OPERATOR'S
INSTRUCTION
BOOK

Cincinnati

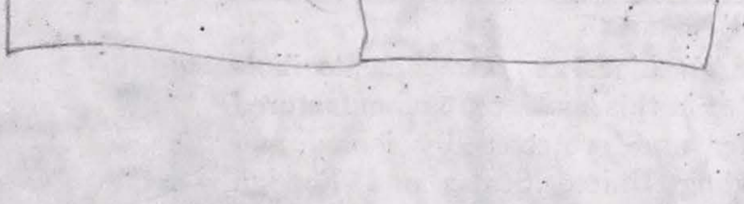
Nos. 2-18 and 2-24
AUTOMATIC RISE AND FALL
MILLING MACHINES

Place this Booklet in the
Hands of the Machine
Operator or Set-Up Man

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO, U.S.A.

THIS booklet was written for the purpose of instructing the operator of a Cincinnati No. 2-18 or 2-24 Automatic Rise and Fall Milling Machine, in the proper care and operation of his machine. Operating instructions are briefly listed, and adjustments explained to aid in maintaining accuracy.

The proper application of the few simple instructions outlined in this booklet should greatly aid the continued usefulness and long life of this machine. At the time of writing, this booklet was completely up to date. However, due to continual improvements in design, it is possible that descriptions contained herein may vary to a slight extent from the machine delivered to you. This would imply nothing more than the fact that the machine has been improved to better fulfill your requirements.



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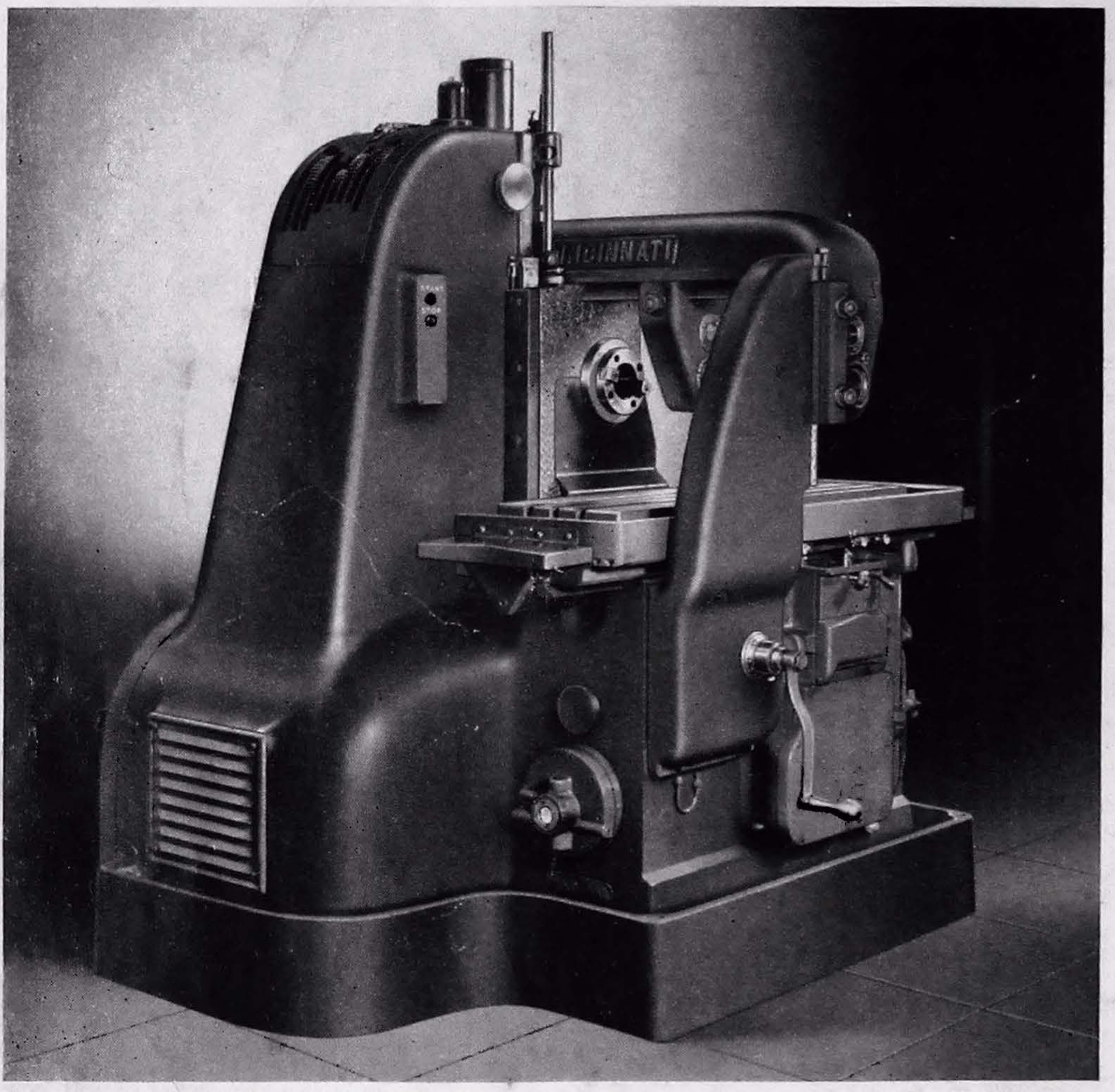


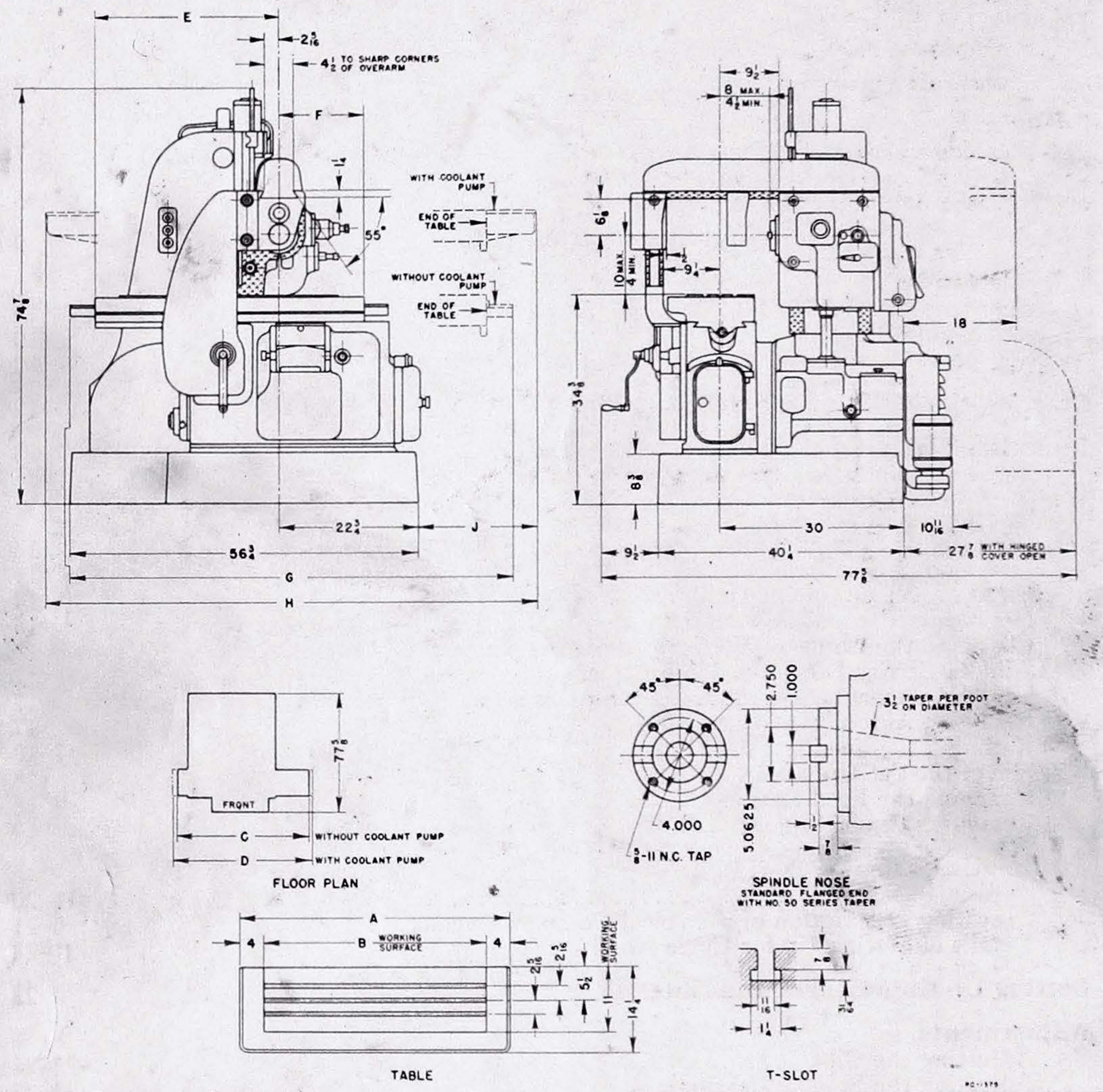
The Cincinnati No. 2-24 Automatic Rise and Fall Milling Machine

PATENT NOTICE

The machines and attachments illustrated in this booklet are manufactured under and protected by issued and pending United States and Foreign Patents.

The design and specifications of these machines are subject to change without notice.

CONTENTS



PC-1379

SIZE OF MACHINE	A	B	C	D	E		F		G	H	J
					MIN.	MAX.	MIN.	MAX.			
2-18	44	36	73	80	10	30	14	34	73	80	$19\frac{1}{4}$
2-24	50	42	85	92	10	36	14	40	85	92	$25\frac{1}{4}$

Figure 1
Dimensional Drawing

MACHINE SPECIFICATIONS (Model ER)

	No. 2-18	No. 2-24
Table		
Working surface	11"x36"	11"x42"
Size overall	14¼"x44"	14¼"x50"
T-slots (number and size)	Three $\frac{11}{16}$" wide	Three $\frac{11}{16}$" wide
Distance between T-slots	$2\frac{5}{16}$"	$2\frac{5}{16}$"
Range		
Longitudinal table movement (power)	18"	24"
Vertical movement of spindle carrier (power)	6"	6"
Centerline of spindle to top of table		
Maximum	10"	10"
Minimum	4"	4"
Centerline of table to face of spindle carrier	9½"	9½"
Face of spindle carrier to inside of outer arbor support	18⅝"	18⅝"
Quill		
Adjustment (dial graduated in thousandths of an inch)	3½"	3½"
Diameter	6½"	6½"
End of spindle nose to center line of table		
Maximum	8"	8"
Minimum	4½"	4½"
End of spindle nose to face of carrier		
Maximum	5"	5"
Minimum	1½"	1½"
Overarm—Rectangular, with dovetail.		
Width at dovetail	7½"	7½"
Distance from underside to centerline of arbor	6⅛"	6⅛"
Spindle—National Std. end with No. 50 series taper hole.		
Diameter of nose	$5\frac{1}{16}$"	$5\frac{1}{16}$"
Size of hole through	1⅛"	1⅛"
Speeds—number (selected with pick-off gears and back gear lever)	20	20
Speeds—range—r. p. m.	30 to 1200	30 to 1200
Feeds		
Table feeds—number (selected with pick-off gears)	16	16
Table feeds (inches per minute)		
Standard Series	1 to 40	1 to 40
Low Series	½ to 20	½ to 20
High Series	2 to 80	2 to 80
Spindle carrier feeds—number	Infinitely Variable	Infinitely Variable
Spindle carrier feeds—range in inches per minute (down only)	1 to 10	1 to 10
Power Rapid Traverse (inches per minute)		
Table, with standard or high series feed ranges	250	250
Table, with low series feed range	125	125
Spindle carrier (independent of table traverse) up and down	100	100
Drive		
Constant speed A. C. or D. C. motor, N. E. M. A. dimensions	5 H.P.	5 H.P.
Floor Space	See Fig. 1	See Fig. 1

INSTALLATION INSTRUCTIONS

Foundation. Special foundations are not necessary for this machine. Any substantial floor, wood or concrete, fairly flat, sufficiently strong to withstand the weight of the machine, and free from vibration, will be satisfactory. If the machine is to be placed on an upper floor, locate it directly over a supporting beam or girder to cut down, as far as possible, any vibrations being transmitted to it from nearby machines.

