Shop Manual
L10 Series Engines

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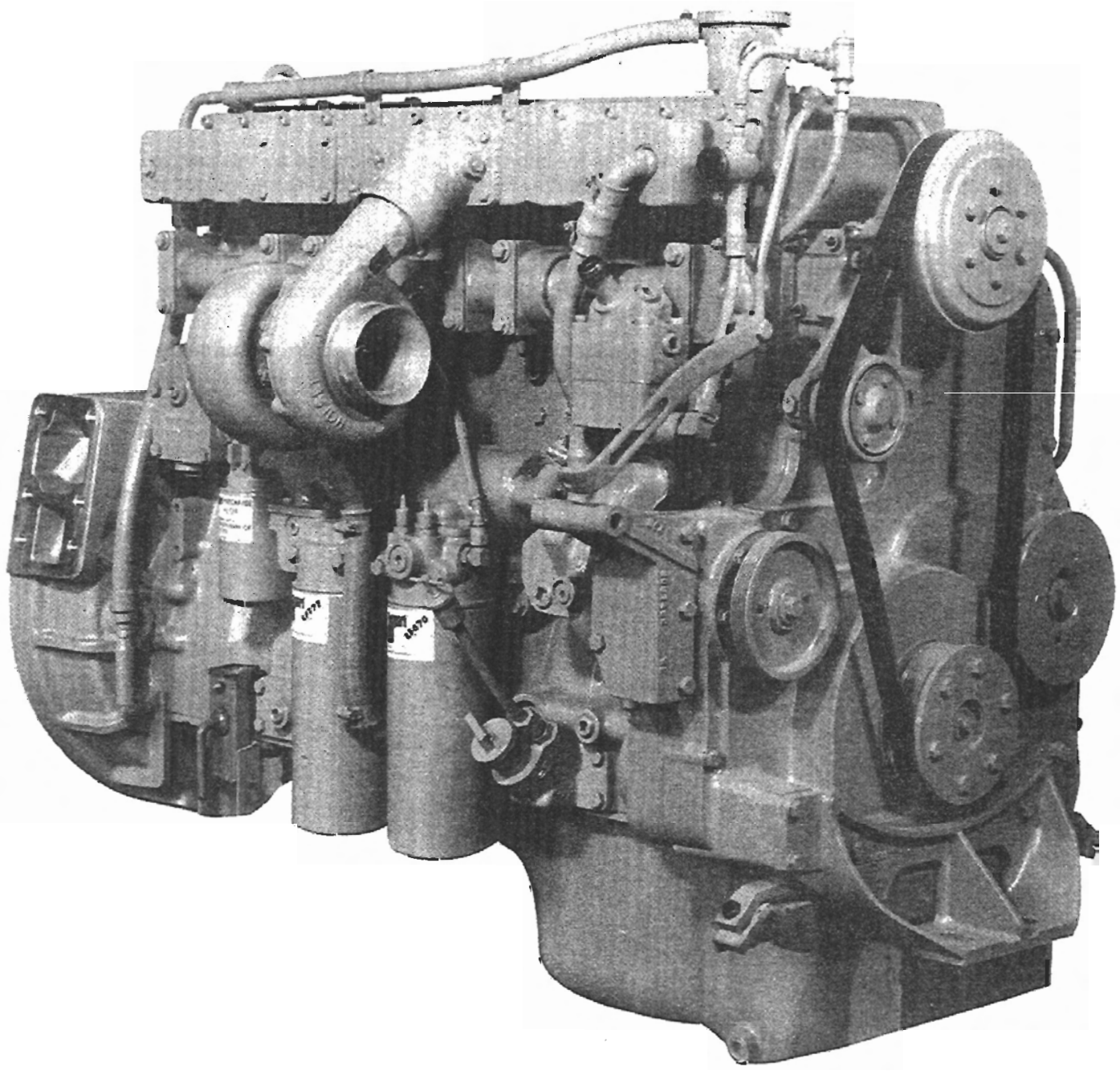
L10 Series Engines
Internal Damper Models



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Foreword

This manual contains complete rebuild specifications and information for the L10 engine and all associated components manufactured by Cummins Engine Company, Inc. A listing of accessory and component suppliers' addresses and telephone numbers is located in Section C-1. Suppliers can be contacted directly for any information **not** covered in this manual.

The repair procedures in this manual are based on the engine being installed on an approved engine stand. Some rebuild procedures require the use of special service tools. Make sure the correct tools are used as described in the procedures.

When a specific brand name, number, or special tool is referenced in this manual, an equivalent product can be used in place of the recommended item.

A series of specific L10 service manuals (Troubleshooting and Repair, Specifications, Alternative Repair, etc.) are available and can be ordered by filling out and mailing the Literature Order Form located in the Service Literature Section L-1.

Reporting of errors, omissions, and recommendations for improving this publication by the user is encouraged. Please use the postage paid, self-addressed Literature Survey Form in the back of this manual for communicating your comments.

The specifications and rebuild information in this manual is based on the information in effect at the time of printing. Cummins Engine Company, Inc. reserves the right to make any changes at any time without obligation. If differences are found between your engine and the information in this manual, contact a Cummins Authorized Repair Location, a Cummins Division Office, or the factory.

The latest technology and the highest quality components are used to manufacture Cummins engines. When replacement parts are needed, we recommend using only genuine Cummins or ReCon® exchange parts. These parts can be identified by the following trademarks:

TABLE OF CONTENTS

Introduction

Contents

Manual Organization

All references to engine components in this manual are divided into 22 specific groups. The organization is consistent with the service bulletins, service parts topics, and the parts catalogs for your convenience in updating the shop manual.

Table of Contents

The Table of Contents in the front of the manual contains a quick page reference for each group number.

Group Contents

Each group contains the following information:

- A Contents page at the beginning of each group to quickly aid in locating the information desired.
- A Service Tools list with recommended tools needed to rebuild the components.
- General information to aid in rebuilding the component and an explanation of design change differences.
- Step-by-step rebuild instructions for disassembly, cleaning, inspection, and assembly of the component.
- Symbols which represent the action outlined in the instructions. The definitions of the symbols, listed in four languages (English, Spanish, French, and German), appear on pages i-5 through i-8.

Index

An alphabetical Index is in the back of the manual to aid in locating specific information.

Metric Information

Both metric and U.S. customary values are used in this manual. The metric value is listed first, followed by the U.S. customary in brackets. An example is 60°C [140°F].

General Safety Instructions

Important Safety Notice

Read and understand all safety precautions and warnings before performing repairs.

This symbol appears in the manual when a potential safety hazard exists that can cause personal injury or death. These hazards are not always apparent to a trained mechanic.

It is not possible for Cummins Engine Co., Inc. to anticipate every possible circumstance that can involve a potential hazard.

Warning: Cummins Engine Company, Inc. does not recommend or authorize any modifications or repairs to engines or components except for those detailed in **CUMMINS SERVICE INFORMATION**.

In particular, unauthorized repair to safety-related components can cause personal injury. Components classified as safety-related include the following:

- Air Compressor
- Air Controls
- Air Shutoff Assemblies
- Balance Weights
- Cooling Fan
- Fan Hub Assembly
- Fan Mounting Bracket(s)
- Fan Mounting Capscrews
- Fan Hub Spindle
- Flywheel
- Flywheel Crankshaft Adapter
- Flywheel Mounting Capscrews
- Fuel Shutoff Assemblies
- Fuel Supply Tubes
- Lifting Brackets
- Throttle Controls
- Turbocharger Compressor Casing
- Turbocharger Oil Drain Line(s)
- Turbocharger Oil Supply Line(s)
- Turbocharger Turbine Casing
- Vibration Damper Mounting Capscrews

Read and understand all of the safety precautions and warnings before performing any repair. This list contains the general safety precautions that **must** be followed to provide personal safety. Special safety precautions are included in the procedures when they apply.

Be sure the work area surrounding the product is safe. Be aware of hazardous conditions that can exist.

Always wear protective glasses and protective shoes when working.

Do not wear loose-fitting or torn clothing. Remove all jewelry such as rings, watches, etc., when working.

Disconnect the battery and discharge any capacitors before beginning any repair work. Disconnect the air starter if equipped to prevent accidental engine starting. Put a "Do Not Operate" tag in the operator's compartment or on the controls.

General Safety Instructions

Important Safety Notice

Use **ONLY** the proper engine barring techniques for manually rotating the engine. Do not attempt to rotate the engine by pulling or prying on the fan. This practice can cause serious personal injury, property damage, or damage to the fan blade(s) causing premature fan failure.

If an engine has been operating and the coolant is hot, allow the engine to cool before you slowly loosen the filler cap and relieve the pressure from the cooling system.

Do not work on anything that is supported **ONLY** by lift jacks or a hoist. Always use blocks or proper stands to support the product before performing any service work.

Relieve all pressure in the air, oil, and the cooling systems before any lines, fittings, or related items are removed or disconnected. Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. Do not check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.

To prevent suffocation and frostbite, wear protective clothing and **ONLY** disconnect liquid refrigerant (freon) lines in a well ventilated area.

To avoid personal injury, use a hoist or get assistance when lifting components that weigh 23 kg [50 lbs] or more. Be sure all chains, hooks, slings, etc., are in good condition and are of the correct capacity. Be sure hooks are positioned correctly. Always use a spreader bar when necessary. The lifting hooks must not be side-loaded.

Corrosion inhibitor contains alkali. Do not get the substance in your eyes. Avoid prolonged or repeated contact with skin. Do not swallow internally. In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. **IMMEDIATELY CALL A PHYSICIAN. KEEP OUT OF REACH OF CHILDREN .**

Naptha and Methyl Ethyl Ketone (MEK) are flammable materials and must be used with caution. Follow the manufacturer's instructions to provide complete safety when using these materials. **KEEP OUT OF REACH OF CHILDREN.**

To avoid burns, be alert for hot parts on products that have just been turned **OFF**, and hot fluids in lines, tubes, and compartments.

Always use tools that are in good condition. Be sure you understand how to use them before performing any service work. Use **ONLY** genuine Cummins or Cummins Recon® replacement parts.

Always use the same fastener part number (or equivalent) when replacing fasteners. Do not use a fastener of less quality if replacements are necessary.

Symbols Used in this Manual

The following group of symbols have been used in this manual to help communicate the intent of the instructions. When one of the symbols appears, it conveys the meaning defined below.

