M.I. 316 *Rev. B

Maintenance Instruction

Technical Publications

ELECTRO-MOTIVE

RESURFACING OF CYLINDER HEAD RETAINERS -567C, D, AND ALL 645 AND 710 ENGINES-

INTRODUCTION

During normal operation, the cylinder head retainer surface is subject to wear in the head seat ring contact area. This wear can be kept to a minimum by in-service tightness checks on new equipment, retorquing the crab nuts annually as recommended in the Scheduled Maintenance Program, and by applying the correct torque when a power assembly is installed.

Head retainer wear should be measured whenever the power assemblies are removed from an engine. Engines with head retainer wear steps greater than the maximum specified in the Service Data, should be machined to resurface the head retainer.

This M.I. provides the information necessary to measure the head retainer wear step and to perform the resurfacing operation using tools available from Electro-Motive.

TOOL DESCRIPTION

The cylinder head retainer resurfacing tool is an air-motor-powered mill type cutter designed to be installed in the engine crankcase. The tool is held in position by two locking bars which secure to the lower pilot, and is self-centering in the upper pilot by a cam locking system.

The resurfacing tool utilizes disposable, triangle shaped cutting tools with six interchangeable cutting surfaces. Expected cutting tool life is 24 cylinders, with each cutting surface capable of machining approximately 4 cylinder retainers.

Horizontal (cross) feed travel is automatic when the tool is in operation. Feed travel per revolution of the cutting head is adjustable. The tool is also equipped with an adjustable automatic stop, which disengages the self-feeding mechanism when the cutting tool reaches the outer edge of the head retainer. When properly set, this stop prevents inadvertent contact between the cutting tool and camshaft bearing support pads.

The tool, Fig. 1, comes equipped with air filter, air regulator and gauge, air motor oiler, and automatic venting air control valve, mounted on a bracket designed to hang on the side of the crankcase within operator's reach. Also included are extra cutting tools, air hose, tool holder tray, and a metal storage/shipping container.

HEAD RETAINER INSPECTION

The action of the cylinder head seat ring on the head retainer causes a wear step to be formed on the head retainer surface. This wear step can be measured using the gauge shown in Fig. 2.

PREPARATION

To ensure proper wear step measurement, the entire upper cylinder pilot bore and head retainer surface must be clean and free of any carbon deposits. A flexible scraper and wire brush are recommended.

WEAR STEP MEASUREMENT

The following procedure should be followed for each cylinder. All dial indicator readings for each cylinder should be recorded for later reference.

1. Place calibration block on gauge leg as shown in Fig. 3. Slide calibration block toward dial indicator until block comes in contact with gauge feet. Dial indicator should read "0". If indicator does not read "0" loosen set screw, zero indicator, and retighten set screw.

*This bulletin is revised and supersedes previous issues of this number.
▌Areas of change are indicated by vertical bars.

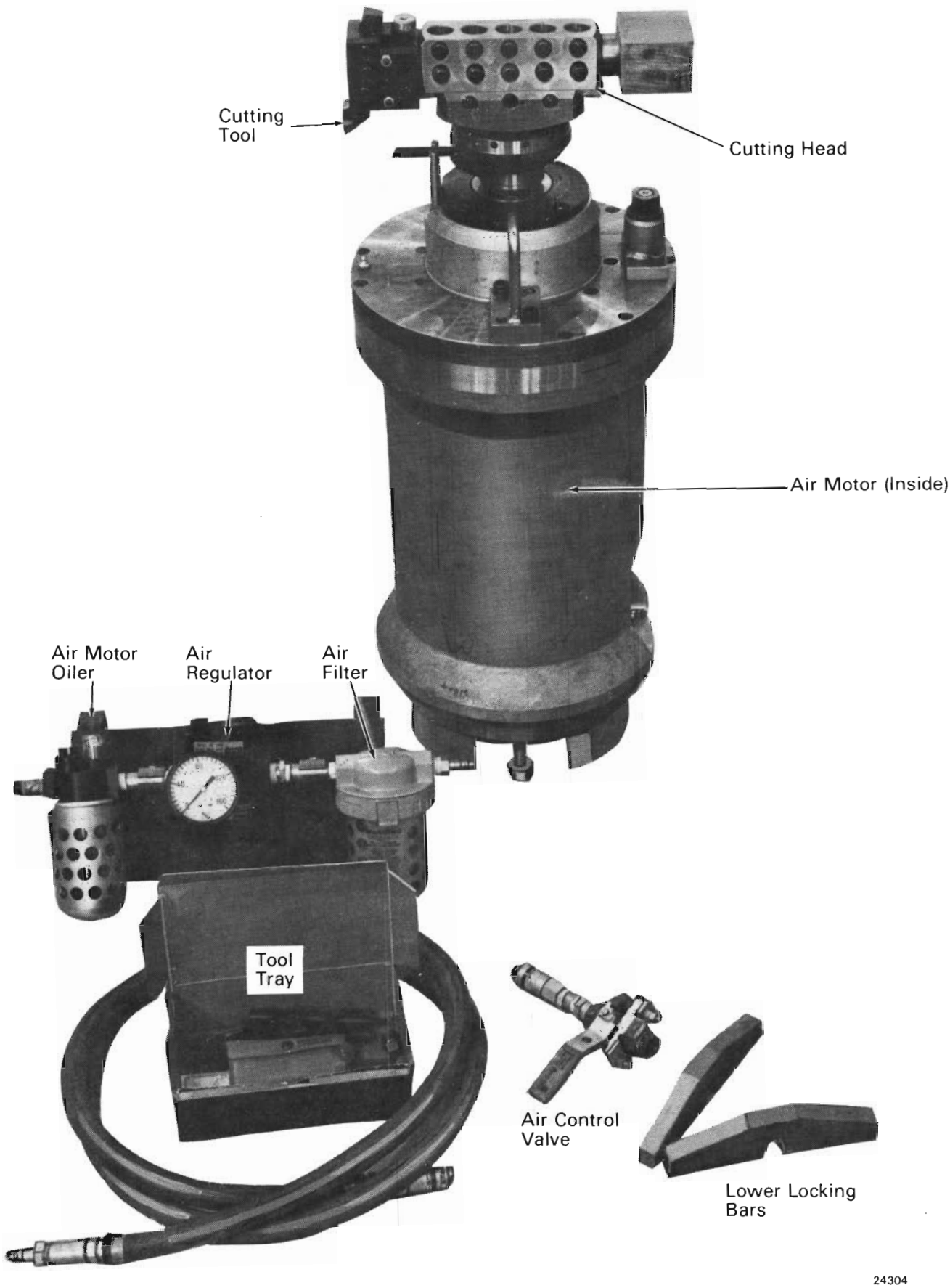

Fig.1 – Cylinder Head Retainer Resurfacing Tool

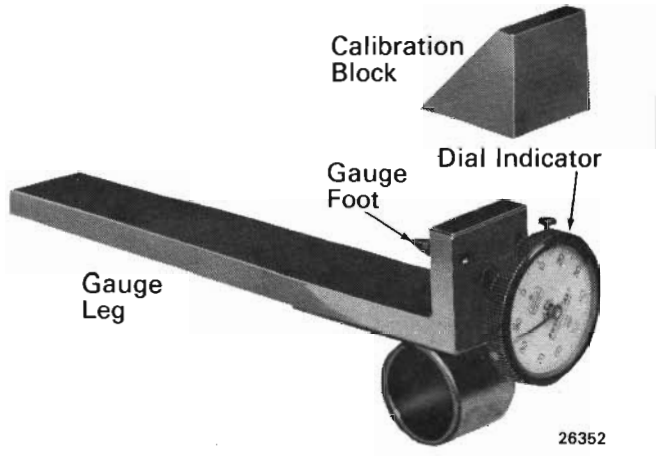

Fig.2 - Head Retainer Wear Step Gauge, Shown With Dial Indicator (Not Included)

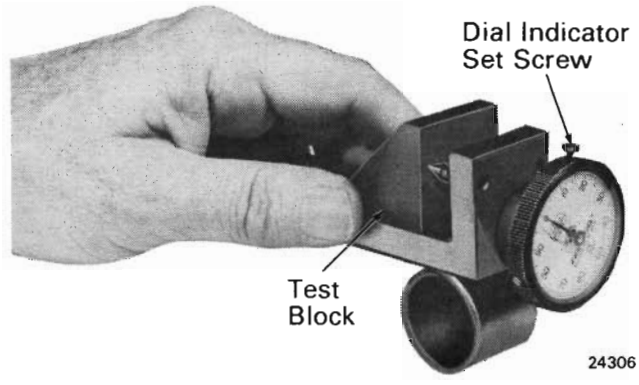

Fig.3 – Checking Head Retainer Wear Step Gauge Calibration

2. Measure head retainer wear step by placing the wear step gauge leg firmly against upper cylinder pilot bore and lowering gauge until feet contact head retainer surface, Fig. 4. Make certain that gauge feet make contact with the machined but unworn portion of the head retainer surface. In some cases this is not possible due to uneven upper pilot bore wall thickness. In this case measure only the area of the head retainer surface where the gauge feet make contact with the unworn surface.