Lifting the Machine. These machines may easily be lifted with a crane. Use a three point chain hookup, as shown in Fig. 2. Be sure that the ropes or chains used are strong enough to safely support the weight of the machine (see blueprint of data sheet, packed with the machine, for the correct weight).

Remove the louver cover from the left-hand end of the bed, swing open the hinged motor compartment cover, and insert a hook in each of these openings in the bed. Place a leather protected sling around the right-hand end of the table, which should be centrally located on the bed, and pass the third hook through the sling. This third cable acts as the balancing member and should be adjusted until the machine is perfectly balanced when lifted.

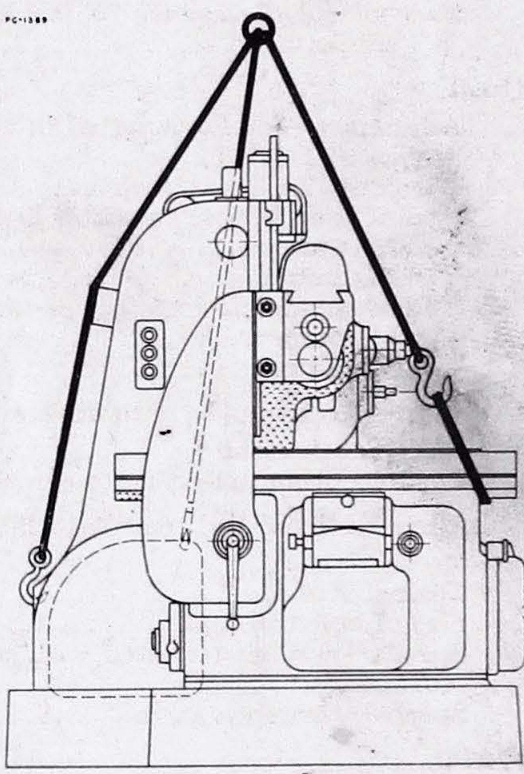


Figure 2
Method of Lifting

Always use the recommended lifting points to avoid serious damage to the machine, and protect the surface finish by placing wood blocks under the chains at any points where they may contact a painted surface.

Bolting the Machine to a Concrete Floor. When bolting the machine to a concrete floor, please note that the center distances between bolt holes, as shown on the "floor plan", are approximated. Proceed as follows:

1. Drill the bolt holes about 6″ in diameter in the concrete floor.
2. Insert each hold-down bolt through a $1\frac{1}{2}$″ pipe, as illustrated in Fig. 3, and fill the pipe with dry sand.

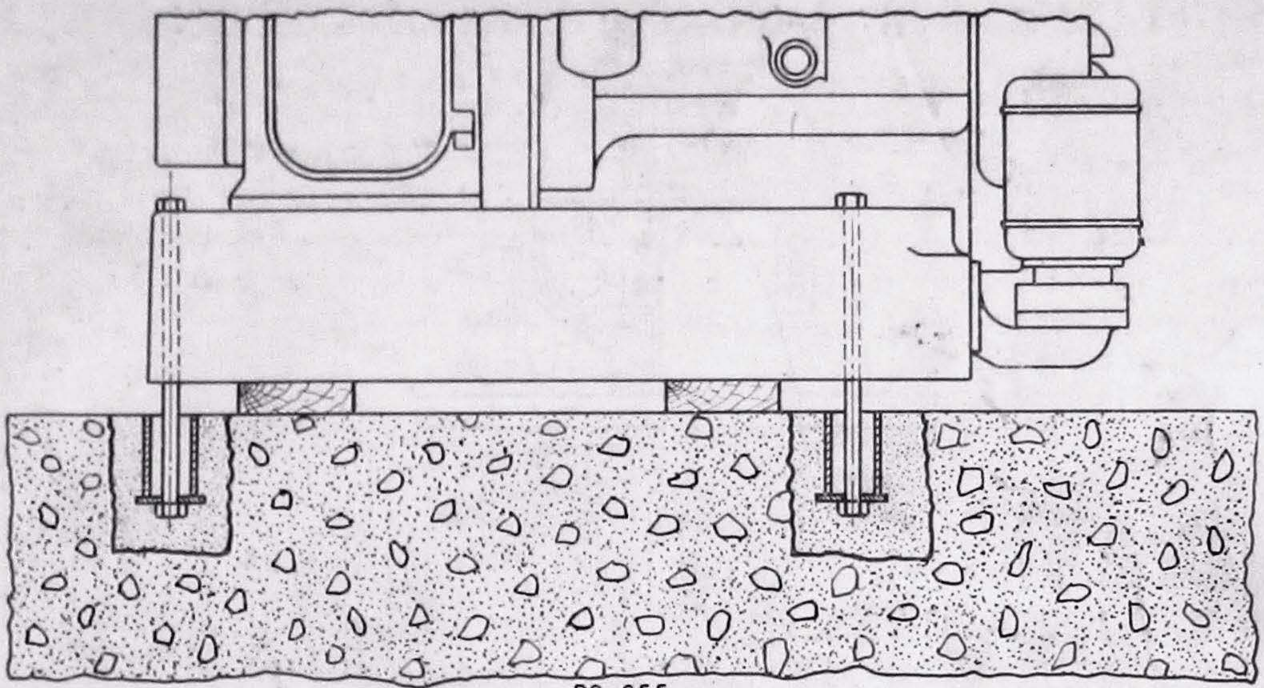


Figure 3

Method of Bolting to Concrete Floor

3. Lower the machine into place on two 1″ thick boards, and engage the nuts on two or three threads of the bolts.

4. Fill the holes around the pipes with quick drying cement, thin enough to flow easily.

5. When cement is dry, remove boards, level machine, and tighten hold-down nuts.

Leveling the Machine. After the cement around the hold-down bolts has set, the machine must be carefully leveled. Use the most accurate level available, preferably one having a micrometer screw adjustment. A carpenter's level, or the level in a machinist's combination square is not accurate enough. Drive steel wedges under the corners of the base until the table is level in both directions. Then drive additional wedges under the base to distribute the weight of the machine evenly, and recheck for level. Place the leveling instrument on the machine table when taking readings. It is necessary, of course, that the machine table be clean, and the leveling instrument free from burrs, if the desired accuracy is to be obtained.

Cleaning. Do not attempt to move any of the sliding units before cleaning thoroughly with naphtha, or other grease solvent, to remove the slushing compound and dirt accumulated in transit.

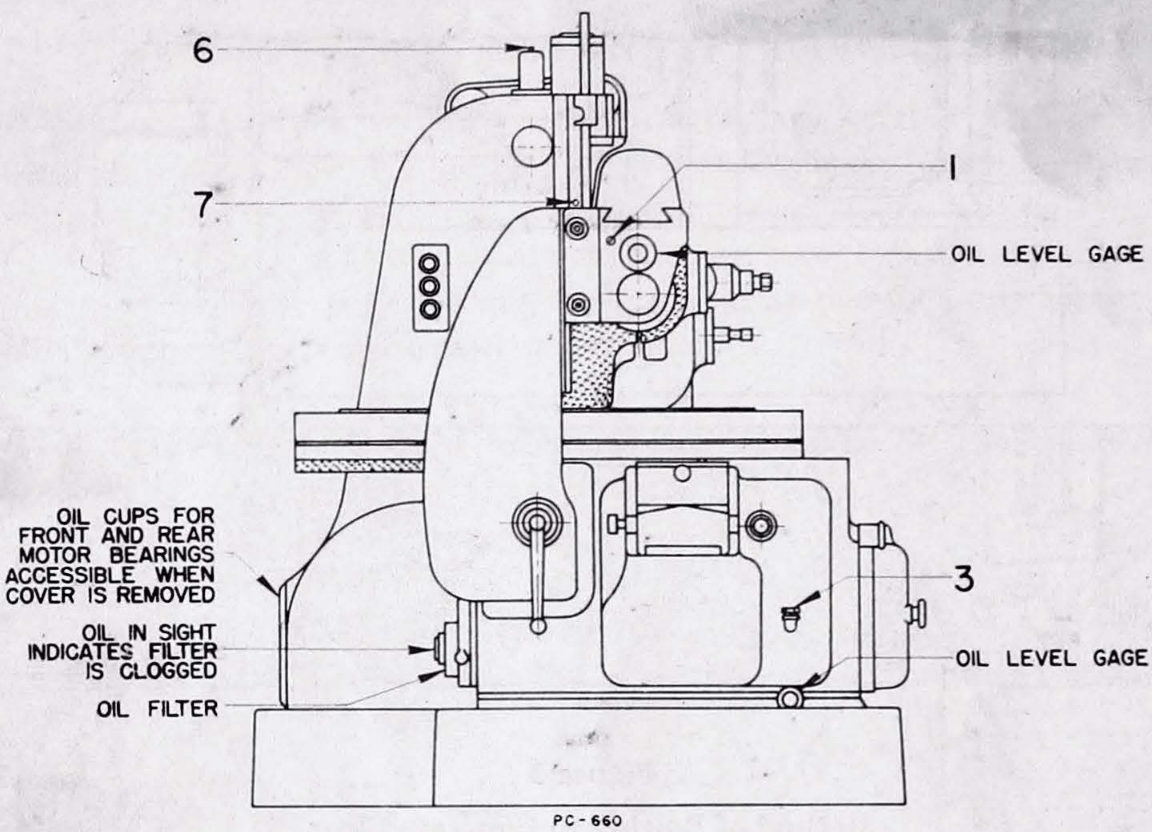


Figure 4
Lubrication Diagram (Front View)

