CATERPILLAR®

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May 2010

# TOOL OPERATING MANUAL

## Using the 223-2454 Tool Group on 3114, 3116, and 3126 Engines with Mechanical Unit Injectors (MUI)

SMCS Code: 1250

# Important Safety Information


***Think Safety***

Most accidents that involve product operation, maintenance, and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills, and tools to perform these functions properly.

**Improper operation, lubrication, maintenance, or repair of this product can be dangerous and could result in injury or death.**

**Do not operate or perform any lubrication, maintenance, or repair on this product until you have read and understood the operation, lubrication, maintenance, and repair information.**

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING”, or “CAUTION”. The Safety Alert “WARNING” label is shown below.

**⚠ WARNING**

The meaning of this safety alert symbol is as follows:

**Attention! Become Alert! Your Safety is Involved.**

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

**Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all-inclusive. If a tool, procedure, work method, or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.**

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job.

**⚠ WARNING**

**When replacement parts are required for this product, Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength, and material.**

**Failure to heed this warning can lead to premature failures, product damage, personal injury, or death.**

# Contents



# Literature Information

This manual should be stored with the tool group.

This manual contains safety information, operation instructions, and maintenance information.

Some photographs or illustrations in this publication show details that can be different from your service tool. Guards and covers might have been removed for illustrative purposes.

Continuing improvement and advancement of product design might have caused changes to your service tool, which are not included in this publication.

Whenever a question arises regarding your service tool or this publication, please consult Dealer Service Tools (DST) for the latest available information.

## Safety Section

The Safety section lists basic safety precautions.

Read and understand the basic precautions listed in the Safety section before operating or performing maintenance and repair on this service tool.

## General Information Section

The General Information section describes tooling functions and features. It provides useful information on individual parts, additional tooling, and resources.

# Literature Information (continued)

## Operation Section

The Operation section is a reference for the new operator and a refresher for the experienced operator.

Photographs and illustrations guide the operator through correct procedures for using the tool group.

Operating techniques outlined in this publication are basic. Skill and techniques develop as the operator gains knowledge of the service tool and its capabilities.

# Safety Section

## Safety Icon Nomenclature

### Personal Protection


Read the manual


Eye protection


Face protection

### Prohibited Action


No smoking

### Hazard Avoidance


Fire hazard


Pressurized air


Slipping hazard


Tripping hazard

# Safety Warnings

**⚠ WARNING**

**To avoid personal injury or death, carefully read and understand all instructions before attempting to operate any equipment or tools. Do not operate or work on a machine unless you read and understand the instructions and warnings in this and all other applicable manuals. Contact Dealer Service Tools for replacement manuals. Proper care is your responsibility. Always follow all State and Federal health and safety laws and/or local regulations.**

**To avoid eye injury, always wear protective glasses or face shield. Make sure no one can be injured by flying objects or debris when using tools or working on a component.**

**Clean up all leaked or spilled fluids immediately. Oil, fuel, or cleaning fluid leaked or spilled onto any hot surfaces or electrical components can cause a fire, resulting in personal injury or death.**

**Personal injury can result from slips or falls. DO NOT leave tools or components laying around the work area and clean up all spilled fluids immediately.**

**Personal injuries can occur as a result of using pressurized air. Maximum air pressure at the nozzle must be below 205 kPa (30 psi) for cleaning purposes. Wear protective clothing, protective glasses, and a protective face shield when using pressure air.**

# General Information Section

## Introduction

The 223-2454 Tool Group is used to check and perform all on-engine fuel system adjustments, including injector synchronization, timing, and fuel setting (rack) on Caterpillar 3114, 3116, and 3126 Engines equipped with mechanical unit injectors (MUI). The group also includes tools to remove and install the unit injectors and adjust the valves.

The new group replaces the 1U-6680, 9U-7305, and 128-8822 Tool Groups. The new tools are available individually to update former groups at a considerable cost savings, and offers the advantage of simplified tooling which provides more accurate adjustments in less time.

## Features of 223-2454 Tool Group

### Injector Synchronization

The new 128-9640 Injector Synchronizing Fixture Group replaces the former 9U-7276 Linkage Spring-Loading Tool and 9U-7275 Support. The new fixture features a spring-loaded plunger which pushes directly on the end of the number 1 injector rack head. It is used in conjunction with the 9U-7270 Synchronizing Gauge Block (3.5 mm) or 220-0123 Synchronizing Gauge Block (3.0 mm), which can be attached directly to the fixture.

The 128-8823 Long Nose Locking Pliers is used to clamp directly to the control rod (in-between two rocker stands), and is used as a lever to actuate the control rod in the fuel-on and fuel-off directions. This ability to actuate the rack in both directions is necessary for consistent readings when using the new procedure; the pliers replace the former 9U-7264 Linkage Lever.

### Timing

The 123-4940 Magnetic Timing Indicator Fixture, used with the direct-reading 1U-8869 Programmable Digital Position Indicator and associated tooling, moves quickly from injector to injector to make checking or adjusting the timing quick and easy.

**NOTE:** The 123-4940 Magnetic Timing Indicator Fixture replaced the original 9U-7308 Magnetic Base, in order to adapt to an engine change to large-diameter elephant's foot rocker connections.

New high-quality, deep offset, box wrenches are also part of this group, making timing adjustment easier.

### Fuel Setting

The 128-8827 Fuel Setting Pin is an improved version of the 9U-7271 Pin; made easier to use in the very tight space that is available. It works on all versions of governors.

The 130-2711 Holding Tool is used to hold the fuel setting pin against the governor housing face. It is a redesigned version of the older 1U-6681 Holding Tool (part of the 1U-6680 Tool Group), with modifications to make it easier to insert and allow alternate handle locations. The 130-2711 Holding Tool replaces the 9U-7265 Clamp Assembly (part of 9U-7305) which would not adapt to the later "Type V" version governor.

### Valve Adjustment

The new double-ended (intake/exhaust) 123-4941 Valve Setting Feeler Gauge has special, short, offset 45 degree legs. This design greatly simplifies setting valves on newer engines with a larger diameter elephant's foot, and works on any engine with 0.38 mm (.015 in) intake and 0.64 mm (.025 in) exhaust valve lash.

New high-quality, deep offset, box wrenches make valve adjustments easier.

### Injector Installation

The 1U-8013 (5 mm) Hex Bit Driver is included to tighten the injector hold-down bolt which helps to reduce combustion gas leaks.

## Tooling Nomenclature

The tools shown in this chart are required to complete the synchronization and adjusting procedures provided in this manual and in the machine's Service Manual.

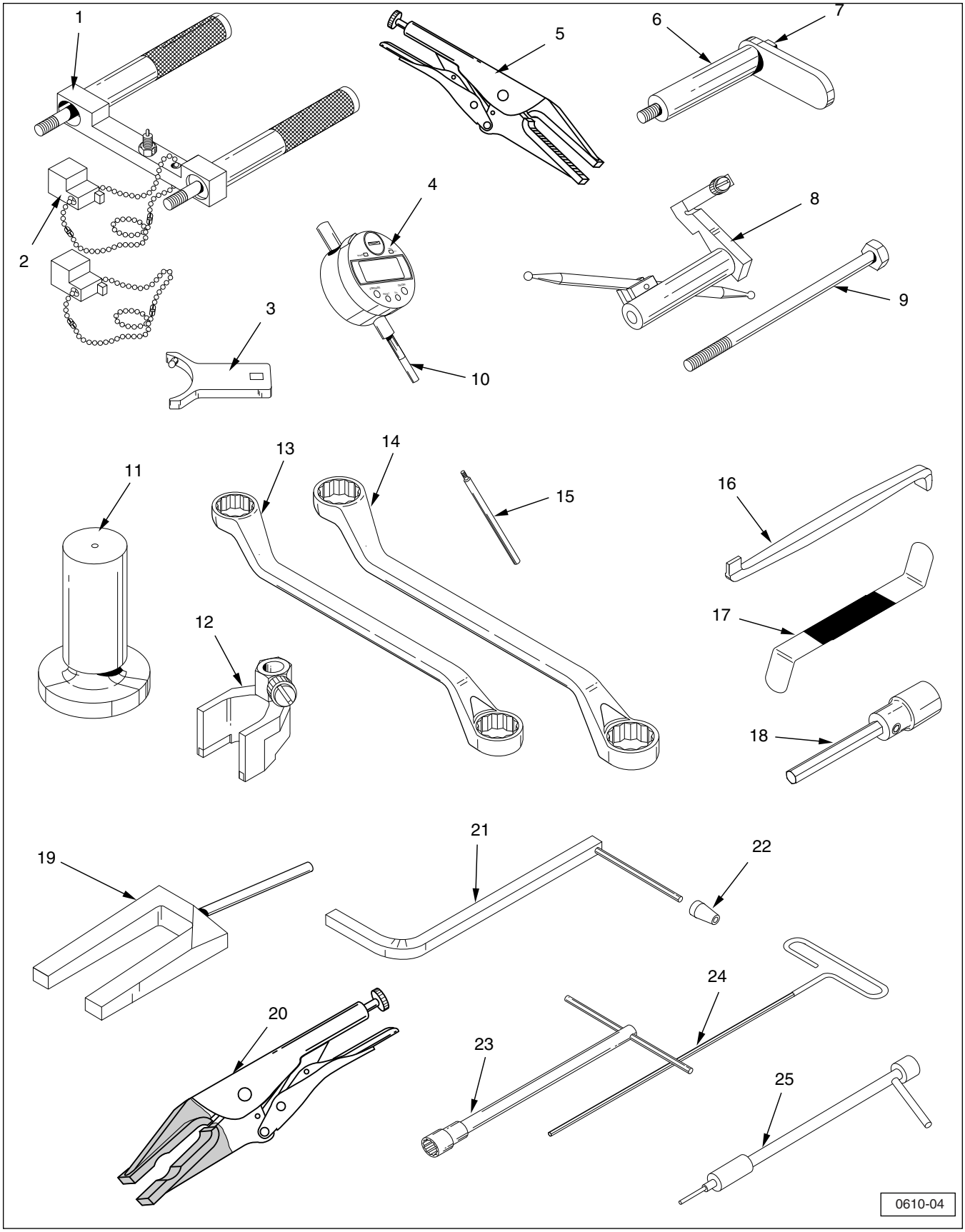
| Nomenclature for 223-2454 Tool Group | | | | | |
|---|---|---|---|---|---|
| | | | | Tools Required to Upgrade Former Groups | |
| Item | Part No. | Description | Qty. | 9U-7305 | 1U-6680 |
| | | **Synchronization Tooling** | | | |
| 1 | 128-9640<br>128-8706 | Injector Synchronization Fixture Group<br>Spring Plunger (serviceable part) | 1 | X | X |
| 2 | 9U-7270<br>220-0123 | Sync Gauge Block, 3.5 mm<br>Sync Gauge Block, 3.0 mm | 1<br>1 | | X |
| 3 | 9U-5120 | Solenoid Spanner Wrench | 1 | | |
| 4 | 1U-8869 | Digital Position Indicator | 1 | | X |
| 5 | 128-8823 | Locking Long Nose Pliers, 150 mm (6.0 in) long | 1 | X | X |
| 6 | 1U-6675 | Spring Compressor | 6 | | |
| 7 | 8T-4177 | Bolt, Spring Compressor | 6 | | |
| 8 | 9U-7282<br>9U-6272 | Indicator Fixture Group<br>Nylon Screw (serviceable part) | 1 | | |
| 9 | 8C-4984 | Bolt, Indicator Stand | 1 | | |
| 10 | 9U-7263 | Contact Point [18.5 mm (.73 in) long] | 1 | | X |
| | | **Fuel Timing Tooling** | | | |
| 11 | 9U-7269 | Timing Gauge Block | 1 | | X |
| 12 | 123-4940[2] | Magnetic Base Group | 1 | X[2] | X |
| 13 | 128-8824 | Deep Offset Wrench, 16 mm and 18 mm | 1 | R | R |
| 14 | 128-8825 | Deep Offset Wrench, 17 mm and 19 mm | 1 | R | R |
| 15 | 9U-7274 | Contact Point, [85 mm (3.35 in) long] | 1 | | |
| | | **Miscellaneous Engine Tools** | | | |
| 16 | 5P-0302[3] | Injector Removal Bar | 1 | | |
| 17 | 123-4941[3] | Valve Setting Gauge (feeler gauge for adjusting valves) | 1 | X | X |
| 18 | 194-3542[3] | Hex Socket Bit Driver, 5 mm | 1 | R | R |
| | | **Fuel Setting Tooling** | | | |
| 19 | 130-2711 | Fuel Setting Holding Tool | 1 | R | |
| 20 | 136-4149 | Governor Connection Pliers | 1 | | |
| 21 | 128-8827 | Fuel Setting Pin Assembly | 1 | R | X |
| 22 | 1U-7523[3] | Pin Insert Pilot (use with 128-8827 Pin Assembly) | 1 | | X |
| 23 | 1U-7299 | Adjustment (FRC) Wrench (“Type V” 1994 and later Trucks) | 1 | X | X |
| 24 | 1U-7300 | T-Handle Wrench, 3 mm hex (“Type V” 1994 and later Trucks) | 1 | X | X |
| 25 | 1U-6673 | Injector Sync and FRC Adjust Wrench (all models, except “Type V” 1994 and later Trucks) | 1 | | |
| — | 6V-7145 | Case | 1 | | |
| — | 128-8828 | Foam Insert Group | 1 | R | R |
| — | NEEG2688 | Decal | | R | R |
| — | NEHS0610 | Tool Operating Manual | 1 | X | X |

