



# MAINTENANCE MANUAL



HLV machine with optional Acu-Rite III digital readout

TP4327

## Hardinge High Speed Super-Precision HLV-H Toolroom and TFB-H Production Lathes

**This maintenance manual applies to machines  
with serial number 13585 or higher.**

**- CAUTION -**

**Use petroleum base cutting fluids only! Use of water base coolants will void the warranty.**

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Manual No. M-10C  
Part No. M C-0009500-0010

Litho in U.S.A.  
February, 1991

**- NOTICE -**

**Damage resulting from misuse, negligence, or accident is not covered by the Hardinge Machine Warranty.**

Information in this manual is subject to change without notice.

This manual covers the maintenance of the Hardinge High Speed Super-Precision® HLV®-H Toolroom and TFB-H® Production Lathes.

In no event will Hardinge Inc. be responsible for indirect or consequential damages resulting from the use or application of the information in this manual.

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**CONVENTIONS USED IN THIS MANUAL**

**- WARNING -**

**Warnings must be followed carefully to avoid the possibility of personal injury or damage to the machine, tooling, or workpiece.**

**- CAUTION -**

**Cautions must be followed carefully to avoid the possibility of damage to the machine, tooling, or workpiece.**

**- NOTES -**

Notes contain supplemental information.

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## **READ COMPLETE INSTRUCTIONS CAREFULLY BEFORE OPERATING MACHINE**

When this instruction book was printed, the information given was current. However, since we are constantly improving the design of our machine tools, it is possible that the illustrations and descriptions may vary from the machine you received.

### **- WARNING -**

**Occupational Safety and Health Administration (OSHA) Hazard Communication Standard 1910.1200, effective May 25, 1986, and various state "employee right-to-know laws" require that information regarding chemicals used with this equipment be supplied to you. A complete list of the chemicals used with this machine, their reference data sheet numbers, and their suppliers appears as an insertion at the end of this manual. Refer to the applicable section of the Material Safety Data Sheets supplied with your machine when handling, storing, or disposing of chemicals.**

## **HARDINGE SAFETY RECOMMENDATIONS**

Your Hardinge machine is designed and built for maximum ease and safety of operation.

However, some previously accepted shop practices may not reflect current safety regulations and procedures, and should be re-examined to insure compliance with the current safety and health standards.

Hardinge recommends that all shop supervisors, maintenance personnel, and machine tool operators be advised of the importance of safe maintenance, setup, and operation of Hardinge-built equipment. Our recommendations are described below. **READ THESE SAFETY RECOMMENDATIONS BEFORE PROCEEDING ANY FURTHER.**

**READ THE APPROPRIATE MANUAL OR INSTRUCTIONS** before attempting operation or maintenance of the machine. Make sure you understand all instructions.

**CONSULT YOUR SUPERVISOR** when in doubt as to the correct way to do a job.

**DON'T OPERATE EQUIPMENT** unless proper maintenance has been regularly performed and the equipment is known to be in good working order.

**DON'T REMOVE** any warning or instruction tags from machine.

**DON'T OPERATE EQUIPMENT** if unusual or excessive heat, noise, smoke, or vibration occurs. Report any excessive or unusual vibration, sounds, smoke, or heat as well as any damaged parts.

**MAKE SURE** equipment is properly grounded. Consult National Electric Code and all local codes.

**DISCONNECT MAIN ELECTRICAL POWER** before attempting repair or maintenance.

**DON'T REACH** into any control or power case area unless electrical power is OFF.

(continued on the next page)

DON'T TOUCH ELECTRICAL EQUIPMENT when hands are wet or when standing on a wet surface.

ALLOW ONLY AUTHORIZED PERSONNEL to have access to enclosures containing electrical equipment.

DON'T ALLOW the operation or repair of equipment by untrained personnel.

REPLACE BLOWN FUSES with fuses of the same size and type as originally furnished.

ASCERTAIN AND CORRECT cause of a shutdown caused by overload heaters before starting machine.

WEAR SAFETY GLASSES AND PROPER FOOT PROTECTION at all times. When necessary, wear respirator, helmet, gloves and ear muffs or plugs.

KEEP AREA THE AROUND THE MACHINE well lighted and dry.

KEEP CHEMICAL AND FLAMMABLE MATERIAL away from electrical or operating equipment.

HAVE THE CORRECT TYPE OF FIRE EXTINGUISHER handy when machining combustible material and keep chips clear of the work area.

DON'T USE a toxic or flammable substance as a solvent cleaner or coolant.

MAKE SURE PROPER GUARDING is in place and all doors are closed and secured.

DON'T ALTER THE MACHINE to bypass any interlock, overload, disconnect or other safety device.

MAKE SURE chucks, closers, fixture plates, and all other spindle-mounted work-holding devices are properly mounted and secured before starting machine.

MAKE CERTAIN all tools are securely clamped in position before starting machine.

REMOVE ANY LOOSE PARTS OR TOOLS left on machine or in the work area before operating machine. Always check machine and work area for loose tools and parts, especially after work has been done by maintenance personnel.

REMOVE CHUCK WRENCHES before starting the machine.

KNOW WHERE ALL stop pushbuttons are located in case of an emergency.

CHECK THE LUBE LEVEL before operating the machine.

INSPECT ALL SAFETY DEVICES AND GUARDS to make certain that they are in good condition and are functioning properly before operating the machine.

CHECK THE TURRET POSITION before initiating carriage/cross slide motion.

CHECK SETUP, TOOLING, AND SECURITY OF WORKPIECE if the machine has been OFF for any length of time.

MAKE CERTAIN you are clear of any “pinch point” created by moving slides before starting the machine.

DON'T OPERATE any equipment while any part of the body is in the proximity of a potentially hazardous area.

DON'T REMOVE CHIPS with hands. Use a hook or similar device and make certain that all machine movements have ceased.

BE CAREFUL of sharp edges when handling newly machined workpieces.

DON'T REMOVE OR LOAD workpieces while any part of the machine is in motion.

DON'T OPERATE ANY MACHINE while wearing rings, watches, jewelry, loose clothing, neckties or long hair not contained by a net or shop cap.

DON'T ADJUST tooling or coolant hoses while the machine is running.

DON'T LEAVE tools, workpieces or other loose items where they can come in contact with a moving component of the machine.

DON'T CHECK finishes or dimensions of workpiece near running spindle or moving slides.

DON'T ROTATE SPINDLE in either direction when checking threads with a thread gage.

DON'T ATTEMPT to brake or slow the machine with hands or any makeshift device.

ANY ATTACHMENT, TOOL, OR MACHINE MODIFICATION not obtained from Hardinge Inc., must be reviewed by a qualified safety engineer before installation.

USE CAUTION around exposed mechanisms and tooling especially when setting up. Be careful of sharp edges on tools.

DON'T USE worn or defective hand tools. Use the proper size and type for job being performed.

USE ONLY a soft-faced hammer on turret tools and fixtures.

DON'T USE worn or broken tooling on machine.

MAKE CERTAIN that all tool mounting surfaces are clean before mounting tools.

INSPECT ALL CHUCKING DEVICES daily to make sure they are in good operating condition.

REPLACE DEFECTIVE CHUCK before starting machine.

USE MAXIMUM ALLOWABLE gripping pressure on the chuck. Consider weight, shape and balance of workpiece.

USE LIGHTER THAN NORMAL feedrates and depth of cut when machining a workpiece diameter that is larger than the gripping diameter.

(continued on the next page)

DON'T EXCEED the rated capacity of machine.

DON'T LEAVE the machine unattended while it is operating.

DON'T CLEAN the machine with an air hose.

DON'T OVERFILL tote pans.

KEEP TOTE PANS a safe distance from machine.

DON'T LET STOCK project past the back end of the collet closer or machine spindle without being adequately covered and properly supported.

USE FEED TUBE BUSHINGS when using a bar feed.

MAKE CERTAIN that any bar feed mechanism is properly aligned with spindle. If floor-mounted type, it must be securely bolted to floor.

## **FOR YOUR PROTECTION - WORK SAFELY**

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- NOTES -

# CHAPTER 1 - CARRIAGE

## CARRIAGE APRON DISASSEMBLY

1. Press "Start/Stop" pushbutton "A", Figure 1.1, IN to turn the machine OFF.
2. Place a drain pan capable of holding one pint of liquid under drain plug "C", Figure 1.2 .
3. Remove and clean magnetic drain plug "C".
4. Allow the reservoir to drain.
5. Replace magnetic drain plug "C".
6. Remove the drain pan and properly dispose of the used oil.
7. Remove three screws "J" and remove power feed assembly "K", Figure 1.3, from the apron cover.
8. Remove three screws "G" and remove handwheel assembly "D".
9. Remove eight screws "L", Figure 1.4, and clutch housings "M" and "N".



Figure 1.1 - Variable Speed Control Box (HLV®-H Machine Model Shown)

### - NOTE -

Do not misplace the seal under cover "P", Figure 1.5 .

10. Remove two screws "O" and cover "P", Figure 1.5 .

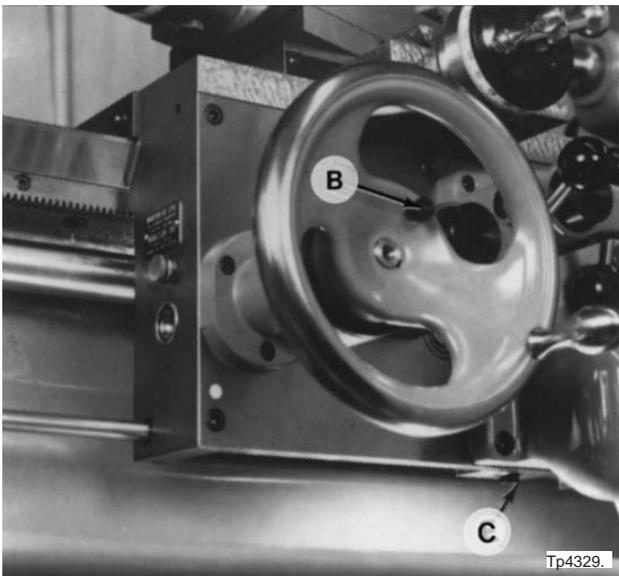


Figure 1.2 - Magnetic Drain Plug

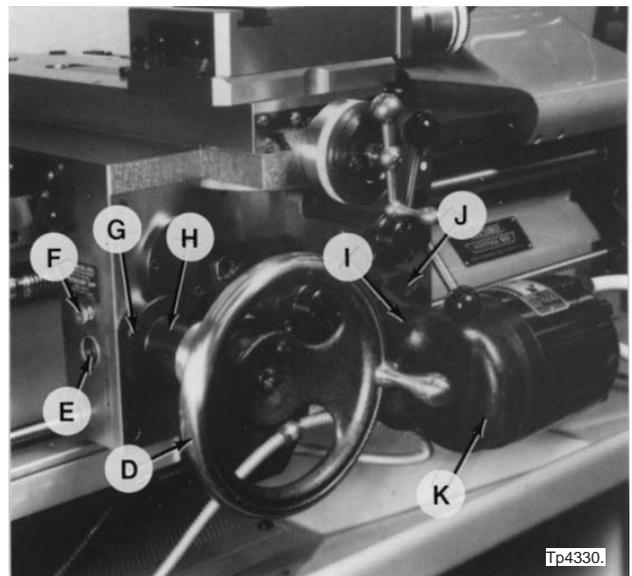


Figure 1.3 - Carriage Handwheel and Power Feed Drive

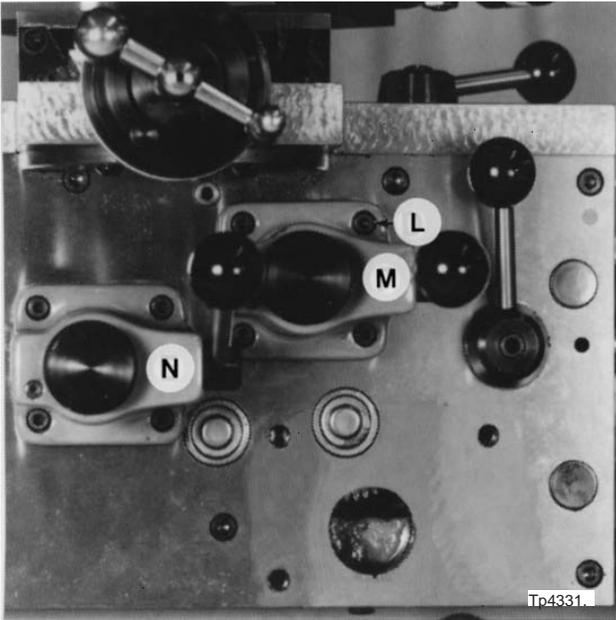


Figure 1.4 - Carriage Clutch Housing

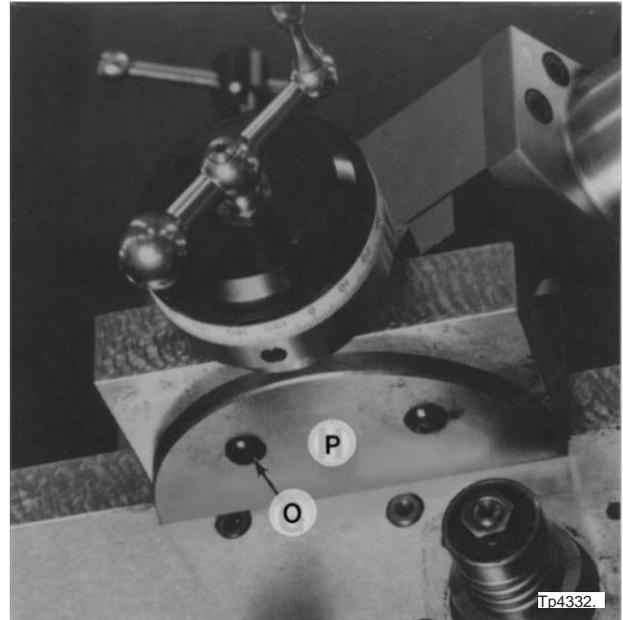


Figure 1.5 - Carriage Cover

11. Remove taper pin "S", Figure 1.6, to remove lead screw nut handle "U" and the fiber washer under the lead screw nut handle
12. Remove lock screw "T".
13. Remove seven screws "Q" from apron cover "R" .

**- NOTE -**

The apron cover is sealed with Permatex® sealant.

14. Remove apron cover "R" :
  - a) Pull the cover outward with the left hand while striking the edge of the cover with a soft-faced hammer until a crack appears in the sealant. Refer to Figure 1.7 .
  - b) Tap the cover back into place.
  - c) Repeat steps "a" and "b" until the seal is completely broken and the apron cover can be removed.
15. Remove rack pinion and 70 tooth gear "V", Figure 1.8 .

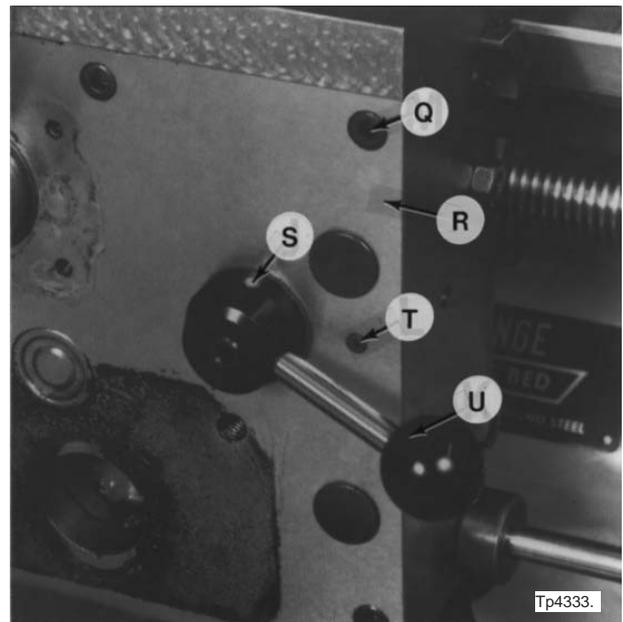


Figure 1.6 - Lead Screw Nut Handle

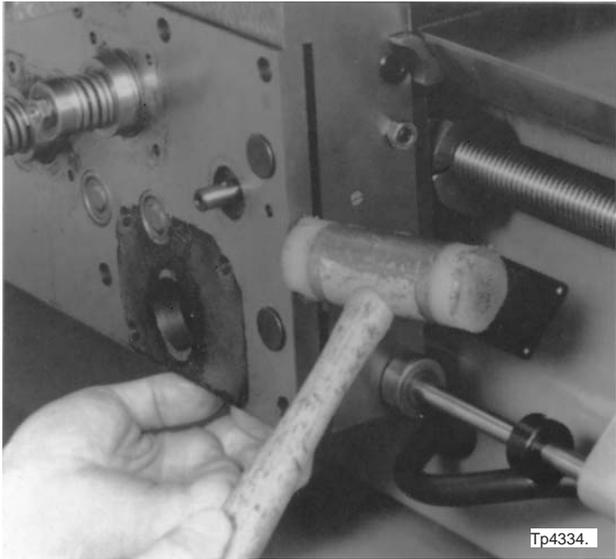


Figure 1.7 - Apron Cover Removal

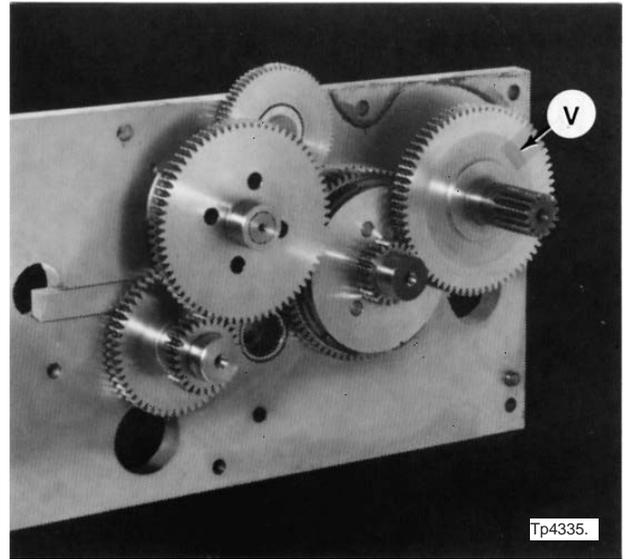


Figure 1.8 - Apron Cover Assembly

**- WARNING -**

**Spring "D", Figure 1.9, is under tension. Use caution when loosening and removing nuts "A".**

**- NOTE -**

Clutch components on the front side of the apron cover are identical, with the exception of the springs. **DO NOT** interchange the springs.

16. Carefully loosen and remove two nuts "A", Figure 1.9 .

17. Remove bearings "B", washers "C", springs "D", spring seats "E", and spacers "F".

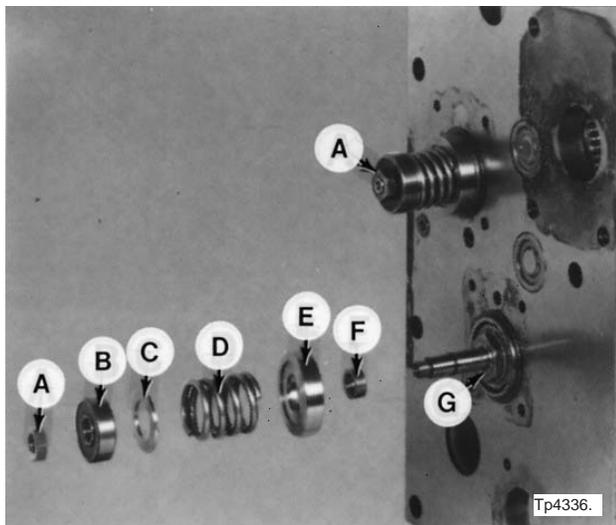


Figure 1.9 - Power Feed Clutch Components

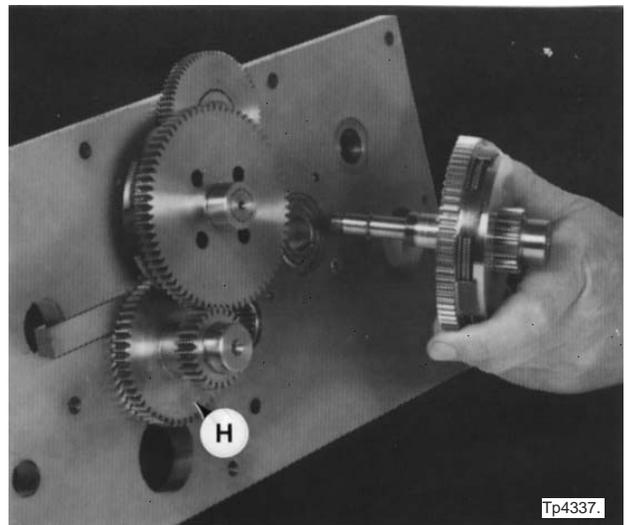


Figure 1.10 - Clutch Removal

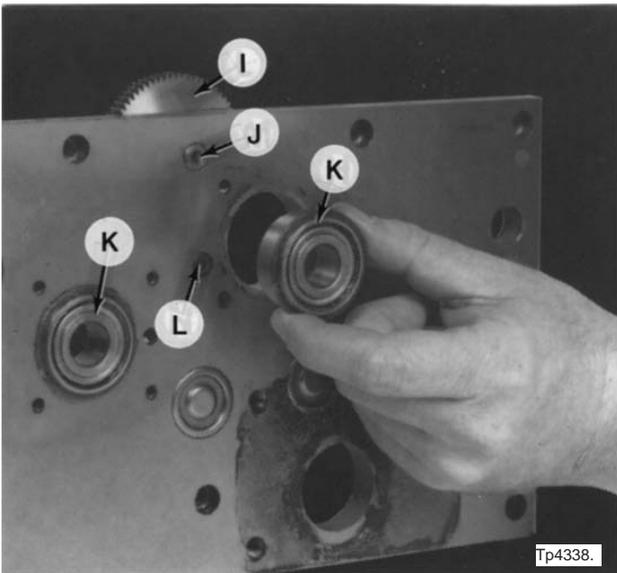


Figure 1.11 - Clutch Bearing Removal

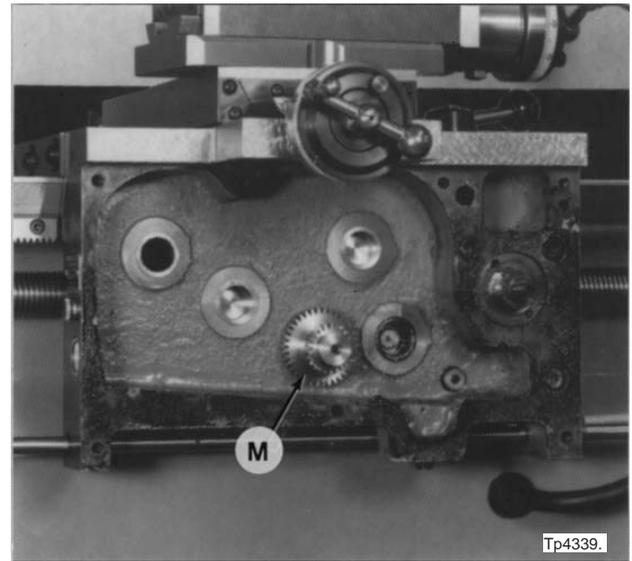


Figure 1.12 - Carriage Apron with Cover Removed

18. Remove two nuts "G", Figure 1.9, to remove the carriage and cross feed clutch assemblies, as shown in Figure 1.10 .

**- NOTE -**

It is not necessary to remove the snap ring from bearing "K", Figure 1.11, to disassemble the clutch assemblies.

19. Remove two clutch bearings "K", Figure 1.11, from the face of the apron cover.
20. Remove intermediate gears "H", Figure 1.10 and "M", Figure 1.12 .
21. If necessary, remove 70 tooth gear "I", Figure 1.11, by driving out stud "J".
22. Remove screw "L", Figure 1.11, to remove interlock plate "N", Figure 1.13 .
23. Remove longitudinal feed interlock bar "O", Figures 1.13 and 1.14, and spring "P" and plunger "Q", Figure 1.14 .
24. To disassemble the longitudinal (carriage) clutch assembly:
  - a) Remove snap ring "R", Figure 1.15 .
  - b) Remove 70 tooth gear "S", Figure 1.16 .
  - c) Remove clutch plate "T".
  - d) Remove snap rings "U", clutch disc "V", clutch plate "W", and wave washer "X", Figure 1.17 .

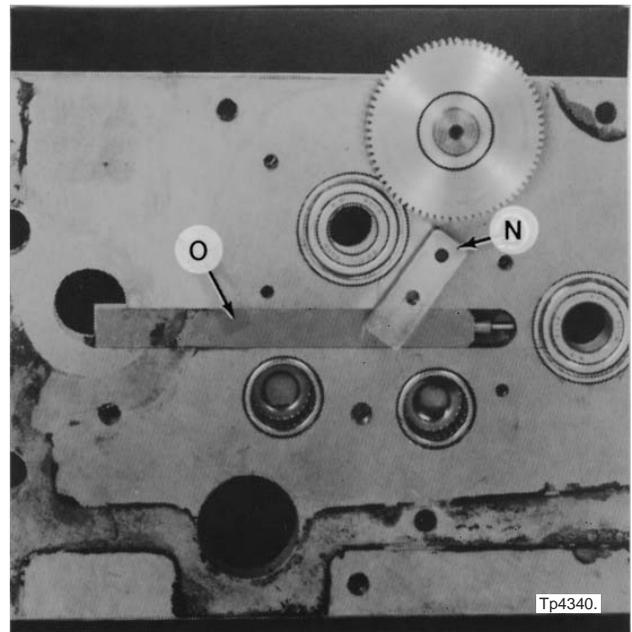


Figure 1.13 - Longitudinal Feed Interlock

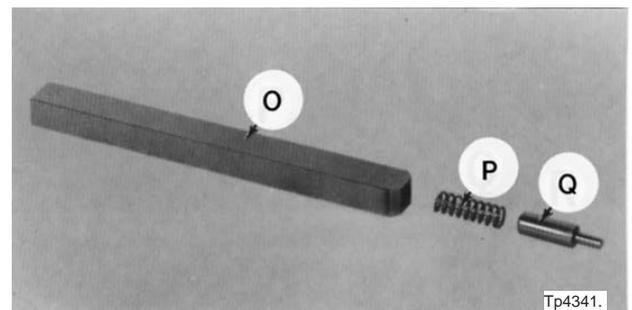


Figure 1.14 - Interlock Components

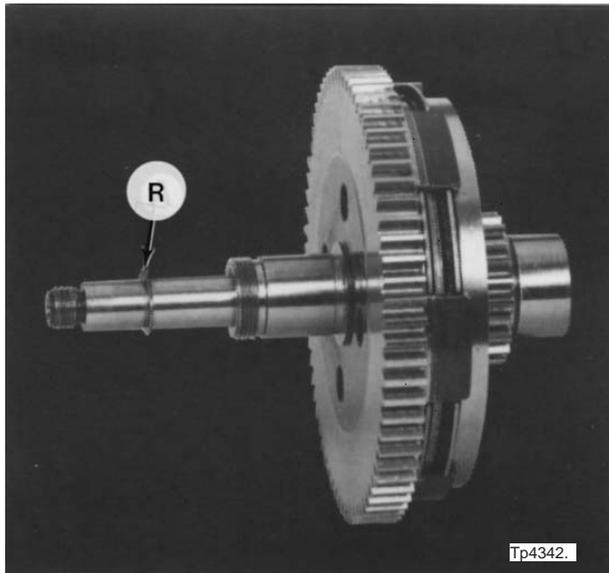


Figure 1.15 - Longitudinal (Carriage) Clutch

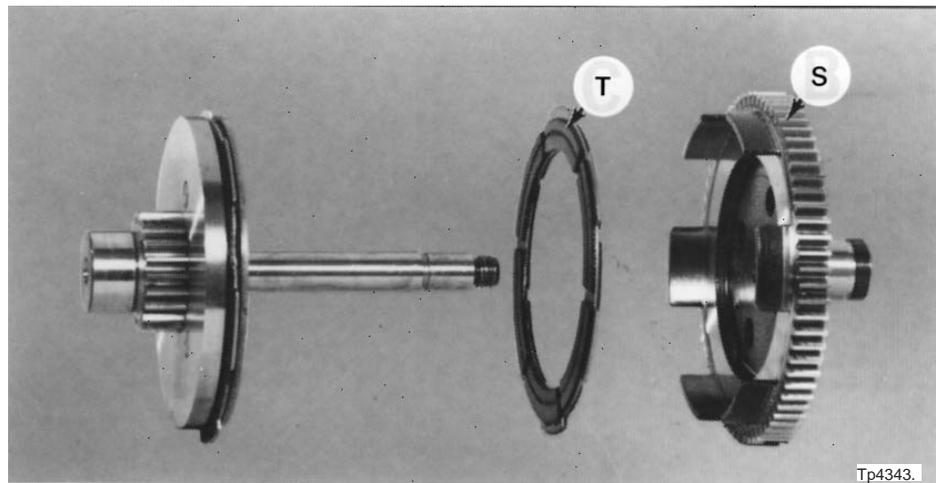


Figure 1.16 - Longitudinal Clutch Components

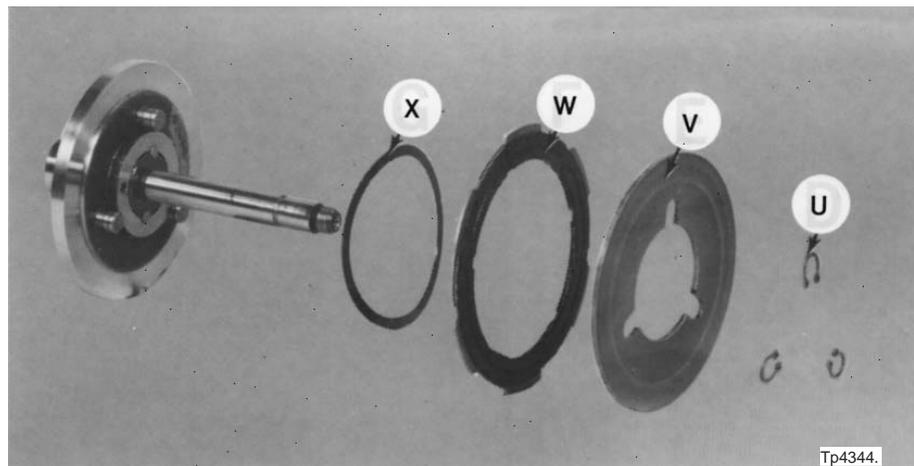


Figure 1.17 - Longitudinal Clutch Components

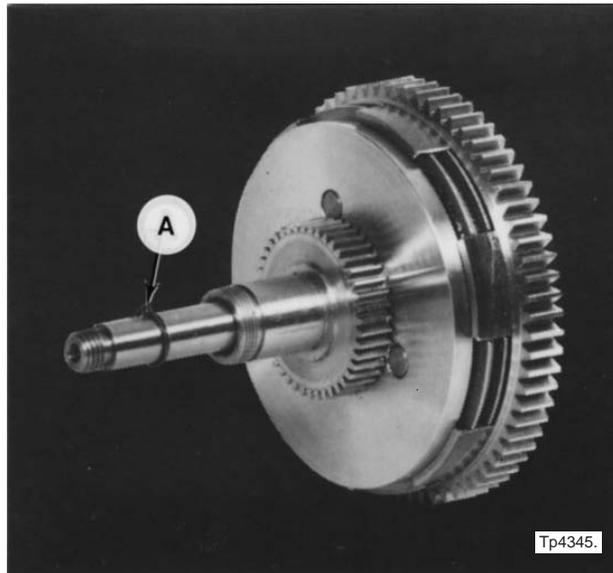


Figure 1.18 - Cross Feed Clutch

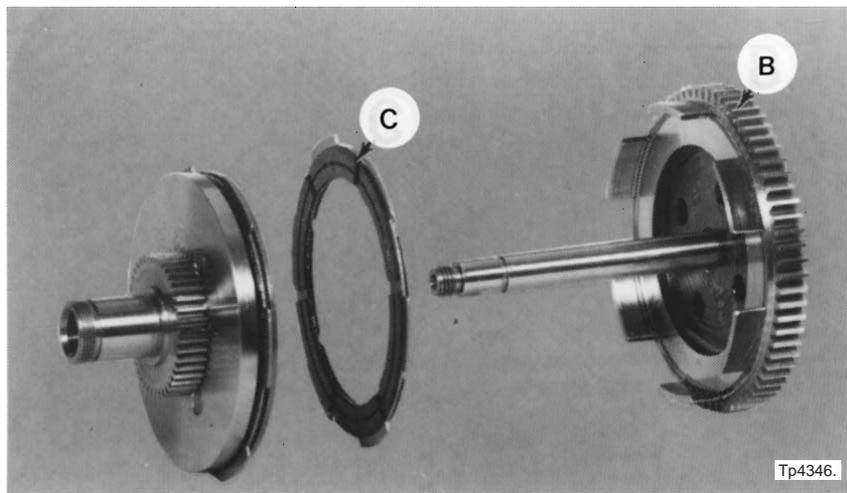


Figure 1.19 - Cross Feed Clutch Components

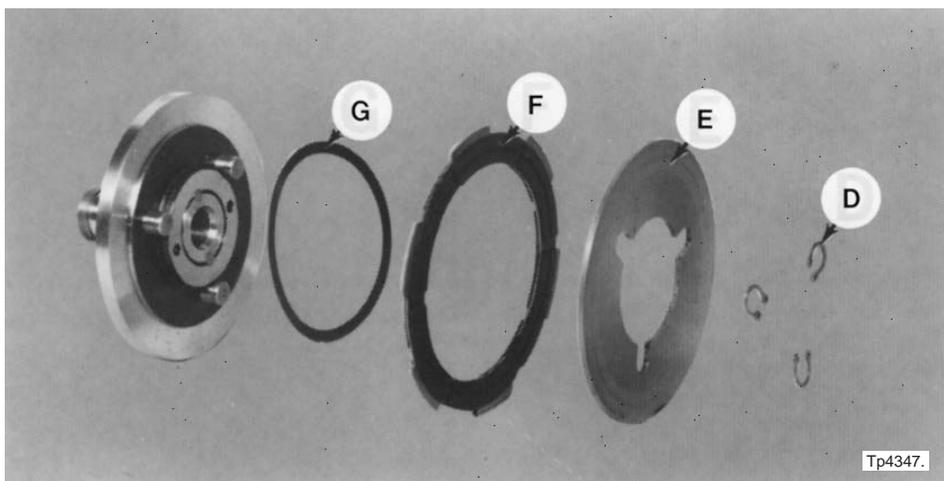


Figure 1.20 - Cross Feed Clutch Components

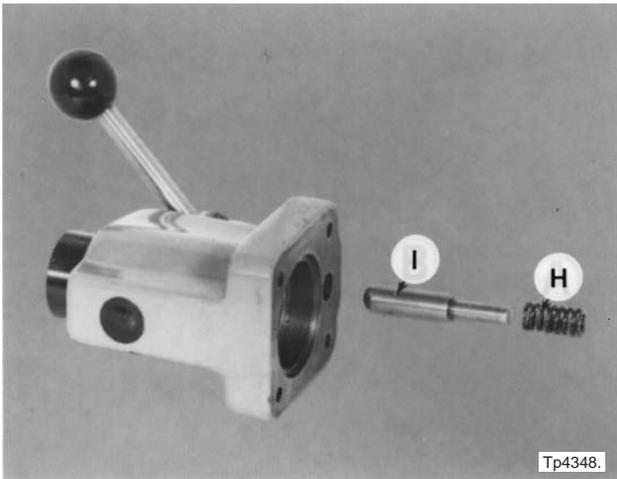


Figure 1.21 - Longitudinal Clutch Plunger and Spring

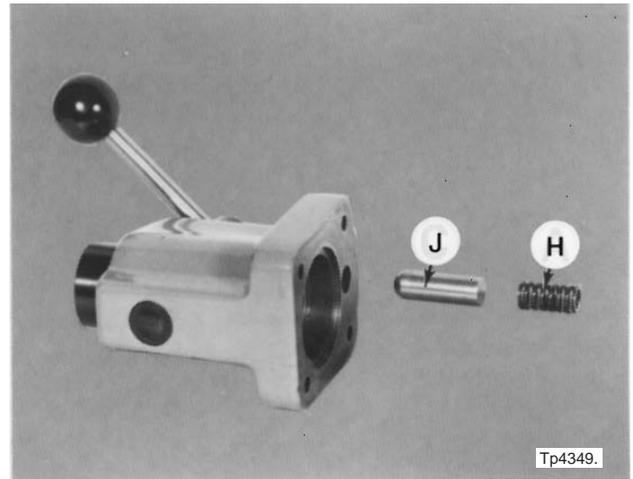


Figure 1.22 - Cross Feed Clutch Plunger and Spring

25. To disassemble the cross feed clutch assembly:

- a) Remove snap ring "A", Figure 1.18 .
- b) Remove shaft and 70 tooth gear "B", Figure 1.19 .
- c) Remove clutch plate "C".
- d) Remove snap rings "D", clutch disc "E", clutch plate "F", and wave washer "G", Figure 1.20 .

26. To disassemble the clutch housings:

- a) Remove springs "H", Figures 1.21 and 1.22, from the clutch housings.
- b) Remove cap "K" and nut "L", Figure 1.23, from each clutch housing.
- c) Loosen set screw "P" and remove camshaft "N" from each clutch housing.
- d) Remove sleeve "M" and bolt "O" from each clutch housing.

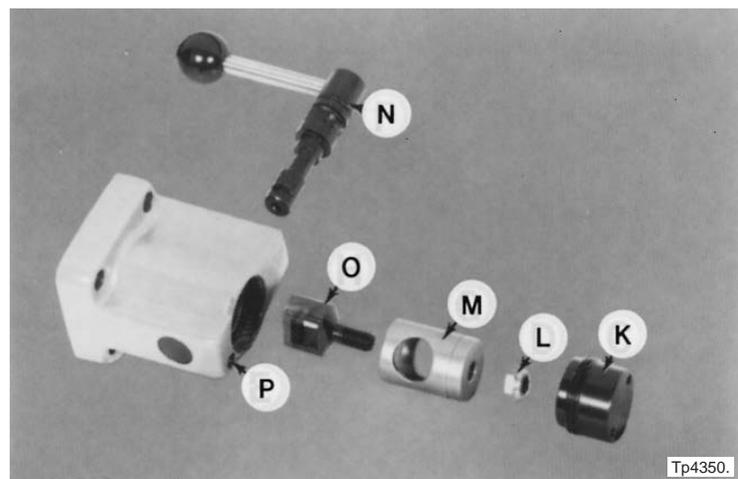


Figure 1.23 - Clutch Housing and Components

## CARRIAGE APRON REASSEMBLY

1. To reassemble the clutch housings:
  - a) Replace bolt “O” and sleeve “M”, Figure 1.23, in each clutch housing.
  - b) Replace camshaft “N” and tighten set screw “P” in each clutch housing.
  - c) Replace nut “L” and cap “K” in each clutch housing.
  - d) Replace interlock plunger “I”, Figure 1.21, and plunger “J”, Figure 1.22, in the clutch housings.
  - e) Replace springs “H”, Figures 1.21 and 1.22, in the clutch housings.
2. To reassemble the longitudinal (carriage) clutch assembly:
  - a) Replace wave washer “X”, clutch plate “W”, clutch disc “V”, and snap rings “U”, Figure 1.17 .
  - b) Replace clutch plate “T”, Figure 1.16 .
  - c) Replace 70 tooth gear “S”.
  - d) Replace snap ring “R”, Figure 1.15 .
3. To reassemble the cross feed clutch assembly:
  - a) Replace wave washer “G”, clutch plate “F”, clutch disc “E”, and snap rings “D”, Fig. 1.20.
  - b) Replace clutch plate “C”, Figure 1.19 .
  - c) Replace shaft and 70 tooth gear “B”.
  - d) Replace snap ring “A”, Figure 1.18 .
4. Install spring “P”, Figure 1.14, and plunger “Q” in longitudinal feed interlock bar “O”.

### - NOTE -

Longitudinal feed interlock bar “O”, Figure 1.13, must be positioned with the clearance chamfers as shown.

5. Replace longitudinal feed interlock bar “O”, as shown in Figure 1.13 .
6. Remount interlock plate “N”, Figure 1.13, using screw “L”, Figure 1.11 .
7. If removed, replace 70 tooth gear “I”, Figure 1.11 .
8. Replace intermediate gears “H”, Figure 1.10 and “M”, Figure 1.12 .
9. Replace clutch bearings “K”, Figure 1.11 .
10. Install the carriage and cross feed clutch assemblies in the apron cover as shown in Figure 1.10, using two nuts “G”, Figure 1.9 .
11. Replace spacers “F”, spring seats “E”, springs “D”, washers “C”, and bearings “B”, Figure 1.9 .

### - NOTE -

Compress springs “D”, Figure 1.9, until nuts “A” can be threaded on flush with the top of the shaft. Note the bracket used in Figure 1.24 .

12. Install two nuts “A”, Figure 1.9 .

13. Replace rack pinion and 70 tooth gear “V”, Figure 1.8 .

**- CAUTION -**

**Use care when installing the apron cover so as not to damage the gears.**

14. Apply Permatex® sealant to apron cover “R”, Figure 1.6, and replace using seven screws “Q”.
15. Apply Permatex sealant to cover “P”, Figure 1.5; then remount the cover seal and cover using two screws “O”.
16. In the clutch housings, pack springs “H,~ Figures 1.21 and 1.22, with Shell Alvania® #3 grease.

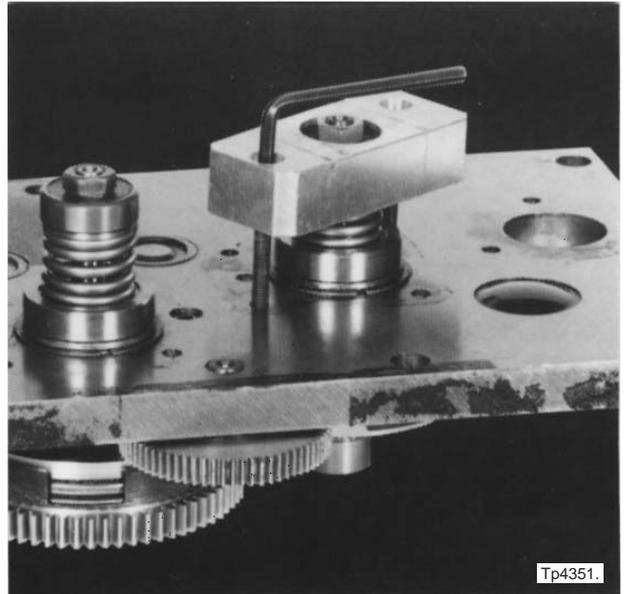


Figure 1.24 - Clutch Spring Replacement

17. Apply Permatex sealant to the surface of clutch housings “M” and “N”, Figure 1.4, that will be against the carriage apron cover.
18. Remount clutch housings “M” and “N” using eight screws “L”.
19. Apply Permatex sealant to the surface of handwheel housing “H”, Figure 1.3, that will be against the carriage apron cover.
20. Remount handwheel assembly “D” using three screws “G”.
21. Apply Permatex sealant to the surface of power feed housing “I”, that will be against the carriage apron cover.
22. Remount power feed assembly “K” using three screws “J”.
23. Replace lock screw “T”, Figure 1.6 .
24. Replace the fiber washer, handle “U”, and taper pin “S”.

**- NOTE -**

The carriage apron oil reservoir is full when sight window “E”, Figure 1.3, is completely filled with oil.

25. Fill the carriage apron oil reservoir:
  - a) Remove cap “F”, Figure 1.3 .
  - b) Fill the carriage apron oil reservoir with Mobilfluid® 350 oil.
  - c) Replace cap “F”.
26. With the clutch handles in one of the notched positions (up or down), tighten screw “R”, Figure 1.25, in each clutch housing.
27. Adjust the clutches according to the instructions in the next section, “Clutch Adjustment”.

## CLUTCH ADJUSTMENT

### - NOTE -

When properly adjusted, each clutch will release when the ball lever is between 10° and 20° above horizontal.

1. Using a spanner wrench, remove threaded cover "K", Figure 1.23, from each clutch assembly.

### - NOTE -

The clutches are spring loaded and cannot be adjusted for more pulling power.

2. Adjust each clutch at nut "S", Figure 1.25.
3. Replace threaded cover "K", Figure 1.23, on each clutch assembly.

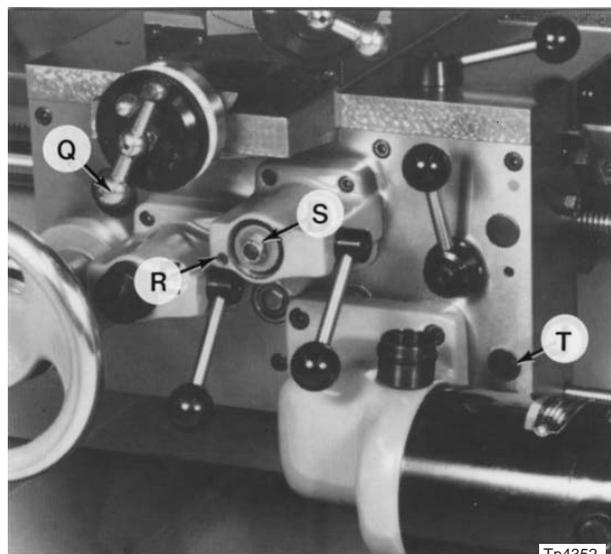


Figure 1.25 - Power Feed Clutch Adjustment

## CARRIAGE LOCK

### REMOVAL

1. Press "Start/Stop" pushbutton "A", Figure 1.1, IN to turn the machine OFF.
2. Place handle "U", Figure 1.26, in the unlocked position.
3. Lift handle "U" UP to remove.

If it is necessary to remove the two piece lock bolt shown in Figure 1.27, proceed to step 4.

4. Place a drain pan capable of holding one pint of liquid under drain plug "C", Figure 1.2.
5. Remove and clean magnetic drain plug "C".
6. Allow the reservoir to drain.
7. Replace magnetic drain plug "C".
8. Remove the drain pan and properly dispose of the used oil.
9. Remove three screws "J" and remove power feed assembly "K", Figure 1.3, from the apron cover.
10. Remove three screws "G" and remove handwheel assembly "D".
11. Remove eight screws "L", Figure 1.4, and clutch housings "M" and "N".

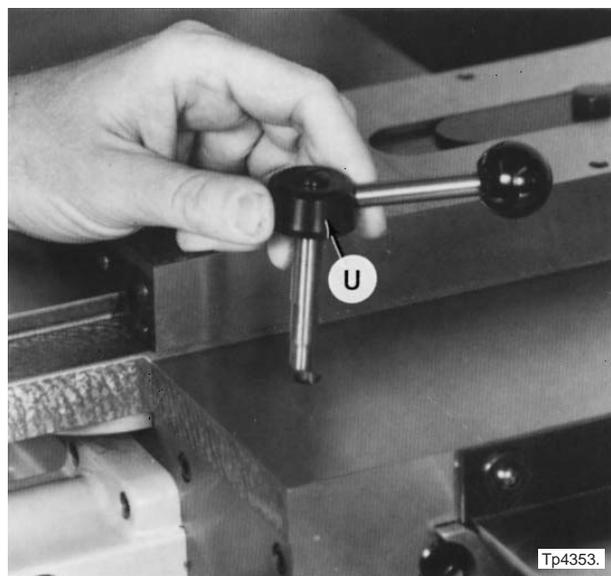


Figure 1.26 - Carriage Lock Handle

**- NOTE -**

Do not misplace the seal under cover "P", Figure 1.5 .

12. Remove two screws "O" and cover "P", Figure 1.5 .
13. Remove taper pin "S", Figure 1.6, to remove lead screw nut handle "U" and the fiber washer under the lead screw nut handle
14. Remove lock screw "T".
15. Remove seven screws "Q" from apron cover "R".

**- NOTE -**

The apron cover is sealed with Permatex® sealant.

16. Remove apron cover "R":
  - a) Pull the cover outward with the left hand while striking the edge of the cover with a soft-faced hammer until a crack appears in the sealant. Refer to Figure 1.7 .
  - b) Tap the cover back into place.
  - c) Repeat steps "a" and "b" until the seal is completely broken and the apron cover can be removed.
17. Remove the two piece lock bolt, as shown in Figure 1.27 .

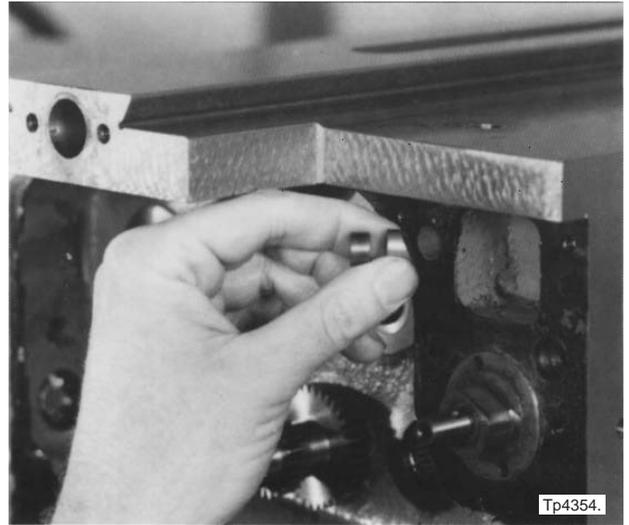


Figure 1.27 - Two Piece Lock Bolt

**REPLACEMENT**

1. If removed, replace the two piece lock bolt, as shown in Figure 1.27 .
2. Replace handle "U", Figure 1.26 .
3. Check the carriage lock for proper operation.
4. Apply Permatex sealant to apron cover "R" and replace using seven screws "Q", Figure 1.6.
5. Apply Permatex sealant to cover "P", Figure 1.5; then remount the cover seal and cover using two screws "O".
6. In the clutch housings, pack springs "H", Figures 1.21 and 1.22, with Shell Alvania #3 grease.
7. Apply Permatex sealant to the surface of clutch housings "M" and "N", Figure 1.4, that will be against the carriage apron cover.
8. Remount clutch housings "M" and "N" using eight screws "L".
9. Apply Permatex sealant to the surface of handwheel housing "H", Figure 1.3, that will be against the carriage apron cover.
10. Remount handwheel assembly "D" using three screws "G".
11. Apply Permatex sealant to the surface of power feed housing "I" that will be against the carriage apron cover.

12. Remount power feed assembly "K" using three screws "J".
13. Replace lock screw "T", Figure 1.6 .
14. Replace the fiber washer, handle "U", and taper pin "S".

**- NOTE -**

The carriage apron oil reservoir is full when sight window "E", Figure 1.3, is completely filled with oil.

15. Fill the carriage apron oil reservoir:
  - a) Remove cap "F", Figure 1.3 .
  - b) Fill the carriage apron oil reservoir with Mobilfluid® 350 oil.
  - c) Replace cap "F".

## GEAR RACK

### REMOVAL

1. Press "Start/Stop" pushbutton "A", Figure 1.1, IN to turn the machine OFF.

**- NOTE -**

Locking lever "V", Figure 1.28, is shown in the locked position.

2. Release locking lever "V", Figure 1.28, and remove the tailstock assembly from the end of the machine.
3. Remove the taper pin from positive stop "D", Figure 1.29 .

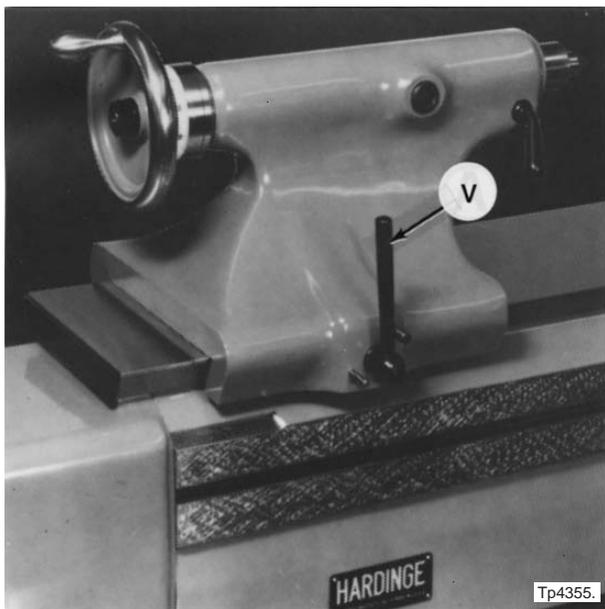


Figure 1.28 - Tailstock Locking Lever

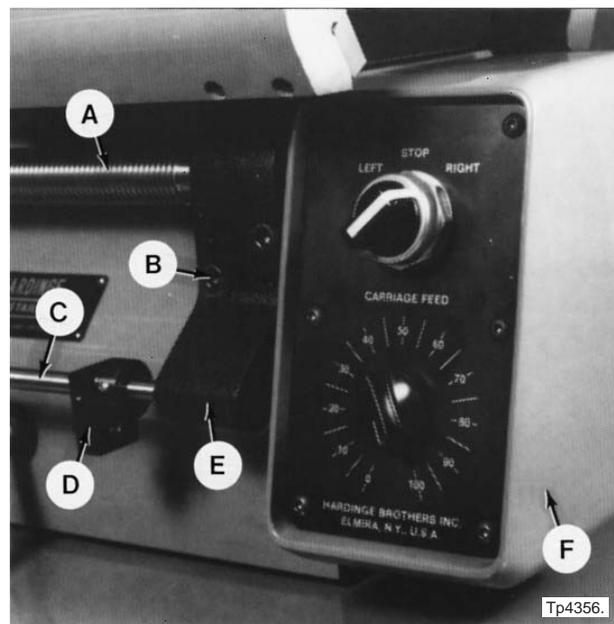


Figure 1.29 - Lead Screw and Bracket

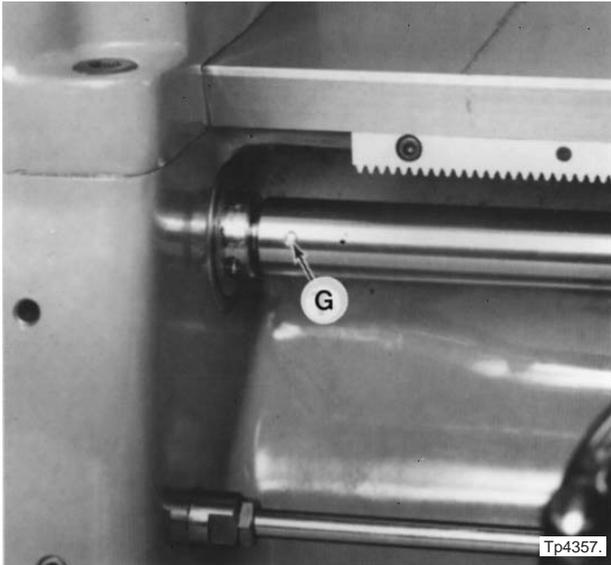


Figure 1.30 - Taper Pin for Lead Screw

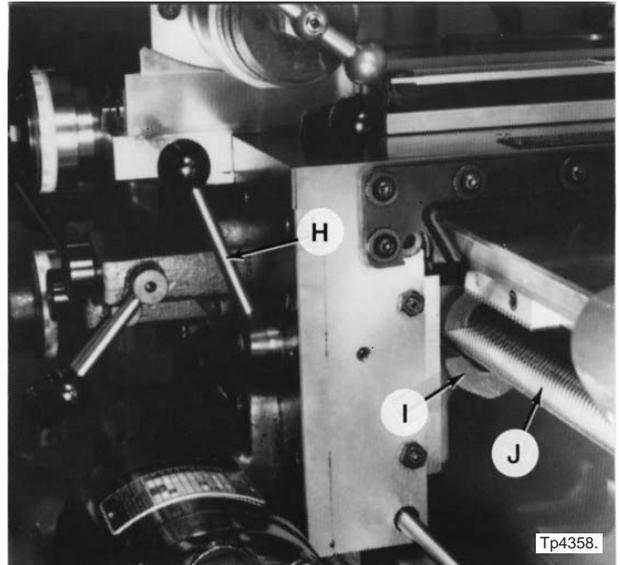


Figure 1.31 - Carriage Lead Screw Nut

**- NOTE -**

Taper pin "G", Figure 1.30, connects the carriage lead screw to the gear box cluster shaft.

4. Remove taper pin "G", Figure 1.30 .
5. Engage carriage lead screw nut "I", Figure 1.31, with carriage lead screw "J" by rotating lever "H" clockwise (as viewed from the front of the machine).
6. Move the carriage approximately 1/2 inch to right using handwheel "D", Figure 1.3 .
7. Disengage carriage lead screw nut "I", Figure 1.31, from carriage lead screw "J" by rotating lever "H" counterclockwise.
8. Remove three bolts "K", Figure 1.32 .
9. Set power feed control box "F", Figure 1.29, toward the rear of the machine.
10. Move the carriage to the extreme left using handwheel "D", Figure 1.3 .
11. Remove two screws "B", Figure 1.29 .

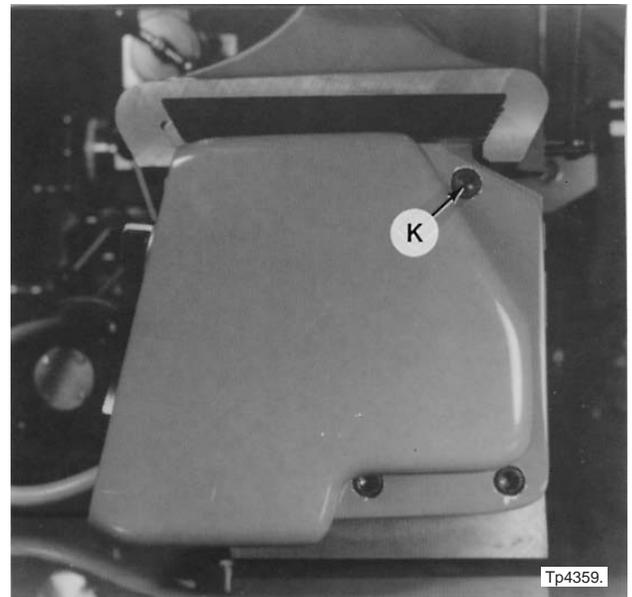


Figure 1.32 - Power Feed Control Box (End View)

**- CAUTION -**

**Support lead screw "A" by hand while removing bracket "E" to prevent damage to the threads on the lead screw. Continue supporting lead screw "A" while it is being removed.**

**- NOTE -**

DO NOT lose any shims located between bracket "E" and the bed. These shims are factory installed and must be present to ensure proper alignment of the bed and carriage ball screw "A".

12. Remove bracket "E" and any shims located between the bracket and the bed:
  - a) Carefully pull bracket "E" straight away from the bed until the dowel pins in bracket "E" clear the bed.
  - b) Slide bracket "E" to the right to remove it from carriage lead screw "A" and stop rod "C".
13. Remove carriage lead screw "J", Figure 1.31, from the machine by carefully removing it to the right through feed screw nut "I".
14. Remove positive stop "D", Figure 1.29 .
15. Move the carriage to the right using handwheel "D", Figure 1.3, until travel stops.
16. Pull the carriage by hand past the end of the bed until gear rack "N", Figure 1.33, is completely exposed.
17. Remove eight screws "M".

**- NOTE -**

Dowel pins "L" may remain in the bed or come out with rack "N" when the rack is removed.

18. Remove rack "N" by prying alternately and evenly at both ends of the rack with a small screwdriver to free the rack from the bed.

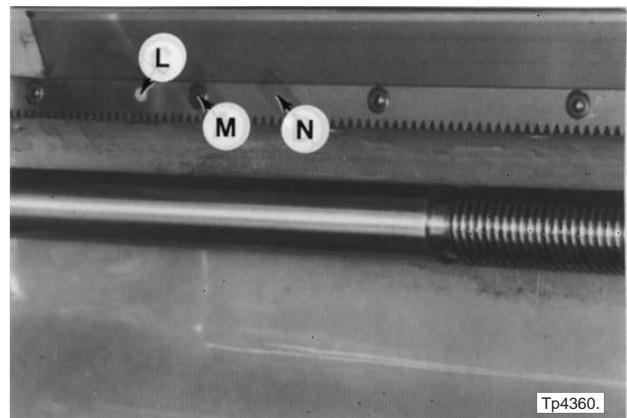


Figure 1.33 - Carriage Rack

## REPLACEMENT

**- NOTE -**

Dowel pins "L", Figure 1.33, may have remained in the bed or come out when rack "N" was removed.

1. Install rack "N", Figure 1.33, on the bed:
  - a) Align dowel pins "L" with their mating holes.
  - b) Using a soft-faced hammer, tap rack "N" into position alternately and evenly.
2. Install and tighten eight screws "M".

3. Carefully pull the carriage toward the headstock until the carriage handwheel pinion engages carriage rack "N".
4. Move the carriage to the extreme left using handwheel "D", Figure 1.3 .
5. Install positive stop "D", Figure 1.29, on stop rod "C".

**- CAUTION -**

**Support lead screw "A" by hand while it is being installed to prevent damage to the threads on the lead screw. Continue supporting lead screw "A" while installing bracket "E".**

**- NOTE -**

The end of carriage lead screw closest to the headstock has a hole drilled though it to accept taper pin "G", Figure 1.30 .

6. Install carriage lead screw "J", Figure 1.31, in the machine by carefully moving it to the left through feed screw nut "I".
7. Install bracket "E", Figure 1.29, and any shims that were located between the bracket and the bed:
  - a) Slide bracket "E" to the left to install it on carriage lead screw "A" and stop rod "C".
  - b) Align the dowel pins in bracket "E" with the dowel pin holes in the bed.
  - c) Position the shim(s) between bracket "E" and the bed.
  - d) Mount bracket "E" to the bed of the machine using two screws "B".
8. Remount power feed control box "F", Figure 1.29, using three bolts "K", Figure 1.32 .
9. Move the carriage to the extreme right using handwheel "D", Figure 1.3 .
10. Engage carriage lead screw nut "I", Figure 1.31, with carriage lead screw "J" by rotating lever "H" clockwise.
11. Move the carriage approximately 1/2 inch to left using handwheel "D", Figure 1.3 .
12. Disengage carriage lead screw nut "I", Figure 1.31, from carriage lead screw "J" by rotating lever "H" counterclockwise.

**- NOTE -**

Properly align the tapered hole in the left end of carriage lead screw "J", with the corresponding hole in the gear box cluster shaft.

13. Install taper pin "G", Figure 1.30 .
14. Install the taper pin in positive stop "D", Figure 1.29 .
15. Replace the tailstock assembly on the machine.

## **LUBRICATION**

Clean and lubricate the gear rack at least once a week:

1. Remove all chips and clean the gear rack using mineral spirits.
2. Lubricate the gear rack using a pressure oil can containing Mobil® Velocite® oil No. 6.

## GIB ADJUSTMENT

After a period of continued use, it may become necessary to adjust the carriage gib. The gib is the tapered type and adjustment is made from the large end of the gib at "O", Figure 1.34 .

### - NOTE -

Excessive gib pressure or drag does not improve machine performance.

To adjust the carriage gib:

1. Insert a 1/4 inch hexagon wrench into adjusting screw "O", Figures 1.34 and 1.35 .
2. Loosen adjusting screw "O" by turning the wrench one full turn in the counterclockwise direction.
3. Push the wrench through adjusting nut "O" and into adjusting nut "P", Figure 1.35 .
4. Advance adjusting nut "P" by turning the wrench a fraction of a turn in the clockwise direction.

### - NOTE -

Do not overtighten adjusting screw "O".

5. Pull the wrench out of adjusting nut "P" and tighten adjusting nut "O" by turning the wrench in the clockwise direction.
6. Test the carriage for "feel". The carriage should have a slight drag, but it should not bind.
7. Repeat this procedure if necessary.

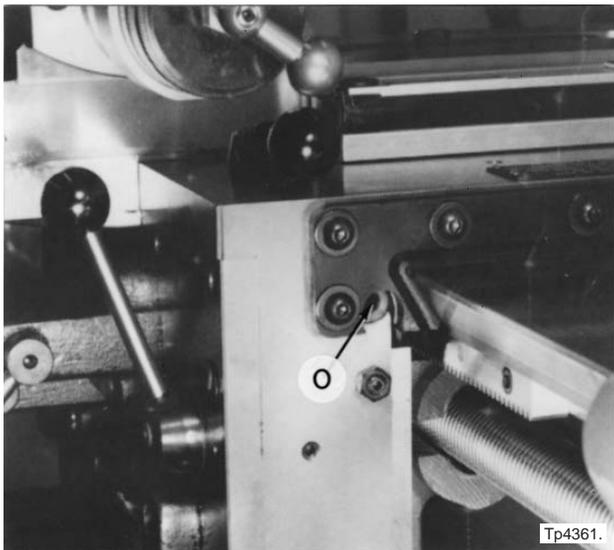


Figure 1.34 - Carriage Gib Adjustment

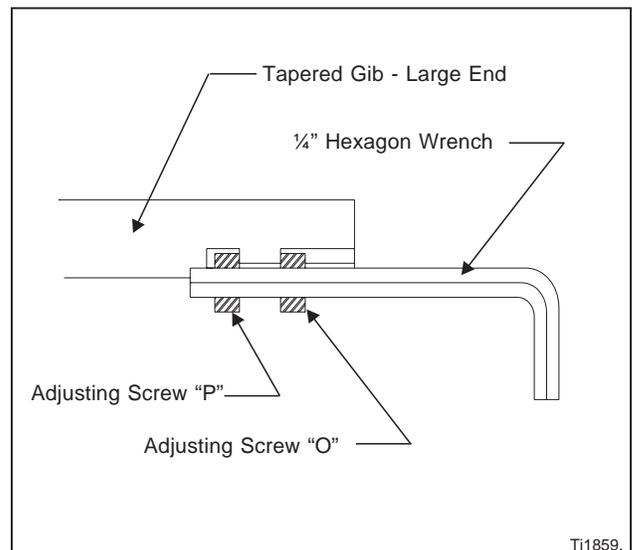


Figure 1.35 - Gib Adjustment Illustration

## HANDWHEEL

After a period of continual use, it may become necessary to remove handwheel assembly "D", Figure 1.3, to clean or replace internal components.

### REMOVAL

1. Press "Start/Stop" pushbutton "A", Figure 1.1, IN to turn the machine OFF.
2. Place a drain pan capable of holding one pint of liquid under drain plug "C", Figure 1.2.
3. Remove and clean magnetic drain plug "C".
4. Allow the reservoir to drain.
5. Replace magnetic drain plug "C".
6. Remove the drain pan and properly dispose of the used oil.
7. Remove three screws "G", Figure 1.3, and remove handwheel assembly "D".

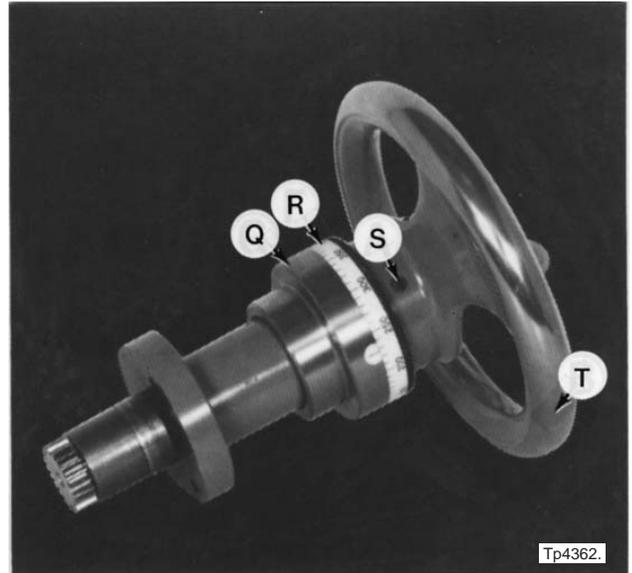


Figure 1.36 - Carriage Handwheel Assembly

### DISASSEMBLY

1. Remove the lock screw located at "S", Figure 1.36 .
2. Loosen the set screw located at "S".
3. Remove handwheel "T".
4. Remove key "U", Figure 1.37 .
5. Remove shaft and 21 tooth gear "V", Figures 1.37 and 1.38 .

#### - NOTE -

Do not misplace the nylon plug between lock screw "B", Figure 1.2, and dial "R", Figure 1.36 .