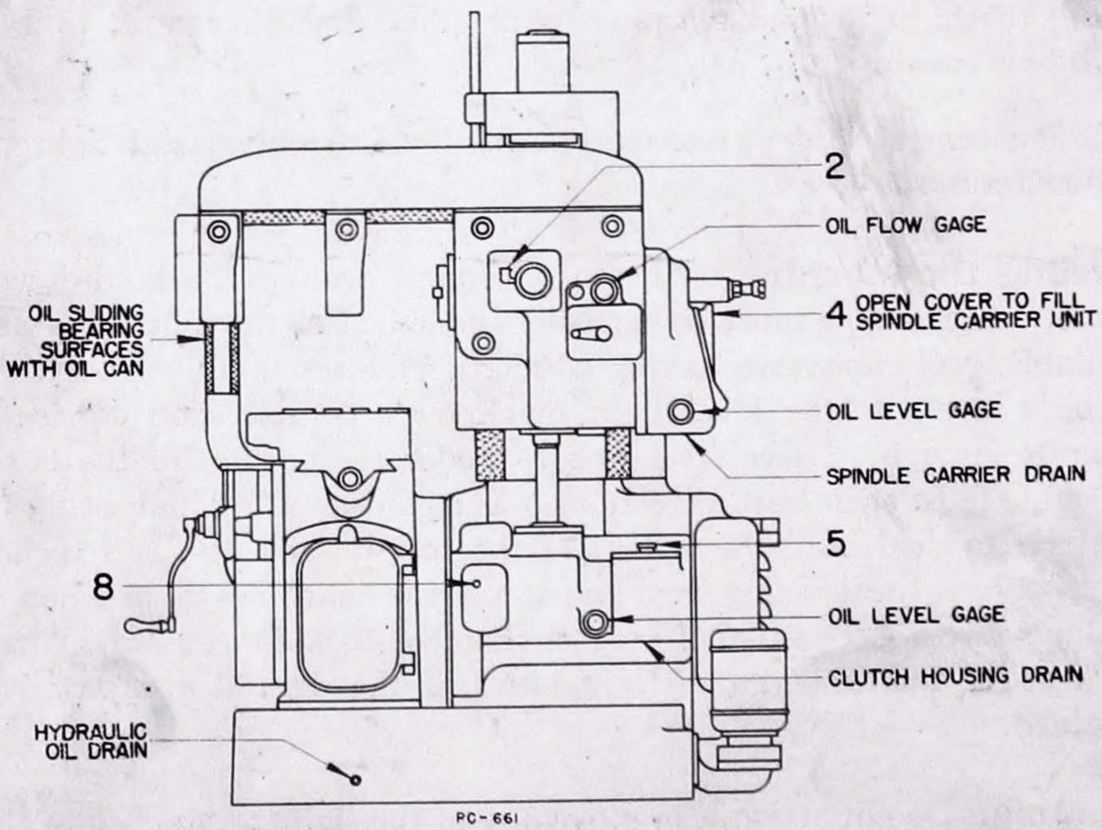


Figure 5
Lubrication Diagram (Side View)

LUBRICATING INSTRUCTIONS AND SPECIFICATIONS

(Refer to Figs. 4 and 5 for Station Numbers referred to below)

When to Oil	Station Number	Lubricating Instructions	Specifications of Lubricants
Daily	6 2	A few drops of oil from a squirt can.	P-31 Medium machine mineral oil. Viscosity 190 to 210 Sec. Saybolt at 100° F.
Weekly	7-8	One shot of grease with a grease gun.	P-37 Good grade of cup grease. Free of acid and fillers.
Inspect daily. Refill when oil level reaches low limit on gage.	3	Keep oil level between high and low limits on gage, fill only with machine stopped. Drain, refill, and clean filter every 3 months. About 5 gallons required.	P-38 High grade light turbine mineral oil of paraffin base. Viscosity 148-155 Sec. Saybolt at 100° F.
Inspect daily. Refill when oil level reaches low limit on gage.	4	Keep oil level between high and low limits on level gage Oil must be flowing through flow gage while spindle is running. Drain and refill every 6 months. About 3 pints required.	Same as specifications P-31 above.
Inspect daily. Refill when oil level reaches low limit on gage.	5	Keep oil level between high and low limits on level gage. Fill only with machine stopped. Drain and refill every 6 months. About one gallon required.	Same as specifications P-31 above.
Inspect daily. Refill when oil level reaches low limit on gage.	1	Keep oil level between high and low limits on gage. About ½ pint required to fill.	Same as specifications P-31 above.

Oil or grease main drive motor bearings and coolant pump motor bearings in accordance with manufacturer's recommendations.

LUBRICATION

After installing the machine, and before starting it for the first time it is important to properly lubricate the machine. (See "Lubricating Instructions and Specifications" pages 8 and 9).

Lubrication of this machine is exceedingly simple, as all parts except stations 2, 6, and 7 are automatically lubricated. However, do not allow the simplicity of lubrication to cause neglect of this important phase of operation. Be sure that the oil and container are clean before filling the various units, especially station No. 3 for the hydraulic oil reservoir. Specifications and instructions are given on pages 8 and 9. Oil should flow continually through the oil flow gage (Fig. 5) when spindle is running.

Removable Oil Filter. The oil filter in the hydraulic system is located in a pressure chamber at the left-hand side of the bed (see Fig. 7). The filter housing is fitted with an oil sight gage indicator, and a by-pass valve which opens when the filtering element becomes clogged beyond the point of efficient operation. As soon as this valve opens, the hydraulic pressure in the system will drop. The oil is then not being filtered, and flows through the chamber in the sight gage indicator. *This is a warning to clean the filter.* It is also a good practice to remove and clean the filter when draining and refilling the hydraulic reservoir. The filter should be cleaned as follows:

1. Remove the seven 3/8" Allen-head screws which hold the sight gage housing in place.
2. Remove the housing and the filter.
3. Clean the filter by washing with naphtha.
4. Replace the filter, and screw the sight gage housing in place.

Strainers in Hydraulic Circuit. The intake line in the hydraulic circuit is fitted with two rectangular wire screen strainers. The purpose of these strainers is to keep out of the circulating oil any large particles of foreign matter which may be present in the oil when the reservoir is filled.

It should never become necessary to clean these strainers if the oil used is reasonably clean, but if there is any indication of insufficient circulation in the hydraulic circuit, they may have become clogged enough to prevent a free intake of oil. These strainers are accessible when the sheet metal guard in the feed change gear compartment is removed.

STARTING THE MACHINE FOR THE FIRST TIME

In starting a new machine for the first time, follow the procedure outlined below:

1. Read and follow the instructions given under "Installation".

2. Read "Lubricating Instructions and Specifications" and "Lubrication".

3. Study the "Functional Diagrams" (Figs. 6, 7, and 8) and "Operating Instructions".

4. Having become familiar with the machine, and having met all requirements given under the above instructions, and the proper electrical connections having been made, the machine is ready to be started.

5. Place the set-up knob (Fig. 13) in "Set-Up" position.

6. Open the cover over the cycle selector (camshaft) (Fig. 12) and be sure the camshaft is in the "Stop" position, with the flat portion marked "Stop" in a vertical position at the front of the cycle selector (camshaft).

7. *This step is very simple, yet it is overlooked more frequently than any other.* Press the starting button and immediately note the direction of rotation of the motor. It must be the same as that indicated by the direction plate mounted on the motor frame, or the machine will not function.

8. Set the table dogs and the adjustments to the rise and fall mechanism (see pages 15-17) so that the automatic cycle may be observed. Move the table by means of the handcrank to make sure that the dog settings are correct, then return the table to the starting position and remove the crank. Be sure that set-up knob is in the "Set-Up" position when using the table handcrank.

Note: When the machine is running, the table should under no circumstances be moved by hand unless the set-up knob on the front of the hydraulic unit (see Fig. 13) is in the "Set-Up" position. Also see "Use of Set-Up Knob" (page 18).

9. Set the feed change gears for the desired rate of table feed as shown on the feed change gear instruction plate.

10. Set the speed change gears for the desired spindle speed as shown on the speed change gear instruction plate.

11. Turn the set-up knob into the "Run" position, and momentarily flip the starting lever in a counter-clockwise direction (see Fig. 13). The machine will run through the automatic cycle and return to a stop at the loading position.

Note: To stop the *table only* at any point during the cycle, turn the set-up knob to the "Set-Up" position. Return the knob to the "Run" position and the machine will continue through its normal cycle.

CAUTION: If the machine (motor) is stopped at any point in the cycle, the table *must* be returned to the starting position by hand. See "Re-timing the Feed Cycle", pages 17-18.