X = Essential tools for new procedures.

R = Recommended or improved tools.

[2] Some of the former 9U-7305 Groups used the new 123-4940 Magnetic Base; check your specific tool group.

[3] Refer to the appropriate engine Service Manual for additional information on use of these tools.

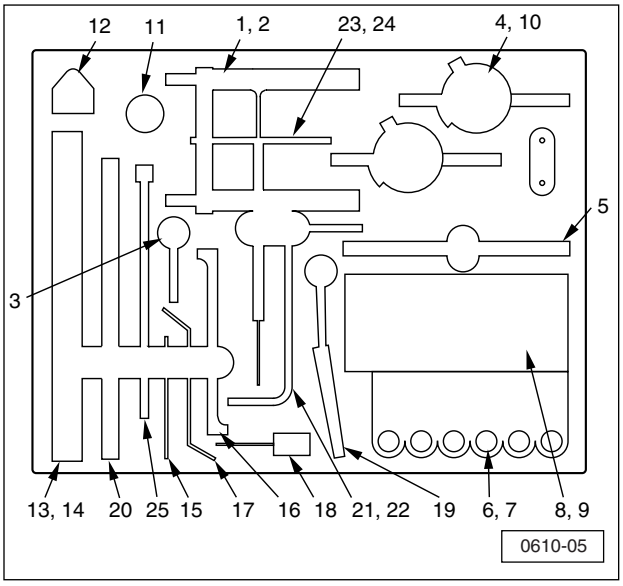



223-2454 Tool Group.

Refer to the Nomenclature for 223-2454 Tool Group chart for item identification.

## Tool Placement

The following illustration shows the placement of tools in the foam insert.




Placement Of Tools In The 223-2454 Tool Group. Refer To Tooling Nomenclature For Item Identification.

**NOTE:** One dial indicator is included in the 223-2454 Tool Group, which is all that is required to perform the procedures described in this manual.

# Operation Section

## Injector Synchronization

Injector synchronization is the setting of all injector racks to a reference position so each injector gives the same amount of fuel to each cylinder. This is done by setting each injector rack to the same position while the control linkage is in a fixed position (called the synchronizing position).

Synchronizing injectors is accomplished in this procedure by placing the Sync Gauge Block between the injector rack head pin and the injector body of number 1 injector.

**NOTE:** There is no adjustment screw in the control linkage lever for number 1 injector, since it is the reference point for all the other injectors. Therefore, no synchronizing adjustment is made for the number 1 injector.

Always synchronize an injector after it has been removed and reused/replaced. If the number 1 injector is reused or replaced, synchronization on ALL injectors must be checked and adjusted.

### Tooling and Equipment

The tools shown in Chart A "Injector Synchronization Tooling" are required to complete the synchronizing procedure.

**Chart A.**
**Injector Synchronization Tooling**

| Part No. | Description | Qty. | Item[1] |
|---|---|---|---|
| 128-9640 | Injector Synchronization Fixture Group | 1 | 1 |
| 9U-7270 | Sync Gauge Block | 1 | 2 |
| 220-0123 | Sync Gauge Block | 1 | 2 |
| 9U-5120 | Spanner Wrench (solenoid) | 1 | 3 |
| 1U-8869 | Position Indicator (digital) | 1 | 4 |
| 128-8823 | Locking Long Nose Pliers 150 mm (6.0 in) long | 1 | 5 |
| 1U-6675 | Spring Compressor | 6 | 6 |
| 8T-4177 | Bolt, Spring Compressor | 6 | 7 |
| 9U-7282 | Indicator Fixture Group | 1 | 8 |
| 8C-4984 | Bolt, Indicator Stand | 1 | 9 |
| 9U-7263 | Contact Point 18.5 mm (.728 in) | 1 | 10 |
| 1U-6673 | Adjustment Wrench | 1 | 25 |

[1] Refer to nomenclature chart, at the beginning of this manual, for item identification.

### Optional Removal of Rocker Arm Assembly

While synchronizing the injectors, removal of rocker arm assemblies will provide greater access and visibility of control linkage and injector rack. This procedure includes steps for removing rocker arm assemblies for both the number 1 injector and the injector being checked. However, removal of rocker arm assemblies is optional for the injector being checked. If the person performing the work is very familiar with the procedures and hardware involved, it is possible to check and adjust injector synchronization with the rocker mechanism in place.

NOTICE

Since visibility of control linkage and injector is very limited with rocker arm assembly in place, care must be taken to make sure the tooling is located properly and the procedure is completed correctly.

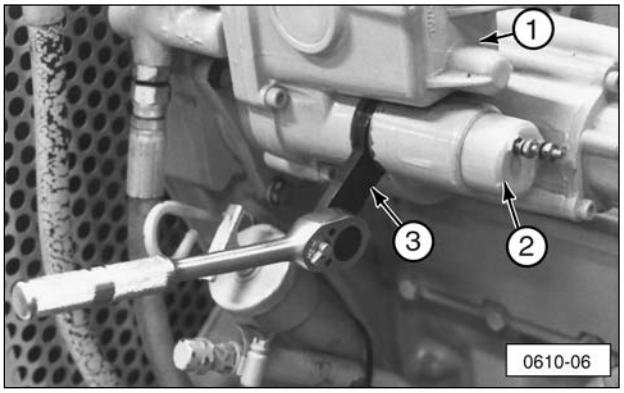
A complete set of 1U-6675 Spring Compressors is supplied in the 223-2454 Tool Group. This is useful when rebuilding an engine (or when a control linkage has been replaced) to allow all the injectors to be synchronized without the rocker arms in the way.

NOTICE

The injector spring must be slightly compressed to allow free movement of the injector rack. Either the rocker arm assembly or the 1U-6675 Spring Compressor (6) MUST be installed on all injectors to prevent internal damage to the injectors.

**NOTE:** If rocker arm assemblies are removed, checking valve clearance and fuel timing is recommended.

## Synchronizing Procedure



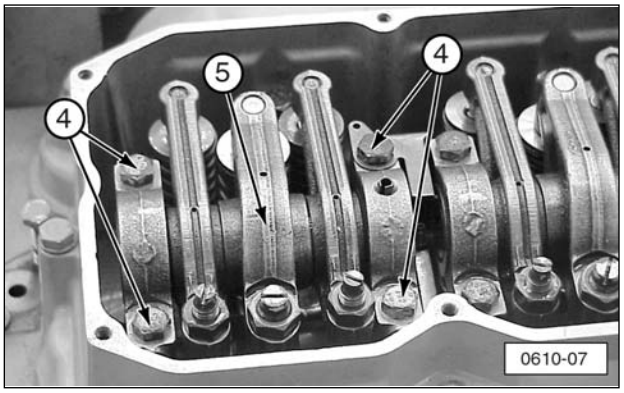

Fuel Shut-Off Solenoid (energize to run). (1) Governor. (2) Fuel Shut-Off Solenoid. (3) 9U-5120 Spanner Wrench.

**1**. Stop the engine and turn OFF its electrical system.

**2**. Remove fuel shut-off solenoid (2) using a 9U-5120 Spanner Wrench (3). Removing the solenoid allows free movement of injector rack control linkage during injector synchronization.

**3**. Remove the cylinder head valve cover.

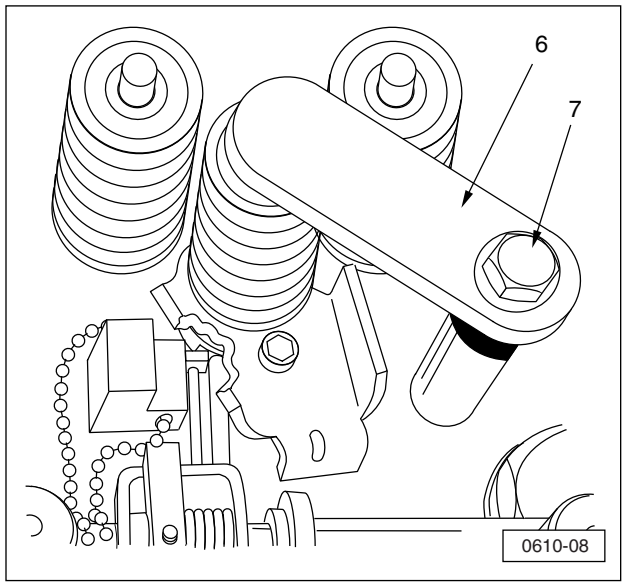
**4**. Remove four bolts (4) and number 1 cylinder rocker arm assembly (5). Remove the push rods (intake, exhaust, and injector), making sure to mark their location. The push rods should be reinstalled in their original locations to minimize readjustment of the valves.




Remove Number 1 Rocker Arm Assembly. (4) Bolts. (5) Rocker Arm Assembly.

**NOTE:** To prevent accidental disassembly, hold rocker arm assembly (5) level when removing from the engine.

**5**. Apply a small amount of clean engine oil to the top of the injector and install 1U-6675 Spring Compressor (6) and 8T-4177 Bolt (7) into the rocker arm bolt hole.