WARNING - Serious personal injury or extensive property damage can result if the warning instructions are not followed.

CAUTION - Minor personal injury can result or a part, an assembly or the engine can be damaged if the caution instructions are not followed.

Indicates a **REMOVAL or DISASSEMBLY** step.

Indicates an **INSTALLATION or ASSEMBLY** step.

INSPECTION is required.

CLEAN the part or assembly.

PERFORM a mechanical or time **MEASUREMENT**.

LUBRICATE the part or assembly.

Indicates that a **WRENCH or TOOL SIZE** will be given.

TIGHTEN to a specific torque.

PERFORM an electrical **MEASUREMENT**.

Refer to another location in this manual or another publication for additional information.

The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Simbolos Usados En Este Manual

Los simbolos siguientes son usados en este manual para clarificar el proceso de las instrucciones. Cuando aparece uno de estos simbolos, su significado se especifica en la parte inferior.

ADVERTENCIA - Serios daños personales o daño a la propiedad puede resultar si las instrucciones de Advertencia **no** se consideran.

PRECAUCION - Daños menores pueden resultar, o de piezas del conjunto o el motor puede averiarse si las instrucciones de Precaución **no** se siguen.

Indica un paso de **REMOCION** o **DESMONTAJE.**

Indica un paso de **INSTALACION** o **MONTAJE.**

Se requiere **INSPECCION.**

LIMPIESE la pieza o el montaje.

EJECUTESE una **MEDICION** mecánica o del tiempo.

LUBRIQUESE la pieza o el montaje.

Indica que se dará una **LLAVE DE TUERCAS** o el **TAMAÑO DE HERRAMIENTA.**

APRIETESE hasta un par torsor especîfico.

EJECUTESE una **MEDICION** eléctrica.

Para información adicional refiérase a otro emplazamiento de este manual o a otra publicación anterior.

El componente pesa 23 kgs [50 lb] o mas. para evitar dano corporal empleen una cabria u obtengan ayuda para elevar el componente.

Symboles Utilises Dans Ce Manuel

Les symboles suivants sont utilisés dans ce manuel pour aider à communiquer le but des instructions. Quand l'un de ces symboles apparaît, il évoque le sens défini ci-dessous:

AVERTISSEMENT - De graves lésions corporelles ou des dommages matériels considérables peuvent survenir si les instructions données sous les rubriques "Avertissement" **ne** sont **pas** suivies.

ATTENTION - De petites lésions corporelles peuvent survenir, ou bien une pièce, un ensemble ou le moteur peuvent être endommagés si les instructions données sous les rubriques "Attention" **ne** sont **pas** suivies.

Indique une opération de **DEPOSE.**

Indique une opération de **MONTAGE.**

L'INSPECTION est nécessaire.

NETTOYER la pièce ou l'ensemble.

EFFECTUER une **MESURE** mécanique ou de temps.

GRAISSER la pièce ou l'ensemble.

Indique qu'une **DIMENSION DE CLE** ou **D'OUTIL** sera donnée.

SERRER à un couple spécifique.

EFFECTUER une **MESURE** électrique.

Se reporter à un autre endroit dans ce manuel ou à une autre publication pour obtenir des informations plus complètes.

Le composant pese 23 kg [50 lb] ou davantage. Pour eviter toute blessure, employer un appariel de levage ou demander de l'aide pour le soulever.

Symbole

In diesem Handbuch werden die folgenden Symbole verwendet, die wesentliche Funktionen hervorheben. Die Symbole haben folgende Bedeutung:

WARNUNG - Wird die Warnung **nicht** beachtet, dann besteht erhöhte Unfall- und Beschädigungsgefahr.

VORSICHT - Werden die Vorsichtsmassnahmen **nicht** beachtet, dann besteht Unfall- und Beschädigungsgefahr.

AUSBAU bzw. **ZERLEGEN.**

EINBAU bzw. **ZUSAMMENBAU.**

INSPEKTION erforderlich.

Teil oder Baugruppe **REINIGEN.**

DIMENSION - oder **ZEITMESSUNG.**

Teil oder Baugruppe **ÖLEN.**

WERKZEUGGRÖSSE wird angegeben.

ANZUG auf vorgeschriebenes Drehmoment erforderlich.

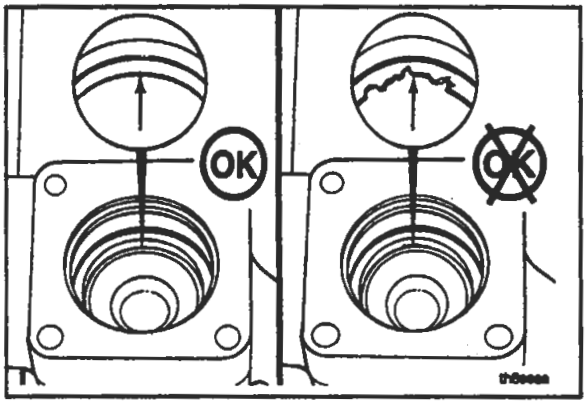
Elektrische **MESSUNG DURCHFÜHREN.**

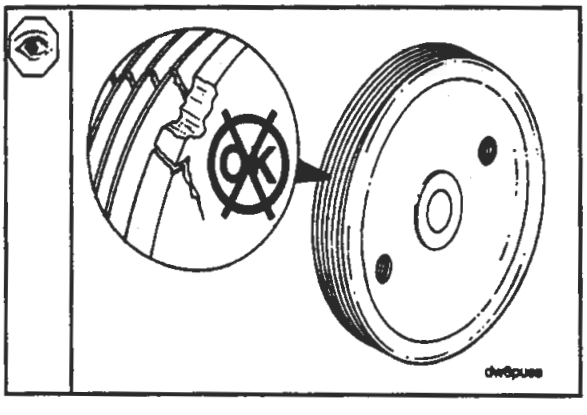
Weitere Informationen an anderer Stelle bzw. in anderen Handbüchern.

Das teil weigt 23 kg [50 lb] oder mehr. Zur vermeidung von koerperverletzung winde benutzen oder hilfe beim heben des teils in anspruch nehmen.

Illustrations

The illustrations used in this manual are intended to give an example of how to perform the action or the repair being described. Many of the illustrations are common and will **not** look exactly like the engine or the parts used in your application. Most of the illustrations contain symbols to indicate an action required or to indicate an **acceptable (OK)** or **unacceptable (not OK)** condition.

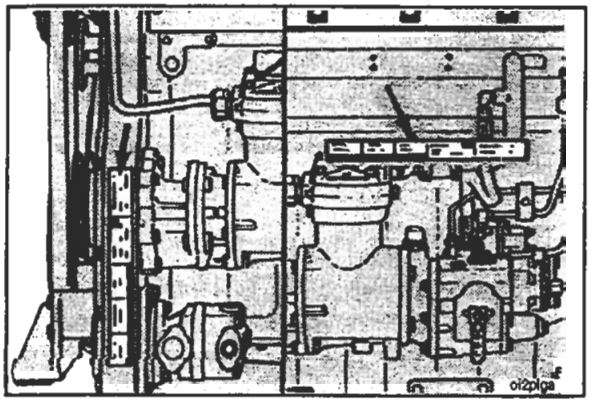




Glossary Of Terms

A.C.:	Alternating Current
AFC:	Air Fuel Control; a device in the fuel pump that limits the fuel delivery until there is sufficient intake manifold pressure to allow for complete combustion.
ATDC:	After Top Dead Center; refers to the position of the piston or the crankshaft rod journal. The piston is moving downward on the power stroke or intake stroke.
BDC:	Bottom Dead Center; refers to the position of the piston or the crankshaft rod journal. The piston is at its lowest position in the cylinder.
BTDC:	Before Top Dead Center; refers to the position of the piston or the crankshaft rod journal. The piston is moving upward on the power stroke or exhaust stroke.
Circumferential Direction:	In the direction of a circle in respect to the centerline of a round part or a bore.
Concentricity:	A measurement of the **difference** between the centers of **either** two or more parts, **or** the bores in one part.
CPL:	Control Parts List; this listing identifies the specific parts that **must** be installed on the engine to meet agency certification.
Cummins Sealant:	This is a one part Room Temperature Vulcanizing (RTV) silicone rubber, adhesive and sealant material having **high** heat and oil resistance, and **low** compression set. Some of the equivalent products are Marston Lubricants, Hylosil, Dow Corning, Silastic 732, Loctite Superflex, General Electric 1473, and General Electric 1470.
D.C.:	Direct Current
Dye Penetrant Method:	A method used to check for cracks in a part by using a dye penetrant and a developer. Use Part No. 3375432 Crack Detection Kit, or equivalent.
End Clearance:	The clearance in an assembly determined by pushing the shaft in an axial direction **one way**, and then pushing the shaft the **other way.**
E.S.N.:	Engine Serial Number
Hammer:	A hand tool consisting of a hard steel head on a handle.
ID:	Inside Diameter
Loctite 290:	A single component, anaerobic, polyester resin, liquid sealant compound that hardens between closely fitted metal surfaces producing a tough, hard bond with good characteristics. An equivalent product is Perma-Lok HL 126.

Loctite 609:	A single component anaerobic, liquid adhesive that meets **or** exceeds the requirements of MIL-R-46082A (MR) TYPE 1. Some of the equivalent products are Loctite 601 and Permabond HL 138.
Lubriplate 105:	A mineral oil base grease with calcium soap (2 percent to 6 percent), and zinc oxide (2 percent to 4 percent) additives.
Magnetic Particle Inspection:	A method of checking for cracks in **either** steel **or** iron parts. This method requires a Magnaflux machine, or an equivalent machine that imparts a magnetic field on the part being checked.
Mallet:	A hand tool consisting of a soft head; **either** wood, plastic, lead, brass, **or** rawhide on a handle.
MAX:	Maximum allowed
MIN:	Minimum allowed
No.:	Number
O.D.:	Outside Diameter
OS:	Oversize
Protrusion:	The **difference** in the height between two parts in the assembled state.
STD:	Standard
TC:	Torque Converter; used when referring to the torque converter cooler.
TDC:	Top Dead Center; refers to the position of the piston or the crankshaft rod journal. The piston is at its highest position in the cylinder. The rod journal is pointing straight up toward the piston.
TIR:	Total Indicator Reading; used when measuring the concentricity or the run out. The TIR refers to the total movement of the needle on a dial indicator, from the most **negative** reading to the most **positive** reading.
Water Pump Grease:	A premium high temperature grease that will lubricate antifriction bearings continually from **minus** 40 C [**minus** 40 F] to **plus** 150 C [**plus** 350 F]. Some of the greases meeting this requirement are Aeroshell No. 5, Chevron SRI, Amoco Rykon Premium No. 2, Texaco Premium RB, and Shell Dolium R. Aeroshell No. 5 is **not** compatible with the other greases and **must not** be mixed. Cummins Engine Co., Inc., uses Aeroshell No. 5 on new engines and components.