   Measure head retainer wear step at the 10, 11, 12, 1, and 2 o'clock positions. Head retainer wear steps are most prominent at these positions. To eliminate false indicator readings due to isolated fretting, move gauge slightly to the right and left of each o'clock position.

   Record readings obtained.

TOOL OPERATION

The following paragraphs describe the proper operation and maintenance of the head retainer resurfacing tool.

WARNING

Do not perform any of the following procedures, or attempt to make any adjustments while the cutting head is in motion.

AUTOMATIC HORIZONTAL FEED

SETTING FEED RATE

Horizontal (cross) feed rate is the distance the tool holder slide travels horizontally per tool revolution. This distance is set using the feed buttons numbered 1 through 12, located on the feed control collar, (5) Fig. 5.

Each feed button provides a slide feed of 0.020 mm (.0008″) per revolution. To obtain, for example, a feed rate of 0.122 mm (.0048″), six buttons must be pushed. To obtain smooth slide movement, feed buttons selected, should be evenly distributed over the periphery of the feed control collar. Referring to the above example, feed buttons numbered 2, 4, 6, 8, 10, and 12 would be pressed. Refer to Fig. 6 for other examples.

DECREASING FEED RATE

To decrease feed rate, it is necessary to release all feed buttons first. The lower feed rate is then established by pressing the appropriate feed buttons.

Use the following steps to release feed buttons.

1. Rotate retaining ring until retaining pin can be pushed into recess in feed control collar, Fig. 7.

2. Rotate cutting head assembly until stop rod holder is positioned between the two rod stops extending from the top of the tool body.

3. Insert stop rod into holder and between the rod stops.

4. While pressing retaining pin, insert round bar end of T-wrench, Fig. 7, into release ring hole. By jerking the T-wrench sharply toward the stop rod, the feed buttons will release. The resistance will vary according to the number of feed buttons engaged. The release of 12 buttons requires considerable force. A few buttons can be released simply by holding the feed control collar.

ENGAGING AUTOMATIC FEED

To engage the automatic horizontal feed, it is necessary to retain the feed control collar in a stationary position.

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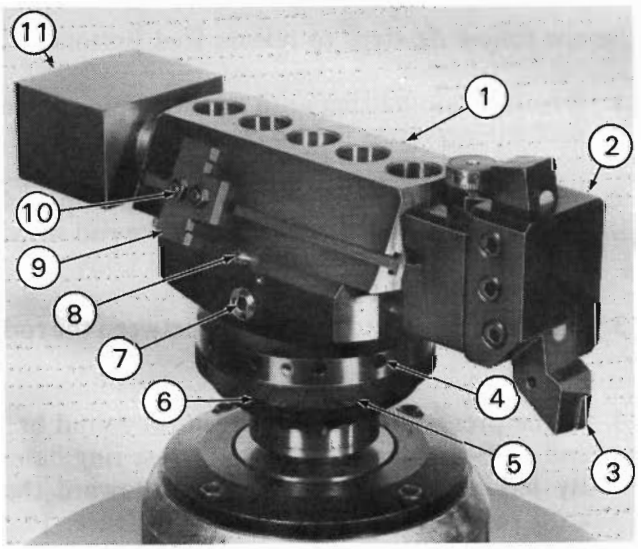
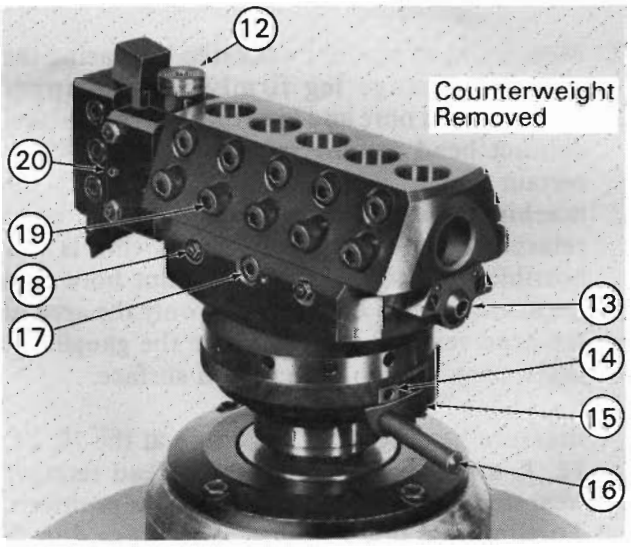
Fig.4 – Measuring Head Retainer Wear Step





1. Tool Holder Slide
2. Tool Holder
3. Cutting Tool
4. Feed Buttons
5. Feed Control Collar
6. Feed Control Collar Recess
7. Fine Setting Screw
8. Stop Pin
9. Stop Plate
10. Stop Plate Retention Nuts
11. Counterweight

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12. Tool Holder Depth Adjustment Dial
13. Rough Setting Screw
14. Release Ring
15. Retaining Ring And Stop Rod Holder
16. Stop Rod
17. Tool Holder Slide Lock Screw
18. Gib Screws
19. Clamping Screws
20. Vertical Lock Screw

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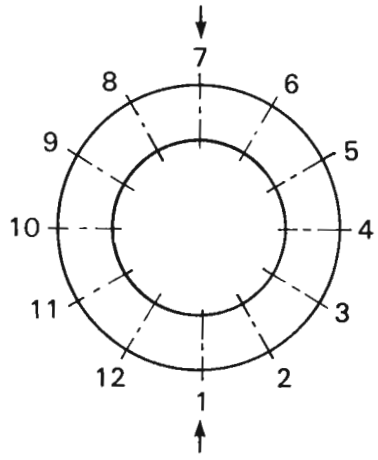
Fig.5 – Cutting Head Assembly

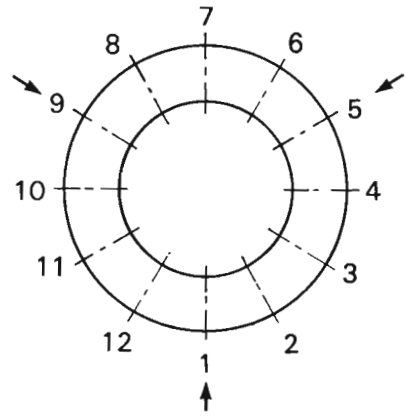
0.041 mm (.0016")*

Two Feed Buttons Required



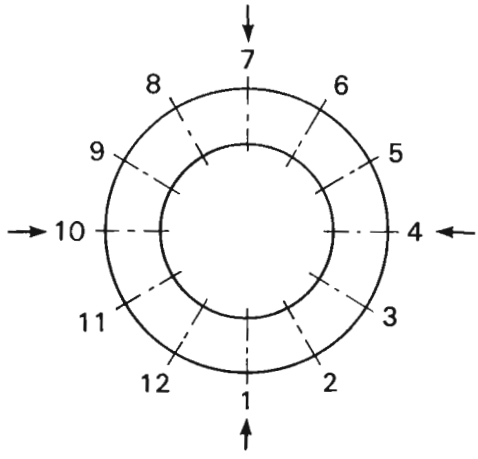
0.061 mm (.0024")*

Three Feed Buttons Required



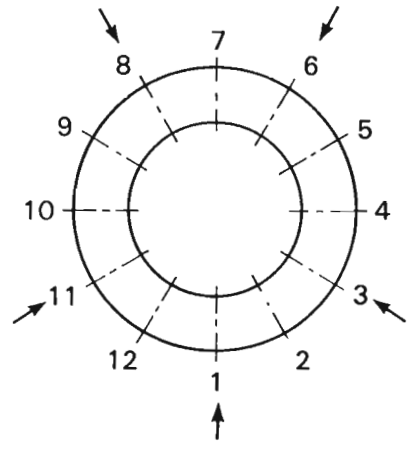
0.081 mm (.0032")*

Four Feed Buttons Required



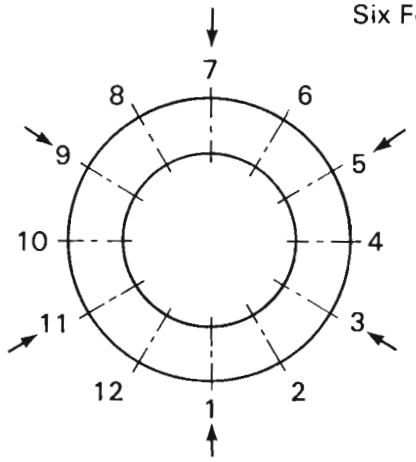
0.102 mm (.0040")*

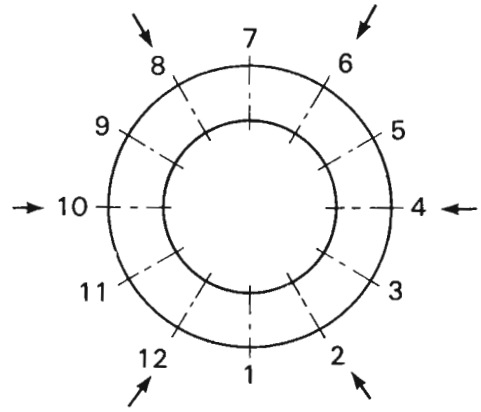
Five Feed Buttons Required



0.122 mm (.0048")*

Six Feed Buttons Required





*Feed travel per tool revolution.