Install Spring Compressor On Number 1 Injector.
(6) 1U-6675 Spring Compressor. (7) 8T-4177 Bolt.

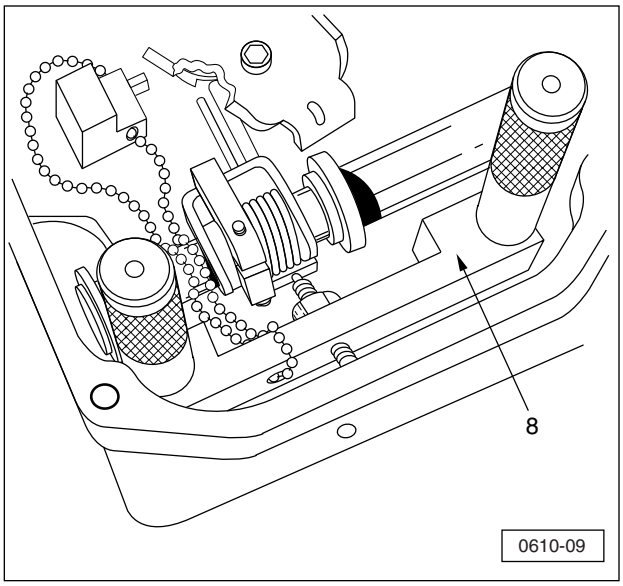
NOTICE

The injector spring must be slightly compressed to allow free movement of the injector rack. Either the rocker arm assembly or the 1U-6675 Spring Compressor (6) MUST be installed on all injectors to prevent internal damage to the injectors.

**6**. Install 128-9640 Injector Synchronization Fixture Group (8) by threading the two pins of the fixture group into the rocker arm bolt holes. Tighten the threaded pins finger tight.

NOTICE

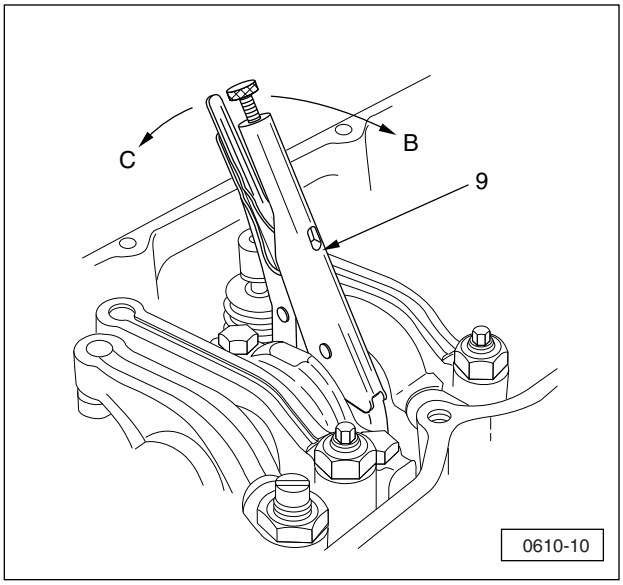
To prevent engine damage, the 9U-7270 or 220-0123 Sync Gauge should always be attached to the 128-9640 Injector Synchronization Fixture Group with the chain. This will prevent the gauge from being left inside the engine.




Install 128-9640 Injector Synchronization Fixture Group (8).

**7**. Attach 128-8823 Locking Pliers (9) firmly to the control rod, as shown. The pliers should be attached at an approximate 45 degree angle.

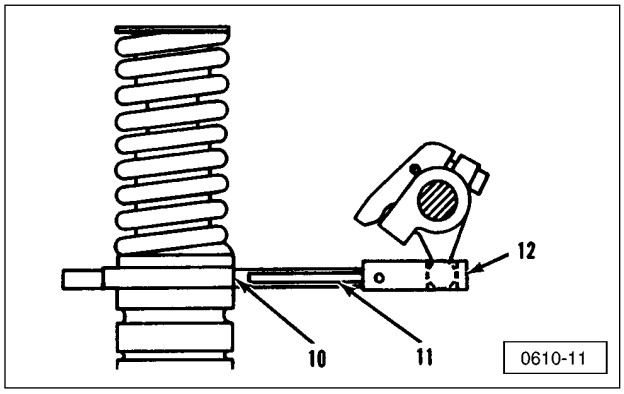
**NOTE:** Slight marring (damage) of the control rod by the locking pliers is acceptable. Do not clamp the locking pliers right next to one of the control shaft bearing supports.




Attach Locking Pliers (9) To Control Rod.
(B) Fuel-Off Direction. (C) Fuel-On Direction.

**NOTE:** Make sure there is no interference between the pliers and the sides of the rocker arm assemblies. Also, make sure the ends of the locking pliers do not contact the cylinder head bolt under the control rod. The locking pliers and control rod must actuate freely and smoothly throughout the rack travel range.

**8**. Make sure injector rack stop pin (11), the square shoulder on injector body (10), and rack head (12) are clean.



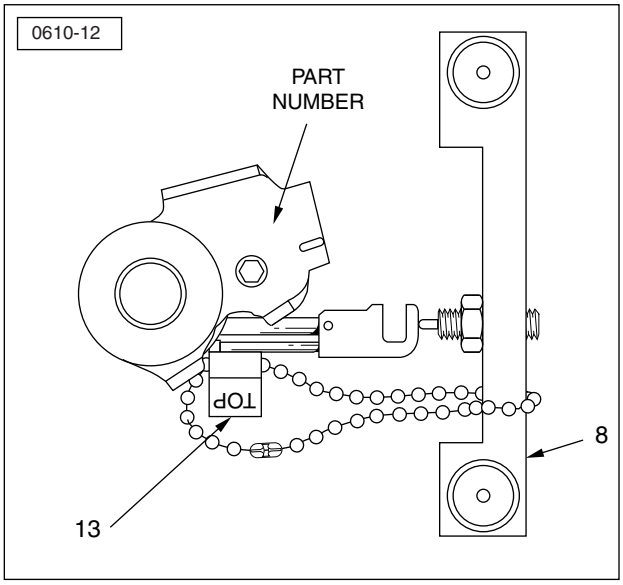

Clean The Area Around The Injector Rack. (10) Square Shoulder On Injector Body. (11) Injector Rack Head Stop Pin. (12) Rack Head.

**9**. Install proper Sync Gauge Block (13).

- **a**. Locate injector part number (see illustration for part number location).
- **b**. Determine proper Sync Gauge Block using part number and Chart B.
- **c**. Push locking pliers (9) and rotate the control rod to the "fuel-on" direction (so the rack head pulls away from the injector).
- **d**. Place the gauge block with the 3.0 mm/3.5 mm wide "finger" between injector rack head stop pin (11) and the square shoulder on injector body (10).
- **e**. Release the control rod (rotate to “fuel off”), allowing gauge block (13) to be held tightly and squarely against the injector body.

**Chart B.**
**Sync Gauge Block/Injector Cross Reference**

| Injector Part No. | Sync Gauge Block Used |
|---|---|
| 127-8207 | 220-0123 (3.0 mm) |
| 127-8213 | |
| 140-8413 | |
| 4P-2995 | |
| 127-8228 | |
| 127-8225 | |
| 127-8216 | |
| 173-4647 | |
| 127-8220 | |
| 127-8218 | |
| 127-8222 | |
| 162-0212 | |
| 162-0218 | |
| 127-8234 | |
| 127-8209 | |
| 127-8205 | |
| 127-8211 | |
| 127-8226 | |



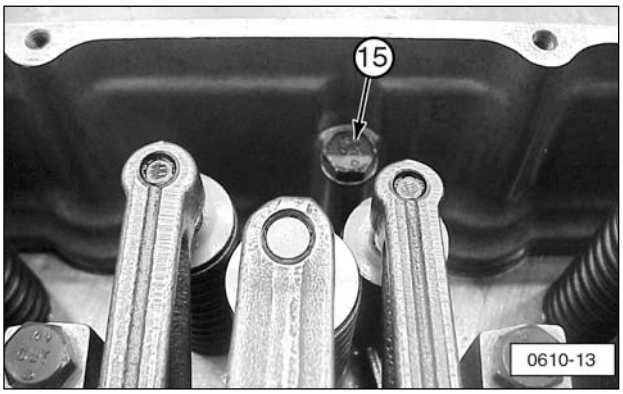

Install Sync Gauge Block (13). (8) 128-9640 Injector Synchronization Fixture Group.

**10**. If desired, remove the rocker arm assembly for the injector to be checked. **This step is optional.** If the rocker arm assembly is not removed, proceed to Step 11.

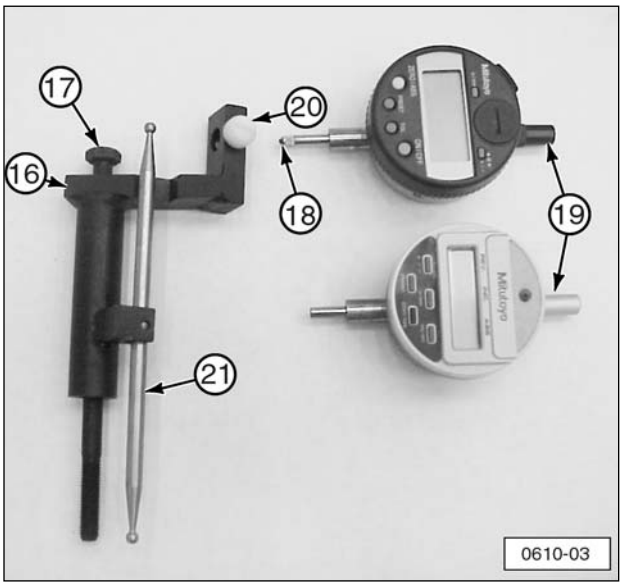
**a**. Apply a small amount of clean engine oil to the top of the injector and install 1U-6675 Spring Compressor (6).

**b**. Tighten bolt (7) and compress the injector spring.

**11**. Remove bolt (15) nearest the injector to be checked.



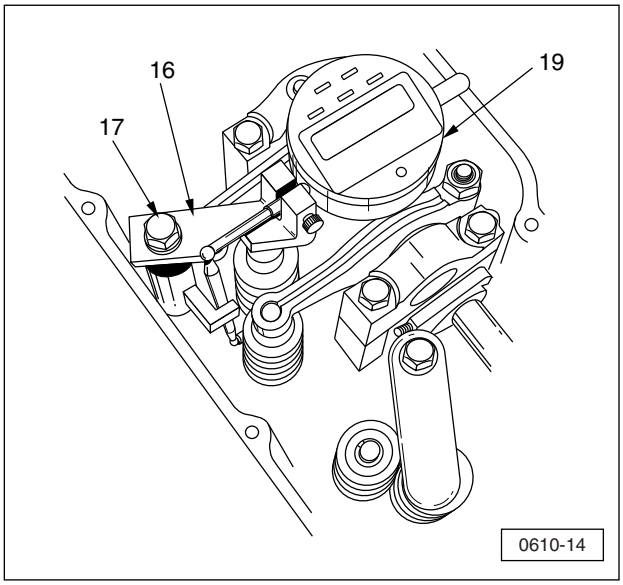

Remove Bolt (15) And Install Indicator Group.