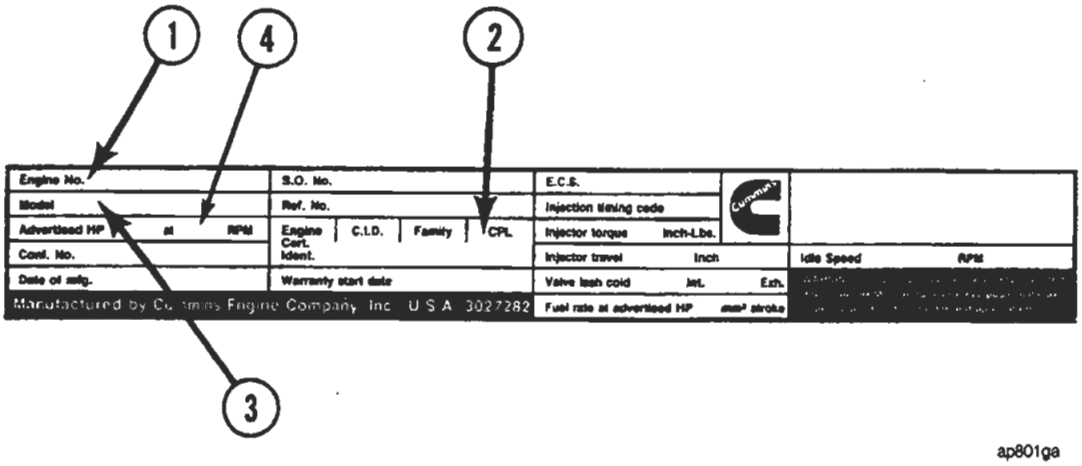


Engine Identification

The engine data plate provides the model identification and other important information about the engine.

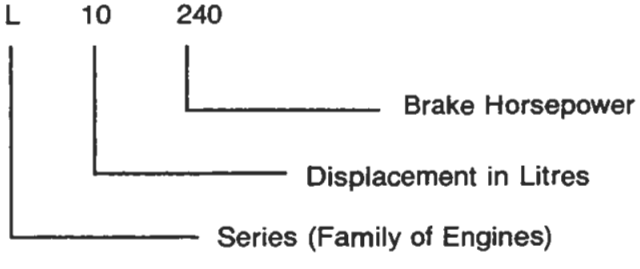
Have the following engine data available when communicating with a Cummins' Authorized Repair Location. The information on the dataplate is **mandatory** when sourcing service parts:

1. Engine Serial Number (E.S.N.)
2. Control Parts List (CPL)
3. Model
4. Horsepower and RPM Rating



ap801ga

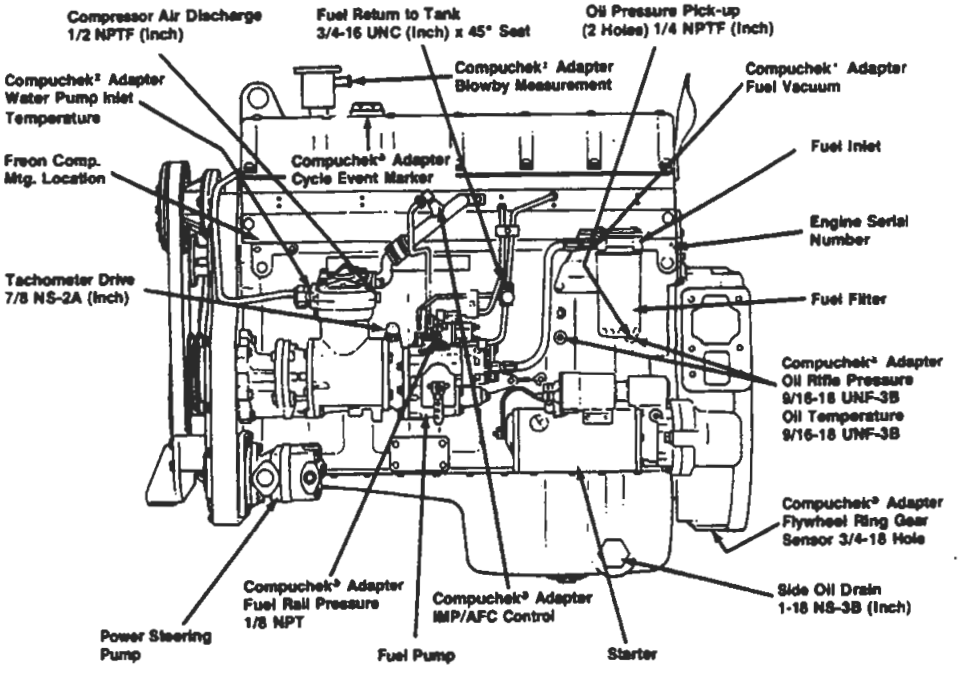
The model name provides the following data:



Engine Diagrams

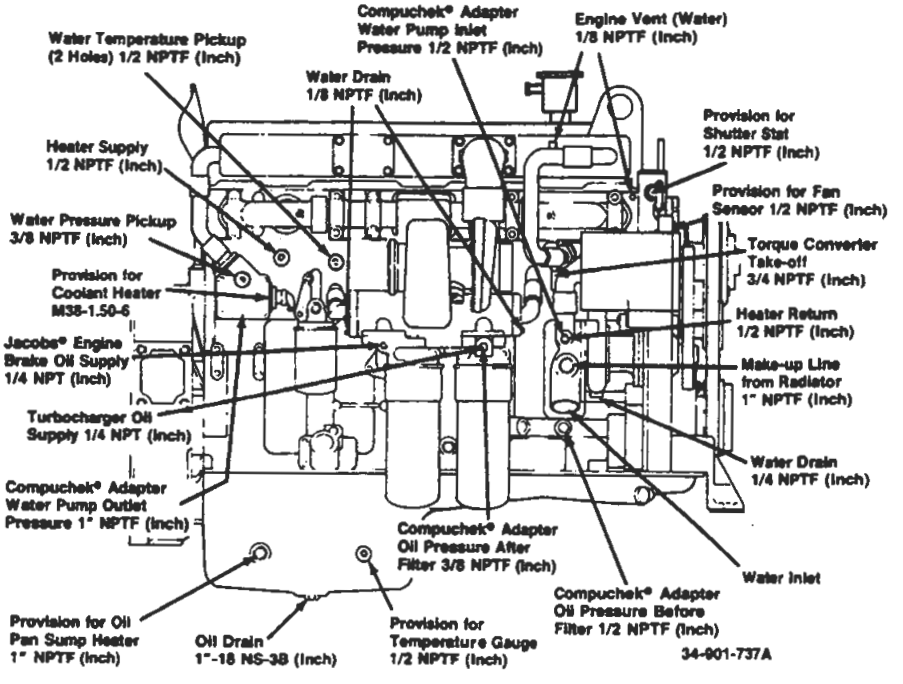
The following drawings contain information about engine components, filter locations, drain points and access locations for instrumentation and engine controls:

The information and configuration of components shown in these drawings are of a general nature. Some component locations will vary depending on applications and installations.