FUNCTIONAL DIAGRAMS

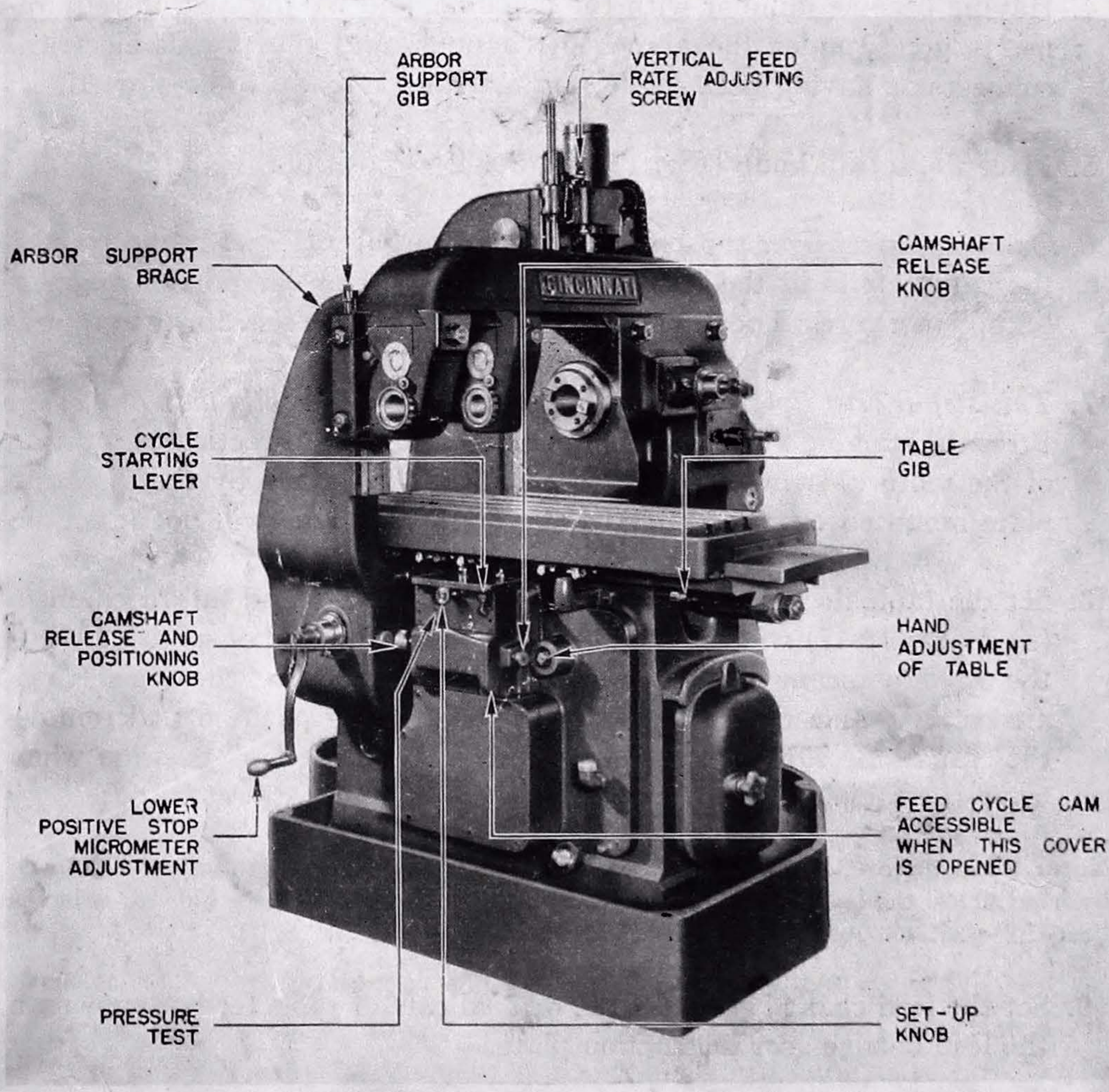


Figure 6
A View of the Right-Hand Side of the Machine

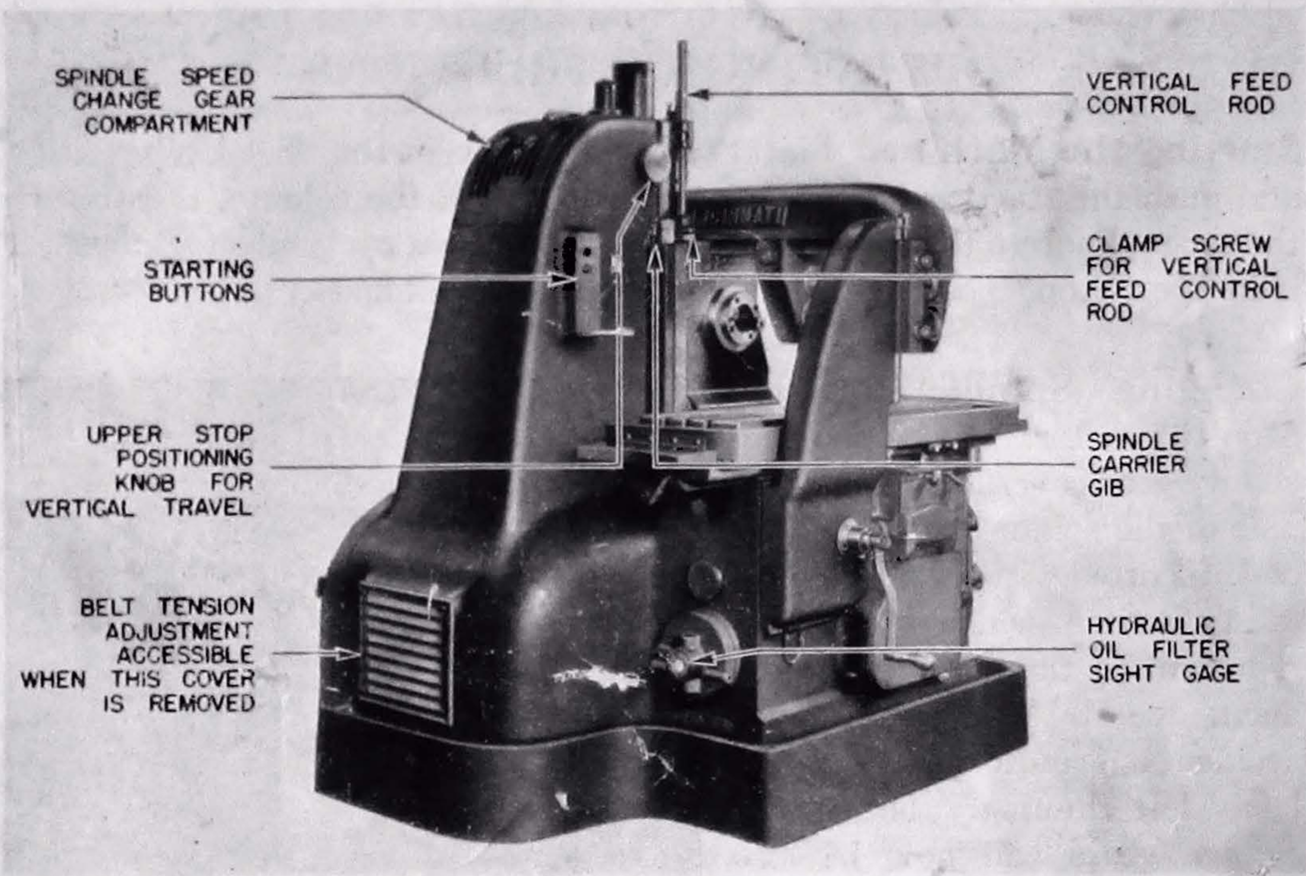


Figure 7

A View of the Left-Hand Side of the Machine

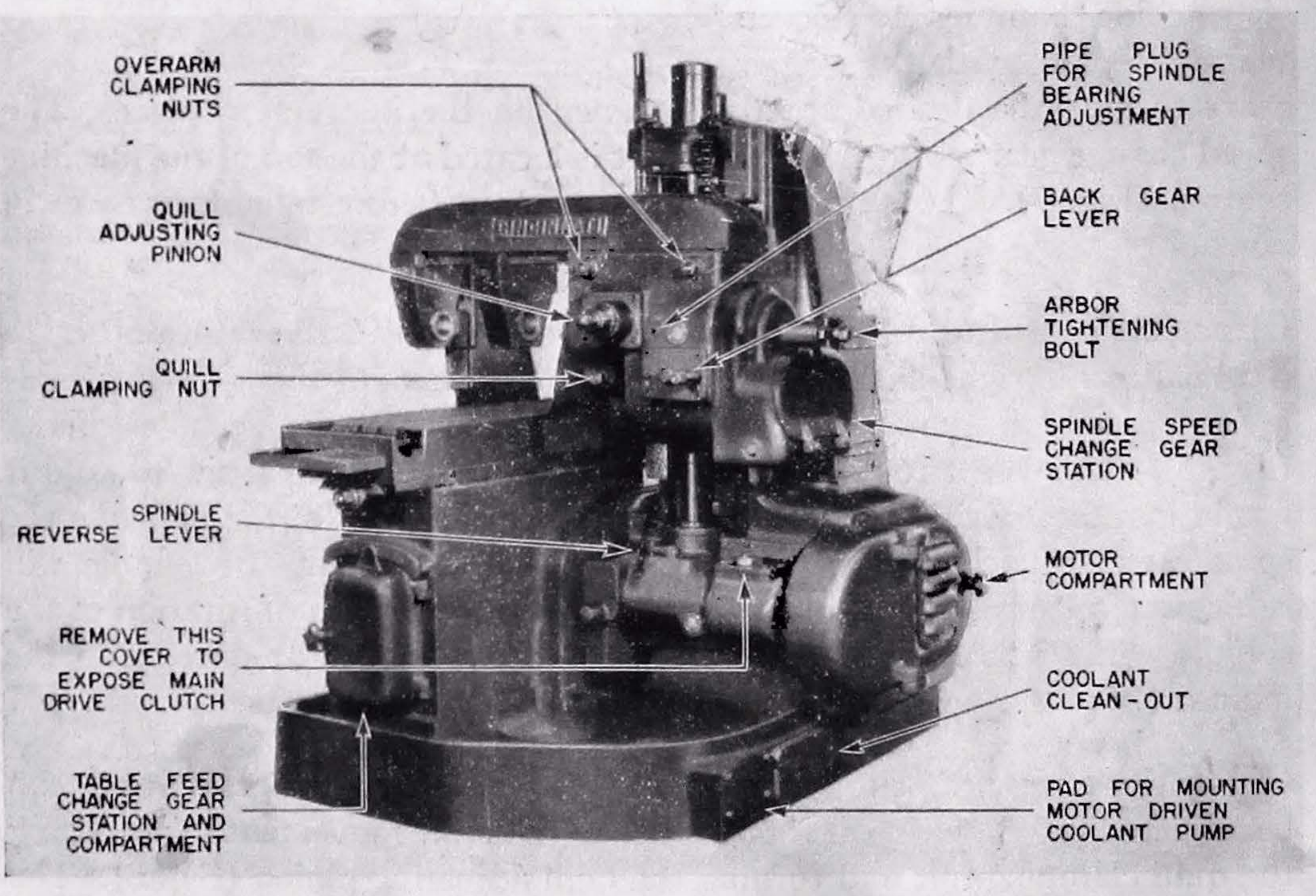


Figure 8

A View from the Rear of the Machine

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OPERATING INSTRUCTIONS

Starting the Machine. Place the set-up knob in the "Set-Up" position and push the starting button on the front face of the column, then return the set-up knob to the "Run" position. Be sure that cycle selector camshaft is in the "Stop" position (Fig. 12), and the table hand crank is removed.

Changing Spindle Speeds. Stop the motor. Snap open the change gear cover located on the rear of the spindle carrier. The cover is fitted with an automatic safety switch which stops the motor when the cover is swung open, thereby preventing any accidents if motor is thoughtlessly left running. The speed change gears will now be exposed. Remove the two nuts which hold the gears in position and tap the gears with a babbit or rawhide hammer to loosen them. Replace with the proper gears to give the desired speed, as shown on the instruction plate. The speed change gear storage compartment is located at the top of the machine column (Fig. 7). Be sure that gears are clean before mounting them in position.

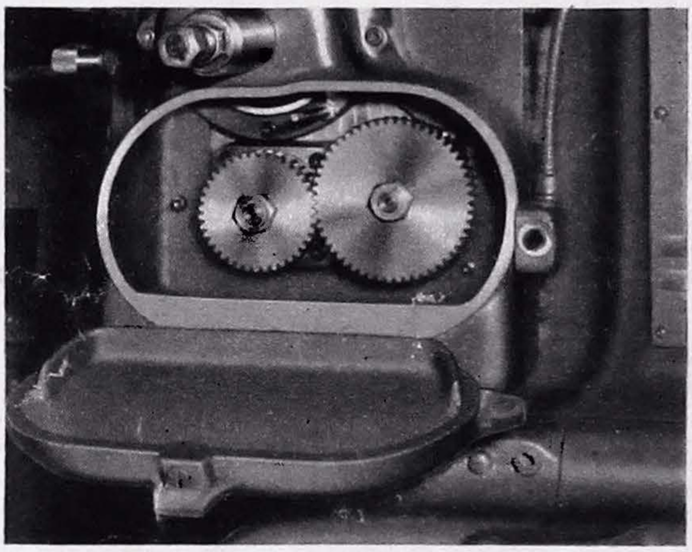

Figure 9
Speed Change Gear Compartment

Direction of Spindle Rotation. The direction of spindle rotation can be changed from "right-hand" to "left-hand" by means of the spindle reverse lever located on the pulley bracket directly under the spindle carrier (Fig. 8). This is a two-position lever fitted with a locking screw to hold it firmly in either position. When swung toward the front of the machine the spindle will run clockwise; when swung toward the rear, the spindle will run counterclockwise. Do not try to reverse the direction of rotation of the spindle while it is in motion. If lever does not engage at once, stop the main drive motor and rotate the spindle by hand until the teeth mesh.

Cross Movement of the Quill. The spindle and its supporting quill can be adjusted in a direction at right angles to the table movement by loosening the quill clamping nut and turning the quill adjusting pinion (Fig. 8). The quill may be accurately adjusted by means of a dial, graduated in thousandths of an inch. Reclamp the quill after the desired setting is obtained.

Hydraulic Rise and Fall Mechanism. The vertical movement of the spindle carrier is actuated by an hydraulic cylinder carried by a bracket mounted on top of the headstock. A 6″ automatic vertical movement of the spindle carrier is available, all of which may be used for rapid advance of cutter to work, down feed at slow rates, or varying combination of both, and for the rapid retraction of the cutter from the work.

There are two adjustments for the vertical range of spindle carrier movements, one controls the depth of the lower position for the cutting stroke, and the other controls the height of the upper or retracted position. The adjustment for the height of retraction, the "Upper Positive Stop Positioning Knob", is shown in Fig. 7. The adjustment for the lower, or cutting position, the "Lower Positive Stop Micrometer Adjustment", is shown in Fig. 6. This adjustment consists of a handcrank fitted with a dial graduated in thousandths of an inch, and a thumbscrew for locking the adjustment. As the spindle carrier is held down against the lower positive stop by the hydraulic pressure in the cylinder, it assures repeated accuracy of the automatic vertical positioning of the cutter in relation to the workpiece.