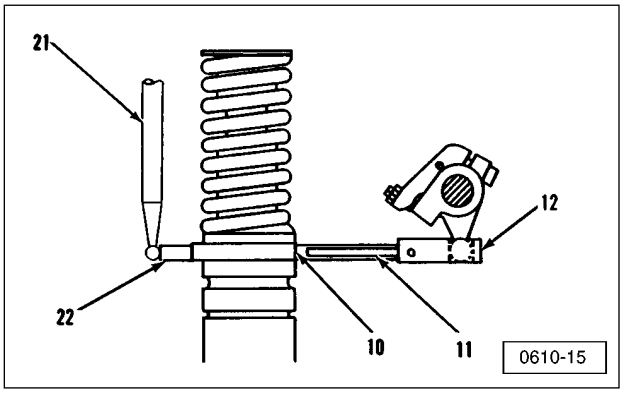

Injector Synchronization Tooling.
(16) 9U-7282 Indicator Fixture Group. (17) 8C-4984 Bolt. (18) 9U-7263 Contact Point. (19) 1U-8869 Digital Position Indicator (Top-New Version, Bottom-Former Version). (20) 9U-6272 Nylon Screw (Part of 9U-7282). (21) Lever (Part of 9U-7282).

**12**. Install 9U-7263 Contact Point (18) [18.5 mm (0.728 inch) long] into 1U-8869 Digital Position Indicator (19). Center the indicator in 9U-7282 Indicator Fixture Group (16) and tighten 9U-6272 Nylon Screw (20).

**NOTE:** The entire face of the 1U-8869 Digital Position Indicator can be rotated for better visibility.




Injector Synchronization Tooling Installed.
(16) 9U-7282 Indicator Fixture Group. (17) 8C-4984 Bolt. (19) 1U-8869 Digital Position Indicator.




Injector To Be Checked.
(10) Square Shoulder On Injector Body. (11) Injector Rack Head Stop Pin. (12) Rack Head. (21) Lever. (22) Rack Bar.

**13**. Make sure the end face of rack bar (22) on injector to be checked is clean. Install assembled 9U-7282 Indicator Fixture Group (16) and 1U-8869 Digital Position Indicator (19) with 8C-4984 Bolt (17) (M8 x 1.25 x 150 mm long), where bolt (15) was removed in Step 11. Lever (21), on indicator fixture group, must contact and be centered on the end face of rack bar (22). Tighten bolt (17).

**14**. Turn indicator (19) to ON and make sure the indicator units are set to mm, and ± travel direction is correct (the plunger traveling out of the indicator should read positive).

**NOTE:** Make sure the indicator is able to travel in both directions before proceeding to the next step. If necessary, reposition the indicator in the indicator fixture group.

**15**. Using locking pliers (9), rotate control rod in the "fuel-off" direction until injector rack head stop pin contacts the shoulder on the injector body.

NOTICE

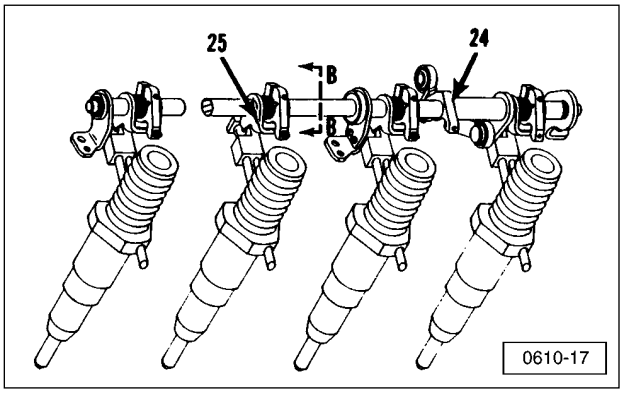
The contact between the injector rack head stop pin and the shoulder on the injector body is a solid stop. DO NOT put excessive force on it once contact is made. Excessive force will cause damage to the control assembly.

**16**. While maintaining the position of the control rod, with indicator (19) ON, press the "zero-set" button. This defines the zero-rack ("fuel-off") position.

**17**. Allow the linkage to spring back. Again rotate the control rod link to the "fuel-off" position and check the zero position of the indicator.

**NOTE:** Repeat this step two or three times to confirm the reading. If the readings are not consistent, check for binding.

**18**. Repeat this sequence several times (re-pressing the zero set button as necessary) until it is certain that a consistent zero reading is being obtained.




Injector Assembly Control Linkage.
(24) Clamp Assembly. (25) Injector Lever.

**19**. Using locking pliers (9), rotate the control rod in the "fuel-on" direction. Now, release locking pliers (9). This makes sure the springs and bearings of the control linkage are in their "normal" positions.

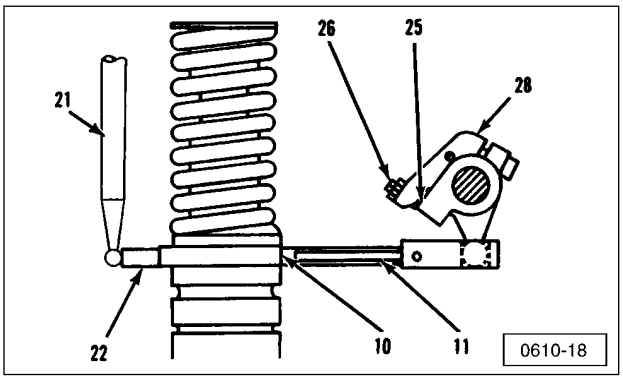
**NOTE:** Using the method described in Step 20 lets the spring plunger push the linkage against the gauge block, providing the most consistent results.

**20**. Rotate the control rod in the "fuel off" direction with the locking pliers and then release. Indicator (19) should now read 3.50 ± 0.02 mm, if using the 9U-7270 Sync Gauge, or 3.00 ± 0.02, if using the 220-0123 Sync Gauge.

**NOTE:** Repeat this step two or three times to confirm the reading. If the readings are not consistent, check for binding.

**21**. If the indicator reading is within the specified tolerance, go to STEP 25.

**22**. If the indicator reading is not within the specified tolerance, go to the next step.




Synchronizing Injector (Side View).
(10) Square Shoulder on Injector Body. (11) Injector Rack Head Stop Pin. (21) Lever. (22) Rack Bar. (25) U-Shaped Lever. (26) Setscrew. (28) Clamp.

NOTICE

DO NOT loosen screws holding clamps (28) to control shaft. Loosening the clamps will cause poor engine performance and may damage the engine. (The screws can be identified as those with socket heads filled with sealant.) Clamps (28) are factory preset onto the shaft.

**23**. Use 1U-6673 Wrench (14) to loosen lock nut and turn setscrew (26) clockwise until indicator (19) reads 3.50 ± 0.02 mm, if using the 9U-7270 Sync Gauge, or 3.00 ± 0.02, if using the 220-0123 Sync Gauge. Turning the adjusting screw clockwise increases reading; counterclockwise decreases reading. Tighten the locknut while holding setscrew (26) in position.

**24**. Check the adjustment by rotating the control rod, in the "fuel-off" direction, with the locking pliers and then release. If the indicator does not read 3.50 ± 0.02 mm, if using the 9U-7270 Sync Gauge, or 3.00 ± 0.02, if using the 220-0123 Sync Gauge, re-adjust setscrew (26) again.

**25**. After the injector is synchronized, remove indicator fixture group (16) and indicator (19). Install bolt (15) and tighten to 25 ± 7 N·m (18.5 ± 5 lb ft).

**26**. If the rocker arm assembly was removed for the injector that was checked, remove spring compressor (6). Install the rocker arm assembly (follow standard torque specifications). Make sure the push rods are properly seated in the rocker arms and lifters.

**27**. Synchronize the remaining injectors as necessary.

**28**. When synchronization procedure is complete, remove synchronization fixture (8) and sync gauge block (13) from the number 1 injector. Remove locking pliers (9).

**29**. If fuel setting is to be checked, refer to the "Fuel Setting" section in this manual.

**30**. If the fuel setting is known to be correct, remove spring compressor (6) from number 1 injector. Install the rocker arm assembly and tighten the bolts to 25 ± 7 N·m (18.5 ± 5 lb ft). Make sure the push rods are properly seated in the rocker arms and lifters are in their original positions.

**31**. Check valve clearance and fuel timing for cylinders that had rocker arms removed. Refer to the "Fuel Timing" section in this manual, and "Valve Clearance" in the Engine Service Manual.

**32**. With the engine stopped and the engine's electrical system shut OFF, install the fuel shut-off solenoid. Install the valve cover.

# Fuel Setting

## Tooling and Equipment

The tools shown in Chart C "Fuel Setting Tooling" are required to complete the fuel setting procedure.

**Chart C.**
**Fuel Setting Tooling**

| Part No. | Description | Qty. | Item[1] |
|---|---|---|---|
| 9U-5120 | Spanner (solenoid) Wrench | 1 | 3 |
| 1U-8869 | Digital Position Indicator | 1 | 4 |
| 9U-7282 | Indicator Fixture Group | 1 | 8 |
| 9U-6272 | Nylon Screw | 1 | — |
| 130-2711 | Holding Tool | 1 | 19 |
| 136-4149 | Governor Connection Pliers | 1 | 20 |
| 1U-7299 | Adjustment Wrench | 1 | 23 |
| 1U-7300 | T-handle | 1 | 24 |
| 1U-6673 | Wrench | 1 | 25 |
| 128-8827 | Fuel Setting Pin Assembly | 1 | 21 |

[1] Refer to nomenclature chart, at the beginning of this manual, for item identification.

## Fuel Setting Check

Fuel setting is the adjustment of the fuel setting screw to provide a specified injector rack position measured on number 1 injector rack bar. The fuel setting screw limits the power output of the engine by setting the maximum travel of all injector racks.

Before the fuel setting is checked, injectors must be correctly synchronized. Refer to "Injector Synchronization" in this manual.

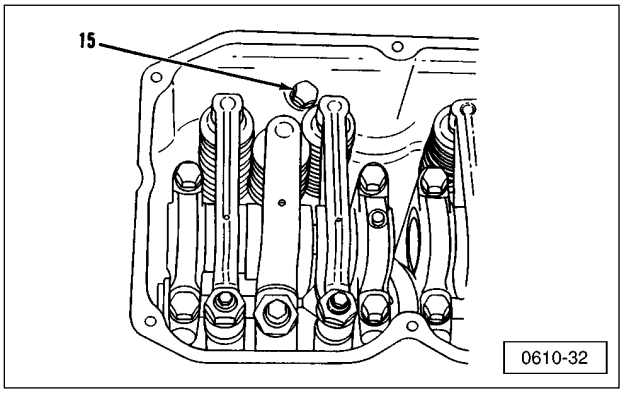
**NOTE:** This procedure is illustrated with the number 1 cylinder rocker arm assembly installed. Greater access to the injector rack and control linkage is provided when the number 1 rocker arm assembly is removed. Instructions for removing the rocker arm assembly are given in the "Injector Synchronization" section. Checking valve clearance and fuel timing is recommended after the rocker arm assembly is reinstalled.