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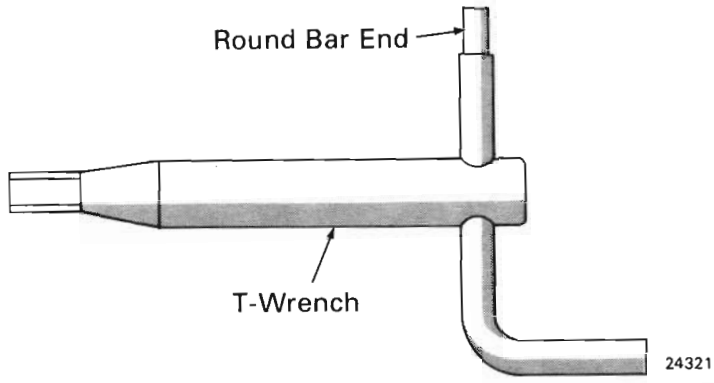
Fig.6 – Examples Of Feed Buttons To Be Pressed, For Specific Feed Rates



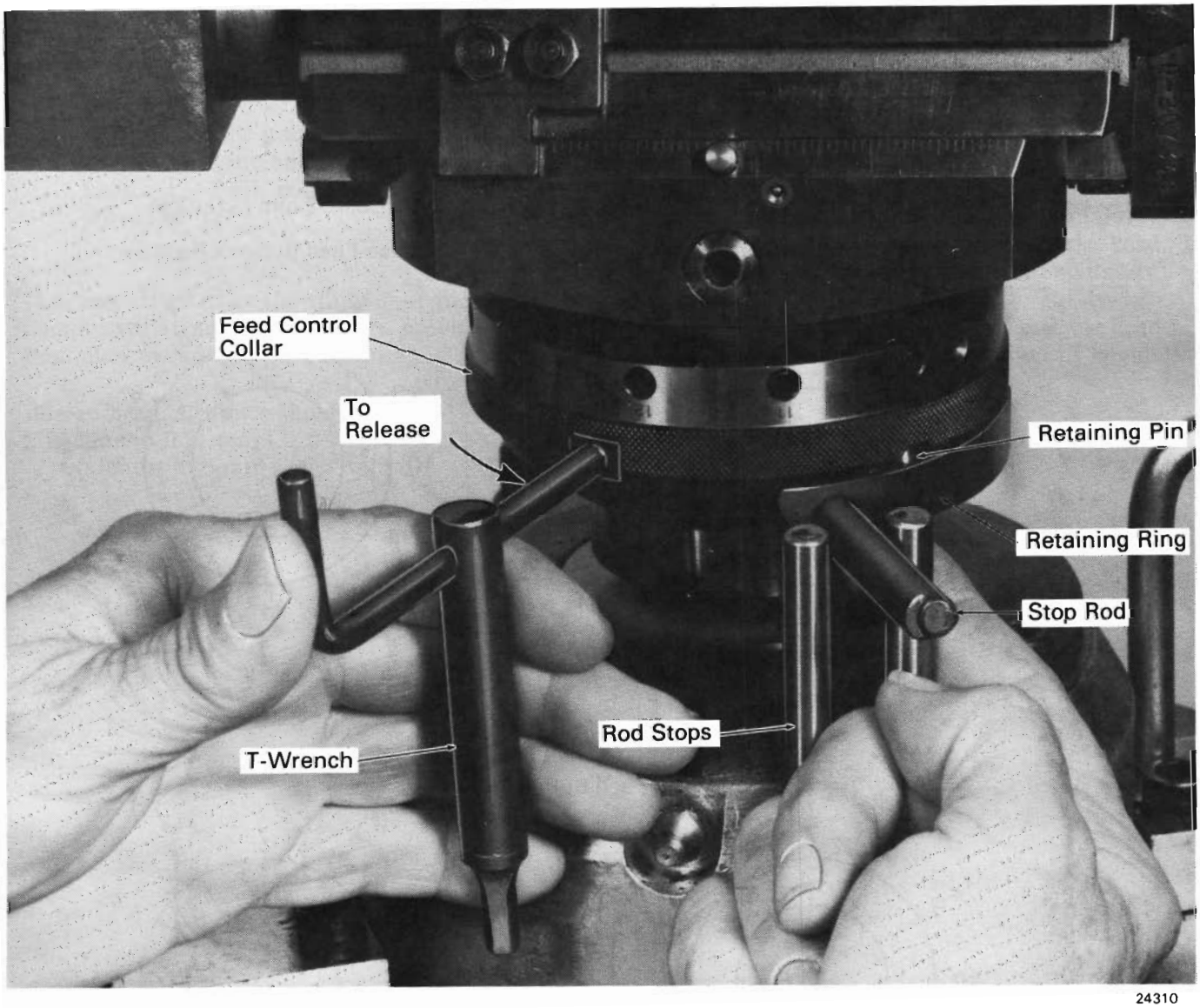


Fig.7 – Releasing Feed Buttons

1. Confirm that tool holder slide lock screw, Fig. 8, is not tightened. Use T-wrench to turn lock screw.
2. Using T-wrench and extension piece, turn rough setting screw to determine if tool holder slide will move smoothly over the entire feed range. If movement is rough, adjust gib screws, Fig. 8, and clean slide surface. If lubrication is required, see lubrication section.
3. Rotate retaining ring until retaining pin can be pushed into recess in feed collar. Fig. 9.