Lowering of the spindle carrier into the cutting position and its retraction at the end of the cutting stroke are interlocked with the hydraulic circuit by means of a pilot valve, mounted on the rear surface of the headstock. A pair of dogs, mounted in T-slots on the rear surface of the spindle carrier, act to shift the pilot valve at the instant the spindle carrier engages either positive stop. The shifting of the pilot valve indexes the cycle selector camshaft, thereby engaging the next function of the automatic cycle.

Changing the Range of Vertical Power Movements. It is not necessary for the spindle carrier to utilize the maximum vertical range of its stroke. By adjustment of the upper and lower positive stops any desired amount of vertical travel may be obtained from $\frac{1}{4}$″ up to 6″. As the dogs which trip the spindle carrier pilot valve are adjusted to shift the valve at the instant the spindle carrier engages either positive stop, the only time adjustment of these dogs will be necessary is when adjustments are to be made to either positive stop. If adjustment of either positive stop is to be made, proceed as follows.

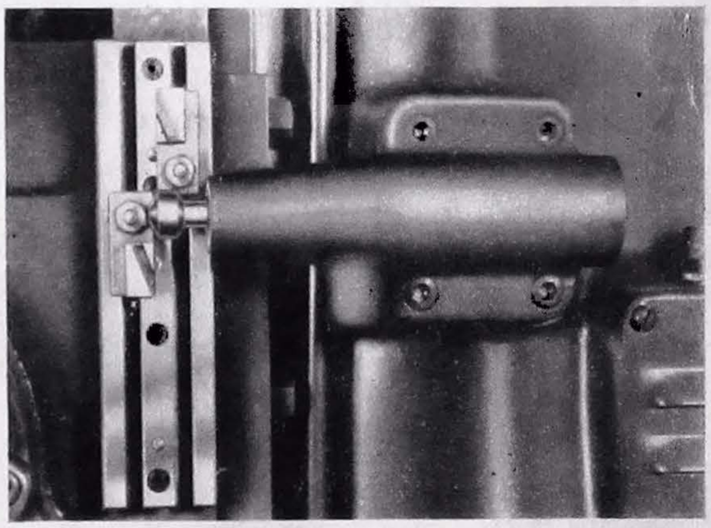

Figure 10
Spindle Carrier Pilot Valve

1. Loosen the dog corresponding to the positive stop which is to be adjusted. If the upper stop is to be moved loosen the lower dog, and if the lower stop is to be moved loosen the upper dog.

2. Adjust the positive stop to the desired position. Before moving the lower stop, loosen the locking screw for this adjustment.

3. Start the machine through its automatic cycle. When the cycle reaches that point at which the spindle carrier contacts the stop which was adjusted, the next function of the cycle will not take place. The reason for this is that the spindle carrier pilot valve has not been shifted to engage the next step in the cycle.

   At this point adjust the loosened dog slowly until it has shifted the pilot valve plunger *just enough* to index the cycle selector (camshaft) in the hydraulic unit, and then lock the dog firmly in place.

Spindle Carrier Down Feed Adjustment. Adjustments for spindle carrier rapid traverse down, and feed down, are made by use of the vertical feed control rod (Fig. 11) which controls the rate valve, mounted in the hydraulic cylinder bracket. Retraction of the cutter from the work is always at a rapid traverse rate.

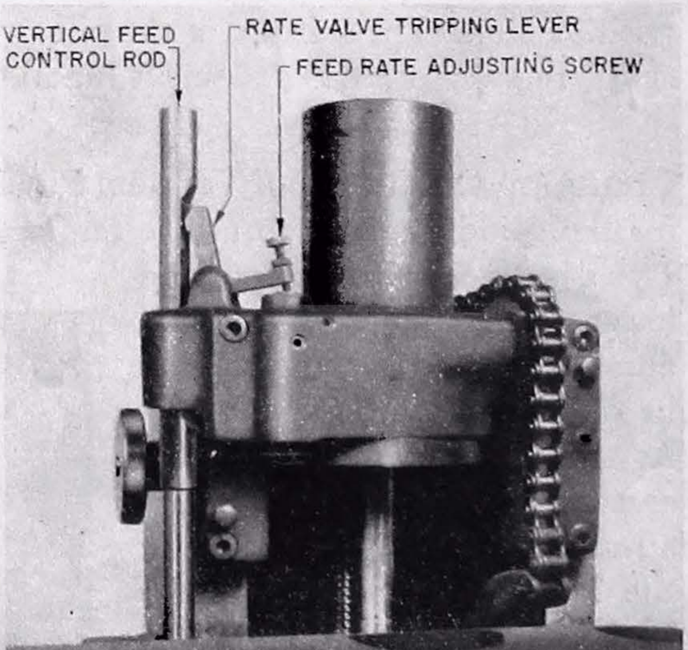

Figure 11
Down Feed Adjustment

The vertical feed control rod actuates the L-shaped tripping lever to take the rise and fall mechanism out of rapid advance into a down feed rate, the L-shaped lever acting directly upon an external portion of the rate valve plunger. The L-shaped lever is fitted with an adjusting screw and locking nut for varying the down feed rate. Backing off this adjusting screw increases the feed rate. When the L-shaped lever is in contact with the cutaway portion of the feed control rod, the spindle carrier is in rapid traverse; while it is in contact with the non-recessed portion of the rod it is in feed. The feed control rod is adjustable to give any amount of feed or rapid traverse up to the range of the machine. Adjustment is made by loosening the feed control rod clamping screw (Fig. 7), shifting the rod to the desired position, and reclamping.

Table Movements. All table movements, as well as spindle carrier movements, are automatically controlled by the cycle selector (preadjusted camshaft) furnished for each automatic cycle. The placing of the trip dogs, located on the underneath side of the front of the table, control the range of each portion of the cycle as explained on pages 20–21.

The table may be moved by hand, by means of the handcrank. When using the handcrank be sure the setup knob is in the "Set Up" position. If the table has been moved by hand *it is important* to return the table to the loading position, and remove the crank, before returning the set up knob to the "Run" position.

Changing Automatic Cycles. The automatic cycles of the table and the spindle carrier are controlled by the cycle selector, located in the hydraulic unit at the front of the machine. *Do not tamper with* the adjustment of the cams.

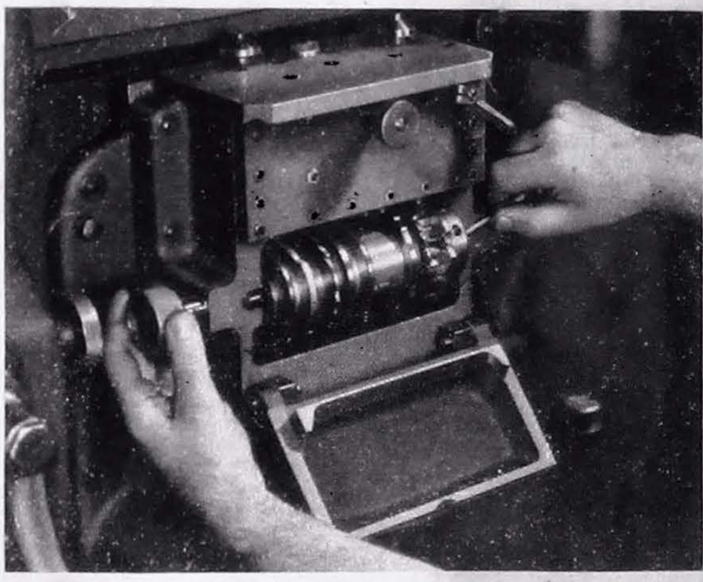

Figure 12
Removing Cycle Selector Camshaft

To remove the cycle selector camshaft open the hinged cover on the front of the hydraulic unit, rotate camshaft until pin through left end of camshaft is in horizontal position, pull outward on the camshaft release and positioning knobs (see Fig. 6) and rotate until open portions of camshaft bearings are to the front. Start camshaft out of bearings with a screw driver, as shown in Fig. 12, and lift out, replacing with the new one. Change the settings of the dogs to correspond to the new cycle. It is advisable to raise the lower positive stop somewhat before running through the new cycle.

Retiming the Feed Cycle. If the machine (main drive motor) is stopped before the completion of the cycle, the functions of the cycle will be "out of time". Before attempting to start the machine again, return the table, by hand, to the loading position. Then open the cover on the front of the hydraulic unit, and turn the camshaft positioning knob (Fig. 6) until the "STOP" position, stamped on the cycle selector, is in a vertical position at the front of the cycle selector. The machine will now begin its normal cycle when again started.

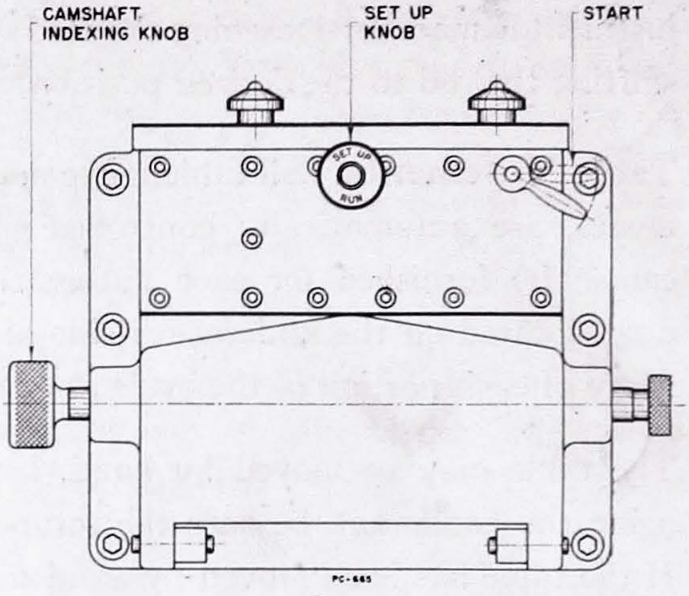

Figure 13
Hydraulic Control Box

Use of the Set-Up Knob. The set-up knob, located on the front of the hydraulic unit (Fig. 13), is a valuable aid when setting up a new job, or when making adjustments to the existing set-up. When rotated to the "Set-Up" position, power movements of the table are made "dead" while retaining the pressure in the hydraulic rise and fall mechanism. This allows the table to be moved by hand in accurately locating the table dogs, and allows for adjusting the cutter to depth with the table stationary. Power movements of the spindle carrier may be actuated by indexing the cycle selector by hand, by means of the knurled knob at the left-hand side of the hydraulic unit.

Changing the Feed Rate. Power feed rates to the table are changed by means of pick-off gears, which are accessible when the hinged cover on the right-hand side of the bed is swung open. *Stop the motor* before opening the cover. The cover is fitted with a safety switch, which automatically stops the motor when the cover is swung open, thereby preventing any accidents in case the motor is left running. *It is imperative* that this cover be closed firmly, as the pick-off gears are held in place by the cover.