6. Remove snap ring "X", Figure 1.39, to remove dial "Y", from the handwheel.

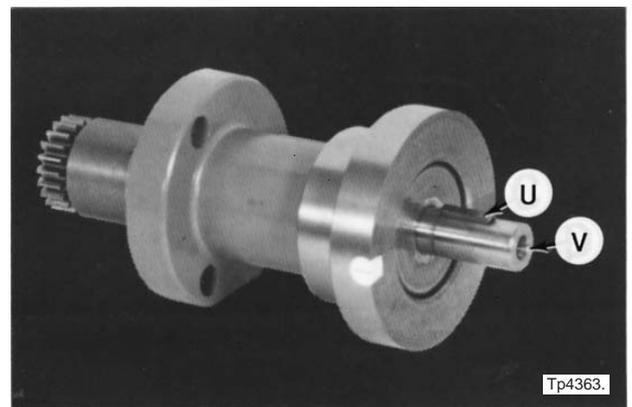


Figure 1.37 - Carriage Handwheel Components

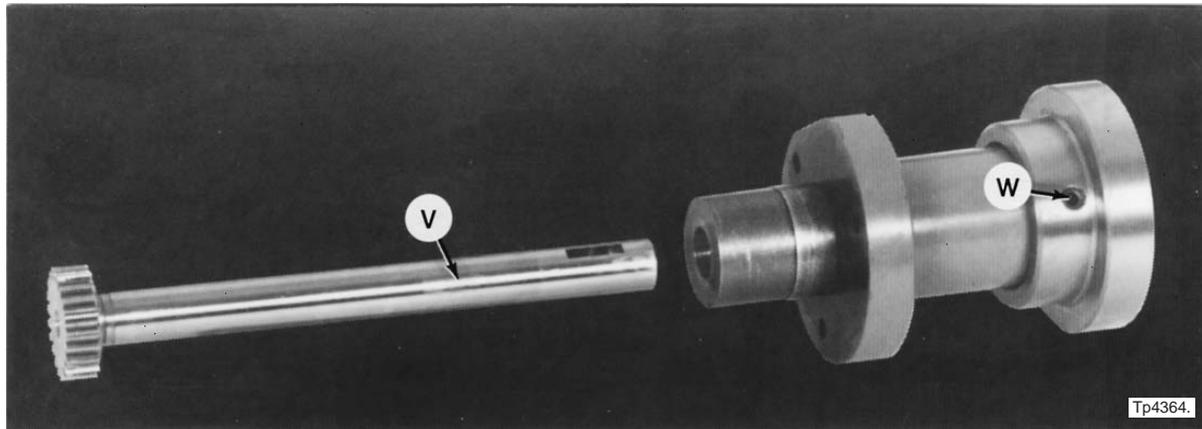


Figure 1.38 - Carriage Handwheel Components

## REASSEMBLY

### - NOTE -

Be sure the nylon plug is in position before mounting dial "Y", Figure 1.39, onto the handwheel.

1. Mount dial "Y" onto the handwheel using snap ring "X", Figure 1.39 .
2. Replace shaft and 21 tooth gear "V", Figures 1.37 and 1.38 .
3. Replace key "U", Figure 1.37 .
4. Replace handwheel "T", Figure 1.36 .
5. Tighten the set screw located at "S".
6. Install and tighten the lock screw located at "S".

## REPLACEMENT

1. Use Permatex<sup>®</sup> sealant on surface of handwheel housing "H", Figure 1.3, that will be against carriage apron cover "R", Figure 1.6 .
2. Replace handwheel assembly "D", Figure 1.3, using three screws "G".

### - NOTE -

The carriage apron oil reservoir is full when sight window "E", is completely filled with oil.

3. Fill the carriage apron oil reservoir:
  - a) Remove cap "F".
  - b) Fill the carriage apron oil reservoir with Mobilfluid<sup>®</sup> 350 oil.
  - c) Replace cap "F".



Figure 1.39 - Carriage Handwheel and Dial

## CLEARANCE ADJUSTMENT

### - NOTE -

The clearance between dial "R", Figure 1.36, and zero ring "Q" should be set at .002" to .004" [.05mm to .1mm].

To adjust the clearance:

1. Loosen set screw "W", Figure 1.38 .
2. Adjust the clearance between dial "R", Figure 1.36, and zero ring "Q" as needed.
3. Tighten set screw "W", Figure 1.38 .

## LEAD SCREW (HLV<sup>®</sup>-H Machines only)

### REMOVAL

1. Press "Start/Stop" pushbutton "A", Figure 1.1, IN to turn the machine OFF.

### - NOTE -

Taper pin "G", Figure 1.30, connects carriage ball screw "J", Figure 1.31, to the gear box cluster shaft.

2. Remove taper pin "G", Figure 1.30 .
3. Engage carriage lead screw nut "I", Figure 1.31, with carriage lead screw "J" by rotating lever "H" clockwise (as viewed from the front of the machine).
4. Move the carriage approximately ~2 inch to right using handwheel "D", Figure 1.3 .
5. Disengage carriage lead screw nut "I", Figure 1.31, from carriage lead screw "J" by rotating lever "H" counterclockwise.
6. Remove three bolts "K", Figure 1.32 .
7. Set power feed control box "F", Figure 1.29, toward the rear of the machine.
8. Move the carriage to the extreme left using handwheel "D", Figure 1.3 .
9. Remove two screws "B", Figure 1.29 .

**- CAUTION -**

**Support lead screw "A" by hand while removing bracket "E" to prevent damage to the threads on the lead screw. Continue supporting lead screw "A" while it is being removed.**

**- NOTE -**

DO NOT lose any shims located between bracket "E" and the bed. These shims are factory installed and must be present to ensure proper alignment of the bed and carriage ball screw "A".

10. Remove bracket "E" and any shims located between the bracket and the bed:
  - a) Carefully pull bracket "E" straight away from the bed until the dowel pins in bracket "E" clear the bed.
  - b) Slide bracket "E" to the right to remove it from carriage lead screw "A" and stop rod "C".
11. Remove carriage lead screw "J", Figure 1.31, from the machine by carefully removing it to the right through feed screw nut "I".

**- NOTE -**

Locating dowel pins "A", Figure 1.40, and needle bearing "B" are press fit in lead screw bracket "C".

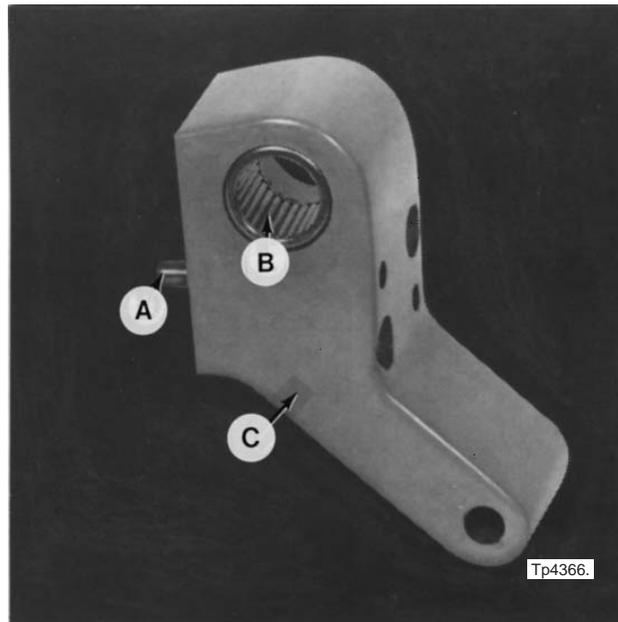


Figure 1.40 - Lead Screw Bracket

## REPLACEMENT

### - CAUTION -

**Support lead screw “A”, Figure 1.29, by hand while it is being installed to prevent damage to the threads on the lead screw. Continue supporting lead screw “A” while installing bracket “E”.**

### - NOTE -

The end of carriage lead screw closest to the headstock has a hole drilled though it to accept taper pin “G”, Figure 1.30 .

1. Install carriage lead screw “J”, Figure 1.31, in the machine by carefully moving it to the left through feed screw nut “I”.
2. Install bracket “E”, Figure 1.29, and any shims that were located between the bracket and the bed:
  - a) Slide bracket “E” to the left to install it on carriage lead screw “A” and stop rod “C”.
  - b) Align the dowel pins in bracket “E” with the dowel pin holes in the bed.
  - c) Position the shim(s) between bracket “E” and the bed.
  - d) Mount bracket “E” to the bed of the machine using two screws “B”.
3. Remount power feed control box “F”, Figure 1.29, using three bolts “K”, Figure 1.32 .
4. Move the carriage to the extreme right using handwheel “D”, Figure 1.3 .
5. Engage carriage lead screw nut “I”, Figure 1.31, with carriage lead screw “J” by rotating lever “H” clockwise.
6. Move the carriage approximately 1/2 inch to left using handwheel “D”, Figure 1.3 .
7. Disengage carriage lead screw nut “I”, Figure 1.31, from carriage lead screw “J” by rotating lever “H” counterclockwise.

### - NOTE -

Properly align the tapered hole in the left end of carriage lead screw “J” with the corresponding hole in the gear box cluster shaft.

8. Install taper pin “G”, Figure 1.30 .

## LUBRICATION

Clean and lubricate the carriage lead screw at least once a week:

1. Remove all chips and clean the carriage lead screw using mineral spirits
2. Lubricate the carriage lead screw using a pressure oil can containing Mobil® Velocite® oil No. 6.

## LEAD SCREW NUT (HLV<sup>®</sup>-H Machines only)

### REMOVAL

1. Press “Start/Stop” pushbutton “A”, Figure 1.1, IN to turn the machine OFF.

**- NOTE -**

Locking lever “V”, Figure 1.28, is shown in the locked position.

2. Release locking lever “V”, Figure 1.28, and remove the tailstock assembly from the end of the machine.
3. Remove the taper pin from positive stop “D”, Figure 1.29 .

**- NOTE -**

Taper pin “G”, Figure 1.30, connects carriage ball screw “J”, Figure 1.31, to the gear box cluster shaft.

4. Remove taper pin “G”, Figure 1.30 .
5. Engage carriage lead screw nut “I”, Figure 1.31, with carriage lead screw “J” by rotating lever “H” clockwise.
6. Move the carriage approximately 1/2 inch to right using handwheel “D”, Figure 1.3 .
7. Disengage carriage lead screw nut “I”, Figure 1.31, from carriage lead screw “J” by rotating lever “H” counterclockwise.
8. Remove three bolts “K”, Figure 1.32 .
9. Set power feed control box “F”, Figure 1.29, toward the rear of the machine.
10. Move the carriage to the extreme left using handwheel “D”, Figure 1.3 .
11. Remove two screws “B”, Figure 1.29 .

**- CAUTION -**

**Support lead screw “A” by hand while removing bracket “E” to prevent damage to the threads on the lead screw. Continue supporting lead screw “A” while it is being removed.**

**- NOTE -**

DO NOT lose any shims located between bracket “E” and the bed. These shims are factory installed and must be present to ensure proper alignment of the bed and carriage ball screw “A”.

12. Remove bracket “E” and any shims located between the bracket and the bed:
  - a) Carefully pull bracket “E” straight away from the bed until the dowel pins in bracket “E” clear the bed.
  - b) Slide bracket “E” to the right to remove it from carriage lead screw “A” and stop rod “C”.
13. Remove carriage lead screw “J”, Figure 1.31, from the machine by carefully removing it to the right through feed screw nut “I”.
4. Remove positive stop “D”, Figure 1.29 .

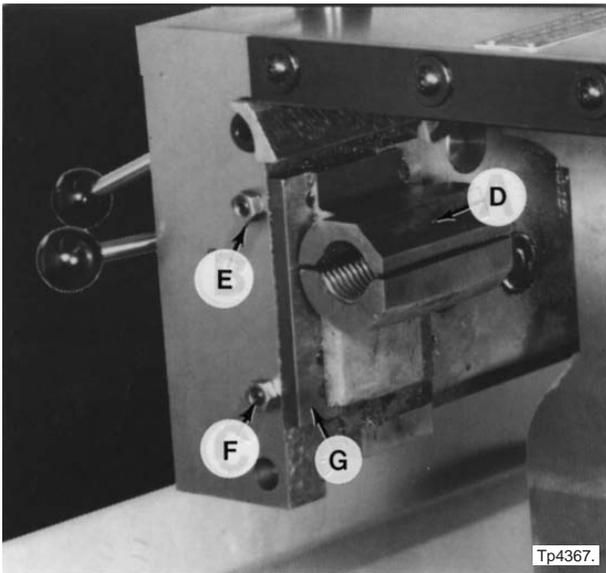


Figure 1.41 - Lead Screw Nut

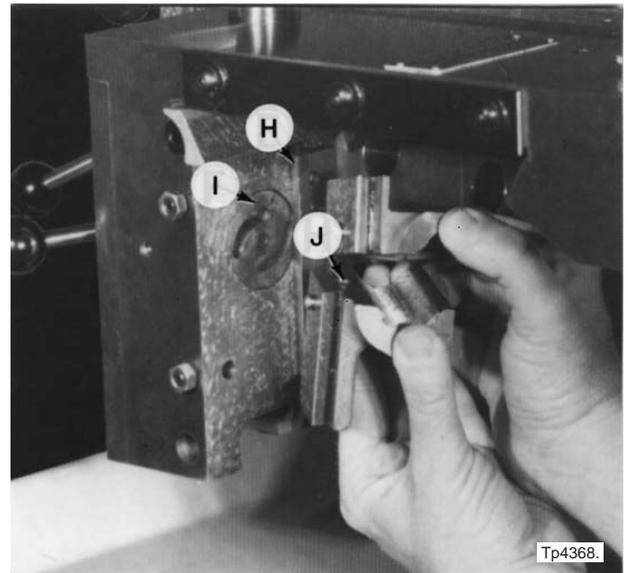


Figure 1.42 - Lead Screw Nut Removal

15. Move the carriage to the right using handwheel "D", Figure 1.3, until travel stops.
16. Pull the carriage to the right by hand until lead screw nut "D", Figure 1.41, clears the bed.
17. Loosen two lock nuts "E".
18. Loosen two screws "F".
19. Remove two dot plugs "T", Figure 1.25 .

**- NOTE -**

Hold gib "G", Figure 1.41, to prevent it from dropping from position.

20. Remove the two screws located under dot plugs "T", Figure 1.25 .
21. Remove gib "G", Figure 1.41 .
22. Remove lead screw nut "D".

**- NOTE -**

If it is necessary to remove gib "H" or cam "I", Figure 1.42, perform steps 23 through 37.

23. Place a drain pan capable of holding one pint of liquid under drain plug "C", Figure 1.2 .
24. Remove and clean magnetic drain plug "C".
25. Allow the reservoir to drain.
26. Replace magnetic drain plug "C".
27. Remove the drain pan and properly dispose of the used oil.
28. Remove three screws "J", Figure 1.3, and remove power feed assembly "K" from the apron cover.
29. Remove three screws "G" and remove handwheel assembly "D".
30. Remove eight screws "L", Figure 1.4, and clutch housings "M" and "N".

**- NOTE -**

Do not misplace the seal under cover "P", Figure 1.5 .

31. Remove two screws "O" and cover "P", Figure 1.5 .
32. Remove taper pin "S", Figure 1.6, to remove lead screw nut handle "U" and the fiber washer under the lead screw nut handle
33. Remove lock screw "T".
34. Remove seven screws "Q" from apron cover "R".

**- NOTE -**

The apron cover is sealed with Permatex® sealant.

35. Remove apron cover "R" :
  - a) Pull the cover outward with the left hand while striking the edge of the cover with a soft-faced hammer until a crack appears in the sealant. Refer to Figure 1.7 .
  - b) Tap the cover back into place.
  - c) Repeat steps "a" and "b" until the seal is completely broken and the apron cover can be removed.
36. Remove two screws "K", Figure 1.43, and remove gib "H", Figure 1.42 .
37. Loosen screw "L", Figure 1.43, and remove cam "I".

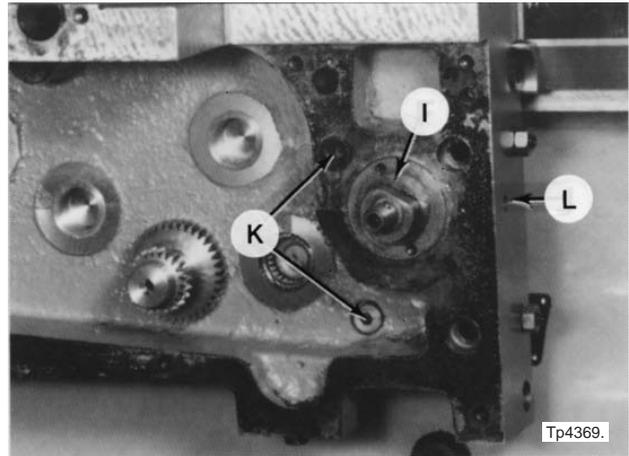


Figure 1.43 - Lead Screw Nut Cam and Gib Screws

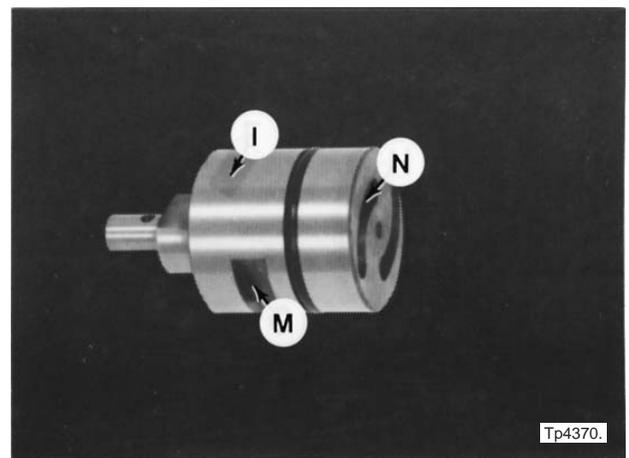


Figure 1.44 - Cam for Lead Screw Nut

**REPLACEMENT**

1. Replace cam "I", Figures 1.43 and 1.44, with cam slots "M", Figure 1.44, in line with screw "L", Figure 1.43 .
2. Replace gib "H", Figure 1.42, using two screws "K", Figure 1.43 .

**- CAUTION -**

**Use care when installing the apron cover so as not to damage the gears.**

3. Apply Permatex sealant to apron cover "R", Figure 1.6, and replace using seven screws "Q".
4. Apply Permatex sealant to cover "P", Figure 1.5; then, remount the cover seal and cover using two screws "O".

5. In the clutch housings, pack springs “H”, Figures 1.21 and 1.22, with Shell Alvania® #3 grease.
6. Apply Permatex® sealant to the surface of clutch housings “M” and “N”, Figure 1.4, that will be against the carriage apron cover.
7. Remount clutch housings “M” and “N” using eight screws “L”.
8. Apply Permatex sealant to the surface of handwheel housing “H”, Figure 1.3, that will be against the carriage apron cover.
9. Remount handwheel assembly “D” using three screws “G”.
10. Apply Permatex sealant to the surface of power feed housing “I” that will be against the carriage apron cover.
11. Remount power feed assembly “K” using three screws “J”.
12. Replace lock screw “T”, Figure 1.6, but do not tighten .
13. Replace the fiber washer, handle “U”, and taper pin “S”.

**- NOTE -**

The carriage apron oil reservoir is full when sight window “E”, Figure 1.3, is completely filled with oil.

14. Fill the carriage apron oil reservoir:
  - a) Remove cap “F”, Figure 1.3 .
  - b) Fill the carriage apron oil reservoir with Mobilfluid® 350 oil.
  - c) Replace cap “F”.
15. Replace both halves of lead screw nut “D”, Figure 1.41, placing the pins on the lead screw nut in cam slots “N”, Figure 1.44 .
16. Replace gib “G”, Figure 1.41 using the two screws removed in step 20 of the lead screw nut removal procedure.
17. Replace dot plugs “T”, Figure 1.25 .
18. Adjust the feed screw nut:
  - a) Tighten screw “L”, Figure 1.43, gradually clockwise until handle “U”, Figure 1.6, has approximately 5 overtravel after lead screw nut pin “J”, Figure 1.42, contacts the upper half of the lead screw nut.
  - b) Tighten lock screw “T”, Figure 1.6 .
  - c) Alternately tighten two screws “F”, Figure 1.41, until pressure is required to close the lead screw nut.
  - d) Tighten two lock nuts “E”.
19. Push the carriage toward the headstock slowly using care that the rack pinion and the rack engage properly.
20. Replace positive stop “D”. Figure 1.29 .

**- CAUTION -**

**Support lead screw "A" by hand while it is being installed to prevent damage to the threads on the lead screw. Continue supporting lead screw "A" while installing bracket"E".**

**- NOTE -**

The end of carriage lead screw closest to the headstock has a hole drilled though it to accept taper pin "G", Figure 1.30 .

21. Install carriage lead screw "J", Figure 1.31, in the machine by carefully moving it to the left through feed screw nut "I".
22. Install bracket "E", Figure 1.29, and any shims that were located between the bracket and the bed:
  - a) Slide bracket "E" to the left to install it on carriage lead screw "A" and stop rod "C".
  - b) Align the dowel pins in bracket "E" with the dowel pin holes in the bed.
  - c) Position the shim(s) between bracket "E" and the bed.
  - d) Mount bracket "E" to the bed of the machine using two screws "B".
23. Remount power feed control box "F", Figure 1.29, using three bolts "K", Figure 1.32 .
24. Move the carriage to the extreme right using handwheel "D", Figure 1.3 .
25. Engage carriage lead screw nut "I", Figure 1.31, with carriage lead screw "J" by rotating lever "H" clockwise.
26. Move the carriage approximately ~2 inch to left using handwheel "D", Figure 1.3 .
27. Disengage carriage lead screw nut "I", Figure 1.31, from carriage lead screw "J" by rotating lever "H" counterclockwise.

**- NOTE -**

Properly align the tapered hole in the left end of carriage lead screw "J" with the corresponding hole in the gear box cluster shaft.

28. Install taper pin "G", Figure 1.30 .

## **LUBRICATION**

Clean and lubricate the lead screw nut at least once a week:

1. Remove all chips and clean the lead screw nut using mineral spirits
2. Lubricate the lead screw nut using a pressure oil can containing Mobil® Velocite® oil No. 6.

## CARRIAGE LUBRICATION SYSTEM

Lubricating oil for the carriage is channeled from lubricator “O”, Figure 1.45, to an oil junction block at the rear of the carriage. From the junction box, the oil is fed through four tubes to channels in the top and bottom of the carriage. Two of these channels can be seen when the cross slide is removed. On the bottom of the carriage is a large “X” shaped channel for lubricating the bed ways.

It is recommended that the metering unit on each oil feed tube assembly be replaced annually. If an oil tube assembly becomes plugged, the metering unit should be replaced.

### - NOTE -

If the machine is equipped with an Acu-Rite® III Digital Readout, it will be necessary to remove part of the digital readout system to gain access to junction block cover “I”, Figure 1.53 .

### REPLACING AN OIL FEED TUBE METERING UNIT

1. Press “Start/Stop” pushbutton “A”, Figure 1.1, IN to turn the machine OFF.
2. Remove the chip and coolant guard, if the machine is so equipped.
3. If the machine is equipped with an Acu-Rite III Digital Readout, perform steps 4 through 41.

If the machine is not equipped with an Acu-Rite III digital readout, perform steps 15 through 29.

4. Thoroughly clean the top of the carriage and cross slide using mineral spirits.
5. Remove two screws “S”, Figure 1.46, washers, lock washers, and clamp “R”.
6. Remove cover “T”.
7. Remove four screws “U”, Figure 1.47, and cover “V”.
8. Using cross slide handle “Q”, Figure 1.25, move the cross slide to align the threaded holes in read head “W”, Figure 1.48, with two access holes “X”.

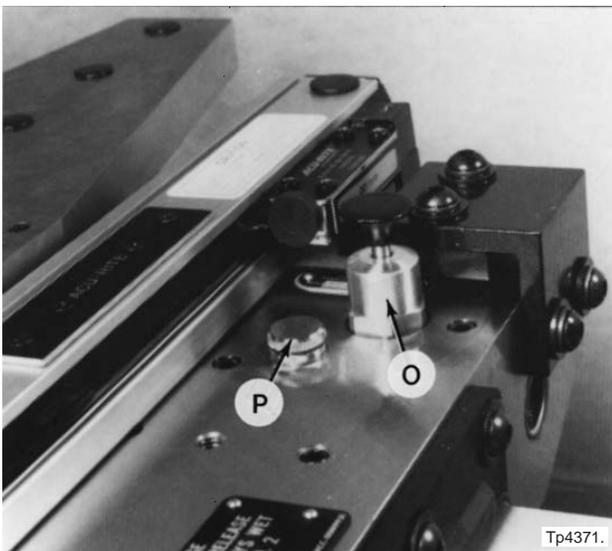


Figure 1.45 - Carriage Lubricator

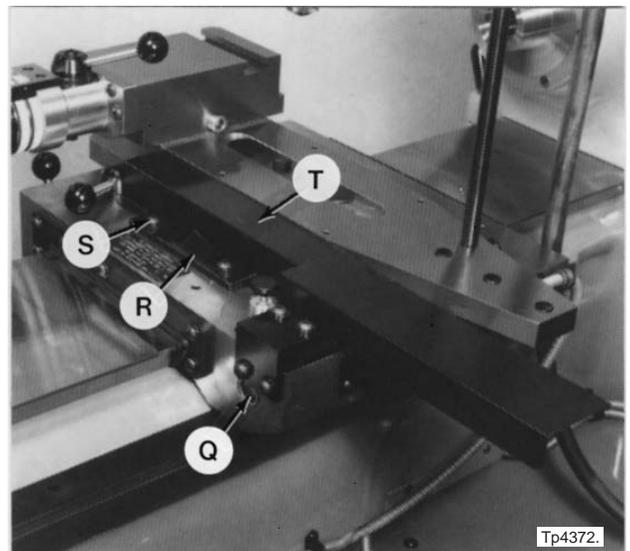


Figure 1.46 - Chip Cover and Clamp

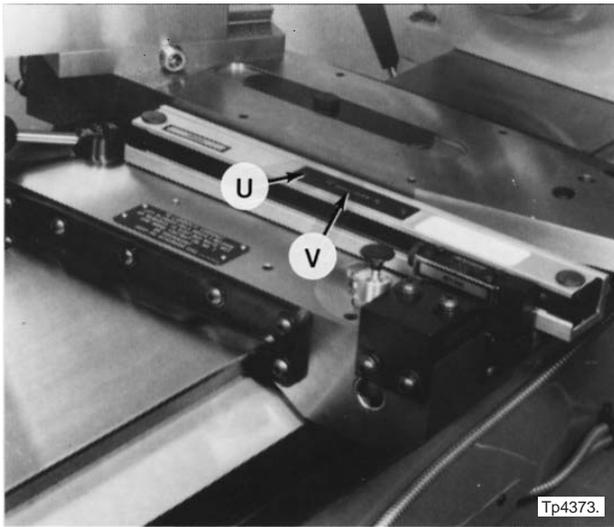


Figure 1.47 - Scale and Reader Head Covers

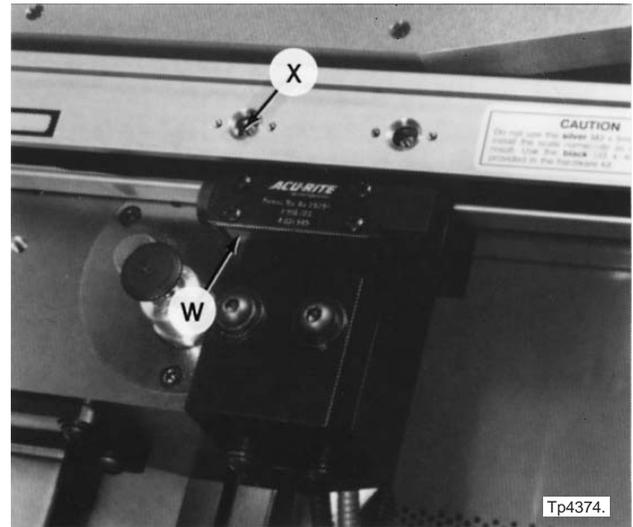


Figure 1.48 - Mounting Holes for Alignment Brackets

**- NOTE -**

Brackets "C", Figure 1.49, and the required screws are located in the machine documentation package, located in a pocket inside the power case door.

9. Mount two brackets "C", Figure 1.49, as follows:
  - a) Position the brackets over two access holes "X", Figure 1.48 .
  - b) Install a long screw through the center hole in each bracket, but do not tighten.
  - c) Install a short screw through each of the four outer holes in each bracket, but do not tighten.
  - d) Tighten the center screws in the brackets; then the remaining four screws.
10. Remove four screws "A" and reader head cover "B", Figure 1.49 .
11. Remove paper wire cover "D", Figure 1.50 .
12. Remove screw "E", Figure 1.51, to release cable clamp "F".

**- CAUTION -**

**Use extreme care when handling reader head cable "J", Figure 1.53 . Rough handling may result in damage to the reader head wiring.**

13. Gently lift reader head cable connector "G", Figure 1.52, and reposition reader head cable "J", Figure 1.53, as shown, to gain access to lubricator junction block cover "I".



Figure 1.49 - Reader Head Alignment Brackets

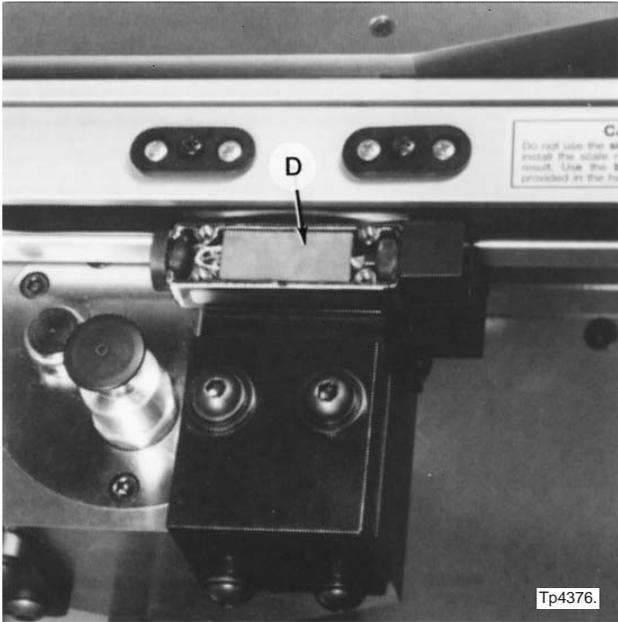


Figure 1.50 - Reader Head Wire Cover

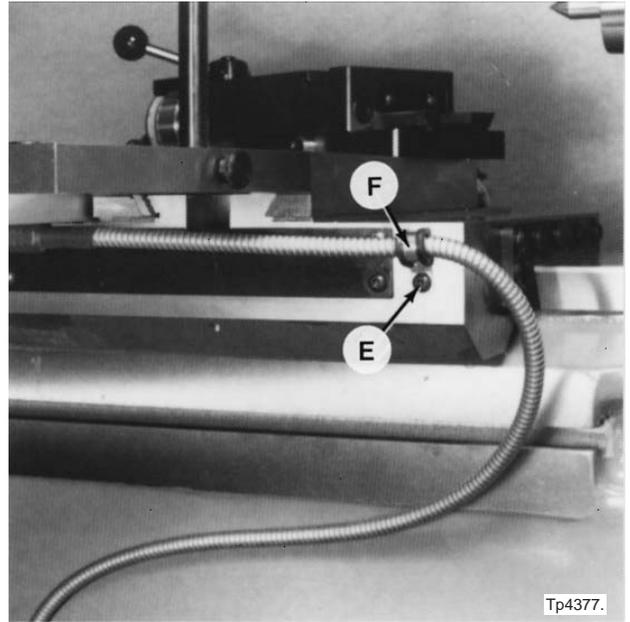


Figure 1.51 - Reader Head Cable Clamp

**- CAUTION -**

**The reader head cable MUST be secured to eliminate the possibility of the cable moving. Damage to the reader head wires may result if the cable is allowed to move. Refer to Figure 1.53 .**

14. Secure the reader head cable as shown in Figure 1.53 .
15. Remove four screws "H" and lubricator junction block cover "I".
16. Remove four screws "K" and junction block "L", Figure 1.54, to gain access to oil feed tube assemblies "M", "N", "O", and "P", Figure 1.55 .

**- NOTES -**

Oil feed tube assemblies "M" and "P", Figure 1.55, feed oil to the channel in the bottom of the carriage.

Oil feed tube assemblies "N" and "O" feed oil to the channels in the top of the carriage.

DO NOT interchange the oil feed tube assemblies. To avoid interchanging the oil feed tube assemblies, it is recommended that they be serviced one at a time.

17. Remove the oil feed tube assembly from the carriage.
18. Remove oil tube "U", Figure 1.56, from the feed tube assembly by unthreading nut "T".

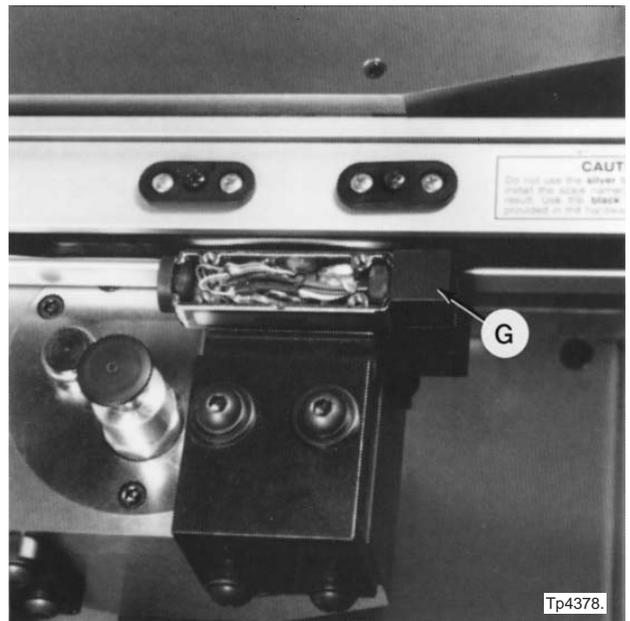


Figure 1.52 - Reader Head Cable Connector

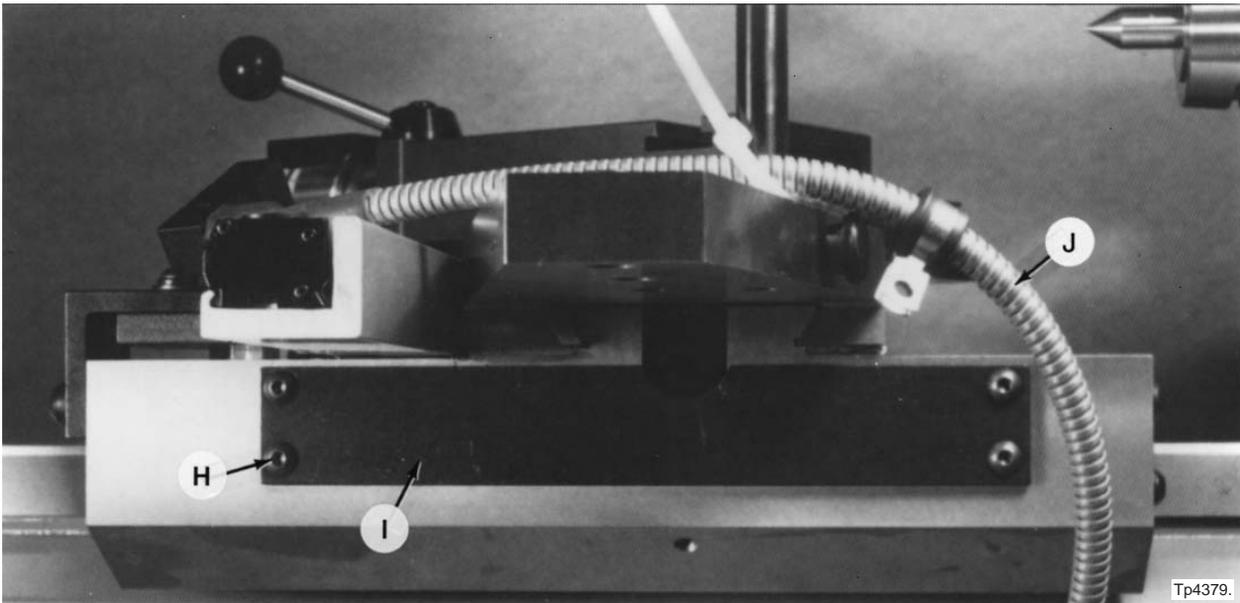


Figure 1.53 - Reader Head Cable Secured

19. Using a 7/16 inch wrench, remove metering unit “S” from connector “R”.

**- CAUTION -**

**When installing a new metering unit in connector “R”, be sure not to overtighten the metering unit.**

20. Using a 7/16 inch wrench, install the new metering unit in connector “R”.

**- NOTE -**

When installing an oil feed tube, be sure the non-tapered end of the oil feed tube is inserted into the metering unit.

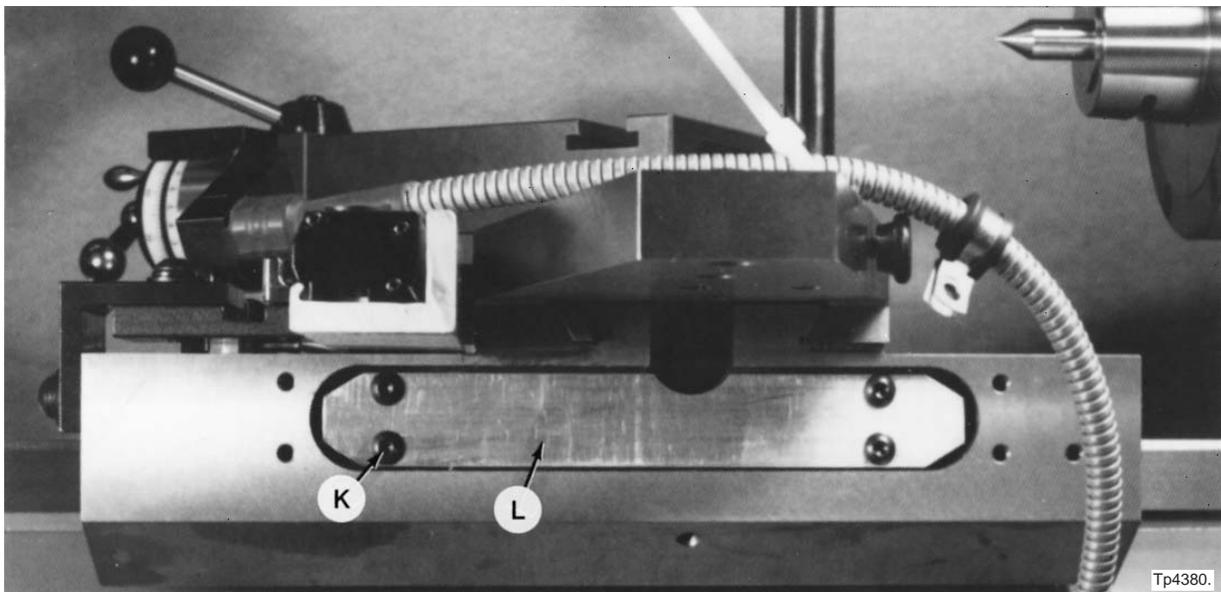


Figure 1.54 - Lubricator Junction Box

21. Install oil tube "U" on the feed tube assembly.
22. Tighten nut "T".
23. Check O-ring "Q" for possible replacement.

**- NOTES -**

When installing an oil feed tube assembly, be sure the tapered end of the oil feed tube is seated properly in the bushing located inside the carriage.

One method that may be used to check if an oil feed tube is seated properly is to check the alignment of the connector on the oil feed tube assembly in question with the connectors on the other three oil feed tube assemblies.

24. Install the oil feed tube assembly in the carriage.

**- NOTE -**

A seating tool similar to tool "V" can easily be manufactured from aluminum or brass. The diameter of the pin shown on the right end of tool "V" must be small enough to fit inside the hole in the oil feed tube assembly.

25. Gently seat the oil feed tube by placing the seating tool against the oil feed tube assembly, as shown in Figure 1.57, and gently tapping the seating tool with a hammer.
26. Repeat steps 17 through 25, as needed, for the other oil feed tube assemblies.
27. Remount lubricator junction block "L" using four screws "K", Figure 1.54 .
28. Install cover "I" using four screws "H", Figure 1.53 .
29. Refill carriage lubricator "O", Figure 1.45, with Mobil® Vactra® oil No. 2.

**- CAUTION -**

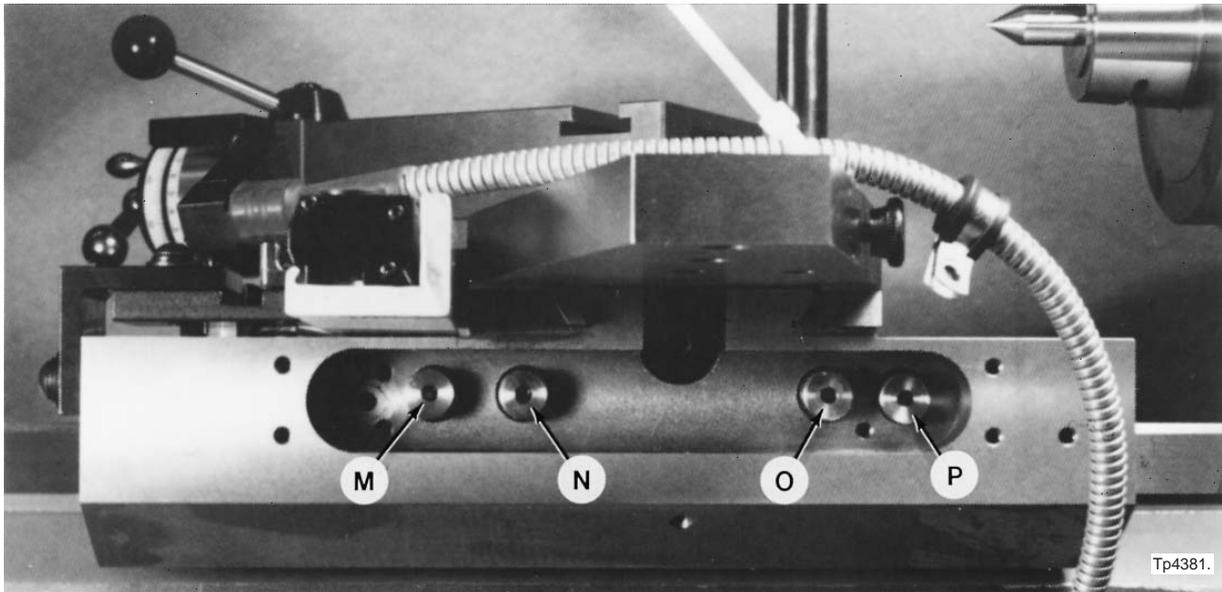


Figure 1.55 - Oil Feed Tube Assemblies in the Carriage

**Use extreme care when handling reader head cable "J", Figure 1.53 . Rough handling may result in damage to the reader head wiring.**

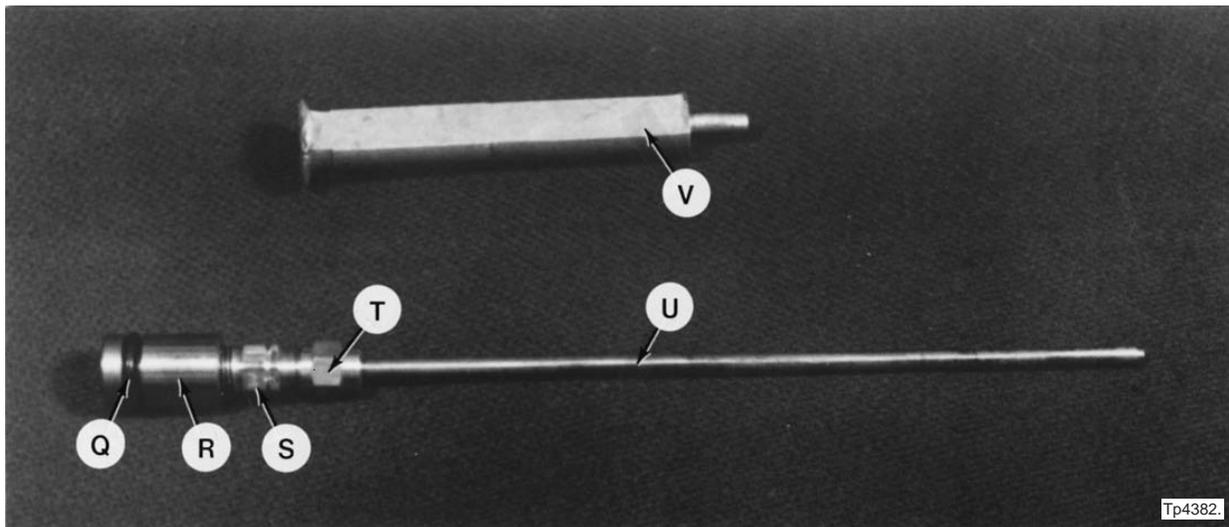


Figure 1.56 - Oil Feed Tube Assembly

30. Hold cable "J", Figure 1.53, while releasing it
31. Gently reposition cable connector "G", Figure 1.52 .
32. Remount cable clamp "F", Figure 1.51, using mounting screw, but do not tighten fully.
33. Remove any slack in cable "J", Figure 1.53, between cable connector "G", Figure 1.52, and cable clamp "F", Figure 1.51 .
34. Tighten clamp mounting screw "E", Figure 1.51 .
35. Replace paper wire cover "D", Figure 1.50 .
36. Replace reader head cover "B", Figure 1.49, using four screws "A".
37. Remove two brackets "C" as follows:
  - a) Remove the two outside screws from each bracket.
  - b) Remove the screw from the center of each bracket.

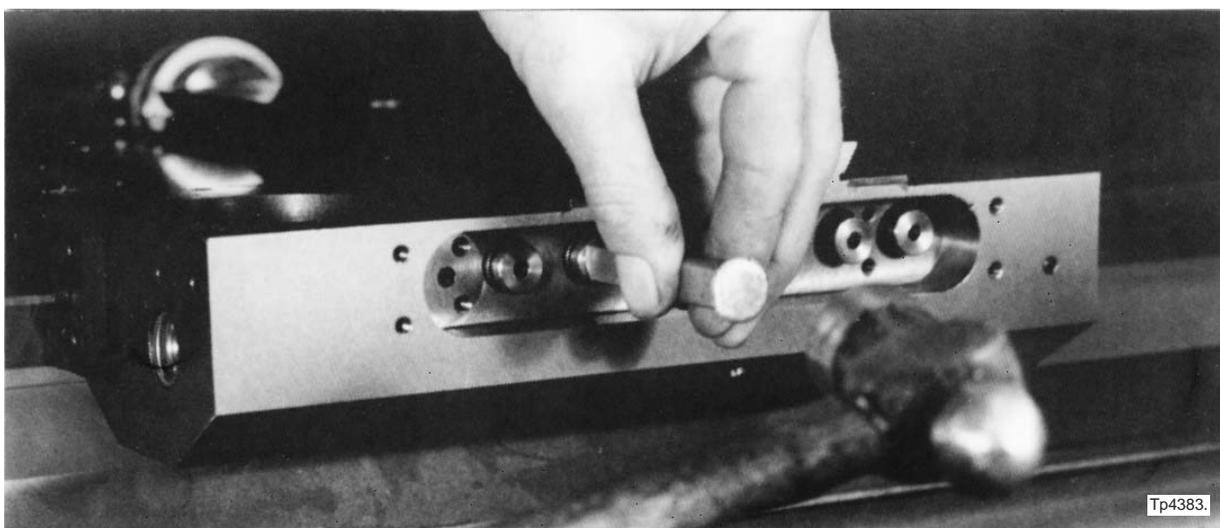


Figure 1.57 - Oil Feed Tube Assembly Installation

**- WARNING -**

**Be sure to follow the procedure outlined in the operator's manual for safely accessing the power case.**

38. Place the two brackets and the six screws removed in step 37 in the machine documentation package, located in a pocket inside the power case door.
39. Mount cover "V", Figure 1.47, using four screws "U".
40. Replace cover "T", Figure 1.46 .
41. Replace clamp "R", washers, lock washers, and two screws "S".

### **OPERATING THE LUBRICATOR**

To operate the lubricator, lift the plunger on lubricator "O", Figure 1.45, hold the plunger up briefly, and release. **DO NOT PUSH THE PLUNGER DOWN.** Allow the plunger to return to the down position on it's own.

Operate the lubricator as often as required to keep the bed ways wet or a minimum of once a day.

### **FILLING THE LUBRICATOR RESERVOIR**

To fill the oil reservoir, open reservoir cap "P", Figure 1.45, and fill with Mobil® Vactra® oil No. 2. Maintain the oil level in sight gauge "Q", Figure 1.46 .

- NOTES -

# CHAPTER 2 - CROSS SLIDE AND TOOL POST

## CROSS SLIDE FEED SCREW

### DISASSEMBLY

1. Loosen nut "C", Figure 2.1 .
2. Remove lock screw "A".
3. Loosen the set screw located under lock screw "A".
4. Remove handle "B".
5. Remove nut "C".

#### - NOTE -

Do not misplace the nylon plug located under the lock screw in washer and screw assembly "D".

6. Remove washers and screw assembly "D".
7. Remove dial "F", and bushing "G", Figure 2.2.
8. Remove two screws "H", Figure 2.3 .
9. Remove cross feed screw and end cap assembly, as shown in Figure 2.4 .
10. Remove nut "I", two bearings "J", and feed screw "M" from end cap "K", Figure 2.5 .

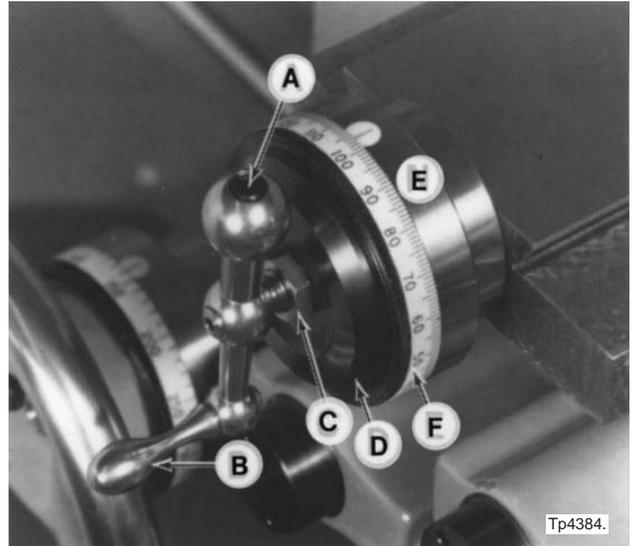


Figure 2.1 - Cross Slide Feed Screw Handle and Dial

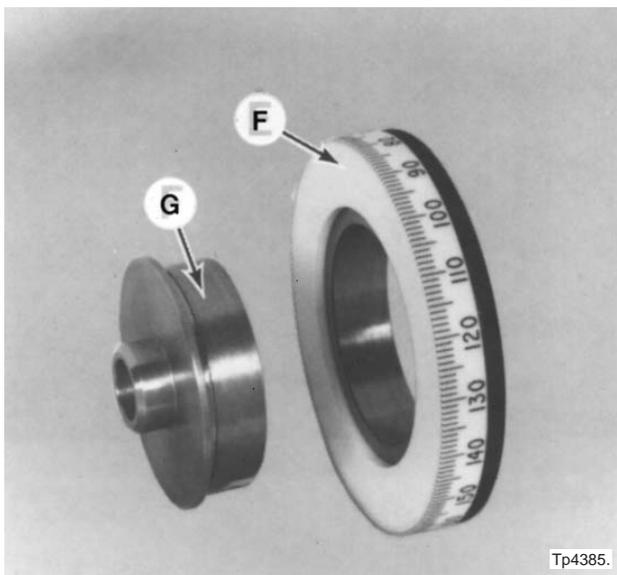


Figure 2.2 - Dial and Bushing

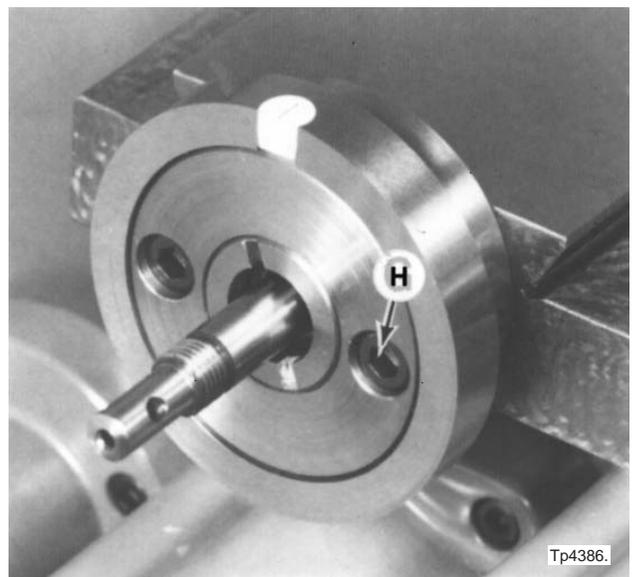


Figure 2.3 - End Cap and Zero Ring



Figure 2.4 - Cross Slide Feed Screw Removal

## REASSEMBLY

1. Assemble feed screw "M", two bearings "J", nut "I", and end cap "K", Figure 2.5 .
2. Lubricate the cross feed screw with Mobil® Vactra® Oil No. 6.
3. Replace the cross feed screw and end cap assembly, as shown in Figure 2.4 .
4. Replace two screws "H", Figure 2.3 .
5. Replace bushing "G", Figure 2.2, and dial "F", Figures 2.1 and 2.2 .

### - NOTE -

When replacing washer and screw assembly "D", Figure 2.1, be sure the nylon plug is in position under the lock screw.

6. Replace washer and screw assembly "D", Figure 2.1 .
7. Replace nut "C".
8. Replace handle "B".
9. Tighten the set screw and replace lock screw "A".
10. Tighten nut "C".

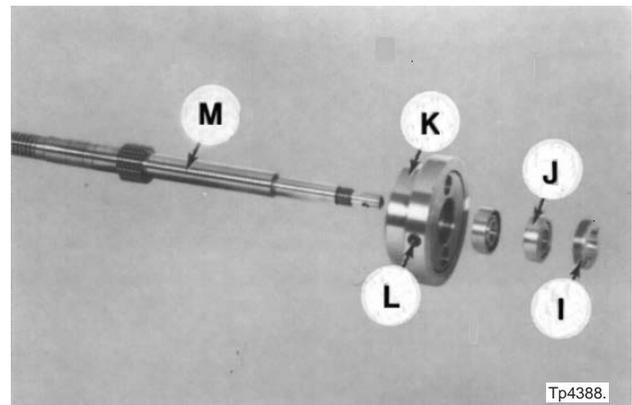


Figure 2.5 - Cross Slide Feed Screw and Components

**- NOTE -**

The gap between zero ring "E" and dial "F", Figure 2.1, should be set at 0.002" [0.05mm] to 0.004" [0.1mm].

11. Check the gap between zero ring "E" and dial "F", Figure 2.1 . If the gap needs to be adjusted, proceed to step 11. If the gap is correct, this procedure is complete.
12. Loosen set screw "L", Figure 2.5 .
13. Adjust the gap between zero ring "E" and dial "F", Figure 2.1 .
14. Tighten set screw "L", Figure 2.5 .
15. Repeat step 10.

### **CROSS SLIDE FEED SCREW NUT ADJUSTMENT**

1. Remove screw "N", Figure 2.6 .
2. Remove cover "O".
3. Loosen screw "P", Figure 2.7 .
4. Turn adjusting screw "Q" gradually clockwise to reduce the feed screw backlash to a maximum of four graduations on the cross feed dial.
5. Tighten screw "P".
6. Replace cover "O", Figure 2.6, in the center of the slot with the long end of the cover toward the rear of the machine.
7. Replace screw "N".

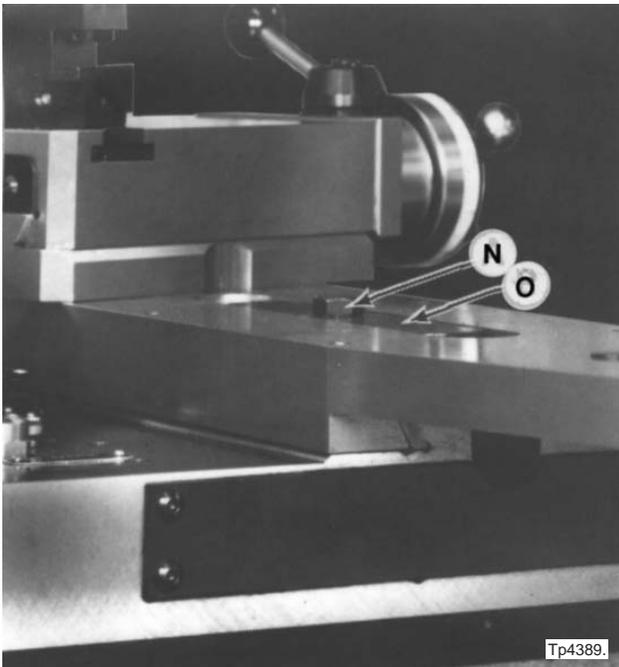


Figure 2.6 - Cover for Cross Slide Feed Screw Nut

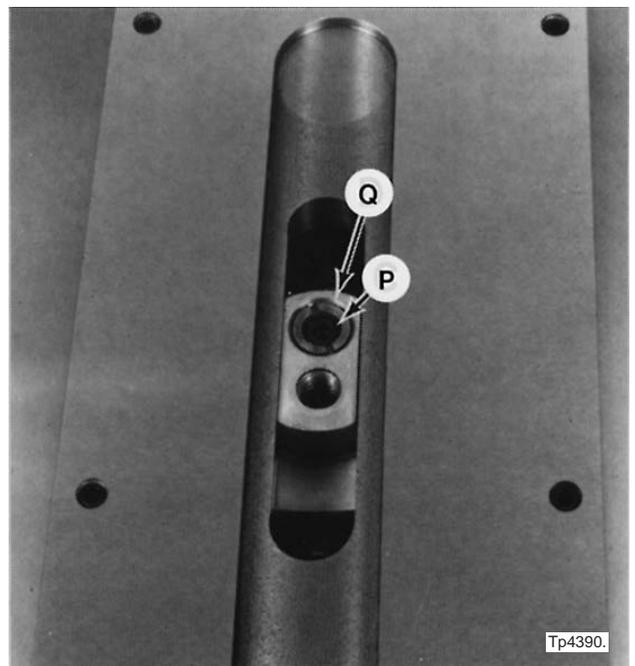


Figure 2.7 - Nut for Cross Slide Feed Screw

## CROSS SLIDE

The cross slide should be removed monthly to clean and lubricate the cross feed screw and nut and to clean the cross slide ways. Lubricate the cross slide feed screw and feed screw nut with Mobil® Vactra® Oil No. 2.

### REMOVAL

1. Remove the tooling and the tool post.
2. Loosen and remove eccentric lock "R", Figure 2.8 .
3. Lift the tool post slide from the cross slide.
4. Rotate cross slide handle "B", Figure 2.1, clockwise to feed the cross slide toward the rear of the machine until travel stops.
5. Remove the chip and coolant shield, if the machine is so equipped.
6. Remove the cross slide from the rear of the machine by hand, as shown in Figure 2.9.
7. Clean the cross slide ways with mineral spirits.

### REPLACEMENT

1. Lubricate the cross slide ways with Mobil Vactra Oil No. 2.
2. Lubricate the feed screw nut with Mobil Vactra Oil No. 2.

#### - CAUTION

**During cross slide replacement, do not force the cross slide into position. Damage to the feed screw or feed screw nut may result.**

3. Start the cross slide onto the carriage dovetail and move it slowly into position while turning cross slide handle "B", Figure 2.1, counterclockwise until the feed screw engages the feed screw nut.
4. If three cross slide wipers "V", Figure 2.10, have been disturbed, adjust the clearance between the wipers and the dovetail surfaces:
  - a) Loosen screws "W".
  - b) Set the clearance between the wipers and the dovetail surfaces at .001" [.025mm].
  - c) Tighten screws "W".

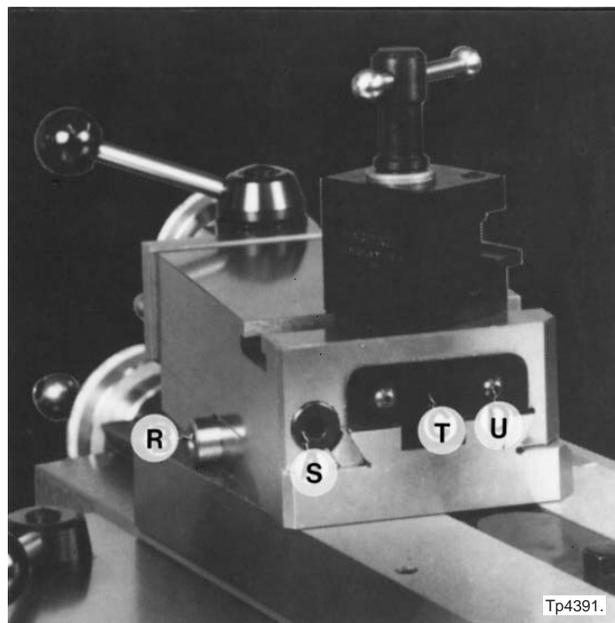


Figure 2.8 - Tool Post Assembly

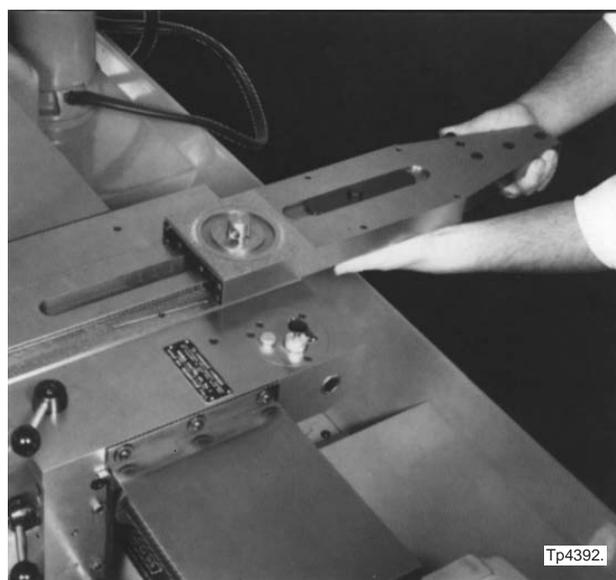


Figure 2.9 - Cross Slide Removal

**- NOTE -**

The cross slide should be positioned over the slot in the carriage dovetail before mounting the tool post slide.

5. Replace the tool post slide on the cross slide.
6. Replace and tighten eccentric lock "R" Figure 2.8 .
7. Remount the chip and coolant shield.

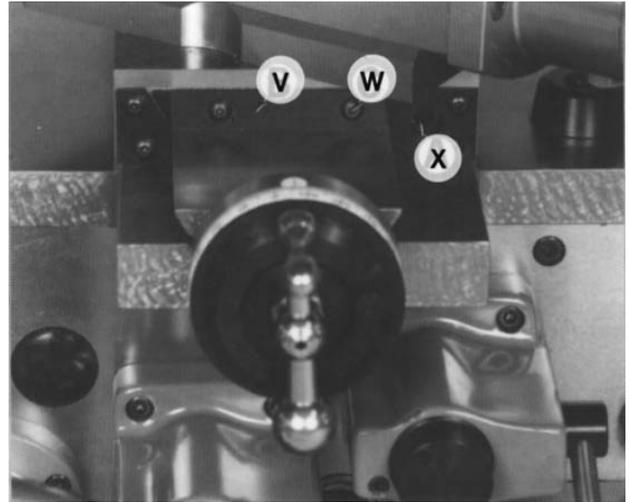


Figure 2.10 - Cross Slide Wipers and Gib Adjustment

### CROSS SLIDE GIB ADJUSTMENT

After considerable use, it may be necessary to adjust the cross slide gib.

1. Insert 1/4" hex wrench into screw "X", Figures 2.10 and 2.11, and loosen one full turn.

**- NOTE -**

Excessive gib pressure or drag does not improve machine performance.

2. Insert 1/4" hex wrench through screw "X" and into screw "Y", Figure 2.11 .
3. Advance screw "Y" a fraction of a turn to increase gib pressure or retract screw "Y" a fraction of a turn to decrease gib pressure.

**- CAUTION -**

**Do not overtighten screw "X".**

4. Pull the hex wrench out of screw "Y" and tighten screw "X" until snug.

**- NOTE -**

The cross slide should have a slight drag, but should not bind.

5. Move the cross slide to test for proper gib adjustment:

If the gib is not properly adjusted, repeat this procedure.

If the gib is properly adjusted this procedure is complete.

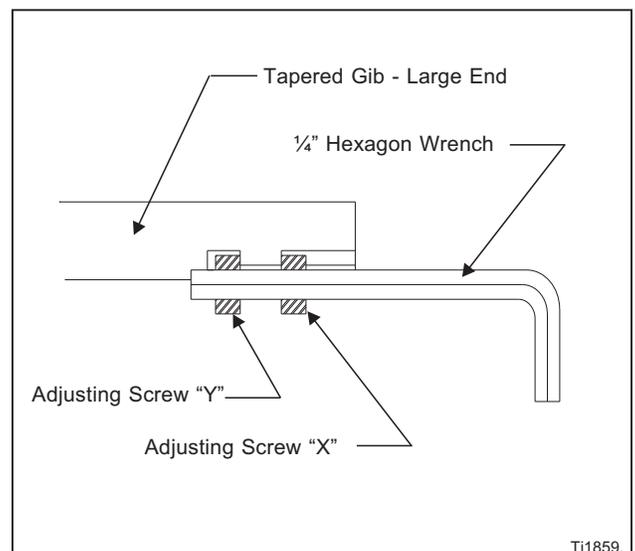


Figure 2.11 - Gib Adjustment Illustration

## TOOL POST

### TOOL POST SLIDE DISASSEMBLY

1. Remove the tooling and the tool post.
2. Loosen and remove eccentric lock "R", Figure 2.8 .
3. Lift the tool post slide from the cross slide.
4. Remove four screws "Z", Figure 2.12 .
5. Turn handle "B", Figure 2.1, counterclockwise to remove the end cap and dial assembly from the slides, as shown in Figure 2.13 .
6. Disassemble end cap and dial assembly:
  - a) Loosen nut "C", Figure 2.14 .
  - b) Remove lock screw "A".
  - c) Loosen the set screw located under lock screw "A".
  - d) Remove handle "B".
  - e) Remove nut "C".



Figure 2.12 - Tool Post Slide

#### - NOTE -

Do not misplace the nylon plug located under the lock screw in washer and screw assembly "D", Figure 2.15 .

- f) Remove washer and screw assembly "D", Figure 2.15 .
- g) Remove dial "E" and bushing "F".
- h) Remove two plugs "G" and springs "H".
- i) Remove nut "I".
- j) Remove feed screw "J" and two bearings "K", Figure 2.16 .
- k) Remove screw "L", wave washer "M", and handle "N", Figure 2.17 .
- l) Remove two screws "O", eccentric support "P", and eccentric shaft "Q", Figure 2.18 .
- m) Loosen nut "R" and remove eccentric stop "S", Figure 2.19 .
- n) Remove end cap "T" from housing "U", Figure 2.20 .
- o) Remove block "V".

7. Disassemble the slides and feed screw nut:
  - a) Separate the slides by moving the top slide to the rear.
  - b) Loosen lock nut "W", Figure 2.21 .
  - c) Unscrew half nut "X".
  - d) Loosen set screw "A", Figure 2.22, and remove half nut "Y", Figure 2.21 .

**- NOTE -**

Screw "B", Figure 2.22, and screw "C", Figure 2.23, are stop screws. It is not necessary to disturb these screws during disassembly.