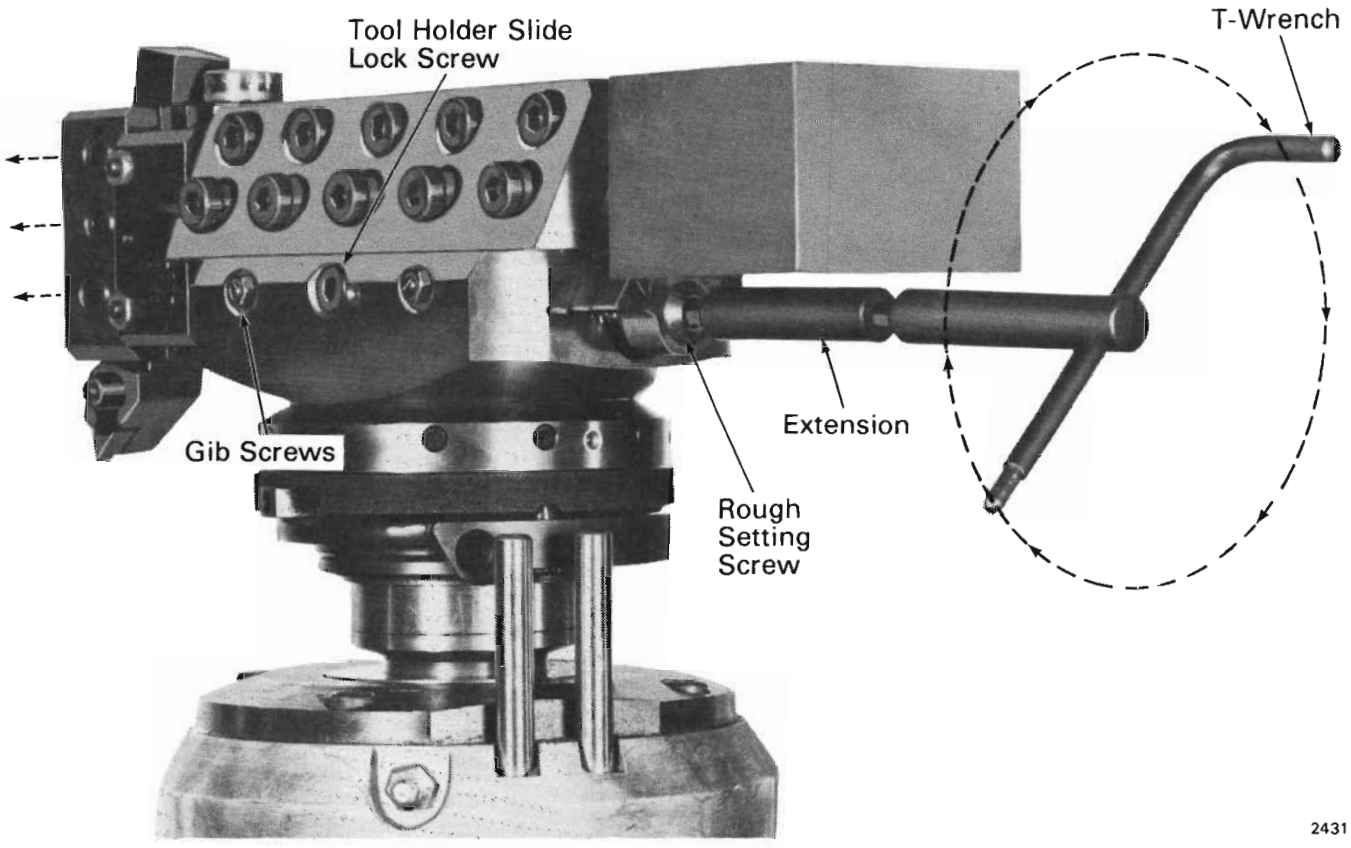


Fig.8 – Manual Operation Of Tool Holder Slide

4. Rotate cutting head assembly until stop rod holder is positioned between the two rod stops extending from the top of the tool body.

5. Insert stop rod into holder and between the rod stops.

AUTOMATIC FEED STOP

Horizontal feed will stop automatically when the stop plate strikes the stop pin, (8) Fig. 5. Dull or broken cutting tools, that create excessive turning resistance, will also stop automatic feed operation.

The stop plate striking the stop pin will cause the release ring to force the retaining pin out of the feed control collar recess. The feed control collar is then disengaged from the retaining ring, allowing it to rotate with the cutting head.

ADJUSTING STOP PLATE

Use the following steps to adjust horizontal feed stop plate, when tool is installed.

1. Using a small open end wrench, loosen stop plate retention nuts, Fig. 10.

2. Insert T-wrench with extension into rough setting screw and rotate screw in direction of arrow until cutting tool edge is adjusted to the proper diameter, Fig. 8.

3. Slide stop plate toward stop pin, Fig. 10, until they touch. Tighten retention nuts.

ADJUSTING STOP SENSITIVITY

A regulating screw, Fig. 10, is provided to adjust pressure required to release the retaining pin to stop feed travel. Tensile strength of the material being cut, depth of cut, and cutting speed are things to be considered when adjusting stop sensitivity. To maintain high sensitivity and long service life of the release mechanism, make certain that regulating screw is not tightened more than necessary.

SETTING DEPTH OF CUT

Use the following steps to set depth of cut, before machining.

1. Loosen vertical lock screw, Fig. 11.

2. Using an Allen wrench, turn tool holder depth adjustment dial counterclockwise to raise cutting tool above surface to be machined.

3. Position cutting tool over highest spot to be machined, by turning rough setting screw with T-wrench, Fig. 8.

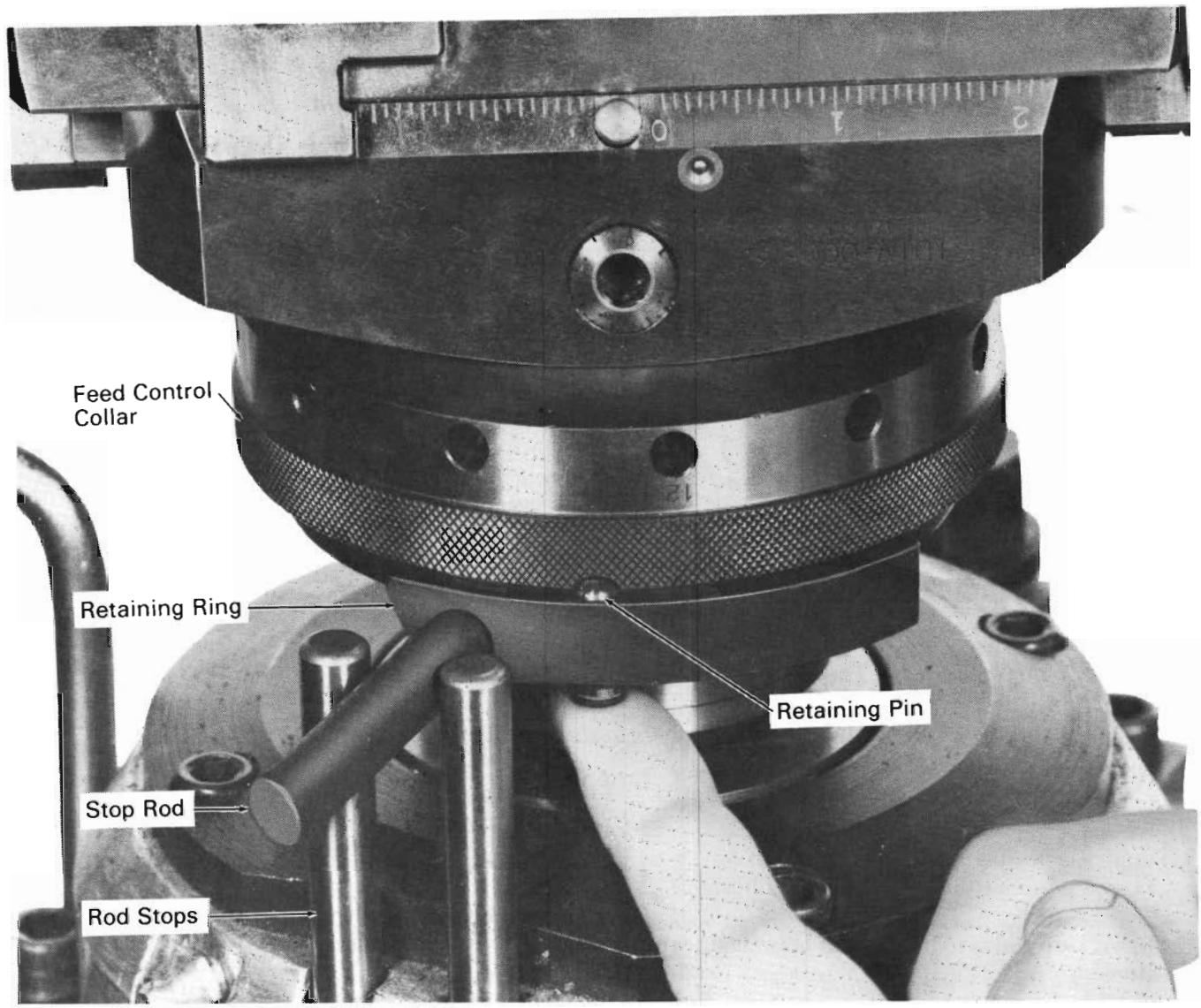


Fig.9 - Engaging Automatic Horizontal Feed

4. Turn depth adjustment dial clockwise to lower cutting tool to within .001″ or .002″ of the head retainer surface, using a dial indicator mounted to the cutting head or a feeler gauge under the cutting tool. Note reading on depth adjustment dial.

5. Return cutting tool to starting position, by turning rough setting screw. Remove dial indicator.

Depth of cut can now be set by turning depth adjustment dial clockwise. Each graduation on dial lowers the cutting tool .0005″. When setting cut depth, keep in mind that cutting tool is set .001″ or .002″, as set in Step 4, above retainer surface. Tighten vertical lock screw after setting depth of cut.

NOTE

Keep track of total material removed from head retainer, by noting depth adjustment dial reading before each machining pass.

CHANGING CUTTING TOOLS

Each triangle shaped cutting tool has six interchangeable cutting surfaces. To change cutting tool (surface), loosen retainer arm set screw, Fig. 12. Turn lock pin to remove cutting tool.

NOTE

Expected tool life is 24 cylinders, with each cutting surface changed after four cylinder head retainers have been machined.