NOTICE

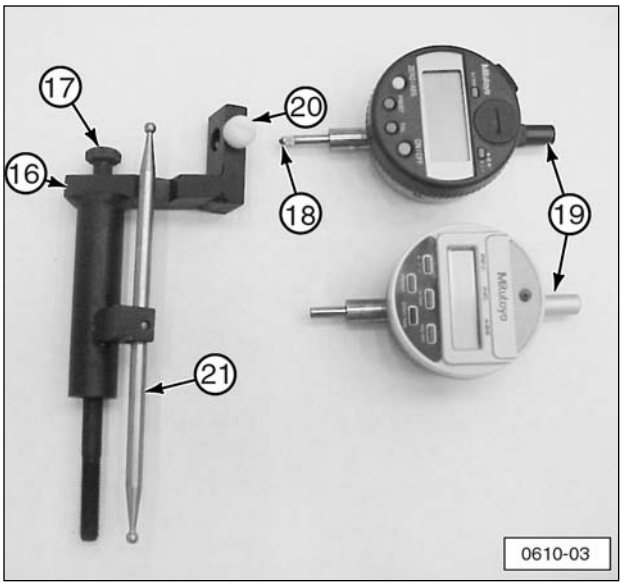
The injector spring must be slightly compressed to allow free movement of the injector rack. Either the rocker arm assembly, or the 1U-6675 Spring Compressor, MUST be installed on all injectors to prevent internal damage to the injectors.

**1**. With engine stopped and the engine's electrical system shut off, remove the fuel control solenoid to allow free movement of injector rack control linkage during fuel setting.

**2**. Remove bolt (15) from the inlet manifold.

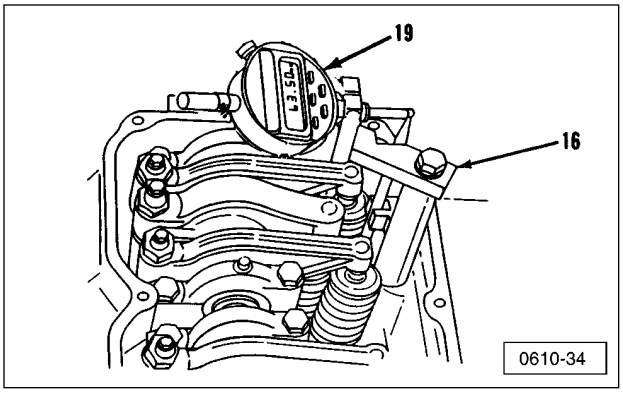



Remove Bolt (15).



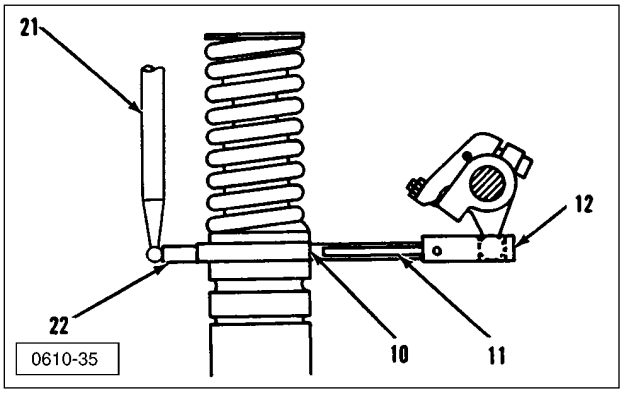

Fuel Setting Tooling. (16) 9U-7282 Indicator Fixture Group. (17) 8C-4984 Bolt. (18) 9U-7263 Contact Point. (19) 1U-8869 Digital Position Indicator (Former and Current Style). (20) 9U-6272 Nylon Screw (Part of 9U-7282). (21) Lever (Part of 9U-7282).

**3**. Install 1U-8869 Digital Position Indicator (19) in 9U-7282 Indicator Fixture Group (16). Tighten nylon setscrew (20).



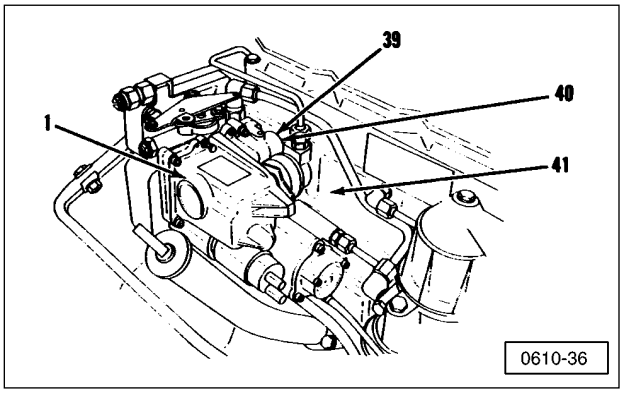

Fuel Setting Indicator (Former Style) Installed. (16) 9U-7282 Indicator Fixture Group. (19) 1U-8869 Digital Position Indicator.

**4**. Make sure the end of rack bar (22) is clean. Install assembled 9U-7282 Indicator Fixture Group (16) and indicator (19). Bolt of indicator group (17) is threaded into hole where bolt (15) was removed from the engine valve base. Position the indicator group so that the indicator stem is parallel to the rack bar of the number 1 injector (perpendicular to the rocker arm shafts). Lever (21) must contact the end face of rack bar (22).




Number 1 Injector. (10) Square Shoulder On Injector Body. (11) Injector Rack Head Stop Pin. (12) Rack Head. (21) Lever. (22) Rack Bar.

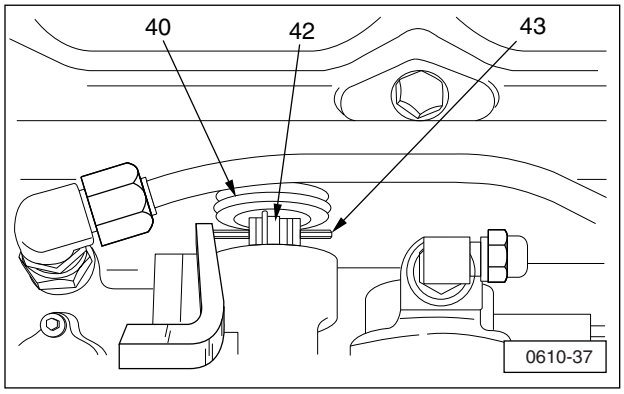
**5**. Remove clip (39) that keeps sleeve (40) in position between governor (1) and cylinder head (41).




(1) Governor. (39) Clip. (40) Sleeve. (41) Cylinder Head.

**NOTE:** Do not use hard-jaw pliers to move sleeve (40). Damage of the sleeve will result in damage to the wiper seal in cylinder head (41). This damage will occur when sleeve (40) is retracted to allow access to governor link connection pin (42).

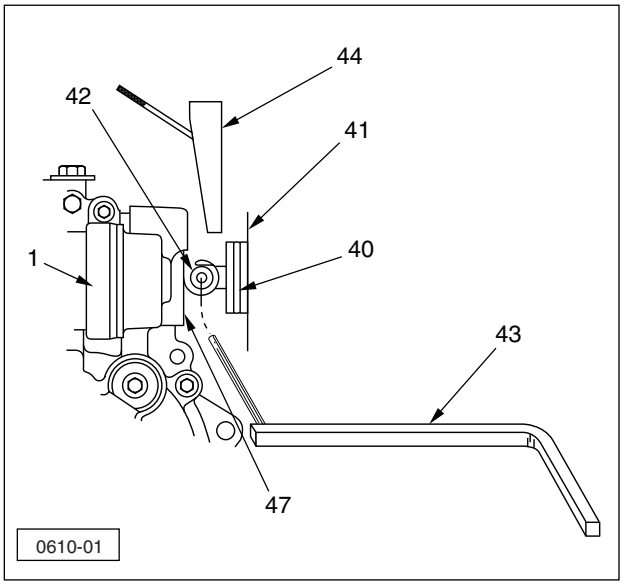
**6**. With 136-4149 Governor Connection Pliers, slide sleeve (40) away from governor (1) in to cylinder head (41).




"Type V" Version Governor - Install Pilot Pin. (40) Sleeve. (42) Link Pin. (43) 128-8827 Fuel Setting Pin Assembly.

**7**. Install 128-8827 Fuel Setting Pin Assembly (43) into link pin (42) of the governor output shaft. When properly installed, equal lengths of small diameter on pin (43) will extend from both ends of link pin (42).

**NOTE:** 1U-7523 Pin Insert Pilot is included in this tool group. It is used with the 128-8827 Fuel Setting Pin Assembly to align the links and insert pin (42). The 1U-7523 is only used if the governor has been disconnected.




Governor Viewed From Rear Side.
(1) Governor. (40) Sleeve. (41) Cylinder Head.
(42) Link pin. (43) 128-8827 Fuel Setting Pin Assembly.
(44) 130-2711 Holding Tool. (47) Face Of Governor.

**NOTE:** For "Type V" version governors, the 128-8827 Fuel Setting Pin Assembly (43) must be inserted from the front of the link pin, as shown. For all other governors, the pin can be inserted from the rear of the governor.

**8**. Install 130-2711 Holding Tool (44) to hold fuel setting pin assembly (43) tightly against governor housing calibration face (47).

**NOTE:** If the holding tool is installed too tightly, the governor can be deflected away from the engine, making the fuel setting adjustments incorrect.

**NOTE:** If the small diameter of calibration pin (43) does not contact governor calibration face (47), remove air line connected to the governor fuel ratio control (FRC). Use FT-1906 Fabricated Tester (or other REGULATED air supply) and apply 105 kPa (15 psi) air pressure to the FRC. Pressurizing the FRC will prevent it from restricting the movement of the governor output, thus allowing the calibration pin to contact governor calibration face (47). After the fuel setting check is completed, remove the FT-1906 Fabricated Tester and install the air line to the FRC.

**9**. Turn indicator (19) to ON. Make sure the indicator units are set to mm and ± travel direction is correct (plunger traveling out of indicator should read positive).

**10**. Firmly push rack head (12) of number 1 injector, by hand, toward the injector until rack head stop pin (11) touches square shoulder of injector body (10), and hold in this position. The number 1 injector is now at "fuel-off". Press the "zero-set" button on the indicator to define zero rack at this position.

**NOTE:** If rocker arm assembly is installed, rotate the control shaft in the "fuel-off" direction (against spring pressure). Rotate the shaft until ALL injector levers are in the shut-off position before pressing the "zero-set" button. This makes sure that number 1 injector rack is at zero.

**NOTE:** The 128-8823 Locking Long Nose Pliers may be used to actuate the control linkage throughout this procedure. (Refer to the description in the "Injector Synchronization" section for additional information.)

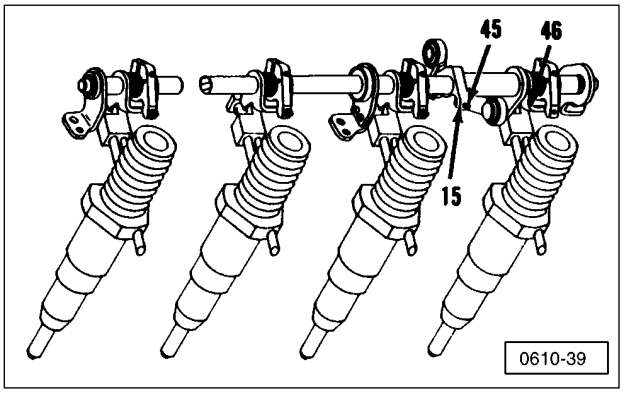
**11**. Release number 1 rack head (or control rod, if rocker arms were not removed), then push it back into zero rack. Repeat several times to make sure that a consistent zero point has been established.