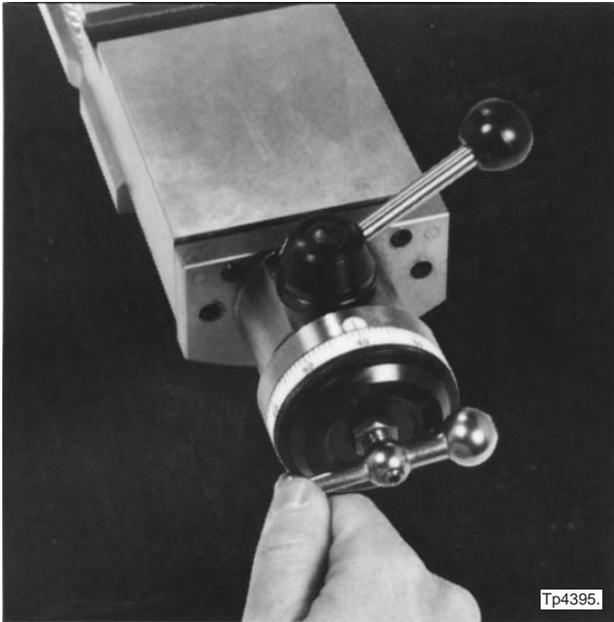


Figure 2.13 - End Cap and Dial Assembly Removal

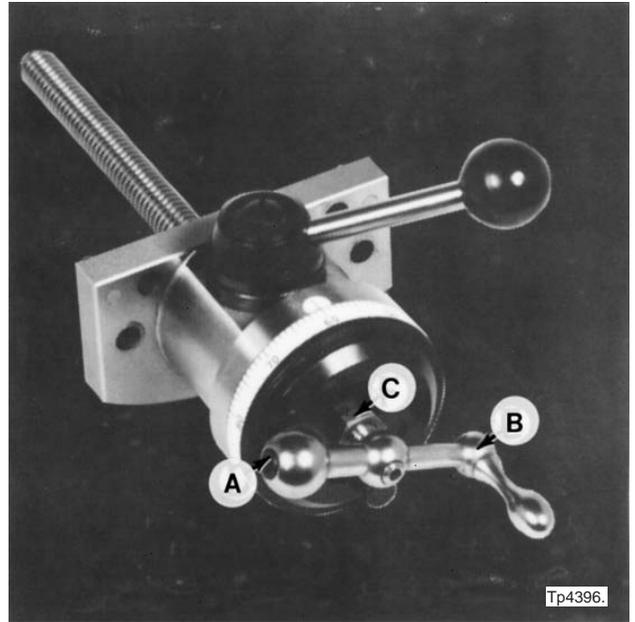


Figure 2.14 - End Cap and Dial Assembly

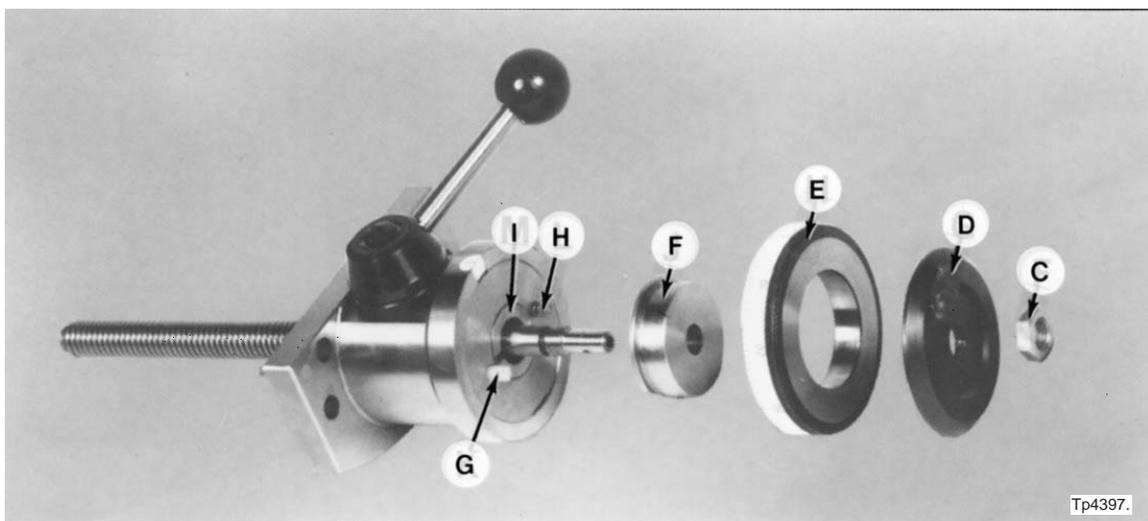


Figure 2.15 - End Cap and Dial Components

## TOOL POST SLIDE REASSEMBLY

### - CAUTION -

Do Not overtighten set screw "A", Figure 2.22 . Distortion of half nut "Y", Figure 2.21, may result.

### - NOTE -

The counterbored hole in half nut "Y", Figure 2.21, must be lined up with set screw "A", Figure 2.22 .

1. Reassemble the slides and feed screw nut:
  - a) Replace feed screw half nut "Y", Figure 2.21, and tighten set screw "A", Figure 2.22.

### - NOTE -

After replacing half nut "X", Figure 2.21, do not tighten lock nut "W" until instructed.

- b) Thread half nut "X", Figure 2.21, into the casting, leaving approximately  $11/32$  inch [8.7mm] projecting from the casting.
- c) Coat the inside of the feed screw nut with Die Makers Grease.
- d) Assemble the top and bottom slides.

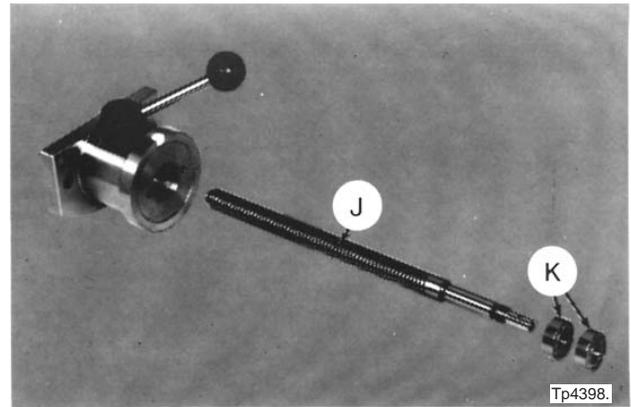


Figure 2.16 - End Cap and Feed Screw

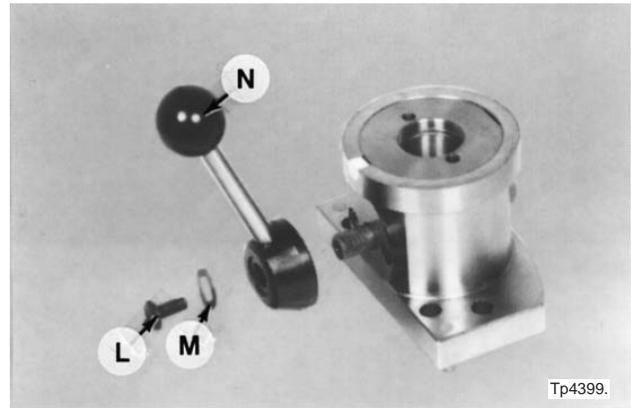


Figure 2.17 - Handle Removal

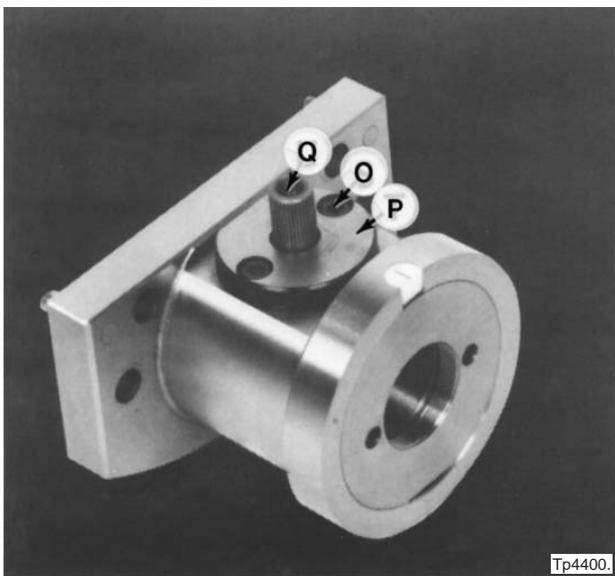


Figure 2.18 - Eccentric for Handle

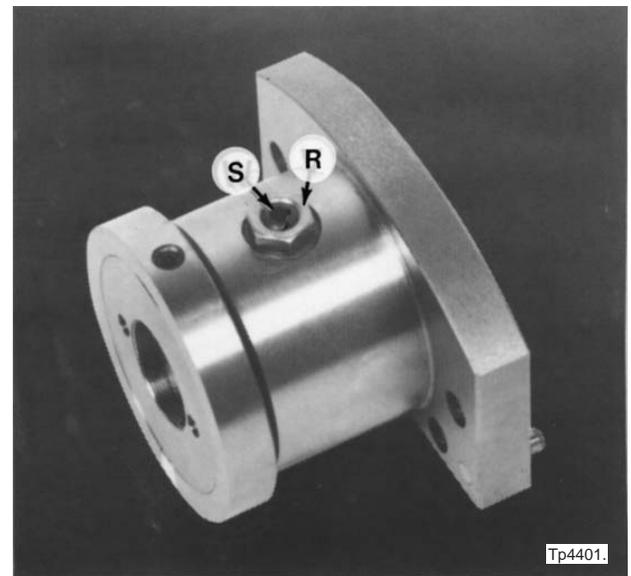


Figure 2.19 - Stop Screw for Handle

2. Reassemble the end cap and dial assembly:

**- NOTE -**

The hole in block "V" is located off center and should be positioned left of center, as viewed in Figure 2.20 .

- a) Coat block "V", Figure 2.20, with Die Makers Grease and replace as shown.
- b) Assemble end cap "T" and bearing housing "U".

**- NOTE -**

After replacing eccentric stop screw "S", Figure 2.19, do not tighten lock nut "R" until instructed.

- c) Replace eccentric stop screw "S", Figure 2.19 .
- d) Coat the eccentric end of shaft "Q", Figure 2.18, with Die Makers Grease; then replace shaft "Q" as shown.
- e) Replace eccentric support "P" and two screws "O".
- f) Replace handle "N", wave washer "M", and screw "L", Figure 2.17 .
- g) Replace bearings "K" and feed screw "J", Figure 2.16, in the end cap.
- h) Replace nut "I", Figure 2.15 .
- i) Replace two springs "H" and plugs "G".
- j) Replace bushing "F" and dial "E".

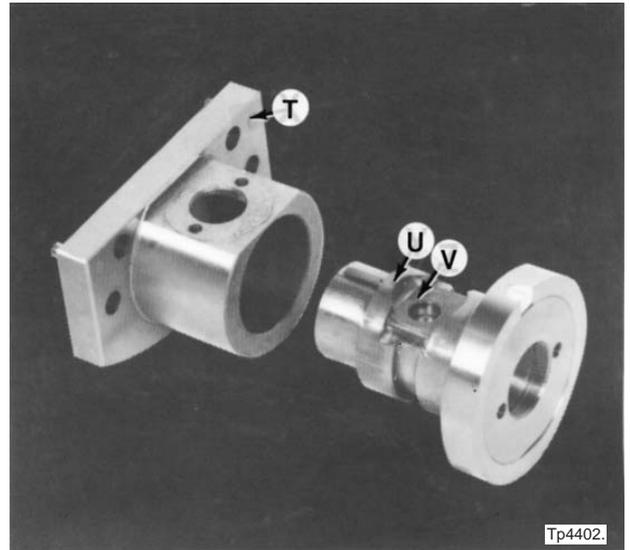


Figure 2.20 - End Cap and Bearing Housing

**- NOTE -**

When replacing washer and screw assembly "D", be sure the nylon plug is in position under the lock screw.

- k) Replace washer and screw assembly "D".
    - l) Replace nut "C".
  - m) Replace handle "B", Figure 2.14 .
  - n) Tighten the set screw located at "A".
  - o) Install and tighten the lock screw located at "A".
  - p) Tighten nut "C".
3. Coat the feed screw with Mobil® Vactra® Oil No. 2.

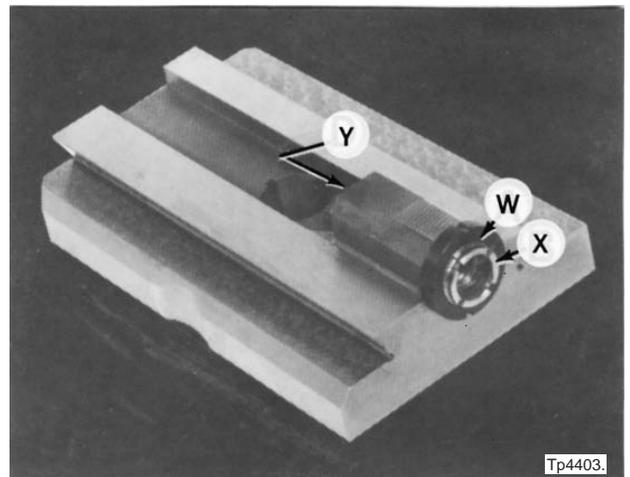


Figure 2.21 - Adjustable Feed Screw Nut

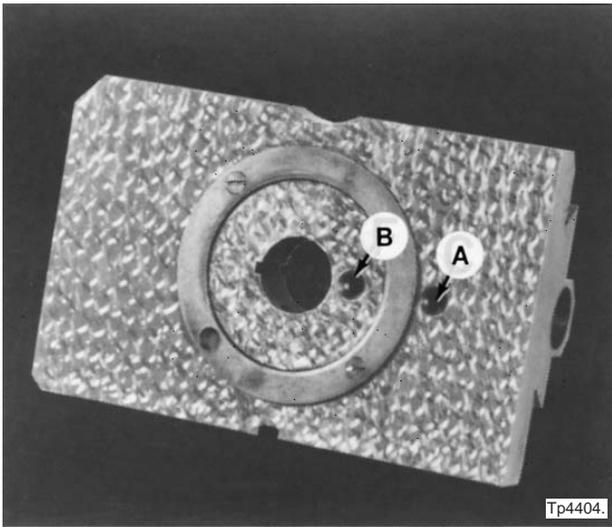


Figure 2.22 - Stop Screw and Half Nut Retaining Screw

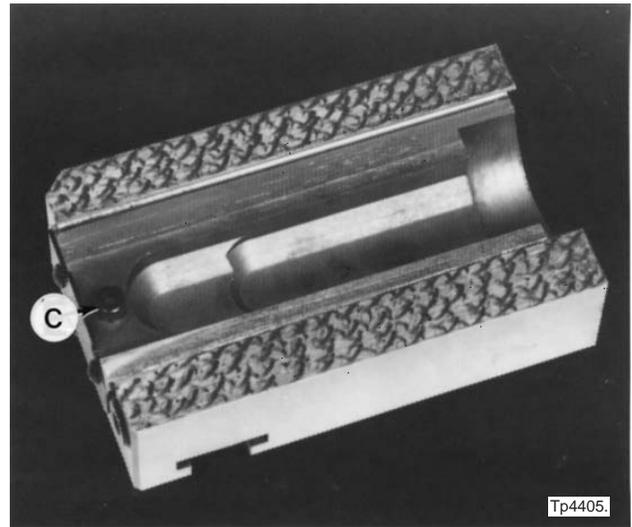


Figure 2.23 - Stop Screw for Top Side

**- CAUTION -**

**DO NOT force the feed screw into the feed screw nut. Turn half nut "E", Figure 2.24, gradually until it lines up with half nut "Y", Figure 2.21, to permit assembly of the tool post slide assembly.**

4. Replace the end cap and dial assembly using four screws "Z", Figure 2.12 .

**- NOTE -**

The gap between dial "E", Figure 2.15, and zero ring "I", Figure 2.24, should be set at .002" [.05mm] to .004" [.1mm].

5. Check the gap between dial "E", Figure 2.15, and zero ring "I", Figure 2.24 .

If the gap needs to be adjusted, proceed to step 6.

If the gap is correct, proceed to step 10.

6. Loosen set screw "H", Figure 2.24 .
7. Adjust the gap between dial "E", Figure 2.15, and zero ring "I", Figure 2.24 .
8. Tighten set screw "H", Figure 2.24 .
9. Repeat step 5.

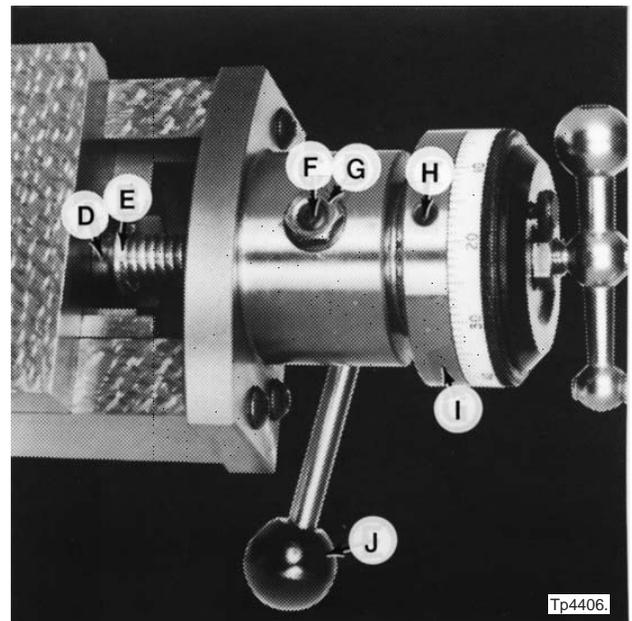


Figure 2.24 - End Cap and Dial

**- NOTE -**

The clearance between wiper "T", Figure 2.8, and the bottom slide should be set at .0015" [.038mm].

10. Check the clearance between wiper "T", Figure 2.8, and the bottom slide.  
If the clearance needs to be adjusted, proceed to step 11.  
If the clearance is correct, proceed to step 13.
11. Loosen two screws "U" and adjust the clearance.
12. Tighten two screws "U".
13. Turn the tool post slide assembly over to have the bottom slide facing upward.
14. Turn feed screw handle "B", Figure 2.14, to separate the top and bottom slides and to expose lock nut "D", Figure 2.24, and adjustable feed screw half nut "E".

**- NOTE -**

Maximum allowable backlash is two graduations on the tool post feed screw dial.

15. Adjust half nut "E" IN for minimum backlash.
16. Hold half nut "E" and tighten lock nut "D".
17. Replace the tool post slide assembly on the cross slide.
18. Replace eccentric lock "R", Figure 2.8 .
19. Turn eccentric stop screw "F", Figure 2.24, until it bottoms out; then back it off two full turns.

**- NOTE -**

To get positive holding and repeatability, adjust eccentric screw "F" to obtain equal throw of lever "J" in both directions from the point perpendicular with the cross slide feed screw.

20. If necessary, adjust eccentric screw "F" to obtain the proper range of movement for lever "J".

**- NOTE -**

Fine adjustments to eccentric screw "F" from this point may be necessary to obtain the desired solid stop.

21. Hold eccentric screw "F" with a hex wrench and tighten lock nut "G".

## **TOOL POST SLIDE FEED SCREW NUT ADJUSTMENT**

Following considerable use or after disassembly of the tool post slide, it may be necessary to adjust the feed screw nut for proper backlash.

1. Remove the tooling and the tool post.
2. Loosen and remove eccentric lock "R", Figure 2.8 .
3. Lift the tool post slide from the cross slide.
4. With the bottom slide UP, rotate feed screw handle "B", Figure 2.14, to separate the top and bottom slide and to expose adjustable feed screw nut "E", Figure 2.24 .
5. Loosen lock nut "D".
6. Adjust half nut "E" IN for minimum backlash.
7. Hold half nut "E" and tighten lock nut "D".
8. Replace the tool post slide assembly on the cross slide.
9. Replace eccentric lock "R", Figure 2.8 .

## **TOOL POST SLIDE LUBRICATION**

The tool post slide should be removed monthly to lubricate the feed screw and nut, and to clean and lubricate the slide ways. Use Mobil® Vactra® Oil No. 2 to lubricate the feed screw, feed screw nut, and slide ways.

1. Remove the tooling and the tool post.
2. Loosen and remove eccentric lock "R", Figure 2.8 .
3. Lift the tool post slide from the cross slide.
4. Lubricate the feed screw and feed screw nut "E", Figure 2.24 .
5. Clean and lubricate the slide ways
6. Replace the tool post slide assembly on the cross slide.
7. Replace eccentric lock "R", Figure 2.8 .

## TOOL POST SLIDE GIB ADJUSTMENT

After considerable use, it may be necessary to adjust the tool post slide gib.

1. Insert 1/4" hex wrench into screw "S", Figures 2.8 and 2.25, and loosen one full turn.

**- NOTE -**

Excessive gib pressure or drag does not improve machine performance.

2. Insert 1/4" hex wrench through screw "S" and into screw "K", Figure 2.25 .
3. Advance screw "K" a fraction of a turn to increase gib pressure or retract screw "K" a fraction of a turn to decrease gib pressure.

**- CAUTION -**

**Do not overtighten screw "S".**

4. Pull the hex wrench out of screw "K" and tighten screw "S" until snug.

**- NOTE -**

The tool post slide should have a slight drag, but should not bind.

5. Move the tool post slide to test for proper gib adjustment:
  - a) If the gib is properly adjusted this procedure is complete.
  - b) If the gib is not properly adjusted, repeat this procedure.

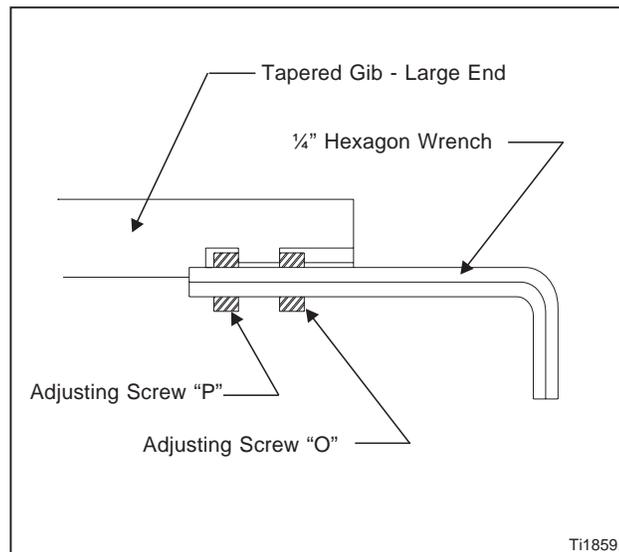


Figure 2.25 - Gib Adjustment Illustration

- NOTES -

# CHAPTER 3 - SPINDLE AND POWER FEED DRIVES

## SPINDLE DRIVE

### CHECKING DRIVE BELT TENSION

#### - NOTE -

If the drive belts slip when they are properly adjusted, the machine is being overloaded.

1. On HLV®-H machines, place lever "A", Figure 3.1, in the "Stop" position and lever "B" in the center position.

On TFB®-H machines, place lever "F", Figure 3.2, in the "Brake" position and lever "G" in the "Stop" position.

2. Pull "Start/Stop" pushbutton "D", Figure 3.1, OUT to turn the machine ON.

3. On HLV-H machines, turn brake switch "E" to the OFF position.

4. On HLV-H machines, place lever "A" in "High" range.

On TFB-H machines, place lever "F", Figure 3.2, in "Forward" or "Reverse" and lever "G" in "High" range.

5. Turn speed adjustment knob "C", Figure 3.1, to "Faster" and hold in that position until spindle speed stabilizes at 3000 rpm.

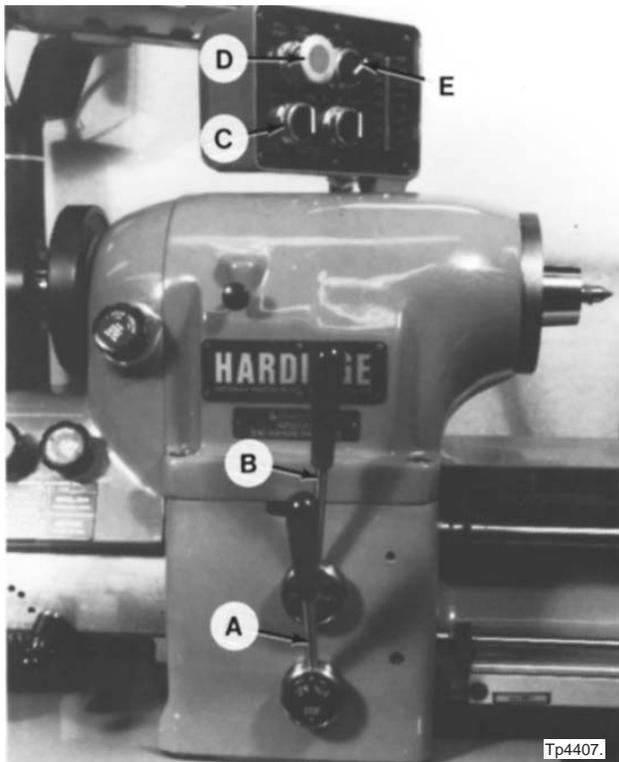


Figure 3.1 - HLV-H Headstock

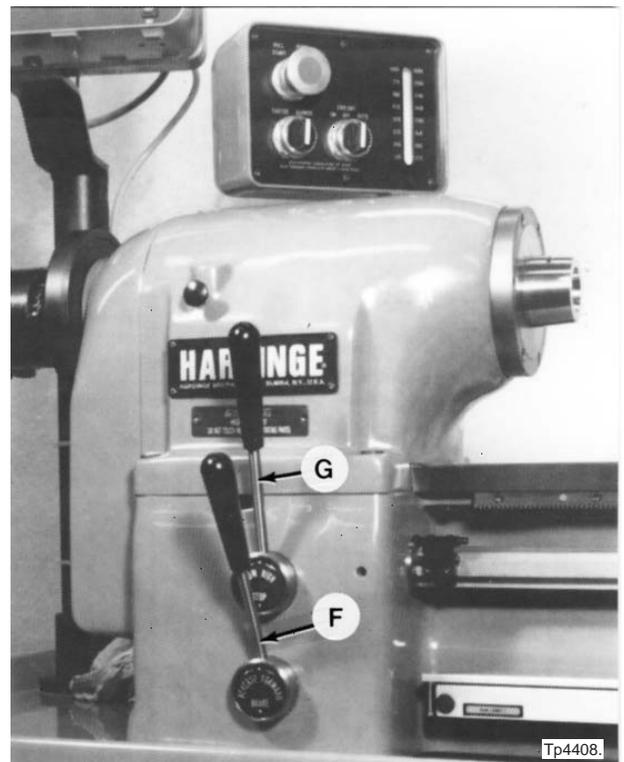


Figure 3.2 - TFB-H Headstock

6. On HLV®-H machines, place lever “A” in the “Stop” position and allow the spindle to coast to a stop.

On TFB®-H machines, place lever “G”, Figure 3.2, in the “Stop” position and allow the spindle to coast to a stop.

7. Press “Start/Stop” pushbutton “D”, Figure 3.1, IN to turn the machine OFF.

8. Open door “H”, Figure 3.3.

**- NOTE -**

The drive belts should not be loose or excessively tight. Proper belt tension will allow approximately 3/4 inch [19.1 mm] of belt deflection per side by hand.

9. Check drive belts “I” and “N”, Figure 3.4, for proper tension.

If the drive belts are not properly adjusted, refer to the next section, “Adjusting Drive Belt Tension”.

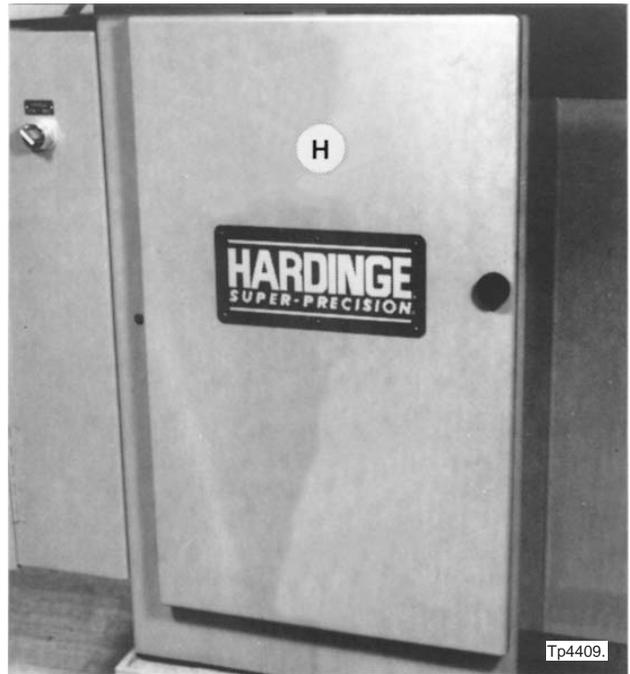


Figure 3.3 - Pedestal Door

**ADJUSTING DRIVE BELT TENSION**

1. Press “Start/Stop” pushbutton “D”, Figure 3.1, IN to turn the machine OFF.

2. Open door “H”, Figure 3.3.

3. Determine whether the drive belts are too loose or too tight.

4. Loosen lock nut “P”, Figure 3.5.

5. Turn adjusting screw “Q”:

Clockwise to lower the drive motor and tighten the drive belts.

Counterclockwise to raise the drive motor and loosen the drive belts.

6. Tighten lock nut “P”.

7. Recheck drive belt tension. Refer to the previous section, “Checking Drive Belt Tension”.

8. Close door “H”, Figure 3.3.

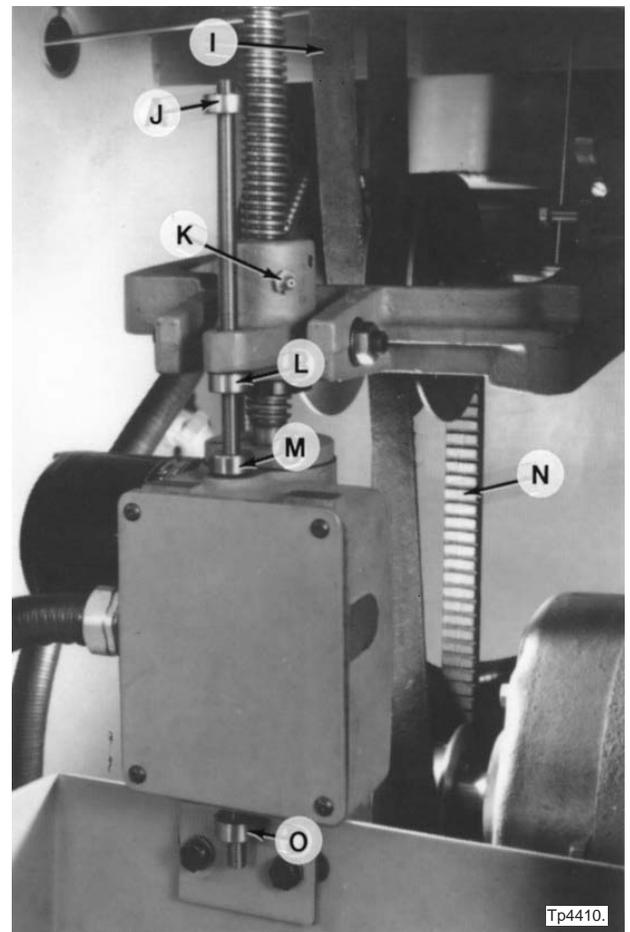


Figure 3.4 - Spindle Drive Compartment

## MOTOR AND SPINDLE BELT REPLACEMENT

1. On HLV<sup>®</sup>-H machines, place lever “A”, Figure 3.1, in the “Stop” position and lever “B” in the center position.

On TFB<sup>®</sup>-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.

2. Pull “Start/Stop” pushbutton “D”, Figure 3.1, OUT to turn the machine ON.

3. On HLV-H machines, place lever “A”, Figure 3.1, in “Low” range.

On TFB-H machines, place lever “F”, Figure 3.2, in “Forward” or “Reverse” and lever “G” in “Low” range.

4. Turn speed adjustment knob “C”, Figure 3.1, to “Slower” and hold in that position until spindle speed stabilizes at 125 rpm.

5. On HLV-H machines, place lever “A” in the “Stop” position to stop the spindle

On TFB-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.

6. Press “Start/Stop” pushbutton “D”, Figure 3.1, IN to turn the machine OFF.

7. Open door “H”, Figure 3.3 .

8. Remove lock nut “P”, Figure 3.5.

9. Raise the front of the motor mounting plate approximately two inches and block it in this position, as shown in Figure 3.6.

10. Roll motor belt “S”, Figure 3.7, to the right off the pulley and let it rest on the pulley hub, as shown.

11. Loosen mounting bolts “U” on brake assembly “X”, Figure 3.8 .

12. Pull the brake assembly away from motor pulley “T”.

13. Remove the motor belt from motor pulley “T”.

14. Pull “Start/Stop” pushbutton “D”, Figure 3.1, OUT to turn the machine ON.

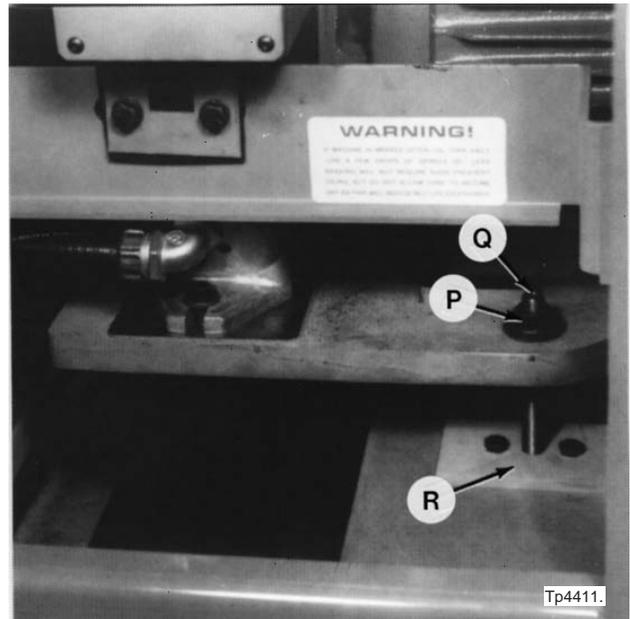


Figure 3.5 - Drive Belt Adjusting Screw



Figure 3.6 - Motor Mounting Plate Blocked in Position

### - WARNING -

**Stay clear of the spindle drive motor compartment while the spindle motor is running.**

15. On HLV®-H machines, place lever "A" in "High" range.

On TFB®-H machines, place lever "F", Figure 3.2, in "Forward" or "Reverse" and lever "G" in "High" range.

16. Turn speed adjustment knob "C", Figure 3.1, to "Faster" and hold in that position until pulley hanger assembly "Y", Figure 3.9, reaches maximum upward travel.

17. On HLV-H machines, place lever "A", Figure 3.1, in the "Stop" position and allow the spindle motor to coast to a stop.

On TFB-H machines, place lever "G", Figure 3.2, in the "Stop" position and allow the spindle motor to coast to a stop.

18. Press "Start/Stop" pushbutton "D", Figure 3.1, IN to turn the machine OFF.

19. Slide countershaft assembly "Z", Figure 3.9, to the extreme right and remove both belts over the left end of the countershaft.

20. Remove the cotter pin from the end of speed change pull rod "A", Figure 3.10, which passes through the headstock belt in the motor compartment.

21. Move the headstock belt around the end of the pull rod.

22. Remove the collet closer according to the procedure outlined Chapter 4.

23. Remove snap ring "B", Figure 3.11, and handwheel "C".

24. Remove key "D", Figure 3.12, and washers "E" and "F".

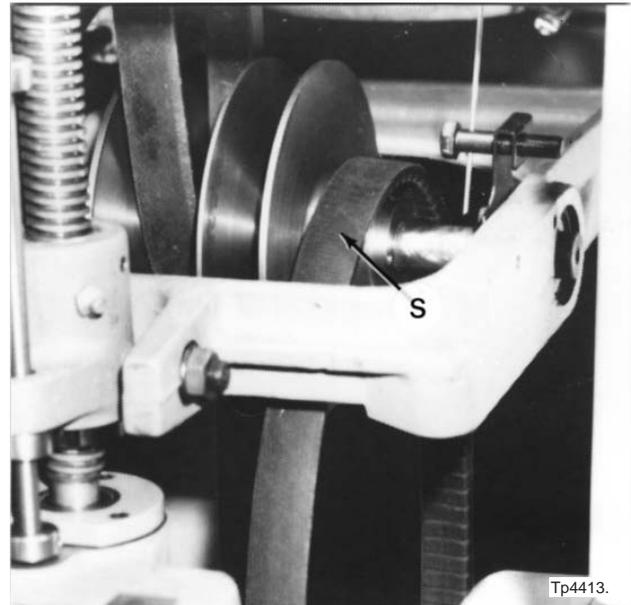


Figure 3.7 - Motor Belt on Pulley Hub

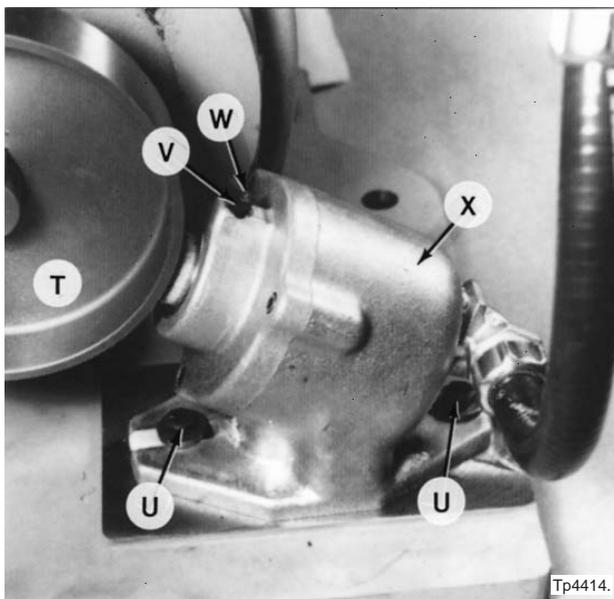


Figure 3.8 - Spindle Brake

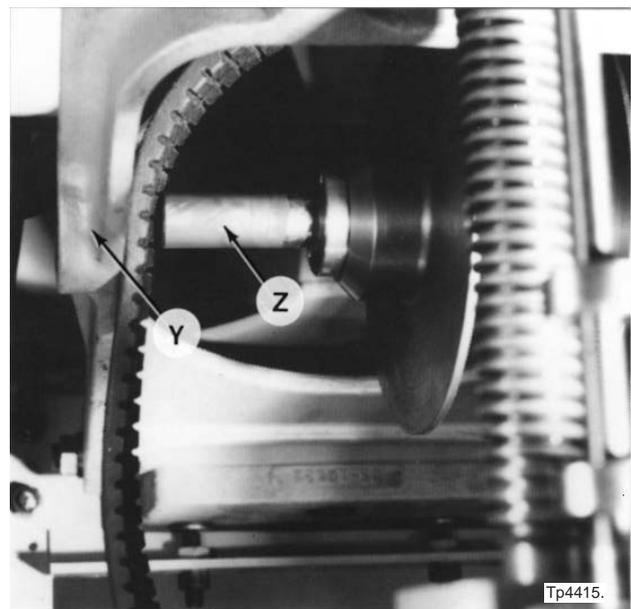


Figure 3.9 Belt Removal Over Countershaft

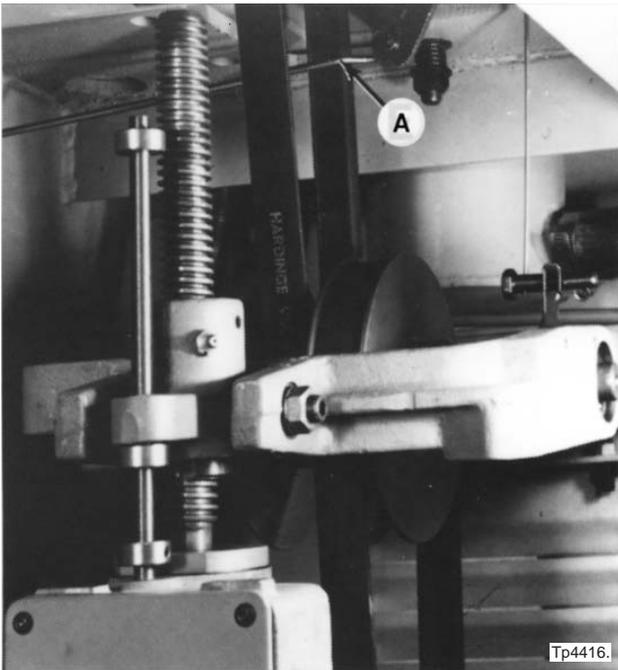


Figure 3.10 - Speed Change Pullrod

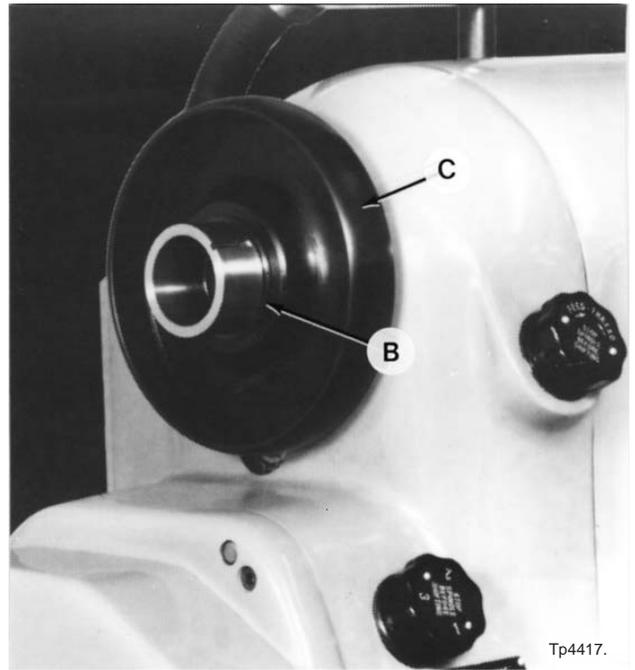


Figure 3.11 - Spindle Handwheel

- On HLV<sup>®</sup>-H machines, proceed to step 27.

- On TFB<sup>®</sup>-H machines, proceed to step 25.

25. Remove four screws "I" and cover "J", Figure 3.13.

26. Proceed to step 34.

27. Remove covers "K" and "L", Figure 3.14.

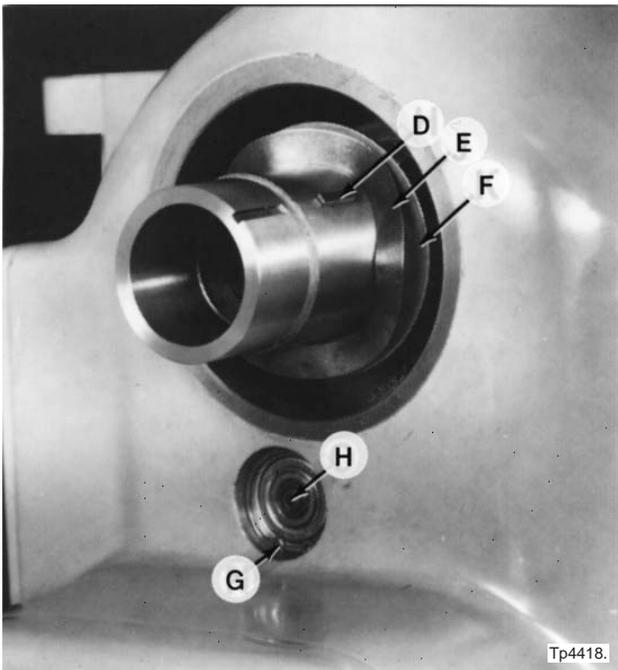


Figure 3.12 - Handwheel Washers and Key

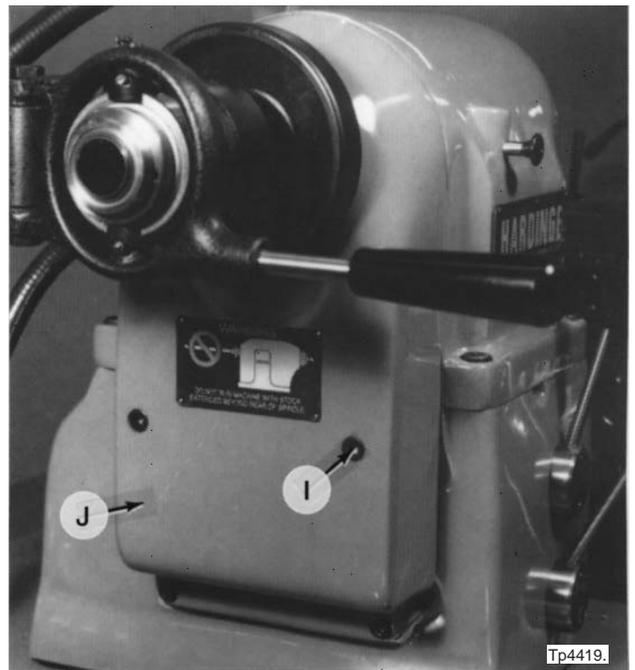


Figure 3.13 - Headstock Cover  
(TFB-H Machines)

28. Remove snap ring "G", Figure 3.12.
29. Turn push screw "H", Figure 3.12 clockwise to remove the gear, shaft, and bearing, as shown in Figure 3.15.
30. Remove lock screw "M, Figure 3.16.
31. Remove lock screw "N" and loosen the set screw under lock screw "N".
32. Unscrew shaft "O", Figure 3.17, with a hex wrench.
33. Pull shaft "O" out approximately 5 inches [127mm].

**- NOTE -**

Pull the spindle drive belt part way out of the top opening in the rear of the gear box (refer to Figure 3.17, to aid in the passing the narrow width of the spindle belt past the underside of the spindle pulley and over the boss in the gear box housing.

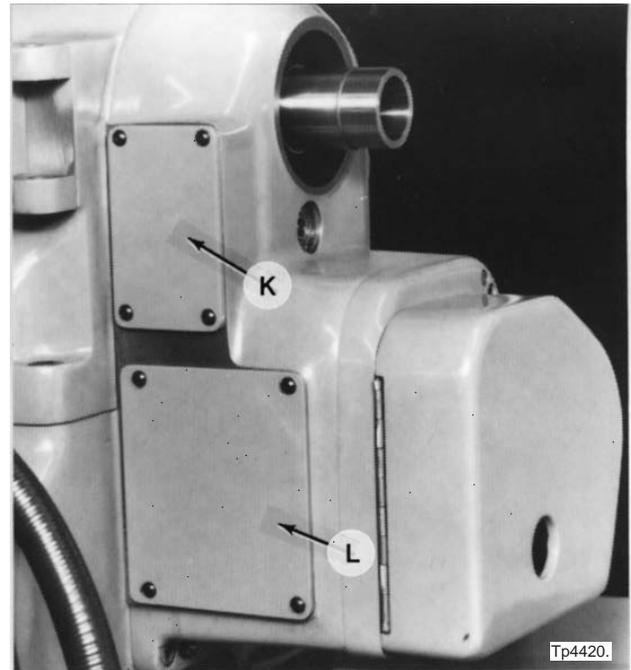


Figure 3.14 - Gear Box Covers

34. Use a piece of wire as a hook to lift the spindle belt out of the pulley and out of the opening in the headstock.
35. Slide the new motor belt over the left end of countershaft assembly "Z", Figure 3.9, and onto the right pulley on the countershaft assembly.
36. Cross the new spindle belt, as shown in Figure 3.18, feed it into the headstock and down into the pedestal.
37. Use a piece of wire as a hook to lift the spindle belt into the spindle pulley.
38. Move the headstock belt over the end of pull rod "A", Figure 3.10.

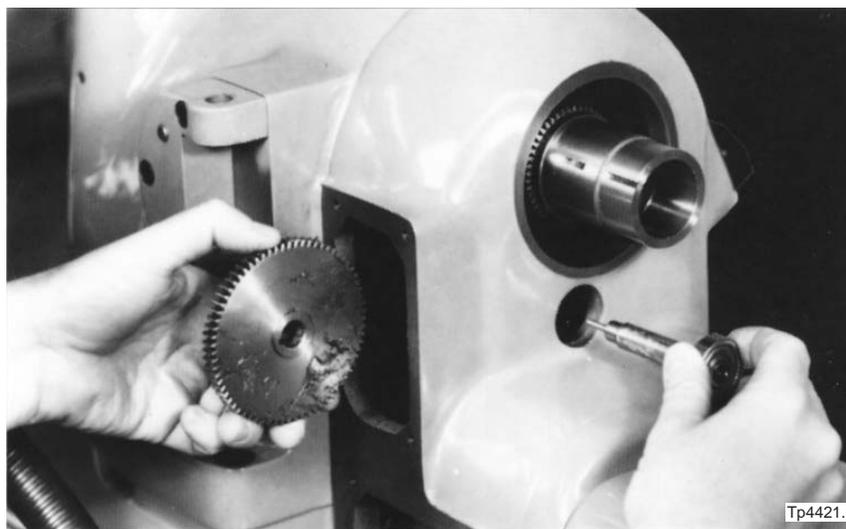


Figure 3.15 - Idler Gear and Shaft Removal

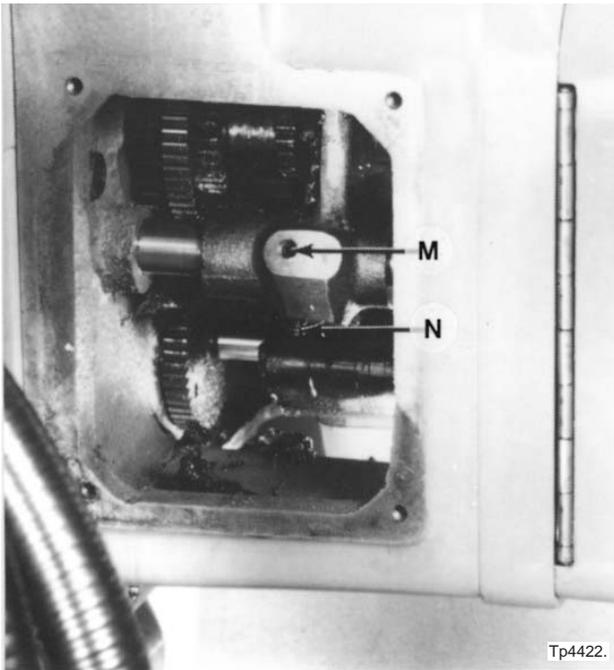


Figure 3.16 - Gear Box Shifter Fork

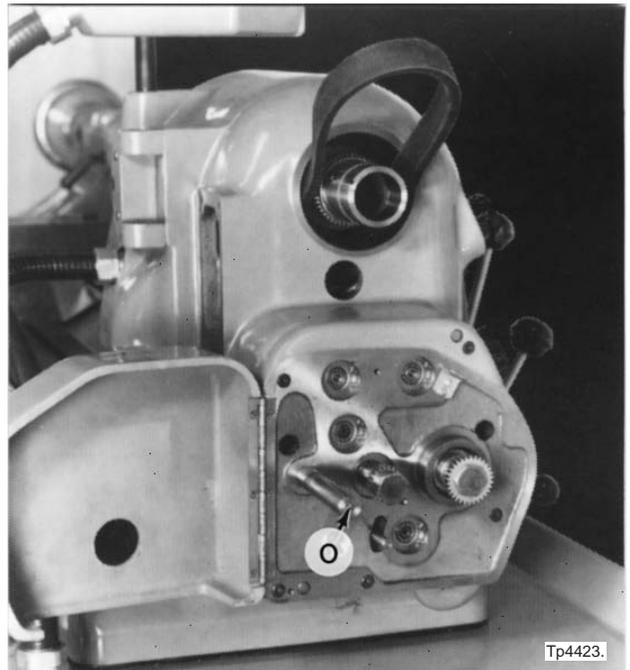


Figure 3.17 - Spindle Belt Removal

39. Slide the new headstock belt over the left end of countershaft assembly "Z", Figure 3.9, and onto the left pulley of the countershaft assembly.
40. Remount the countershaft assembly by sliding the left end of the countershaft assembly back into countershaft support bracket "Y".
41. Reconnect pull rod "A", Figure 3.10, and insert the cotter pin removed in step 20.
  - On HLV<sup>®</sup>-H machines, proceed to step 42.
  - On TFB<sup>®</sup>-H machines, proceed to step 49.
42. Replace shaft "O", Figure 3.17.
43. Replace lock screw "M", Figure 3.16.
44. Replace the set screw and lock screw "N".

**- NOTE -**

Match timing mark "K", Figure 3.19, on the worm gear and timing mark "L" on the pinion.

45. Back off push screw "H", Figure 3.12, counterclockwise to replace the gear, shaft, and bearing, as shown in Figure 3.15 .
46. Replace snap ring "G", Figure 3.12.
47. Replace covers "K" and "L", Figure 3.14.
48. Proceed to step 50.

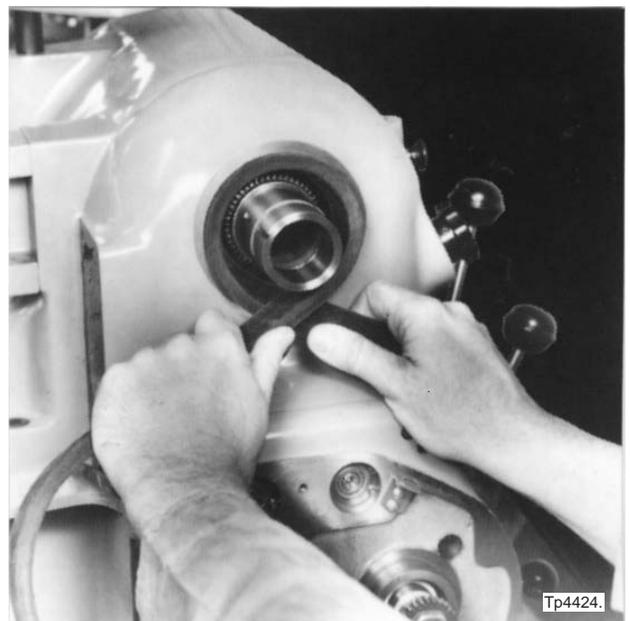


Figure 3.18 - Spindle Belt Replacement

49. Replace cover "J" and four screws "I", Figure 3.13.
50. Replace washers "F" and "E", Figure 3.12, and key "D".
51. Replace handwheel "C", Figure 3.11, and snap ring "B".
52. Remount the collet closer according to the procedure outlined in Chapter 4.
53. Pull "Start/Stop" pushbutton "D", Figure 3.1, OUT to turn the machine ON.

**- WARNING -**

**Stay clear of the spindle drive motor compartment while the spindle motor is running.**

54. On HLV<sup>®</sup>-H machines, place lever "A" in "Low" range  
 On TFB<sup>®</sup>-H machines, place lever "G", Figure 3.2, in "Low" range and lever "F" in "Forward" or "Reverse".
55. Turn speed adjustment knob "C", Figure 3.1, to "Slower" and hold in that position until pulley hanger assembly "Y", Figure 3.9, reaches maximum downward travel.
56. On HLV-H machines, place lever "A", Figure 3.1, in the "Stop" position and allow the spindle motor to coast to a stop.  
 On TFB-H machines, place lever "F", Figure 3.2, in the "Brake" position and lever "G" in the "Stop" position.

**- WARNINGS -**

**The spindle brake is not in position to stop the spindle. Allow the spindle to come to a complete stop.**

**Be sure the machine is turned OFF before attempting to work in the motor compartment.**

57. Press "Start/Stop" pushbutton "D", Figure 3.1, N to turn the machine OFF.
58. Install the motor belt on motor pulley "T", Figure 3.8 .
59. Realign spindle brake "X" with the braking surface on the motor pulley and tighten two brake mounting bolts "U".
60. Check and adjust the gap between the cork insert in the brake and the braking surface on the spindle motor pulley. Refer to "Spindle Brake Gap Adjustment", Page 3-10.
61. Remove the block and carefully lower the front of the motor mounting plate.
62. Install lock nut "P", Figure 3.5, but do not tighten.

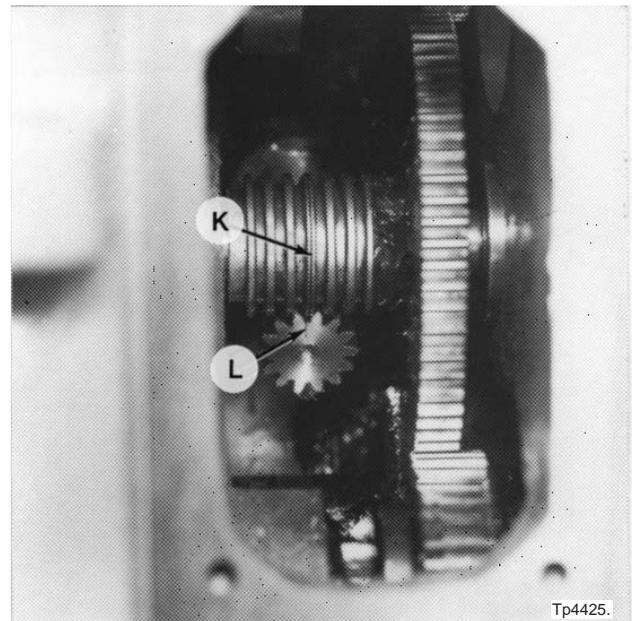


Figure 3.19 - Timing Marks for Worm Gear and Pinion

63. Adjust belt tension according to the procedure outlined in "Adjusting Drive Belt Tension", Page 3-2.
64. Turn stop collar "J", Figure 3.4, down on the trip rod 1 inch [25.4mm] from the top of the rod.
65. Adjust stop collar "J" gradually upward, running the speed change mechanism between settings, until the spindle belt is flush to 1/16 inch [1.6mm] out of the countershaft pulley when the limit switch stops upward motion.
66. Tighten the set screw in stop collar "J".
67. If stop collar "L" has been disturbed, turn stop collar "L" down on the trip rod to a point 1/4 inch [57.2mm] from the drive housing casting.
68. Adjust stop collar "L" gradually downward, running the speed change mechanism between settings, until the motor belt is flush to 1/16 inch [1.6mm] out of the countershaft pulley when the limit switch stops downward motion.
69. Tighten the set screw in stop collar "L".
70. Stop collars "M", Figures 3.4 and 3.20, and "O", Figures 3.4 and 3.21, are set to allow 1/16 inch of clearance after the limit switches have tripped and the drive has drifted to a stop.
71. Close door "H", Figure 3.3 .

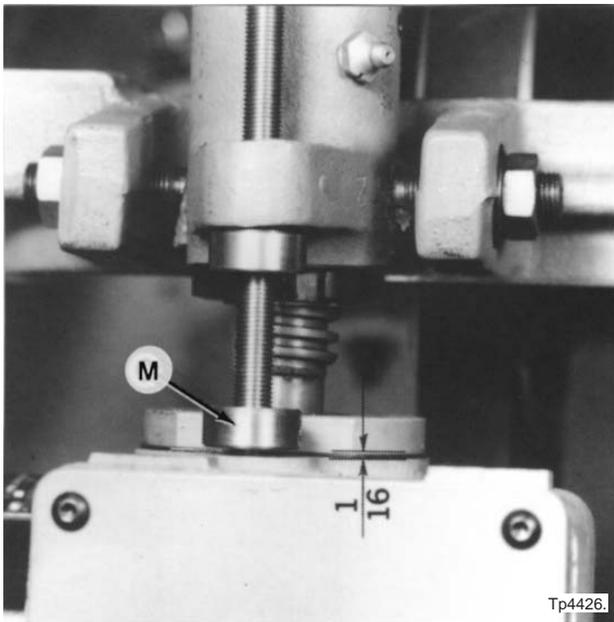


Figure 3.20 - Stop Collar Adjustment

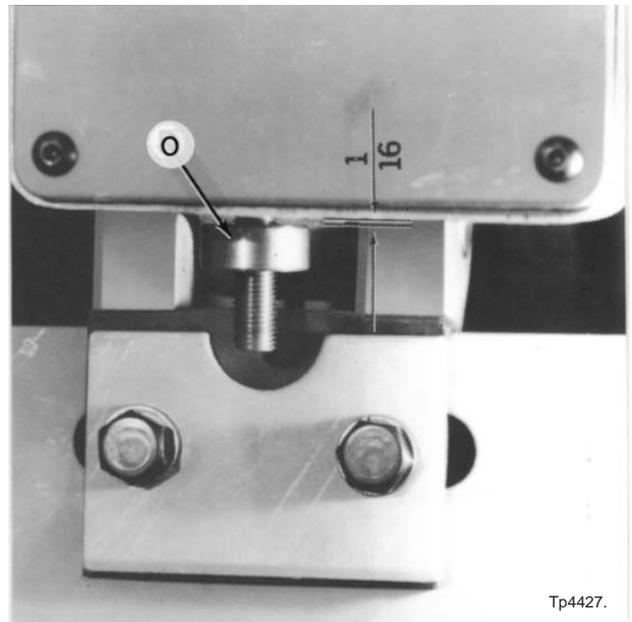


Figure 3.21 - Stop Collar Adjustment

## SPINDLE BRAKE

### Spindle Brake Gap Adjustment

#### - NOTE -

There should be a .010" to .013" [.25mm to .33mm] clearance between the cork insert and the brake drum.

1. On HLV<sup>®</sup>-H machines, place lever "A", Figure 3.1, in the "Stop" position and lever "B" in the center position.  
On TFB<sup>®</sup>-H machines, place lever "F", Figure 3.2, in the "Brake" position and lever "G" in the "Stop" position.
2. Pull "Start/Stop" pushbutton "D", Figure 3.1, OUT to turn the machine ON.
3. On HLV-H machines, turn brake switch "E" to the OFF position.
4. On HLV-H machines, place lever "A" in "High" range.  
On TFB-H machines, place lever "G", Figure 3.2, in "High" range and lever "F" in "Forward" or "Reverse".
5. On HLV-H machines, place lever "A", Figure 3.1, in the "Stop" position and allow the spindle to coast to a stop.  
On TFB-H machines, place lever "G", Figure 3.2, in the "Stop" position and allow the spindle to coast to a stop.

#### - WARNING -

**Be sure the spindle motor has come to a complete stop before attempting to work in the motor compartment.**

6. Open door "H", Figure 3.3 .
7. Turn adjusting screw "P", Figure 3.22, clockwise or counterclockwise until there is a .010" to .013" [.25mm to .33mm] clearance between the cork insert and the brake drum.
8. Close door "H", Figure 3.3 .
9. On HLV-H machines, set brake switch "E", Figure 3.1, to the "ON" position.  
On TFB-H machines, place lever "F", Figure 3.2, in the "Brake" position
10. Push "Start/Stop" pushbutton "D", Figure 3.1, IN to turn the machine OFF.

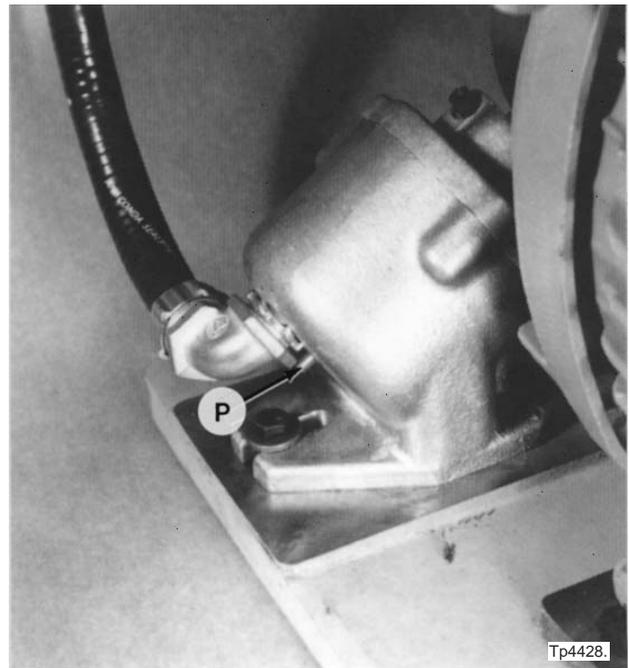


Figure 3.22 - Spindle Brake Adjustment

## Spindle Brake Insert Replacement

### - WARNING -

**Be sure the machine is turned OFF before attempting to work in the motor compartment.**

1. Push “Start/Stop” pushbutton “D”, Figure 3.8, IN to turn the machine OFF.
2. Open door “H”, Figure 3.3.
3. Loosen two bolts “U”, Figure 3.8 .
4. Remove one bolt “U” to allow brake removal.
5. Remove the brake assembly for easy access to the cork insert.
6. Loosen locknut “V”.
7. Loosen keyway guide screw “W”.
8. Turn adjusting screw “P”, Figure 3.22, counterclockwise until the cork housing is free from the brake.
9. Push the cork insert out of the housing by means of the threaded hole in the bottom of the housing.

### - NOTE -

Be sure that the new cork insert is seated firmly in the cork insert housing.

10. Install the new cork insert.
11. Replace the cork insert housing in the brake, orienting the keyway toward keyway guide screw “W”, Figure 3.8 .
12. Turn keyway guide screw “W” clockwise until it bottoms out in the cork housing.
13. Back keyway guide screw “W” out 1/4 turn and tighten locknut “V”.
14. Reposition the brake assembly.
15. Replace mounting bolt “U” removed in step 4.
16. Tighten both mounting bolts “U”.
17. Adjust the gap between the cork insert and the brake drum according to the steps outlined under “Spindle Brake Gap Adjustment”, Page 3-10.

## Spindle Brake Insert Lubrication

### - NOTE -

Do not over-oil the cork insert.

Oil the cork insert in the spindle brake with two drops of spindle oil (Mobil® Velocite® oil No. 6) as needed. When it is dry, the cork insert will squeak when applied against the spindle motor pulley.

Allowing the cork insert to dry out will greatly reduce the life of the drive belts and cork insert.

## SPEED CHANGE FEED SCREW NUT

### Removal

1. On HLV<sup>®</sup>-H machines, place lever "A", Figure 3.1, in the "Stop" position and lever "B" in the center position.

On TFB<sup>®</sup>-H machines, place lever "F", Figure 3.2, in the "Brake" position and lever "G" in the "Stop" position.

2. Pull "Start/Stop" pushbutton "D", Figure 3.1, OUT to turn the machine ON.

3. Open door "H", Figure 3.3 .

4. Loosen two nuts "S", Figure 3.23, and loosen pivot screws "T" to clear feed screw nut "R".

5. Loosen set screw and remove stop collar "J", Figure 3.4 .

6. On HLV-H machines, place lever "A", Figure 3.1, in "Low" range.

On TFB-H machines, place lever "F", Figure 3.2, in "Forward" or "Reverse" and lever "G" in "Low" range.

### - WARNING -

**Use extreme caution when reaching into the drive compartment while the spindle motor is running.**

7. Press down on pulley carrier bracket "U", Figure 3.23, near pivot screws "T" to place the bracket in the down position.

8. On HLV-H machines, place lever "A", Figure 3.1, in the "Stop" position.

On TFB-H machines, place lever "F", Figure 3.2, in the "Brake" position and lever "G" in the "Stop" position.

9. Push "Start/Stop" pushbutton "D", Figure 3.1, IN to turn the machine OFF.

10. Turn vertical screw "Q", Figure 3.23, by hand to remove feed screw nut "R".

11. Remove half nut "V", Figure 3.24 .

12. Remove nut "Z" to remove half nut "Y" and spring "X" from housing "W".

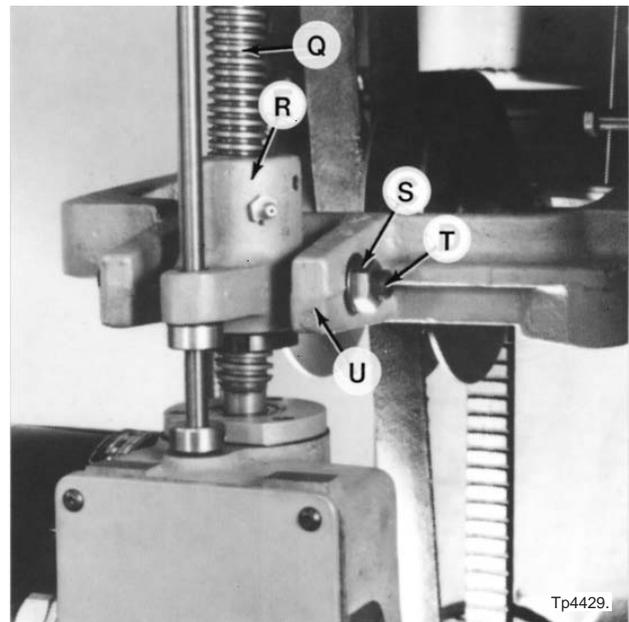


Figure 3.23 - Speed Change Feed Screw Nut

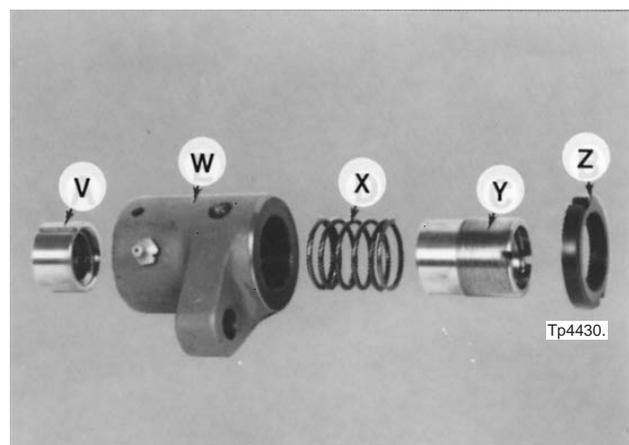


Figure 3.24 - Feed Screw Nut Components

## Replacement

### - NOTE -

Do not tighten nut “Z”, Figure 3.24, until instructed to do so.