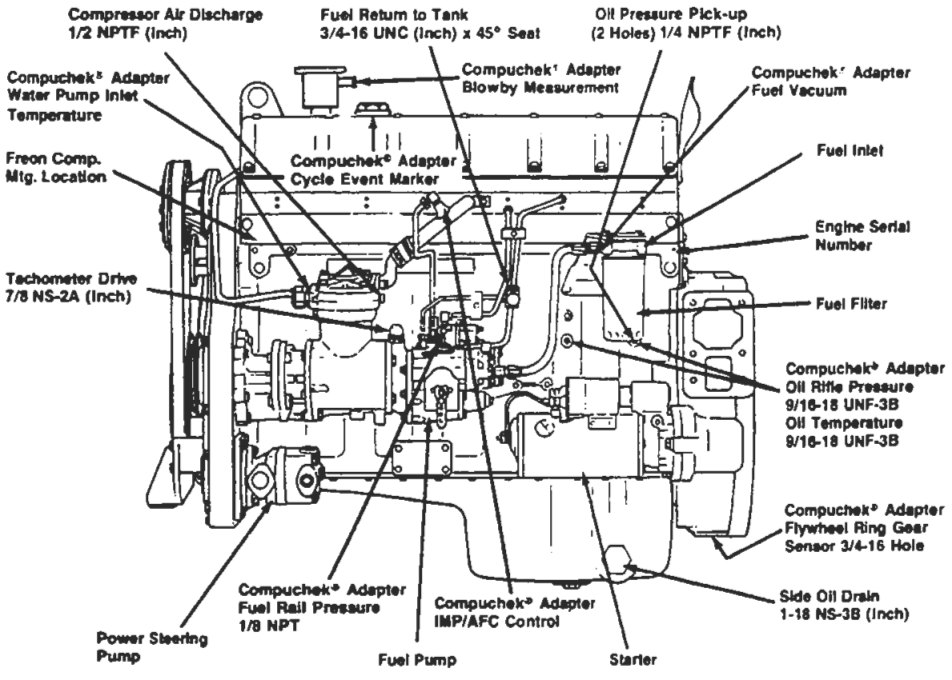
CONVENTIONAL AFTERCOOLING

ew200gx



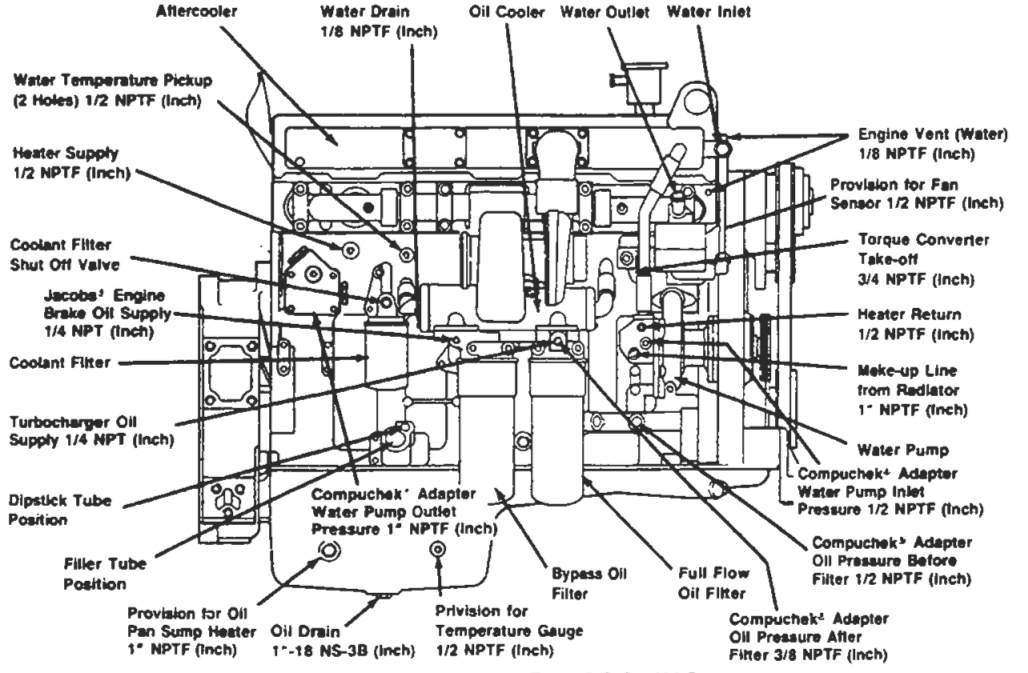
CONVENTIONAL AFTERCOOLING

ew200gy



OPTIMIZED AFTERCOOLING

ew200gw



OPTIMIZED AFTERCOOLING

ew200gz

General Cleaning Instructions

Solvent And Acid Cleaning

Several solvent and acid type cleaners can be used to clean the engine parts. **Cummins Engine Co., Inc. does not recommend any specific cleaners.** Always follow the cleaner manufacturer's instructions.

Experience has shown that the best results can be obtained using a cleaner that can be heated to 90 to 95 degrees Celsius [180 to 200 degrees Fahrenheit]. A cleaning tank that provides a constant mixing and filtering of the cleaning solution will give the best results.

Remove all the gasket material, o-rings, and the deposits of sludge, carbon, etc., with a wire brush or scraper before putting the parts in a cleaning tank. Be careful **not** to damage any gasket surfaces. When possible, steam clean the parts before putting them in the cleaning tank.

Warning: The use of acid can be extremely dangerous to personnel and can damage the machinery. Always provide a tank of strong soda water as a neutralizing agent.

Rinse all of the parts in hot water after cleaning. Dry completely with compressed air. Blow the rinse water from all of the capscrew holes and the oil drillings.

If the parts are **not** to be used immediately after cleaning, dip them in a suitable rustproofing compound. The rustproofing compound **must** be removed from the parts before installation on the engine.

Steam Cleaning

Steam cleaning can be used to remove all types of dirt that can contaminate the cleaning tank. It is a good way to clean the oil drillings.

Warning: Wear protective clothing to prevent personal injury from the high pressure and extreme heat.

Do **not** steam clean the following parts:

1. Electrical Components
2. Wiring
3. Injectors
4. Fuel Pump
5. Belts and Hoses
6. Bearings

Glass Bead Cleaning

Glass bead cleaning can be used on many engine components to remove carbon deposits. The cleaning process is controlled by the size of the glass beads, the operating pressure, and the cleaning time.

Caution: Do not use glass bead cleaning on aluminum piston skirts or ring grooves. Small particles of glass will embed in the aluminum and result in premature wear. Valves, turbocharger shafts, etc., can also be damaged. Follow the cleaning directions listed in the procedures.

Plastic Bead Cleaning

A new plastic bead media, Part No. 3822735, has been released for piston cleaning. This media can be used to clean the piston dome or crown, the ni-resist ring grooves and the aluminum ring grooves. As with walnut shell or glass bead blasting, plastic bead blasting must be done at the minimum pressure that is effective (276 kPa [40 psi]) and the spray must not be concentrated in any one area for an extended period of time.

Follow the equipment manufacturer's cleaning instructions. The following guidelines can be used to adapt to the manufacturer's instructions:

1. Bead size: Use U.S. size No. 70 for piston domes.

   Use U.S. size No. 60 for general purpose cleaning.

2. Operating Pressure: Use 620 kPa [90 psi] for general purpose cleaning.

3. Steam clean or wash the parts with solvent to remove all of the foreign material and glass beads after cleaning. Rinse with hot water. Dry with compressed air.

4. Do **not** contaminate the wash tanks with glass beads.

General Repair Instructions

Read the safety section in this manual found on page i-3. Follow all of the additional safety instructions included in the procedures.

Provide a clean environment. Follow the general cleaning guidelines **except** where specific cleaning instructions are included in the procedures.

Perform the inspections specified in the procedures. The inspections will result in a minimal number of parts requiring replacement. The cost of the rebuild will be reduced more than the cost of the additional inspection time.

Follow the order of **assembly** and **disassembly** as described in the procedures to avoid causing damage to the parts.

Engine Disassembly and Assembly - Group 00

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Page

Engine Disassembly (Cont'd.)

Page

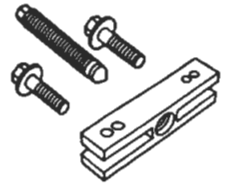
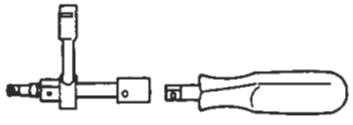
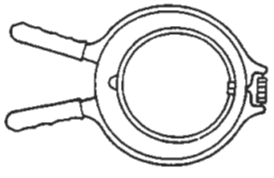
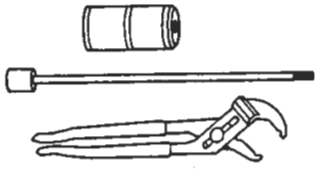
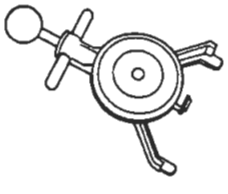
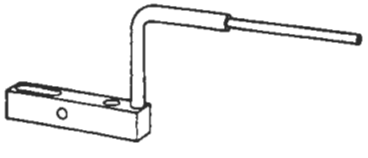
Engine Assembly (Cont'd.)

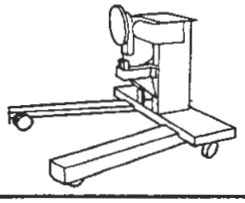
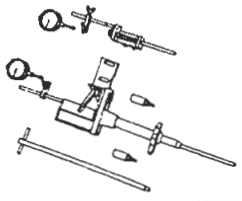
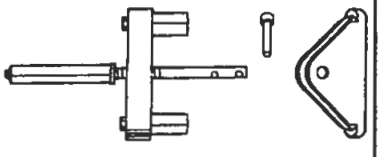
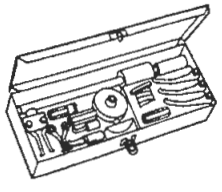
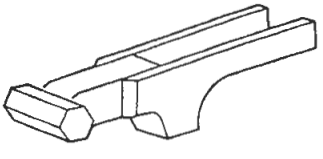
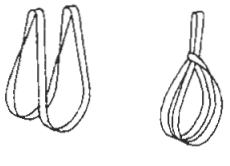
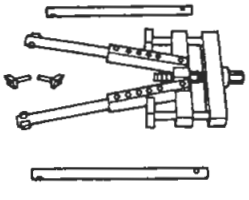
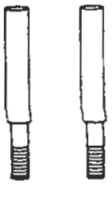
Page

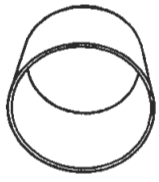
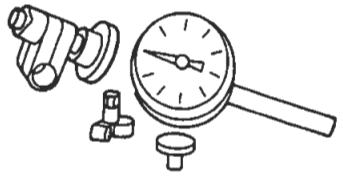
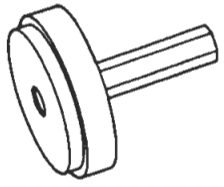
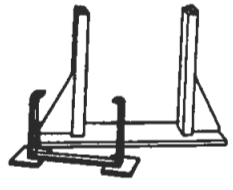
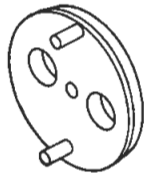
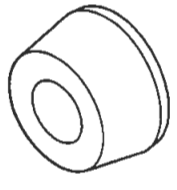
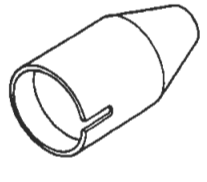
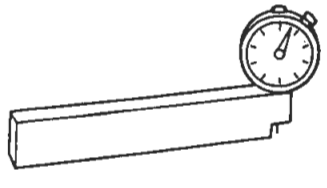
Engine Assembly (Cont'd.)

