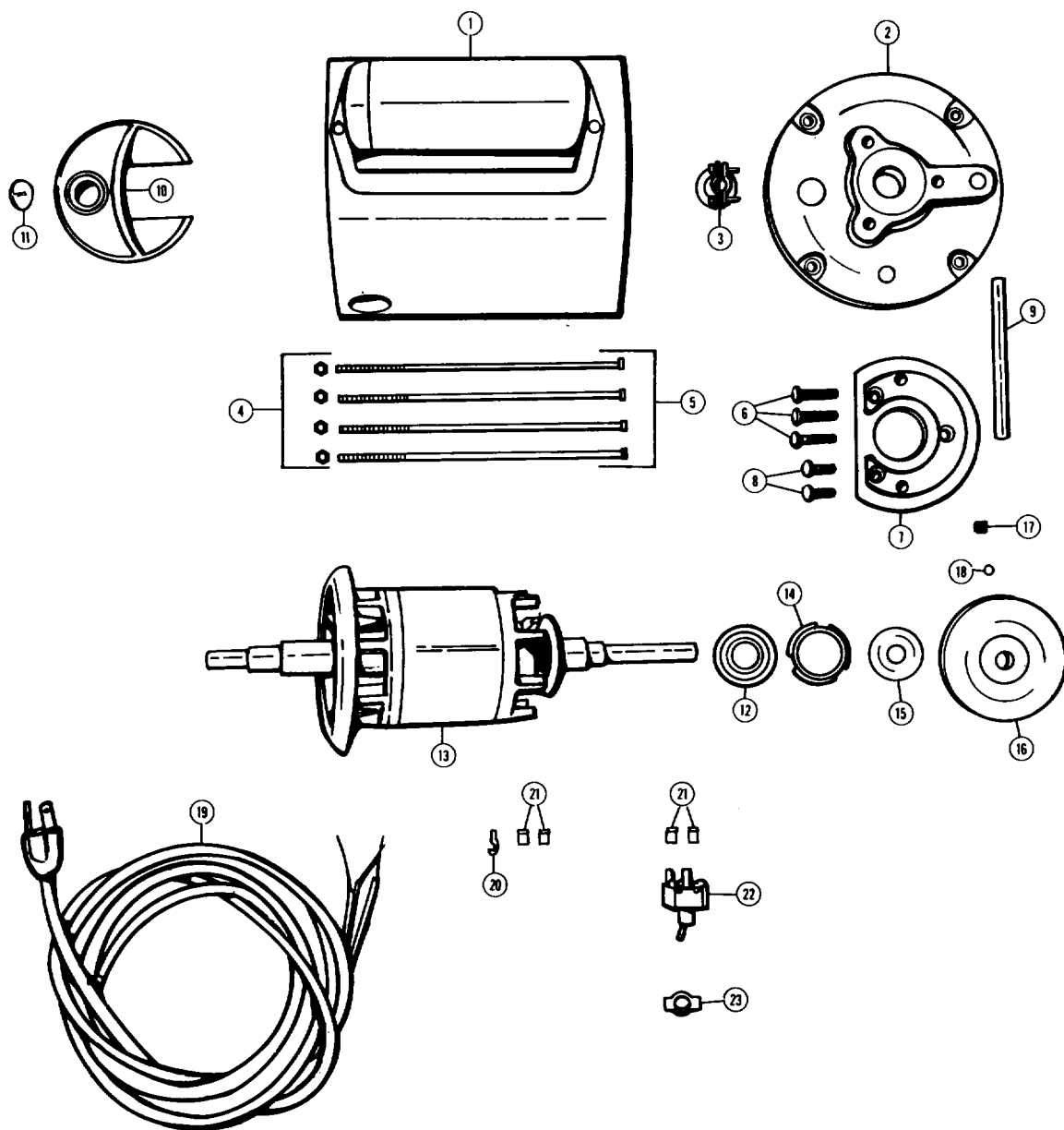


PLATE VII

1	001-1957-19	Stator 115/230 Volt - 60 Hertz - 1 Phase	1 - Req'd.
		or	
1	001-1956-11	Stator 115/230 Volt - 50 Hertz - 1 Phase	1 - Req'd.
2	062-0605-30	Upper Motor Endshield.....	1 - Req'd.
3	000-1243-03	Cable Clamp.....	1 - Req'd.
4	000-1097-62	10-32 Hex Machine Screw Nut.....	4 - Req'd.
5	000-1440-37	7-11/16 Thru Bolt 115/230 Volt - 60 Hertz - 1 Phase	4 - Req'd.
		or	
5	000-1439-52	9-1/16 Thru Bolt 115/230 Volt - 50 Hertz - 1 Phase	4 - Req'd.
6	000-0250-38	1/4-20 x 1 Fill.Head Machine Screw.....	3 - Req'd.
7	062-0605-81	Lapping Disc Guard Spacer	1 - Req'd.
8	000-0100-22	1/4-20 x 5/8 Hex Head Capscrew	2 - Req'd.
9	061-0115-01	Lapping Fixture Stud	1 - Req'd.
10	062-0612-00	Lapping Disc Guard.....	1 - Req'd.
11	000-1732-66	5/8 Round x 5/8 Long Felt Wicking	1 - Req'd.
12	000-1604-58	Bearing	1 - Req'd.