**12**. Push down on rack lever (46) and quickly release it. "Flip" the lever in this manner several times to make sure there is smooth movement of the injector rack.

**13.** Refer to the "Engine Information Plate" or the "Fuel Setting and Related Information" area of TMI for the correct fuel setting.

**14**. If reading on digital indicator is within ± 0.25 mm of the specified fuel setting, go to Step 17.

**15**. If the fuel setting needs adjustment, use 1U-6673 Wrench or 1U-7299/1U-7300 Adjustment Wrench to loosen the locknut of fuel setting screw (45). Adjust fuel setting screw (45) until the indicator reading matches the correct fuel setting. Turn screw (45) CCW for more fuel (greater fuel setting) or CW for less fuel (lower fuel setting).




Rack Control Linkage. (15) Clamp Assembly. (45) Fuel Setting Screw. (46) Rack Lever For Number 1 Injector.

NOTICE

Do not loosen screw holding clamp assembly (15) to the control rod. (This screw can be identified by sealant in socket head). Clamp assembly (15) is factory preset onto the rod. Loosening the clamp will cause poor performance and may damage the engine.

**16**. With the 1U-6673 or 1U-7299/1U-7300 Wrench, hold fuel setting screw (45) in position and tighten the locknut. Recheck the fuel setting by "flipping" (pushing down and releasing) lever (46). Check the reading on the indicator again. If the fuel setting is not correct, repeat Steps 15 and 16 until the correct settings are obtained.

**17**. Remove holding tool (44) and fuel setting pin assembly (43) from the engine. Use 136-4149 Governor Connection Pliers to slide sleeve (40) back into the governor (lubricate the O-ring seal on the sleeve with engine oil, if needed). Install clip (39).

**18**. Remove indicator fixture group (16) and indicator (19). Install bolt (15) into engine valve base and tighten to 25 ± 7 N·m (18.5 ± 5 lb ft).

**NOTE:** If the rocker arm assembly was removed for this procedure, remove 1U-6675 Spring Compressor. Install rocker arm assembly. Make sure push rods are properly seated in the rocker arms and lifters. Check valve clearance and fuel timing. Refer to "Valve Clearance" and "Fuel Timing" sections in the engine Service Manual.

**19**. With engine stopped and the engine's electrical system turned OFF, install the fuel shut-off solenoid. Install the valve cover.

# Fuel Timing

## Tooling and Equipment

The tools shown in Chart D "Fuel Timing Tooling" are required to complete the fuel timing procedure.

**Chart D.**
**Fuel Timing Tooling**

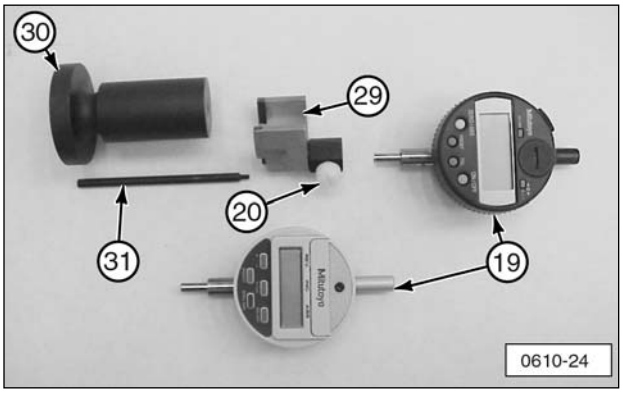
| Part No. | Description | Qty. | Item[1] |
|---|---|---|---|
| 1U-8869 | Digital Position Indicator | 1 | 4 |
| 9U-7269 | Timing Gauge Block | 1 | 11 |
| 123-4940 | Magnetic Base Group | 1 | 12 |
| 9U-6272 | Nylon Holding Screw | 1 | — |
| 128-8824 | Wrench, 16 mm and 18 mm | 1 | 13 |
| 128-8825 | Wrench, 17 mm and 19 mm | 1 | 14 |
| 9U-7274 | Contact Point, 85 mm (3.35 in) long | 1 | 15 |

[1] Refer to nomenclature chart, at the beginning of this manual, for item identification.

# Indicator Calibration

Before a check or an adjustment of the fuel timing dimension can be made, the 1U-8859 Digital Position Indicator (19) must be calibrated. Refer to the following calibration procedure. There is a procedure for both the former indicator group and the current indicator group.

## Initial Calibration Setup




Calibrate Injector Timing Tooling.
(19) 1U-8869 Digital Position Indicator. (20) 9U-6272 Nylon Holding Screw (Part of 9U-7282). (29) 123-4940 Indicator Fixture Group. (30) 9U-7269 Timing Gauge Block. (31) 9U-7274 Contact Point.

**1**. Install 85 mm (3.35 inch) long 9U-7274 Contact Point (31) on the digital position indicator stem.

**2**. Insert digital position indicator (19) in 123-4940 Magnetic Base Group (29) until it stops. Tighten nylon holding screw (20).

**3**. Make SURE the magnetic bottom of indicator fixture group (29) is clean (NO particles sticking to magnet). Also make sure both the top and shoulder of 9U-7269 Timing Gauge Block are clean.

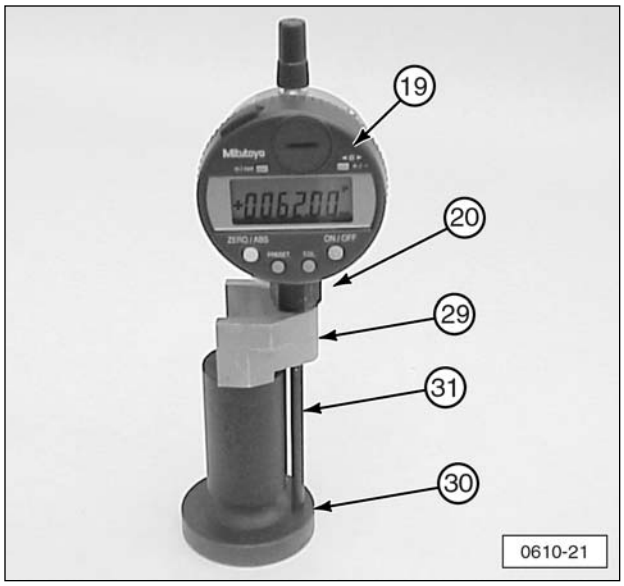
**4**. Push (fully retract) indicator contact point (31) into the digital position indicator and hold it.

NOTICE

The magnets in the 123-4940 Indicator Fixture Group (29) are very powerful and can “snap” into place when attaching the base assembly to any metallic surface. To avoid damaging the digital position indicator, hold the indicator contact point in the retracted position while attaching the base.

**5**. Carefully place the indicator and base assembly on timing gauge block (30). Once the base firmly attaches to the gauge block, release (extend) contact point (31).

**6**. Preset (calibrate) the indicator group. Refer to the appropriate procedure based on the digital indicator group (former style or current style) in use .

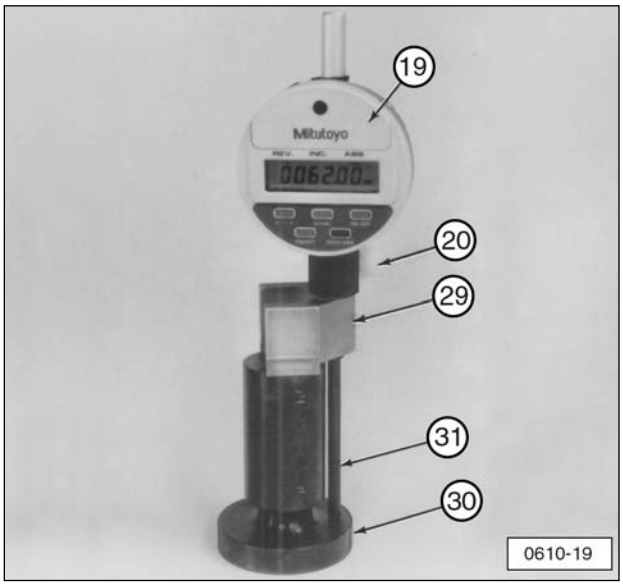



Indicator Group (Current Style).
(19) 1U-8869 Digital Position Indicator. (20) 9U-6272 Nylon Holding Screw (Part Of 9U-7282). (29) 123-4940 Indicator Fixture Group. (30) 9U-7269 Timing Gauge Block. (31) 9U-7274 Contact Point.

**NOTE:** Check the travel of the dial indicator. As the contact point is pressed in towards the dial, the reading on the indicator should decrease.

## Presetting the Indicator Group (Former Style)

Program 1U-8869 Digital Position Indicator (19) to a preset value of 62.00 mm (the dimension of 9U-7269 Timing Gauge Block), as follows:



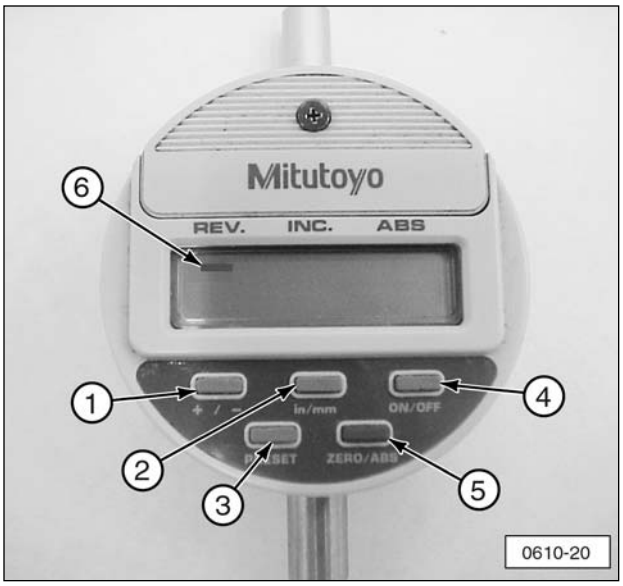

Indicator Group (Former Style). (19) 1U-8869 Digital Position Indicator. (20) 9U-6272 Nylon Holding Screw (Part of 9U-7282). (29) 123-4940 Indicator Fixture Group. (30) 9U-7269 Timing Gauge Block.
(31) 9U-7274 Contact Point.

**1**. Turn the indicator ON by pressing the “ON/OFF” button (4).

**2**. Press the "in/mm" button (2) to change the display to millimeters.

**3**. Indicator bar (6) should be in the display window under REV. If the space is blank, select "+ / -" button (1) so the display shows the indicator bar, as shown.

**4**. Press and hold "preset" button (3) until there is a flashing (P) in the upper right corner of the display. When the flashing (P) appears, release the button.




1U-8869 Digital Position Indicator (Former Style). (1) Positive/Negative Select Button. (2) Inch/ Millimeter Select Button. (3) Preset Button. (4) On/Off Button. (5) Zero/ABS Button. (6) Indicator Bar.

**NOTE:** Press and hold the preset button to change the positions of the flashing cursor. Also, press and release the preset button to change the value of the number.

**5**. Press and hold "preset" button (3) until the (P) stops flashing, and a flashing indicator bar is seen in the lower left corner of the display. When the indicator bar appears, release the button. Pressing and releasing the "preset" button will cause a minus sign to appear or disappear above the flashing indicator. Use the "preset" button to make this position blank.