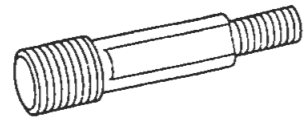
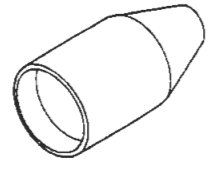
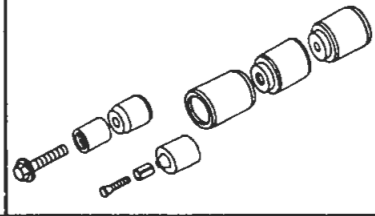
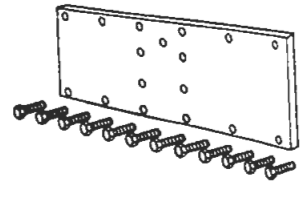
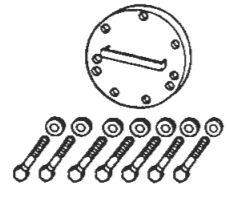
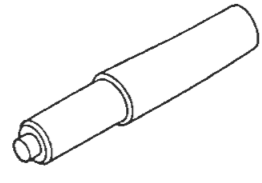
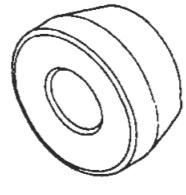
Engine Disassembly and Assembly - Service Tools

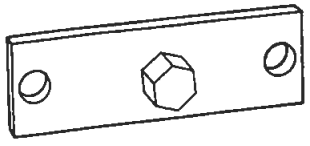
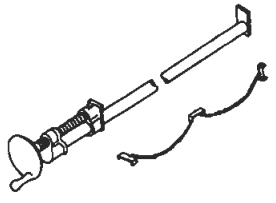
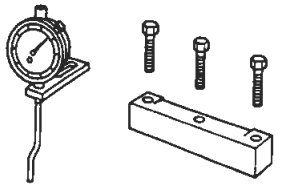
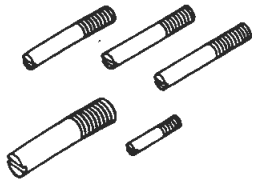
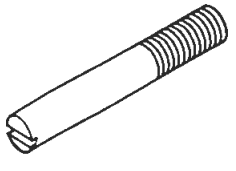
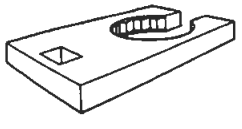
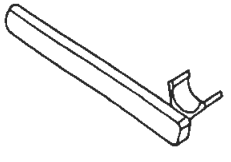
The following special tools are recommended to perform the procedures in Group 00. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

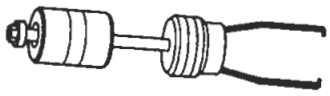
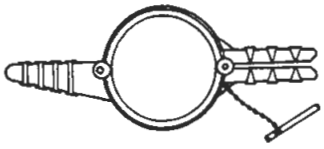
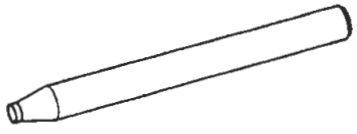
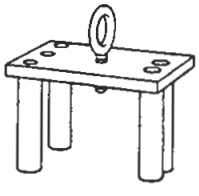
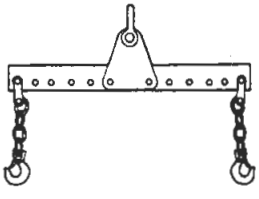
Tool No.	Tool Description	Tool Illustration
ST-647	**Standard Puller** Remove accessory and alternator drive pulleys. Use with Part No. 3376104 Pulley Puller Capscrews.	
ST-669	**Torque Wrench Adapter** Tighten crosshead and rocker lever adjusting screws.	
ST-821	**Piston Ring Expander** Remove and install piston rings on pistons.	
ST-1178	**Main Bearing Cap Puller** Remove main bearing caps.	
ST-1293	**Belt Tension Gauge** Measure drive belt tension.	
ST-1325	**Dial Gauge Attachment** Attaches to crankshaft flange to provide measuring of flywheel and flywheel housing runout with dial bore gauge.	

Tool No.	Tool Description	Tool Illustration
3375194	**Engine Rebuild Stand** Support cylinder block during engine rebuild. Used with Part No. 3376432 Adapter Plate.	
3375522	**Injector Timing Tool** Adjust injection timing.	
3375629	**Universal Cylinder Liner Puller** Remove cylinder liners from cylinder block. Requires Part No. 3376049 Cylinder Liner Puller Plate.	
3375784	**Light Duty Puller Kit** Remove high oil pressure regulator retainer plug.	
3375790	**Rocker Lever Actuator** Check injector adjustments.	
3375957	**Nylon Lifting Sling** Aid in removal and installation of crankshaft, flywheel and other heavy components.	
3376015	**Universal Cylinder Liner Puller** Remove cylinder liners from the cylinder block. Requires two Part No. 3376649 Puller Arm Extension Feet.	
3376038	**Connecting Rod Guide Pins** Guide connecting rods over crankshaft during removal or installation of connecting rods.	

Tool No.	Tool Description	Tool Illustration
3376046	**Piston Ring Compressor Sleeve** Compress piston rings on pistons during installation of pistons in engine.	
3376050	**Dial Indicator and Sleeve Assembly** Use with Part No. ST-1325 Dial Gauge Attachment to measure flywheel and flywheel housing runout.	
3376056	**Cylinder Liner Driver** Install cylinder liner in cylinder block.	
3376057	**Engine Support Stand** Support engine when not in-chassis or on the engine rebuild stand.	
3376076	**Oil Seal Guide** Install rear crankshaft oil seal.	
3376098	**Oil Seal Guide** Install gear driven fan hub oil seal in the gear cover.	
3376099	**Oil Seal Guide** Install accessory drive oil seal in the gear cover.	
3376220	**Gauge Block** Measure cylinder liner protrusion on the cylinder block, flywheel housing and gear cover protrusion below the cylinder block.	

Tool No.	Tool Description	Tool Illustration
3376326	**Pulley Installation Tool** Install drive pulleys. Use Part No. 3377453 Pulley Pusher Adapter to install the accessory drive pulley. Use Part No. 3377401 Pulley Pusher Adapter to install the alternator drive pulley.	
3376383	**Pulley Pusher Adapter** Used with Part No. 3376326 Pulley Installation Tool to install drive pulleys on early production engines..	
3376386	**Water Pump Oil Seal Expander** Install water pump oil seal in gear cover.	
3376388	**Camshaft Guide Pilot** Aid in removal and installation of the camshaft in cylinder block.	
3376432	**Engine Stand Adapter Plate** Adapt L10 cylinder block to the Part No. 3375194 Engine Rebuild Stand. Requires 12 Part No. 3376434 Hex Head Capscrews.	
3376472	**Cylinder Liner Clamping Kit** Install cylinder liner in the cylinder block.	
3376489	**Regulator Retainer Plug Driver** Install the high oil pressure regulator retainer plug in the cylinder block to a specified depth.	
3376496	**Oil Seal Guide** Install crankshaft front oil seal.	

Tool No.	Tool Description	Tool Illustration
3376601	**Engine Barring Tool** Used to rotate the crankshaft.	
3376606	**Flywheel Housing Alignment Plate** Align flywheel housing with cylinder block.	
3376645	**Camfollower Clamping Fixture** Remove and install camfollower assembly. Used with Part No. 3376639 Shim Assembly.	
3376648	**Injector Travel Adjustment Kit** Adjust injector travel.	
3376695	**Guide Pin Kit** Aid during installation of flywheel, flywheel housing, vibration damper, accessory drive support, and water pump bearing support.	
3376696	**Guide Pin (2)** Aid in replacing air manifold side cover.	
3376867	**Injector Locknut Wrench** Tighten "Top-Stop" injector locknut.	
3376868	**"Top-Stop" Injector Adjusting Tool.** Set "Top-Stop" injector adjustment.	

Tool No.	Tool Description	Tool Illustration
3376872	**Universal Injector Puller** Remove injectors from cylinder head.	
3376877	**Piston Ring Compressor** Compress piston rings on pistons during installation of pistons in the cylinder block.	
3822372	**Expansion Plug Driver** Install expansion plug to specified depth.	
3822479	**Cylinder Head Lifting Bracket** Remove and install cylinder head to the cylinder block.	
3822512	**Engine Lifting Fixture** Lift engine.	

General Information

These procedures apply to all L10 engines. The differences between engine models due to the application, the optional equipment on an engine, and the year an engine was built are included in the instructions. Omit the steps that do **not** apply to the engine being rebuilt.

1. A **Warning** statement is included for any component or assembly that weighs more than 23 Kg [50 lb]. To avoid personal injury, use a hoist or get assistance from more than one person when **removing** or **installing** these parts.
2. Most of the capscrews used on the L10 engine are metric. Some components, such as the air compressor and fuel pump, are installed using U.S. Customary capscrews. All fasteners have **right-hand** threads unless a **Caution** states that a fastener has **left-hand** threads.

Disassembly

The instructions in this procedure are organized in a logical sequence to **disassemble** an engine. This is **not** the **only** sequence to **disassemble** an engine. Certain parts **must** be removed in the sequence indicated. Use this sequence until you become familiar with the engine.

Discard all gaskets, seals, hoses, filters, and o-rings. **Keep** these parts if they are needed for a failure analysis.

Label, tag, or mark the parts for location as the parts are removed. This will help find all of the parts that can be involved in a failure, and simplify the **assembly** procedure.

Label, tag, mark, or photograph all special equipment prior to the removal from an engine. This engine **assembly** procedure does **not** include the installation of special optional equipment.

Force **must** be used to remove certain parts. A mallet **must** be used when force is required. All of the fasteners **must** be removed before using force.

Avoid **as** much dirt **as** possible during **disassembly**. The accumulation of additional dirt will make it more difficult to clean the components.

Assembly

This procedure assumes that all of the components and assemblies have been cleaned, replaced, or rebuilt and are ready to be installed on the engine.

Torque values are listed in each step. If a torque value is not specified, use the chart listed in the specifications section, group 18, to determine the correct torque value.

Many of the gaskets and o-rings are manufactured from a material designed to absorb oil. These gaskets will enlarge and provide a tight seal after coming in contact with oil. Use ONLY a recommended contact adhesive or a vegetable based oil to install these parts.

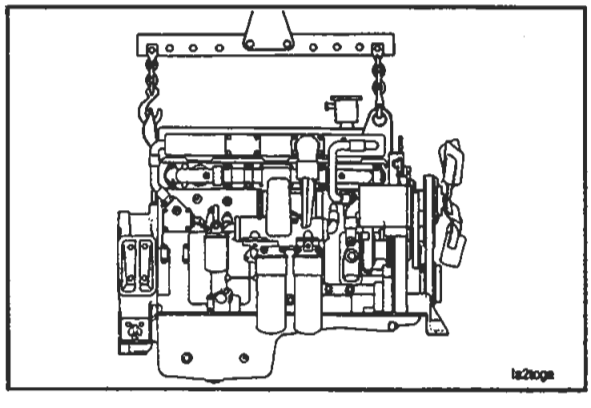
Always use a capscrew of the same system, metric or U.S. Customary, the same dimension and the same grade as the capscrew removed. The use of a longer capscrew than the capscrew that is listed can result in damage to the engine.