13	001-1954-25	Rotor/Shaft/Throw Out Switch 115/230V - 60Hz - 1PH.....	1 - Req'd.
		or	
13	001-1956-20	Rotor/Throw Out Switch 115/230V - 50Hz - 1PH	1 - Req'd.
	053-0603-40	Motor Shaft 115/230V - 50Hz - 1PH.....	1 - Req'd.
14	000-1820-44	S-17 Loading Spring.....	1 - Req'd.
15	000-1701-00	Felt Washer 1-1/2 x 1/2 x 1/4	1 - Req'd.
16	062-0611-11	Lapping Disc Assembly	1 - Req'd.
17	000-0407-70	5/16-18 x 5/16 Cup Point Headless Setscrew.....	1 - Req'd.
18	000-6400-18	Lockscrew Plug	1 - Req'd.
19	000-1260-71	14-3 SJO Cord Set/3 Prong Plug 8'6" 115V-50/60Hz-1PH.....	1 - Req'd.
		or	
19	000-1261-28	16-3 SJO Cord Set/3 Prong Plug 8'16" 230V-50/60Hz-1PH.....	1 - Req'd.
20	000-1242-57	Insulated Hook Terminal	1 - Req'd.
21	000-1242-49	Female Flag Terminal	4 - Req'd.
22	000-1202-19	C-H Switch	1 - Req'd.
23	000-1204-30	On-Off Switch Plate.....	1 - Req'd.