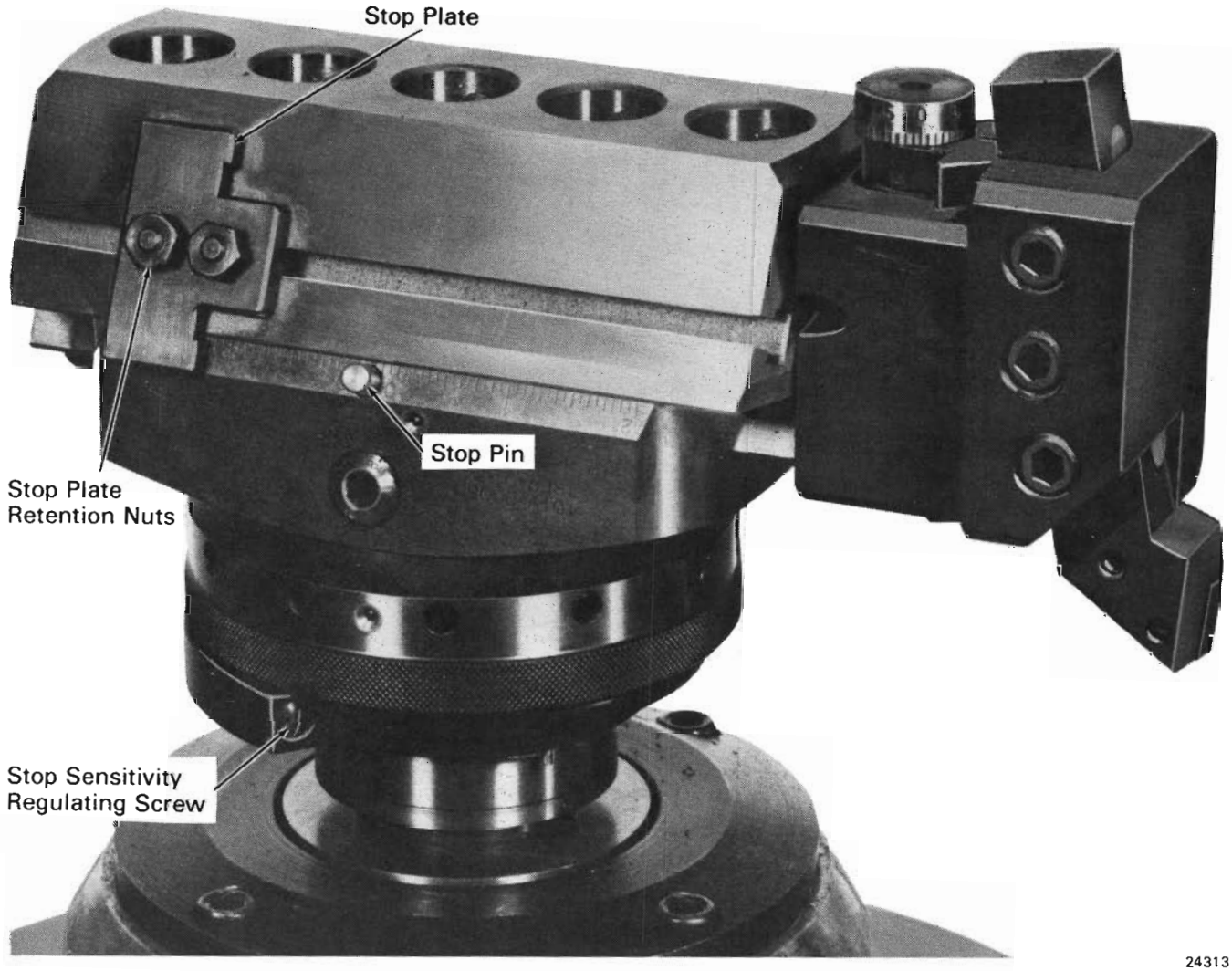


Fig.10 - Adjusting Automatic Feed Stop And Stop Sensitivity

LUBRICATION

Before starting machining operations, the resurfacing tool should be lubricated. Ball bearing grease of medium consistency with a dripping point of approximately 180° C (350° F) is recommended.

SLIDEWAYS

Slideways are greased through two fittings. One fitting is located on each side of the cutting tool head, Fig. 13.

TOOL HEAD DRIVE

The tool head drive is lubricated through four grease fittings. One located on the feed control collar between feed buttons numbered 9 and 10. The other three are located on the resurfacing tool body, Fig. 13.

HEAD RETAINER RESURFACING

Resurfacing of the head retainer is accomplished by removing material from the high (unworn) side of the wear step, thus lowering and blending it with the low (worn) side. The amount of material to be removed by machining is dependent on the severity of the wear step.

After machining, the head retainer surface to crankshaft centerline distance is restored to approximately the original dimension by using oversize head seat rings. Oversize head seat rings are available either .018″ or .038″ over the standard .192″ thickness. To standardize the engine, oversize head seat rings should be installed only in full engine sets.

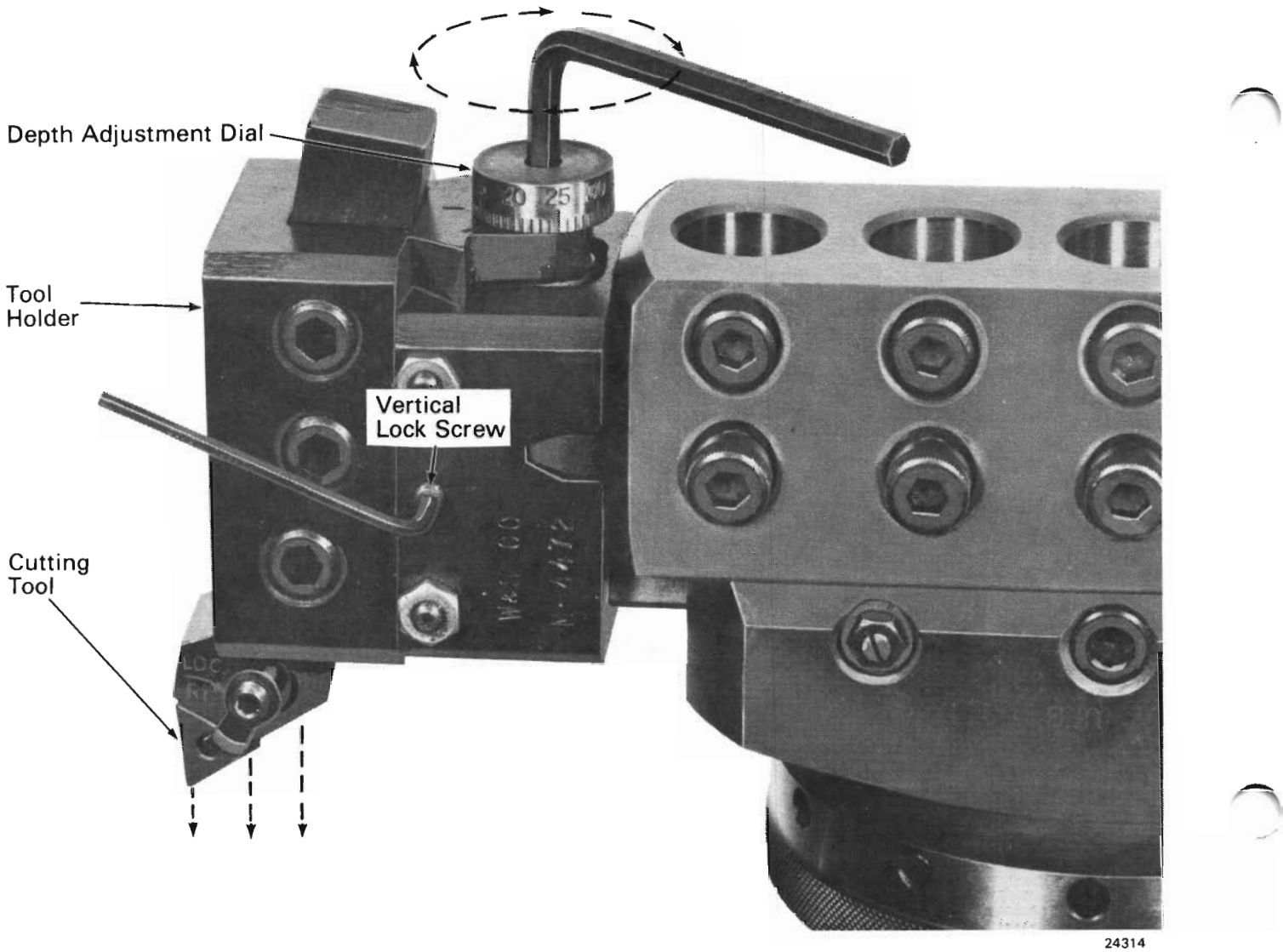


Fig.11 – Setting Depth Of Cut

NOTE

If engine crankcase is scheduled to be line bored, it is recommended that the line bore operation be performed before head retainer resurfacing operation.

A change in the distance between the head retainer surface and the crankshaft centerline, may result due to line boring. This distance is critical for the selection of the proper thickness head seat ring.

PROCEDURE

The following procedure is to be used as a guideline while performing head retainer resurfacing.

WARNING

Do not attempt to make any adjustments to the cutting head, while head is in motion.

To avoid accidental injury, eye protection must be worn. Loose fitting clothing should be avoided.

1. Prepare engine by removing power assemblies and covering water discharge elbow openings. If top deck head frames and covers have been removed from the engine, these pieces should be installed and used as guards when operating the resurfacing tool.

   Due to lower liner insert wear, it is recommended that lower liner inserts be renewed.