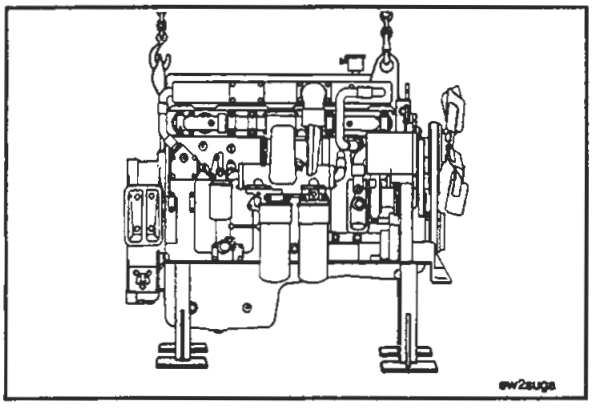
Engine Disassembly (00-01)

Engine - Prepare for Cleaning

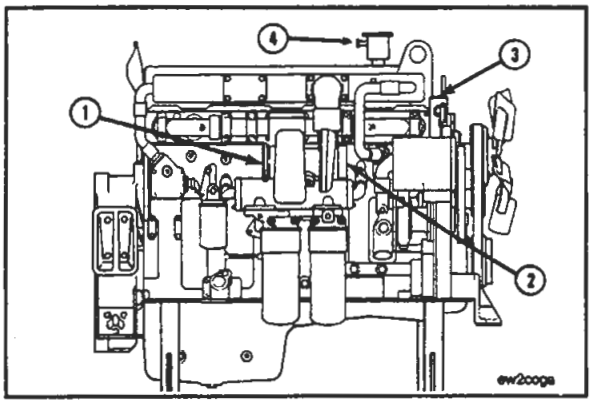
Warning: The engine weighs approximately 855 Kg [1950 lb]. Personal injury can result.

Use the Part No. 3822512 Lifting Fixture and a hoist with a minimum lifting capacity of 1.8m ton [2.0 tons] to lift the engine.





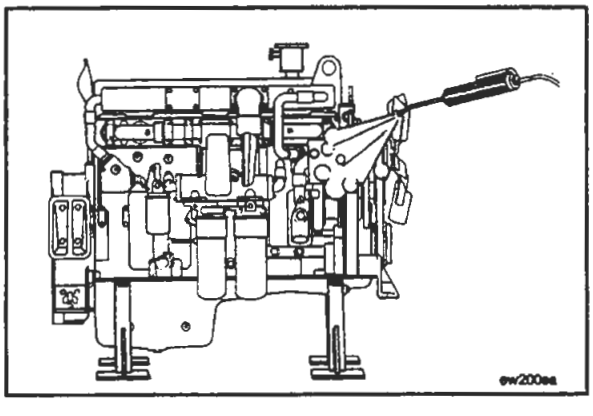
Install the engine on two Part No. 3376057 Engine Support Stands.



Label and remove all electrical wiring and controls.

Install caps or tape on the following openings to prevent moisture and dirt from entering the engine:

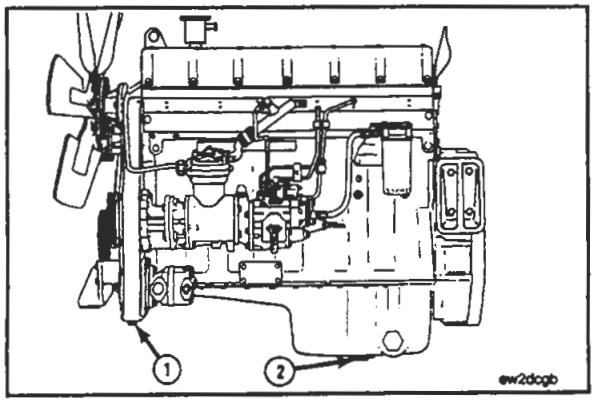
- Both sides of the turbocharger (1) and (2)
- Coolant outlet connection (3)
- Crankcase breather (4)
- All oil, water and fuel openings



Engine - Clean

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Steam clean and dry with compressed air.



Lubricating Oil - Drain

Note: The oil pan capacity is 26.5 Liters [7.0 U.S. Gallons].

Remove the plugs from points (1) and (2).

Use a suitable container to catch the oil as it is drained.

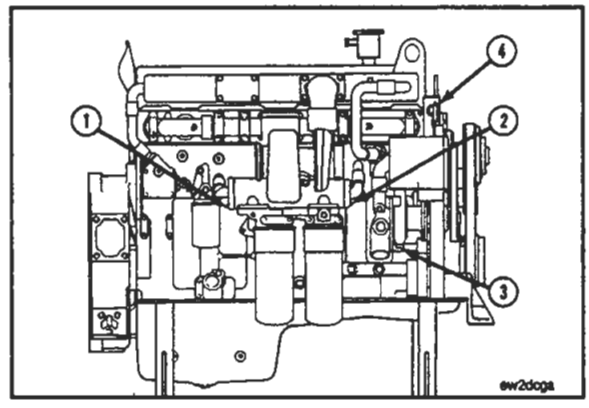
Note: The plug (1) is not found on current production engines.

Coolant - Drain

Remove the plugs from the following points:

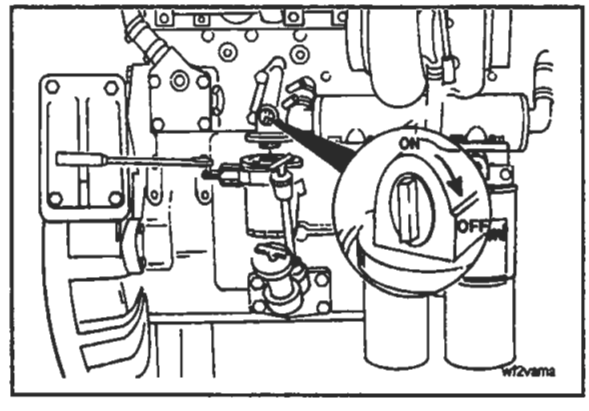
- Lubricating oil cooler (1) and (2)
- Water pump (3)
- Thermostat housing (4)

Use a suitable container to catch the coolant as it is drained.



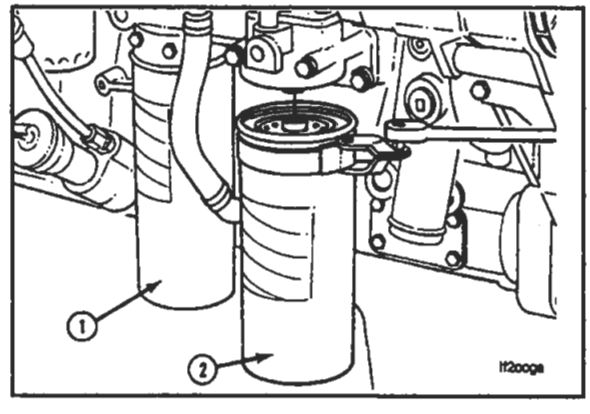
Coolant Filter - Remove

Use a Part No. 3376807 Water and Fuel Filter Wrench to remove the coolant filter.



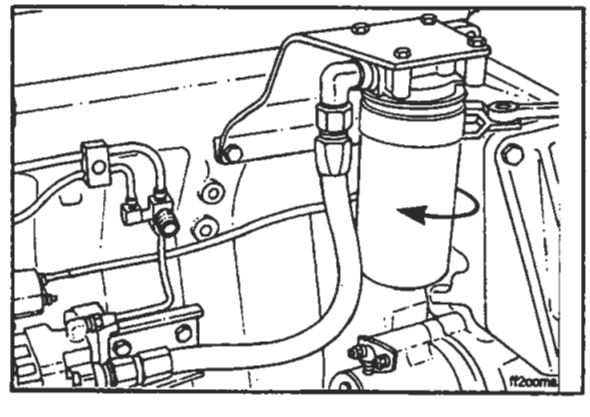
Lubricating Oil Filters - Remove

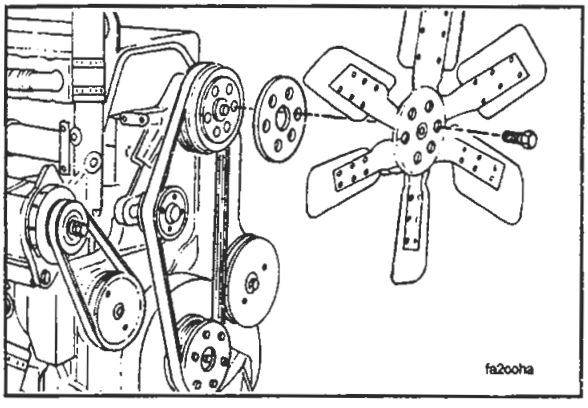
Use a Part No. 3375049 Oil Filter Wrench to remove the bypass filter (1) and the full flow filter (2).



Fuel Filter - Remove

Use a Part No. 3376807 Water and Fuel Filter Wrench to remove the fuel filter.



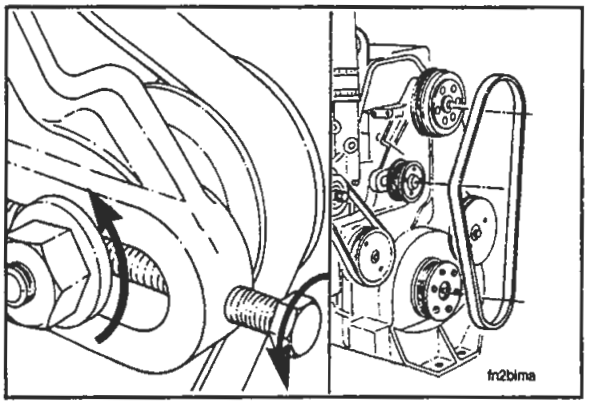


Fan and Fan Hub Spacer - Remove

Caution: A fan hub spacer can be behind the fan. It will drop as the fan is removed. Make sure to remove the fan and fan hub spacer together.

Remove the six capscrews and the fan.