PLATE VII-A
LOWER HALF OF MOTOR ASSEMBLY

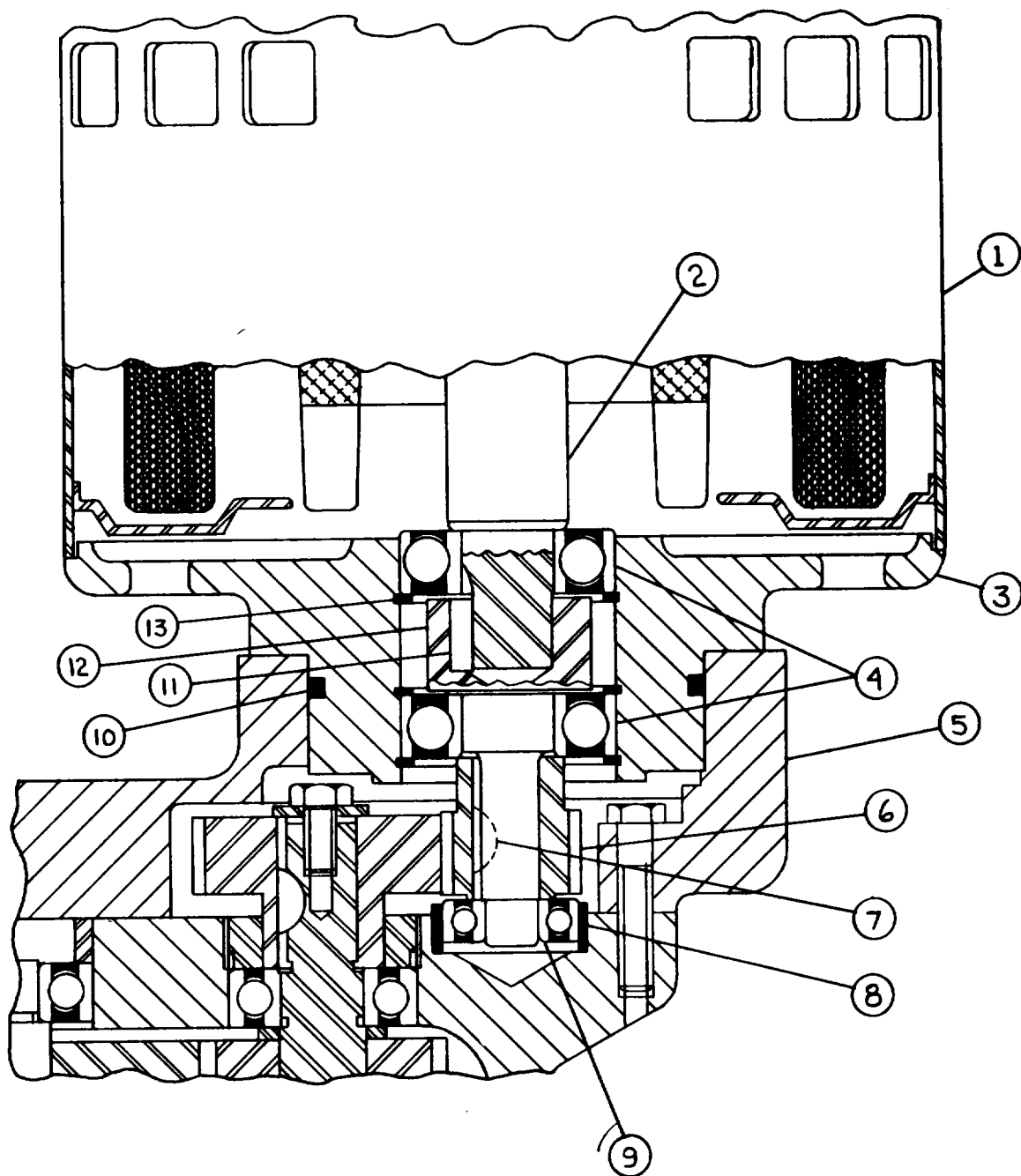


PLATE VII-A
LOWER HALF OF MOTOR ASSEMBLY

1	001-1957-19	Stator 115/230 Volt - 60 Hertz - 1 Phase	1 - Req'd.
		or	
1	001-1956-11	Stator 115/230 Volt - 50 Hertz - 1 Phase	1 - Req'd.
2	001-1954-25	Rotor/Shaft/Throw Out Switch 115/230V - 60Hz - 1Ph	1 - Req'd.
		or	
2	001-1956-20	Rotor/Throw Out Switch 115/230V - 50Hz - 1Ph.....	1 - Req'd.
	053-0603-40	Motor Shaft 115/230V - 50Hz - 1Ph	1 - Req'd.
3	053-0601-29	Lower Motor Endshield.....	1 - Req'd.
4	000-1604-58	Bearing	2 - Req'd.
5	053-0103-42	Motor Base	1 - Req'd.
6	053-0106-28	Motor Shaft Driven Gear	1 - Req'd.
7	000-7300-33	#3 Woodruff Key	1 - Req'd.
8	000-1400-40	Tolerance Ring	1 - Req'd.
9	000-1605-04	Bearing	1 - Req'd.
10	000-2301-46	#8231 O Ring	1 - Req'd.
11	053-0604-04	Key	1 - Req'd.
12	053-0606-09	Driving Shaft.....	1 - Req'd.
13	000-1830-83	RR-156 Spirolox Ring.....	3 - Req'd.

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General, United States Army
Chief of Staff

Official:

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