**6**. Press and hold "preset" button (3) until the flashing indicator begins to flash under the first number position (fourth position to the left of the decimal), then release the button. Pressing and releasing the "preset" button will cause the display number in that position to change.

**7**. Use the "preset" button to move the flashing indicator and change the value of the display numbers to read 0062.00 mm.

**8**. Press and hold the "preset" button until the flashing (P) shows in the upper right corner of the display, and then release the button. Momentarily push the "preset" button so the flashing (P) and the zeros to the left of 62.00 mm disappear.

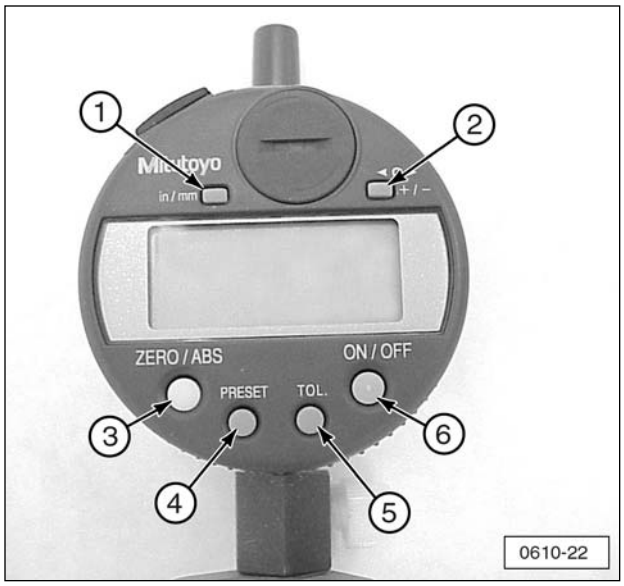
**NOTE:** To recall a preset number, repeat Steps 1 through 4, then press and release the “preset” button so the flashing (P) and the zeroes to the left of 62.00 mm disappear.

**9**. Turn the indicator OFF. The indicator will retain the preset number in memory (only one preset number is retained).

## Presetting the Indicator Group (Current Style)

Program 1U-8869 Digital Position Indicator (19) to a preset value of 62.00 mm (the dimension of 9U-7269 Timing Gauge Block), as follows:


Indicator Group (Current Style). (19) 1U-8869 Digital Position Indicator. (20) 9U-6272 Nylon Holding Screw (Part Of 9U-7282). (29) 123-4940 Indicator Fixture Group. (30) 9U-7269 Timing Gauge Block. (31) 9U-7274 Contact Point.




1U-8869 Digital Position Indicator (Current Style).
(1) Inch/Millimeter Select Button. (2) Positive/ Negative Select Button. (3) Zero/ABS Button. (4) Preset Button. (5) Tolerance Button. (6) On/Off Button.

**1**. Turn the indicator ON by pressing “ON/OFF” button (6).

**2**. Press "in/mm" button (1) to change the display to millimeters.

**3**. Press and hold preset button (4) until the (+ or -) sign flashes. If the indicator displays (-), reset to (+).

**NOTE:** Press “preset” once to go into programming mode. Press and hold to advance position. Press and release to increase number.

**4.** Press and hold the preset button until the first character begins to flash. Release the button when character flashes.

**5**. Press and release the preset button to set the value of the character.

**6**. Repeat Steps 4 and 5 until the display numbers read +0062.00 mm.


Correctly Entered Display Numbers.

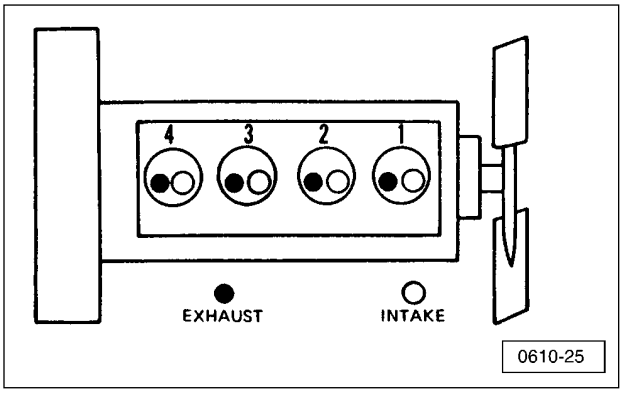
**7**. Press and hold the preset button until “P” starts flashing.

**8**. Press and release the preset button. The indicator is now preset and should read 62.00 mm.

# Measuring Fuel Timing Setting

| Chart E-1.<br>3114 Crankshaft Positions For<br>Fuel Timing Setting and Valve Lash Setting | |
|---|---|
| SAE Standard (Counterclockwise) Rotation Engines<br>As Viewed From The Flywheel End | |
| **Item** | **Cylinders to Adjust** |
| Check/adjust with Number 1 piston on TC compression stroke[1] | |
| Injectors | 3-4 |
| Inlet Valves | 1-2 |
| Exhaust Valves | 1-3 |
| Check/adjust with Number 1 piston on TC exhaust stroke[2] | |
| Injectors | 1-2 |
| Inlet Valves | 3-4 |
| Exhaust Valves | 2-4 |
| Firing Order | 1-3-4-2 |

[1] Note that the number 1 injector is not checked or adjusted with the number 1 piston on Top Center (TC) compression stroke. Be certain that the number 1 piston is TC on the correct stroke (compression or exhaust) to check or adjust each cylinder (injector). Refer to the topic "Finding Top Center for number 1 Piston" in this manual. [2] After TC position for a particular stroke is found and the cylinders are checked or adjusted, remove timing bolt and turn the flywheel counterclockwise 360 degrees. This will put number 1 piston at TC on the exhaust stroke. Install timing bolt in the flywheel and check or adjust the remaining cylinders (injectors).

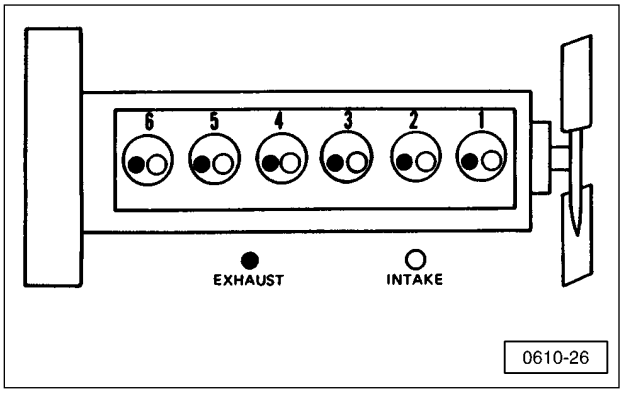



3114 Cylinder and Valve Location.

**NOTE:** Refer to Testing and Adjusting, Engine Valve Lash - Inspect/Adjust for more information on adjusting valves.

| Chart E-2.<br>3116, 3126 Crankshaft Positions For<br>Fuel Timing Setting and Valve Lash Setting | |
|---|---|
| SAE Standard (Counterclockwise) Rotation Engines<br>As Viewed From The Flywheel End | |
| **Item** | **Cylinders to Adjust** |
| Check/adjust with Number 1 piston on TC compression stroke[1] | |
| Injectors | 3-5-6 |
| Inlet Valves | 1-2-4 |
| Exhaust Valves | 1-3-5 |
| Check/adjust with Number 1 piston on TC exhaust stroke[2] | |
| Injectors | 1-2-4 |
| Inlet Valves | 3-5-6 |
| Exhaust Valves | 2-4-6 |
| Firing Order | 1-5-3-6-2-4 |

[1] Note that the number 1 injector is not checked or adjusted with the number 1 piston on Top Center (TC) compression stroke. Be certain that the number 1 piston is TC on the correct stroke (compression or exhaust) to check or adjust each cylinder (injector). Refer to the topic "Finding Top Center for number 1 Piston" in this manual. [2] After TC position for a particular stroke is found and the cylinders are checked or adjusted, remove timing bolt and turn the flywheel counterclockwise 360 degrees. This will put number 1 piston at TC on the exhaust stroke. Install timing bolt in the flywheel and check or adjust the remaining cylinders (injectors).




3116, 3126 Cylinder and Valve Location.

**NOTE:** Refer to Testing and Adjusting, Engine Valve Lash - Inspect/Adjust for more information on adjusting valves.

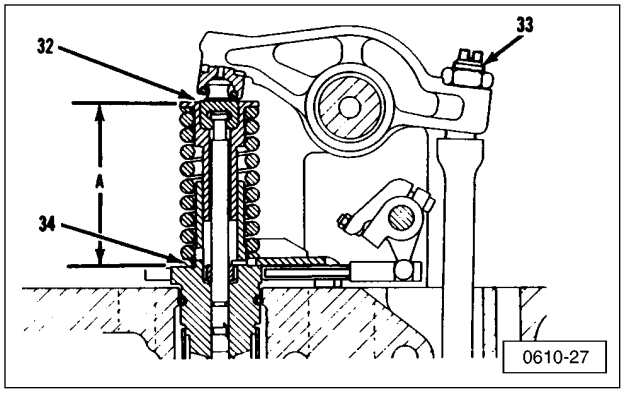
With the crankshaft positions given in Chart(s) E "Crankshaft Positions for Fuel Timing Setting", all of the injectors can be checked or adjusted. This will make sure push rod lifters are off the lobes and on base circles of the camshaft.

**NOTE:** Always rotate the engine's crankshaft with four large bolts on the front of the crankshaft. **Do not** use eight small bolts on the front of the crankshaft pulley.

**NOTE:** If rocker arm assemblies are removed and installed prior to checking the fuel timing dimension, rotate the crankshaft two complete revolutions to allow rocker arms to properly seat on injectors before checking the timing dimension.

**1**. Put number 1 piston at top center (TC) position and determine the stroke (compression or exhaust). Refer to "Finding Top Center Position for Number 1 Piston" in the engine service manual.

**2**. Make sure the top surfaces of injector tappet (32) and shoulder (34) are clean and dry.




Fuel Timing Dimensions. (32) Injector Tappet.
(33) Adjustment Screw. (34) Shoulder.
(A) Fuel Timing Dimension.

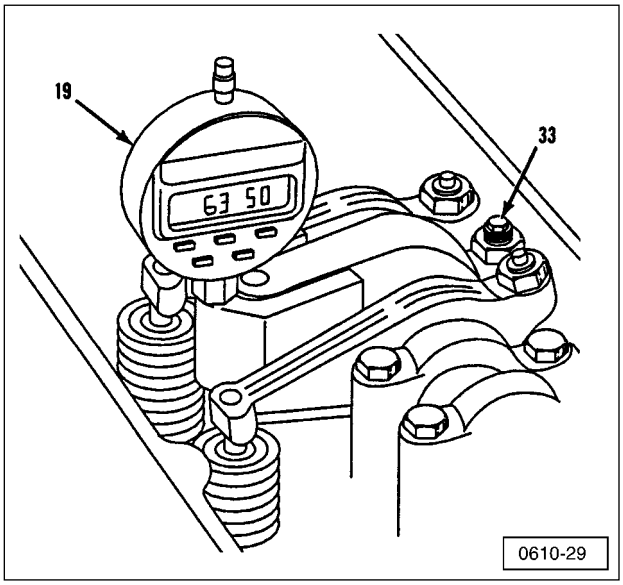
**3**. Remove indicator and magnetic base from the gauge block. Push (fully retract) indicator contact point (31) into the digital position indicator.