2. Locate head retainer having the greatest wear step, using the data obtained during Head Retainer Inspection. Start machining operations with this head retainer.

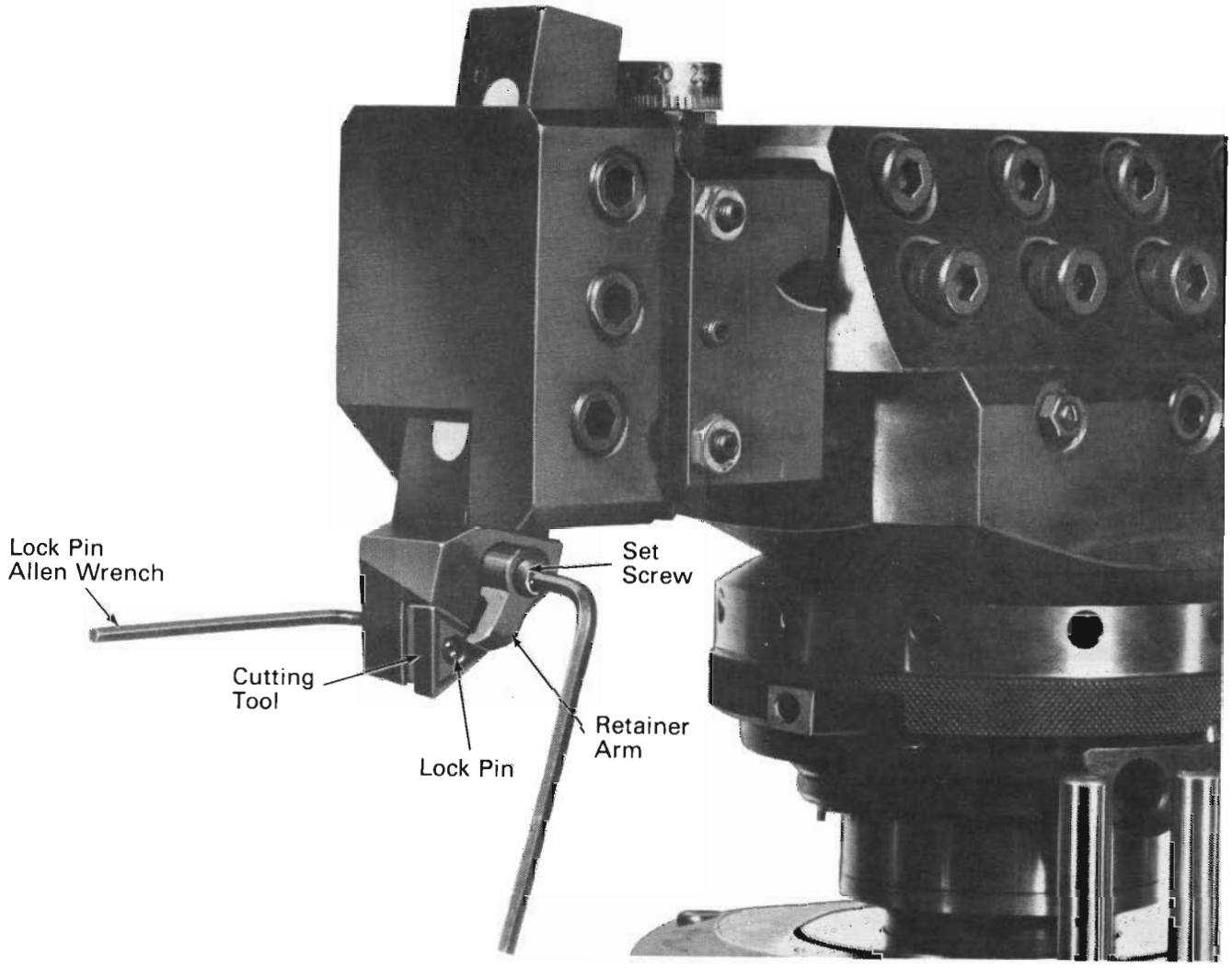


Fig.12 - Changing Cutting Tools

3. Remove tool from container using a suitable lifting sling and hoist. Secure sling through the lifting shackles provided on the top of the tool body. Arrange sling through shackles so that no pressure is exerted on the cutting tool head while lifting. The tool weighs approximately 104 kg (230 lbs).

4. With cylinder pilot bores and tool body clean, lower resurfacing tool into the engine crankcase at the same angle as a cylinder power assembly, Fig. 14. Lifting shackles should be parallel to length of engine.

NOTE

Air connection fitting should show through air box handhole.

5. Engage self-centering cam locking system by turning cam actuating nut located on top of tool body. Secure tool at lower pilot with two locking bars.

6. As shown in Fig. 15, hang air control manifold and tool holder tray on side of crankcase. Attach air control valve to air motor oiler. Connect short length of air hose from control valve to resurfacing tool, through air box handhole. With air control valve off, valve handle perpendicular to air pipe, attach supply air hose to air filter. A minimum of 621 kPa (90 psi) supply air is required.

NOTE

Air valve may be locked in the off position using locking holes provided in valve handle and body.

7. Check cutting head runnout using a dial indicator mounted to the cutting head. Mount indicator so that dial indicator button contacts the unworn portion of the head retainer, Fig. 16. Rotate cutting head by hand, noting dial indicator reading. Maximum allowable runnout is .005" TIR.