1. Replace spring “X”, half nut “Y”, and nut “Z” in housing “W”, Figure 3.24 .
2. Line up the keyway in half nut “V” with the key screw in housing “W”; then slide half nut “V” into housing “W”, until approximately 1/16 inch [1.6mm] of the half nut is protruding from the housing.

### - NOTE -

Hold half nut “V” within 1/16 inch [1.6mm] of flush with housing “W” while installing the feed screw nut on the vertical screw.

It may be necessary to turn half nut “Y” slightly to line up the threads in both half nuts.

3. Noting the orientation shown in Figure 3.23, replace feed screw nut “R” by turning vertical screw “Q” by hand.
4. Tighten nut “Z”, Figure 3.24 .
5. On HLV®-H machines, place lever “A”, Figure 3.1, in the “Stop” position and lever “B” in the center position.  
On TFB®-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.
6. Pull “Start/Stop” pushbutton “D”, Figure 3.1, OUT to turn the machine ON.
7. On HLV-H machines, place lever “A” in “Low” range.  
On TFB-H machines, place lever “G”, Figure 3.2, in “Low” range and lever “F” in “Forward” or “Reverse”.

### - WARNING -

**Use extreme caution when reaching into the drive compartment while the spindle motor is running.**

8. Pull up on pulley carrier bracket “U”, Figure 3.23, near pivot screws “T” to align the pivot screws with the feed screw nut.
9. Turn pivot screws “T” into the feed screw nut housing.
10. Tighten lock nuts “S”.
11. Push “Start/Stop” pushbutton “D”, Figure 3.1, IN to turn the machine OFF.

### - NOTE -

Vertical feed screw “Q”, Figure 3.23, should turn freely by hand.

12. Try to rotate vertical feed screw “Q”, Figure 3.23, by hand.  
If the vertical feed screw does not turn freely by hand, proceed to step 13.  
If the vertical feed screw does turn freely by hand, proceed to step 16.

13. Loosen lock nuts “S”.
14. Adjust pivot screws “T” so that they each apply equal side pressure on the feed screw nut.
15. Tighten lock nuts “S”.
16. Pull “Start/Stop” pushbutton “D”, Figure 3.1, OUT to turn the machine ON.
17. Replace stop collar “J”, Figure 3.4, and turn it down on trip rod 1 inch [25.4mm] from the top of the rod.
18. Adjust stop collar “J” gradually upward, running the speed change mechanism between settings, until the spindle belt is flush to 1/16 inch [1.6mm] out of the countershaft pulley when the limit switch stops upward motion.
19. Tighten the set screw in stop collar “J”.
20. Close door “H”, Figure 3.3 .
21. On HLV<sup>®</sup>-H machines, place lever “A”, Figure 3.1, in the “Stop” position.  
On TFB<sup>®</sup>-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.
22. Push “Start/Stop” pushbutton “D”, Figure 3.1, IN to turn the machine OFF.

## **SPEED CHANGE MECHANISM**

### **Removal**

1. On HLV-H machines, place lever “A”, Figure 3.1, in the “Stop” position and lever “B” in the center position.  
On TFB-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.
2. Pull “Start/Stop” pushbutton “D”, Figure 3.1, OUT to turn the machine ON.
3. On HLV-H machines, place lever “A” in “Low” range.  
On TFB-H machines, place lever “F”, Figure 3.2, in “Forward” or “Reverse” and lever “G” in “Low” range.
4. Turn speed adjustment knob “C”, Figure 3.1, to “Slower” and hold in that position until spindle speed stabilizes at 125 rpm.
5. On HLV-H machines, place lever “A” in the “Stop” position to stop the spindle.  
On TFB-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.
6. Press “Start/Stop” pushbutton “D”, Figure 3.1, IN to turn the machine OFF.
7. Open door “H”, Figure 3.3 .
8. Turn main disconnect switch “B”, Figure 3.25, OFF
9. Loosen two screws “A” and open power case door “C”.
10. Disconnect the three black wires connected to the bottom of T1R, T2R, and T3R on terminal block “D”, Figure 3.26 . (Reference 2TB)

11. Disconnect the green ground wire, which enters the power case through the same conduit, from ground post "E". (Reference MACH GND #3)
12. Remove conduit nut "F", Figure 3.27, and pull the wires into the pedestal.
13. Loosen lock nuts "S", Figure 3.23, and loosen pivot screws "T" to clear feed screw nut "R".

**- NOTE -**

Do not disturb mounting bracket "I", Figure 3.28, which is factory adjusted for alignment.

14. Remove set screw "G", Figure 3.28 .
15. Support the speed change mechanism and remove pin "H".
16. Remove the speed change mechanism from the pedestal.

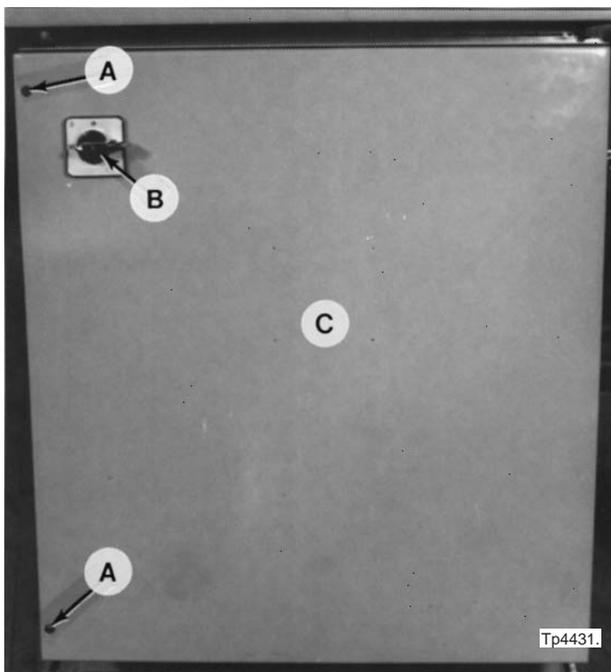


Figure 3.25 - Power Case (External View)

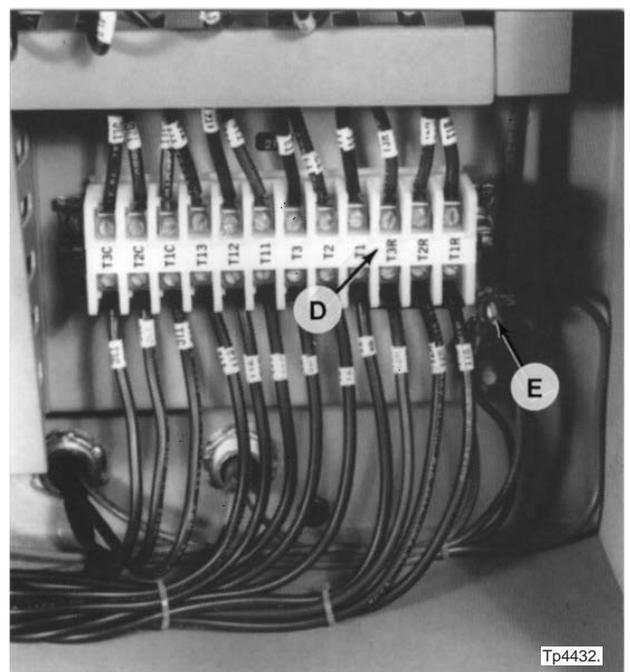


Figure 3.26 - Power Case (Partial Internal View)

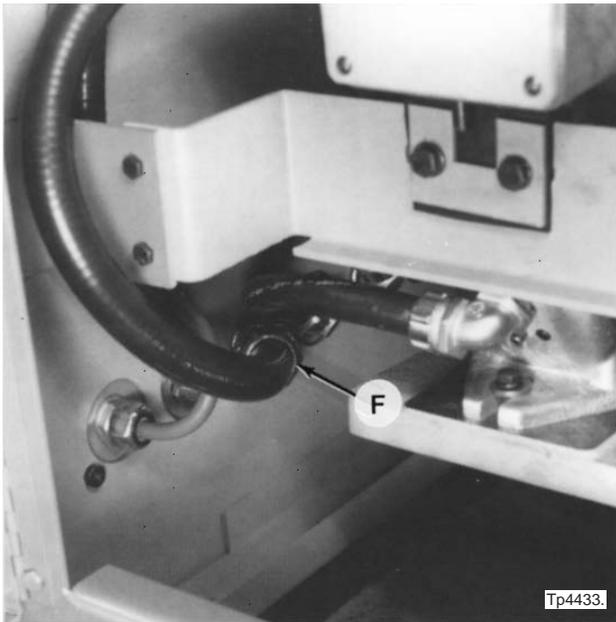


Figure 3.27 - Speed Change Conduit Nut

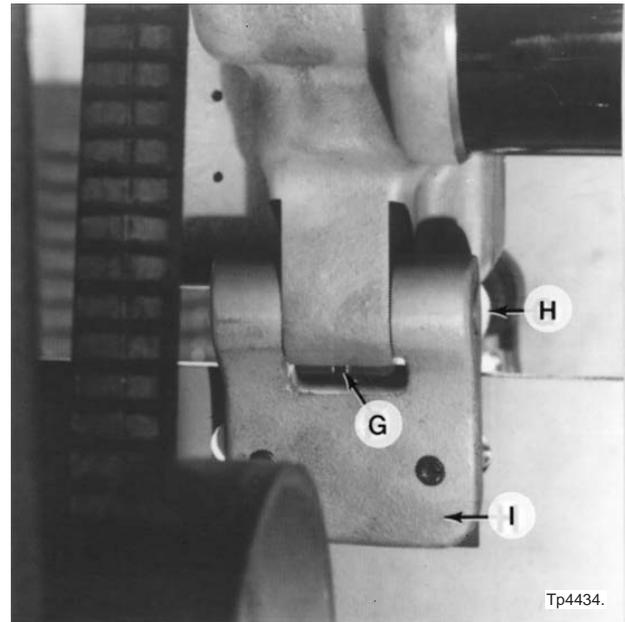


Figure 3.28 - Speed Change Mounting Bracket (Rear View)

### Disassembly

1. Loosen set screw and remove stop collar "K", Figure 3.29 .
2. Turn vertical screw "J" by hand to remove feed screw nut "L".
3. Remove four screws "M" and cover "N".
4. Disconnect the three (black) motor leads.
5. Remove two screws "O", Figure 3.30, and remove the motor.
6. Remove three screws "P", Figure 3.1, and remove the vertical screw assembly, as shown in Figure 3.2 .

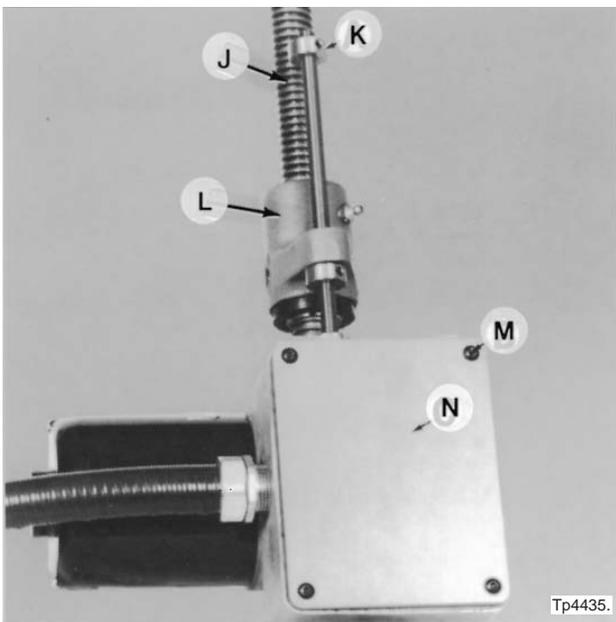


Figure 3.29 - Speed Change Mechanism

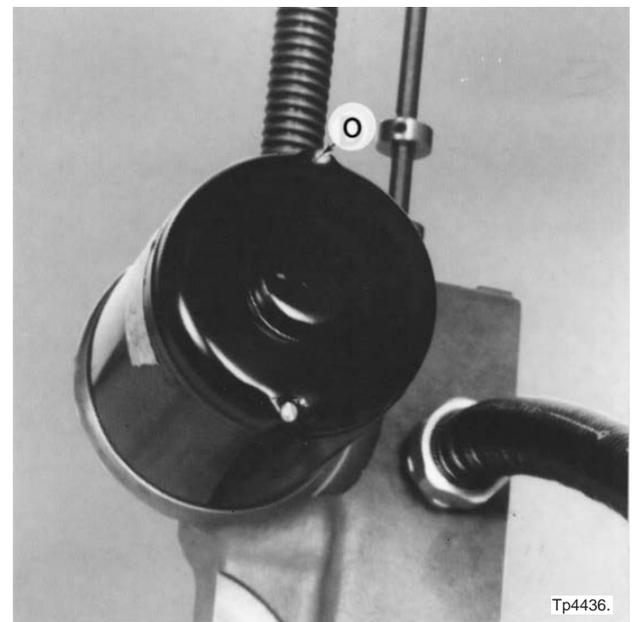


Figure 3.30 - Speed Change Motor

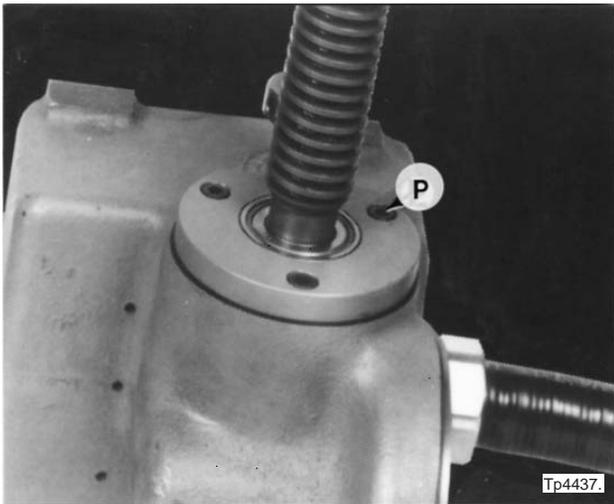


Figure 3.31 - Feed Screw Housing

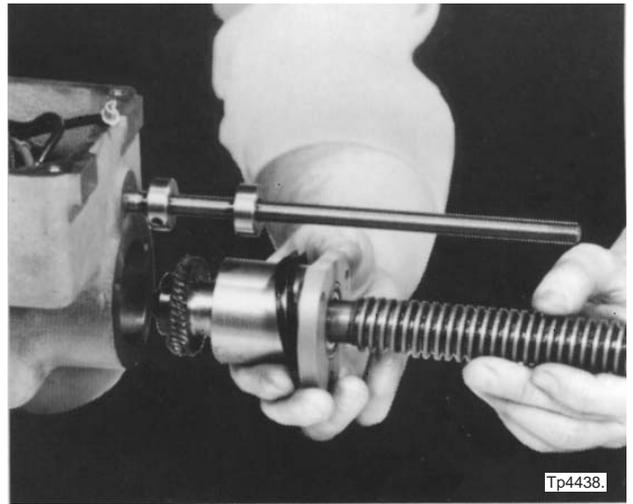


Figure 3.32 - Vertical Feed Screw Removal

**- NOTE -**

Do not lose the nylon plug under set screw "R", Figure 3.33 .

7. Loosen set screw "R", Figure 3.33, and remove nut "Q" using a spanner wrench.

**- NOTE -**

On some machine models the worm wheel has been replaced with a straight tooth wheel and the shims shown in Figure 3.32 are not required.

8. Remove worm wheel "S" and key "X", Figure 3.33 .

9. Remove the vertical screw from drive housing "V".

10. Remove bearing "T", spacer "U", and shim "W".

11. If necessary, press bearing "Y" from vertical screw shaft "Z".

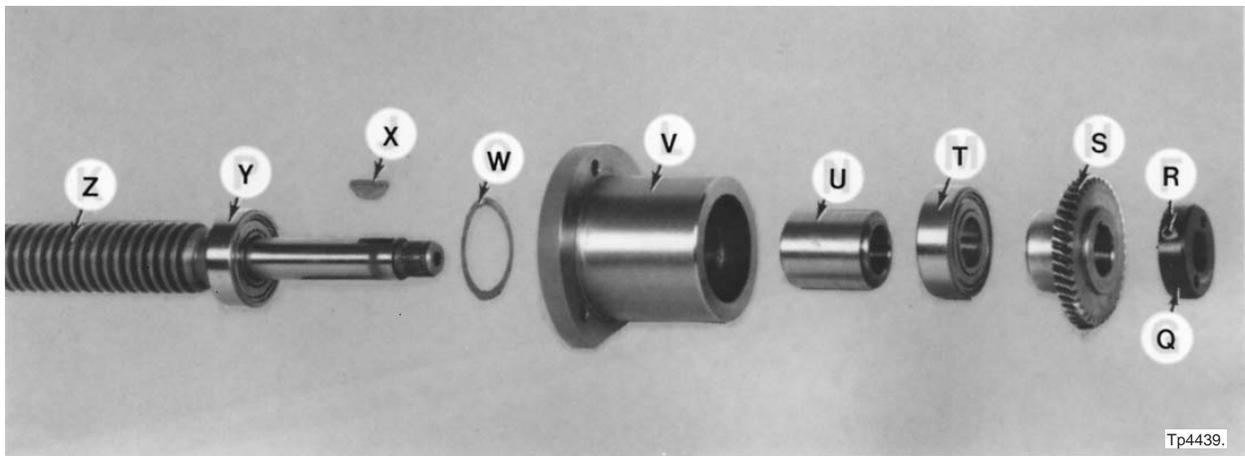


Figure 3.33 - Variable Feed Screw Components

12. Record the connections; then disconnect wires 15, 17, 18, and 20, Figure 3.34 .
13. Remove four screws "D" to remove the limit switches and the green ground wire.
14. Loosen set screw "E" and remove stop collar "F".
15. Remove two roll pins "G" and stop rod "A" to free cams "B" and springs "C".
16. Remove the motor armature, Figure 3.35 .
17. Remove nut "H" to remove worm "I".
18. If necessary, press bearings "J" and "K" from the armature shaft.

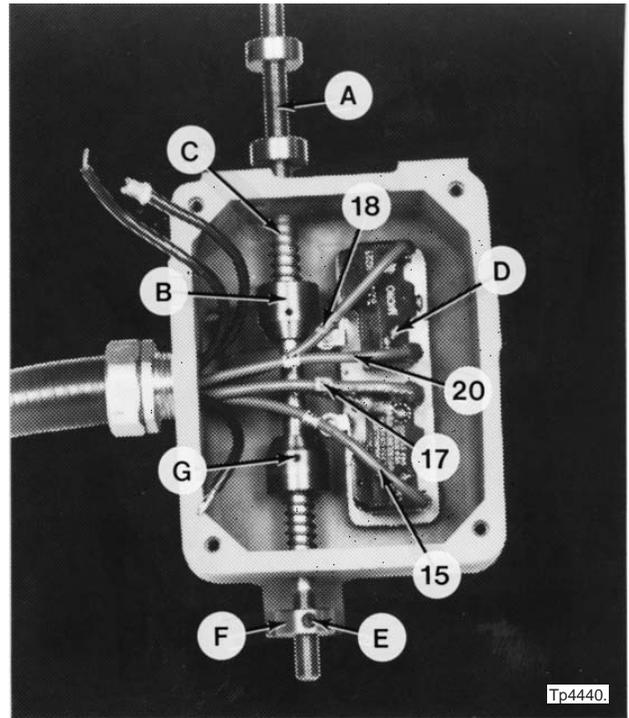


Figure 3.34 - Drive Switches and Cams

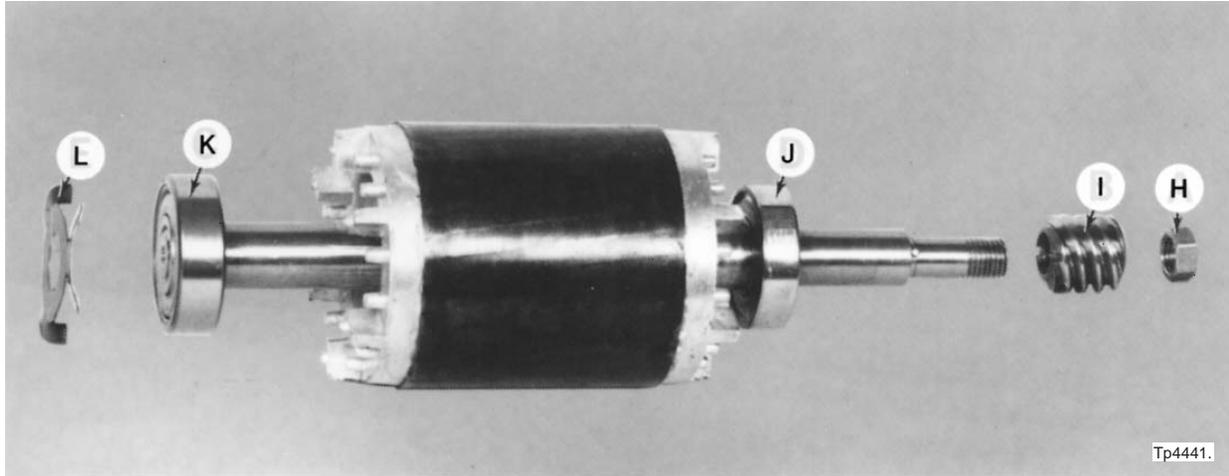


Figure 3.35 - Drive Motor Components

## Reassembly

1. If required, press replacement bearings “J” and “K”, Figure 3.35, onto the armature shaft.
2. Replace worm “I” and nut “H”.

### - NOTE -

Note the orientation of wave washer “L”, which is located in the motor cap.

3. Replace motor armature.
4. Replace motor and two screws “O”, Figure 3.30 .
5. Replace the limit switches and the green ground wire with four screws “D”, Figure 3.34 .
6. Reconnect wires 15, 17, 18, and 20.
7. Replace springs “C”, cams “B”, stop rod “A”, and roll pins “G”.
8. Reconnect the three (black) motor leads.
9. If required, press bearing “Y”, Figure 3.33, onto vertical screw shaft “Z”.
10. Assemble shim “W”, vertical screw “Z”, housing “V”, spacer “U”, and bearing “T”.

### - NOTE -

On some machine models the worm wheel has been replaced with a straight tooth wheel and the shims shown in Figure 3.32 are not required.

11. Replace key “X”, Figure 3.33, and worm wheel “S”.

### - NOTE -

Be sure the nylon plug is in position under set screw “R”.

12. Replace nut “Q” and tighten set screw “R”.
13. Grease worm wheel and worm with Andok® “B” grease.
14. Replace the vertical screw assembly, as shown in Figure 3.32 .
15. Replace three screws “P”, Figure 3.31 .
16. Replace cover “N” using four screws “M”, Figure 3.29 .

### - NOTE -

Hold half nut “V”, Figure 3.24, within 1/16 inch [1.6mm] of flush with housing “W” while installing the feed screw nut on the vertical screw.

17. Noting the orientation shown in Figure 3.23, replace feed screw nut “R” by turning vertical screw “Q” by hand.

### - NOTE -

Do not tighten the lock screws in stop collars “K”, Figure 3.29, and “F”, Figure 3.34.

18. Start stop collars “K”, Figure 3.29, and “F”, Figure 3.34, onto the trip rod.

## Replacement

1. Place the speed change mechanism in the pedestal.
2. Support the speed change mechanism and install pin “H”, Figure 3.28 .
3. Replace and tighten set screw “G”.
4. Feed the wires through the conduit elbow and into the power case.
5. Secure conduit nut “F”, Figure 3.27 .
6. Reroute and connect the three black wires labeled T1R, T2R, and T3R to their corresponding connections on the bottom of terminal block “D”, Figure 3.26 . (Reference 2TB)
7. Connect the green ground wire, which enters the power case through the same conduit, to ground post “E”. (Reference MACH GND #3)
8. Close power case door “C”, Figure 3.25, and secure two screws “A”.
9. Turn main disconnect switch “B” ON.
10. On HLV<sup>®</sup>-H machines, place lever “A”, Figure 3.1, in the “Stop” position.  
On TFB<sup>®</sup>-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.
11. Pull “Start/Stop” pushbutton “D”, Figure 3.1, OUT to turn the machine ON.
12. On HLV-H machines, place lever “A” in “Low” range.  
On TFB-H machines, place lever “F”, Figure 3.2, in “Forward” or “Reverse” and lever “G” in “Low” range.

### - WARNING -

**Use extreme caution when reaching into the drive compartment while the spindle motor is running.**

13. Pull up on pulley carrier bracket “U”, Figure 3.23, near pivot screws “T” to align the pivot screws with the feed screw nut.
14. Turn the pivot screws into the feed screw nut housing.
15. Tighten lock nuts “S”.
16. On HLV-H machines, place lever “A”, Figure 3.1, in the “Stop” position.  
On TFB-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.
17. Press “Start/Stop” pushbutton “D”, Figure 3.1, IN to turn the machine OFF.

### - NOTE -

Vertical feed screw “Q”, Figure 3.23, should turn freely by hand.

18. Try to rotate vertical feed screw “Q”, Figure 3.23, by hand.  
If the vertical feed screw does not turn freely by hand, proceed to step 19.  
If the vertical feed screw does turn freely by hand, proceed to step 22.
19. Loosen lock nuts “S”.

20. Adjust pivot screws “T” so that they each apply equal side pressure on the feed screw nut.
21. Tighten lock nuts “S”.

**- CAUTION -**

**Make small changes in spindle speed when checking for proper drive rotation. The drive may jam up on the stop collars if speed change motor rotation is not correct. This could result in damage to the worm wheel.**

22. Pull “Start/Stop” pushbutton “D”, Figure 3.1, OUT to turn the machine ON.
23. On HLV®-H machines, place lever “A” in “Low” range.  
On TFB®-H machines, place lever “F”, Figure 3.2, in “Forward” or “Reverse” and lever “G” in “Low” range.

**- NOTE -**

When changing spindle speed, if spindle speed is to increase, the pulley assembly should move upward. If spindle speed is to decrease, the pulley assembly should move downward.

24. Make a small change in the spindle speed by turning switch “C”, Figure 3.1, to “Faster” or “Slower” and observe the movement of the pulley assembly.  
If the pulley assembly does not move in the correct direction, proceed to step 25.  
If the pulley assembly moves in the correct direction, proceed to step 33.
25. On HLV-H machines, place lever “A”, Figure 3.1, in the “Stop” position.  
On TFB-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.
26. Press “Start/Stop” pushbutton “D” IN to turn the machine OFF.
27. Turn main disconnect switch “B”, Figure 3.25, OFF
28. Loosen two screws “A” and open power case door “C”.
29. Interchange the two black wires connected to T1R and T2R on terminal block “D”, Figure 3.26 . (Reference 2TB)
30. Close power case door “C”, Figure 3.25, and tighten two screws “A”.
31. Turn main disconnect switch “B” ON.
32. Repeat steps 22 through 24.
33. Replace stop collar “J”, Figure 3.4, and turn it down on the trip rod 1 inch [25.4mm] from the top of the rod.
34. Adjust stop collar “J” gradually upward, running the speed change mechanism between settings, until the spindle belt is flush to 1/16 inch [1.6mm] out of the countershaft pulley when the limit switch stops upward motion.
35. Tighten the set screw in stop collar “J”.
36. If stop collar “L” has been disturbed, turn stop collar “L” down on the trip rod to a point 2-1/4 inches [57.2mm] from the drive housing casting.

37. Adjust stop collar “L” gradually downward, running the speed change mechanism between settings, until the motor belt is flush to 1/16 inch [1.6mm] out of the countershaft pulley when the limit switch stops downward motion.
38. Tighten the set screw in stop collar “L”.
39. Stop collars “M”, Figures 3.4 and 3.20, and “O”, Figures 3.4 and 3.21, are set to allow 1/16 inch of clearance after the limit switches have tripped and the drive has drifted to a stop.
40. Close door “H”, Figure 3.3 .

## Lubrication

### - NOTE -

For proper lubrication of the drive, run the drive through the entire speed range at least once a day.

Lubricate the feed screw nut a minimum of once a month or more often if necessary.

Apply Cosmolube® grease No. 2 at fitting “K”, Figure 3.4 . The grease is sufficient when it is forced out of the slot in fitting “K”.

Lubricate the bearing surfaces of the countershaft with Molyube® Anti-Seize grease every three months.

The main drive motor and speed change motor bearings are grease packed for life and require no further lubrication.

## PULLEY AND SHAFT ASSEMBLY

### Removal

1. On HLV®-H machines, place lever “A”, Figure 3.1, in the “Stop” position and lever “B” in the center position.  
On TFB®-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.
2. Pull “Start/Stop” pushbutton “D”, Figure 3.1, OUT to turn the machine ON.
3. On HLV-H machines, place lever “A” in “Low” range.  
On TFB-H machines, place lever “F”, Figure 3.2, in “Forward” or “Reverse” and lever “G” in “Low” range.
4. Turn speed adjustment knob “C”, Figure 3.1, to “Slower” and hold in that position until spindle speed stabilizes at 125 rpm.
5. On HLV-H machines, place lever “A”, Figure 3.1, in the “Stop” position.  
On TFB-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.
6. Press “Start/Stop” pushbutton “D”, Figure 3.1, IN to turn the machine OFF.
7. Open door “H”, Figure 3.3 .
8. Remove lock nut “P”, Figure 3.5 .

9. Raise the front of the motor mounting plate approximately two inches and block it in this position, as shown in Figure 3.6 .
10. Loosen two bolts "U", Figure 3.8, and slide brake assembly "X" away from motor pulley "T".
11. Remove motor belt "N", Figure 3.4, from motor pulley "T", Figure 3.8 .
12. Roll motor belt "S", Figure 3.7, to the right off the pulley and let it rest on the pulley hub, as shown.
13. Pull "Start/Stop" pushbutton "D", Figure 3.1, OUT to turn the machine ON.
14. On HLV®-H machines, place lever "A" in "High" range.

On TFB®-H machines, place lever "F", Figure 3.2, in "Forward" or "Reverse" and lever "G" in "High" range.

15. Turn speed adjustment knob "C", Figure 3.1, to "Faster" and hold in that position until pulley hanger assembly "Y", Figure 3.9, reaches maximum upward travel.
16. On HLV-H machines, place lever "A", Figure 3.1, in the "Stop" position.

On TFB-H machines, place lever "F", Figure 3.2, in the "Brake" position and lever "G" in the "Stop" position.

17. Press "Start/Stop" pushbutton "D", Figure 3.1, IN to turn the machine OFF.
18. Slide countershaft assembly "Z", Figure 3.9, to the extreme right and remove both belts over the left end of the countershaft.
19. Remove the snap ring from the right side of the pulley hanger assembly, as shown in Figure 3.36 .

**- NOTE -**

A small piece of sheet metal wrapped around the pulley shaft can be used to remove the bearing and spacer.

20. Remove the bearing and spacer from the right side of the pulley hanger assembly, as shown in Figure 3.37 .
21. Move the pulley shaft to the right out of the left bearing and remove the pulley and shaft assembly, as shown in Figure 3.38 .
22. If necessary, remove the snap ring to remove the left bearing and spacer.

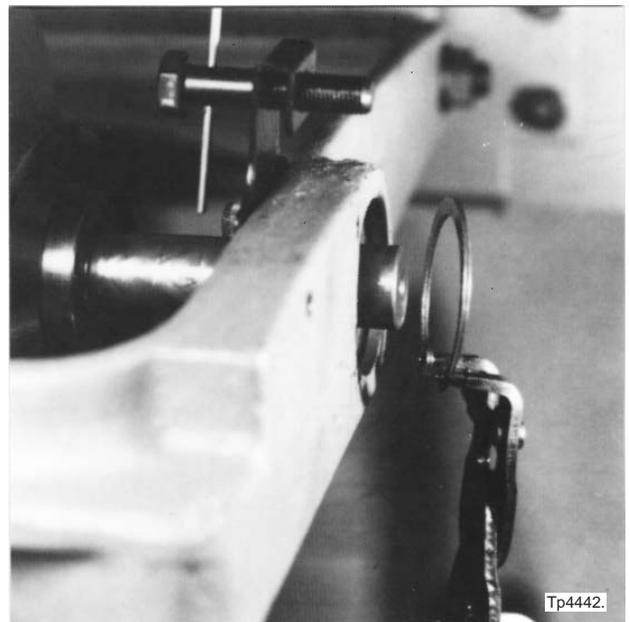


Figure 3.36 - Countershaft Snap Ring Removal

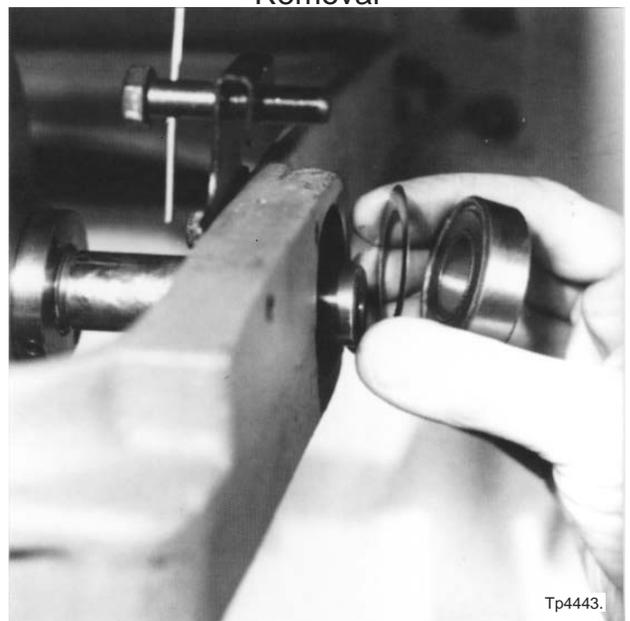


Figure 3.37 - Countershaft Bearing and Spacer Removal

## Replacement

1. If removed, install the spacer, bearing, and snap ring in the left side of the pulley hanger.

### - NOTE -

The shaft on the pulley assembly is longer on the right side, as viewed from the front of the machine.

2. Coat the bearing surfaces of the pulley shaft with Molykote<sup>®</sup> Anti-Seize grease and install the pulley assembly in the bearing in the left side of the pulley hanger.
3. Install the spacer and bearing in the right side of the pulley hanger, as shown in Figure 3.37 .
4. Install the snap ring in the right side of the pulley hanger, as shown in Figure 3.36 .

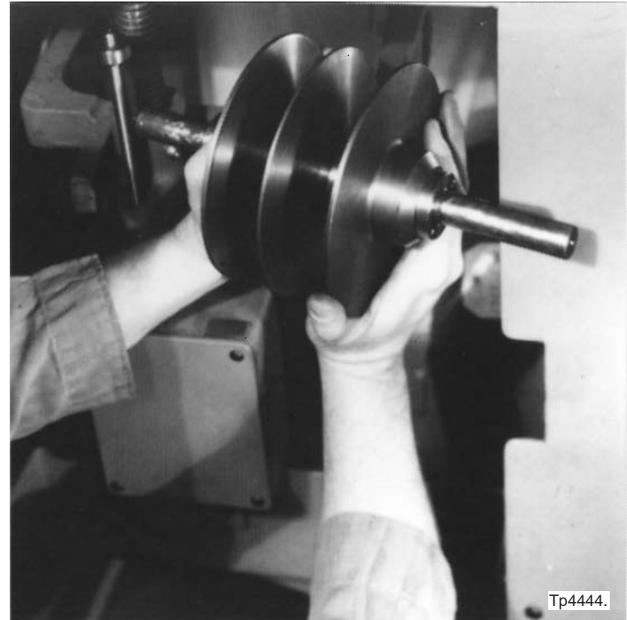


Figure 3.38 - Countershaft Removal

5. Slide countershaft assembly “Z”, Figure 3.9, to the extreme right and slide the motor belt over the left end of the countershaft.
6. Position the motor belt at the right end of the pulley, resting on the pulley hub, as shown in Figure 3.7 .
7. Slide the spindle drive belt over the left end of the countershaft and position it on the left pulley, as viewed from the front of the machine.
8. Slide countershaft assembly “Z”, Figure 3.9, to the left until the left end of the pulley shaft is positioned inside the bearing in the left side of pulley hanger “Y”.

### - WARNING -

**Use extreme caution when running the spindle motor while pedestal door “H”, Figure 3.3, is open.**

9. Pull “Start/Stop” pushbutton “D”, Figure 3.1, OUT to turn the machine ON.
10. On HLV<sup>®</sup>-H machines, place lever “A” in “Low” range.  
On TFB<sup>®</sup>-H machines, place lever “F”, Figure 3.2, in “Forward” or “Reverse” and lever “G” in “Low” range.
11. Turn speed adjustment knob “C”, Figure 3.1, to “Slower” and hold in that position until spindle speed stabilizes at 125 rpm.
12. On HLV-H machines, place lever “A”, Figure 3.1, in the “Stop” position.  
On TFB-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.
13. Press “Start/Stop” pushbutton “D”, Figure 3.1, IN to turn the machine OFF.
14. Position the motor belt on the right pulley, as viewed from the front of the machine.
15. Remove the wooden block and carefully lower the front of the motor mounting plate.

16. Install lock nut “P”, Figure 3.5, but do not tighten.
17. Adjust drive belt tension by turning adjusting screw “Q” clockwise to lower the drive motor and tighten the drive belts.
18. Tighten lock nut “P”.
19. If it was necessary to replace the pulley and shaft assembly:
  - a) Turn stop collar “J”, Figure 3.4, down on trip rod 1 inch [25.4mm] from the top of the rod.
  - b) Turn stop collar “L” down on trip rod to a point 2-1/4 inches [57.2mm] from the drive housing casting.
20. Balance the tension on the motor and spindle belts:
  - a) Close door “H”, Figure 3.3 .
  - b) Pull “Start/Stop” pushbutton “D”, Figure 3.1, OUT to turn the machine ON.
  - c) On HLV<sup>®</sup>-H machines, turn brake switch “E” to the OFF position.
  - d) On HLV-H machines, place lever “A” in “Low” range.  
On TFB<sup>®</sup>-H machines, place lever “F”, Figure 3.2, in “Forward” or “Reverse” and lever “G” in “Low” range.
  - e) Turn speed adjustment knob “C”, Figure 3.1, to “Faster” and hold in that position until spindle speed stabilizes at 3000 rpm.
  - f) On HLV-H machines, place lever “A”, Figure 3.1, in the “Stop” position and allow the spindle to coast to a stop.  
On TFB-H machines, place lever “G”, Figure 3.2, in the “Stop” position and allow the spindle to coast to a stop.
  - g) Press “Start/Stop” pushbutton “D”, Figure 3.1, IN to turn the machine OFF.
  - h) Open door “H”, Figure 3.3 .
21. Recheck motor and spindle belt tension.  
If belt tension needs to be adjusted, proceed to step 22.  
If belt tension does not need to be adjusted, proceed to step 25.
22. Loosen lock nut “P”, Figure 3.5 .
23. Adjust drive belt tension by turning adjusting screw “Q”:  
Clockwise to lower the drive motor and tighten the drive belts.  
Counterclockwise to raise the drive motor and loosen the drive belts.
24. Tighten lock nut “P”.
25. Close door “H”, Figure 3.3 .
26. Pull “Start/Stop” pushbutton “D”, Figure 3.1, OUT to turn the machine ON.

27. On HLV<sup>®</sup>-H machines, place lever “A” in “Low” range.  
On TFB<sup>®</sup>-H machines, place lever “F”, Figure 3.2, in “Forward” or “Reverse” and lever “G” in “Low” range.
28. On HLV-H machines, turn brake switch “E”, Figure 3.1, to the ON position.
29. Turn speed adjustment knob “C” to “Slower” and hold in that position until the spindle speed stabilizes at 125 rpm.
30. On HLV-H machines, place lever “A” in the “Stop” position.  
On TFB-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.
31. Press “Start/Stop” pushbutton “D”, Figure 3.1, IN to turn the machine OFF.
32. If it was necessary to replace the pulley and shaft assembly:
  - a) Open door “H”, Figure 3.3 .
  - b) Pull “Start/Stop” pushbutton “D”, Figure 3.1, OUT to turn the machine ON.
  - c) Adjust stop collar “J”, Figure 3.4, gradually upward, running the speed change mechanism between settings, until the spindle belt is flush to 1/16 inch [1.6mm] out of the countershaft pulley when the limit switch stops upward motion.
  - d) Tighten the set screw in stop collar “J”.
  - e) Adjust stop collar “L” gradually downward, running the speed change mechanism between settings, until the motor belt is flush to 1/16 inch [1.6mm] out of the countershaft pulley when the limit switch stops downward motion.
  - f) Tighten the set screw in stop collar “L”.
  - g) Stop collars “M”, Figures 3.4 and 3.20, and “O”, Figures 3.4 and 3.21, are set to allow 1/16 inch of clearance after the limit switches have tripped and the drive has drifted to a stop.
  - h) Close door “H”, Figure 3.3 .

# POWER FEED DRIVE

## POWER FEED CONTROL PANEL

Refer to Chapter 6 for information on the Power Feed control panel.

## POWER FEED LUBRICATION

The power feed drive is lubricated with oil from the carriage apron. Refer to Chapter 1 for information on maintaining the proper oil level or changing the oil in the carriage apron.

## DRIVE DISASSEMBLY

1. On HLV®-H machines, place lever “A”, Figure 3.1, in the “Stop” position and lever “B” in the center position.  
On TFB®-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.
2. Press “Start/Stop” pushbutton “D” IN to turn the machine OFF.
3. Turn main disconnect switch “B”, Figure 3.25, OFF
4. Remove six screws “M”, Figure 3.39, and set power feed panel “N” out of control box “O”.
5. Record the connections; then disconnect wires A1 and A2 from switch “P”, Figure 3.40 .
6. Record the connection; then disconnect wire F1 from terminal block “R”, Figure 3.41 .
7. Record the connection; then disconnect wire F2 from terminal block “S”, Figure 3.42 .
8. Disconnect the power feed motor ground wire (green) from ground stud “T”.

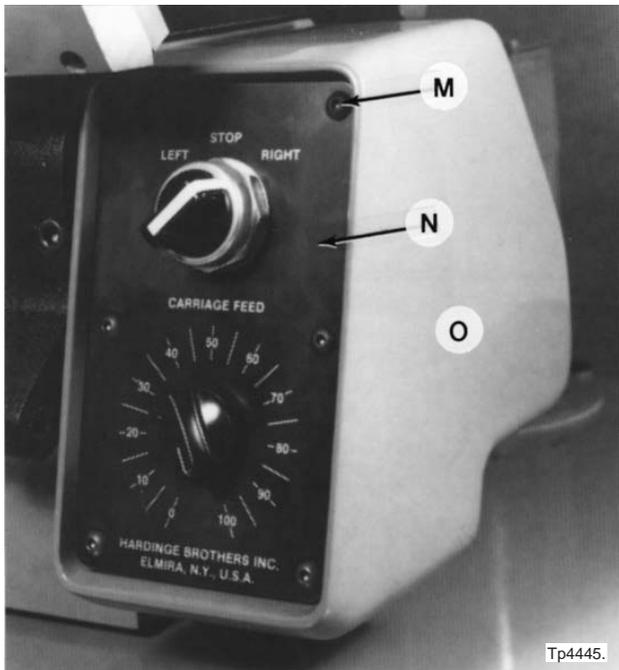


Figure 3.39 - Power Feed Control Box

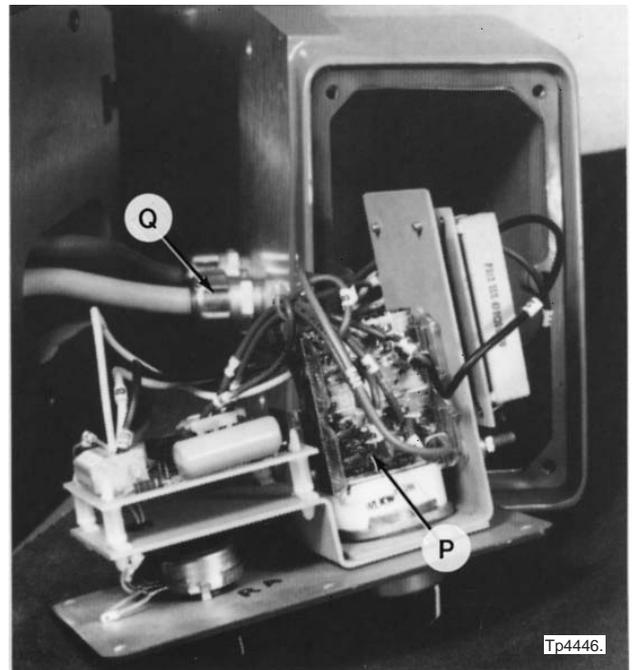


Figure 3.40 - Power Feed Module (Side View)

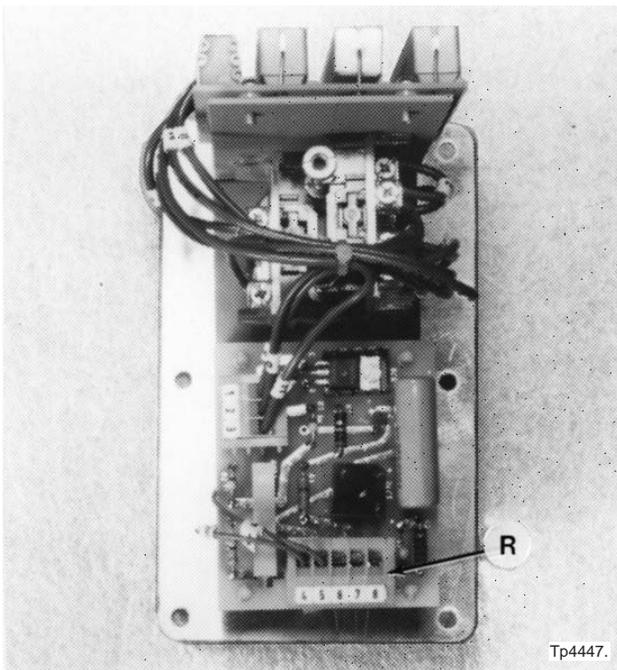


Figure 3.41 - Power Feed Module (Back View)

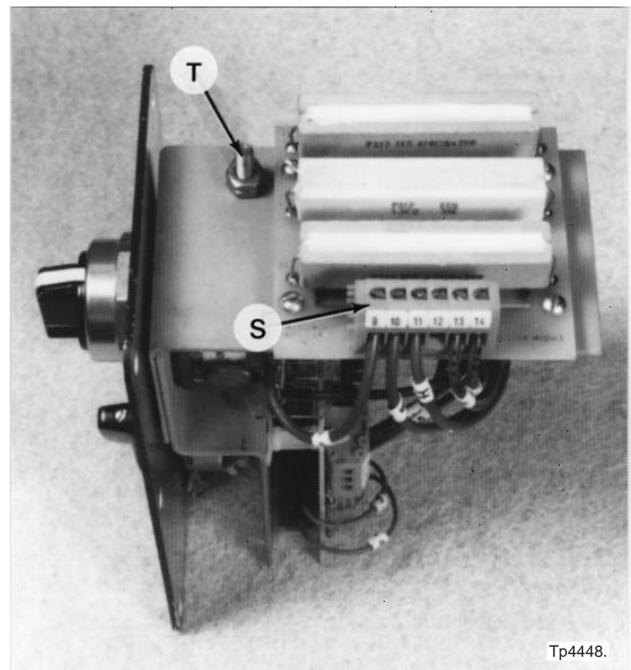


Figure 3.42 - Power Feed Module (Top View)

9. Remove three bolts "U", Figure 3.43, and pull power feed control box "V" away from the end of the bed.
10. Remove cord grip nut "Q", Figure 3.40, and remove the power feed motor cable from the control box.

**- NOTE -**

Do not pull against the motor end of the cable.

11. Pull the power feed motor cable out through grommet "W", Figure 3.44, in the bed.
12. Place a pan capable of holding one pint of liquid under drain plug "A", Figure 3.45 .
13. Remove and clean magnetic drain plug "A".
14. Allow the reservoir to drain.
15. Remove the drain pan and replace magnetic drain plug "A".
16. Properly dispose of the used oil.
17. Remove three screws "X", Figure 3.44, and remove the power feed assembly from the carriage apron cover.
18. Remove four screws "D", Figure 3.46, and separate the power feed motor from worm wheel housing "F".

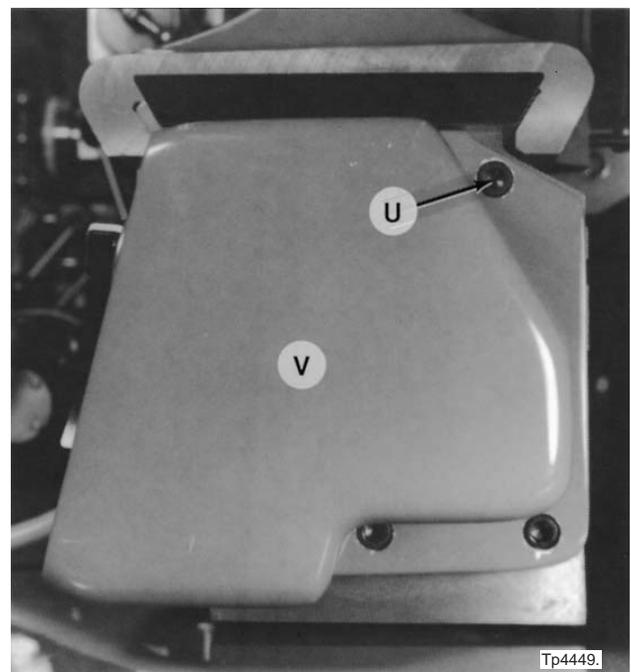


Figure 3.43 - Power Feed Control Box (End View)

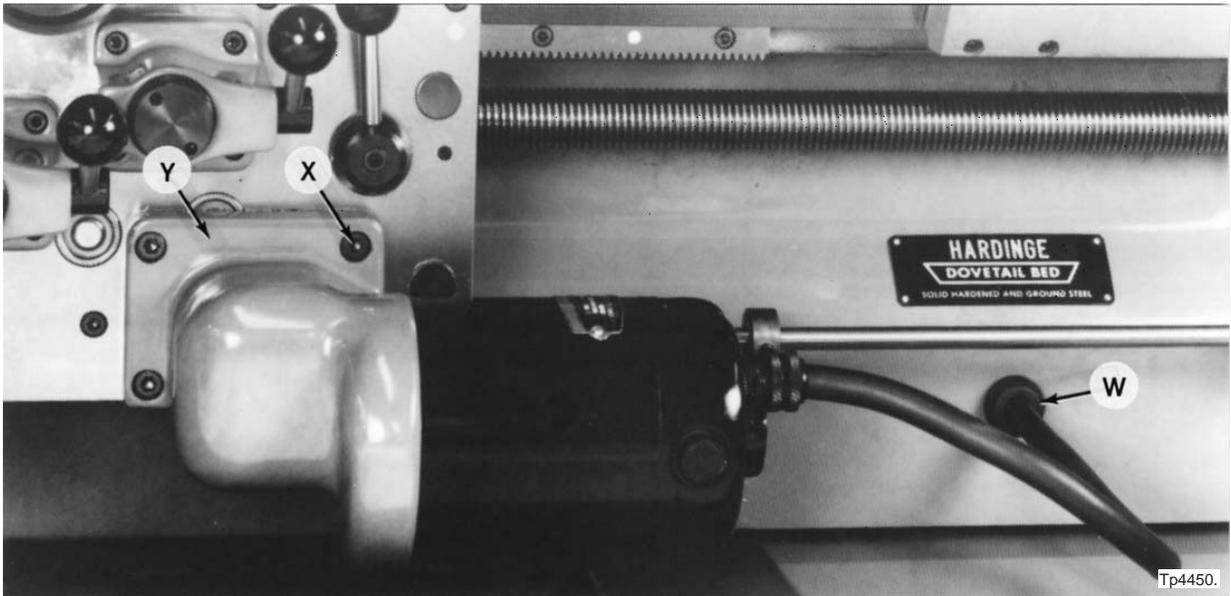


Figure 3.44 - Power Feed Drive Removal

19. Remove screw "G", Figure 3.47, and remove worm wheel and housing, Figure 3.48 .
20. Remove nut "H", Figure 3.48, and worm wheel "I".
21. Remove key "J", Figure 3.49, and remove 21 tooth gear and shaft "K".
22. Remove bearings "L", Figure 3.50, snap rings "M", and seals "N" from housing "O".

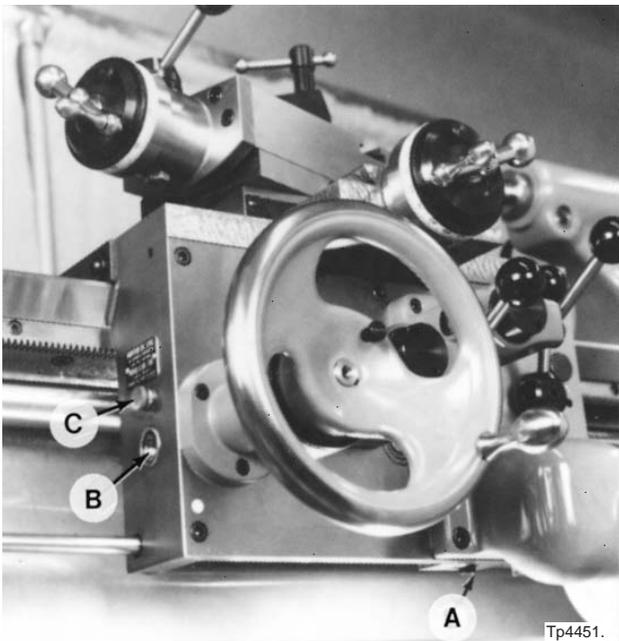


Figure 3.45 - Magnetic Drain Plug

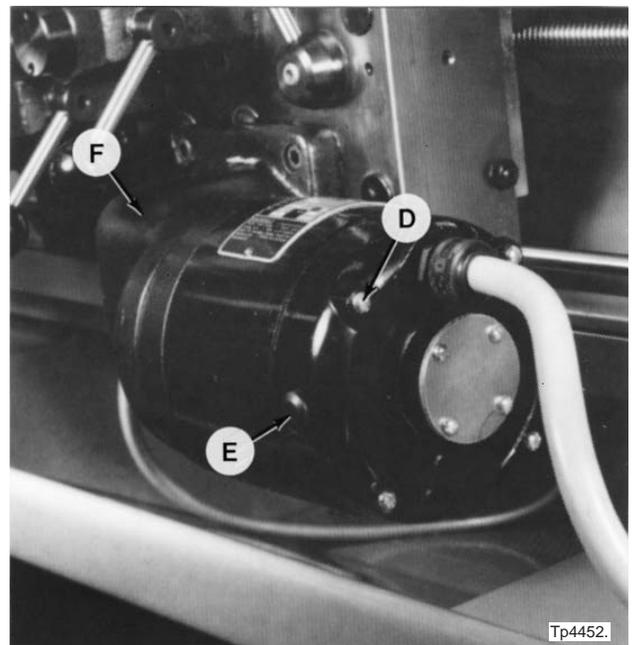


Figure 3.46 - Power Feed Drive

## DRIVE REASSEMBLY

1. Replace seals "N", Figure 3.50, snap rings "M", and bearings "L" in housing "O".
2. Replace 21 tooth gear and shaft "K", Figure 3.49, and key "J".
3. Replace worm wheel "I", Figure 3.48, and nut "H".
4. Replace worm wheel and housing, Figure 3.48, and tighten screw "G", Figure 3.47 .
5. Remount the power feed motor to the power feed housing and install four screws "D", Figure 3.46 .
6. Apply Permatex® sealant to the surface of power feed housing "Y", Figure 3.44, that will be against the carriage apron cover.
7. Remount the power feed assembly on the carriage apron cover using three screws "X".

### - NOTE -

Leave enough slack in the power feed motor cable to allow the full range of carriage movement without putting excessive strain on the cable.

8. Insert the power feed motor cable into grommet "W".
9. Pull the power feed motor cable out of the end of the bed.
10. Slide cord grip nut "Q", Figure 3.40, over the power feed motor cable.
11. Insert the power feed motor cable through the cord grip and into the control box.
12. Tighten cord grip nut "Q".
13. Position control box "V", Figure 3.43, against the end of the bed and install three bolts "U".
14. Connect the power feed motor ground wire (green) to ground stud "T", Figure 3.42 .
15. Connect wire F2 to terminal block "S", as recorded during the removal procedure.
16. Connect wire F1 to terminal block "R", Figure 3.41, as recorded during the removal procedure.
17. Connect wires A1 and A2 to switch "P", Figure 3.40, as recorded during the removal procedure.
18. Mount power feed control panel "N", Figure 3.39, in control box "O" using six screws "M".

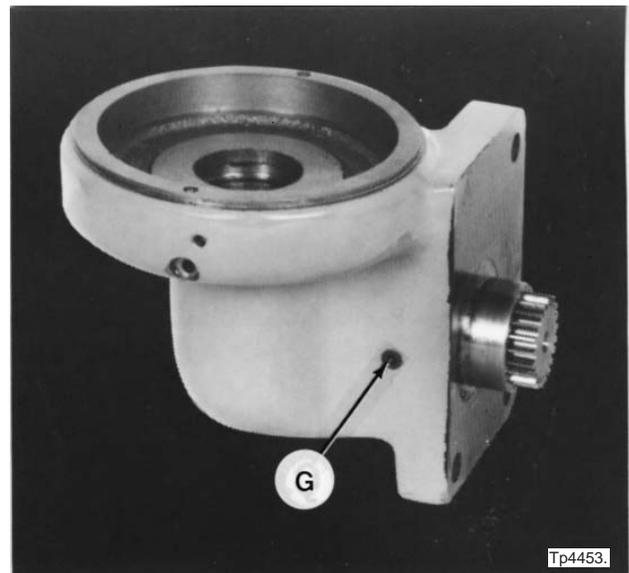


Figure 3.47 - Retaining Screw for Worm Wheel Housing

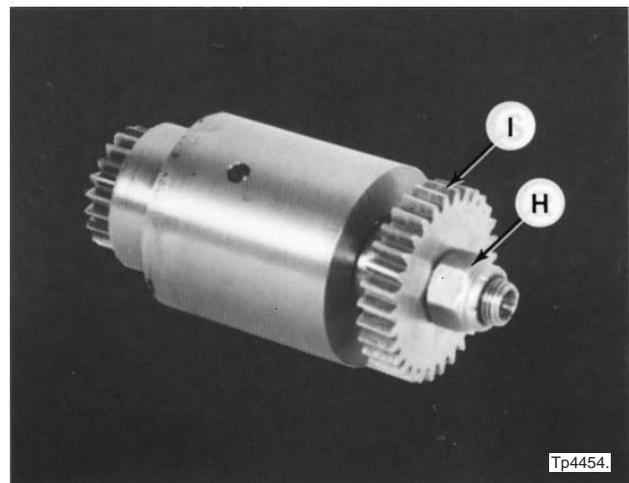


Figure 3.48 - Worm Wheel and Housing

**- NOTE -**

The carriage apron oil reservoir is full when sight window “B”, Figure 3.45, is completely filled with oil.

19. Fill the carriage apron oil reservoir:

- a) Remove cap “C”, Figure 3.45 .
- b) Fill the carriage apron oil reservoir with Mobilfluid® 350 oil.
- c) Replace cap “C”.

**DRIVE MOTOR BRUSH REPLACEMENT**

1. On HLV®-H machines, place lever “A”, Figure 3.1, in the “Stop” position and lever “B” in the center position.

On TFB®-H machines, place lever “F”, Figure 3.2, in the “Brake” position and lever “G” in the “Stop” position.

2. Press “Start/Stop” pushbutton “D”, Figure 3.1, IN to turn the machine OFF.
3. Turn main disconnect switch “B”, Figure 3.25, OFF
4. Remove two caps “E”, Figure 3.46 .
5. Remove the springs and motor brushes located under two caps “E”.
6. Install the new motor brushes in the drive motor.
7. Replace the springs and two caps “E”.

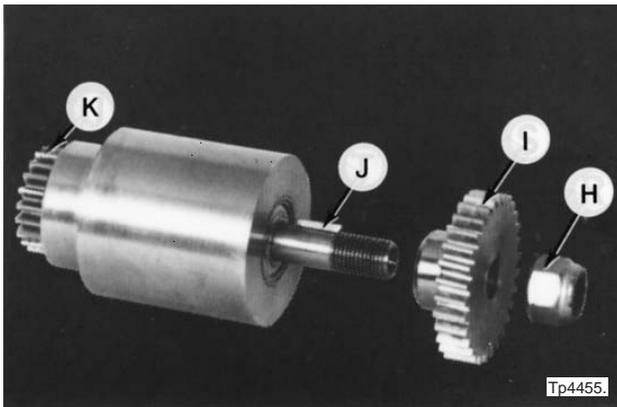


Figure 3.49 - Worm Wheel Housing and Components

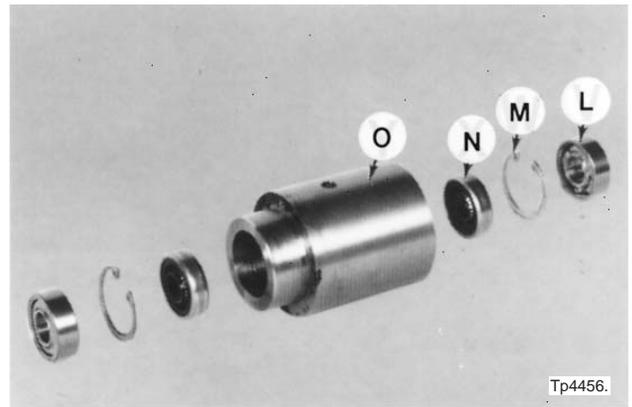


Figure 3.50 - Worm Wheel Housing and Components

- NOTES -

# CHAPTER 4 - GEARBOX AND HEADSTOCK

## COLLET CLOSER

The collet closer should be removed weekly and between setups for cleaning. This will help prevent a buildup of chips between the collet closer tube and the inside of the spindle at the rear of the spindle and at the collet threads.

### REMOVAL AND CLEANING

1. Press "Start/Stop" pushbutton "A", Figure 4.1, IN to turn the machine OFF.

#### - NOTE -

Link pin "B", Figure 4.2, can easily be removed by lifting it up and out.

2. Remove link pin "B", Figure 4.2 .
3. Remove the collet closer as shown in Figure 4.3 .

#### - NOTE -

Do not turn adjusting nut "C"; it is not threaded onto the spindle.

4. Remove adjusting nut "C" by pulling it off the end of the spindle.
5. Clean the inside of the headstock spindle and the outside diameter at the rear of the spindle where collet closer adjusting nut "C" locates.
6. Clean the inside and outside of the collet closer tube with mineral spirits.

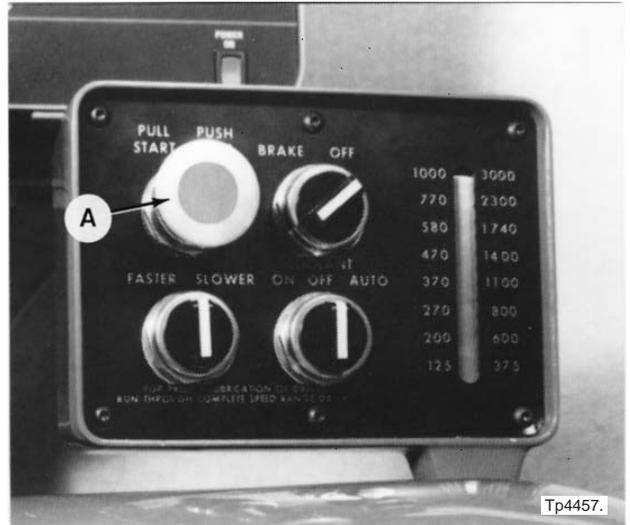


Figure 4.1 - Variable Speed Control Box (HLV®-H Version Shown)

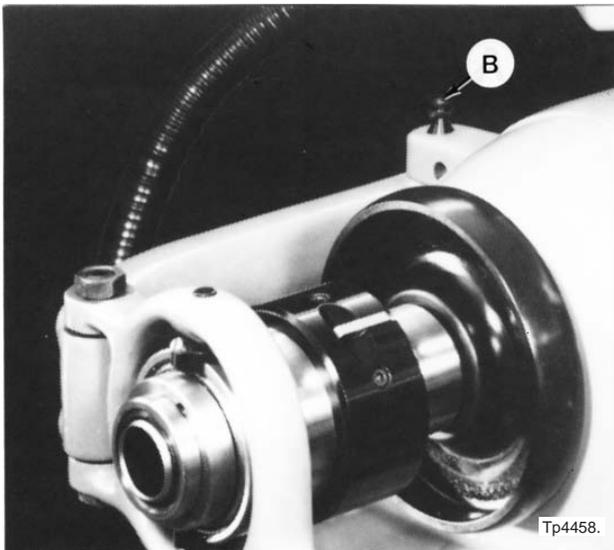


Figure 4.2 - Collet Closer Link Pin

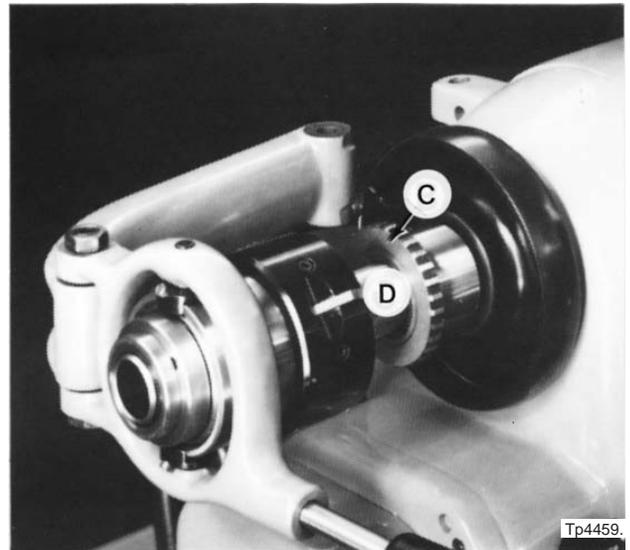


Figure 4.3 - Collet Closer Removal

## REPLACEMENT

1. Apply a light coat of Mobil® Velocite® oil No. 6 on the rear of the headstock spindle.

### - NOTE -

DO NOT force adjusting nut “C”, Figure 4.3, onto the spindle. If the adjusting nut goes on tight, remove it and examine the headstock spindle for scratches or burrs.

2. Replace adjusting nut “C”, Figure 4.3, on the end of the spindle.
3. Apply a thin coat of Mobil Velocite oil No. 6 on bearing section “D” of the collet closer.
4. Mount the collet closer on the headstock spindle.
5. Insert link pin “B”, Figure 4.2 .

## GEARBOX (English)

### LUBRICATION

Lubricate the gears in the gearbox every three months, or more often if necessary, with Darmex® DX-321 grease.

If the gearbox is not shifted for long periods of time, cycle “Feed-Thread” knob “E”, Figure 4.4, three change knob “F”, and thread change handle “G” from one extreme to the other several times.

Lubricate the bushings and shafts on the change gear bracket as needed with Mobil Velocite oil No. 6.