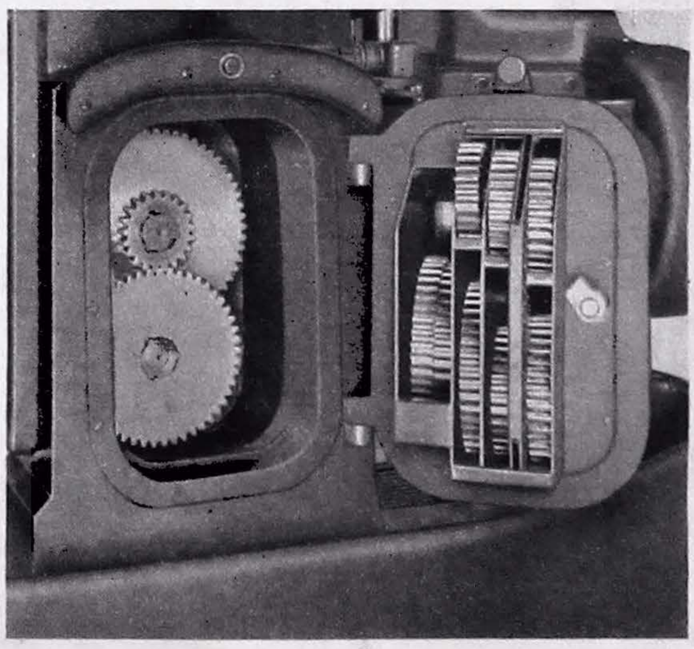

Figure 14
Feed Change Gear Compartment

Removing the Outer Arbor Support. On machines equipped with the slide type overarm brace and arbor support, the arbor support may easily be removed as follows:

1. Loosen the arbor support clamping nut.
2. Remove the two nuts, located on front of arbor support, which clamp the arbor support to the sliding member on the overarm brace.
3. Slide the arbor support toward you, off the overarm.

AUTOMATIC CYCLES

A great number of automatic cycles are available for these machines. The four standard cycles are described below. A typical complex cycle is explained in detail on pages 20–22 to acquaint you with the functions of the various elements during each portion of the automatic cycle. After the action of these various elements is understood, it will be apparent that other cycles are only combinations of the four basic cycles. In cycles designated by letter "B" (none shown), the table feeds from left to right. Cycles in which the table feeds from right to left are designated by letter "A".

Cycle No. 10-A

1. **A**—Start cycle by flipping the starting lever. Table rapid advances and spindle starts rotating.
2. **B**—Feed table.
3. **C**—Rapid return table and stop spindle.
4. Stop table.

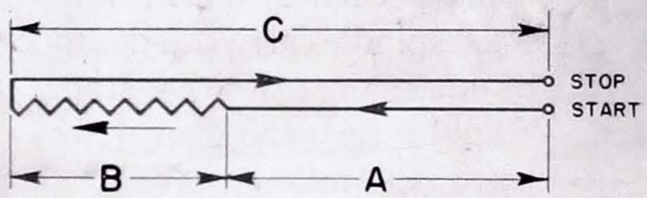

Figure 15
Cycle No. 10-A

Cycle No. 21-A

1. **A**—Start cycle by flipping the starting lever. Table rapid advances and spindle starts rotating.
2. **B**—Feed table.
3. **C**—Rapid advance table to next cut.
4. **D**—Feed table.
5. **E**—Rapid return table and stop spindle.
6. Stop table.

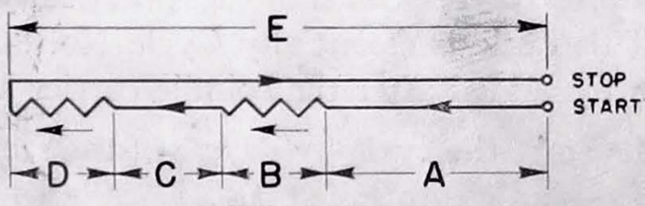

Figure 16
Cycle No. 21-A

Cycle No. 5-A

1. **A**—Start cycle by flipping the starting lever. Table rapid advances and spindle starts rotating.
2. **B**—Stop table, rapid advance spindle carrier down against positive stop.
3. **C**—Feed table.
4. **D**—Stop table, rapid return spindle carrier to top of stroke.
5. **E**—Rapid return table and stop spindle.
6. Stop table.

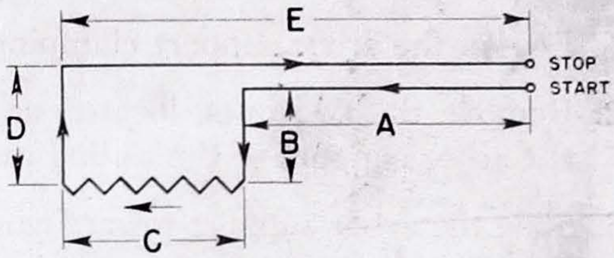

Figure 17

Cycle No. 5-A

Cycle No. 8-A

1. **A**—Start cycle by flipping the starting lever. Table rapid advances and spindle starts rotating.
2. **B**—Feed table to accurate position.
3. **C**—Stop table, rapid advance spindle carrier down, and
   D—Feed spindle carrier to depth of cut against positive stop.
4. **E**—Rapid return spindle carrier to top of stroke.
5. **F**—Rapid return table and stop spindle.
6. Stop table.

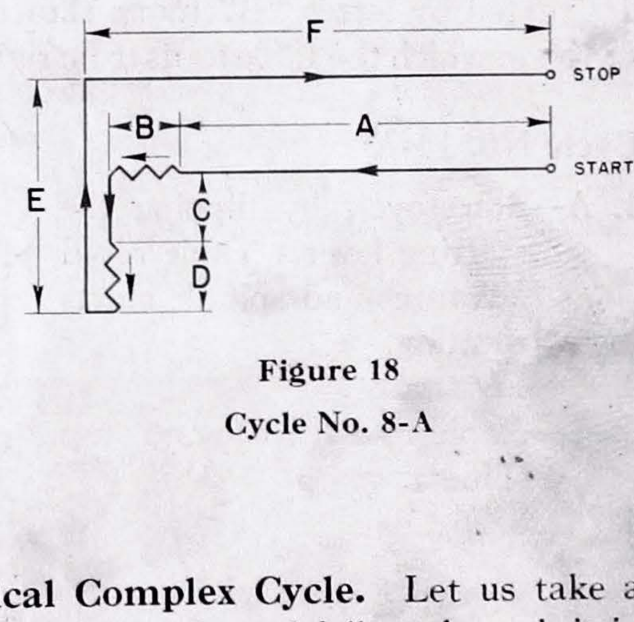

Figure 18

Cycle No. 8-A

Operating Description of a Typical Complex Cycle. Let us take a commonly used complex cycle, No. 2-A (Fig. 19), and follow through it in detail to acquaint you with the functions of the table and spindle carrier trip dogs, and their actions in controlling the various steps of the cycle. This special cycle was selected for description here to illustrate the adaptability of this machine to practically any desired sequence of operations. This cycle is essentially Cycle No. 8-A (Fig. 18) with a feed stroke of the table added after the spindle carrier has fed the cutter to depth.

1. Start the cycle by means of the starting lever—table rapid advances and spindle rotation starts.
2. Dog "A" depresses plunger "X"—table trips out of rapid advance into feed.

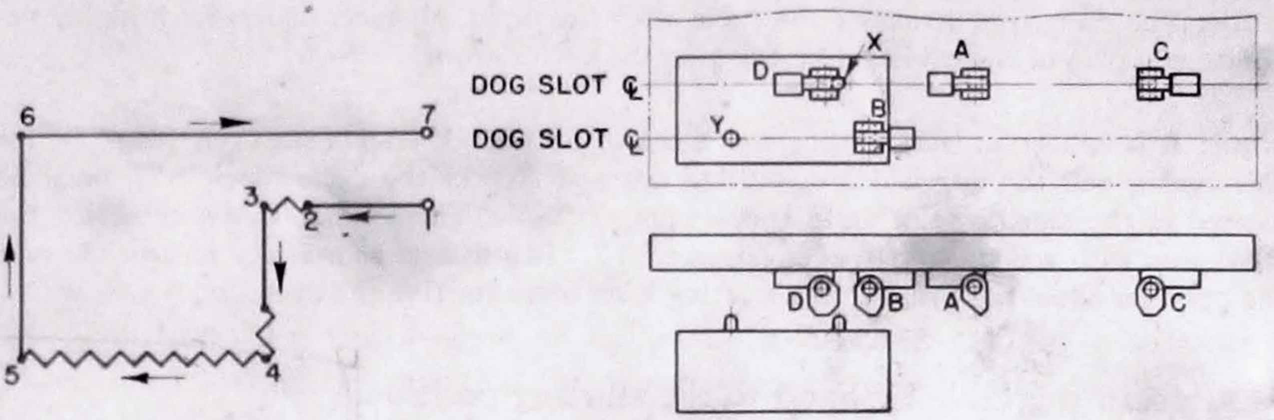

Figure 19
Cycle No. 2-A

3. The table travels at a feed rate for a very short distance until dog "B" depresses plunger "Y"—table stops and hydraulic rise-and-fall mechanism lowers the spindle carrier at a rapid rate.

   The high portion of the vertical feed control rod engages the L-shaped trip—spindle carrier rapid traverse down changes to feed down until the spindle carrier contacts the lower positive stop.

4. As the carrier engages the positive stop, the spindle carrier pilot valve is shifted by the upper dog on the rear of the spindle carrier—the table starts to feed.

5. Dog "C" engages plunger "X"—table stops and hydraulic rise-and-fall mechanism raises the spindle carrier at a rapid rate until it contacts the upper positive stop.

6. As spindle carrier contacts the upper positive stop, the spindle carrier pilot valve is shifted by the lower dog on the rear of the carrier—table rapid returns to the loading position and spindle rotation stops.

7. Dog "D" engages plunger "X"—table stops and cycle is completed.

Details of Setting Up For Cycle No. 2-A. Let us take the typical cycle (No. 2-A), the operation of which has just been described, and follow through the various details of setting it up for operation.

1. Turn the set-up knob to the "Set-Up" position.
2. Place dogs "A", "B", "C", AND "D" in the slots indicated in Fig. 19.
3. Move the table by means of the handcrank and clamp the dogs in position for the length of cut desired. Dogs "A" and "B" should be set to contact plungers "X" and "Y", respectively, allowing the shortest possible table traverse in feed. Be sure that dog "A" contacts plunger "X" *before* dog "B" contacts plunger "Y". This will allow time for plunger "Y" to raise after being depressed by the starting lever.

Note: The short feed stroke of the table after the rapid advance, makes for a highly accurate stopping of the table before bringing the cutter down.

Note: It is important that the dog which completes the last step of the cycle (dog "D" for this cycle), and the dog which completes the first step of the cycle (dog "A"), must be located in the rear dog slot and depress plunger "X". This is done to avoid having the table stop with a dog directly over plunger "Y". It also acts as a safety measure in case the operator should not release the starting lever after starting the cycle.

4. Return the table by hand to the starting position.

5. Rotate the cycle selector by hand. The spindle carrier will move vertically and the upper and lower positive stops may be adjusted (see pages 15-16) to give the desired vertical travel. After the correct depth of cut has been adjusted with the lower stop, lock the adjustment with the locking screw.

6. Adjust the vertical feed control rod to give the desired lengths of rapid advance and feed strokes of the spindle carrier.

7. Rotate the cycle selector by hand until the "STOP" position faces you.

8. Place the set-up knob in the "Run" position, and, with the fixture empty, start the cycle by flipping up the starting lever. The machine should now run through the complete automatic cycle.

9. Set the speed change gears to give the desired spindle speed.

10. Set the feed change gears to give the desired rate of table feed.

11. Adjust the down feed rate of the spindle carrier by means of the adjusting screw on the rate valve tripping lever.

12. Check the positions of the dogs and the depth of cut.

13. Load the work in the fixture and proceed with the operation.

Note: When starting a machine which has been idle for a time, always run it through several cycles before attempting to take a cut. This will accomplish the removal of any air which may have entered the hydraulic system while the machine was idle, and will insure smooth operation while cutting.