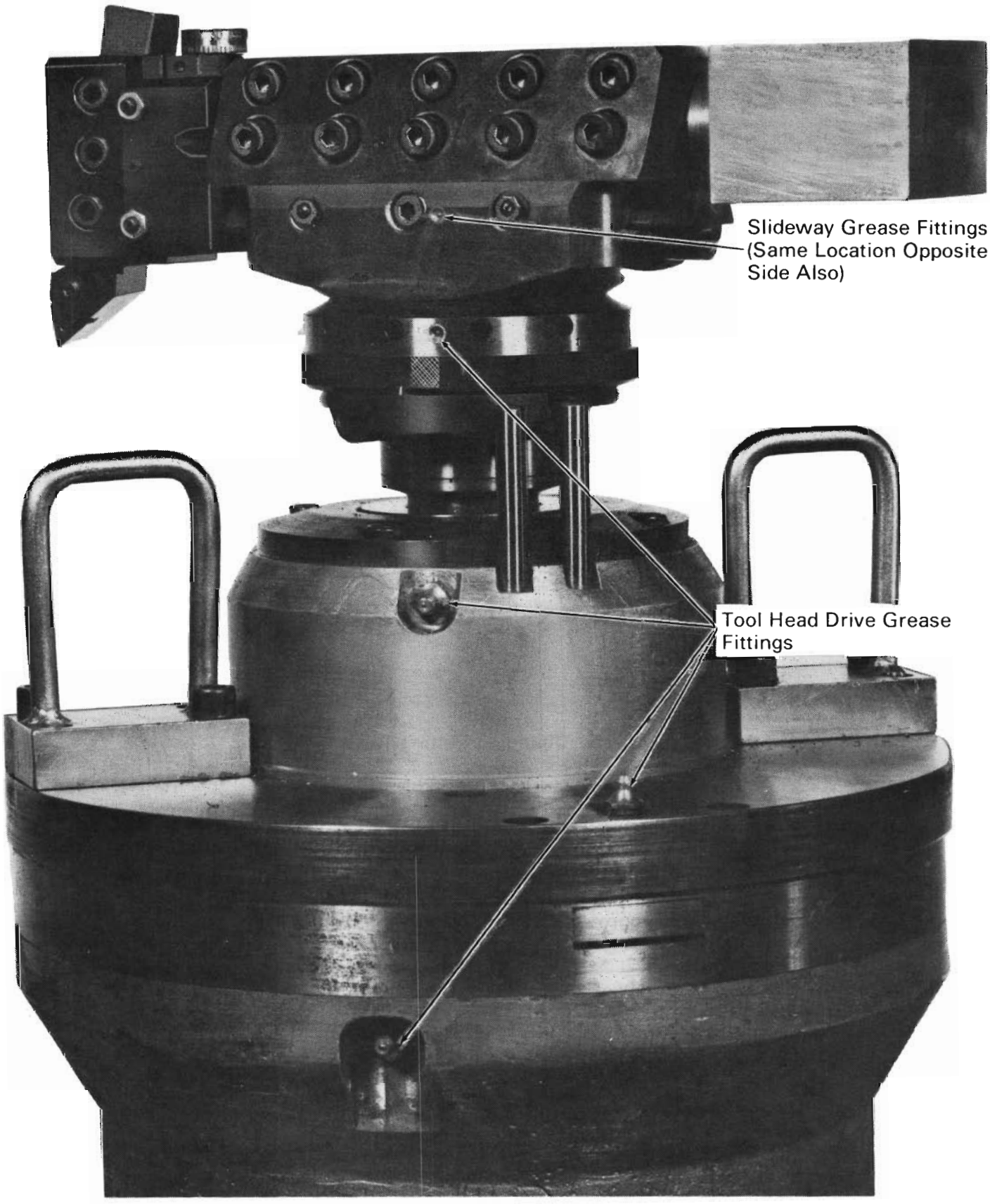


Fig.13 – Lubrication Fittings

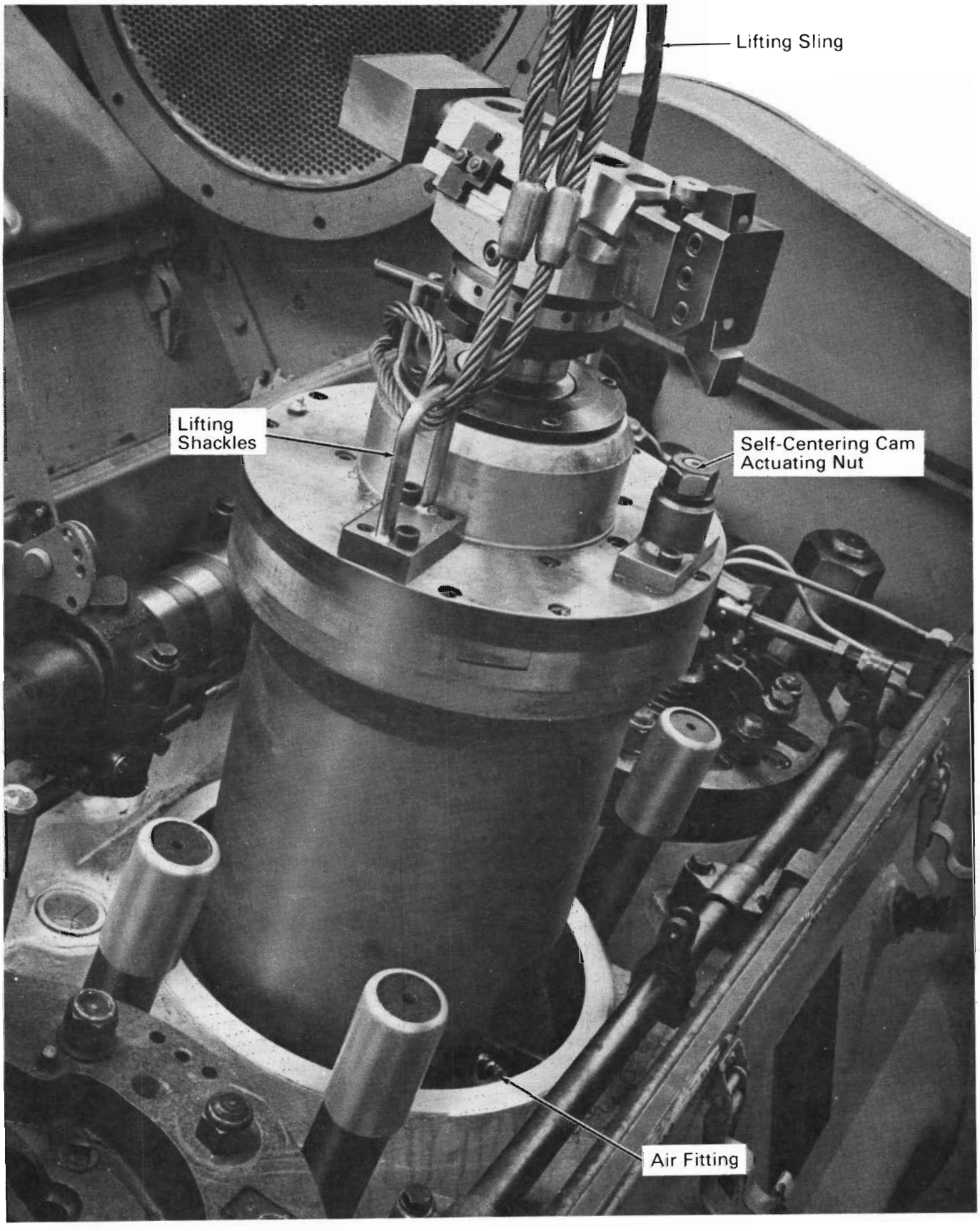


Fig.14 – Installing Resurfacing Tool

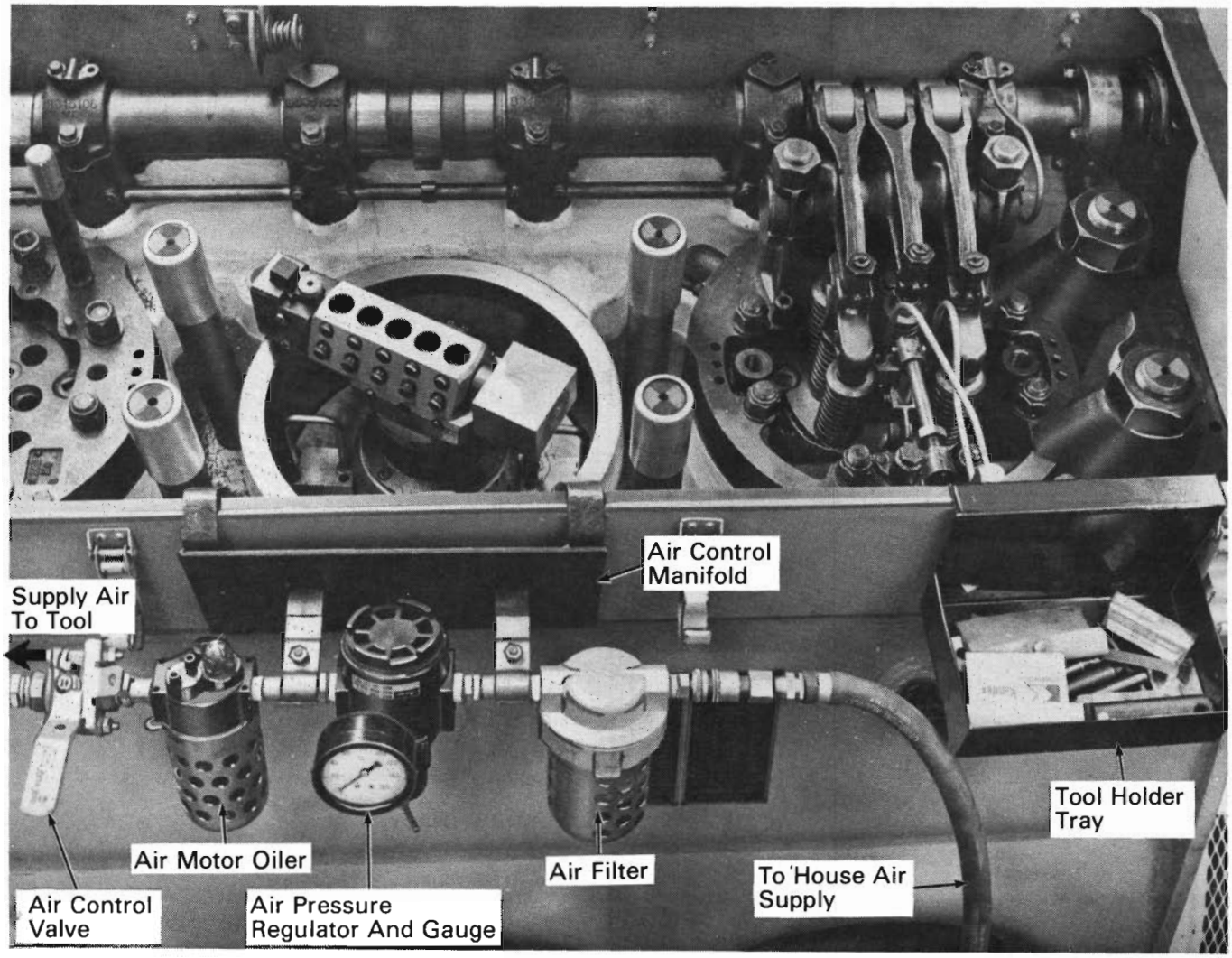


Fig.15 – Tool Operation 24318

Runnout in excess of .005″ TIR indicates that upper pilot bore is worn, causing the tool to be off center. In this case it will be necessary to place shims between the appropriate self-centering guide(s), and the upper pilot bore, to center tool. Recheck runnout with shims in place.

8. Set horizontal feed stop as outlined under Tool Operation.

9. Set horizontal feed rate and depth of cut as outlined under Tool Operation. Remove dial indicator if used.

   Horizontal feed rate and depth of cut may have to be varied, depending hardness of material, to produce a 5.08μm (200μ in.) finish on head retainer surface when final machining pass is completed. During initial machining passes, the depth of cut may be a maximum of 0.25 mm (.010″) at a fast feed rate. During the final machining pass, the depth of cut should be held to a 0.008 mm (.033″) maximum at a slow feed rate.