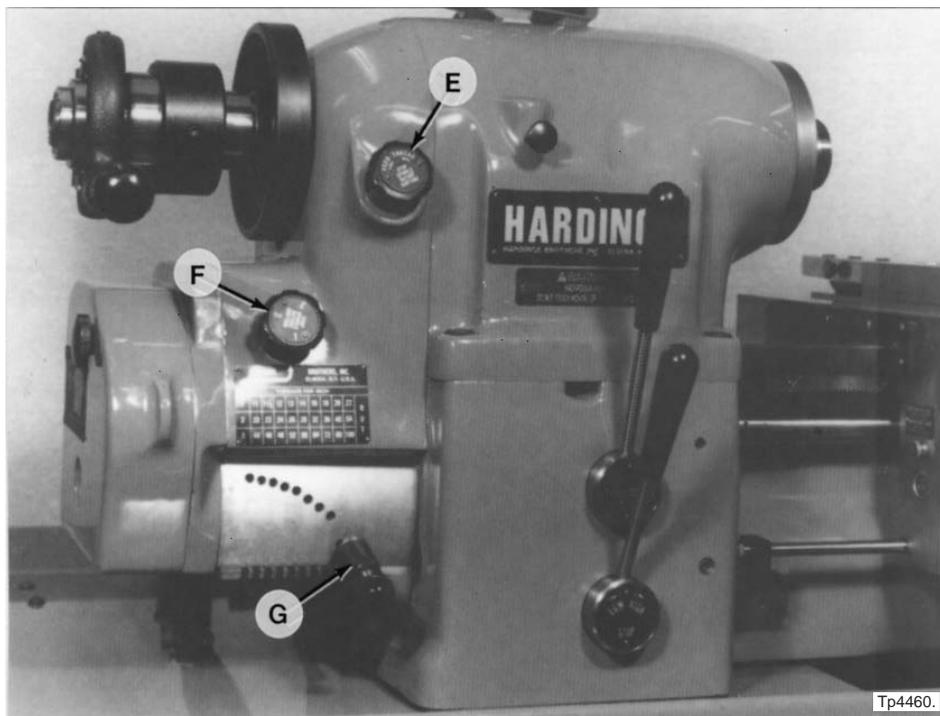


Figure 4.4 - Gearbox (Front View)

## GEARBOX REMOVAL (English)

1. Remove the collet closer according to the procedure outlined on Page 4-1.
2. Remove snap ring "H", Figure 4.5, and remove handwheel "I".
3. Remove key "J", Figure 4.6, washer "K", and washer "L".
4. Remove covers "O" and "P", Figure 4.7 .
5. Remove lock screw "R", Figure 4.8, and loosen the set screw under lock screw "R".
6. Remove lock screw "S".
7. Unscrew shaft "T", Figure 4.9, with a hex wrench.
8. Remove shaft "T", Figure 4.9, and shifter fork "Q", Figure 4.8
9. Remove taper pin "U", Figure 4.10 .
10. Engage carriage lead screw nut "X" Figure 4.11, with carriage lead screw "Y" by rotating lever "W" clockwise (as viewed from the front of the machine).
11. Move the carriage approximately 1/2 inch [12.7mm] to the right using handwheel "Z", Figure 4.12 .
12. Disengage carriage lead screw nut "X" Figure 4.11, from carriage lead screw "Y" by rotating lever "W" counterclockwise.
13. Remove lock nut "V", Figure 4.10 .
14. Turn nut "A", Figure 4.13, clockwise to remove dowel pin "B".

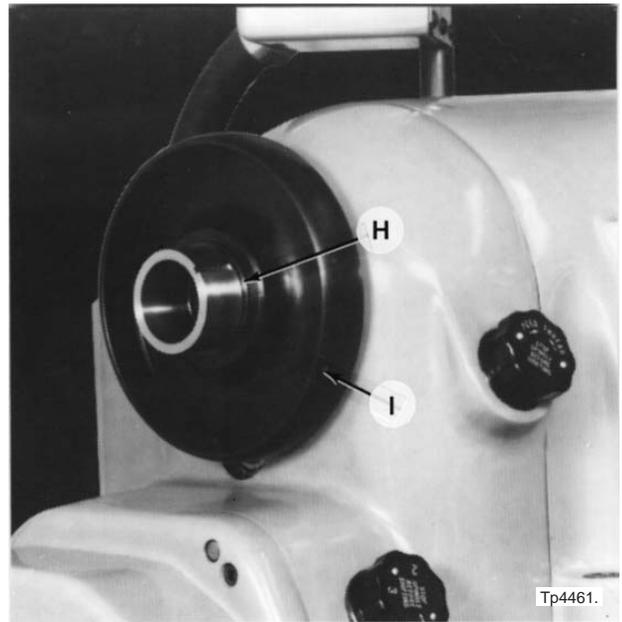


Figure 4.5 - Spindle Headwheel

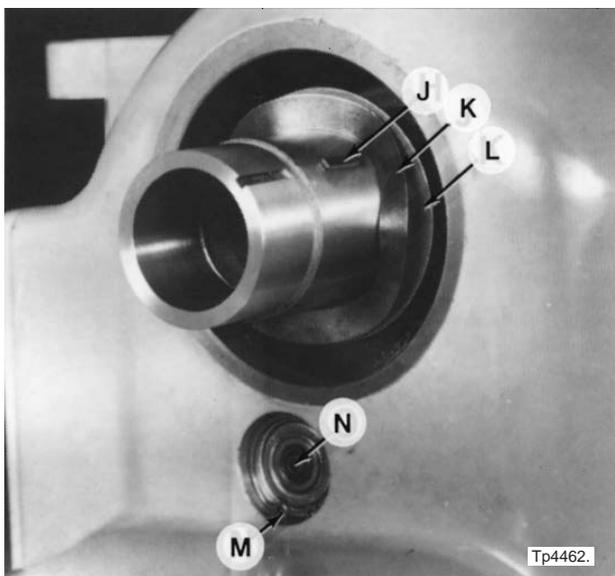


Figure 4.6 - Handwheel Washers and Key

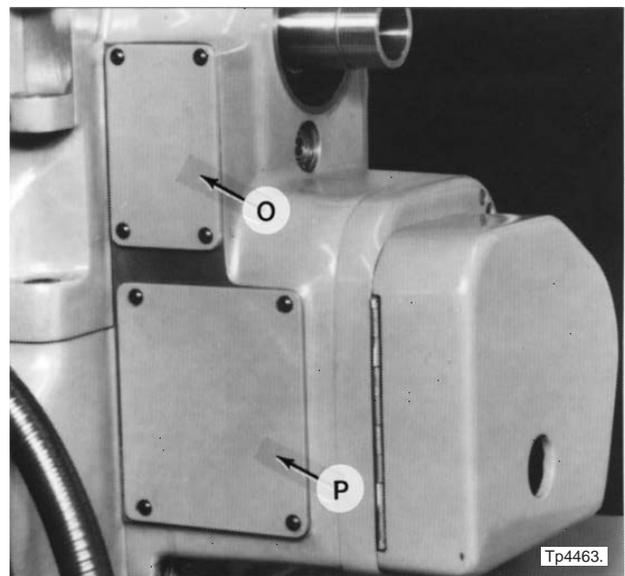


Figure 4.7 - Gearbox Rear Covers

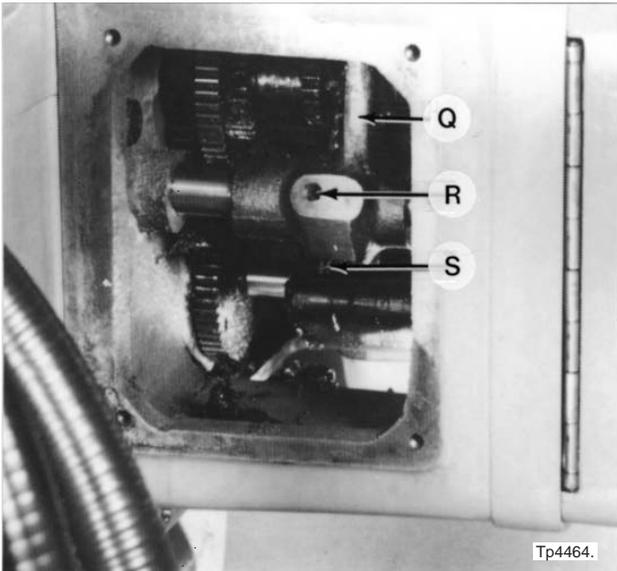


Figure 4.8 - Gearbox Shifter Fork

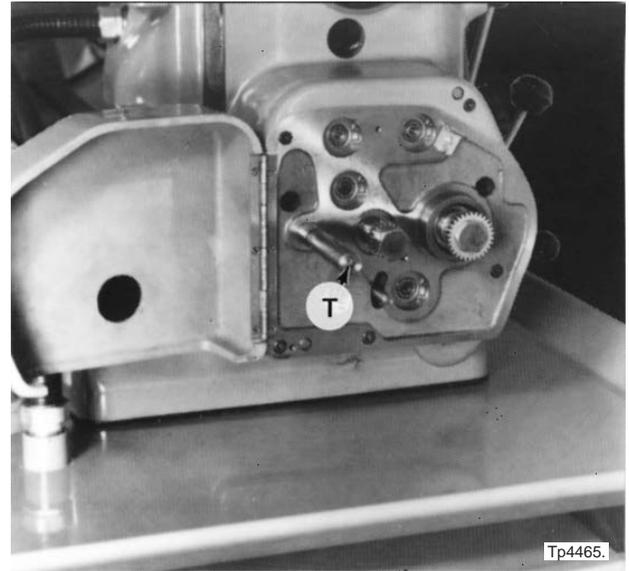


Figure 4.9 - Shifter Fork Shaft Removal

**- NOTE -**

The screw removal shown in Figure 4.14 requires a long 5/16 inch hex wrench or a length of 5/16 inch hex bar stock.

15. Remove four screws located at "C", Figures 4.13 and 4.14 .
16. Remove the gearbox by pulling it straight off the headstock. Refer to Figure 4.15 .

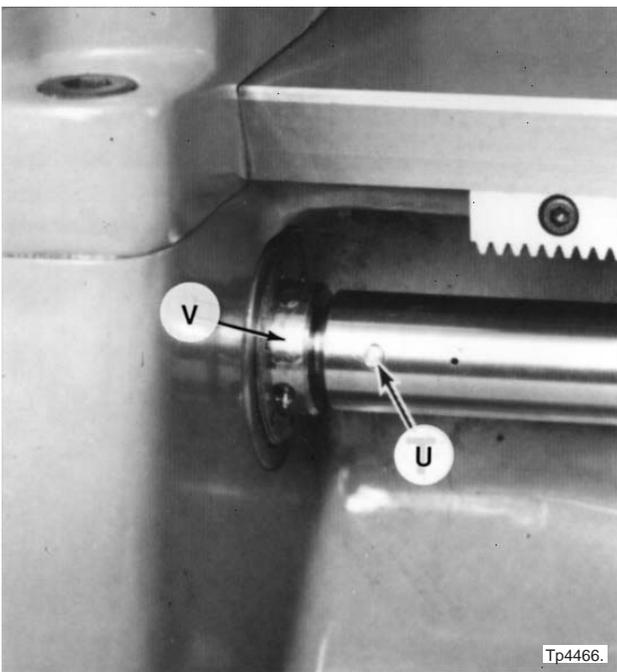


Figure 4.10 - Lock Nut and Taper Pin for Lead Screw

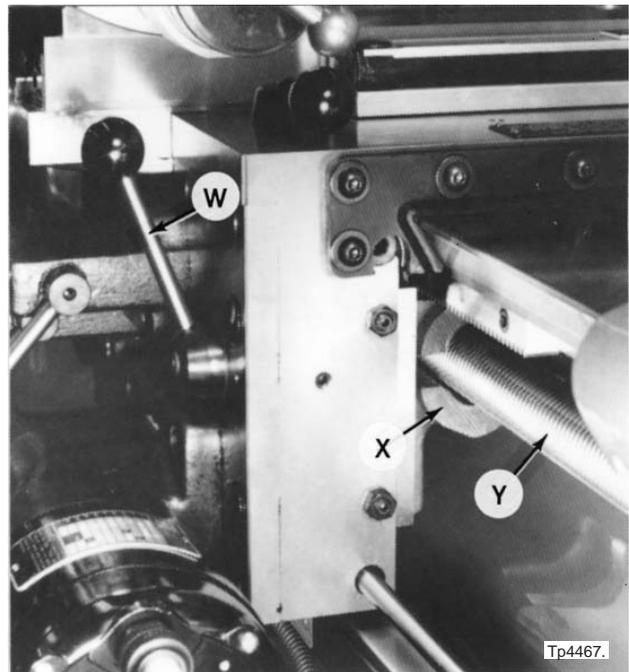


Figure 4.11 - Carriage Lead Screw Nut

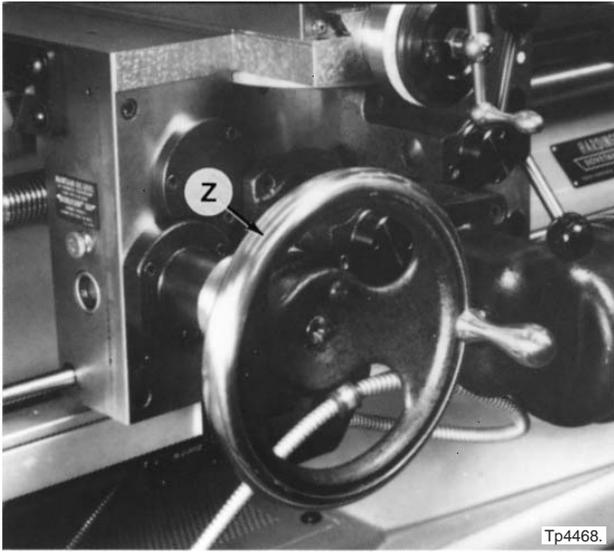


Figure 4.12 - Carriage Handwheel

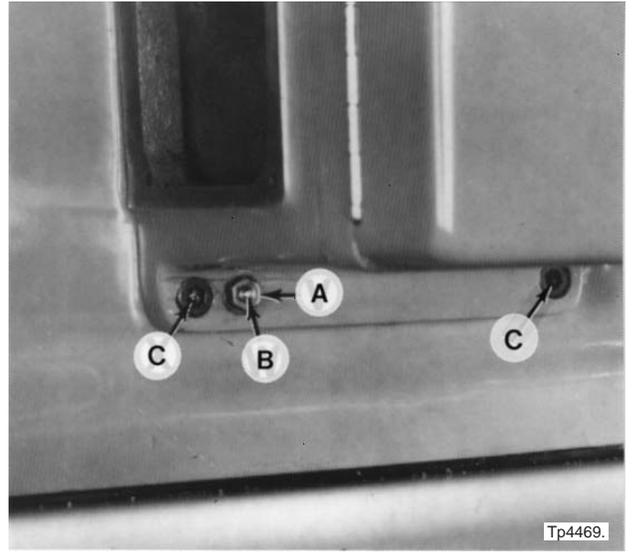


Figure 4.13 - Locating Pins and Mounting Bolts

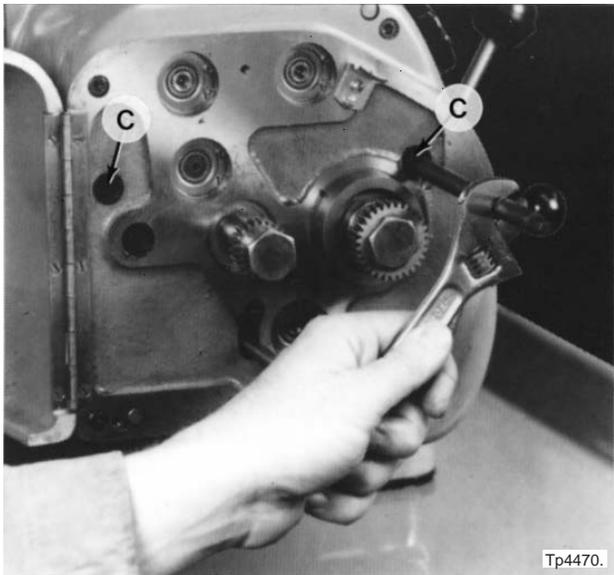


Figure 4.14 - Gearbox Mounting Bolt Removal

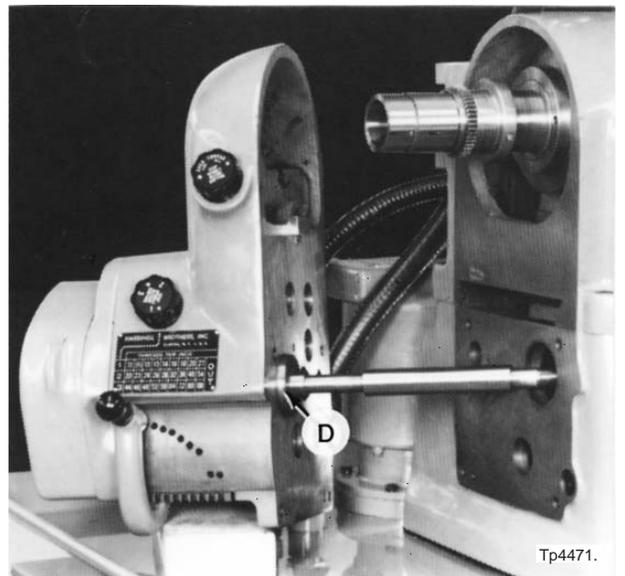


Figure 4.15 - Gearbox Removal

## GEARBOX DISASSEMBLY (English)

1. Perform steps 1 through 16 under "Gearbox Removal".
2. Remove snap ring "M", Figure 4.6 .
3. Turn screw "N", Figure 4.6, clockwise to remove idler gear "G", Figure 4.16 .
4. Remove three screws from hinge "E" and remove gear guard "F".
5. Remove stop block "H", Figure 4.17, and remove bearing "I".
6. If it is necessary to remove "Feed-Thread" pinion assembly "K":
  - a) Remove lock screw "J".
  - b) Loosen the set screw under lock screw "J".
  - c) Pull "Feed-Thread" pinion assembly "K" out of the gearbox housing.
7. If clearance is insufficient for gears "M", Figure 4.18, to pass through cover "N", remove studs "L" and gears "M".

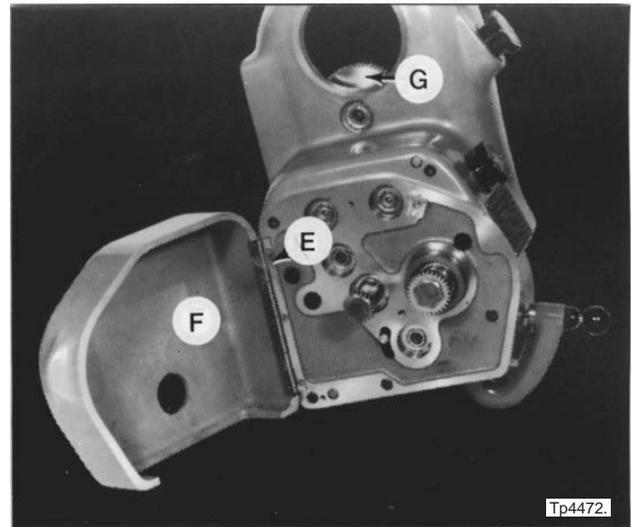


Figure 4.16 - Gearbox Assembly

### - NOTE -

Label snap rings "P", Figure 4.18, and their associated spacers for identification for proper reassembly of the gearbox. Refer also to Figure 4.19 .

8. Remove five snap rings "P", Figure 4.18, and their associated spacers.
9. Remove five screws "O".

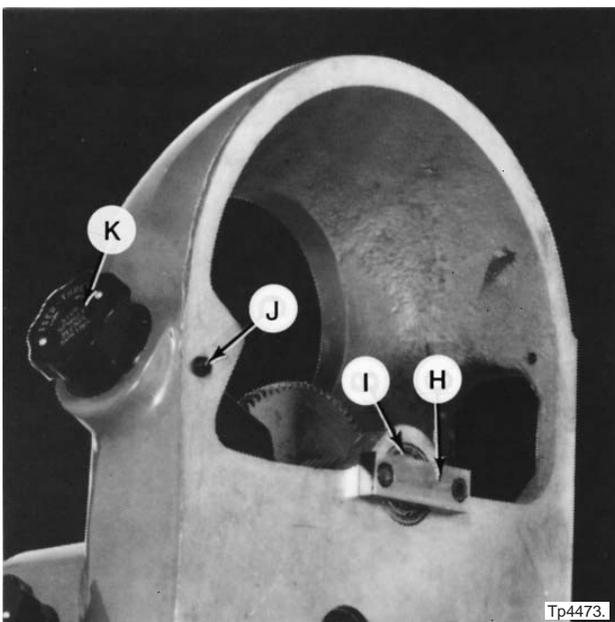


Figure 4.17 - Idler Shaft Rear Bearing

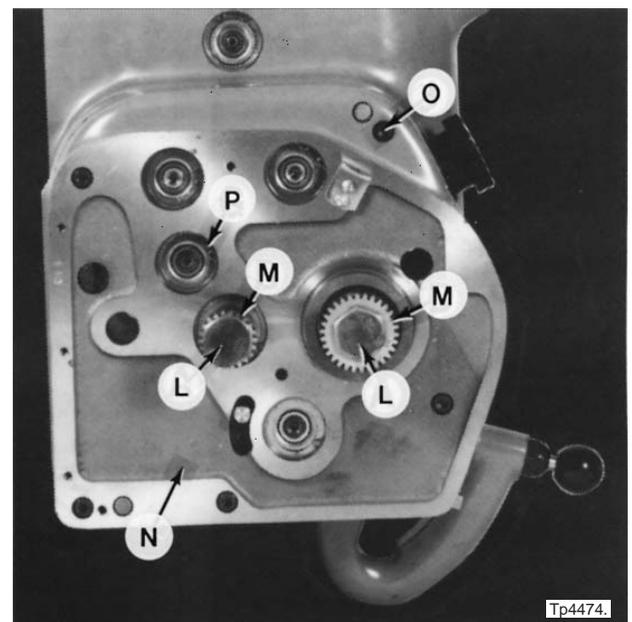


Figure 4.18 - Gearbox Assembly

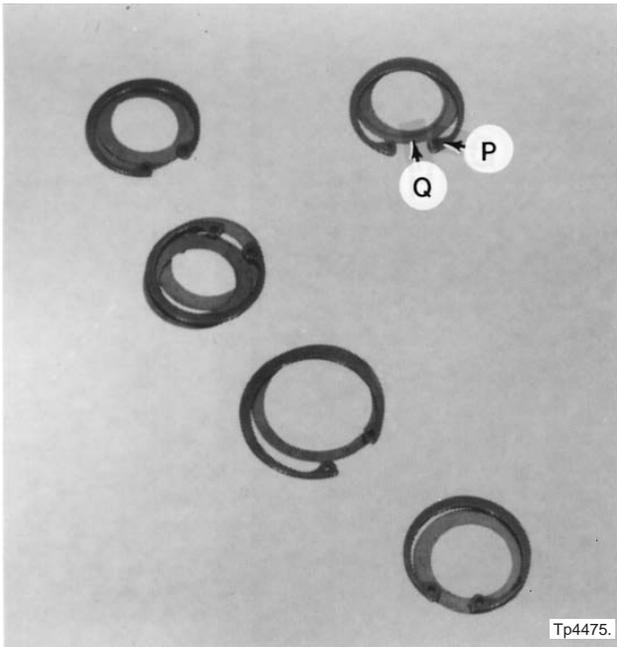


Figure 4.19 - Shim and Snap Ring Layout

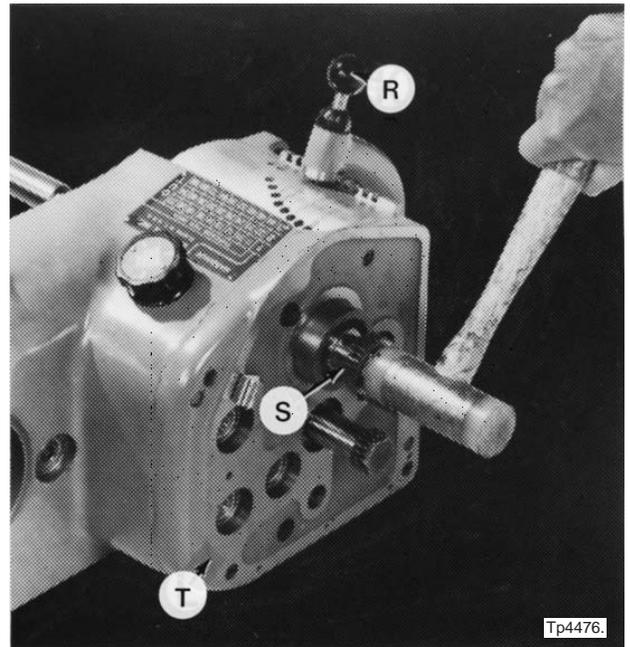


Figure 4.20 - Cluster Shaft Removal from Cover

10. Place shifter shaft "R", Figure 4.20, out of mesh as shown.
11. Tap cluster shaft "S" with a soft-faced hammer until it is free from cover "T".

**- NOTE -**

DO NOT allow the remaining shafts to lift up with cover "T" while the cover is being removed. If necessary, tap the shafts back down into place with a softfaced hammer while cover "T" is being removed. Refer also to Figure 4.21 .

12. Remove cover "T".
13. If it is necessary to remove three change pinion assembly "F", Figure 4.4:
  - a) Remove lock screw "U", Figure 4.22 .
  - b) Loosen the set screw under lock screw "U".
  - c) Pull three change pinion assembly "F", Figure 4.4, out of the gearbox housing.

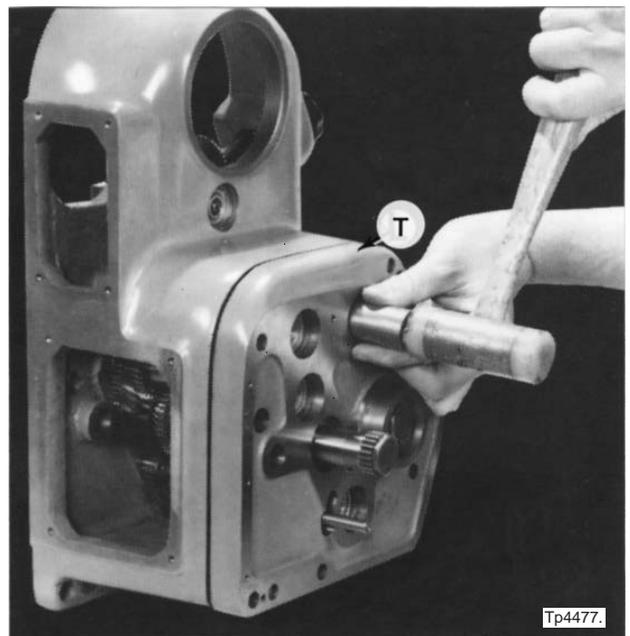


Figure 4.21 - Tapping Shafts in Place During Cover Removal

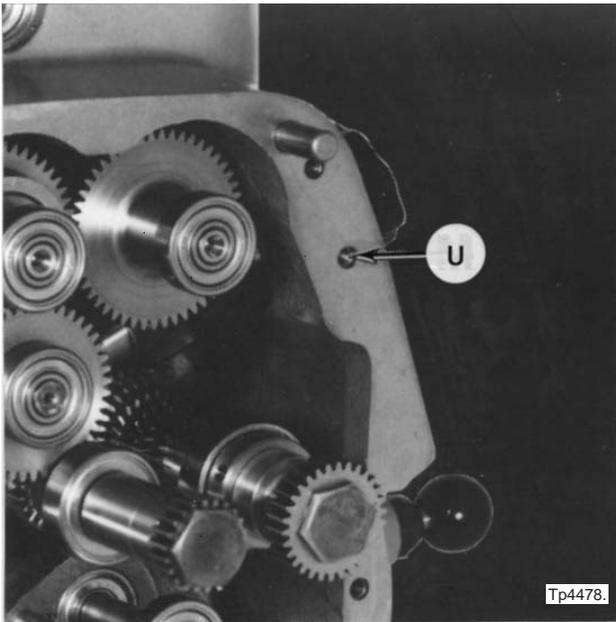


Figure 4.22 - Lock Screw for Three Change Pinion Assembly



Figure 4.23 - Tumbler and Shaft Assembly Removal

**- NOTE -**

USE CARE when removing tumbler and shaft assembly "V", Figure 4.23 . Factory installed spacers may be present behind this shaft assembly. These spacers can vary in thickness and MUST be in place behind the correct shaft during reassembly. LABEL ALL SPACERS located behind all shaft assemblies for proper reassembly.

14. Remove gearbox tumbler and shaft assembly "V", Figure 4.23 .
15. Remove cluster shaft assembly "W", Figure 4.24 .

**- NOTE -**

USE CARE when removing clutch shaft "X", Figure 4.25, intermediate shaft "Y", change shaft "Z", and reverse shaft "A", Figure 4.26 . Factory installed spacers may be present behind these shaft assemblies. These spacers can vary in thickness and MUST be in place behind the correct shaft during reassembly. LABEL ALL SPACERS located behind all shaft assemblies for proper reassembly.

16. Remove clutch shaft "X", Figure 4.25, intermediate shaft "Y", and change shaft "Z" simultaneously.

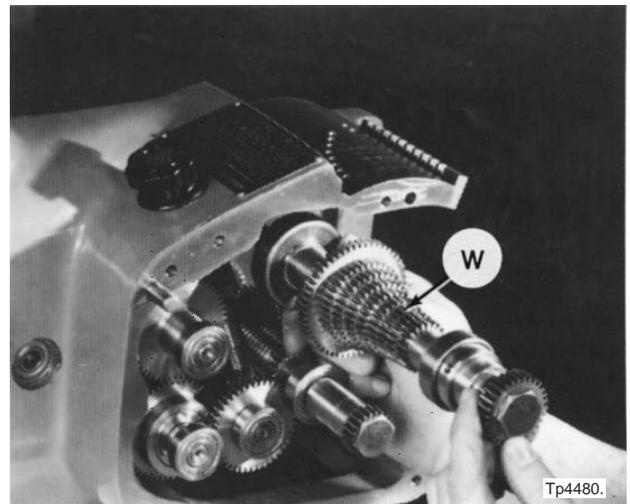


Figure 4.24 - Cluster Shaft Assembly Removal

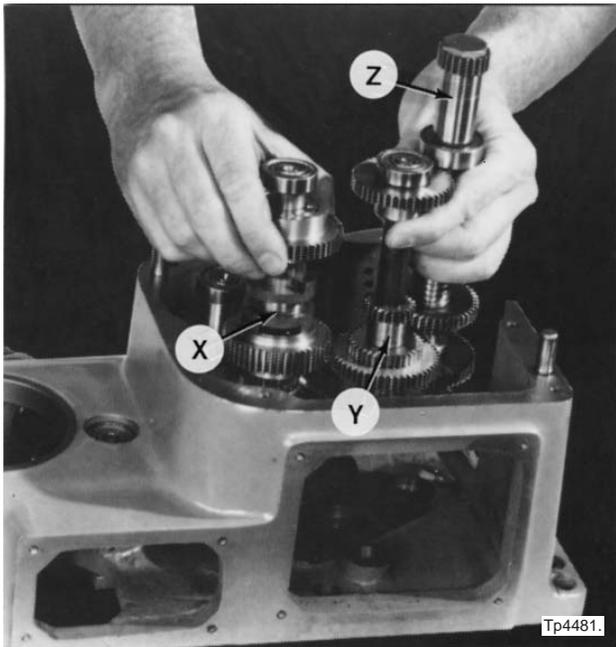


Figure 4.25 - Clutch Shaft, Intermediate Shaft, and Change Shaft Removal



Figure 4.26 - Reverse Shaft Removal

**- NOTE -**

Reverse shaft "A", Figure 4.26, is of one piece construction, with the exception of the bearings that are pressed on each end of the shaft.

17. Remove reverse shaft "A", Figure 4.26 .

18. To disassemble the "Feed Thread" or three change pinion gear assembly:

- a) Remove set screw "E", Figure 4.27 .
- b) Remove pinion shaft "B" and handle "F" from bushing "C".
- c) Remove plunger "D" and spring "G" from handle "F".

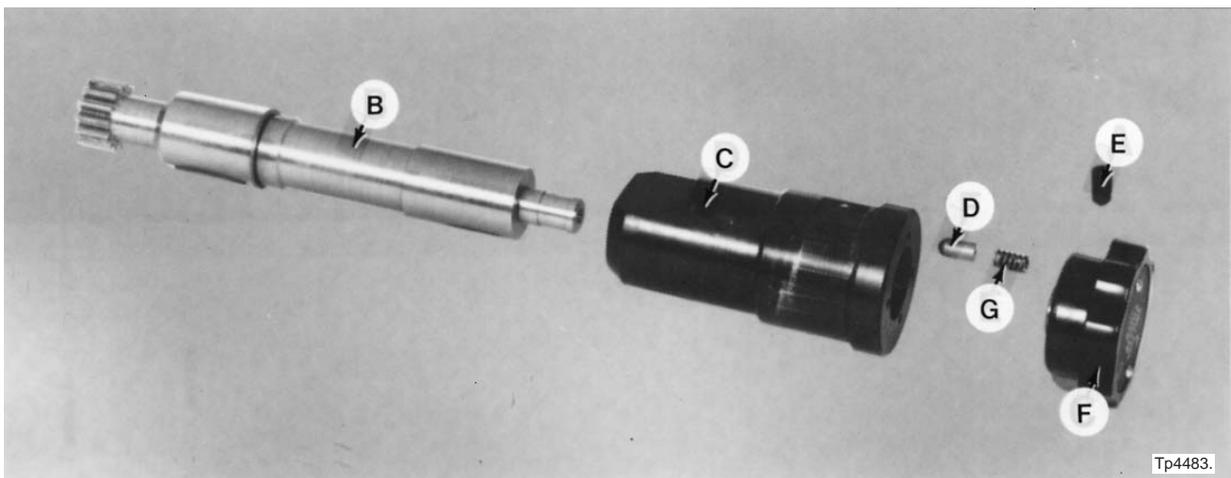


Figure 4.27 - Pinion Assembly Components

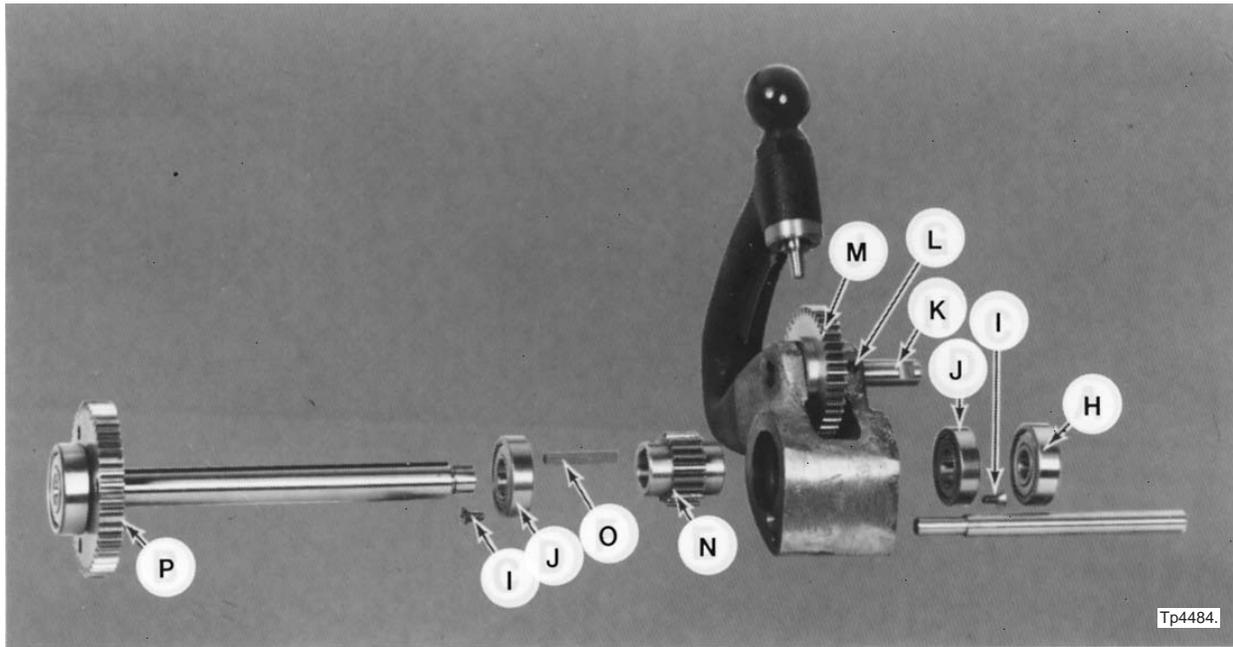


Figure 4.28 - Tumbler and Shaft Assembly

19. To disassemble the gearbox tumbler and shaft assembly:

- a) Press bearing "H", Figure 4.28, off tumbler shaft "P" and remove the tumbler shaft.
- b) Remove two screws "I".
- c) Remove two bearings "J", gear "N", and key "O".
- d) Loosen set screw "L".
- e) Remove shaft "K" to remove gear and bearing "M".
- f) Remove ball handle "Q", Figure 4.29, nut "R", spring "S", plunger "T" and bushing "U".

20. To disassemble the cluster shaft assembly:

- a) Remove stud "A", Figure 4.30, gear "B", and spacer "C".
- b) Remove key "D" and collar "E".
- c) Remove nut "F".
- d) Remove bearing "G".
- e) Remove the 22, 23, 24, 26, 28, 32, 36, 40, and 54 tooth gears.
- f) Remove key "H" and spacer "J".
- g) Press bearing "K" off the shaft.

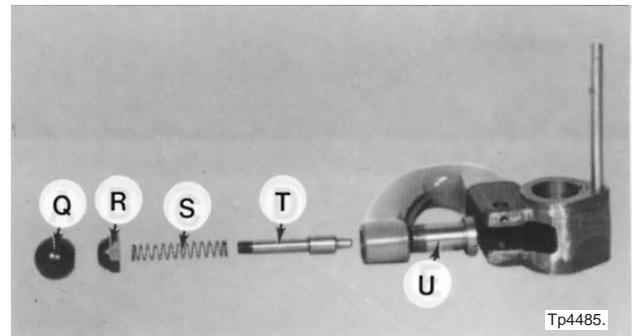


Figure 4.29 - Plunger Assembly

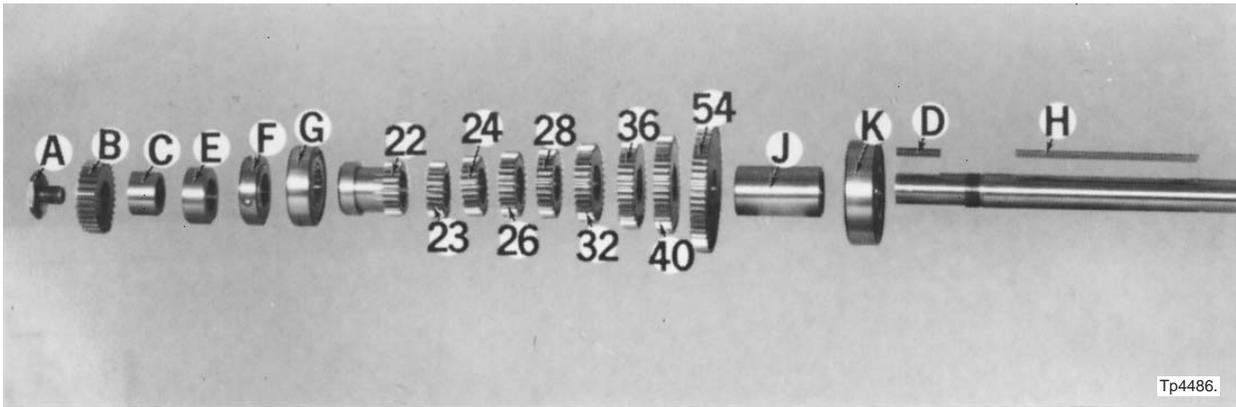


Figure 4.30 - Cluster Shaft Assembly

21. To disassemble the clutch shaft assembly:

- a) Press bearing "A", Figure 4.31, off the shaft.
- b) Remove nut "B" to remove reverse gear assembly "C".
- c) Remove nut "D" to remove bearing "E" from gear assembly "C".
- d) Remove clutch "G" and clutch bushing "F".
- e) Remove forward gear assembly "H" and key "L".
- f) Remove nut "J" to remove bearing "K" from forward gear assembly "H".
- g) If necessary, press bearing "M" off the shaft.

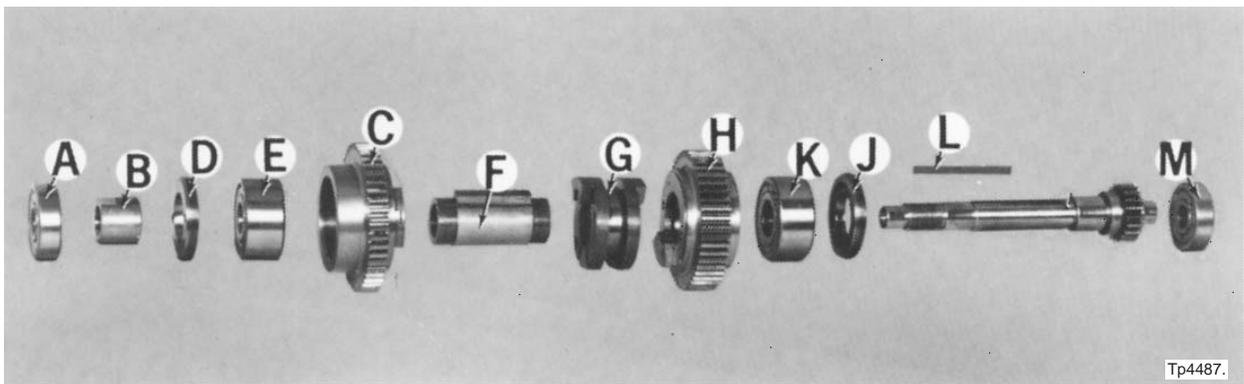


Figure 4.31 - Clutch Shaft Assembly

**- NOTE -**

Gears "C" and "D", Figure 4.32, are pinned together.

22. To disassemble the intermediate shaft assembly:

- a) Press gear "A", Figure 4.32, and bearing "B" off the shaft.
- b) Press gears "C" and "D", bushing "E", and bearing "F" off the shaft.
- c) Press gear "G" off the shaft.
- d) If necessary, remove keys "H" and "J".

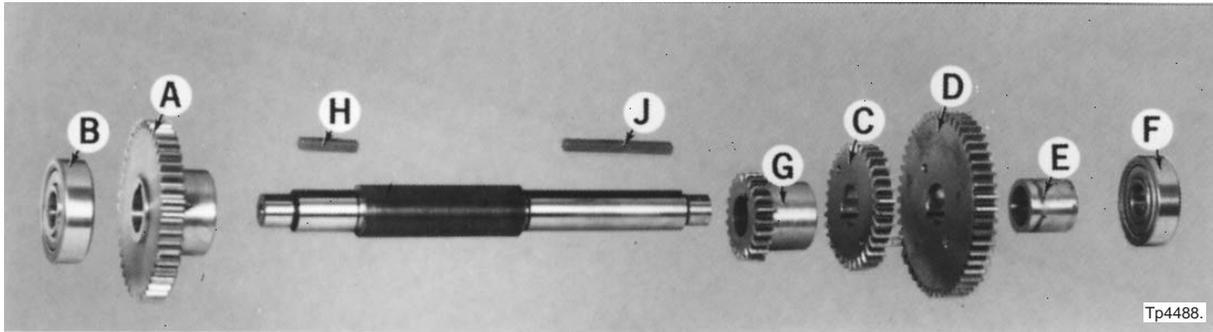


Figure 4.32 - Intermediate Shaft Assembly

**- NOTE -**

Gears "G", Figure 4.33, are pinned together.

23. To disassemble the change shaft assembly:

- a) Remove stud "A", Figure 4.33, gear "B", and spacer "C".
- b) Press gear "D" and bearing "E" off the shaft.
- c) Remove two gears "G" and worm "F".
- d) Remove snap ring "H" and press bearing "J" off the shaft.
- e) If necessary, remove keys "K", "L", "M", and the key located in the inside diameter of worm "F".

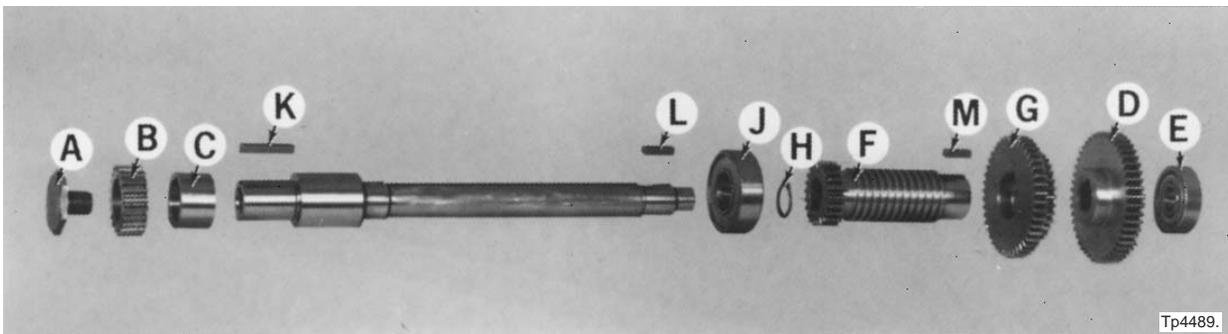


Figure 4.33 - Change Shaft Assembly

## GEARBOX REASSEMBLY (English)

### - NOTE -

Gears “G”, Figure 4.33, are pinned together.

1. To reassemble the change shaft assembly:
  - a) If removed, replace keys “K”, “L”, “M”, Figure 4.33, and the key located in the inside diameter of worm “F”.
  - b) Press bearing “J” onto the shaft and replace snap ring “H”.
  - c) Replace worm “F” and two gears “G”.
  - d) Press gear “D” and bearing “E” onto the shaft.
  - e) Replace spacer “C”, gear “B”, and stud “A”.

### - NOTE -

Gears “C” and “D”, Figure 4.32, are pinned together.

2. To reassemble the intermediate shaft assembly:
  - a) If removed, replace keys “H” and “J”, Figure 4.32 .
  - b) Press gear “G” onto the shaft.
  - c) Press gears “C” and “D” onto the shaft.
  - d) Press bushing “E” and bearing “F” onto the shaft.
  - e) Press bearing “B” and gear “A” onto the shaft.
3. To reassemble the clutch shaft assembly:
  - a) If removed, press bearing “M”, Figure 4.31, onto the shaft.
  - b) Replace bearing “K” and nut “J” on forward gear assembly “H”.
  - c) Replace key “L” and forward gear assembly “H”.
  - d) Replace clutch bushing “F” and clutch “G”.
  - e) Replace bearing “E” and nut “D” on reverse gear assembly “C”.
  - f) Replace reverse gear assembly “C” and nut “B”.
  - g) Press bearing “A” onto the shaft.
4. To reassemble the cluster shaft assembly:
  - a) Press bearing “K”, Figure 4.30, onto the shaft.
  - b) Replace spacer “J” and key “H”.
  - c) Replace the 54, 40, 36, 32, 28, 26, 24, 23, and 22 tooth gears.
  - d) Replace bearing “G”.
  - e) Replace nut “F”.
  - f) Replace collar “E” and key “D”.
  - g) Replace spacer “C”, gear “B”, and stud “A”.

5. To reassemble the gearbox tumbler and shaft assembly:
  - a) Replace bushing "U", Figure 4.29, plunger "T", spring "S", nut "R", and ball handle "Q".
  - b) Hold gear and bearing "M", Figure 4.28, in position and replace shaft "K".
  - c) Tighten set screw "L".
  - d) Replace key "O", gear "N", and two bearings "J".
  - e) Replace two screws "I".
  - f) Replace tumbler shaft "P".
  - g) Press bearing "H" onto shaft "P".
6. To reassemble the "Feed-Thread" or three change pinion assembly:
  - a) Replace spring "G", Figure 4.27, and plunger "D" in handle "F".
  - b) Slide pinion shaft "B" through bushing "C" and replace handle "F".
  - c) Replace and tighten set screw "E".

**- NOTE -**

Factory installed spacers may have been present behind clutch shaft "X", Figure 4.25, intermediate shaft "Y", change shaft "Z", or reverse shaft "A", Figure 4.26 . These spacers can vary in thickness and must be in place behind the correct shaft during reassembly. Replace these spacers as labeled during disassembly.

7. Replace the spacers in the gearbox housing as labeled during disassembly.

**- NOTE -**

As they are installed, gently tap reverse shaft "A", Figure 4.26, clutch shaft "X", Figure 4.25, intermediate shaft "Y", and change shaft "Z" into place with a soft-faced hammer.

8. Install reverse shaft "A", Figure 4.26, and gently tap it into place.
9. Install clutch shaft "X", Figure 4.25, intermediate shaft "Y", and change shaft "Z" simultaneously; then gently tap them into place.

**- NOTE -**

When replacing the cluster shaft, position bearing "D", Figure 4.15, midway in the casting as shown.

10. Replace cluster shaft assembly "W", Figure 4.24 .

**- NOTE -**

Factory installed spacers may have been present behind tumbler and shaft assembly "V", Figure 4.23 . These spacers can vary in thickness and must be in place behind this shaft assembly during reassembly. Replace these spacers as labeled during disassembly.

11. Install tumbler and shaft assembly "V", Figure 4.23, and gently tap it into place.

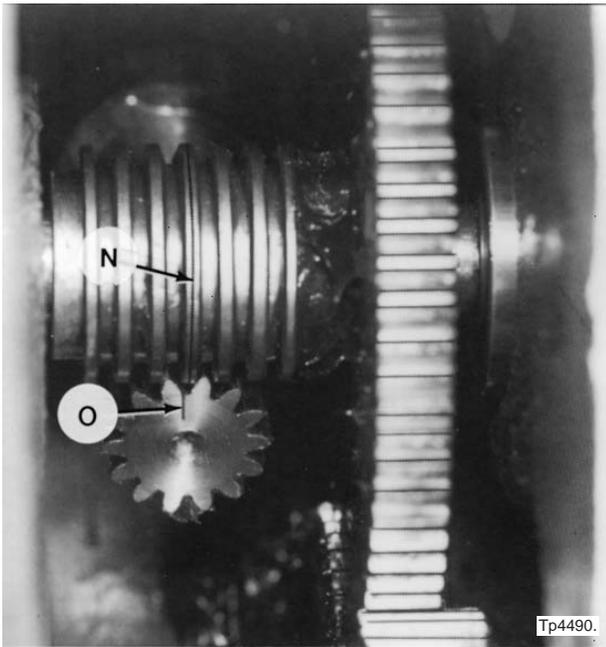


Figure 4.34 - Timing Marks for Worm Gear and Pinion

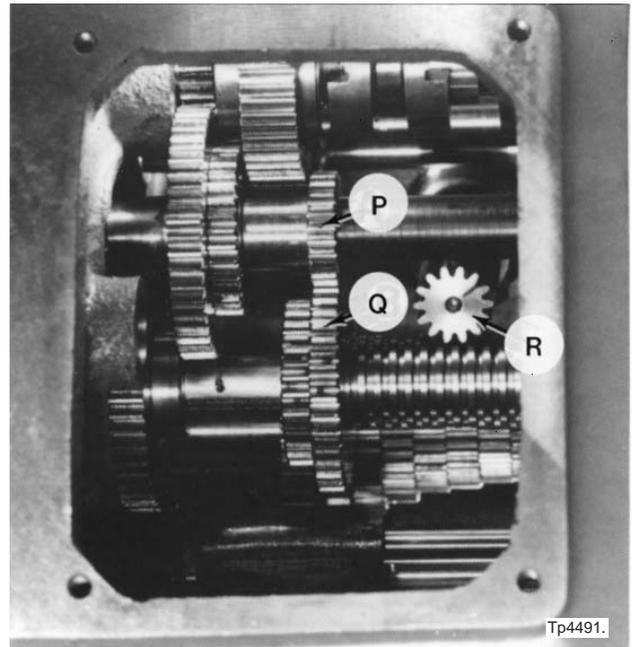


Figure 4.35 - Checking Three Change Gear Position

12. If removed, install three change pinion assembly “F”, Figure 4.4 :

- a) Replace the three change pinion assembly in the gearbox housing.
- b) Tighten the set screw under lock screw “U”, Figure 4.22 .
- c) Replace and tighten lock screw “U”.

**- CAUTION -**

**Use care that all components are properly aligned with the holes in cover “T”, Figure 4.21, as the cover is being mounted on the gearbox housing.**

13. “T”, Figure 4.21, and tap slowly into place using a soft-faced hammer.

14. Replace five screws “O”, Figure 4.18 .

**- NOTE -**

Spacers “Q”, Figure 4.19, and snap rings “P” MUST be installed properly. Refer to the labels that were attached during disassembly.

15. Install spacers “Q”, Figure 4.19, and five snap rings “P”, Figures 4.18 and 4.19.

16. Remount gear guard “F”, Figure 4.16, using three screws in hinge “E”.

**- NOTE -**

When installing the “Feed-Thread” pinion assembly, line up timing mark “N”, Figure 4.34, on the worm gear and timing mark “O” on the pinion.

17. If removed, replace “Feed-Thread” pinion assembly “K”, Figure 4.17:

- a) Replace the “Feed-Thread” pinion assembly in the gearbox housing.
- b) Tighten the set screw under lock screw “J”.
- c) Replace and tighten lock screw “J”.

18. Replace bearing "I" and stop block "H".
19. Replace idler gear "G", Figure 4.16, and screw "N", Figure 4.6.
20. Replace snap ring "M", Figure 4.6.
21. Turn three change" handle "F", Figure 4.4, to the "3" position.
22. Check gears "P", Figure 4.35, and "Q" to be sure they mesh properly.  
If the gears mesh properly, this reassembly procedure is complete.  
If the gears do not mesh properly, go to step 21.
23. Loosen set screw "E", Figure 4.27 .
24. Position gears "P", Figure 4.35, and "Q" as shown.
25. With plunger "D", Figure 4.27, in the notched position, press against pinion "R", Figure

### **GEARBOX REPLACEMENT (English)**

1. Position the gearbox as shown in Figure 4.15.

**- NOTE -**

If resistance is met while pushing the gearbox into position, bearing "D", Figure 4.15, may not be positioning properly.

2. Hold lock nut "V", Figure 4.10, in position and carefully push the gearbox into position.

**- NOTE -**

Screw replacement shown in Figure 4.14 requires a long 5/16 inch hex wrench or a length of 5/16 inch hex stock.

3. Replace four screws "C", Figures 4.13 and 4.14 .
4. Back off nut "A", Figure 4.13, and replace dowel pin "B".
5. Tighten lock nut "V", Figure 4.10 to 300 lb-in [33.9 Nm].
6. Engage carriage lead screw nut "X" Figure 4.11, with carriage lead screw "Y" by rotating lever "W" clockwise (as viewed from the front of the machine).

**- NOTE -**

Properly align the tapered hole in the left end of carriage lead screw "Y" with the corresponding hole in the gearbox cluster shaft.

7. Move the carriage to the left using handwheel "Z", Figure 4.12, to line up the holes in the lead screw and the cluster shaft for taper pin "U", Figure 4.10 .
8. Disengage carriage lead screw nut "X" Figure 4.11, from carriage lead screw "Y" by rotating lever "W" counterclockwise.
9. Install taper pin "U", Figure 4.10 .

**- NOTE -**

When replacing shifter yoke "Q", Figure 4.8, place the shifter fork in the groove of clutch "G", Figure 4.31 .

10. Replace shifter yoke "Q", Figure 4.8, and shaft "T", Figure 4.9 .
11. Locate the shifter yoke on the shaft by lining up the screw holes.

**- NOTE -**

The set screw under lock screw "R", Figure 4.8, is a dog point screw and must locate in the hole in shaft "T", Figure 4.9 .

12. Tighten the set screw located under lock screw "R", Figure 4.8 .
13. Replace lock screws "R" and "S".
14. Replace covers "O" and "P", Figure 4.7 .
15. Replace washers "L" and "K", Figure 4.6, and key "J".
16. Replace handwheel "I", Figure 4.5, and snap ring "H".
17. Remount the collet closer according to the procedure starting on Page 4-2.

## GEARBOX (English-Metric)

### LUBRICATION

Lubricate the gears in the gearbox every three months, or more often if necessary, with Darmex® DX-321 grease.

If the gearbox is not shifted for long periods of time, cycle “Feed-Thread” knob “A”, Figure 4.36, English-Metric knob “B”, three change knob “C”, and thread change handle “D” from one extreme to the other several times.

Lubricate the bushings and shafts on the change gear bracket as needed with Mobil® Velocite® No. 6 oil.



Figure 4.36 - Gearbox (Front View)

## GEARBOX REMOVAL (English-Metric)

1. Remove the collet closer according to the procedure outlined on Page 4-1.
2. Remove snap ring "H", Figure 4.5, and remove handwheel "I".
3. Remove key "J", Figure 4.6, washer "K", and washer "L".
4. Remove covers "E" and "F", Figure 4.37.
5. Remove lock screw "I", Figure 4.38, and loosen the set screw under lock screw "I".
6. Remove lock screw "J".
7. Unscrew shaft "K", Figure 4.39, with a hex wrench.
8. Remove shaft "K", Figure 4.39, and shifter fork "H", Figure 4.38 . Refer also to Figure 4.40 .
9. Remove taper pin "U", Figure 4.10 .
10. Engage carriage lead screw nut "X" Figure 4.11, with carriage lead screw "Y" by rotating lever "W" clockwise (as viewed from the front of the machine).
11. Move the carriage approximately 1/2 inch [12.7mm] to the right using handwheel "Z", Figure 4.12 .
12. Disengage carriage lead screw nut "X" Figure 4.11, from carriage lead screw "Y" by rotating lever "W" counterclockwise (as viewed from the front of the machine).
13. Remove lock nut "V", Figure 4.10 .

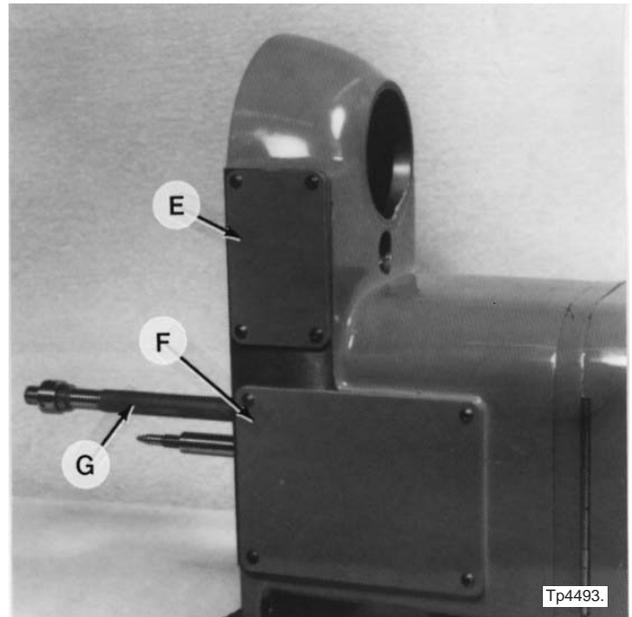


Figure 4.37 - Gearbox Rear Covers

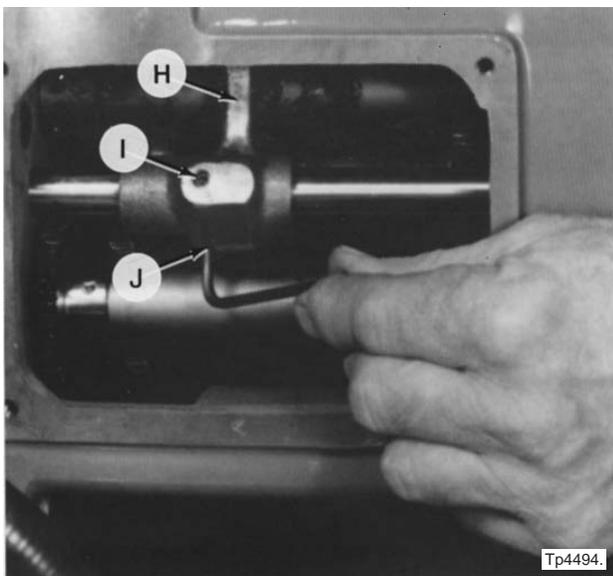


Figure 4.38 - Gearbox Shifter Fork

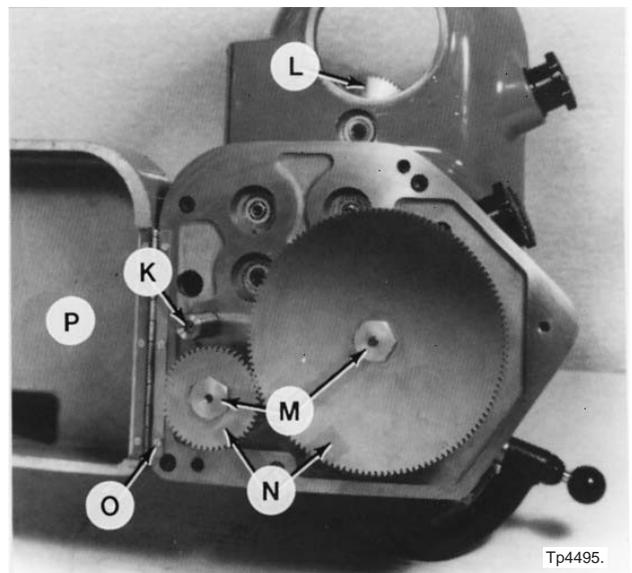


Figure 4.39 - Gearbox Assembly (End View)

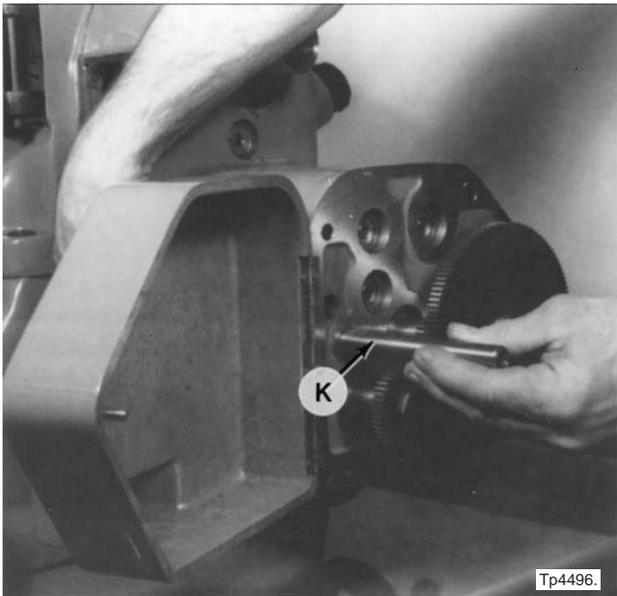


Figure 4.40 - Shifter Fork Shaft Removal

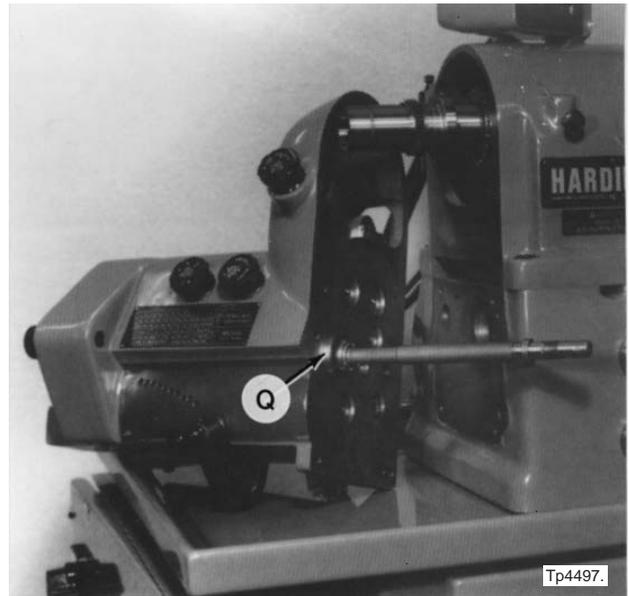


Figure 4.41 - Gearbox Removal

14. Turn nut "A", Figure 4.13, clockwise to remove dowel pin "B".

**- NOTE -**

The screw removal shown in Figure 4.14 requires a long 5/16 inch hex wrench or a length of 5/16 inch hex bar stock.

15. Remove four screws located at "C", Figures 4.13 and 4.14 .

16. Remove the gearbox by pulling it straight off the headstock. Refer to Figure 4.41 .

**GEARBOX DISASSEMBLY (English-Metric)**

1. Perform steps 1 through 16 under "Gearbox Removal".
2. Remove snap ring "M", Figure 4.6 .
3. Turn screw "N", Figure 4.6, clockwise to remove idler gear "L", Figure 4.39 .
4. If possible, remove cluster shaft extension "G", Figure 4.37 .
5. Remove stop block "R", Figure 4.42, and bearing "S".
6. If it is necessary to remove "Feed-Thread" pinion assembly "T":
  - a) Remove lock screw "U" .
  - b) Loosen the set screw under lock screw "U".
  - c) Pull "Feed-Thread" pinion assembly "T" out of the gearbox housing.

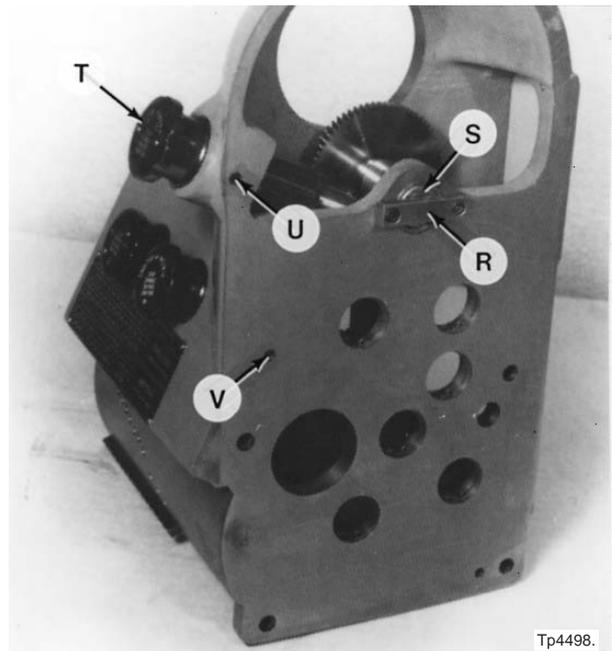


Figure 4.42 - Idler Shaft Rear Bearing

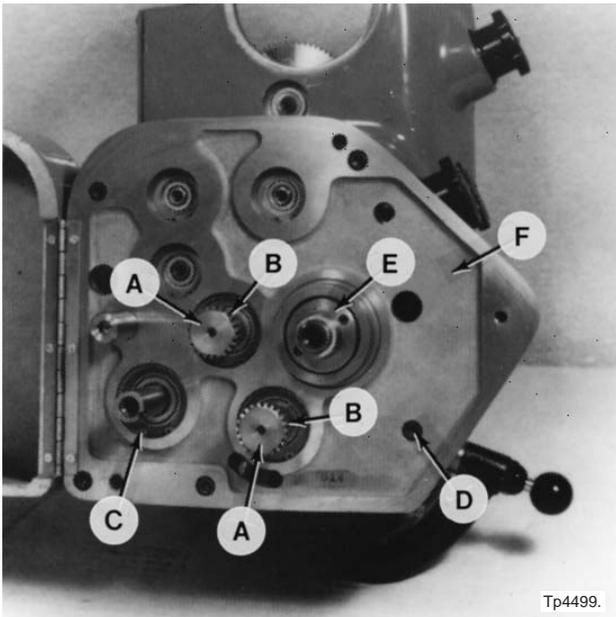


Figure 4.43 - Gears and Mounting Studs

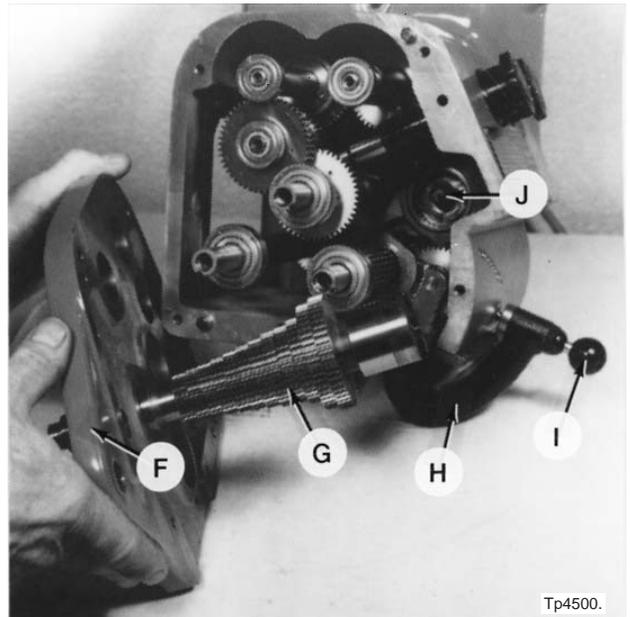


Figure 4.44 - Cover and Cluster Shaft Removal

7. Remove three screws "O", Figure 4.39, and remove gear guard "P".

**- NOTE -**

Tag gears "N", Figure 4.39, and "B", Figure 4.43, as they are removed to ensure proper reassembly of the gearbox.