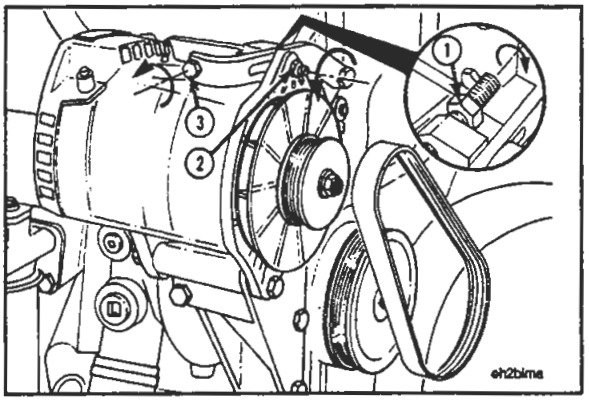
Note: The six capscrews also hold the fan drive pulley in position. Do not allow the pulley to fall.



Fan Drive Belt (Belt Driven Fan Only) - Remove

Loosen the idler pulley shaft locknut.

Turn the adjusting screw **counterclockwise** to release tension, and remove the belt.

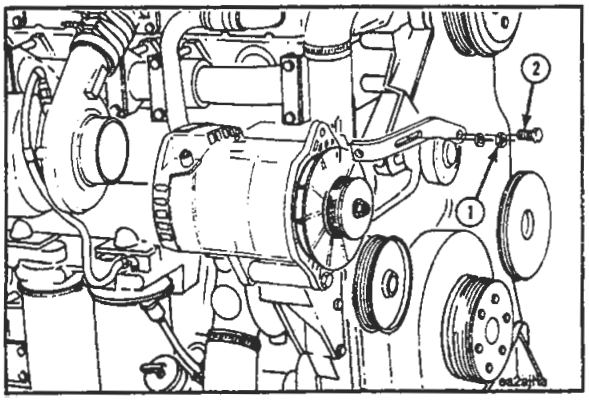


Alternator Belt - Remove

Loosen the locknut (1).

Loosen the nut (2).

Turn capscrew (3) **counterclockwise** to release tension, and remove the belt.



Alternator Adjusting Link - Remove

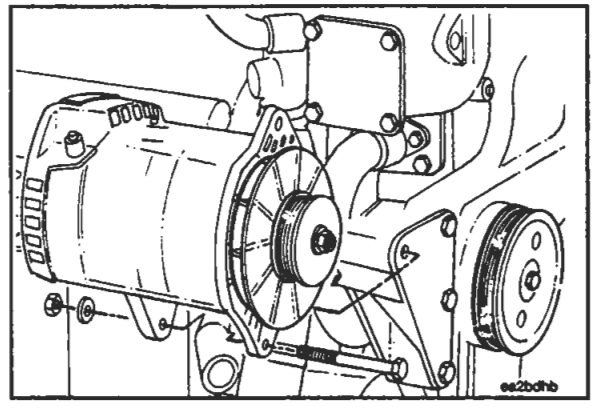
Remove the nut (1).

Remove the capscrew (2) and the adjusting link.

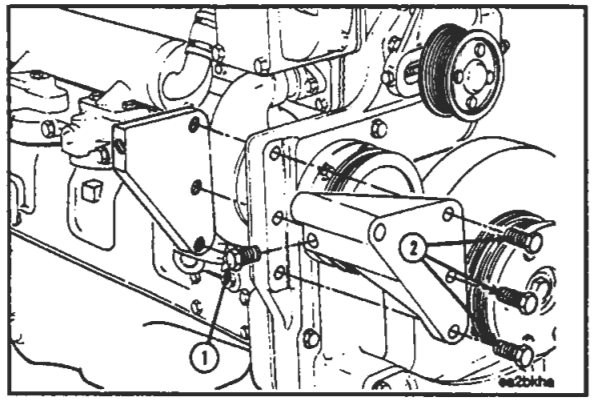
Alternator and Bracket - Remove

Remove the nut from the bolt that holds the alternator to the bracket.

Remove the bolt and alternator.



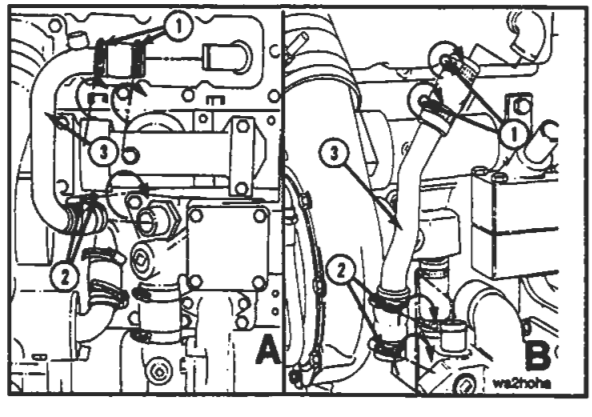
To remove the bracket; loosen capscrew (1), remove the three capscrews (2) and the bracket.



Aftercooler Coolant Outlet Tube - Remove

Loosen the hose clamps (1) and (2) and remove the coolant outlet tube (3).

- Conventional aftercooling (A)
- Optimized aftercooling (B).



Aftercooler Coolant Inlet Tube - Remove

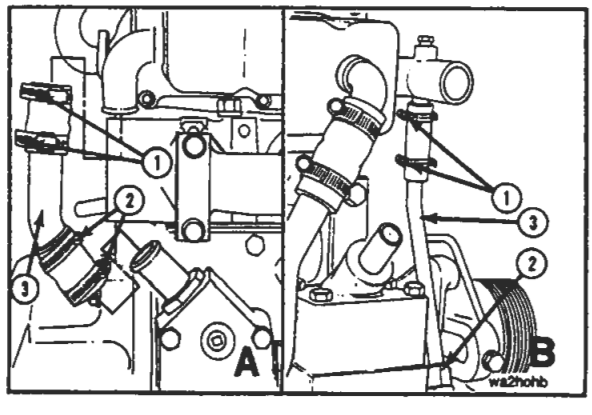
Conventional Aftercooling (A)

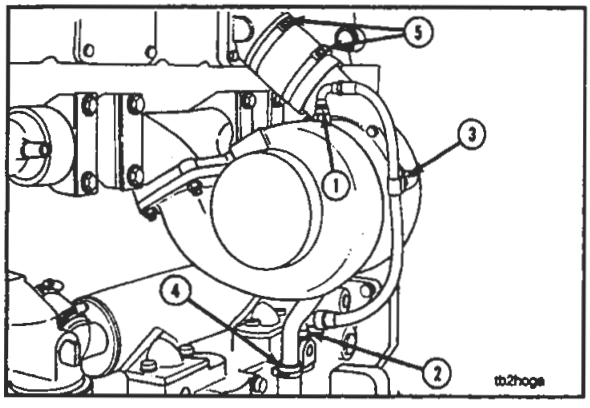
Loosen the hose clamps (1) and (2) and remove the coolant inlet tube (3).

Optimized Aftercooling (B)

Loosen the hose clamps (1) and the nut (2).

Remove the coolant bypass tube (3) .





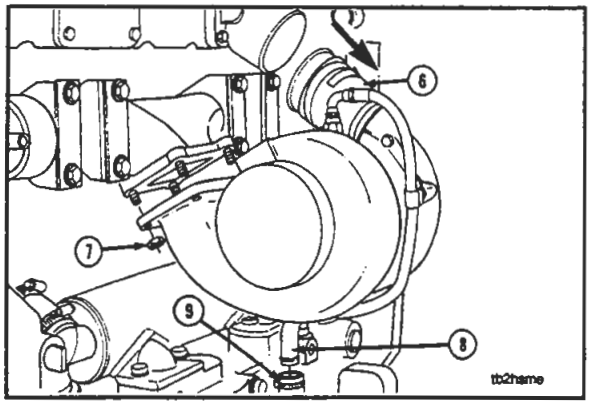
Turbocharger - Remove

Loosen the oil inlet hose connections (1) and (2).

Remove the hose clamp capscrew (3) and remove the hose.

Loosen the hose clamp (4) on the oil drain line.

Loosen the two "T-bolt" clamps (5) on the air inlet hose.

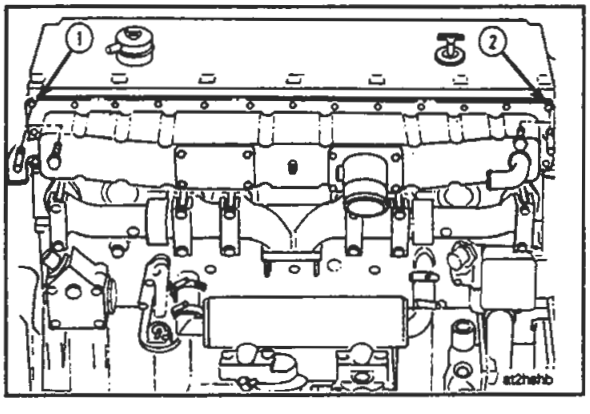


Move the hose (6) toward the turbocharger.

Remove the four nuts (7).

Pull up to remove the oil drain connection (8) from the flexible hose (9) and remove the turbocharger.

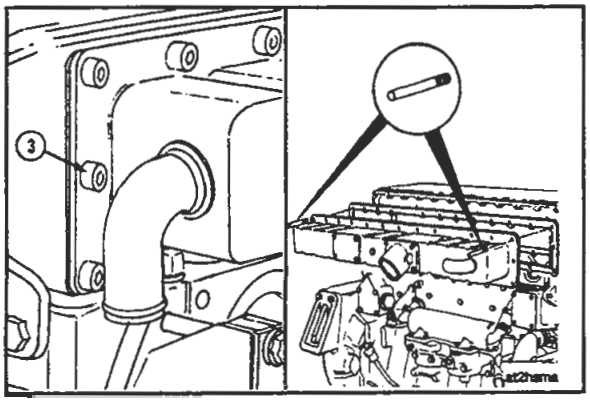
Note: If the turbocharger is **not** to be rebuilt, the exhaust and inlet opening and the oil inlet and drain holes **must be** covered.



Aftercooler Housing - Remove

Remove one socket head capscrew at points (1) and (2) and install two Part No. 3376488 Guide Pins.

Remove the remaining 23 socket head capscrews beginning at the ends and moving toward the center of the housing.



Note: One capscrew (3) is behind the aftercooler inlet tube.