NOTE

Keep a record of material removed with each machining pass.

10. Rotate cutting head, checking for freedom of movement. Engage automatic feed as described under Tool Operation.

    Using rough setting screw and T-wrench, move cutting tool to starting point. Remove T-wrench.

11. Turn on air pressure. Adjust air pressure regulator to supply 345-414 kPa (50-60 psi) air pressure for correct tool cutting speed.

NOTE

Cutting chips which are twisted and blue, indicate proper initial cutting depth and feed rate. If chips become twisted around tool body, shutoff air and remove chips.

Adjust air motor oiler to deliver one drop of light machine oil every 30 seconds. Oil delivery can be observed through clear dome on top of

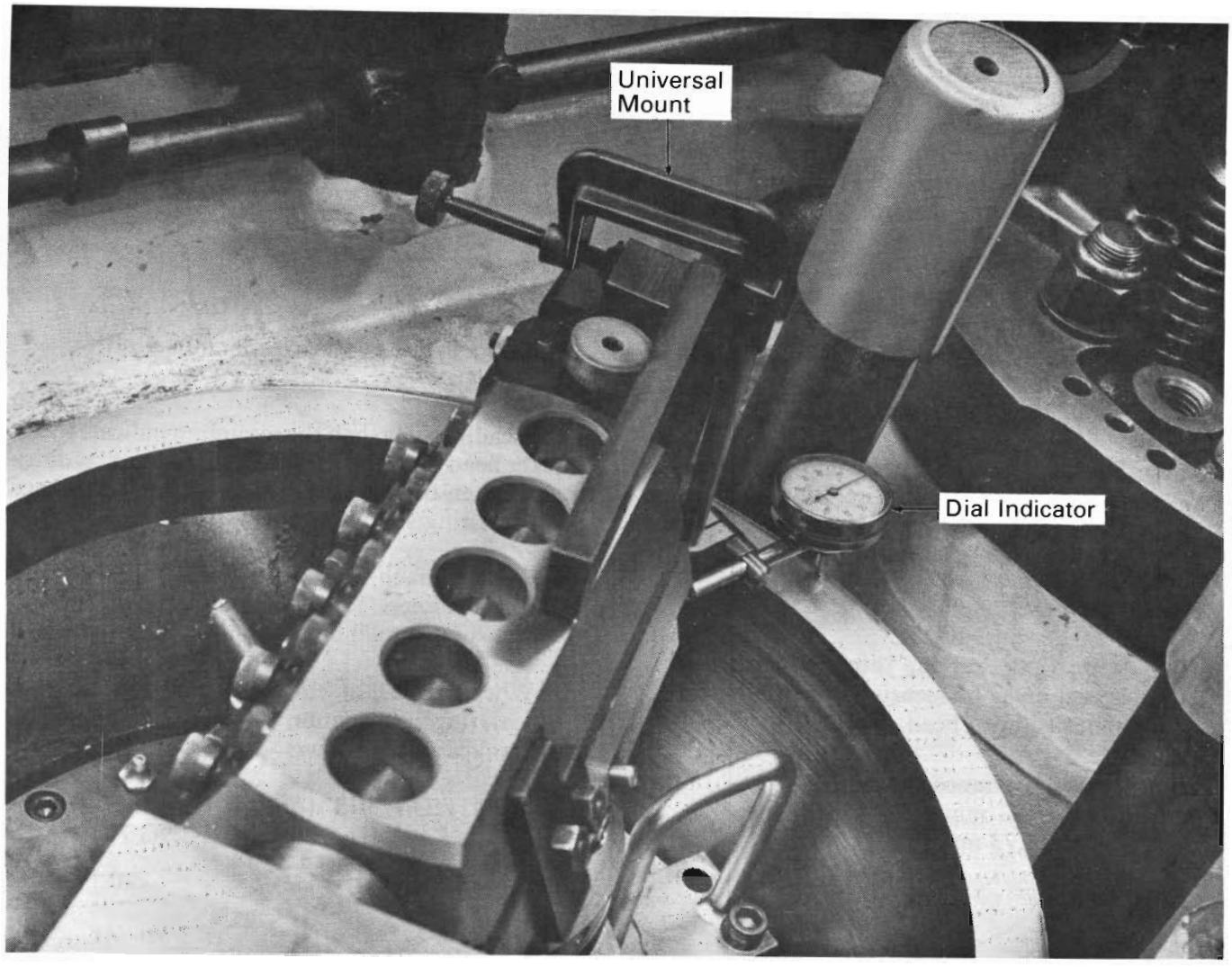


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Fig.16 – Checking Cutting Head Runnout

oiler housing. Oil delivery rate may be adjusted using the small screw located on top of the oiler housing.

NOTE

Automatic feed will stop when tool reaches the outside diameter of the head retainer, provided stop was correctly set.

Tool will continue to rotate until air control valve is turned off.

12. When full feed travel is reached, turn off air control valve. Manually retract cutting head and repeat Steps 9, 10, and 11 until head retainer wear step is removed.

13. When machining is complete, remove resurfacing tool and install a cylinder power assembly as described in the Engine Maintenance Manual.

NOTE

Cylinder power assembly to be installed should be representative (new, requalified, rebuilt, etc.) of those to be installed when engine is reassembled.

Selection of the proper thickness head seat ring should be based on amount of material removed, during resurfacing operation. Final determination will be made when piston to head clearance is obtained in Step 14.

14. It is important to determine the piston to head clearance after machining the head retainer surface. This will provide the final criteria for selection of the proper thickness head set ring.

    The procedure for determining piston to head clearance using lead wire and lead wire holder is as follows:

a. Using a piston of the same size as the one being checked, place a length of 1/8" diameter lead wire in each end of the wire holder. When positioned on top of the piston, each end of the wire should be at least 3.18 mm (1/8") from the outside diameter of the piston.

b. Bar the engine over until the piston being checked is at bottom dead center.

c. Apply the lead wire through a liner port and position it on top of the piston so that it is parallel with the crankshaft.

d. Bar the engine over one complete revolution to compress the lead wire. Remove the wire from the engine and measure the inboard portion of both compressed ends of the wire, Fig. 17.

NOTE

It is important that the thinner of the two compressed areas be measured to provide the minimum piston to head clearance.

Piston to head clearance should be:
Minimum 0.51 mm (.020")
Maximum 1.73 mm (.068")

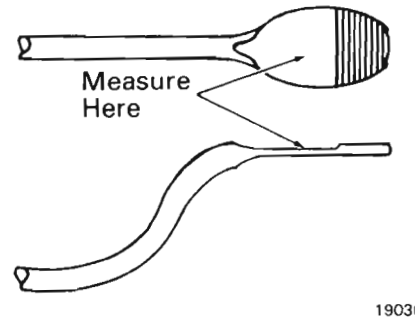

Fig.17 - Lead Wire Measurement

Lead readings less than the minimum indicate that a thicker head seat ring should be used. Lead readings greater than the maximum indicates that a thinner head seat ring should be used.

15. Repeat machining operations on remaining head retainers. Keep in mind that oversize head seat rings should be used only in full engine sets.

    When engine is assembled, stencil oversize head seat ring information on each side of engine crankcase, as follows:

    "CAUTION: .018" (or .038") OVERSIZE HEAD SEAT RINGS."

SERVICE DATA

SPECIFICATIONS

Head Retainer Wear Step - Maximum	0.25 mm (.010″)
Head Retainer Surface Finish	5.08μm (200μ in.)
Piston To Cylinder Head Clearance	
Minimum	0.51 mm (.020″)
Maximum	1.73 mm (.068″)
Tool Runout - Maximum	0.13 mm (.005″)
Air Pressure	
Supply - Minimum	621 kPa (90 psi)
Regulator	345-414 kPa (50-60 psi)
Horizontal Feed Rate/Revolution (each feed button)	0.020 mm (.0008″)
Vertical Tool Movement/Graduation Of	
Depth Adjustment Dial	0.013 mm (.0005″)
Direction Of Rotation	Counterclockwise

EQUIPMENT

Lead Wire Holder	8243220
Lead Wire - 1/8″ Diameter - 5 lb Spool	8243661
Dial Indicator, With Attachments (Universal Mount .001″ to .100″)	8245423
Head Retainer Wear Step Gauge (Less Dial Indicator)	9320750
Wear Step Gauge Calibration Block	9320756
Resurfacing Tool	9509391
Dial Indicator For Head Retainer Wear Step Gauge (.001″ to .100″)	Federal P.N. V8I
Head Seat Rings	Aluminum-Bronze
Standard .192″ Thick	9509180
.018″ Oversize (.210″ Thick)	9516094
.038″ Oversize (.230″ Thick)	9509803

Litho in U.S.A.