8. Loosen the lock screws in studs "M", Figure 4.39; then, remove studs "M", gears "N", and the keys located under gears "N".

9. Loosen the lock screws in studs "A", Figure 4.43; then, remove studs "A", gears "B", and the keys located under gears "B".

**- NOTE -**

Label six snap rings "C" and their associated spacers as they are removed for identification to ensure proper reassembly of the gearbox.

10. Remove six snap rings "C" and their associated spacers.

11. Remove five screws "D".

12. Place tumbler shaft "H", Figure 4.44, out of mesh.

**- NOTES -**

DO NOT allow the remaining shafts to lift up with cover "F" and cluster shaft "G" while they are being removed. If necessary, tap the shafts back down into place with a soft-faced hammer while cover "F" and cluster shaft "G" are being removed.

English-Metric gear "K", Figure 4.46, will drop down slightly when both cluster shaft "G", Figure 4.44, and cluster shaft extension "G", Figure 4.37, have been removed.

13. Remove cover "F", Figure 4.44, and cluster shaft "G".

14. Remove nut "E", Figure 4.43, to remove cluster shaft "G", Figure 4.44, from cover "F".

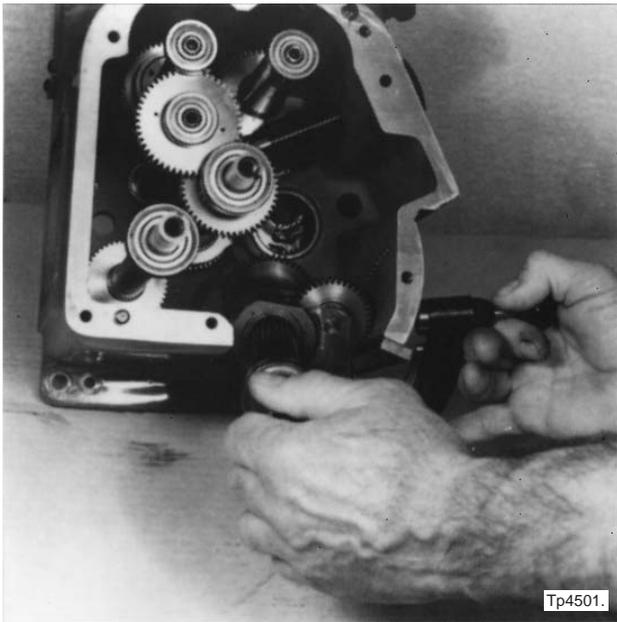


Figure 4.45 - Tumbler and Shaft Assembly Removal

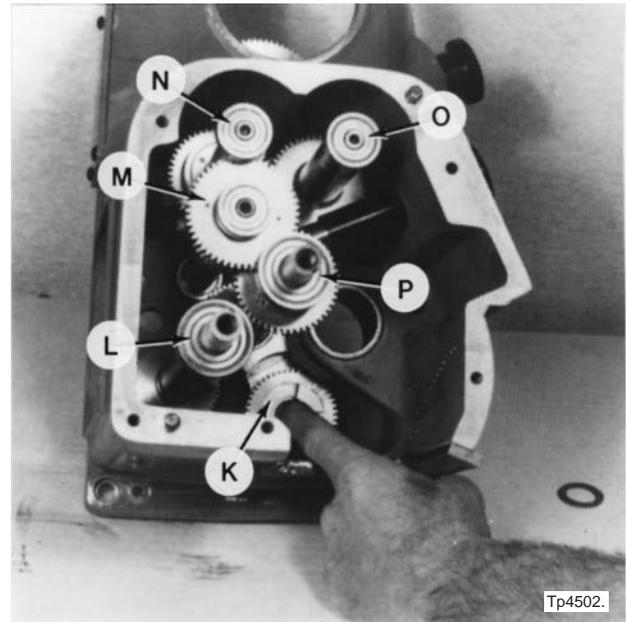


Figure 4.46 - English/Metric Gear Removal

**- NOTE -**

To remove cluster shaft extension "G", Figure 4.37 It may be necessary to tap at point "J", Figure 4.44, with a piece of wood.

15. If it was not possible to do so before, remove cluster shaft extension "G", Figure 4.37 .

**- NOTE -**

USE CARE when removing tumbler and shaft assembly "H", Figure 4.44 . Factory installed spacers may be present behind this shaft assembly. These spacers can vary in thickness and MUST be in place behind the correct shaft during reassembly. LABEL ALL SPACERS located behind all shaft assemblies for proper reassembly.

16. Pull plunger "I", Figure 4.44, out and remove gearbox tumbler and shaft assembly "H". Refer also to Figure 4.45 .

**- NOTE -**

USE CARE when removing three change shaft "P", Figure 4.46, metric conversion shaft "L", intermediate shaft "M", clutch shaft "N", and reverse shaft "O". Factory installed spacers may be present behind these shaft assemblies. These spacers can vary in thickness and MUST be in place behind the correct shaft during reassembly. LABEL ALL SPACERS located behind all shaft assemblies for proper reassembly.

17. Remove English-Metric gear "K", Figure 4.46, by pulling it down and out.
18. Remove three change shaft "P", Figures 4.46 and 4.47 .
19. Remove metric conversion shaft "L", Figures 4.46 and 4.48 .
20. Remove intermediate shaft "M" and clutch shaft "N", Figures 4.46 and 4.49, at the same time.

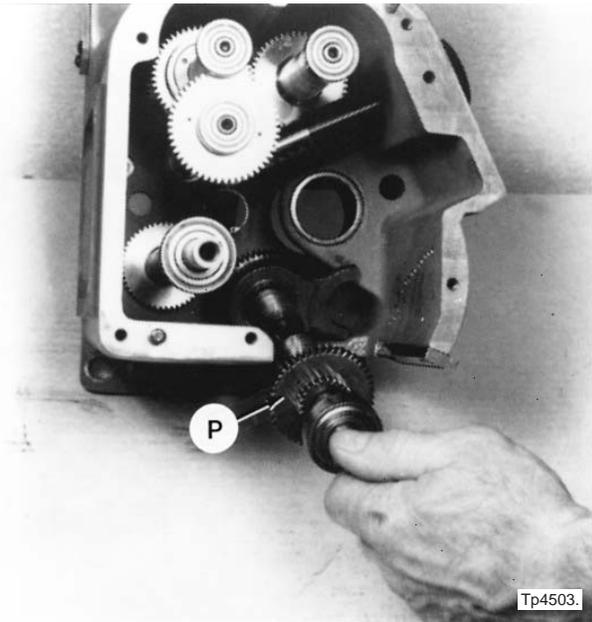


Figure 4.47 - Three Change Shaft Assembly Removal

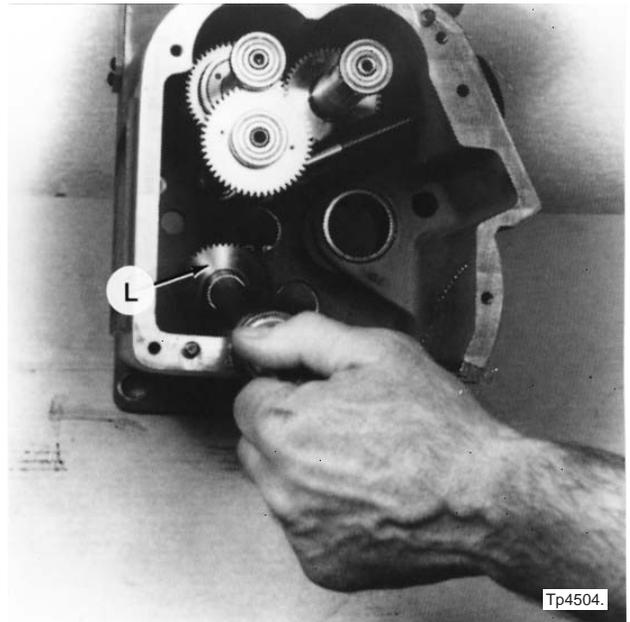


Figure 4.48 - Metric Conversion Shaft Assembly Removal

**- NOTE -**

Reverse shaft "O", Figures 4.46 and 4.50, is of one piece construction, with the exception of the bearings that are pressed on each end of the shaft.

21. Remove reverse shaft "O", Figures 4.46 and 4.50 .
22. If it is necessary to remove three change pinion assembly "C", Figure 4.36:
  - a) Remove lock screw "Q", Figure 4.50 .
  - b) Loosen the set screw under lock screw "Q".
  - c) Pull three change pinion assembly "C", Figure 4.36, out of the gearbox housing.
23. If it is necessary to remove "English-Metric" pinion assembly "B", Figure 4.36:
  - a) Remove lock screw "V", Figure 4.42 .
  - b) Loosen the set screw under lock screw "V".
  - c) Pull "English-Metric" pinion assembly "B", Figure 4.36, out of the gearbox housing.

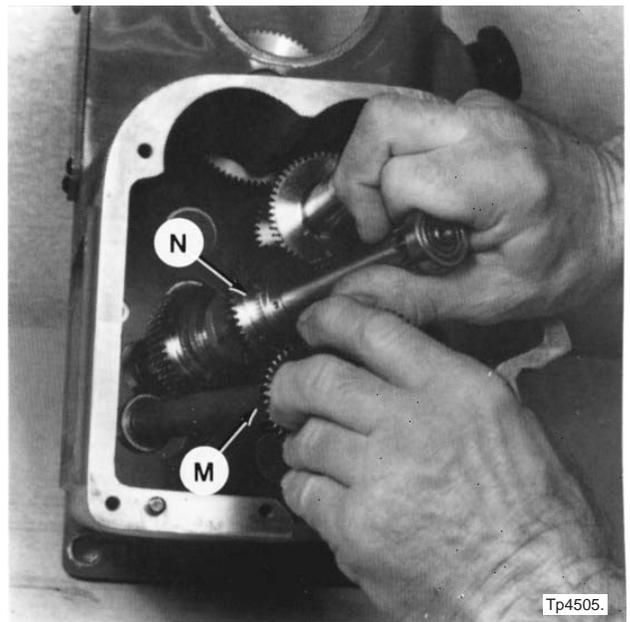


Figure 4.49 - Clutch Shaft Assembly Removal

- 24. To disassemble the "Feed-Thread" pinion assembly:
  - a) Remove set screw "E", Figure 4.27 .
  - b) Remove pinion shaft "B" and handle "F" from bushing "C".
  - c) Remove plunger "D" and spring "G" from handle "F".

25. To disassemble the "English-Metric" pinion assembly:

- a) Remove set screw "U", Figure 4.51 .
- b) Remove pinion shaft "R" and handle "T" from bushing "S".
- c) Remove plunger "W" and spring "V" from handle "T".

26. To disassemble the three change pinion assembly:

- a) Remove set screw "D", Figure 4.52 .
- b) Remove pinion shaft "A" and handle "C" from bushing "B".
- c) Remove plunger "F" and spring "E" from handle "C".

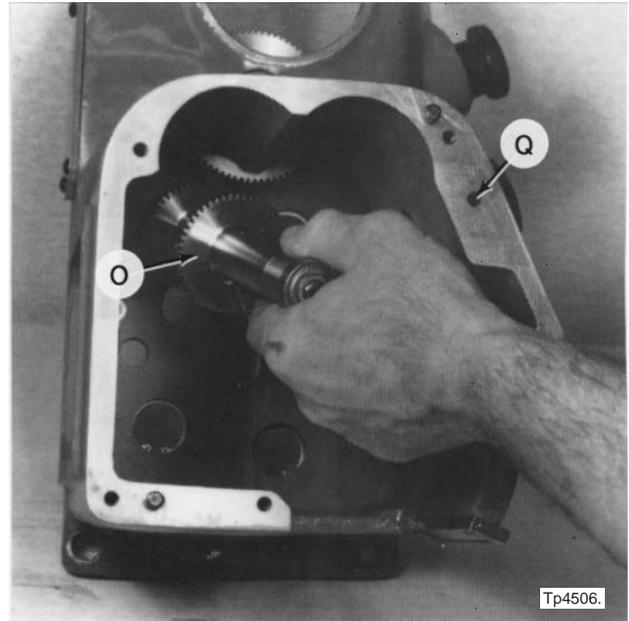


Figure 4.50 - Reverse Shaft Assembly Removal

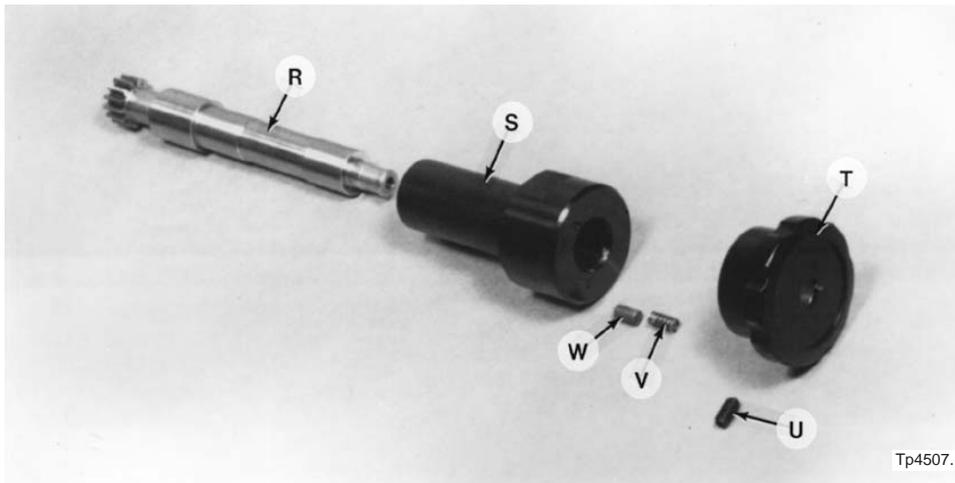
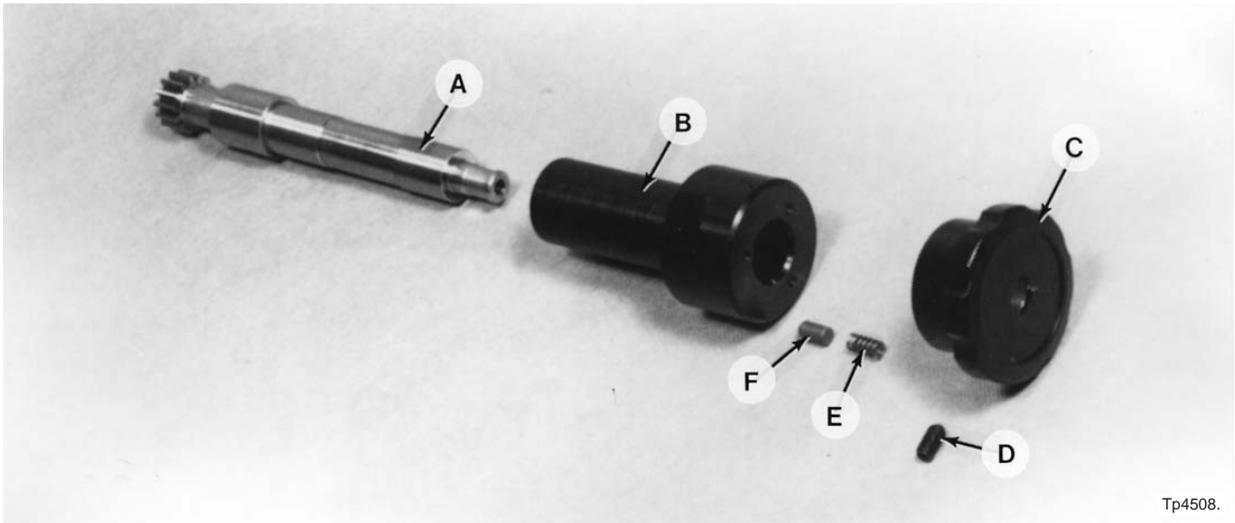
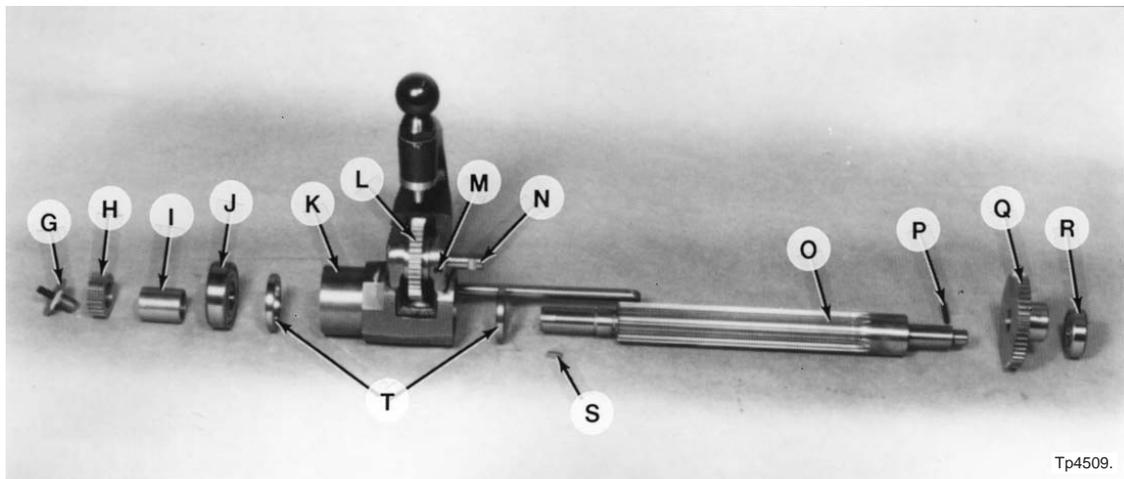


Figure 4.51 - English-Metric Pinion Assembly



Tp4508.

Figure 4.52 - Three Change Pinion Assembly



Tp4509.

Figure 4.53 - Tumbler and Shaft Assembly

**- NOTE -**

Stud "G", gear "H", and key "S", Figure 4.53, were removed in step 9.

27. To disassemble the gearbox tumbler and shaft assembly:

- a) Remove spacer "I", Figure 4.53 .
- b) \_ the tumbler shaft.
- c) Remove pin "P"; then, press gear "Q" and bearing "R" from the tumbler shaft.
- d) Loosen set screw "M".
- e) Remove shaft "N" to remove gear and bearing "L".
- f) If necessary, press two bearings "T", from tumbler body "K" .
- g) Remove ball handle "U", Figure 4.54, nut "V", spring "W", plunger "X" and bushing "Y".

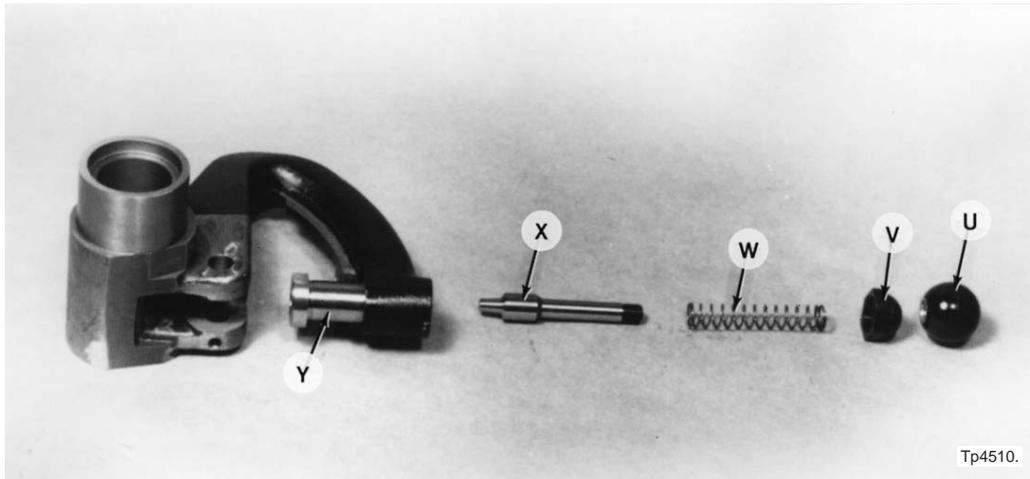


Figure 4.54 - Plunger Assembly Components

**- NOTES -**

Nut "E", Figures 4.43 and 4.55, was removed in step 14.

Bearing "D", Figure 4.55, and spacers are located under nut "E", Figures 4.43 and 4.55, and is held in cover "F", Figure 4.43, by two retaining rings.

28. To disassemble the cluster shaft assembly:

- a) If necessary, remove bearing "D" and spacers from cover "F", Figure 4.43 . Label spacers for proper reassembly.
- c) Remove the 22, 23, 24, 26, 28, 30, 32, 35, 36, 38, 40, and 50 tooth gears, Figure 4.55 .
- d) Remove key "A".
- e) If necessary, remove bearing "B" from the end of shaft "C".

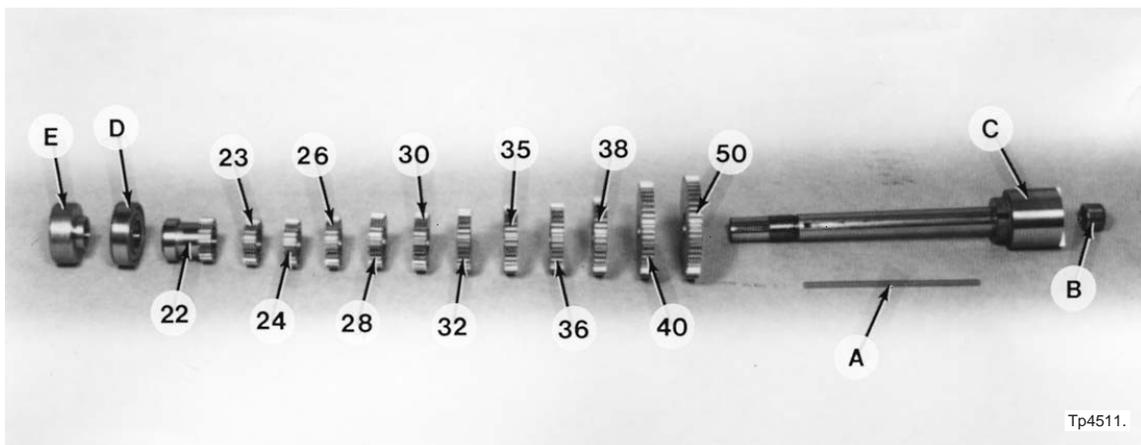


Figure 4.55 - Cluster Shaft Assembly

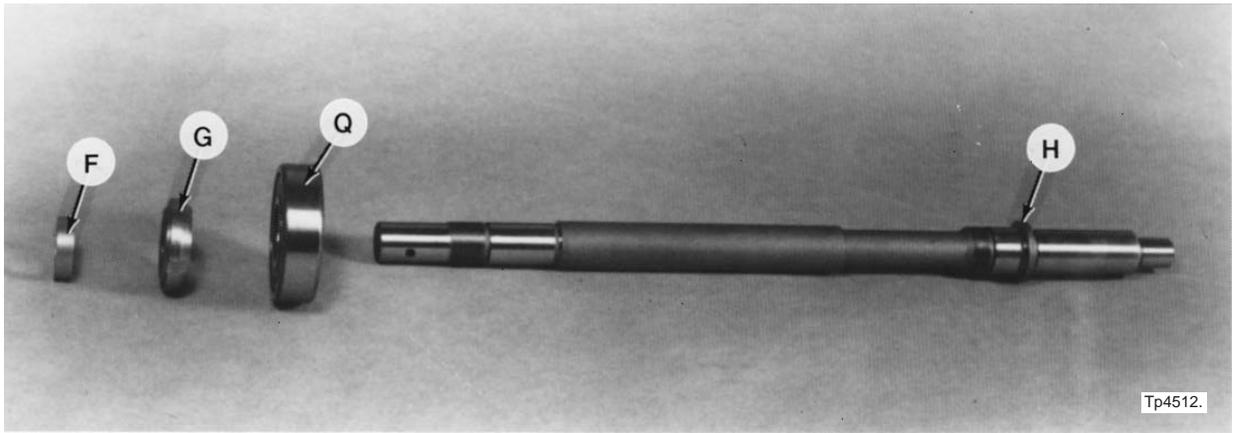


Figure 4.56 - Cluster Shaft Extension

**- NOTE -**

Note the orientation of nut “G”, Figure 4.56, before removing it.

29. To disassemble the cluster shaft extension:

- a) Remove spacer “F”, Figure 4.56 .
- b) Remove nut “G”, Figure 4.56, and press bearing “Q”, Figures 4.41 and 4.56, from the shaft.

30. To disassemble the clutch shaft assembly:

- a) Press bearing “I”, Figure 4.57, off the shaft.
- b) Remove nut “J” to remove forward gear assembly “M”.
- c) Remove nut “K” to remove bearing “L” from forward gear assembly “M”.
- d) Remove quick reverse assembly “N”.
- e) Remove key “S”, and reverse gear assembly “O”.
- f) Remove nut “Q”, to remove bearing “P”, from reverse gear assembly “O”.
- g) If necessary, press bearing “R”, off the shaft.

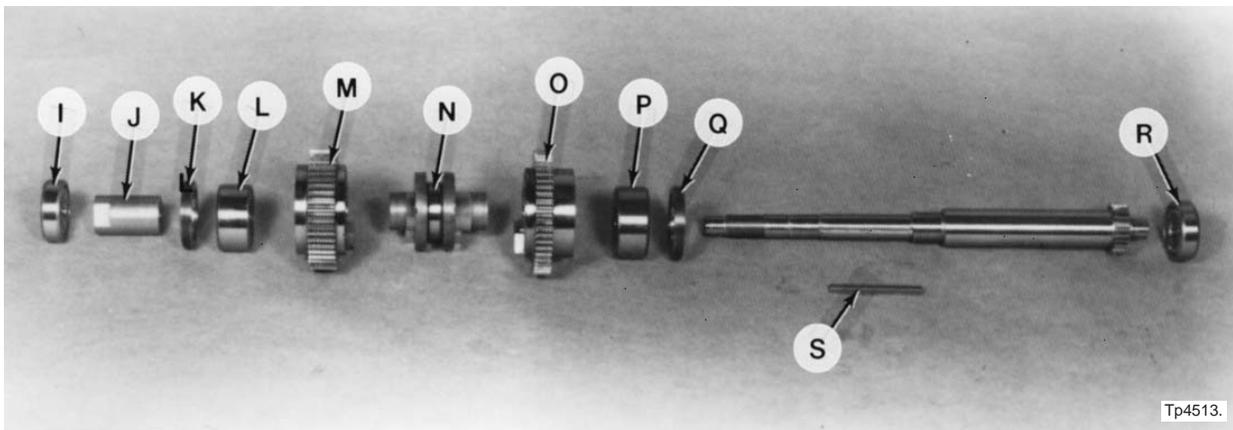


Figure 4.57 - Clutch Shaft Assembly

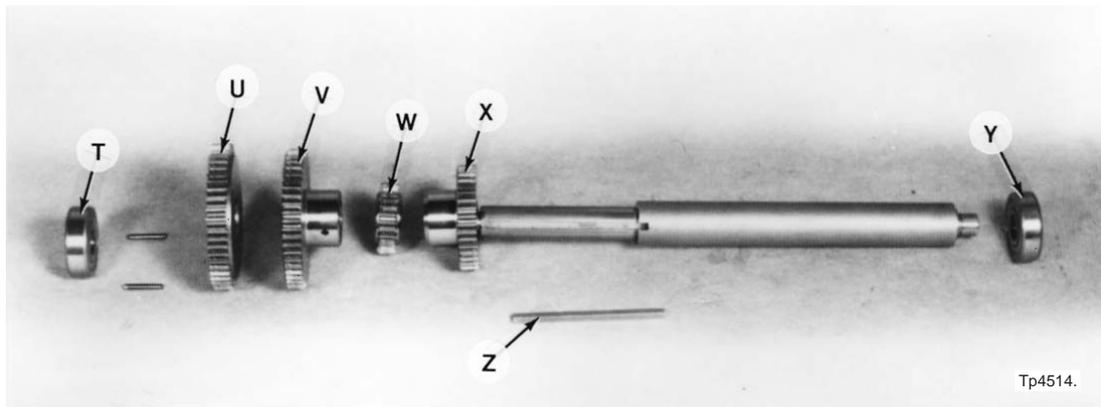


Figure 4.58 - Intermediate Shaft Assembly

**- NOTE -**

Gears “U” and “V”, Figure 4.58, are pinned together. DO NOT separate gears “U” and “V”.

31. To disassemble the intermediate shaft assembly:

- a) Press gears “U” and “V”, Figure 4.58, and bearing “T” from the shaft.
- b) Press gears “W” and “X” from the shaft.
- c) Remove key “Z”.
- d) If necessary, press bearing “Y” off the shaft.

**- NOTES -**

Gears “F” and “G”, Figure 4.59, are pinned together. DO NOT separate these gears.

Stud “A”, gear “B”, and key “P” were removed in step 9.

Key “N” is located between worm “O” and gears “F” and “G”.

32. To disassemble the three change shaft assembly:

- a) Remove spacer “C”, Figure 4.59 .
- b) Press bearing “D” from the shaft.
- c) Press bearing “L” from the shaft.
- d) Remove worm “K” with fork “J”, bearings “I”, and snap ring and spacer “H” still attached.
- e) Remove snap ring and spacer “H” and fork “J” from worm “K”.
- f) If necessary, press bearings “I” from fork “J”.
- g) Remove worm “O” and two gears “F” and “G” from the shaft.
- h) If necessary, remove two gears “F” and “G” and key “N” from worm “O”.
- i) If necessary, remove key “E” from the inside diameter of worm “O” and remove key “M” from the inside diameter of worm “K”.

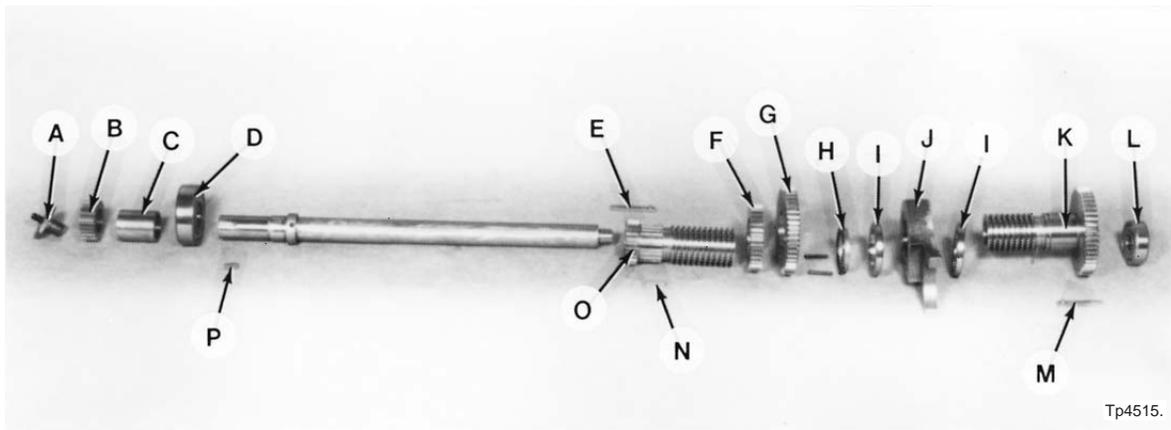


Figure 4.59 - Three Change Shaft Assembly

**- NOTE -**

Stud "M", gear "N", and key "Q", Figures 4.39 and 4.60, were removed in step 8.

33. To disassemble the metric conversion shaft assembly:

- a) Remove spacer "O".
- b) Press bearing "P" off the shaft.
- c) Remove pin "R".
- d) Press gear "T" and bearing "S" off the shaft.

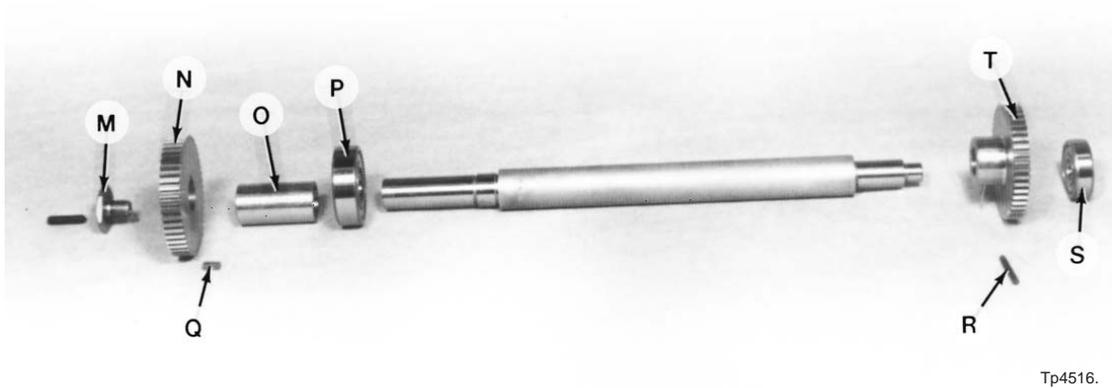


Figure 4.60 - Metric Conversion Shaft Assembly

## GEARBOX REASSEMBLY (English-Metric)

### - NOTES -

During reassembly, line up the hole in gear “T”, Figure 4.60, with the hole in the shaft.

Stud “M”, gear “N”, and key “Q” will be replaced in step 26.

1. To reassemble the metric conversion shaft assembly:

- a) Press gear “T” and bearing “S” onto the shaft.
- b) Replace pin “R”.
- c) Press bearing “P” onto the shaft.
- d) Replace spacer “O”.

### - NOTES -

Stud “A”, Figure 4.59, gear “B”, and key “P” will be replaced in step 25.

Gears “F” and “G” are pinned together.

2. To reassemble the three change shaft assembly:

- a) If removed, replace key “E”, Figure 4.59, in the inside diameter of worm “O” and replace key “M” in the inside diameter of worm “K”.
- b) If removed, replace key “N” and two gears “F” and “G” on worm “O”.
- c) Replace worm “O” on the shaft.
- d) If removed, press two bearings “I” into fork “J”.
- e) Replace fork “J”, the snap ring, and spacer “H” onto worm “K”.
- f) Replace worm “K” on the shaft.
- g) Press bearing “L” onto the shaft.
- h) Press bearing “D” onto the shaft.
- i) Replace spacer “C”.

### - NOTE -

Gears “U” and “V”, Figure 4.53, are pinned together.

3. To reassemble the intermediate shaft assembly:

- a) If removed, press bearing “Y”, Figure 4.58, onto the shaft.
- b) Replace key “Z”.
- c) Press gears “W” and “X” onto the shaft.
- d) Press bearing “T” and gears “U” and “V” onto the shaft.

4. To reassemble the clutch shaft assembly:
  - a) If removed, press bearing "R", Figure 4.57, onto the shaft.
  - b) Replace bearing "P" and nut "Q" in reverse gear assembly "O".
  - c) Replace reverse gear assembly "O".
  - d) Replace key "S".
  - e) Replace quick reverse assembly "N".
    - f) Replace bearing "L" and nut "K" in forward gear assembly "M".
  - g) Replace forward gear assembly "M" and nut "J".
  - h) Press bearing "I" onto the shaft.

**- NOTE -**

Bearing "Q", Figure 4.56, locates against shoulder "H".

5. To reassemble the cluster shaft extension:
  - a) Press bearing "Q", Figure 4.56, onto the shaft.
  - b) Replace nut "G", noting that the nut is oriented correctly.
  - c) Replace spacer "F".

**- NOTE -**

Bearing "B", Figure 4.55, MUST be installed with the rounded end toward the inside and the flat end toward the outside.

6. To reassemble the cluster shaft assembly:
  - a) If removed, press bearing "B", Figure 4.55, into the end of shaft "C".
  - b) Replace key "A".
  - c) Replace the 50, 40, 38, 36, 35, 32, 30, 28, 26, 24, 23, and 22 tooth gears.
  - d) If removed, replace bearing "D", Figure 4.55, and spacers in cover "F", Figure 4.43 .
  - e) Install cluster shaft "G", Figure 4.44, in cover "F" and replace nut "E", Figure 4.43 .

**- NOTE -**

Stud "G", Figure 4.53, gear "H", and key "S" will be replaced in step 25. Refer also to Figure 4.43 .

7. To reassemble the gearbox tumbler and shaft assembly:
  - a) Replace bushing "Y", Figure 4.54, plunger "X", spring "W", nut "V", and ball handle "U".
  - b) If removed, press two bearings "T", Figure 4.53, into tumbler body "K".
  - c) Hold gear and bearing "L" in position and replace shaft "N".
  - d) Tighten set screw "M".
  - e) Press gear "Q" and bearing "R" onto tumbler shaft "O" and replace pin "P".
  - f) Slide tumbler shaft "O" through tumbler body "K".
  - g) Press bearing "J" onto tumbler shaft "O".
  - h) Replace spacer "I".
8. To reassemble the "Feed-Thread" pinion assembly:
  - a) Replace spring "G", Figure 4.27, and plunger "D" in handle "F".
  - b) Slide pinion shaft "B" through bushing "C" and replace handle "F".
  - c) Replace and tighten set screw "E".
9. To reassemble the "English-Metric" pinion assembly:
  - a) Replace spring "V", Figure 4.51, and plunger "W" in handle "T".
  - b) Slide pinion shaft "R" through bushing "S" and replace handle "T".
  - c) Replace and tighten set screw "U".
10. To reassemble the three change pinion assembly:
  - a) Replace spring "E", Figure 4.52, and plunger "F" in handle "C".
  - b) Slide pinion shaft "A" through bushing "B" and replace handle "C".
  - c) Replace and tighten set screw "D".
11. Install "English-Metric" pinion assembly "B", Figure 4.36:
  - a) Replace the "English-Metric" pinion assembly in the gearbox housing.
  - b) Tighten the set screw under lock screw "V", Figure 4.42 .
  - c) Replace and tighten lock screw "V".
12. Install three change pinion assembly "C", Figure 4.36 :
  - a) Replace the three change pinion assembly in the gearbox housing.
  - b) Tighten the set screw under lock screw "Q", Figure 4.50 .
  - c) Replace and tighten lock screw "Q".

**- NOTE -**

Factory installed spacers may have been present behind reverse shaft “O”, Figure 4.46, clutch shaft “N”, intermediate shaft “M”, metric conversion shaft “L”, or three change shaft “P”. These spacers can vary in thickness and **MUST** be in place behind the correct shaft during reassembly. Replace these spacers as labeled during disassembly.

13. Replace spacers in the mounting side of the gearbox housing as labeled during disassembly.

**- NOTE -**

As they are installed, gently tap reverse shaft “O”, Figure 4.46, clutch shaft “N”, intermediate shaft “M”, metric conversion shaft “L”, and three change shaft “P” into place with a soft-faced hammer.

14. Install reverse shaft “O”, Figures 4.46 and 4.50, and gently tap into place.
15. Install clutch shaft “N” and intermediate shaft “M”, Figures 4.46 and 4.49, at the same time; then, gently tap both shafts into place.
16. Replace metric conversion shaft “L”, Figures 4.46 and 4.48, and gently tap into place.
17. Replace three change shaft “P”, Figures 4.46 and 4.47, and gently tap into place.
18. Replace English-Metric gear “K”, Figure 4.46, in the fork on the three change shaft.
19. Align English-Metric gear “K” with the cluster shaft mounting hole.

**- NOTE -**

Factory installed spacers may have been present behind tumbler and shaft assembly “H”, Figure 4.44 . These spacers can vary in thickness and **MUST** be in place behind this shaft assembly during reassembly.

20. Replace any spacers removed during the removal of tumbler and shaft assembly “H”, Figure 4.44 .
21. Pull plunger “I” out and install tumbler and shaft assembly “H” and gently tap into place. Refer also to Figure 4.45 .

**- CAUTION -**

**Use care that all components in the gearbox are properly aligned with the holes in cover “F”, Figure 4.43, and cluster shaft “G”, Figure 4.44, is aligned with the English-Metric gear located at point “J” before the cover is mounted on the gearbox housing.**

22. Mount cover “F”, Figures 4.43 and 4.44, and tap slowly into place using a soft-faced hammer.
23. Replace five screws “D”, Figure 4.43 .

**- NOTE -**

Spacers and snap rings “C”, Figure 4.43, **MUST** be installed properly. Refer to the labels that were attached during disassembly.

24. Install spacers and six snap rings “C”, Figures 4.43 .
25. Replace the keys located under gears “B”, gears “B”, and studs “A”.

26. Replace the keys located under gears “N”, Figure 4.39, gears “N”, and studs “M”.
27. Install cluster shaft extension “G”, Figure 4.37 .
28. Remount gear guard “P”, Figure 4.39, using three screws “O”.

**- NOTE -**

When installing the “Feed-Thread” pinion assembly, line up timing mark “N”, Figure 4.34, on the worm gear and timing mark “O” on the pinion.

29. Install the “Feed-Thread” pinion assembly:
  - a) Replace the “Feed-Thread” pinion assembly in the gearbox housing.
  - b) Tighten the set screw under lock screw “U”, Figure 4.42 .
  - c) Replace and tighten lock screw “U”.
30. Replace bearing “S”, Figure 4.42, and stop block “R”.
31. Replace idler gear “L”, Figure 4.39, and screw “N”, Figure 4.6 .
32. Replace snap ring “M”, Figure 4.6 .
33. Turn three change handle “C”, Figure 4.36, to the “3” position.
34. Check gears “P”, Figure 4.35, and “Q” to be sure they mesh properly.

If the gears mesh properly, this reassembly procedure is complete.

If the gears do not mesh properly, go to step 35.
35. Loosen set screw “E”, Figure 4.27 .
36. Position gears “P”, Figure 4.35, and “Q” as shown.
37. With plunger “D”, Figure 4.27, in the notched position, press against pinion “R”, Figure 4.35, and knob “F”, Figure 4.27, and tighten set screw “E”.

## GEARBOX REPLACEMENT (English-Metric)

1. Position the gearbox as shown in Figure 4.41 .

**- NOTE -**

If resistance is met while pushing the gearbox into position, bearing “Q”, Figure 4.41, may not be positioning properly.

2. Hold lock nut “V”, Figure 4.10, in position and carefully push the gearbox into position.

**- NOTE -**

Screw replacement shown in Figure 4.14 requires a long 5/16 inch hex wrench or a length of 5/16 inch hex stock.

3. Replace four screws located at “C”, Figures 4.13 and 4.14 .
4. Back off nut “A”, Figure 4.13, and replace dowel pin “B”.
5. Tighten lock nut “V”, Figure 4.10, to 300 lb-in [33.9 Nm].
6. Engage carriage lead screw nut “X” Figure 4.11, with carriage lead screw “Y” by rotating lever “W” clockwise (as viewed from the front of the machine).

**- NOTE -**

Properly align the tapered hole in the left end of carriage lead screw “Y” with the corresponding hole in the gearbox cluster shaft.

7. Move the carriage to the left using handwheel “Z”, Figure 4.12, to line up the holes in the lead screw and the cluster shaft for taper pin “U”, Figure 4.10 .
8. Install taper pin “U”, Figure 4.10 .
9. Disengage carriage lead screw nut “X” Figure 4.11, from carriage lead screw “Y” by rotating lever “W” counterclockwise (as viewed from the front of the machine).

**- NOTE -**

When replacing shifter yoke “H”, Figure 4.38, place the shifter fork in the groove of quick reverse assembly “N”, Figure 4.57 .

10. Replace shaft “K”, Figure 4.39, and shifter yoke “H”, Figure 4.38 .
11. Locate the shifter yoke on the shaft by lining up the screw holes.

**- NOTE -**

The set screw under lock screw “I”, Figure 4.38, is a dog point screw and must locate in the hole in shaft “K”, Figure 4.39 .

12. Tighten the set screw located under lock screw “I”, Figure 4.38 .
13. Replace lock screws “I” and “J”.
14. Replace covers “E” and “F”, Figure 4.37 .
15. Replace washers “L” and “K”, Figure 4.6, and key “J”.
16. Replace handwheel “I”, Figure 4.5, and snap ring “H”.
17. Remount the collet closer according to the procedure starting on Page 4-2.

## GEAR CHANGE BRACKET (English)

### DISASSEMBLY

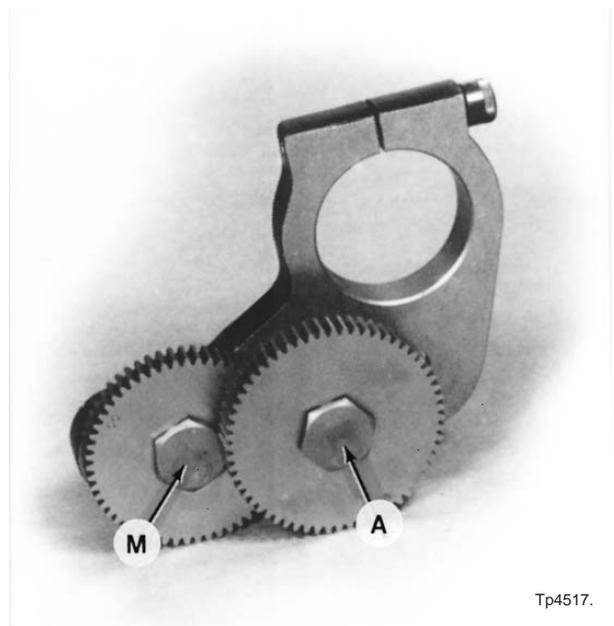
1. Remove bolt "A", Figures 4.61 and 4.62 .
2. Remove gear "B", spacer "C", gear "D", keyed bushing "E", bushing "F", and nut "G", Figure 4.62 .
3. Remove bolt "M", Figures 4.61 and 4.62 .
4. Remove gear "L", keyed bushing "K", bushing "J", and nut "H".

### REASSEMBLY

#### - NOTE -

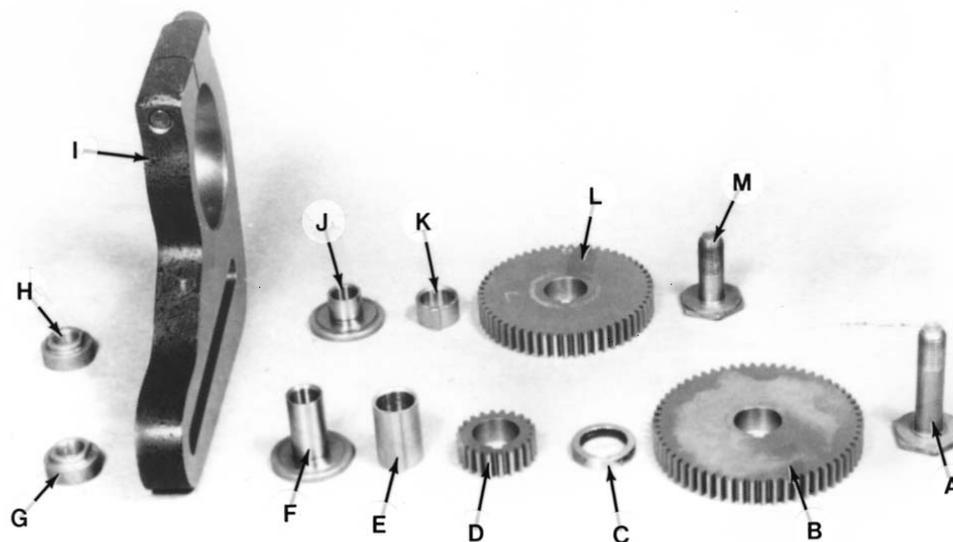
The flats on nuts "G" and "H", Figure 4.62, fit into the relief slot on the back side of bracket "I".

1. Slide keyed bushing "K", Figure 4.62, onto bushing "J".
2. Mount gear "L" onto keyed bushing "K".



Tp4517.

Figure 4.61 - Gear Change Bracket Assembly (English)



Tp4518.

Figure 4.62 - Gear Change Bracket Components (English)

3. Slide bolt "M" through bushing "J" from the side opposite the large flat surface on bushing "J".
4. Hold nut "H" inside the relief slot on the back side of bracket "I".
5. Slide bolt "M" through bracket "I" from the front side and thread bolt "M" into nut "H".
6. Slide keyed bushing "E" onto bushing "F".
7. Mount gear "D", spacer "C", and gear "B" onto keyed bushing "E".
8. Slide bolt "A" through bushing "F" from the side opposite the large flat surface on bushing "F".
9. Hold nut "G" inside the relief slot on the back side of bracket "I",
10. Slide bolt "A" through bracket "I" from the front side and thread bolt "A" into nut "G".

## GEAR CHANGE BRACKET (English-Metric)

### DISASSEMBLY

1. Remove bolt "N", Figures 4.63 and 4.64 .
2. Remove gear "O", spacer "P", gear "Q", keyed bushing "R", bushing "S", and nut "T", Figure 4.64 .
3. Remove bolt "Z", Figures 4.63 and 4.64 .
4. Remove gear "Y", keyed bushing "X", bushing "W", and nut "U", Figure 4.64 .

### REASSEMBLY

#### - NOTE -

The flats on nuts "N" and "Z", Figure 4.64, fit into the relief slot on the back side of bracket "V".

1. Slide keyed bushing "X", Figure 4.64, onto bushing "W".
2. Mount gear "Y" onto keyed bushing "X".
3. Slide bolt "Z" through bushing "W" from the side opposite the large flat surface on bushing "W".
4. Hold nut "U" inside the relief slot on the back side of bracket "V".
5. Slide bolt "Z" through bracket "V" from the front side and thread bolt "Z" into nut "U".
6. Slide keyed bushing "R" onto bushing "S".
7. Mount gear "Q", spacer "P", and gear "O" onto keyed bushing "R".

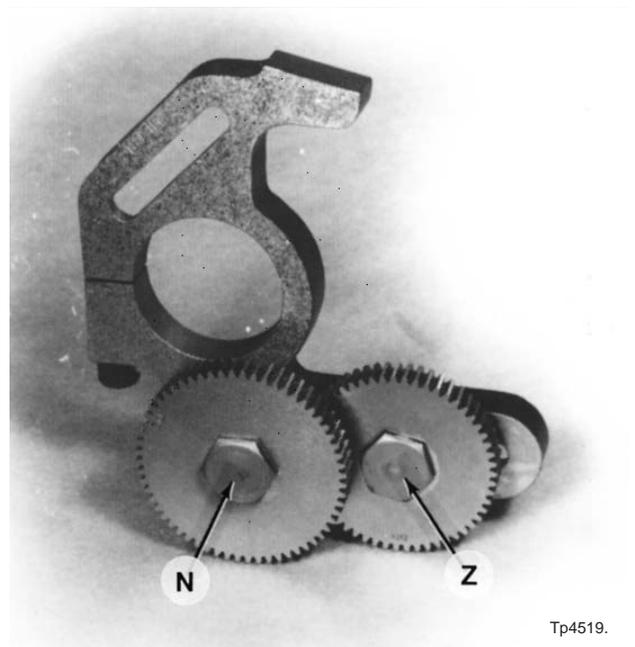
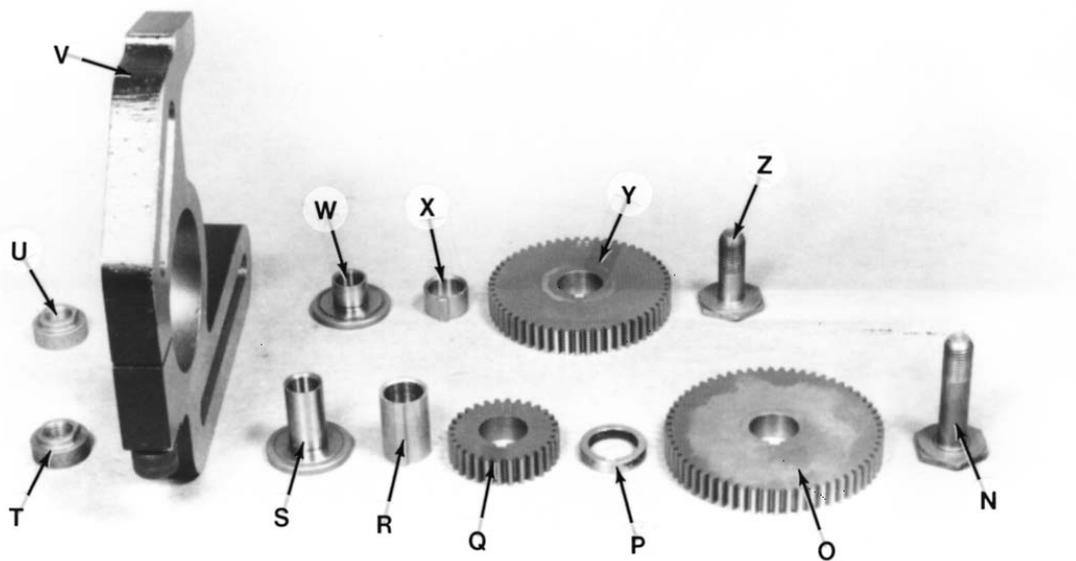


Figure 4.63 - Gear Change Bracket Assembly (English-Metric)

8. Slide bolt "N" through bushing "S" from the side opposite the large flat surface on bushing "S".
9. Hold nut "T" inside the relief slot on the back side of bracket "V",
10. Slide bolt "N" through bracket "V" from the front side and thread bolt "N" into nut "T".



Tp4520.

Figure 4.64 - Gear Change Bracket Components (English)

## GEAR CHANGE BRACKET LUBRICATION

### - NOTE -

This lubrication instruction applies to both the English and English-Metric gear change brackets.

Lubricate the bushings and shafts on the gear change bracket with Mobil® Velocite® oil No. 6, as needed.

If long run threading is involved, lubricate on a daily basis.

## HEADSTOCK

### REMOVAL

1. Remove the collet closer according to the procedure outlined on Page 4-1.
2. Remove three screws "A", Figure 4.65, and collet closer mounting bracket "B".
3. Remove snap ring "H" and remove handwheel "I", Figure 4.5 .
4. Remove key "J", washer "K" and washer "L", Figure 4.6 .
5. On HLV<sup>®</sup>-H machines, remove the gearbox according to the appropriate procedure outlined in this chapter.

On TFB<sup>®</sup>-H machines, remove four screws "C", Figure 4.66, and cover "D".

6. On HLV-H machines, place lever "G", Figure 4.67, in the "Stop" position and lever "H" in the center position.

On TFB-H machines, place lever "M", Figure 4.68, in the "Brake" position and lever "N" in the "Stop" position.

7. Pull "Start/Stop" pushbutton "L", Figure 4.67, OUT to turn the machine ON.

8. On HLV-H machines, place lever "G" in "Low" range.

On TFB-H machines, place lever "M", Figure 4.68, in "Forward" or "Reverse" and lever "N" in "Low" range.

9. Turn speed adjustment knob "K", Figure 4.67, to "Slower" and hold in that position until spindle speed stabilizes at 125 rpm.

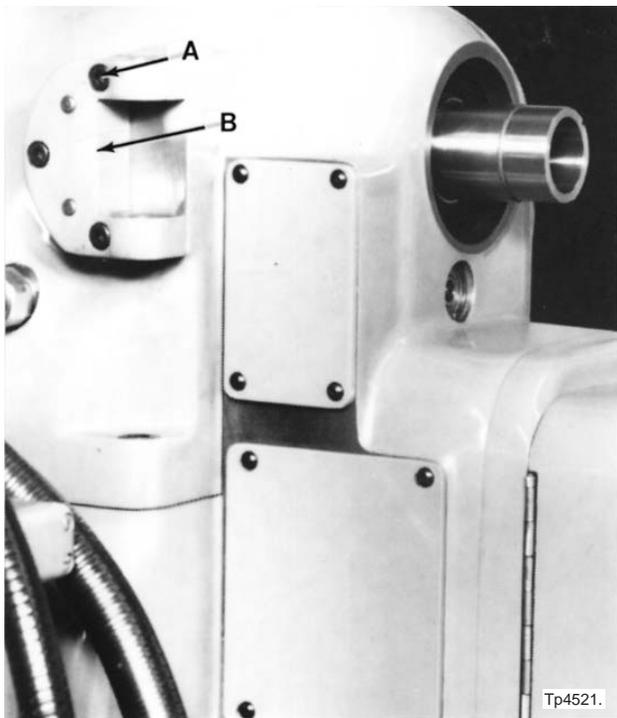


Figure 4.65 - Collet Closer Mounting Bracket Removal

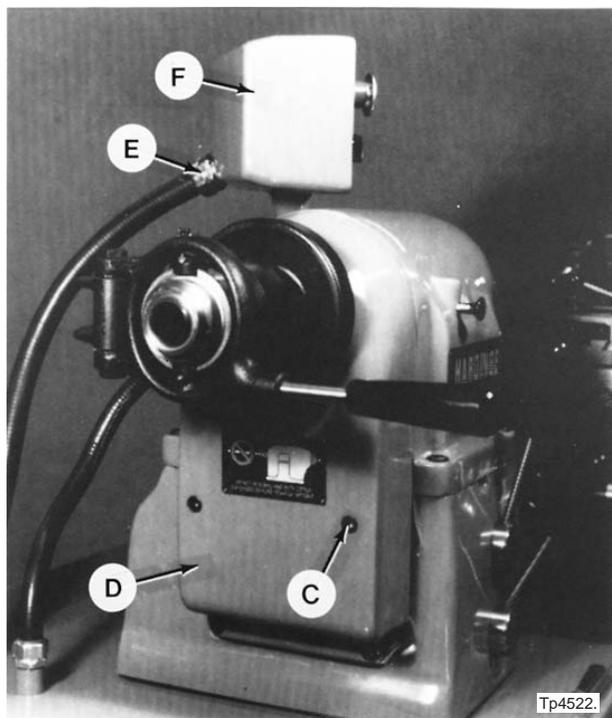


Figure 4.66 - Headstock Cover for TFB<sup>®</sup>-H Machine

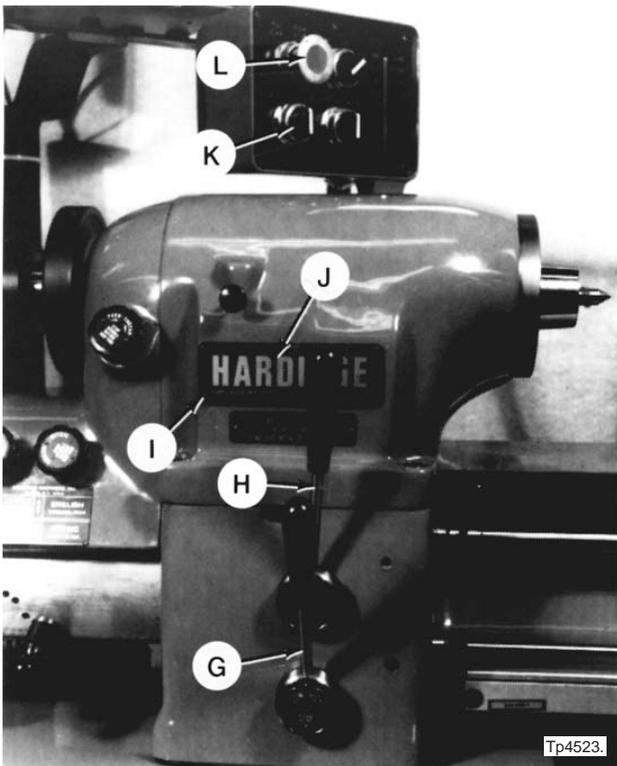


Figure 4.67 - HLV-H Headstock Assembly



Figure 4.68 - TFB-H Headstock Assembly

10. On HLV<sup>®</sup>-H machines, place lever "G" in the "Stop" position to stop the spindle  
     On TFB<sup>®</sup>-H machines, place lever "M", Figure 4.68, in the "Brake" position and lever "N" in the "Stop" position.
11. Press "Start/Stop" pushbutton "L", Figure 4.67, IN to turn the machine OFF.
12. Open door "O", Figure 4.69 .
13. Remove lock nut "P", Figure 4.70 .
14. Raise the front of the motor mounting plate approximately two inches and block it in this position, as shown in Figure 4.71 .
15. Roll motor belt "Q", Figure 4.72, to the right off the pulley and let it rest on the pulley hub, as shown.
16. Pull "Start/Stop" pushbutton "L", Figure 4.67, OUT to turn the machine ON.



Figure 4.69 - Pedestal Door



Figure 4.70 - Drive Belt Adjustment Screw

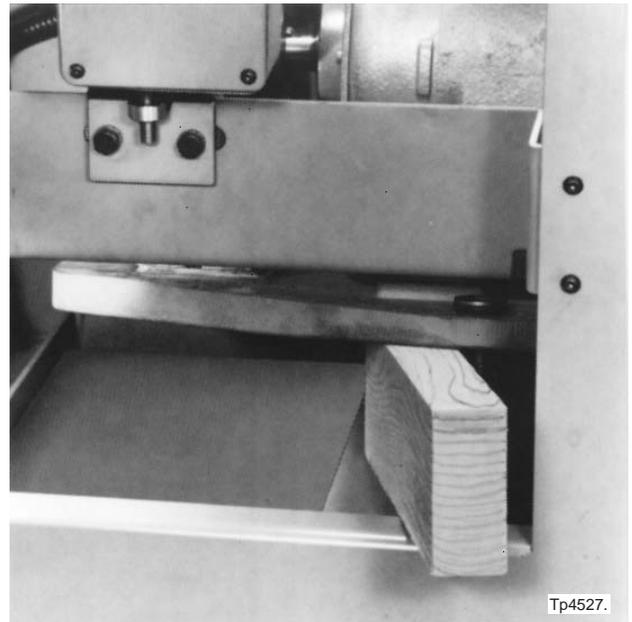


Figure 4.71 - Motor Mounting Plate Blocked in Position

**- WARNING -**

**Stay clear of the spindle drive motor compartment while the spindle motor is running.**

17. On HLV<sup>®</sup>-H machines, place lever "G" in "High" range.  
On TFB<sup>®</sup>-H machines, place lever "M", Figure 4.68, in "Forward" or "Reverse" and lever "N" in "High" range.
18. Turn speed adjustment knob "L", Figure 4.67, to "Faster" and hold in that position until pulley hanger assembly "R", Figure 4.72, reaches maximum upward travel.
19. On HLV-H machines, place lever "G", Figure 4.67, in the "Stop" position and allow the spindle motor to coast to a stop.  
On TFB-H machines, place lever "N", Figure 4.68, in the "Stop" position and allow the spindle motor to coast to a stop.
20. Press "Start/Stop" pushbutton "L", Figure 4.67, IN to turn the machine OFF.
21. Turn main disconnect switch "S", Figure 4.73, to the OFF position.

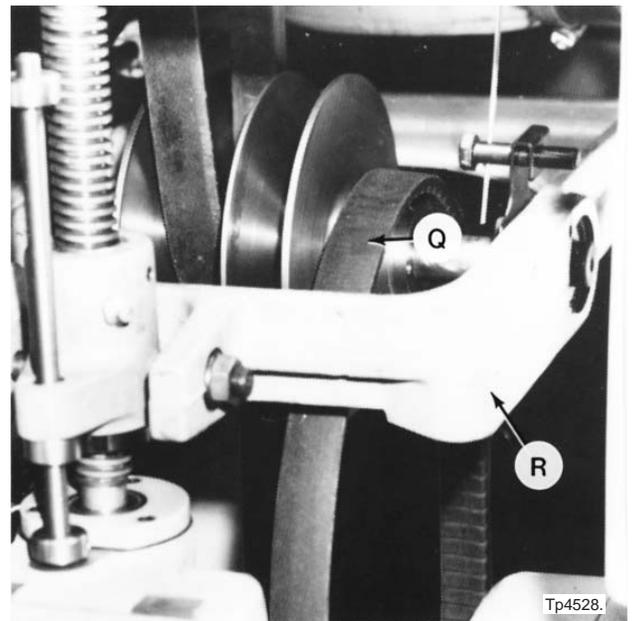


Figure 4.72 - Motor Belt on Pulley Hub

22. Slide countershaft assembly "T", Figure 4.74, to the extreme right and remove the spindle belt over the left end of the countershaft.
23. Remove the cotter pin from the end of speed change pull rod "U", Figure 4.75, which passes through the headstock belt in the motor compartment.
24. Move the spindle belt around the end of the pullrod.
25. Use a piece of wire as a hook to lift the spindle belt out of the pulley and out of the opening in the headstock.
26. Remove lock screw "Y", Figure 4.76, and loosen the set screw under lock screw "Y".
27. Loosen screw "Z", Figure 4.77, in the motor compartment to release the speed indicator rod.



Figure 4.73 - Main Disconnect Switch

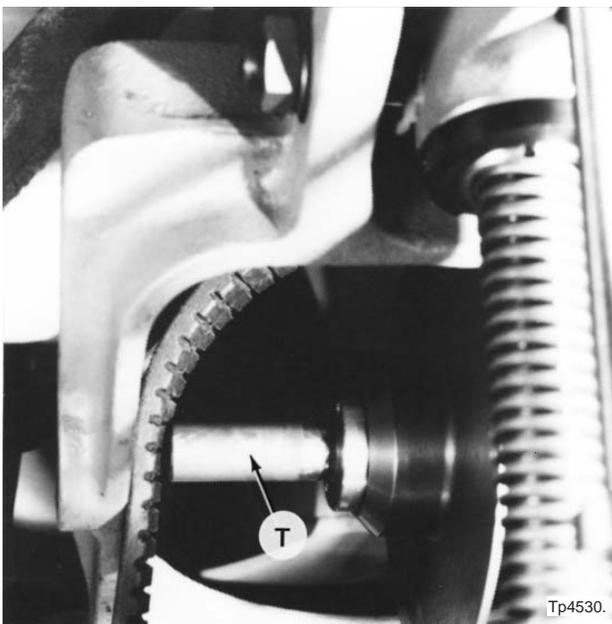


Figure 4.74 - Belt Removal Over Countershaft

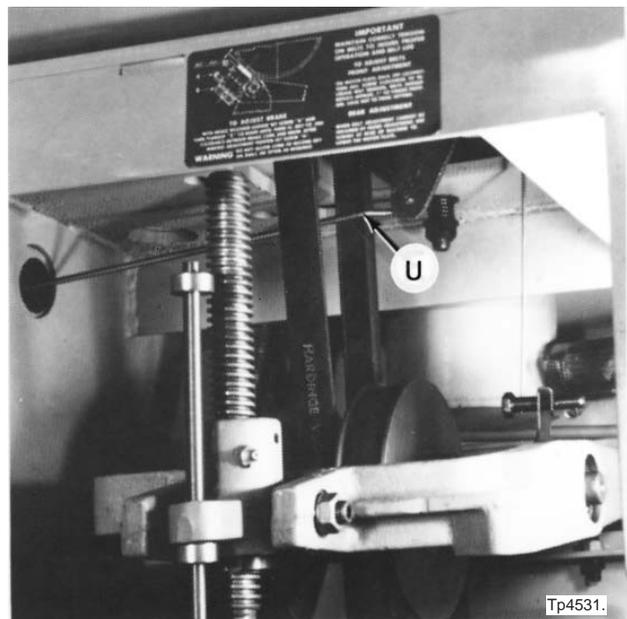


Figure 4.75 - Speed Change Pullrod

**- NOTE -**

It may be necessary to remove cable nut "E", Figure 4.66, to remove variable speed control head "F".

28. Lift variable speed control head "F", Figure 4.66, straight off.
29. Remove the speed indicator rod up through the headstock.
30. Remove six screws "I", Figure 4.67, and name plate "J".
31. Remove two screws "B", Figure 4.78, and pull limit switch "C" out of the headstock to gain access to the wire terminals on the limit switch.
32. Tag the three wires connected to limit switch "C" for reconnection; then disconnect the wires.
33. Remove cable nut "W", Figure 4.76, and pull the limit switch wires out of the headstock.
34. Remove four bolts "X".
35. Remove lock screw "V".
36. Remove the set screw located under lock screw "V".
37. Remove locking plug "E", Figure 4.79 .