SETTING UP THE FIXTURE AND CUTTERS

Clamp the fixture in the center of the table, or as near the center as operating conditions will permit, to avoid as much as possible the undue overhang of the table which causes wear on the ends of the gib.

If you are using a lathe dog to hold the work between centers, do not under any conditions use the T-slots of the table for tightening the dog screw. When these T-slots become marred, the work or fixtures located from them will not line up properly, with the result that a new table must be purchased or the old one replaned to an oversize slot to obtain accurate work.

Where using a cutter and arbor, they should be assembled with the spacing collars and end nut, and tested between dead centers for concentricity. The assembly must run absolutely true and the cutter must be a snug fit on the arbor to obtain a good finish and freedom from chatter. The ends of the spacing collars and arbor nut must be perfectly clean before assembling, as dirt particles between the collars will cause the arbor to spring when the nut is tightened, giving the effect of an eccentric cutter. Always use as short an arbor as possible, and space the cutter on the arbor as near to the spindle as operating conditions will permit.

These machines are equipped with an automatic spindle stop which stops the spindle rotation when the machine is in the loading position. Therefore, to test the concentricity of the arbor assembly in position on the machine, it will be necessary to run the machine through its automatic cycle and use the setup knob (see page 18) to stop the cycle in the cutting stroke.

ADJUSTMENTS

Adjusting the Gibs. The table trip from feed to stop, as used in conjunction with the hydraulic rise-and-fall mechanism at the beginning and at the end of a cut, is very accurate. You will find this feature desirable, or perhaps even necessary, on many types of job. One of the determining factors in the accuracy of trip is the correct adjustment of the table gib. The table, arbor support slide brace, and spindle carrier are fitted with head type gibs. Although the gibs seldom need attention, instructions are listed for obtaining the original setting when adjustment is necessary. To adjust for wear with a head type gib proceed as follows (see Fig. 20), with machine stopped.

1. Loosen nut "A".

2. Turn screw "B" in a clockwise direction two or three turns.

3. Turn nut "A" in a clockwise direction until the gib wedges securely in its bearings, then back it away two or three turns.

4. Turn screw "B" in a counter-clockwise direction until the flange touches the gib head, then continue turning in the same direction for about one turn.

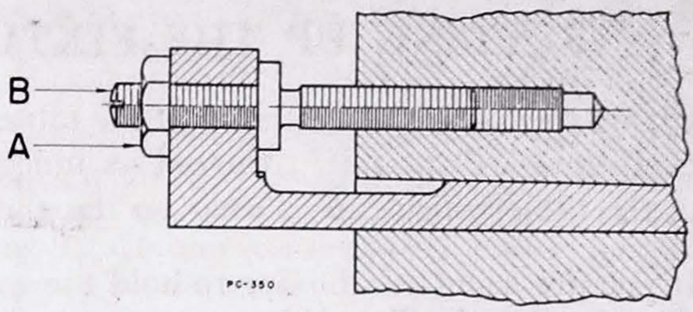

Figure 20
Head Type Gib

5. Lock the gib and screw in position with nut "A".

Adjusting the Spindle Bearings. The spindle has a double mounting of anti-friction bearings both front and rear. As the front bearings carry the thrust load, and the greater portion of the radial load, it should never become necessary to adjust the rear bearings. To adjust the front bearings proceed as follows, with machine stopped:

1. Shift the back gear lever (Fig. 8) to its half-way position.

2. Remove the two spindle driving keys on the spindle nose. Clamp a rectangular rod, about 10 to 12 inches long, in the key slots.

3. Remove the countersunk pipe plug for spindle adjustment (Fig. 8).

4. Rotate the spindle until you can insert a socket wrench through the plug hole, and loosen the hex head screw in the adjusting nut. Tap the socket wrench to loosen the locking shoe under the screw.

5. With the socket wrench in position to keep the adjusting nut from rotating, turn the spindle counterclockwise about one revolution and then clockwise until the bearings are drawn up tight. Alternately rotate the spindle and tighten the adjusting nut until you know by "feel" that the adjustment is correct. Do not continue this process to the point of preloading the bearings.

6. Test the end play by using an indicator on the end of the spindle nose. Tap the spindle lightly on the front end, and then the rear end, and read the indicator. This step is especially important for the higher spindle speeds. Allow about .001″ end play when the bearings are cold.

7. Retighten the locking screw.

8. Replace the pipe plug and remove the leverage rod from the face of the spindle.

Note: When taking up the roller bearing adjustment, rotate the spindle several turns to permit the rolls of the bearing to roll against the rib of the inner race. Never drive the bearing, or the front of the spindle, to accomplish this.

Adjusting the Main Drive Clutch. The main drive clutch is located in the pulley bracket unit directly beneath the spindle carrier. It is a multiple disc wet clutch, and may be adjusted by removing the rectangular cover plate on the top of the unit (Fig. 8) and following the instructions given on the brass plate attached to the cover. A more detailed explanation is as follows:

1. Stop the motor.
2. Remove the cover on top of the pulley bracket unit (Fig. 8).
3. Reach through this opening and pull back pin "A" (Fig. 21), and latch it in the slots provided.
4. Turn nut "B" clockwise a fraction of a revolution, unlatch pin, and continue turning the nut in the same direction until the pin engages the next hole in the lock plate.

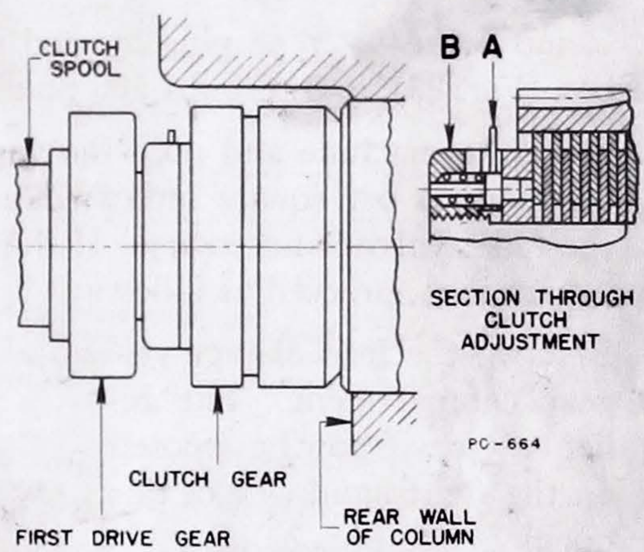

Figure 21
Main Drive Clutch Adjustment

Important: Be sure that the pin is engaged in one of the holes in the lock plate.

5. Replace the cover.

Note: If the automatic spindle stop should function too slowly, the clutch plates have been adjusted too closely and the adjusting nut should be backed away slightly.

Adjusting the Drive Belt Tension. The drive from the motor to the pulley bracket, or driving unit of the machine, is by means of multiple V-belts. The motor is mounted on a pivot which allows the sheave center distance to be increased as a means of compensating for belt stretch and wear. Two adjusting screws are located inside the motor compartment and are accessible when the hinged cover on the rear of the machine is opened.

Testing and Adjusting the Hydraulic Pressure. Resetting the hydraulic pressure is usually wasted effort, because it is not a cure-all for whatever irregularities may arise in the correct functioning of the machine. The relief valve has been properly adjusted at the factory and should not require adjustment. The few simple precautions outlined in this booklet will keep the machine running effectively. For example, if the table overrides or "coasts" past the point of trip, the gib probably needs adjustment. If the table should slip in feed, the safety gear, the main drive clutch, or the tension of the drive belts, may need adjustment. If the trip plungers act sluggishly, you may be using an inferior and gummy grade of oil; it may be dirty; or the oil level may be low. Check, and bring all these points up to standard, and then if the difficulty is not corrected, proceed with the following test of the hydraulic pressure:

1. Remove the $\frac{1}{8}''$ pipe plug located in the front of the hydraulic control box (Fig. 23), and screw a 500 pound pressure gage in its place.
2. Start the machine and note the gage reading. If the pressure registers 300 pounds per square inch (while the oil is warm), no adjustment of the relief valve is necessary. If the pressure is less than 300 pounds per square inch, proceed as follows:
3. Remove the feed change gears and the sheet steel guard in the change gear compartment. The relief valves will now be exposed on the right-hand side of this opening (see Fig. 22).

Note: Fig. 22 is a view of the relief valves, as seen from the *front* of the machine, before the installation of the feed box unit. The change gear compartment, through which the relief valve adjustments should be made, is located on the right-hand end of the bed.

4. Remove the cap from the high pressure relief valve, thereby exposing the pressure adjusting screw and its locking nut. Loosen the lock nut, and set the pressure to 300 pounds per square inch by means of the pressure adjusting screw. Lock the adjustment with the lock nut.
5. Replace the valve cap, sheet steel guard, and change gears.

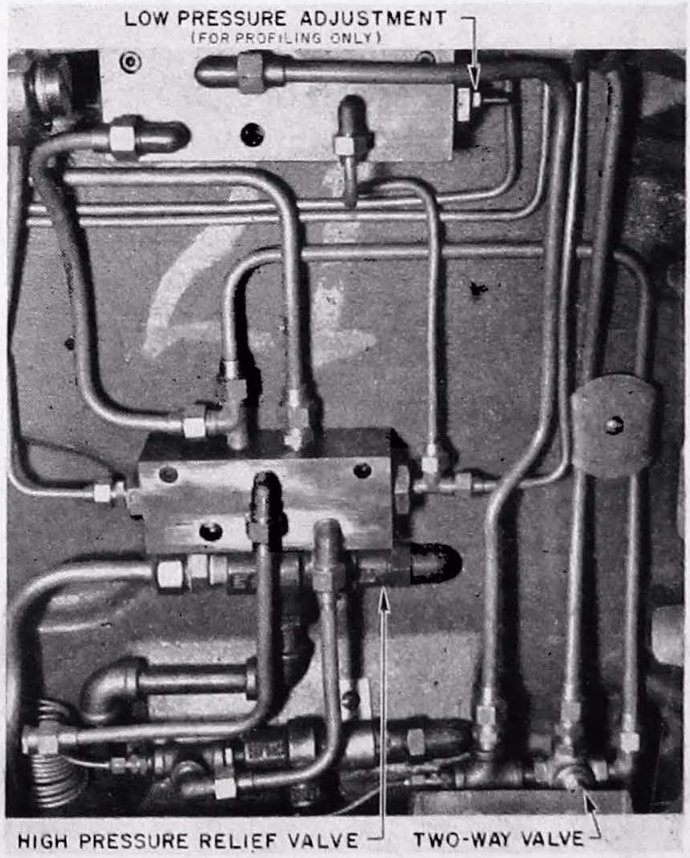

Figure 22
Relief Valves in the Bed

Adjusting the Oil Flow to Table Bearings. The table ways are automatically lubricated by a small plunger type pump located in the hydraulic unit on the front of the machine. The device is set at the factory to properly lubricate the table ways and should not require adjustment during the life of the machine. However, if adjustment should seem necessary, proceed as follows:

1. Remove the hydraulic control box unit from the front of the machine. It is held in place by six socket head cap screws, three on each side of the unit.

2. On the bottom of the hydraulic block, at the left hand rear corner, you will see a pipe plug. Remove this plug.

3. Remove the locking screw (Fig. 23).

4. Adjust the flow by rotating the adjusting screw—clockwise rotation decreases the flow, counterclockwise rotation increases the flow.