**4**. Hold the contact point in the retracted position and carefully position it on top of injector tappet (32) for the injector to be checked.

NOTICE

The magnets in the 123-4940 Indicator Fixture Group (29) are very powerful and can “snap” into place when attaching the base assembly to any metallic surface. To avoid damaging the digital position indicator, hold the indicator contact point in the retracted position while attaching the base.

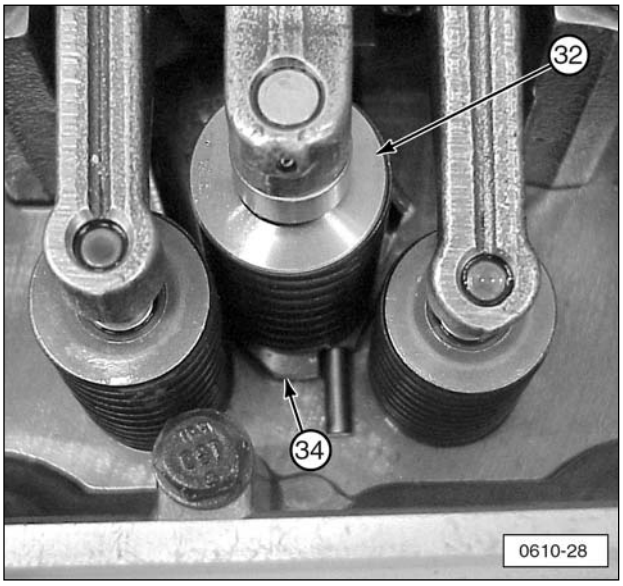

Timing Fixture Installed (Current Style).




Timing Fixture Installed (Former Style).
(19) 1U-8869 Digital Position Indicator. (33) Adjustment Screw.

**NOTE:** The shoulder of the injector is not very wide. It is easy to set the contact point on the cylinder head and not the shoulder of the injector. Make sure the contact point is sitting on injector shoulder (34).

**5**. Release (extend) the indicator plunger and carefully position indicator contact point (31) on shoulder of injector (34). Make sure it moves freely and the contact point does not bind on the injector spring.




(32) Injector Tappet. (34) Shoulder.

NOTICE

After the timing tooling has been positioned on an injector, do not rotate the engine. The timing tooling could be damaged.

**6**. Indicator (19) will display the fuel timing dimension directly.

**NOTE:** Refer to the engine information plate or the "Fuel Setting and Related Information" section in TMI for the correct fuel timing dimension. The indicator must show the correct fuel timing dimension within ± 0.20 mm. Each injector must be checked separately and adjusted, if necessary.

**7**. If indicator (19) displays the correct dimension, or is within the ± 0.20 mm checking tolerance, no adjustment is necessary. Proceed to Step 14.

**8**. If indicator (19) does not show the correct timing dimension, use the 128-8824 or 128-8825 Wrench to loosen the locknut on push rod adjustment screw (33) for the injector to be adjusted.

**9**. Turn adjustment screw (33) until indicator (19) displays the correct fuel timing dimension. Tighten locknut to 25 ± 7 N·m (18.0 ± 5.0 lb ft) and check adjustment again. If necessary, repeat this procedure until the adjustment is correct.

**10**. Sequence for checking the fuel timing dimensions. Refer to explanation at the beginning of this section.

- **a**. Check and adjust fuel timing dimension on half of cylinders with the timing bolt installed.
- **b**. Remove the timing bolt and timing tooling.
- **c**. Rotate flywheel counterclockwise 360 degrees (1 revolution) and install timing bolt.
- **d**. Place timing tooling on remaining injectors and check the fuel timing dimension. Refer to Chart E "Crankshaft Positions for Fuel Timing Setting".

**NOTE:** Half the cylinders can be checked in each engine rotation. For more information refer to Chart E.

**11**. Remove timing bolt from flywheel when the fuel timing check is completed.

# Finding Top Center Position for Number 1 Piston

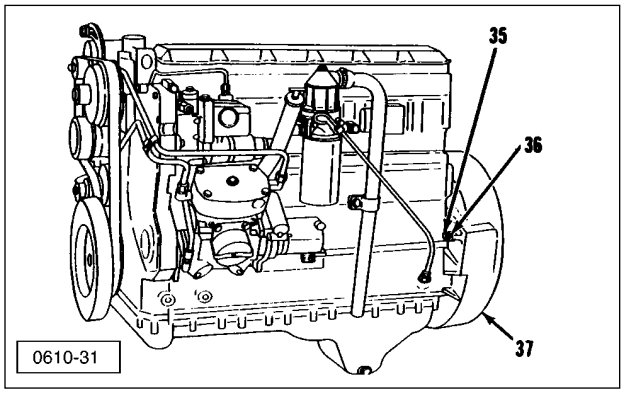
## Tooling and Equipment

The tools, shown in Chart F "Tooling for Finding Top Center (TC) Position", are required to complete the procedure.

| Chart F. Tooling For Finding Top Center (TC) Position | | | |
|---|---|---|---|
| **Part No.** | **Description** | **Qty.** | **Item[1]** |
| 8T-4177 | Bolt, Spring Compressor | 1 | 7 |

[1] Refer to nomenclature chart, at the beginning of this manual, for item identification.

## Procedure




Timing Bolt Location. (35) 8T-4177 Timing Bolt. (36) Timing Hole. (37) Flywheel Housing.

**NOTE:** Depending on engine application, timing hole (36) is located at either the left front face or right front face of the flywheel housing.

**1**. Remove plug from timing hole (36) on the front of the flywheel housing.

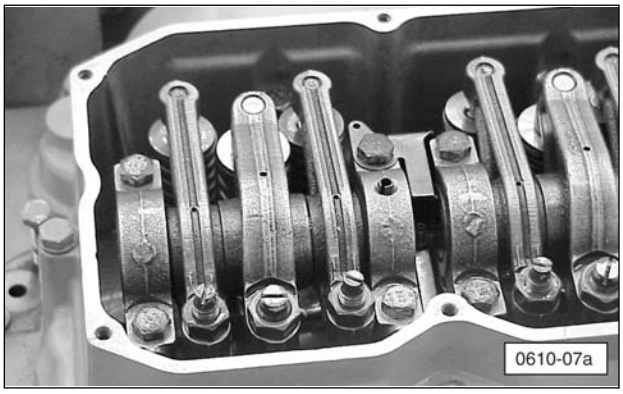
NOTICE

Rotate the engine with four large bolts on the front of the crankshaft. Do not use the eight small bolts on the front of the crankshaft pulley as this could cause damage to the engine.

**2**. Put 8T-4177 Bolt (35) in hole. Turn the engine flywheel counterclockwise until the timing bolt engages with the threaded hole in the flywheel.

**NOTE:** If the flywheel is turned beyond the point the timing bolt engages in the threaded hole, the flywheel must be turned back at least 30 degrees clockwise. Again, turn the flywheel counterclockwise until the timing bolt engages with the threaded hole. This procedure makes sure the play is removed from the gears when number 1 piston is put on TC.

**3**. Remove the cylinder head valve cover.




Valve Cover Removed.

**4**. The intake and exhaust valves for the number 1 cylinder are fully closed if number 1 piston is on the compression stroke and the rocker arms can be moved by hand. If the rocker arms cannot be moved and the valves are slightly open, the number 1 piston is on the exhaust stroke. Refer to Chart E "Crankshaft Positions for Fuel Timing Settings", to determine which cylinder(s) can be checked/adjusted (determined by stroke position of crankshaft when timing bolt is installed).

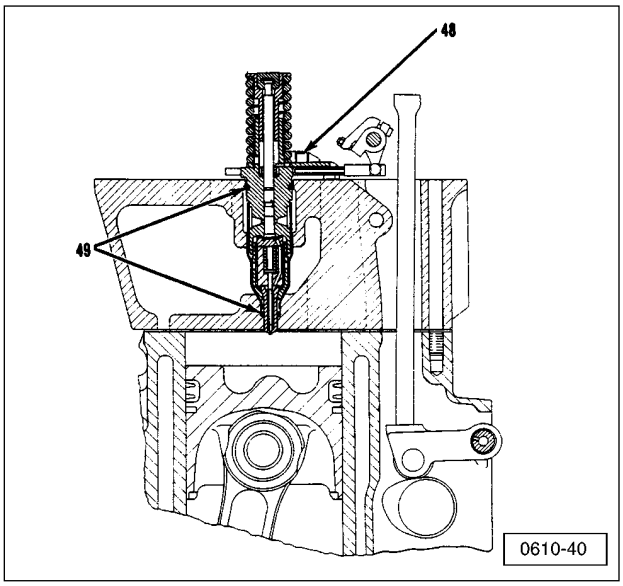
**NOTE:** When the actual stroke position is identified, and the other stroke position is desired, it is necessary to remove the timing bolt from the flywheel. Turn the flywheel counterclockwise 360 degrees, and reinstall the timing bolt.

**5**. After TC position for a particular stroke is obtained and adjustments are made, remove the timing bolt and turn the flywheel counterclockwise 360 degrees. This will put number 1 piston at TC position on the other stroke. Install timing bolt in flywheel and complete adjustments for remaining cylinders.

## Removal and Installation of Unit Fuel Injectors

| Chart G. Injector Removal and Installation Tools | | | |
|---|---|---|---|
| **Part No.** | **Description** | **Qty.** | **Item[1]** |
| 5P-0302 | Injector Removal Bar | 1 | 16 |
| 194-3542 | Hex Socket Bit Driver, 5 mm | 1 | 18 |

[1] Refer to nomenclature chart, at the beginning of this manual, for item identification.




Unit Fuel Injector. (48) Bolt. (49) O-ring(s).

**NOTE:** Not all injectors use a bottom O-ring.

## Removal

**1**. Remove injector hold down bolt (48).

NOTICE

Do not pry on the injector hold down bracket. Damage to the injector could occur. The injector has a notch on the side opposite the rack that is used for prying the injector loose.

**2**. Use the 5P-0302 Injector Removal Bar to loosen the fuel injector.

**3**. Rotate the injector to disengage the injector rack from the control linkage.

**4**. Remove the injector and inspect it to be sure that O-rings (49) were removed with the injector.

NOTICE

Do not move the fuel injector rack with the injector spring slightly compressed. Damage to the injector could occur.

## Installation

**NOTE:** Not all injectors use a bottom O-ring.

**1**. With O-ring(s) in place and lubricated with engine oil, position the injector in the head and then rotate it to engage the injector rack with the control linkage.

**2**. Push down on the top of the injector so the O-ring seals slide into the bore of the cylinder head. Be sure the injector is fully seated in the bore before installing the bolt.

**NOTE:** Do not use the bolt to pull the injector down into the cylinder head.

**3**. Install bolt (48) using the 194-3542 Hex Socket Bit Driver and tighten it to 12 ± 3 N·m (9 ± 2 lb ft).

**4**. Complete the installation by performing the injector synchronization procedure in this manual.

**5**. Install the rocker assembly, and adjust fuel timing and valve clearance. The fuel setting should also be checked.

# Notes

# Notes

For information on service tools or shop supplies,
contact Dealer Service Tools on:

Dealer Service Tools
501 S. W. Jefferson
Peoria, IL U.S.A. 61630-2125
U.S.A.:  1-800-542-8665
Illinois:  1-800-541-8665
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