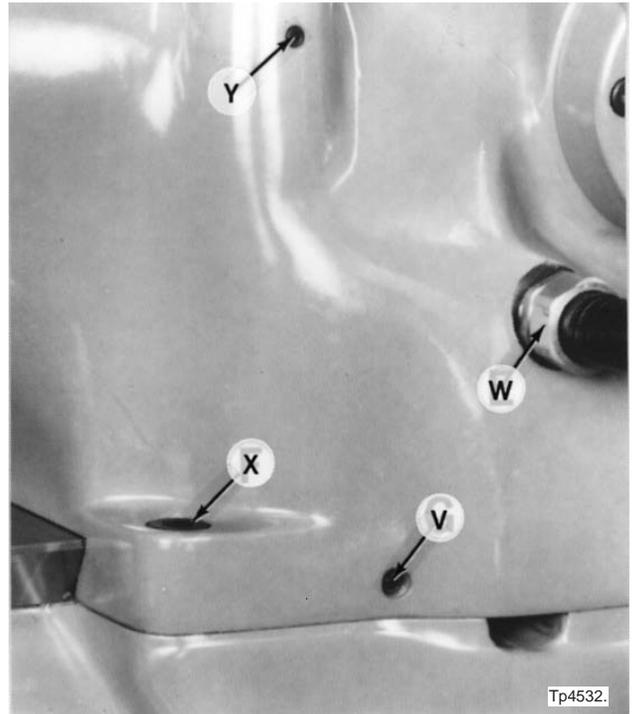


Figure 4.76 - Back of Headstock

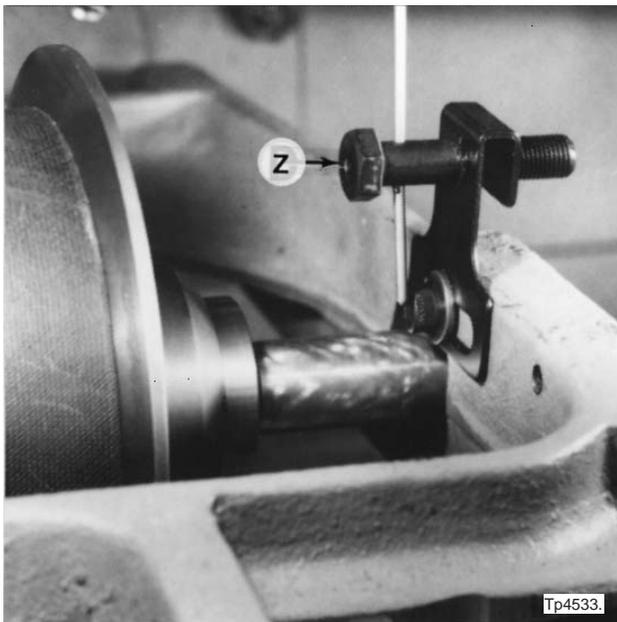


Figure 4.77 - Indicator Rod Bracket

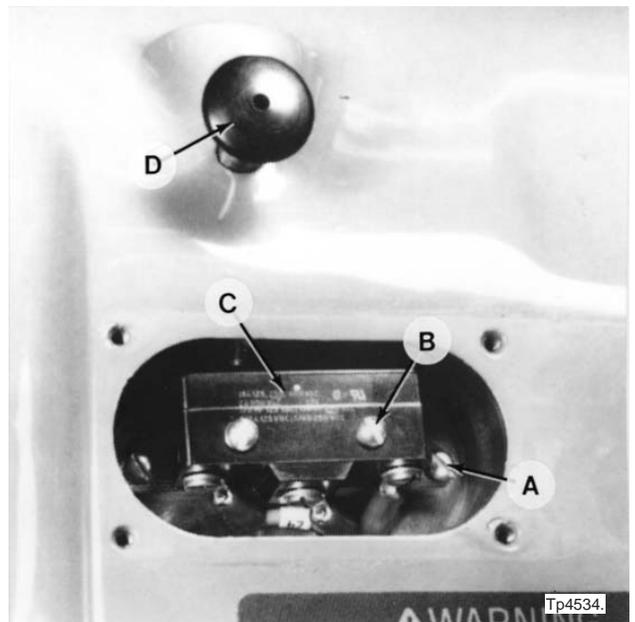


Figure 4.78 - Spindle Lock Pin Limit Switch

**- CAUTION -**

**DO NOT position the straps around each end of the headstock spindle; damage to the spindle bearings may result.**

38. Route lifting straps completely through the headstock spindle.
39. Attach the lifting straps to a hoist.

**- NOTE -**

Do not misplace the seal located under the headstock.

40. Using a hoist and lifting straps carefully slide the headstock OFF and UP with a smooth motion.

**REPLACEMENT**

**- CAUTION -**

**DO NOT position the sling around the machine spindle; damage to the spindle bearings may result.**

1. Route lifting straps completely through the headstock spindle.
2. Attach the lifting straps to a hoist and lift the headstock.
3. Locate and remove any burrs on the machine bed plate and dovetail areas where the headstock is to be mounted; then, thoroughly clean these areas.
4. Locate and remove any burrs on the bottom surface and dovetail areas of the headstock; then, thoroughly clean these areas.

**- NOTE -**

Applying the grease to the headstock seal will cause the seal to stay in place while the headstock is being mounted and also eliminates any shearing effect on the seal while the headstock is being mounted.

5. Apply grease to the headstock seal; then, replace the seal in the bottom of the headstock.

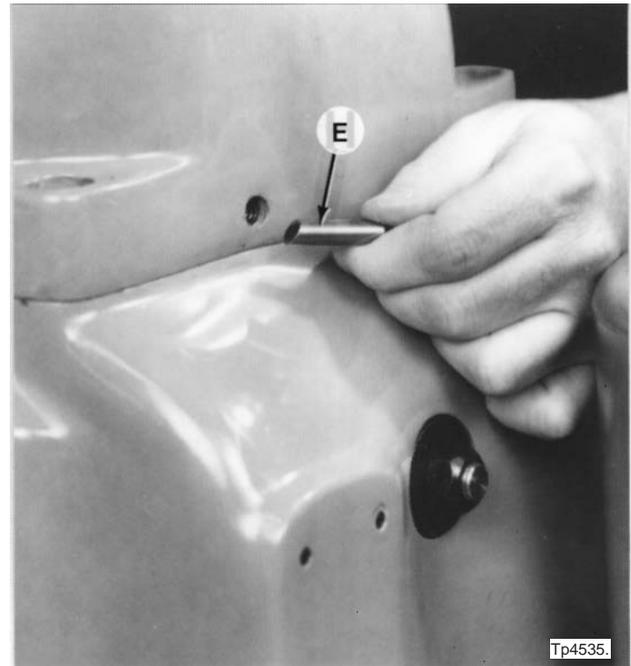


Figure 4.79 - Headstock Locking Plug

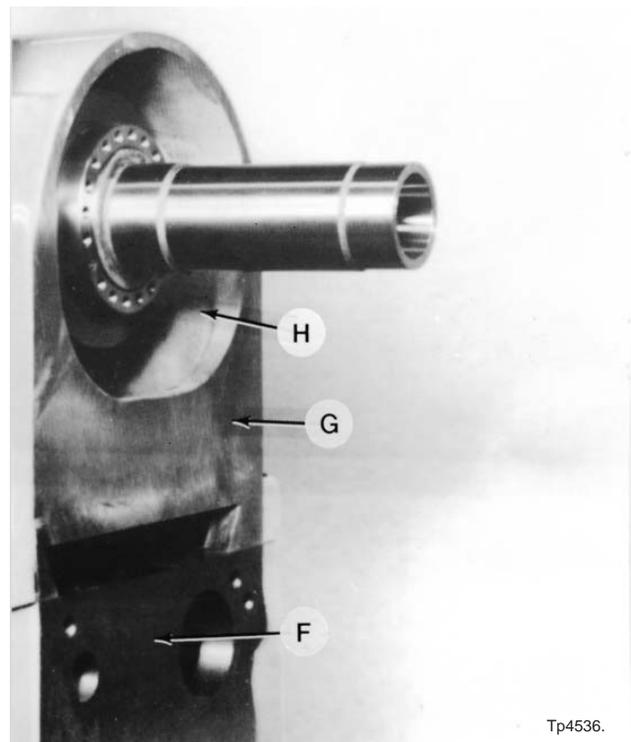


Figure 4.80 - Headstock Locating Surfaces

6. Carefully slide the headstock onto the bed plate with a smooth motion.
7. Position the headstock to locate machined surface “G”, Figure 4.80, of the headstock .008" [0.2 mm] forward (toward the tailstock end of the machine) of machined surface “F” on the bed casting.

**- NOTE -**

Be sure the angle on locking plug “E”, Figure 4.79, matches the angle on the bed plate dovetail.

8. Replace locking plug “E”, Figure 4.79 .
9. Replace the set screw located under lock screw “V”, Figure 4.76 .
10. Replace and tighten lock screw “V”.
11. Replace and torque four bolts “X” to 65 lb-ft [88 Nm].
12. Reroute the spindle lock pin wires through the headstock and tighten cable nut “W”.
13. Connect the three limit switch wires to limit switch “C”, Figure 4.78 .
14. Mount limit switch “C” to the limit switch mounting plate using two screws “B”.

**- NOTE -**

Clearance in the holes for screws “A” will allow the position of the limit switch to be adjusted to ensure that the limit switch works properly.

15. Move spindle lock pin “D” IN and OUT to be sure limit switch “C” is tripped when the spindle lock pin is pushed IN. Loosen screws “A” to reposition limit switch “C” as needed.
16. Mount name plate “J”, Figure 4.67, using six screws “I”.
17. Replace the indicator rod with the flat side facing toward the front of the machine.
18. Replace variable speed control head “F”, Figure 4.66 .
19. Replace the set screw located under lock screw “Y”, Figure 4.76 .
20. Replace lock screw “Y”.
21. Reposition the tip of the indicator rod at 3000 rpm on the variable speed control head and tighten screw “Z”, Figure 4.77, in the motor compartment.

**- NOTE -**

When replacing the spindle belt, the gearbox shown in Figure 4.81, will not be mounted. This allows for easier spindle belt replacement.

22. Cross the spindle belt, as shown in Figure 4.81, feed it through opening “H”, Figure 4.80, and down into the pedestal.

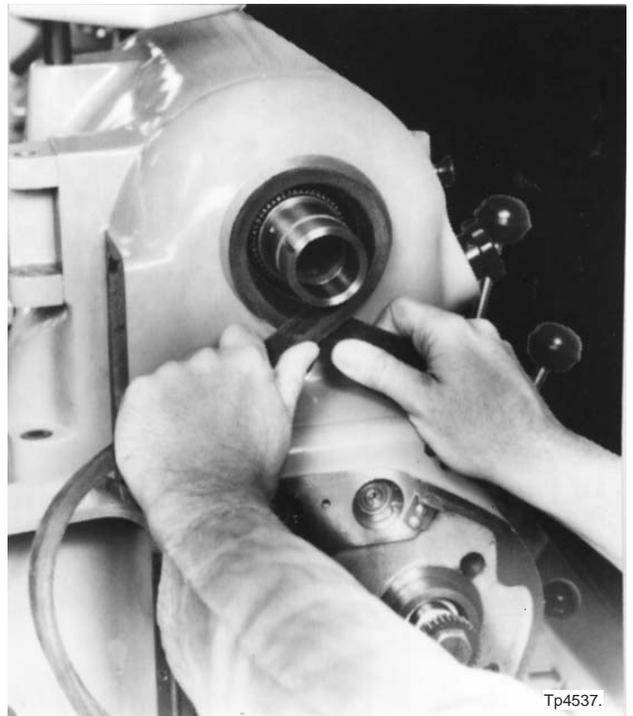


Figure 4.81 - Spindle Belt Replacement

Tr4537.

23. Use a piece of wire as a hook to lift the spindle belt into the spindle pulley.
24. Slide the spindle belt over the left end of countershaft assembly "T", Figure 4.74, and onto the left pulley of the countershaft assembly.
25. Remount the countershaft assembly by sliding the left end of the countershaft assembly back into countershaft support bracket "R", Figure 4.72 .
26. Reconnect pull rod "U", Figure 4.75, and insert the cotter pin.
27. Remount the motor belt on the right side pulley.
28. Remove the block and carefully lower the front of the motor mounting plate.
29. Install lock nut "P", Figure 4.70, but do not tighten.
30. Adjust belt tension according to the procedure outlined in "Adjusting Drive Belt Tension", Page 3-2.
31. On HLV<sup>®</sup>-H machines, remount the gearbox according to the appropriate procedure outlined in this chapter.  
On TFB<sup>®</sup>-H machines, replace cover "D", Figure 4.66, and four screws "C".
32. Replace washers "L" and "K", Figure 4.6, and key "J".
33. Replace handwheel "I", Figure 4.5, and snap ring "H".
34. Remount the collet closer according to the procedure starting on Page 4-2.
35. Run the drive to both extremes of the speed range to be sure the speed indicator is adjusted properly.
36. Check the headstock alignment as outlined in the next section, "Headstock Alignment".

## HEADSTOCK ALIGNMENT

### - NOTE -

To properly check the headstock alignment, it will be necessary to contact the Hardinge Service Department to obtain the use of a test arbor. When calling to obtain a test arbor, a Hardinge Telephone Service Technician will request specific information, including the following:

Machine Model  
Machine Serial Number

1. Thoroughly clean the spindle collet seat angle and check for burrs.
2. Install the test arbor in the headstock spindle.
3. Mount a .0001" [.002mm] indicator to a stable magnetic base holder on top of the tool holder slide.

### Vertical Alignment

4. Locate the vertical centerline of the test arbor:
  - a) Position the indicator to touch the diameter of the test arbor at the outer end. Refer to Figure 4.82 .
  - b) Move the machine cross slide (X axis) to obtain the highest reading on the indicator. This will be the centerline of the test arbor.
5. Determine the center of the runout at the outer end of the test arbor:
  - a) Rotate the headstock spindle by hand and observe the total runout shown on the indicator.
  - b) Note the value at the midpoint of the indicator sweep.
  - c) Rotate the headstock spindle by hand until the indicator shows the value noted in step 5b.
  - d) Without moving the indicator or rotating the headstock spindle, reset the indicator dial to zero (0).
6. Move the machine carriage (Z axis) toward the headstock six (6) inches [152.4 mm] to position the indicator as shown in Figure 4.83 .
7. Observe the value shown on the indicator.

For vertical headstock alignment to be within specification, this observed value must fall within the following range:

0.0 « +.0005" [.012mm] (Outer end LOW)

8. If the vertical alignment is within specification, proceed to Horizontal Alignment, page 4-48.  
If the vertical alignment is NOT within specification, proceed to step 9.
9. Move the machine carriage (Z axis) away from the headstock.
10. Remove the indicator and magnetic base from the top of the tool holder slide.

11. Remove the test arbor from the headstock spindle.
12. Remove the headstock according to the procedure beginning on page 4-39.
13. Locate and remove any burrs on the machine bed plate and dovetail areas where the headstock is to be mounted; then, thoroughly clean these areas.
14. Locate and remove any burrs on the bottom surface and dovetail areas of the headstock; then, thoroughly clean these areas.
15. Replace the headstock according to the procedure beginning on page 4-44.
16. Install the test arbor in the headstock spindle.
17. Replace the indicator and magnetic base on the top of the tool holder slide.
18. Proceed to step 19.

### Horizontal Alignment

19. Position the indicator to touch the diameter of the test arbor at the outer end. Refer to Figure 4.84 .
20. Determine the center of the runout at the outer end of the test arbor:
  - a) Rotate the headstock spindle by hand and observe the total runout shown on the indicator.
  - b) Note the value at the midpoint of the indicator sweep.
  - c) Rotate the headstock spindle by hand until the indicator shows the value noted in step 20b.
  - d) Without moving the indicator or rotating the headstock spindle, reset the indicator dial to zero (0).
21. Move the machine carriage (Z axis) toward the headstock six (6) inches [152.4 mm] to position the indicator as shown in Figure 4.85 .
22. Observe the value shown on the indicator.

For horizontal alignment to be within specification, this observed value must fall within the following range:

$$0.0 \llcorner -.0001" [.002\text{mm}] \text{ (Outer end FORWARD)}$$

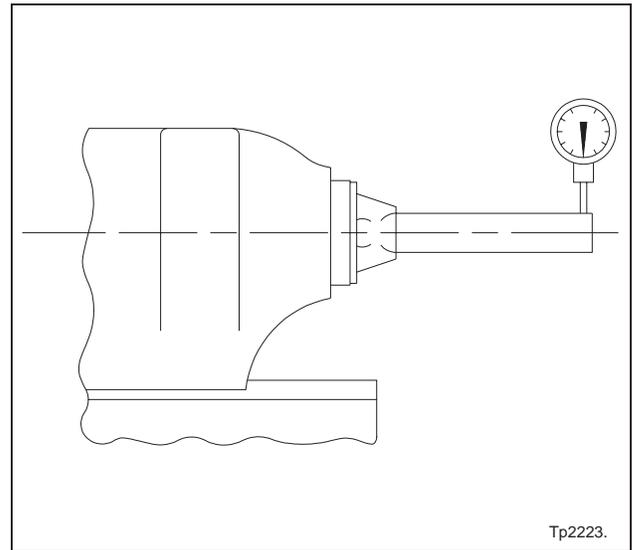


Figure 4.82 - Vertical Alignment  
(Obtaining Value "A")

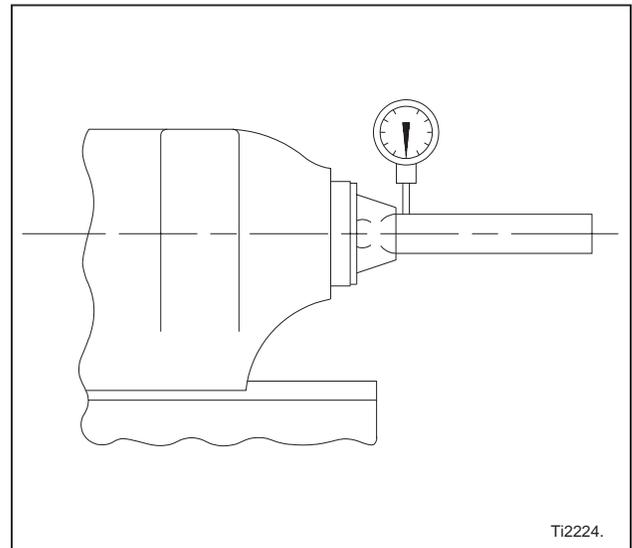


Figure 4.83 - Vertical Alignment  
(Obtaining Value "B")

23. If the horizontal alignment is within specification, the alignment procedure is complete.

If the vertical alignment is NOT within specification, proceed to step 24.

24. Move the machine carriage (Z axis) away from the headstock to move the indicator away from the test arbor.

**- NOTE -**

When loosened, four bolts "X", Figure 4.76, should still apply enough force on the headstock to prevent it from moving freely.

25. Slightly loosen four bolts "X", Figure 4.76 .

26. Remove lock screw "V".

27. Slightly loosen the set screw located under lock screw "V".

**- NOTE -**

It will be necessary to GENTLY tap on the headstock to adjust the horizontal alignment.

28. Place a cloth over the area of the headstock to be tapped.

**- CAUTION -**

**Use a RUBBER or NYLON hammer to tap on the headstock. Damage to the headstock surface may result if another type of hammer is used.**

29. GENTLY tap on the headstock with a RUBBER or NYLON hammer to adjust the horizontal alignment.

30. Tighten the set screw located under lock screw "V", Figure 4.76 .

31. Replace and tighten lock screw "V".

32. Torque four bolts "X" to 65 lb-ft [88 Nm].

33. Proceed to step 19.

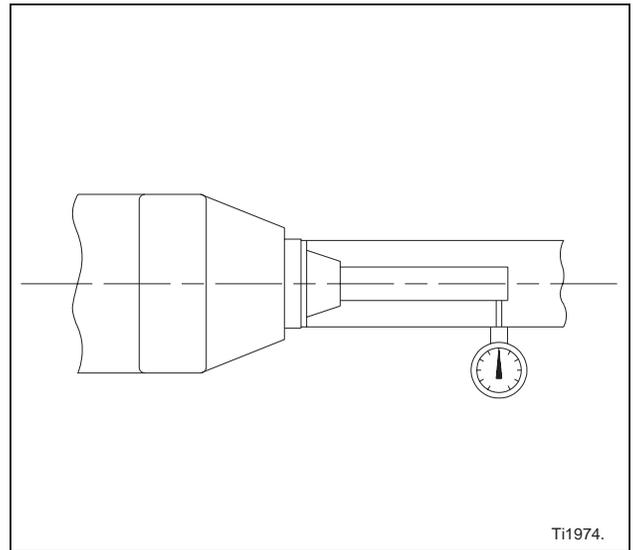


Figure 4.84 - Horizontal Alignment (Obtaining Value "C")

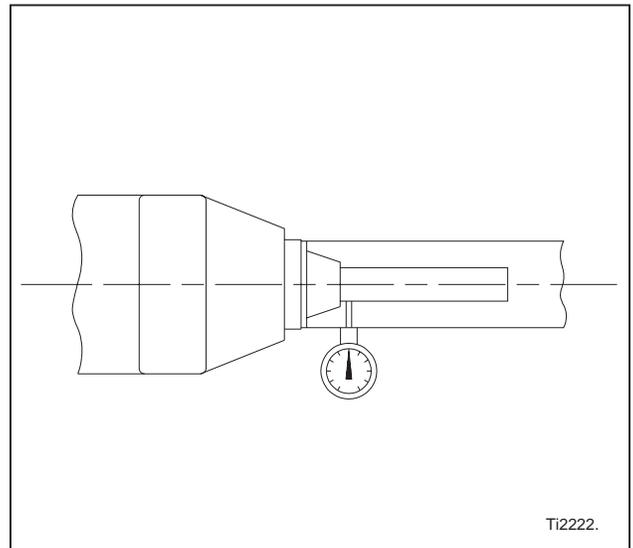


Figure 4.85 - Horizontal Alignment (Obtaining Value "D")

## HEADSTOCK SPINDLE

### Spindle Lock Pin

The electrical interlock between lock pin “D”, Figure 4.78, and the main drive motor is controlled by limit switch “C”. The limit switch is located under name plate “J”, Figure 4.67, and is actuated by a plunger moved by lock pin “B”, Figure 4.78.

### SPINDLE LOCK PIN LIMIT SWITCH REPLACEMENT

1. Turn main disconnect switch “S”, Figure 4.73, OFF.
2. Remove six screws “I”, Figure 4.67, and name plate “J”.
3. Remove two screws “B”, Figure 4.78, pull limit switch “C” out of the headstock to gain access to the wire terminals on the limit switch.
4. Tag the three wires connected to limit switch “C” for reconnection; then disconnect the wires.
5. Connect the three wires to the new limit switch.
6. Mount limit switch “C” to the limit switch mounting plate using two screws “B”.

#### - NOTE -

Clearance in the holes for screws “A” will allow the position of the limit switch to be adjusted to ensure that the limit switch works properly.

7. Move spindle lock pin “D” IN and OUT to be sure limit switch “C” is tripped when the spindle lock pin is pushed IN. Loosen screws “A” to reposition limit switch “C” as needed.
8. Mount name plate “J”, Figure 4.67, using six screws “I”.

### Lubrication

The headstock spindle is mounted on precision preloaded ball bearings. The preloading and resulting load-carrying capacity is engineered to take radial thrust, end thrust, or a combination of both.

The precision preloaded ball bearings are grease-packed for life and require no further lubrication. The entire bearing assembly is housed as a unit and is properly sealed to exclude dirt and foreign matter. The spindle bearings are designed to operate at high speed with minimal friction or wear.

- NOTES -

- NOTES -

# CHAPTER 5 - ELECTRICAL

## POWER CASE

### ACCESSING THE POWER CASE

#### - WARNING -

Be sure disconnect switch "H", Figure 5.2, is turned OFF before opening the power case door.

1. Press "Start/Stop" pushbutton "A", Figure 5.1, or "Start/Stop" pushbutton "G", Figure 5.8, IN to turn the machine OFF.
2. Turn main disconnect switch "H", Figure 5.2, to the OFF position.
3. Loosen two screws "I" and open the power case door.

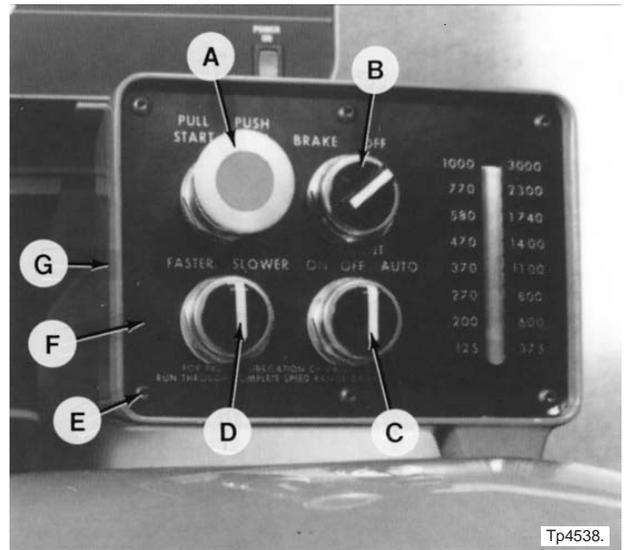


Figure 5.1 - Variable Speed Control Box (HLV®-H Machine)

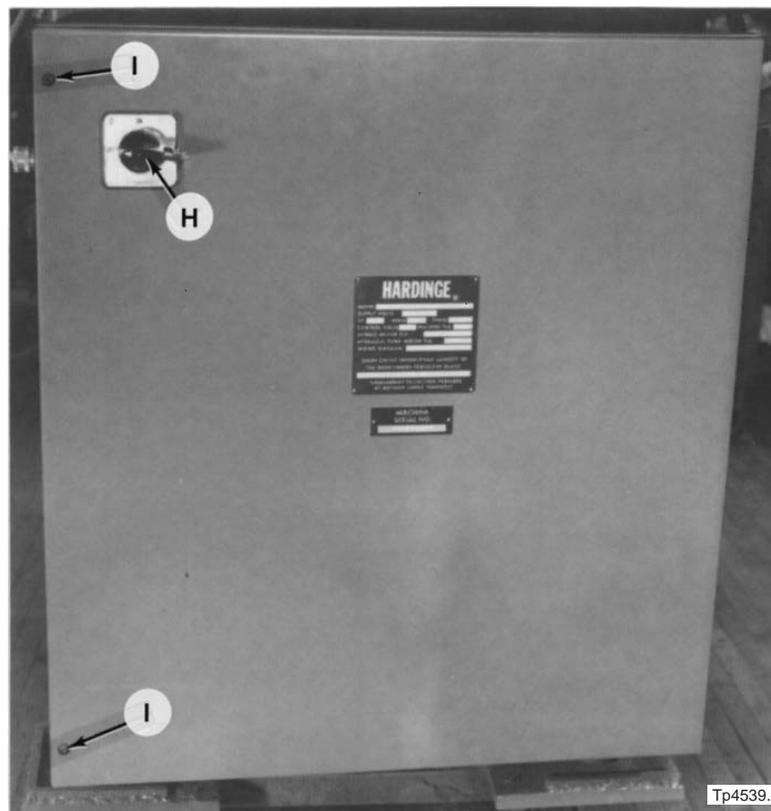


Figure 5.2 - Power Case (External View)

## COMPONENT DESCRIPTION (HLV<sup>®</sup>-H Machine Power Case)

Refer to Figure 5.3 .

A - Terminal block #1 (1TB)

B - Autotransformer (2T)

The autotransformer is used only on machines configured for the following voltages:

208V and 575V - 60Hz

200V, 380V, and 415V - 50Hz

C - Disconnect switch (DISC.)

D - Fuses, main line (1FU)

E - Drum switch, speed range select (1DS)

F - Fuses, control transformer primary (2FU)

G - Control transformer (1T)

H - Terminal block #3 (3TB)

I - Fuse, optional worklight (5FU)

J - Fuse, power feed module (4FU)

K - Fuse, Control transformer secondary (3FU)

L - Main Contactor (4M)

M - Overload relay for coolant pump motor (OL1)

N - Overload relay for spindle motor (OL2)

O - Overload relay for speed change motor (OL3)

P - Terminal block #2 (2TB)

Q - Coolant pump motor contactor (5M)

R - Forward/Reverse contactor for spindle motor (3MF-3MR)

S - Forward/Reverse contactor for speed change motor (2MR-2ML)

T - Rectifier for speed change motor brake (RECT A)

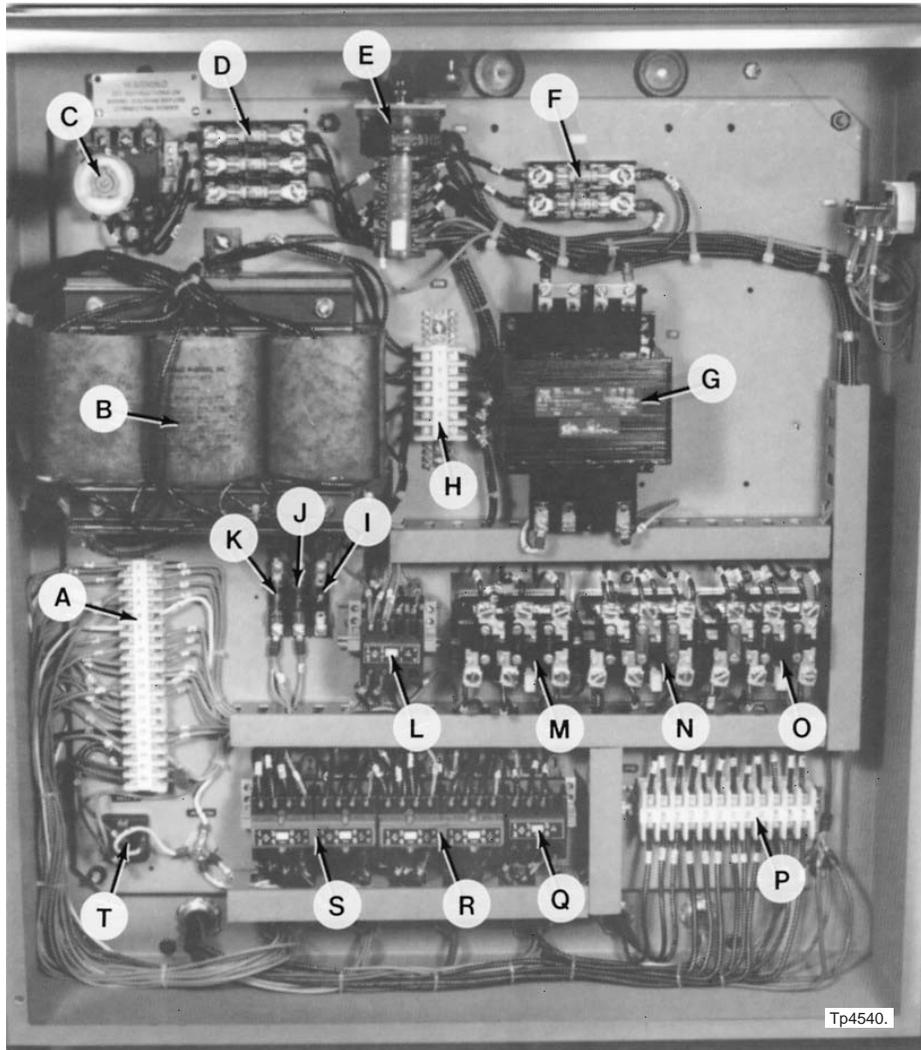


Figure 5.3 - Power Case (Internal View)  
(HLV<sup>®</sup>-H Machines)

## COMPONENT DESCRIPTION (TFB<sup>®</sup>-H Machine Power Case)

Refer to Figure 5.4 .

A - Terminal block #1 (1TB)

B - Autotransformer (2T)

The autotransformer is used only on machines configured for the following voltages:

208V and 575V - 60Hz

200V, 380V, and 415V - 50Hz

C - Disconnect switch (DISC.)

D - Fuses, main line (1FU)

E - Drum switch, speed range select (1DS)

F - Fuses, control transformer primary (2FU)

G - Drum switch, forward/reverse/brake (2DS)

H - Control transformer (1T)

I - Fuse, optional worklight (5FU)

J - Fuse, power feed module (4FU)

K - Fuse, Control transformer secondary (3FU)

L - Main Contactor (4M)

M - Overload relay for coolant pump motor (OL1)

N - Overload relay for spindle motor (OL2)

O - Overload relay for speed change motor (OL3)

P - Terminal Block #2 (2TB)

Q - Coolant pump motor contactor (5M)

R - Forward/Reverse contactor for speed change motor (2MR-2ML)

S - Rectifier for speed change motor brake (RECT A)

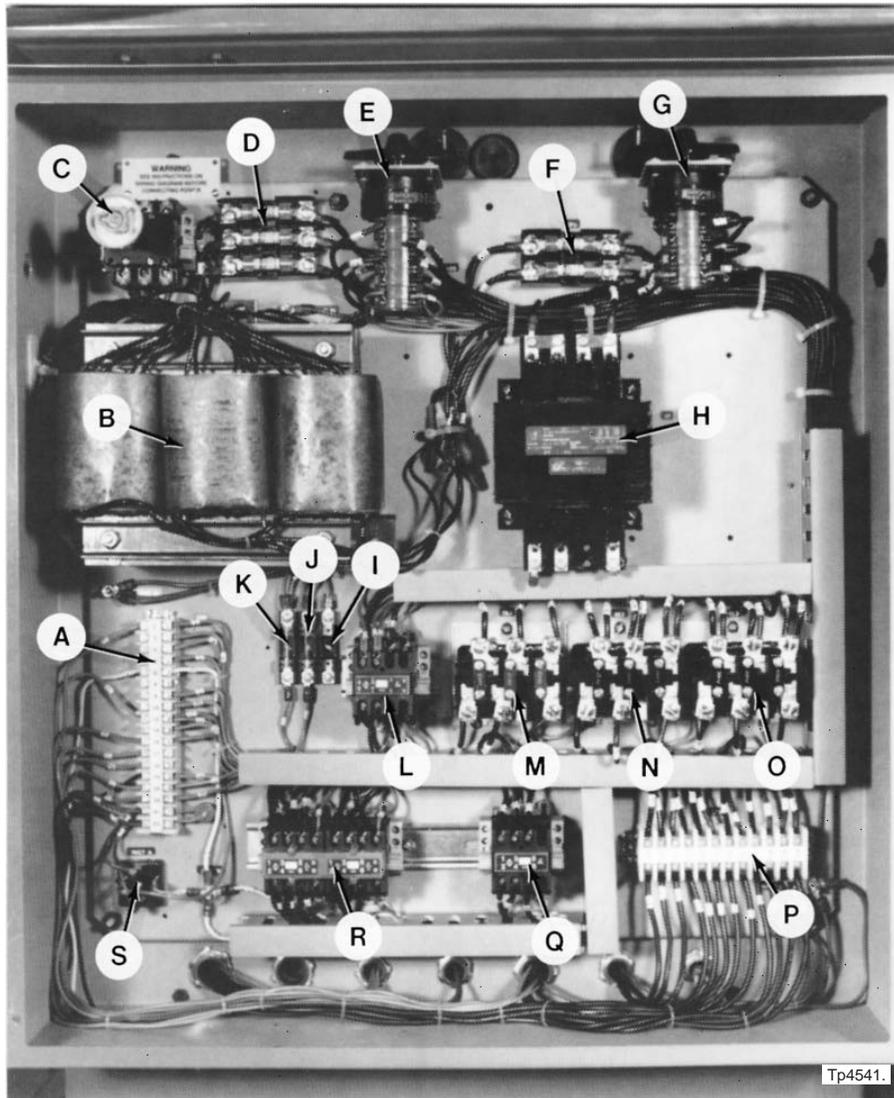


Figure 5.4 - Power Case (Internal View)  
(TFB<sup>®</sup>-H Machines)

## POWER FEED CONTROL PANEL

### - WARNING -

**Be sure disconnect switch "H", Figure 5.2, is turned OFF before attempting to service the power feed control panel.**

1. Press "Start/Stop" pushbutton "A", Figure 5.1, or "Start/Stop" pushbutton "G", Figure 5.8, IN to turn the machine OFF.
2. Turn main disconnect switch "H", Figure 5.2, to the OFF position.
3. Remove six screws "T", Figure 5.5.
4. Remove power feed control panel "U" from housing "V".

## POWER FEED MODULE

Power feed module "W", Figure 5.6, serves two purposes:

The power feed module converts 110 volts A.C. to 90 volts pulsating D.C. for the power feed drive motor.

Through the use of potentiometer "A", Figure 5.7, the power feed module controls SCR "X", Figure 5.6, to vary the effective D.C. voltage level to the power feed drive motor, controlling the motor speed.

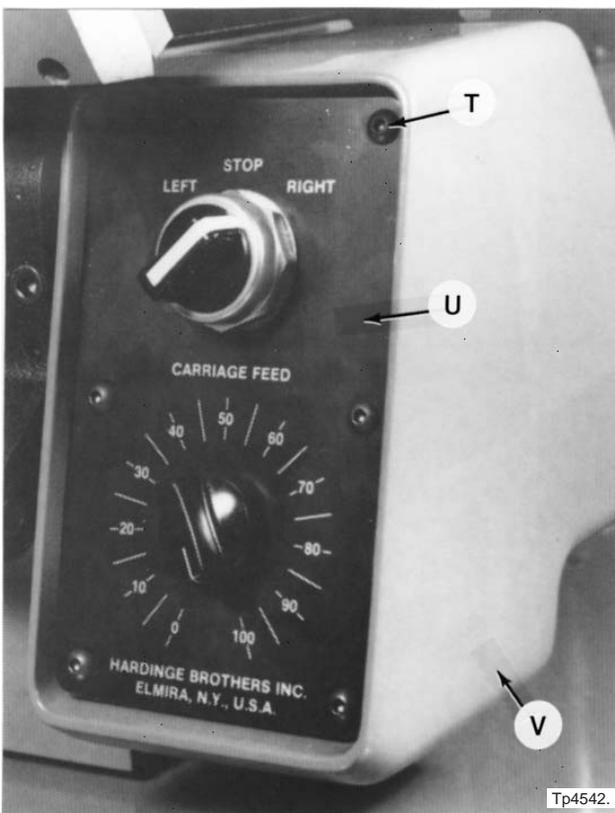


Figure 5.5 - Power Feed Control Panel  
(Front View)

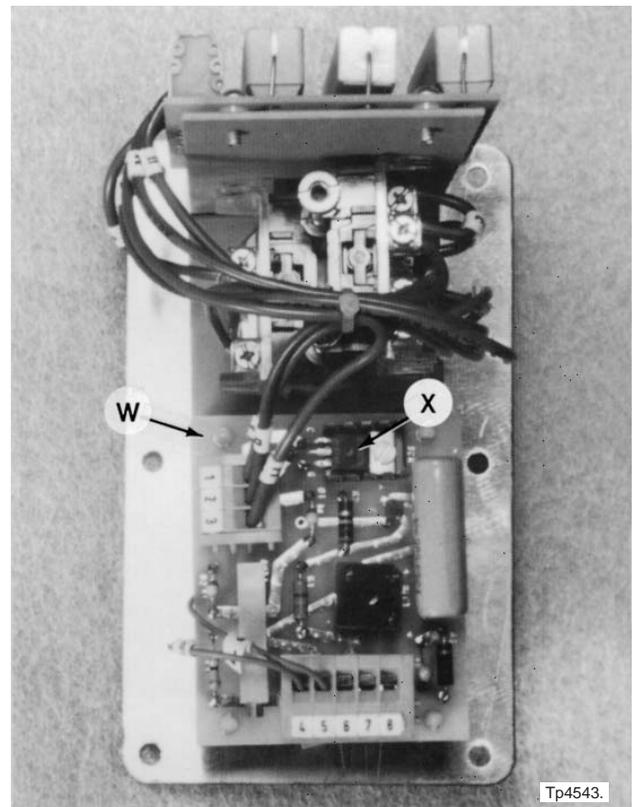


Figure 5.6 - Power Feed Module

## RESISTOR MODULE

Resistor module "C", Figure 5.7, contains three 25 watt resistors and a 6 position terminal block.

Resistor "D" is a 47 $\Omega$  25 watt resistor used for dynamic braking of the power feed drive motor.

Resistor "E", Figure 5.7, is a 1500 $\Omega$  25 watt resistor used as a load resistor for SCR "X", Figure 5.6, on power feed module "W".

Resistor "F", Figure 5.7, is a 470 $\Omega$  25 watt resistor in series with the field windings in the power feed drive motor. This resistor reduces the voltage to the field windings, allowing higher motor speeds.

## SWITCHES

Potentiometer "A", Figure 5.7, varies the effective D.C. voltage level to the power feed drive motor to control the motor speed.

Three position switch "B" controls the direction of travel for the power feed - left, right, or stop.

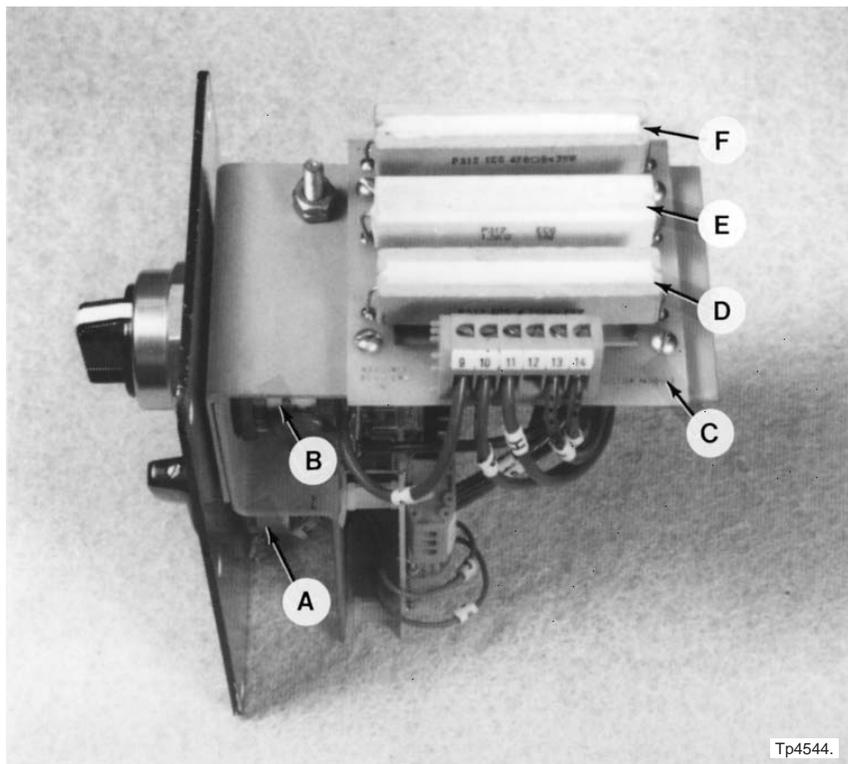


Figure 5.7 - Resistor Module

# VARIABLE SPEED CONTROL PANEL

## OPERATOR CONTROLS

### Spindle Speed Adjustment

Switches “D”, Figure 5.1, and “H”, Figure 5.8, control spindle speed. These three-position switches are spring loaded and will return to the center position when released.

Turn the speed control switch to the desired position (“Faster” or “Slower”) and hold in this position until the spindle reaches the desired speed.

### Coolant

Switches “C”, Figure 5.1, and “I”, Figure 5.8, control the coolant.

In the ON position, coolant will flow whenever the machine is turned ON.

In the OFF position, coolant flow is disabled.

In the AUTO position, coolant will flow whenever the spindle is active.

### - NOTES -

On HLV®-H machines, lever “J”, Figure 5.9, must be in the “Stop” position before the machine can be turned ON with switch “A”, Figure 5.1 .

On TFB®-H machines, lever “K”, Figure 5.10, must be in the “Stop” position before the machine can be turned ON with switch “G”, Figure 5.8 .

### Start/Stop Switch

When main disconnect switch “H”, Figure 5.2, is turned ON, pushbutton “A”, Figure 5.1, or pushbutton “G”, Figure 5.8, turns the machine ON when pulled OUT and turns the machine OFF when pushed IN.

### Spindle Brake (HLV-H Machines only)

Selector switch “B”, Figure 5.1, is a two-position switch that enables the spindle brake when set to the “BRAKE” position and disables the spindle brake when set to the “OFF” position.

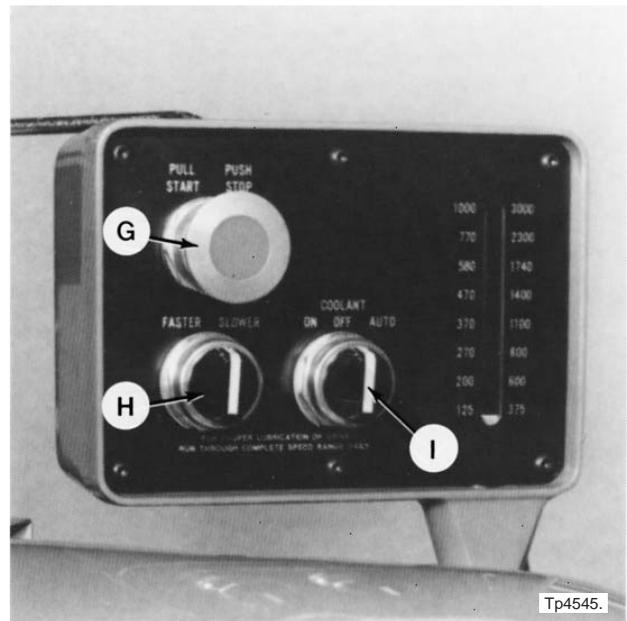


Figure 5.8 - Variable Speed Control Panel (TFB-H Machine)



Figure 5.9 - Headstock Levers  
(HLV®-H Machines)



Figure 5.10 - Headstock Levers  
(TFB®-H Machines)

## SWITCH REPLACEMENT

### - WARNING -

**Be sure disconnect switch “H”, Figure 5.2, is turned OFF before attempting to service the variable speed control panel.**

1. Press “Start/Stop” pushbutton “A”, Figure 5.1, or “Start/Stop” pushbutton “G”, Figure 5.8, IN to turn the machine OFF.
2. Turn main disconnect switch “H”, Figure 5.2, to the OFF position.
3. Remove eight screws “E”, Figure 5.1 .
4. Remove variable speed control panel “F” from control housing “G”.
5. Record the wiring connections on the faulty switch.
6. Disconnect the wiring connections on the faulty switch.
7. Remove the faulty switch.

### - NOTE -

The wiring diagram included in the machine documentation package contains complete machine wiring information.

8. Mount the replacement switch and reconnect the wiring as recorded in step 5.
9. Install variable speed control panel “F”, in control housing “G”, using eight screws “E”.

- NOTES -

# CHAPTER 6 - MISCELLANEOUS

## BED LEVERS (HLV<sup>®</sup>-H Machines)

### REMOVAL

1. Remove the gear box according to the appropriate procedure:  
The procedure for removing the English gearbox begins on page 4-3.  
The procedure for removing the English-Metric gearbox begins on page 4-19.
2. Place lever "A", Figure 6.1, in the "Stop" position and lever "B" in the center position.
3. Turn coolant switch "G", Figure 6.2, to the OFF position.
4. Pull "Start/Stop" pushbutton "E" OUT to turn the machine ON.
5. Place lever "A", Figure 6.1, in "Low" range.
6. Turn speed adjustment knob "F", Figure 6.2, to "Slower" and hold in that position until spindle speed stabilizes at 125 rpm.
7. Place lever "A", Figure 6.1, in the "Stop" position to stop the spindle
8. Press "Start/Stop" pushbutton "E", Figure 6.2, IN to turn the machine OFF.
9. Open door "H", Figure 6.3 .
10. Remove lock nut "I", Figure 6.4 .
11. Raise the front of the motor mounting plate approximately two inches and block it in this position, as shown in Figure 6.5 .
12. Roll motor belt "J", Figure 6.6, to the right off the pulley and let it rest on the pulley hub, as shown.
13. Pull "Start/Stop" pushbutton "E", Figure 6.2, OUT to turn the machine ON.

### - WARNING -

**Stay clear of the spindle drive motor compartment while the spindle motor is running.**

14. Place lever "A", Figure 6.1, in "High" range.

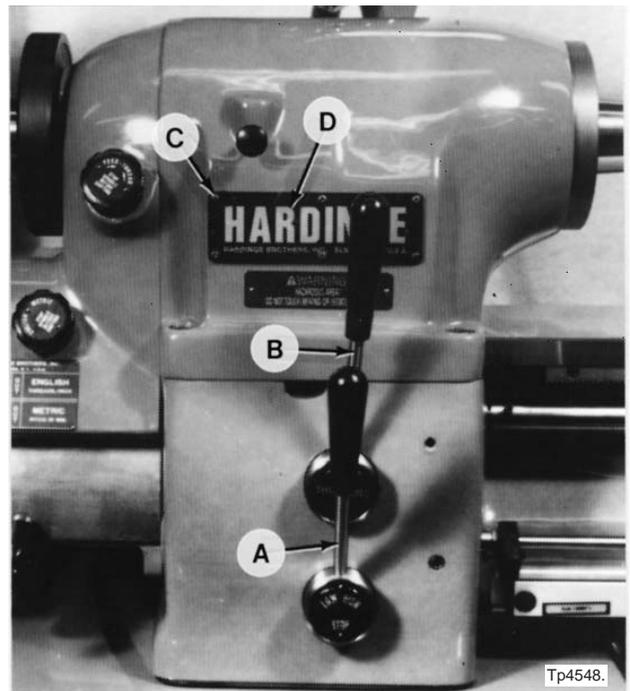


Figure 6.1 - Headstock Assembly (HLV-H Machines)



Figure 6.2 - Variable Speed Control Box



Figure 6.3 - Pedestal Door



Figure 6.4 - Drive Belt Adjusting Screw

15. Turn speed adjustment knob "F", Figure 6.2, to "Faster" and hold in that position until spindle speed stabilizes at 3000 rpm.
16. Place lever "A", Figure 6.1, in the "Stop" position and allow the spindle motor to coast to a stop.
17. Press "Start/Stop" pushbutton "E", Figure 6.2, IN to turn the machine OFF.
18. Slide countershaft assembly "K", Figure 6.7, to the extreme right and remove the spindle belt over the left end of the countershaft.

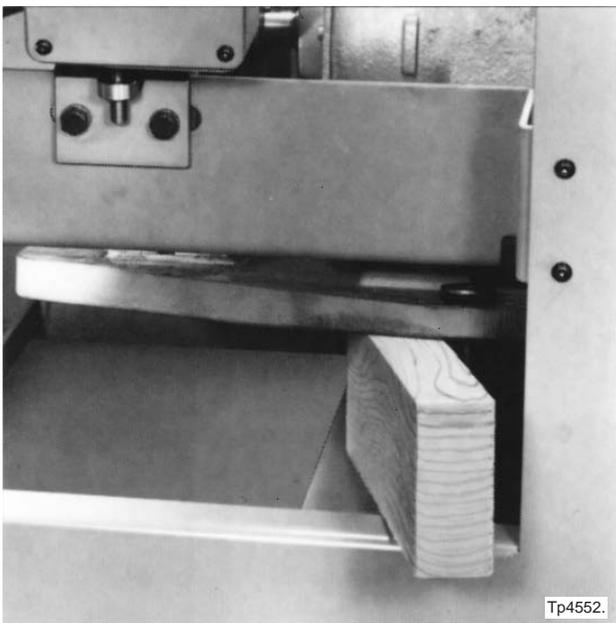


Figure 6.5 - Motor Mounting Plate Blocked in Position

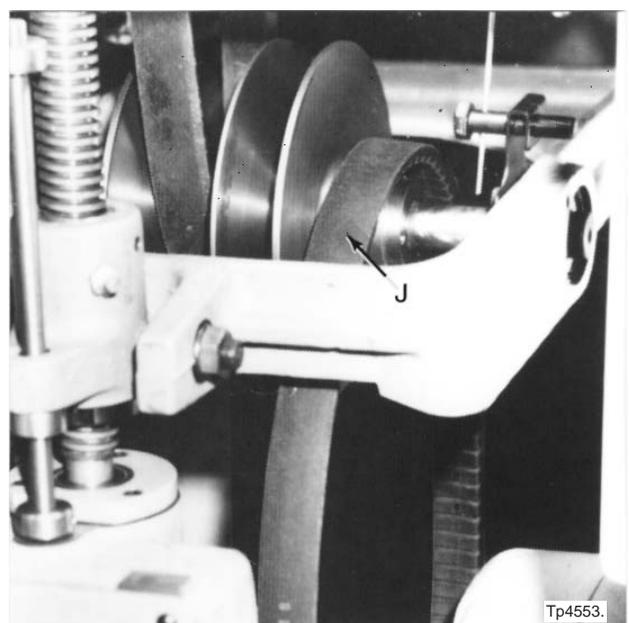


Figure 6.6 - Motor Belt on Pulley Hub

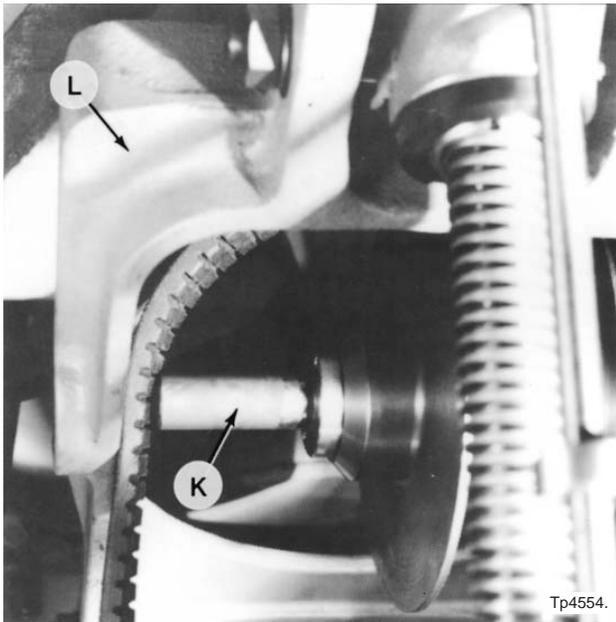


Figure 6.7 - Belt Removal Over Countershaft

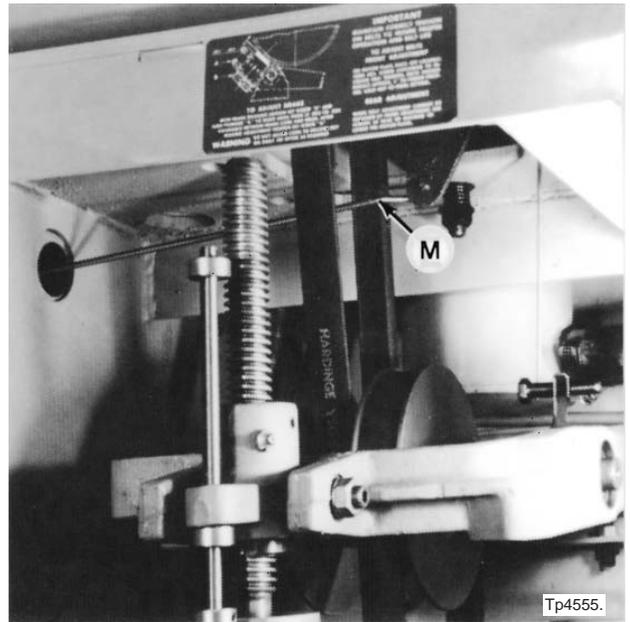


Figure 6.8 - Speed Change Pullrod

19. Remove the cotter pin from the end of speed change pull rod "M", Figure 6.8, which passes through the headstock belt in the motor compartment.
20. Use a piece of wire as a hook to lift the spindle belt out of the pulley and out of the opening in the headstock.
21. Remove lock screw "N", Figure 6.9, and loosen the set screw under lock screw "N".
22. Loosen screw "R", Figure 6.10, located in the motor compartment, to release the speed indicator rod.

**- NOTE -**

It may be necessary to remove conduit nut "S", Figure 6.11, to remove variable speed control head "T".

23. Lift variable speed control head "T", Figure 6.11, straight off.
24. Remove the speed indicator rod by lifting it up through the headstock.
25. Remove six screws "C", Figure 6.1, and name plate "D".
26. Remove two screws "U", Figure 6.12, pull limit switch "W" out of the headstock to gain access to the wire terminals on the limit switch.
27. Tag the three wires connected to limit switch "W" for reconnection; then, disconnect the wires.

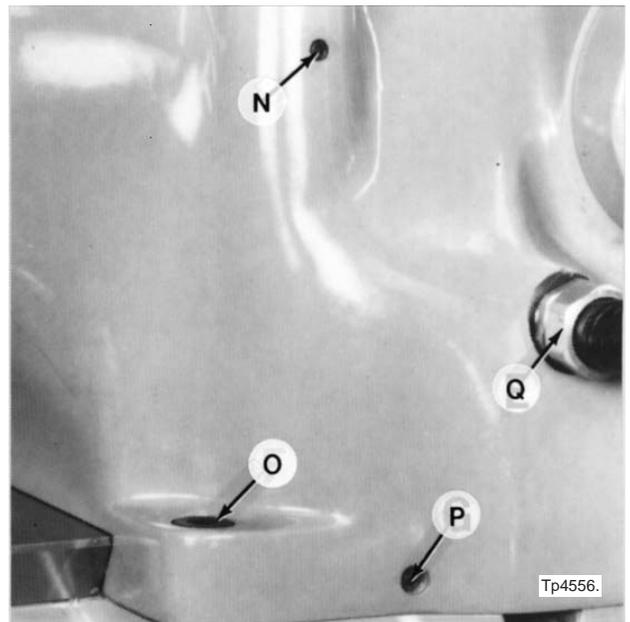


Figure 6.9 - Back of Headstock

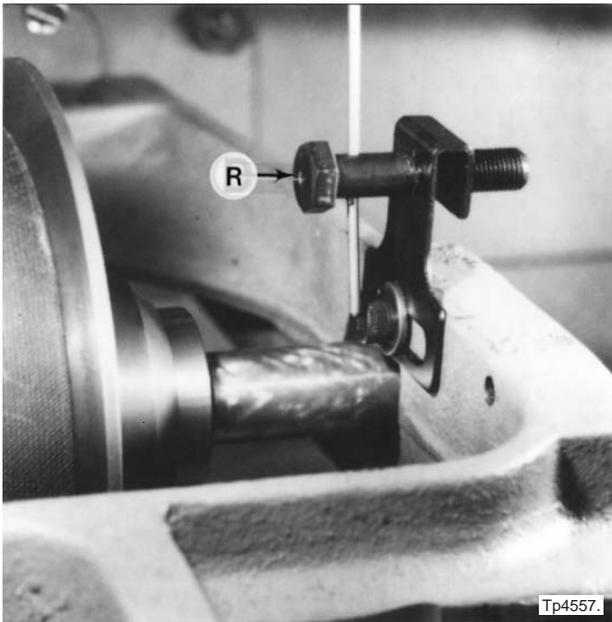


Figure 6.10 - Indicator Rod Bracket

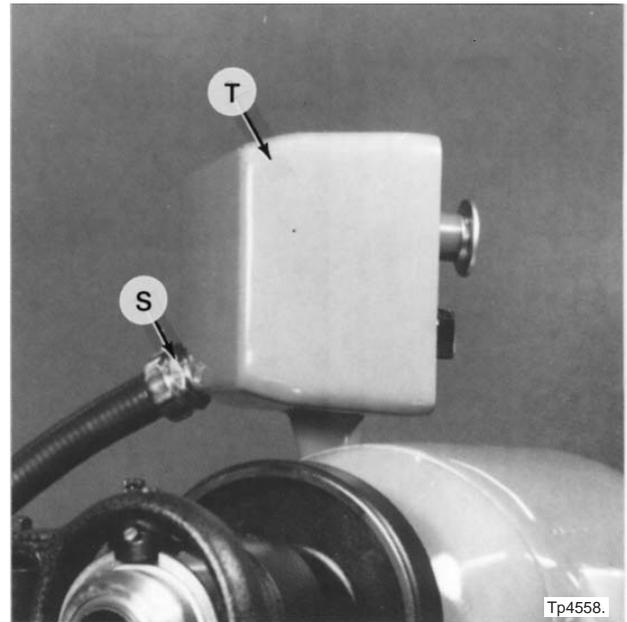


Figure 6.11 - Control Head Conduit Nut

28. Remove cable nut "Q", Figure 6.9, and pull the wires out of the headstock.
29. Remove four bolts "O".
30. Remove lock screw "P".
31. Remove the set screw located under lock screw "P".
32. Remove locking plug "Y", Figure 6.13 .
33. Slide the headstock toward the tailstock to reveal the opening in the bed.
34. Loosen lock nut "B", Figure 6.14 .

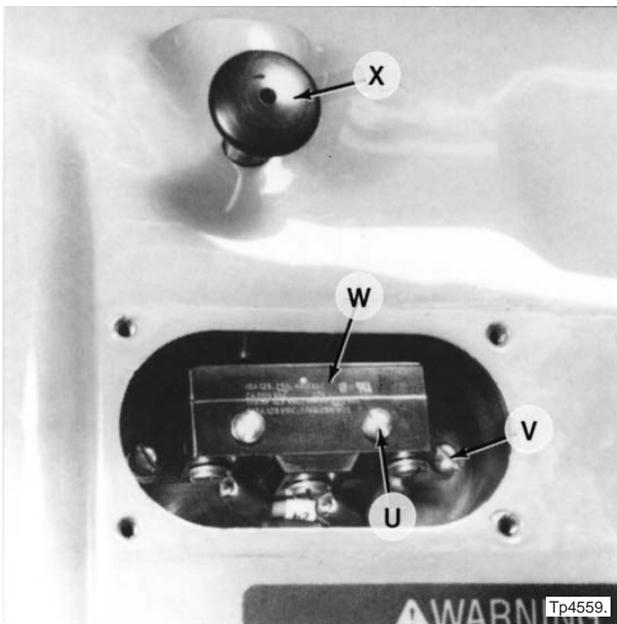


Figure 6.12 - Spindle Lock Pin Limit Switch

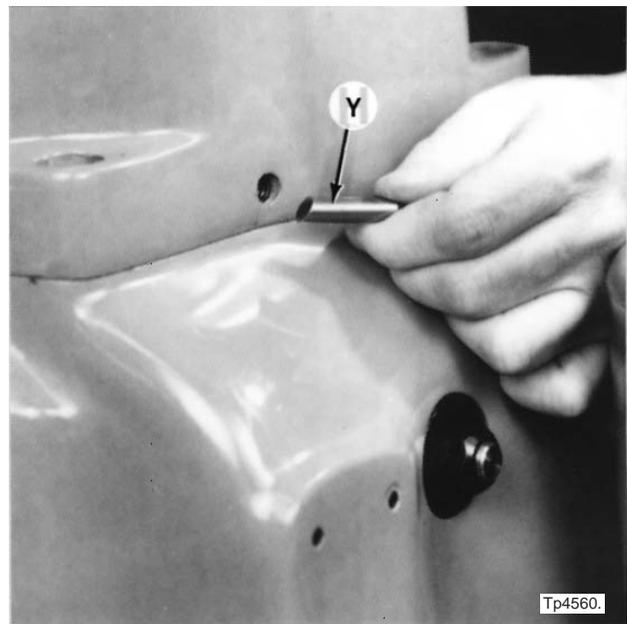


Figure 6.13 - Headstock Locking Plug

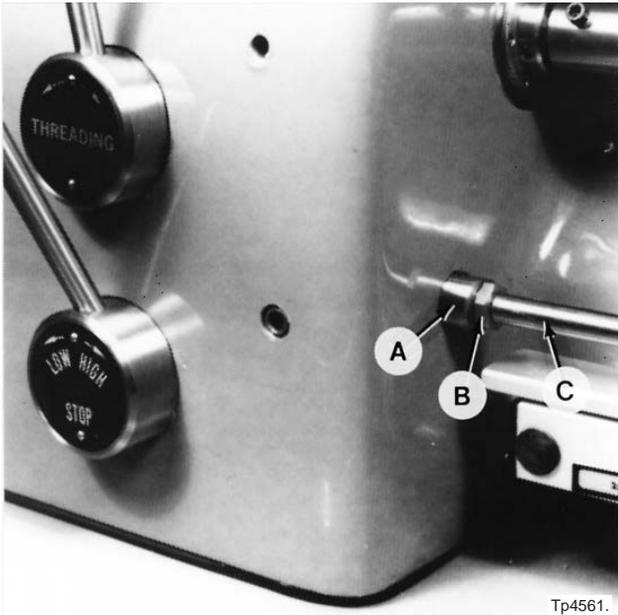


Figure 6.14 - Stop Rod



Figure 6.15 - Stop Rod Positive Stop

35. Remove taper pin "D", Figure 6.15, from the positive stop.
36. Unscrew stop rod "C", Figure 6.14, from stop rod extension "A".

**- NOTE -**

Some of the remaining steps in this procedure will refer to the illustration in Figure 6.16, as well as the appropriate photograph(s).

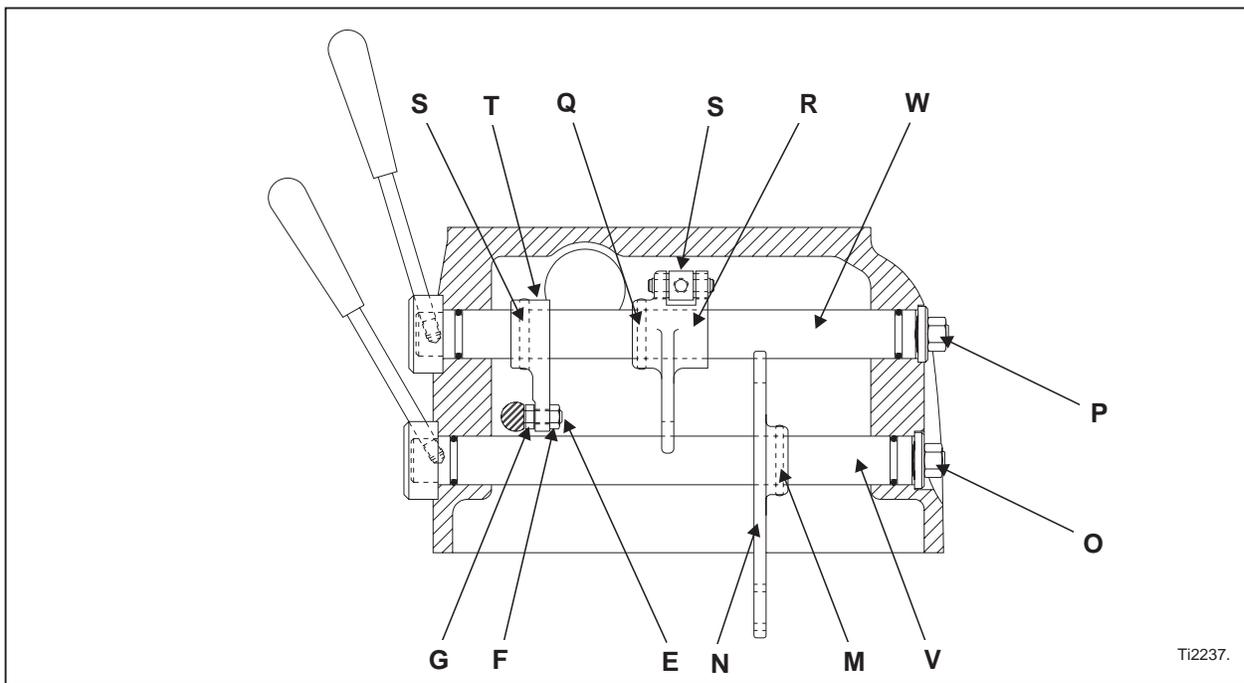


Figure 6.16 - Sectioned View of Bed Assembly (HLV®-H Machines)

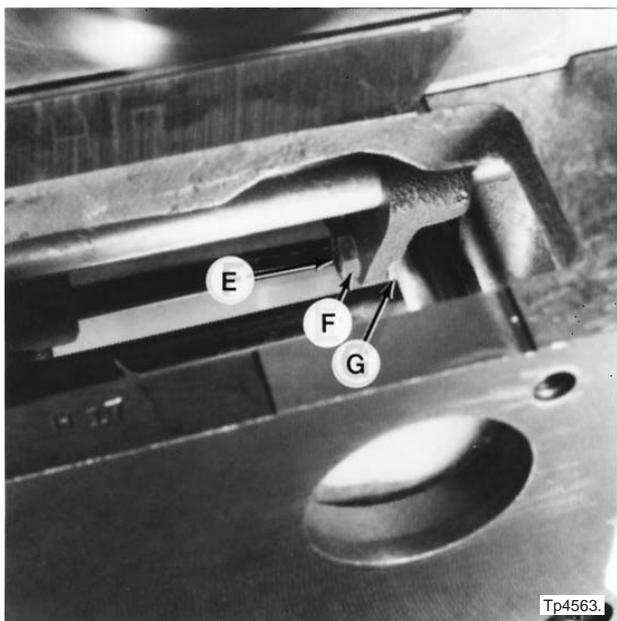


Figure 6.17 - Reverse Lever Shaft

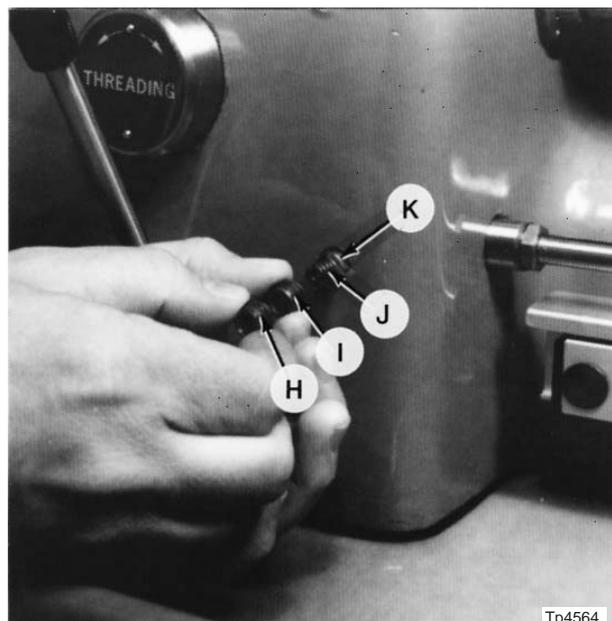


Figure 6.18 - Stop Rod Plunger Assembly

**- NOTE -**

Nut "F", Figures 6.16 and 6.17, is accessible through the opening in the bed.