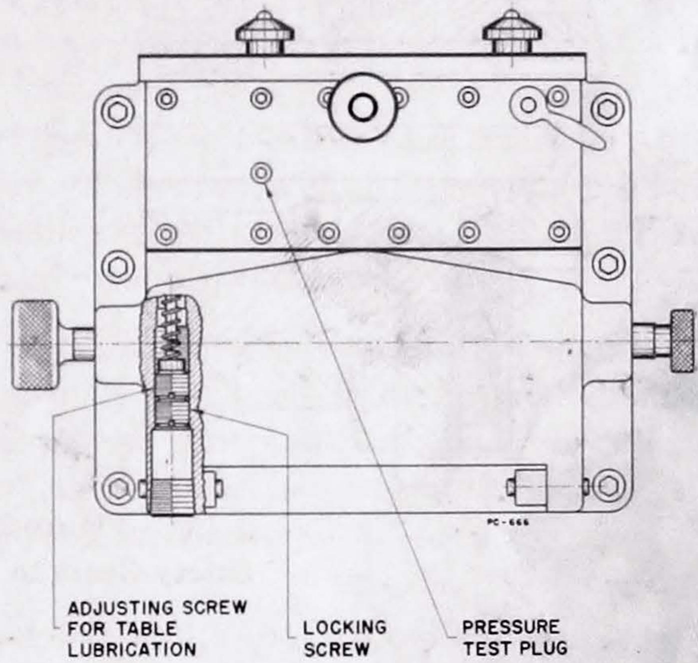

Figure 23
Adjusting the Oil Flow to the Table Bearings

5. Replace the locking screw and pipe plug.

6. Replace the control box unit, making sure that the rear surface of the unit and its mating surface on the front of the feed box unit are *perfectly* clean.

Adjusting the Safety Gears. The rapid traverse and feed gear trains are equipped with safety gears to protect the table drive mechanism. These two safety gears (Fig. 24) are located in the feed box unit mounted in the front of the bed. Unless the machine is continually abused, adjustment of these gears will not be necessary. If adjustment is required proceed as follows:

1. Stop the machine.

2. Remove the change gears and the sheet steel guard in the change gear compartment.

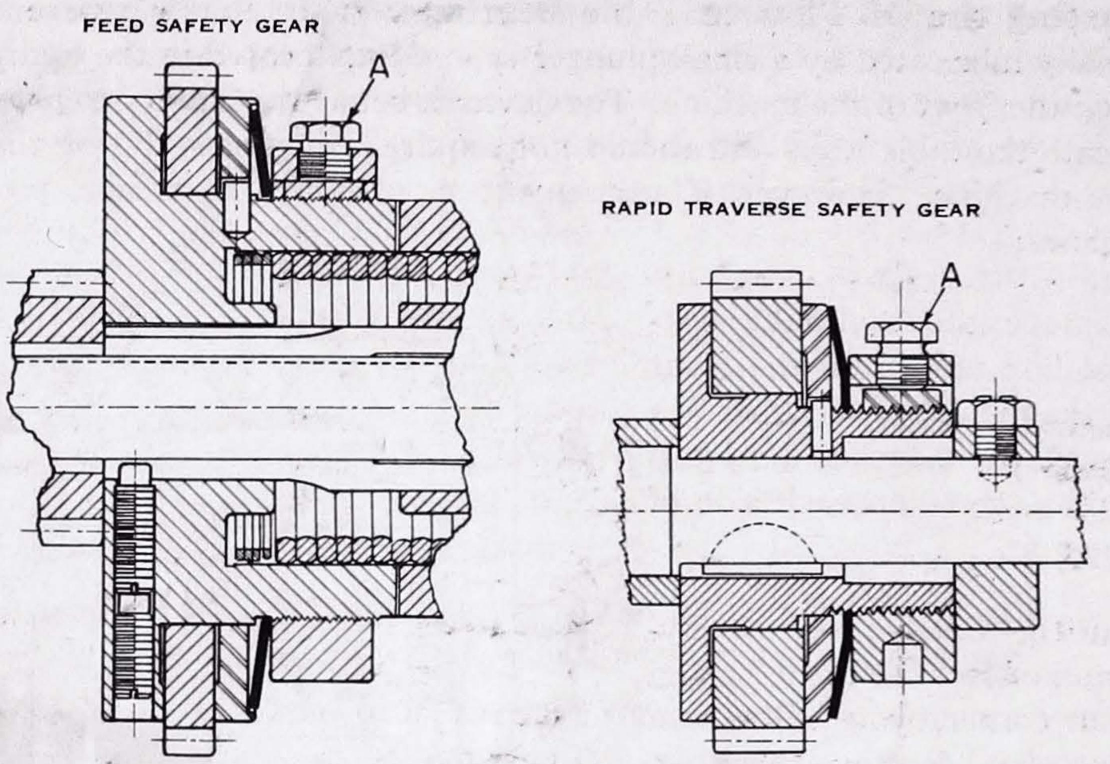

Figure 24
Safety Gears in Feed Box

3. Remove the hydraulic control box unit. This is held in place by six socket head cap screws, three on each side of the unit.

4. After removing the hydraulic unit, insert an eye-bolt in the center hole of each of the three bolt holes for the hydraulic unit. Attach a rope sling to the eye-bolts in order that the weight of the feed box unit may be supported by a crane.

5. Remove the feed box unit from the front of the bed. It is held in place by nine ½″ and two ⅜″ socket head cap screws. Great care should be exercised in carrying out this operation to prevent damage to the gear trains.

6. The safety gears may be seen at the rear of the feed box unit. The smaller of the two, located on the lower shaft, is the rapid traverse safety gear; the larger of the two is the feed safety gear. Loosen lock screw "A" in the adjusting nut and tap the screw lightly to loosen the shoe under the screw.

7. Tighten the adjusting nut about $\frac{1}{16}$ of a turn.

8. Retighten the locking screw "A".

9. Replace the feed box unit on the front of the bed, first coating the lower half of the joint with an oil-proof sealer.

10. Replace the hydraulic unit, the sheet steel guard in the change gear compartment, and the feed change gears. Before replacing the hydraulic unit make certain that the rear surface of the unit, and its mating surface on the front of the feed box unit, are *perfectly* clean.

SPECIAL INSTRUCTIONS FOR PROFILE MILLING

By means of the Cam Roller Attachment these machines are adaptable to the automatic milling of profile shapes. This attachment consists of a profile cam, cam roller assembly, special spindle carrier bored to take the cam roller assembly, pressure reducing valve, and two-way control valve.

The profile cam and cam roller are made to reproduce the desired shape on the milled part. The profile cam is usually mounted on the fixture and the cam roller assembly is mounted in the face of the spindle carrier. The roller on the cam roller assembly is held against the profile cam by the action of the hydraulic pressure in the rise-and-fall mechanism.

Pressure Reducing Valve. On machines equipped for profiling, a pressure reducing valve is used in the hydraulic system to reduce the unit pressure in the hydraulic rise-and-fall mechanism. This valve was added for two reasons:

1. To decrease the contact pressure between the cam and the roller, thereby giving longer life to both parts.

2. To decrease the load on the feed drive and clutch, caused by the action of the roller in climbing a rise in the cam.

This valve reduces the pressure in the rise-and-fall cylinder from the normal pressure of 300 pounds per square inch to 50 to 75 pounds per square inch depending upon the adjustment of the valve spring. It is possible to increase this pressure by using a stronger valve spring.

Note: Under no conditions should a profile cam be employed which has a maximum rise of more than 30°.

Two-Way Valve. Machines equipped for profiling are fitted with a two-way valve (Fig. 22) which is used in conjunction with the pressure reducing valve, and has the following function:

When the valve is moved to one side, the pressure reducing valve is "cut into" the circuit, thereby decreasing the pressure on top of the rise-and-fall cylinder. When the valve is moved to the other side, the pressure reducing valve is "cut out" of the circuit. You then have the full operating pressure of 300 pounds per square inch on top of the cylinder. This valve allows the machine equipped for profiling to be used for either profile milling, or as a standard rise-and-fall spindle carrier machine.

The two-way valve is located in the same compartment as the relief valves for the hydraulic system (see Fig. 22). It is accessible through the change gear compartment, at the right-hand end of the bed, after removing the change gears and the sheet metal guard which forms this compartment.

On machines equipped for profiling, the hydraulic clamps for the spindle carrier and outer arbor support are disconnected. When this machine is to be used as a standard rise-and-fall machine, these tubings should be connected.

Sharpening the Cutters. As the ultimate shape of the finished workpiece is created by the action of the cutter, as controlled by the cam and roller, it is necessary to keep a fixed relationship between the diameter of the roller and the diameter of the cutter.

On many jobs the cutter and the roller may be *exactly* the same size, in which case the roller should be ground each time the cutter is ground, to maintain this relationship.

In some cases it is advantageous to use a roller larger than the cutter, or vice versa. When this condition exists the procedure should be to remove the same amount from the diameter of the roller as was removed from the diameter of the cutter.

In special cases, where there might be some doubt as to the procedure to be followed, our Engineering Department should be consulted.

Adjusting the High Pressure. Although a pressure reducing valve is used to reduce the pressure in the hydraulic rise-and-fall mechanism, the hydraulic control box unit and the table and spindle drive clutches still require an operating pressure of 300 pounds per square inch. This pressure may be tested and adjusted as described under the heading "Testing and Adjusting the Hydraulic Pressure" (see page 26).

Testing and Adjusting the Low Pressure. The pressure reducing valve used in profiling is fitted with an adjusting screw to regulate the low pressure required in the rise-and-fall cylinder. The reduced pressure in the rise-and-fall cylinder may be tested and adjusted as follows:

1. Remove the $\frac{1}{8}''$ pipe plug, located in the rear flange of the hydraulic rise-and-fall cylinder bracket, and screw a pressure gage in its place.

2. Run the machine through its cycle until the cam roller is being held against the profile cam, rotate the set-up knob into the "Set-Up" position, and note the gage reading. The normal operating range for this pressure should be from 50 to 75 pounds per square inch. If adjustment should be indicated, proceed as follows:

3. Remove the feed change gears and the sheet steel guard in the change gear compartment. The low pressure adjusting valve may now be seen through the upper right-hand side of this opening (see Fig. 22).

Note: Fig. 22 is a view of the relief valves as seen from the *front* of the machine, before the installation of the feed box unit. The change gear compartment, through which the relief valve adjustment should be made, is located at the right-hand end of the bed.

4. Loosen the locking nut on the pressure adjusting screw, and rotate the screw until the desired pressure is obtained. Lock the adjustment by tightening the locking nut.

5. Replace the sheet steel guard and the change gears.

ORDERING REPAIR PARTS

Prompt service on repair parts will be given you upon receipt of the correct information at the Cincinnati Milling Machine Co., Cincinnati, Ohio, U. S. A. We must have the following data:

1. *Amount wanted.*

2. *Part number stamped on part.* (If number has been worn off, send us a sketch of the part.)

3. *Name of machine.*

4. *Serial number of machine.*

The correct machine serial number is absolutely necessary in ordering repair parts. This number will be found stamped on the front face of the spindle carrier, just beneath the overarm. It is also stamped in the bottom of the front table T-slot, at the right-hand end of the slot.

Ordering Additional Cycle Selectors. A great number of automatic cycles are available for these machines. When ordering additional cycle selector camshafts it is necessary that you explain in detail what sequence of operations you desire.

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