37. Loosen nut "F", Figures 6.16 and 6.17 .

38. Remove screw "E" and block "G".

39. Remove lock screw "H", Figure 6.18, set screw "I", spring "J", and plunger "K".

40. Remove stop rod extension "L", Figure 6.19 .

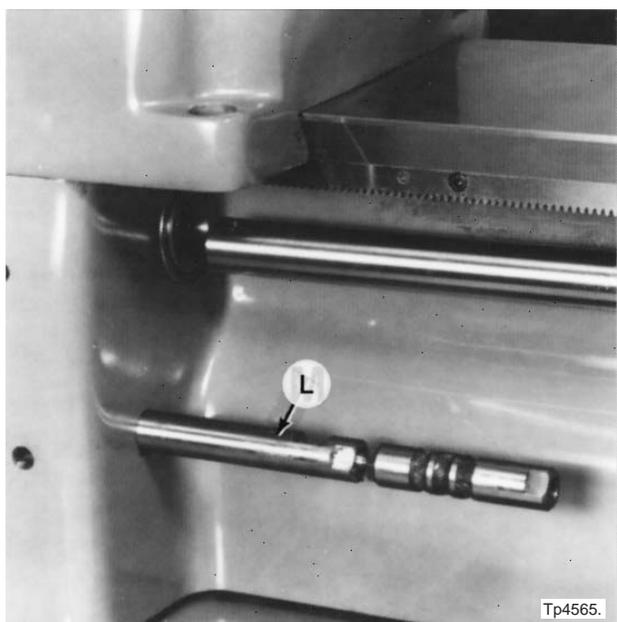


Figure 6.19 - Stop Rod Extension Removal

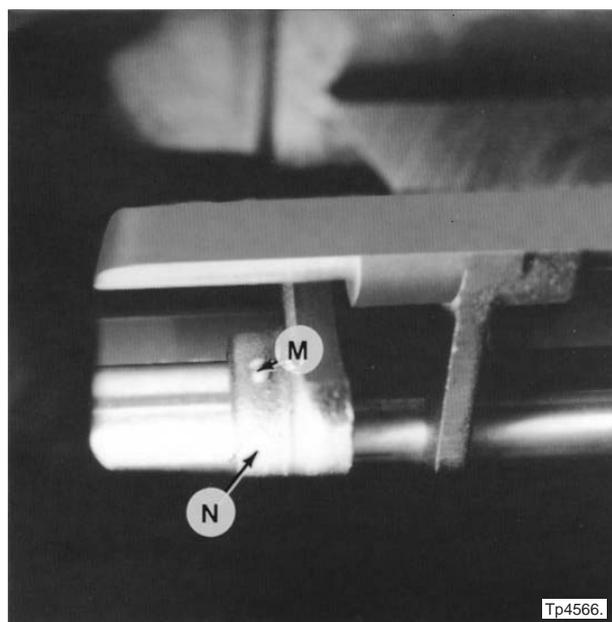


Figure 6.20 - Speed Lever Shaft

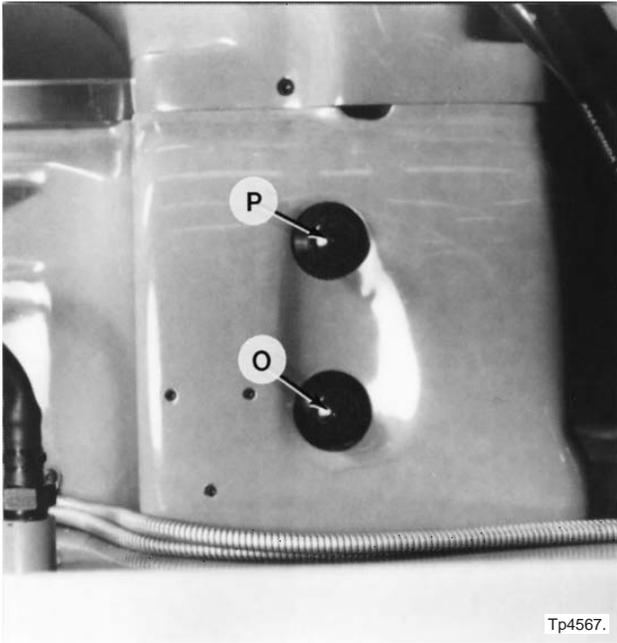


Figure 6.21 - Rear View of Bed Levers

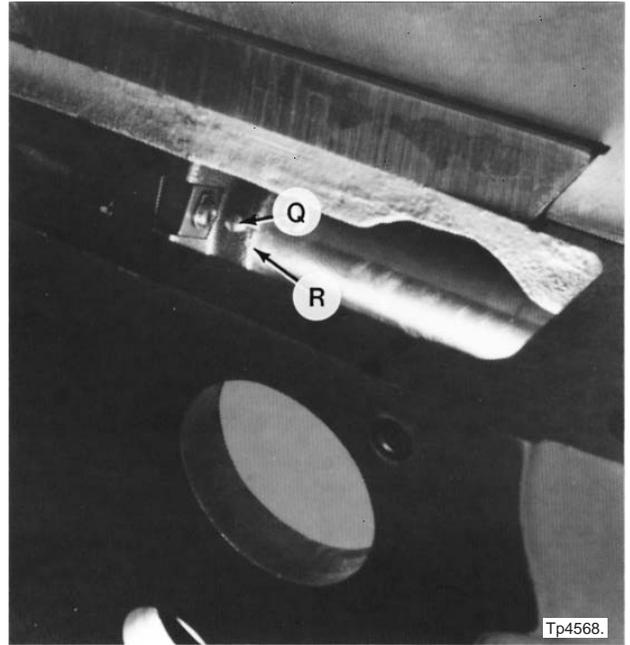


Figure 6.22 - Reverse Lever Shaft

**- NOTE -**

Taper pin "M", Figures 6.16 and 6.20, can be accessed through the spindle drive motor compartment

41. Using a hammer and punch, remove taper pin "M", Figures 6.16 and 6.20, from the lower shaft to free speed range lever "N".
42. Remove nut "O", Figures 6.16 and 6.21, washer, and spring washer.
43. Hold speed range lever "N", Figures 6.16 and 6.20, and remove shaft assembly "V", Figure 6.16, from the bed assembly.

**- NOTE -**

Taper pin "Q", Figures 6.16 and 6.22, can be accessed through the spindle drive motor compartment

44. Using a hammer and punch, remove taper pin "Q", Figures 6.16 and 6.22, from the upper shaft to free reverse lever "R".

(continued on next page)

**- NOTE -**

Taper pin "S", Figures 6.16 and 6.23, can be accessed through the spindle drive motor compartment.

45. Rotate the upper lever shaft to point the small end of taper pin "S", Figures 6.16 and 6.23, down toward the spindle drive motor compartment
46. Using a hammer and punch, remove taper pin "S" from the upper shaft to free stop rod lever "T".
47. Remove nut "P", Figures 6.16 and 6.21, washer, and spring washer.
48. Hold the reverse lever and stop rod lever in position and remove shaft assembly "W", Figure 6.16, from the bed assembly.

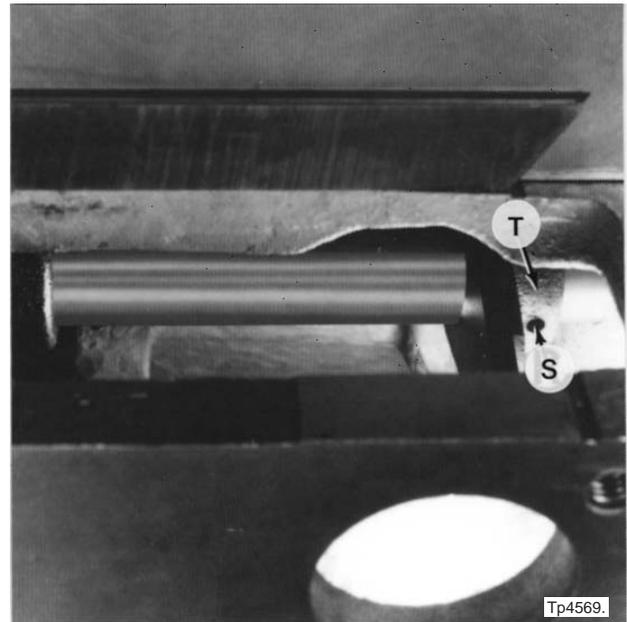


Figure 6.23 - Reverse Lever Shaft

## REPLACEMENT

### - NOTE -

Some of the steps in this procedure will refer to the illustration in Figure 6.16, as well as the appropriate photograph(s).

1. Position block "U", Figure 6.24, in the reverse lever with the chamfered end of the hole oriented as shown.
2. Hold reverse lever "R" and stop rod lever "T", Figure 6.16, in position and slide shaft assembly "W" into the bed assembly.
3. Replace spring washer, washer, and nut "P", Figures 6.16 and 6.21 .
4. Align the hole in reverse lever "R", Figures 6.16 and 6.22, with the appropriate hole in the shaft assembly "W", Figure 6.16 .
5. Replace taper pin "Q", Figures 6.16 and 6.22 .
6. Align the hole in stop rod lever "T", Figures 6.16 and 6.23, with the appropriate hole in shaft assembly "W", Figure 6.16 .
7. Replace taper pin "S".
8. Hold speed lever "N", Figures 6.16 and 6.20, in position and replace shaft assembly "V", Figure 6.16 .
9. Replace spring washer, washer, and nut "O", Figures 6.16 and 6.21 .
10. Align the hole in speed lever "N", Figures 6.16 and 6.20, with the hole in shaft "V", Figure 6.16 .
11. Replace taper pin "M", Figures 6.16 and 6.20 .
12. Replace stop rod extension "L", Figure 6.19 .
13. Replace screw "E" and block "G", Figures 6.16 and 6.17 .
14. Tighten nut "F".
15. Thread stop rod "C", Figure 6.14, into stop rod extension "A", but do not tighten.
16. Position the positive stop and replace taper pin "D", Figure 6.15 .
17. Tighten stop rod "C" in stop rod extension "A"; then, tighten lock nut "B", Figure 6.14 .
18. Replace plunger "K", Figure 6.18, spring "J", and set screw "I".
19. Adjust set screw "I", Figure 6.18, to obtain the desired amount of detent on lever "B", Figure 6.1 .
20. Replace and tighten lock screw "H", Figure 6.18 .

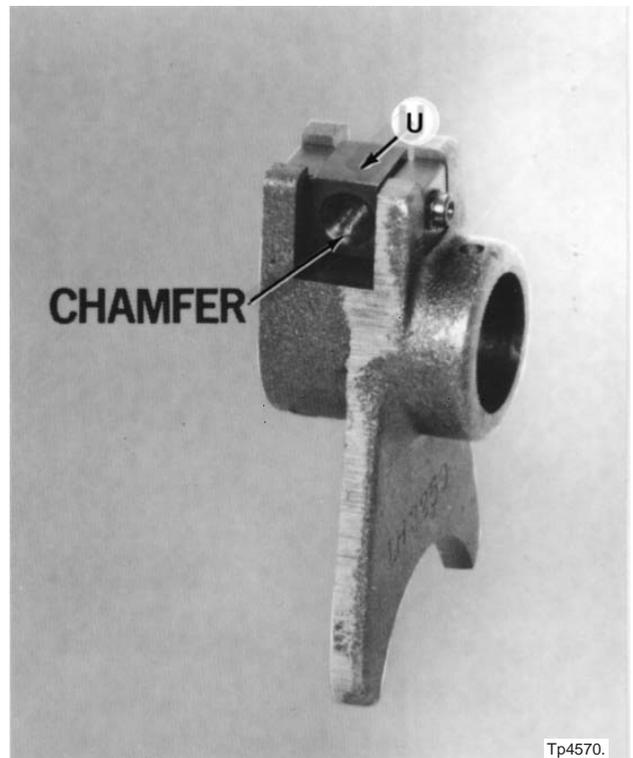


Figure 6.24 - Reverse Lever

21. Position the headstock to locate machined surface "Y", Figure 6.25, of the headstock .008" [0.2 mm] forward (toward the tailstock end of the machine) of machined surface "Z" on the bed casting.
22. Replace locking plug "Y", Figure 6.13 .
23. Replace the set screw located under locking screw "P", Figure 6.9 .
24. Replace and tighten lock screw "P".
25. Replace and torque four bolts "O" to 65 lb-ft [88 Nm].
26. Reroute the spindle lock pin wires through the headstock and tighten cable nut "Q".
27. Connect the three limit switch wires to limit switch "W", Figure 6.12 .
28. Mount limit switch "W" to the limit switch mounting plate using two screws "U".

**- NOTE -**

Clearance in the holes for screws "V" will allow the position of the limit switch to be adjusted to ensure that the limit switch works properly.

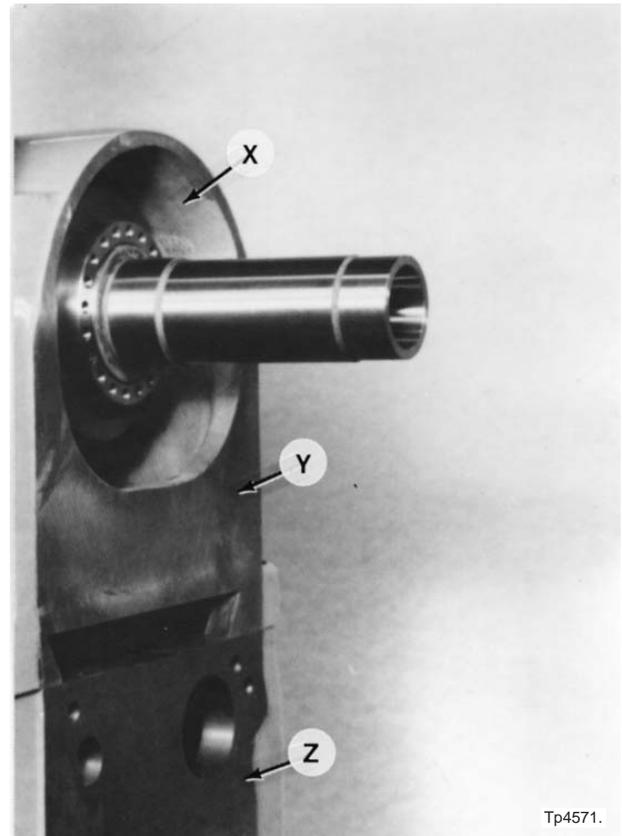


Figure 6.25 - Headstock Locating Surfaces

29. Move spindle lock pin "X" IN and OUT to be sure limit switch "W" is tripped when the spindle lock pin is pushed IN. Loosen two screws "V" to reposition limit switch "W" as needed. Tighten screws "V" to secure the setting.
30. Mount name plate "D", Figure 6.1, using six screws "C".
31. Replace the spindle speed indicator rod with the flat side facing toward the front of the machine.
32. Replace variable speed control head "T", Figure 6.11 .
33. If it was necessary to remove conduit nut "S", Figure 6.11, to remove variable speed control head "T", replace conduit nut "S" at this time.
34. Replace the set screw located under lock screw "N", Figure 6.9 .
35. Replace lock screw "N".
36. Reposition the tip of the spindle speed indicator rod at 3000 rpm on the variable speed control box and tighten screw "R", Figure 6.10, in the motor compartment.

**- NOTE -**

When replacing the spindle belt, the gearbox shown in Figure 6.26 will not be mounted. This allows for easier spindle belt replacement.

37. Cross the spindle belt, as shown in Figure 6.26, and feed it through opening "X", Figure 6.25, and down into the pedestal.

38. Use a piece of wire as a hook to lift the spindle belt onto the spindle pulley.

39. Slide the spindle belt over the end of countershaft assembly "K", Figure 6.7, and onto the left pulley of the countershaft assembly.

40. Remount the countershaft assembly by sliding the left end of the countershaft assembly back into countershaft support bracket "L".

41. Reconnect pullrod "M", Figure 6.8, and insert the cotter pin.

42. Remount the motor belt on the right side pulley of the countershaft assembly.

43. Remove the block and carefully lower the front of the motor mounting plate.

44. Install lock nut "I", Figure 6.4, but do not tighten.

45. Check belt tension according to the procedure outlined in "Checking Drive Belt Tension", Page 3-1.

46. If necessary, adjust belt tension according to the procedure outlined in "Adjusting Drive Belt Tension", Page 3-2.

47. Remount the gearbox according to the appropriate procedure:

The procedure for remounting the English gearbox begins on page 4-16.

The procedure for remounting the English-Metric gearbox begins on page 4-35.

48. Run the drive to both extremes of the speed range to be sure the speed indicator is adjusted properly.

49. Check the headstock alignment according to the procedure outlined in "Headstock Alignment", beginning on page 4-47.



Figure 6.26 - Spindle Belt Replacement

## BED LEVERS (TFB®-H Machines)

### REMOVAL

1. Remove and clean the collet closer according to the procedure outlined on page 4-1.
2. Remove snap ring "A", Figure 6.27, and remove handwheel "B".
3. Remove key "C", Figure 6.28, washer "D", and washer "E".
4. Remove four screws "F", Figure 6.29, and cover "G".
5. Place lever "H", Figure 6.30, in the "Brake" position and lever "I" in the "Stop" position.
6. Turn coolant switch "N", Figure 6.31, to the OFF position.
7. Pull "Start/Stop" pushbutton "L", Figure 6.31, OUT to turn the machine ON.
8. Place lever "H", Figure 6.30, in the "Forward" or "Reverse" position and lever "I" in the "Low" position.
9. Turn speed adjustment knob "M", Figure 6.31, to "Slower" and hold in that position until spindle speed stabilizes at 125 rpm.
10. Place lever "H", Figure 6.30, in the "Brake" position and lever "I" in the "Stop" position.
11. Press "Start/Stop" pushbutton "L", Figure 6.31, IN to turn the machine OFF.
12. Open door "H", Figure 6.3 .
13. Remove lock nut "I", Figure 6.4 .
14. Raise the front of the motor mounting plate approximately two inches and block it in this position, as shown in Figure 6.5 .
15. Roll motor belt "J", Figure 6.6, to the right off the pulley and let it rest on the pulley hub, as shown.
16. Pull "Start/Stop" pushbutton "L", Figure 6.31, OUT to turn the machine ON.

### - WARNING -

**Stay clear of the spindle drive motor compartment while the spindle motor is running.**

17. Place lever "H", Figure 6.30, in the "Forward" or "Reverse" position and lever "I" in the "High" position.

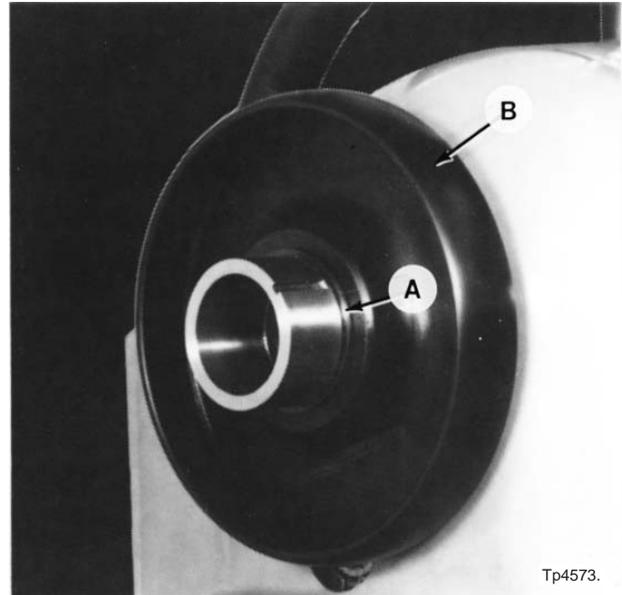


Figure 6.27 - Spindle Handwheel

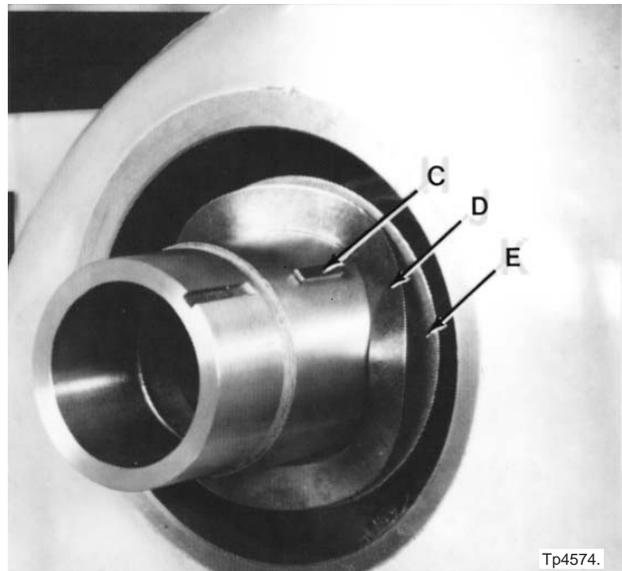


Figure 6.28 - Handwheel Key and Washers

18. Turn speed adjustment knob "M", Figure 6.31, to "Faster" and hold in that position until spindle speed stabilizes at 3000 rpm.
19. Place lever "H", Figure 6.30, in the "Brake" position and lever "I" in the "Stop" position.
20. Press "Start/Stop" pushbutton "L", Figure 6.31, IN to turn the machine OFF.
21. Slide countershaft assembly "K", Figure 6.7, to the extreme right and remove the spindle belt over the left end of the countershaft.
22. Remove the cotter pin from the end of speed change pull rod "M", Figure 6.8, which passes through the headstock belt in the motor compartment.
23. Use a piece of wire as a hook to lift the spindle belt out of the pulley and out of the opening in the headstock.
24. Remove lock screw "N", Figure 6.9, and loosen the set screw under lock screw "N".
25. Loosen screw "R", Figure 6.10, located in the motor compartment, to release the speed indicator rod.

**- NOTE -**

It may be necessary to remove cable nut "S", Figure 6.11, to remove variable speed control head "T".

26. Lift variable speed control head "T", Figure 6.11, straight off.



Figure 6.29 - Headstock Cover (TFB®-H Machines)

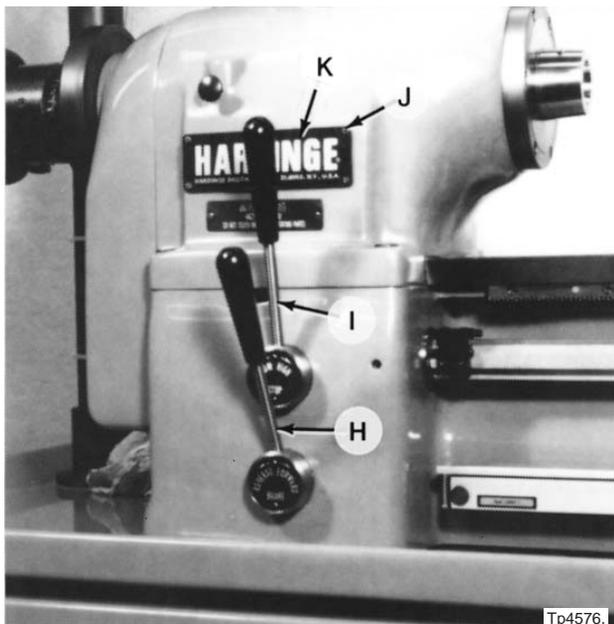


Figure 6.30 - Headstock Assembly (TFB-H Machines)

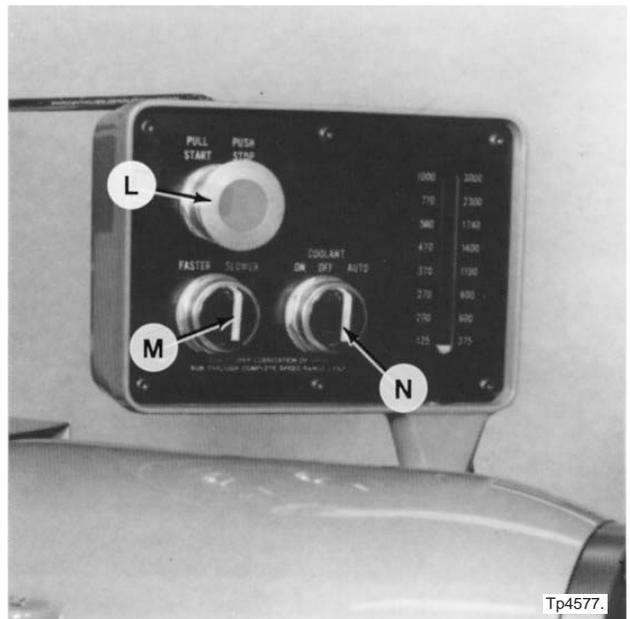


Figure 6.31 - Variable Speed Control Box (TFB-H Machines)

27. Remove the speed indicator rod by lifting it up through the headstock.
28. Remove six screws "J", Figure 6.30, and name plate "K".
29. Remove two screws "U", Figure 6.12, pull limit switch "W" out of the headstock to gain access to the wire terminals on the limit switch.
30. Tag the three wires connected to limit switch "W" for reconnection; then disconnect the wires.
31. Remove cable nut "Q", Figure 6.9, and pull the wires out of the headstock.
32. Remove four bolts "O".
33. Remove lock screw "P".
34. Remove the set screw located under lock screw "P".
35. Remove locking plug "Y", Figure 6.13 .
36. Slide the headstock toward the tailstock to reveal the opening in the bed.

**- NOTE -**

Taper pin "U", Figure 6.32, can be accessed through the spindle drive motor compartment

37. Using a hammer and punch, remove taper pin "U", Figure 6.32, from the lower shaft to free the reverse lever.
38. Remove nut "O", Figures 6.21 and 6.32, washer, and spring washer.
39. Hold reverse lever "T", Figure 6.32, and remove shaft assembly "V".

**- NOTE -**

Taper pin "R" can be accessed through the spindle drive motor compartment.

40. Using a hammer and punch, remove taper pin "R" from the upper shaft to free speed lever "Q".
41. Remove nut "P", Figure 6.21 and 6.32, washer, and spring washer.
42. Hold speed lever "Q", Figure 6.32, and remove shaft assembly "S".

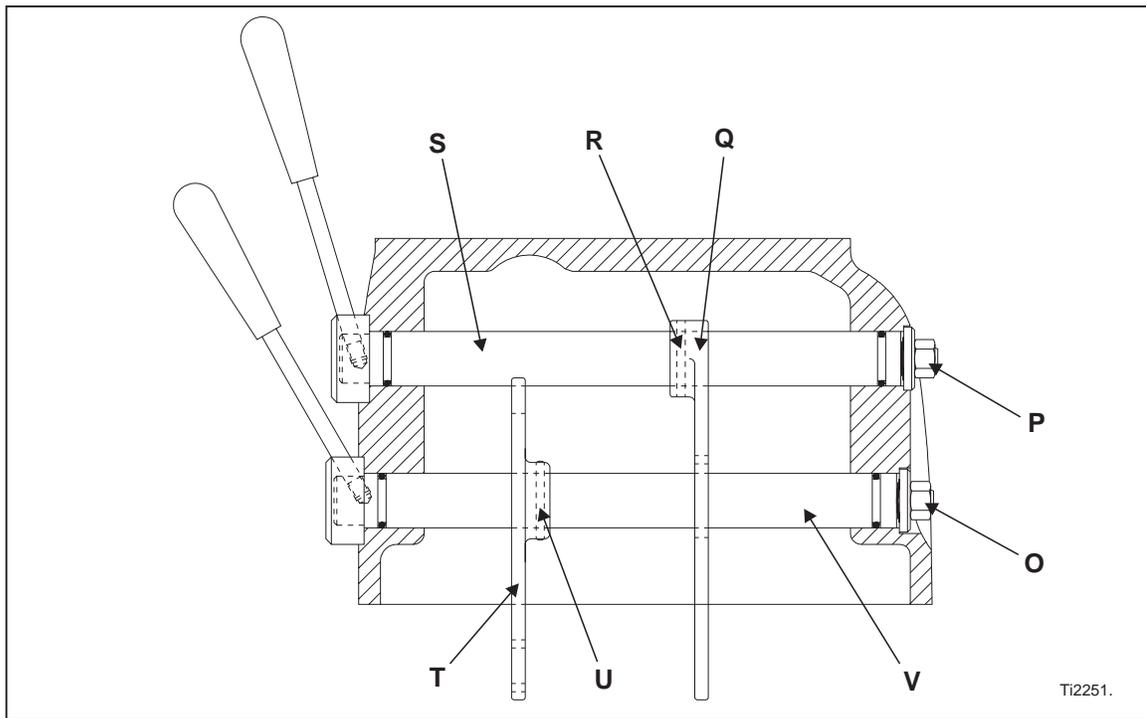


Figure 6.32 - Sectioned View of Bed Assembly  
(TFB®-H Machines)

## REPLACEMENT

### - NOTE -

Some of the steps in this procedure will refer to the illustration in Figure 6.32, as well as the appropriate photograph(s).

1. Hold speed lever "Q", Figure 6.32, in position and slide shaft assembly "S" into the bed assembly.
2. Replace spring washer, washer, and nut "P", Figures 6.21 and 6.32 .
3. Align the hole in speed lever "Q", Figure 6.32, with the hole in the shaft assembly "S".
4. Replace taper pin "R".
5. Hold speed lever "T" in position and replace shaft assembly "V".
6. Align the hole in speed lever "T" with the hole in the shaft assembly "V".
7. Replace taper pin "U".
8. Replace spring washer, washer, and nut "O", Figures 6.21 and 6.32 .
9. Position the headstock to locate machined surface "Y", Figure 6.25, of the headstock .008" [0.2 mm] forward (toward the tailstock end of the machine) of machined surface "Z" on the bed casting.
10. Replace locking plug "Y", Figure 6.13 .
11. Replace the set screw located under locking screw "P", Figure 6.9 .
12. Replace and tighten lock screw "P".

13. Replace and torque four bolts “O” to 65 lb-ft [88 Nm].
14. Reroute the spindle lock pin wires through the headstock and tighten cable nut “Q”.
15. Connect the three limit switch wires to limit switch “W”, Figure 6.12 .
16. Mount limit switch “W” to the limit switch mounting plate using two screws “U”.

**- NOTE -**

Clearance in the holes for screws “V” will allow the position of the limit switch to be adjusted to ensure that the limit switch works properly.

17. Move spindle lock pin “X” IN and OUT to be sure limit switch “W” is tripped when the spindle lock pin is pushed IN. Loosen two screws “V” to reposition limit switch “W” as needed. Tighten screws “V” to secure the setting.
18. Mount name plate “K”, Figure 6.30, using six screws “J”.
19. Replace the spindle speed indicator rod with the flat side facing toward the front of the machine.
20. Replace variable speed control head “T”, Figure 6.11 .
21. If it was necessary to remove conduit nut “S” to remove variable speed control head “T”, replace conduit nut “S” at this time.
22. Replace the set screw located under lock screw “N”, Figure 6.9 .
23. Replace lock screw “N”.
24. Reposition the tip of the spindle speed indicator rod at 3000 rpm on the variable speed control box and tighten screw “R”, Figure 6.10, in the motor compartment.

**- NOTE -**

When replacing the spindle belt, the cover shown in Figure 6.26 will not be mounted. This allows for easier spindle belt replacement.

25. Cross the spindle belt, as shown in Figure 6.26, and feed it through opening “X”, Figure 6.25, and down into the pedestal.
26. Use a piece of wire as a hook to lift the spindle belt onto the spindle pulley.
27. Slide the spindle belt over the end of countershaft assembly “K”, Figure 6.7, and onto the left pulley of the countershaft assembly.
28. Remount the countershaft assembly by sliding the left end of the countershaft assembly back into countershaft support bracket “L”.
29. Reconnect pullrod “M”, Figure 6.8, and insert the cotter pin.
30. Remount the motor belt on the right side pulley of the countershaft assembly.
31. Remove the block and carefully lower the front of the motor mounting plate.
32. Install lock nut “I”, Figure 6.4, but do not tighten.
33. Check belt tension according to the procedure outlined in “Checking Drive Belt Tension”, Page 3-1.

34. If necessary, adjust belt tension according to the procedure outlined in “Adjusting Drive Belt Tension”, Page 3-2.
35. Replace cover “G”, Figure 6.29, and four screws “F”.
36. Run the drive to both extremes of the speed range to be sure the speed indicator is adjusted properly.
37. Check the headstock alignment according to the procedure outlined in “Headstock Alignment”, beginning on page 4-47.

## COOLANT FACILITIES

Clean the machine oil sump regularly, depending on the type of material being machined.

### - CAUTION -

**Use petroleum based cutting fluids only. If water based coolants are used, the machine warranty will be voided.**

### TO CLEAN THE SUMP

1. Press "Start/Stop" pushbutton "E", Figure .2, IN to turn the machine OFF.
2. At the back of the machine, place a drain pan capable of holding at least 3 gallons of liquid under drain plug "W", Figure 6.33 .
3. Remove drain plug "W" and allow the coolant sump to drain into the drain pan.
4. Remove four screws "X", Figure 6.34, and remove sump cover "Y".

### - WARNING -

**DO NOT remove chips by hand. Use a small shovel or similar device for chip removal.**

5. Remove any chips present in the coolant sump.
6. Clean the coolant sump and sump cover with mineral spirits.
7. Replace sump cover "Y" and screws "X", Figure 6.34, and drain plug "W", Figure 6.33 .
8. Remove the drain pan and properly dispose of the used coolant.
9. Refill the coolant sump with three gallons of fresh coolant.

### COOLANT PUMP MOTOR LUBRICATION

The coolant pump motor bearings are grease packed for life and require no further lubrication.

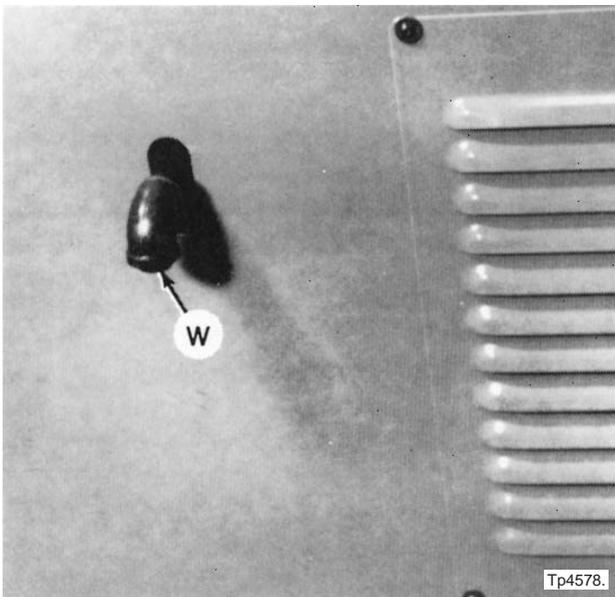


Figure 6.33 - Coolant Drain Plug

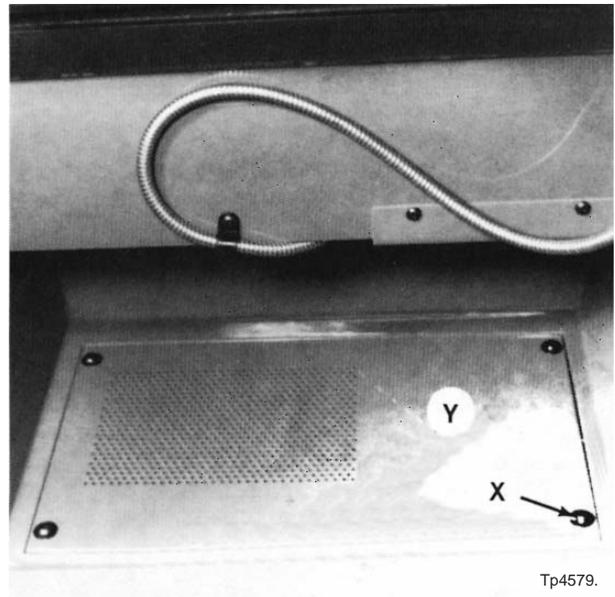


Figure 6.34 - Coolant Sump Cover

## TAILSTOCK

### - NOTE -

Return the tailstock assembly to the factory for repairs involving the tailstock body, spindle, or gib.

### TAILSTOCK DISASSEMBLY

#### - WARNING -

**The tailstock assembly weighs approximately 60 lb [27.2 kg].**

### - NOTE -

Tailstock locking lever "A", Figure 6.35, is shown in the locked position.

1. Loosen tailstock locking lever "A", Figure 6.35, and remove the tailstock over the end of the bed.
2. Disassemble the tailstock spindle and feed screw:
  - a) Remove nut "C", Figure 6.36, and the washer.
  - b) Remove handwheel "D" and dial "E", Figure 6.37, from the tailstock feed screw.
  - c) Remove dial "E" from handwheel "D".

#### - WARNING -

**Plug "F", Figure 6.38, is spring-loaded. Exercise care when removing plug "F" from the handwheel.**

- d) Remove plug "F" and spring "G", Figure 6.38, from the handwheel.

### - NOTE -

Do not misplace the plug located under screw "H", Figure 6.39 .

- e) Loosen screw "H" and remove zero ring "I", Figure 6.39 .
- f) Remove four screws "J" and end cap "K", Figure 6.40, from the tailstock body.
- g) Remove key "L".

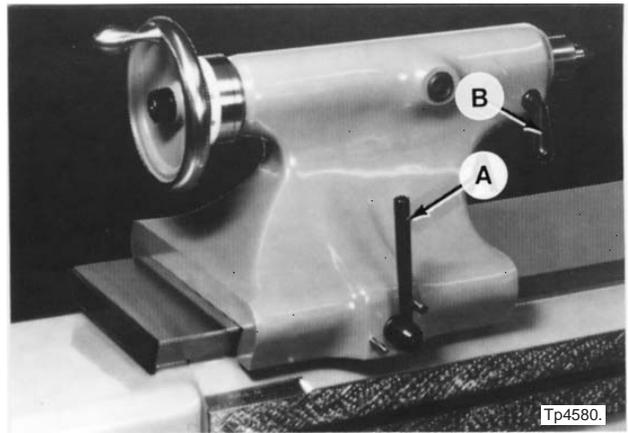


Figure 6.35 - Tailstock Locking Lever

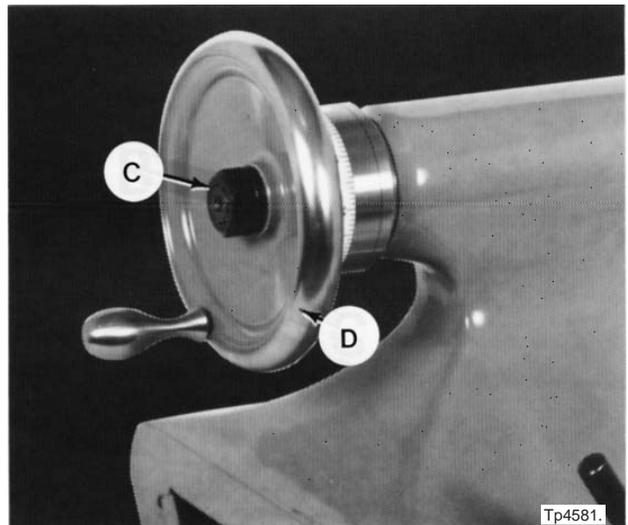


Figure 6.36 - Tailstock Handwheel Locknut

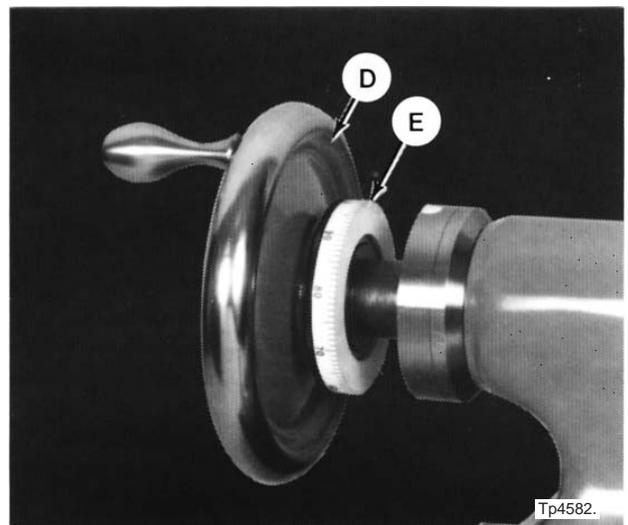


Figure 6.37 - Tailstock Handwheel Removal

- h) Remove screw "M", Figure 6.41 .
- i) Remove spindle key "N", Figure 6.42, using one screw "J", Figure 6.40 .

**- CAUTION -**

**Extreme care should be exercised during steps "j", "k", and "l" to prevent damage to the precision surfaces of the spindle diameters and the tailstock body bore.**

- j) Remove tailstock spindle "O", Figure 6.43.
- k) Remove feed screw "P", Figure 6.44 .
- l) Remove bearing "Q", Figure 6.45 .
- m) Remove nut "R", half nut "S", screw "T", and half nut "U" from tailstock spindle "O", Figure 6.46 .

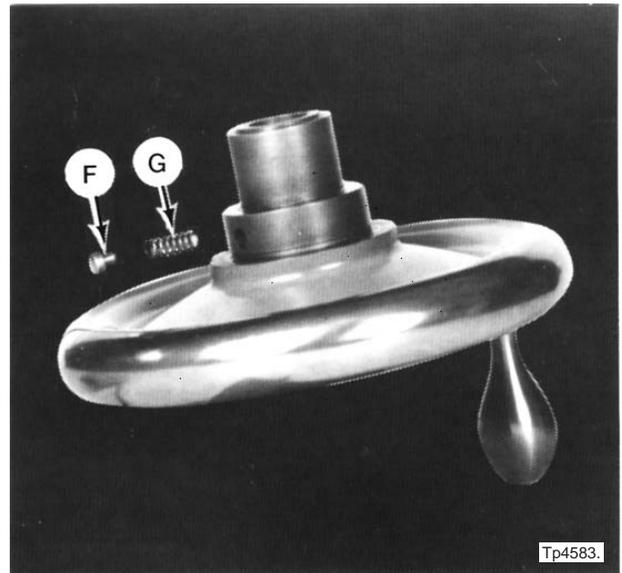


Figure 6.38 - Plug and Spring for Dial

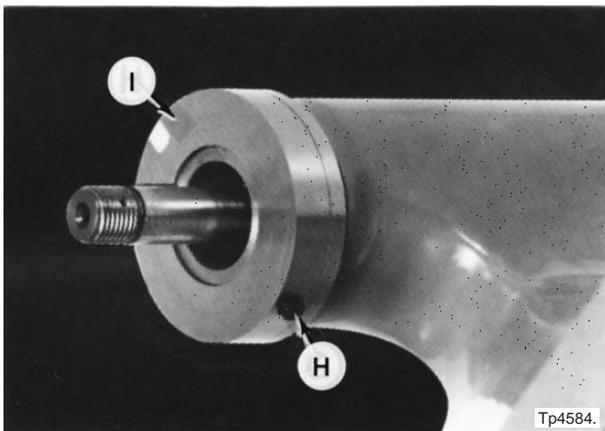


Figure 6.39 - Tailstock Zero Ring

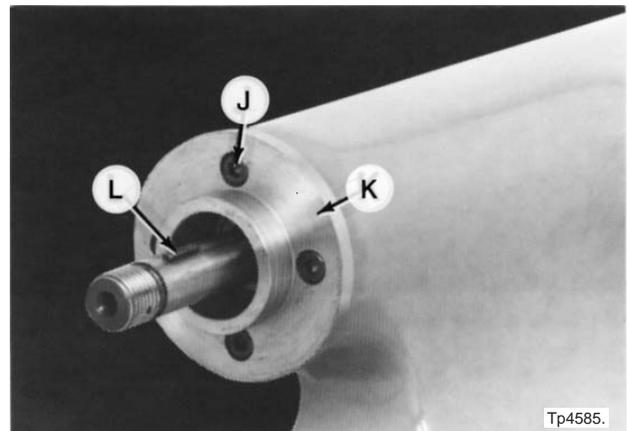


Figure 6.40 - Tailstock End Cap

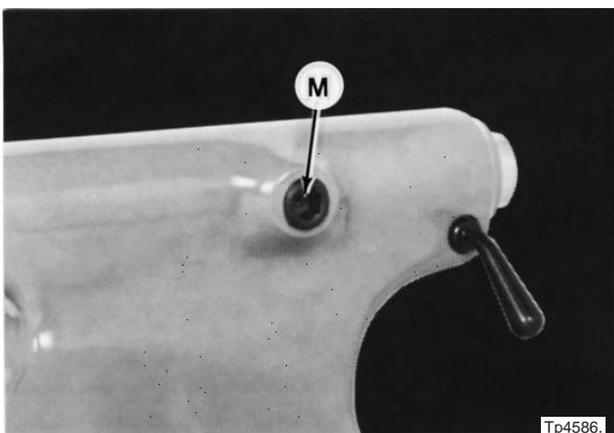


Figure 6.41 - Lockscrew for Tailstock Spindle Key

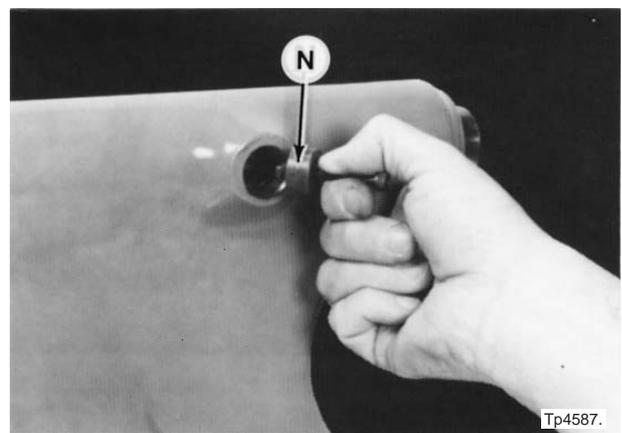


Figure 6.42 - Tailstock Spindle Key Removal

3. Rotate spindle locking lever "A", Figure 6.47, counterclockwise to remove shim "B", and binding nut sections "C" and "D".
4. Remove tailstock locking lever "E", Figure 6.48, and components:
  - a) Remove screw "F", washer "G", lever "E", and spacer "H".
  - b) Unscrew clamp bolt "I".
  - c) Unscrew locking plug "J".



Figure 6.43 - Tailstock Spindle

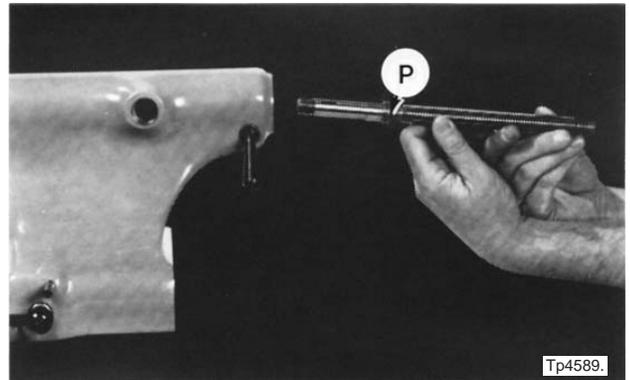


Figure 6.44 - Tailstock Feed Screw

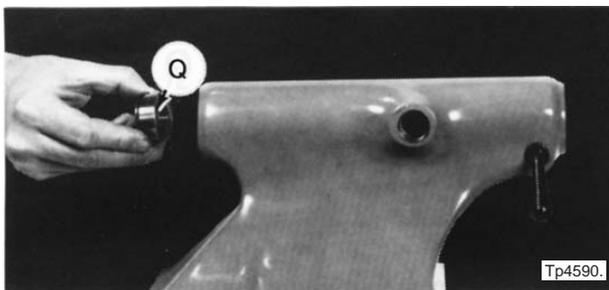


Figure 6.45 - Feed Screw Bearing

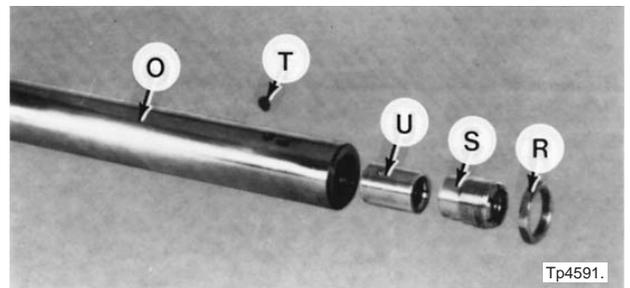


Figure 6.46 - Adjustable Feed Screw Nut

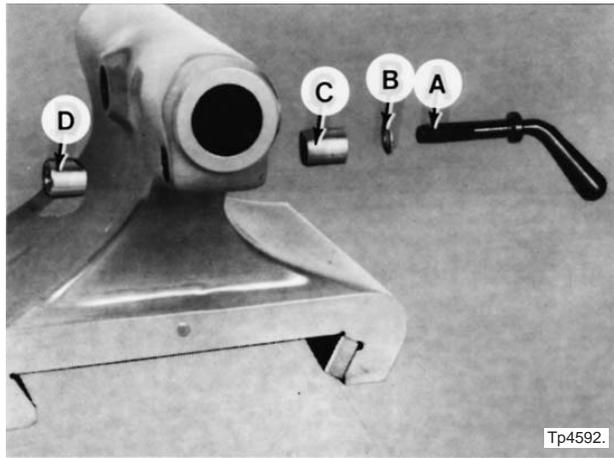


Figure 6.47 - Tailstock Spindle Lock and Components

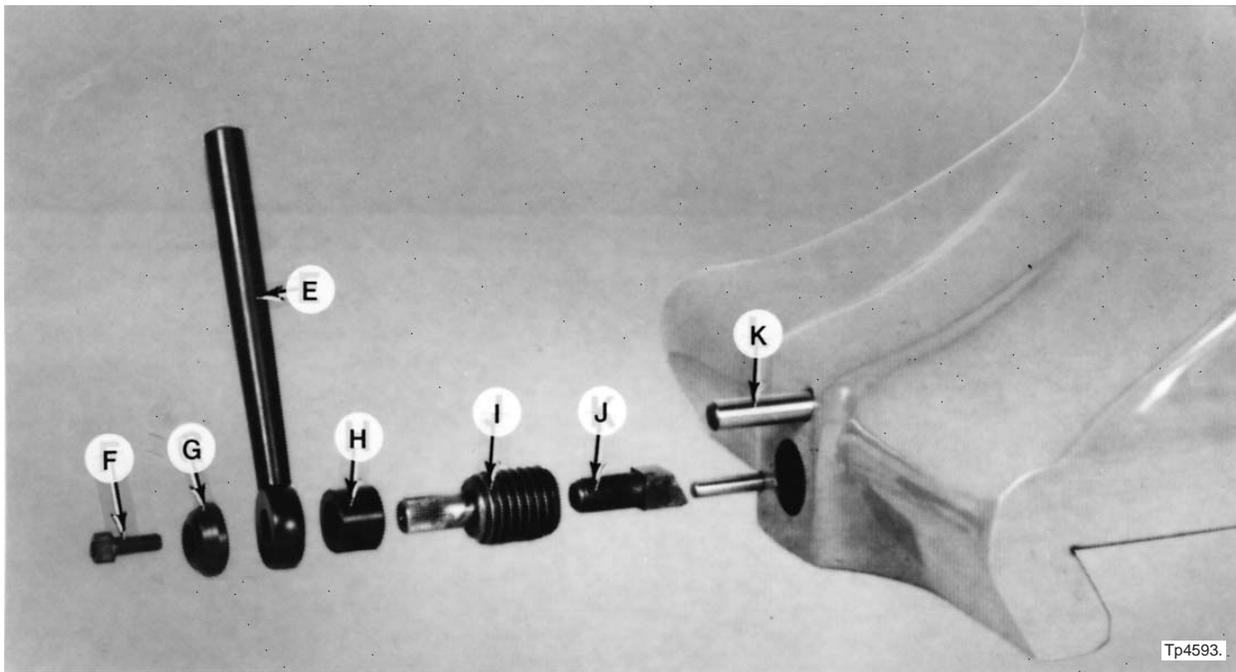


Figure 6.48 - Bed Locking Lever and Components

## TAILSTOCK REASSEMBLY

1. Reassemble the tailstock spindle and feed screw:

- a) Replace half nut “U” and screw “T”, Figure 6.46 .
- b) Install half nut “S” in spindle “O”, leaving a sufficient projection to mount lock nut “R”.
- c) Install lock nut “R” on half nut “S”, but do not tighten.
- d) Thread feed screw “P”, Figure 6.44, into half nut “S”, Figure 6.46, slowly while turning half nut “S” gradually until the threads in half nut “S” line up with the threads in half nut “U”, allowing the feed screw to thread into half nut “U”.
- e) Turn half nut “S”, Figure 6.46, inward until a slight backlash is encountered when feed screw “P”, Figure 6.44, is turned.

### - NOTE -

When the tailstock is assembled, there should be a maximum backlash of three graduations on the handwheel dial.

- f) Hold half nut “S” and tighten nut “R”, Figure 6.46 .
- g) Hold half nut “S” and nut “R”, Figure 6.46, and remove feed screw “P”, Figure 6.44 .

### - CAUTION -

**Extreme care should be exercised during steps “h” and “k” to prevent damage to the precision surfaces of the spindle diameters and the tailstock body bore.**

- h) Replace bearing “Q”, Figure 6.45, in the tailstock body.
- i) Lubricate feed screw “P”, Figure 6.44, with Cosmolube No. 2 grease.
- j) Lubricate spindle “O”, Figure 6.43, with Mobil Velocite Oil No. 6.
- k) Replace feed screw “P”, Figure 6.44, and spindle “O”, Figure 6.43, in the tailstock body.

### - NOTE -

Use one screw “J”, Figure 6.40, to replace spindle key “N”, Figure 6.42 .

- l) Line up the keyway in the spindle and replace spindle key “N”, Figure 6.42 .
- m) Replace screw “M”, Figure 6.41 .

### - NOTE -

Tighten screws “J”, Figure 6.40, alternately and evenly.

- n) Replace end cap “K” using four screws “J”, Figure 6.40 .
- o) Replace key “L”.

### - NOTE -

Be sure the nylon plug is under screw “H”, Figure 6.39 .

- p) Replace zero ring “I”, Figure 6.39, but do not tighten screw “H”.
- q) Replace spring “G” and plug “F”, Figure 6.38 .

- r) Replace dial "E" on handwheel "D", Figure 6.37 .
- s) Mount handwheel "D", Figure 6.37, on the feed screw, as shown in Figure 6.36 .
- t) Replace the washer and nut "C", Figure 6.36 .
- u) Set the clearance between dial "E", Figure 6.37, and zero ring "I", Figure 6.39, at .002" [.05 mm] to .004" [.1 mm].
- v) Tighten screw "H", Figure 6.39 .

2. Replace spindle locking lever "A", Figure 6.47, and components:

**- CAUTION -**

**The angled flats on binding nut sections "C" and "D" must be placed against the tailstock spindle or serious scoring of the spindle will result.**

**- NOTE -**

Binding nut sections "C" and "D" should be flush with the tailstock casting when they are properly positioned.

- a) Replace binding nut sections "C" and "D".
- b) Replace shim "B" on lever "A".
- c) Insert lever "A" through bushing "C" and the tailstock body; then, thread it into binding nut "D".

3. Replace tailstock locking lever "E", Figure 6.48, and components:

- a) Replace the tailstock on the machine bed.
- b) Thread locking plug "J" into clamp bolt "I" until a gap of approximately 13/32 of an inch [10.3 mm] exists between the square shoulder on locking plug "J" and clamp bolt "I".
- c) Thread clamp bolt "I" into the tailstock body.
- d) Replace spacer "H".
- e) Replace lever "E" and turn it clockwise until locking plug "J" contacts the bed plate.
- f) Remove lever "E" and reorient it on the splined shaft so that 150 lb-in [17 Nm] of torque is required to locate lever "E" against stop pin "K".
- g) Replace washer "G" and screw "F".

## TAILSTOCK ALIGNMENT

### - NOTE -

To properly check the tailstock alignment, it will be necessary to contact the Hardinge Service Department to obtain the use of a test arbor. When calling to obtain a test arbor, a Hardinge Telephone Service Technician will request specific information, including the following:

Machine Model  
Machine Serial Number

If tailstock misalignment is suspected, perform the following:

1. Check the tapered shank of the tailstock center being used. Burrs on the tapered shank will not allow the tailstock center to seat evenly.
2. Check the spindle taper of the tailstock for burrs. If necessary, hand ream the tailstock spindle taper VERY LIGHTLY to remove the burrs. (#2 Morse taper)
3. Remove the tailstock from the bed and:
  - a) Check for chip buildup between the tailstock and the bed plate.
  - b) Check for burrs on the tailstock dovetail area and the dovetail on the bed plate.
4. Clean tailstock dovetail area and the dovetail on the bed plate with mineral spirits.
5. Replace the tailstock on the machine bed.
6. Install the tailstock dead center in the tailstock spindle.
7. On the headstock, thoroughly clean the spindle collet seat angle with mineral spirits and check for burrs.
8. Install a dead center in the headstock spindle.
9. Using handwheel "D", Figure 6.36, extend the tailstock spindle 3-1/2 inches [88.9 mm].
10. Holding the test arbor between the headstock and spindle centers, slide the tailstock toward the headstock until the test arbor is barely held in position by the two centers.

### - NOTE -

When locking the tailstock assembly in position for the alignment checks, locking lever "A", Figure 6.35, should be tightened to 150 lb-in [17 Nm].

11. Lock the tailstock in position using bed locking lever "A", Figure 6.35 .

### - NOTE -

The pressure applied against the test arbor should be sufficient to firmly hold the test arbor in place, yet allow it to be rotated by hand.

12. Use tailstock handwheel "D", Figure 6.36, to apply pressure against the test arbor.
13. Lock the tailstock spindle in position by turning locking handle "B", Figure 6.35, clockwise.
14. Mount a .0001" [.002mm] indicator to a stable magnetic base holder on top of the tool holder slide.

## Horizontal Alignment

### - NOTE -

If there are any problems with the horizontal alignment that are not due to the presence of burrs, chips, or other foreign material, it will be necessary to contact the Hardinge Service Department.

15. Position the indicator to touch the diameter of the test arbor at the headstock end as close to the arbor centerline as possible. Refer to Figure 6.49 .
16. Determine the center of the runout at the headstock end of the test arbor:
  - a) Rotate the test arbor and observe the total runout shown on the indicator.
  - b) Note the value at the midpoint of the indicator sweep.
  - c) Rotate the test arbor until the indicator shows the value noted in step 16b.
  - d) Without moving the indicator or turning the test arbor, reset the indicator dial to zero (0).
17. Move the machine carriage (Z axis) toward the tailstock a distance of six (6) inches [152.4 mm] to position the indicator as shown in Figure 6.50 .
18. Observe the value shown on the indicator.

For the horizontal tailstock alignment to be within specification, this observed value must fall within the following range on the indicator dial:

0.0 ↔ +0.0001 inches [.0025 mm] (Tailstock end FORWARD)

19. If the horizontal alignment is within specification, proceed to Vertical Alignment.

If the horizontal alignment is NOT within specification, check for chip buildup or burrs, as described in the beginning of this procedure; then, recheck the horizontal alignment of the tailstock.

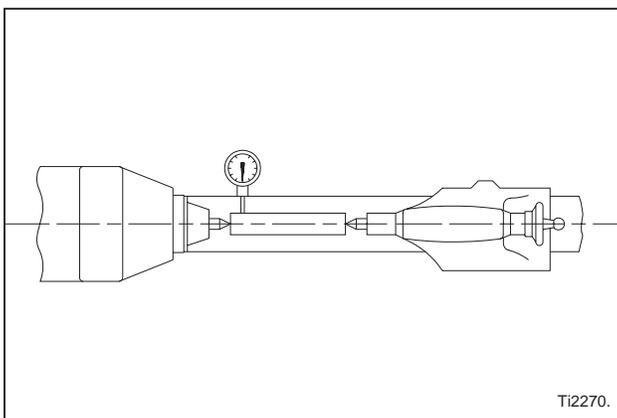


Figure 6.49 - Horizontal Alignment  
(Headstock End of Arbor)

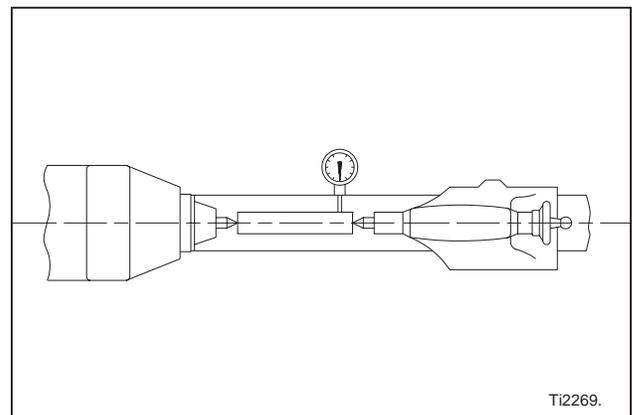


Figure 6.50 - Horizontal Alignment  
(Tailstock End of Arbor)

## Vertical Alignment

20. Position the indicator to touch the diameter of the test arbor at the headstock end as close to the arbor centerline as possible. Refer to Figure 6.51 .
21. Determine the center of the runout at the headstock end of the test arbor:
  - a) Rotate the test arbor and observe the total runout shown on the indicator.
  - b) Note the value at the midpoint of the indicator sweep.
  - c) Rotate the test arbor until the indicator shows the value noted in step 21b.
  - d) Without moving the indicator or turning the test arbor, reset the indicator dial to zero (0).
22. Move the machine carriage (Z axis) toward the tailstock a distance of six (6) inches [152.4 mm] to position the indicator as shown in Figure 6.52 .
23. Observe the value shown on the indicator.
24. For the vertical tailstock alignment to be within specification, this observed value must fall within the following range on the indicator dial:  
 $+0.0005 \text{ inches } [.013\text{mm}] \leftrightarrow +0.001 \text{ inches } [.025\text{mm}]$  (Tailstock end HIGH)

If the vertical alignment is within specification, the alignment procedure is complete.

If the vertical alignment is NOT within specification, check for chip buildup or burrs, as described in the beginning of this procedure; then, recheck the horizontal and vertical alignment of the tailstock.

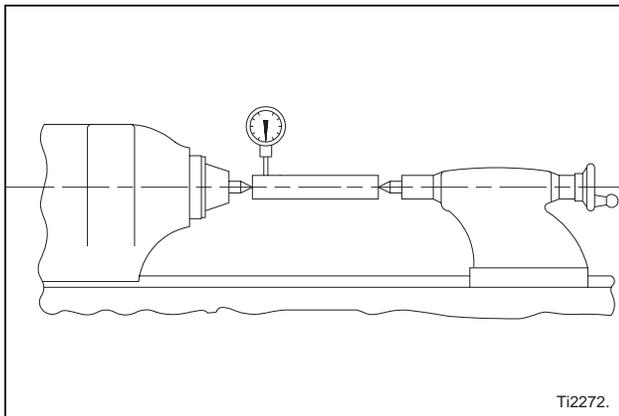


Figure 6.51 - Vertical Alignment  
(Headstock End of Arbor)

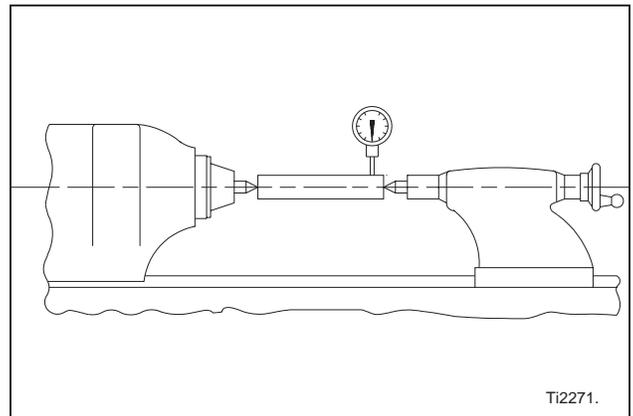


Figure 6.52 - Vertical Alignment  
(Tailstock End of Arbor)

# PREVENTIVE MAINTENANCE SCHEDULE

## DAILY

	Page
Run the drive through the entire speed range . . . . .	3-22
Operate the carriage lubricator . . . . .	1-33
Lubricate the threading change gear bracket . . . . .	4-38

## WEEKLY

Clean and lubricate the carriage gear rack . . . . .	1-15
Clean and lubricate the carriage lead screw. . . . .	1-21
Clean and lubricate the carriage lead screw nut. . . . .	1-26
Remove, clean, and lubricate the collet closer. . . . .	4-1

## MONTHLY

Check spindle and motor belt tension. . . . .	3-1
Lubricate the variable speed drive . . . . .	3-22
Clean and lubricate the tool post slide . . . . .	2-12
Clean and lubricate the cross feed screw and feed screw nut . . . . .	2-4

## BI-MONTHLY

Change the oil in the carriage apron:	
Removing the used oil. . . . .	1-1
Adding the new oil . . . . .	1-9

## QUARTERLY

Lubricate the gear box:	
English gear box . . . . .	4-2,
English-Metric gearbox . . . . .	4-18
Lubricate the drive countershaft . . . . .	3-22

## DEPENDING ON USE

Keep the carriage oil reservoir full . . . . .	1-33
Keep oil in the sight window of the carriage apron. . . . .	1-9
Clean the coolant sump . . . . .	6-18
Oil the spindle brake insert . . . . .	3-11

## LUBRICANT AND SEALANT LISTING

Product	Manufacturer
Andok <sup>®</sup> "B" grease	Humble Oil and Refining Company
Alvania <sup>®</sup> No. 3 grease	Shell Oil Company
Cosmolube <sup>®</sup> No. 2 grease	E.F. Houghton and Company
Darmex <sup>®</sup> DX-321 grease	Darmex Corporation
Die Makers grease	Standard Die Set Company
Mobilfluid <sup>®</sup> 350 oil	Mobil Oil Corporation
Molylube <sup>®</sup> (Anti-Sieze) grease	Bel Ray Company, Inc.
Nevamelt <sup>®</sup> grease	Magnus Chemical
Permatex <sup>®</sup> (3D Sealer) sealant	Permatex Company, Inc.
Mobil Vactra <sup>®</sup> oil No. 2	Mobil Oil Corporation
Mobil Velocite <sup>®</sup> oil No. 6	Mobil Oil Corporation

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