The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

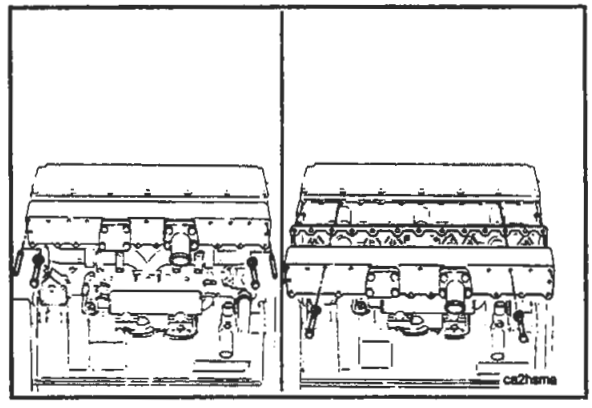
Remove the housing, gasket and the two guide pins.

Air Manifold Side Cover (Optional Non-Aftercooled) - Remove

Remove one capscrew at each end of the cover and install two Part No. 3376696 Guide Pins.

Remove the remaining 23 capscrews.

Remove the cover, gasket and the two guide pins.



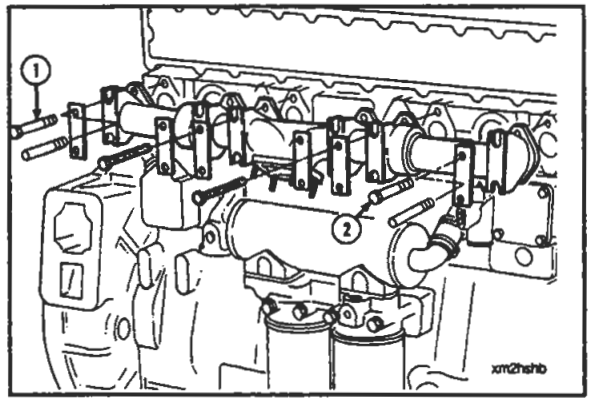
Exhaust Manifold - Remove

Warning: Hold the exhaust manifold assembly on each end to remove it. There are three sections which can separate and fall causing personal injury.

Remove capscrews (1) and (2) and install two Part No. 3376488 Guide Pins.

Remove the remaining ten capscrews and six support plates.

Remove the exhaust manifold, gaskets and the two guide pins.



Thermostat Housing - Remove

Conventional Aftercooling (A)

Loosen the hose clamps (1).

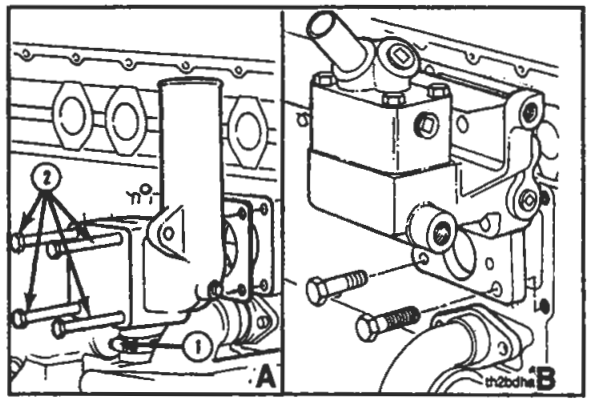
Remove the four capscrews (2), the housing, and the thermostat.

Note: If the housing is stuck, hit the housing with a rubber hammer to loosen it.

Optimized Aftercooling (B)

Remove the two water transfer connection capscrews.

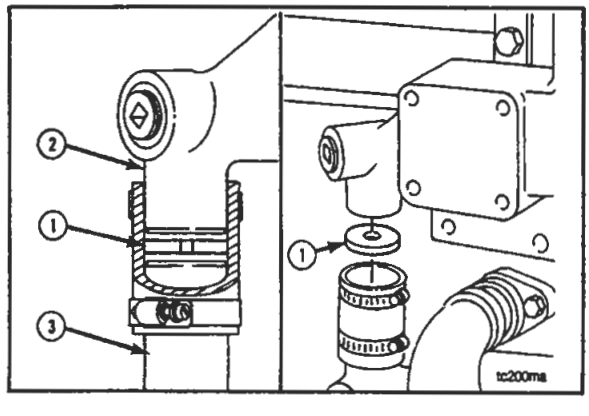
Remove the eight capscrews, the housing, and the thermostat.

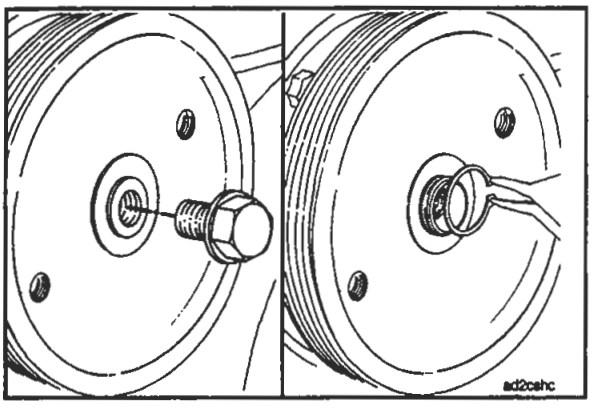


Torque Converter Cooler Disc (Conventional Aftercooling Only) - Remove

Note: The torque converter cooler disc (1) restricts the water flow through the thermostat housing (2) to water pump by-pass hose (3). This allows coolant to be circulated through a remote mounted torque converter oil cooler.

Remove the disc (1) from the thermostat housing to water pump bypass hose connection.

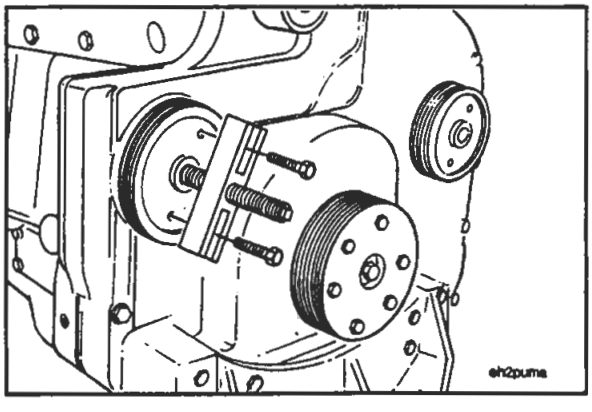




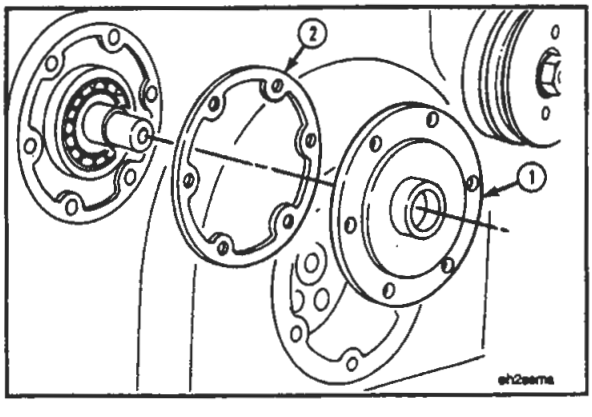
Alternator Drive Pulley - Remove

Note: Early production engines use a retainer snap ring and no capscrew.

Remove the pulley retainer capscrew or snap ring.



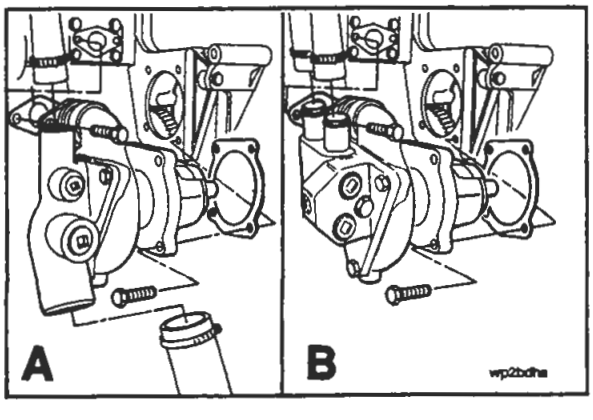
Use the Part No. ST-647 Standard Puller and two Part No. 3376104 (M10–1.50 X 50) Capscrews to remove the pulley.



Alternator Drive Oil Seal - Remove

Remove the six capscrews, oil seal (1) and gasket (2).

Note: Earlier production engines used a seal clamping plate. Present productions engines and replacement seals do not use the clamping plate.



Water Pump - Remove

Conventional Aftercooling (A)

Remove the two water transfer connection capscrews.

Remove the four capscrews and the water pump.

Optimized Aftercooling (B)

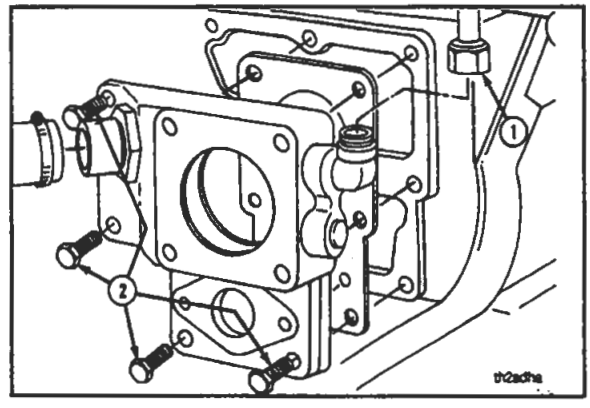
Remove the four capscrews and the water pump.

Thermostat Housing Support (Conventional Aftercooling Only) - Remove

Loosen the air compressor water return tube connection (1).

Remove the four capscrews (2) and the support.

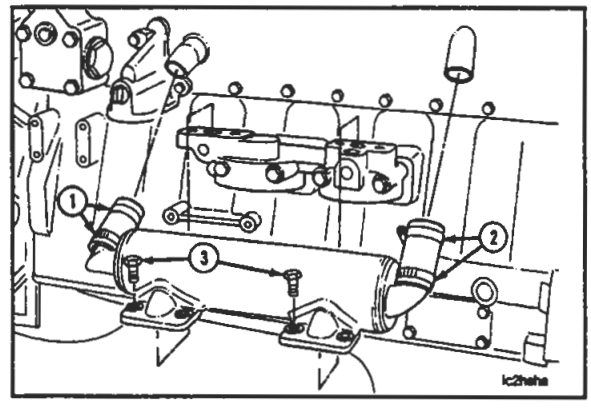
Note: If the support is stuck, hit the support with a rubber hammer to loosen it.



Lubricating Oil Cooler - Remove

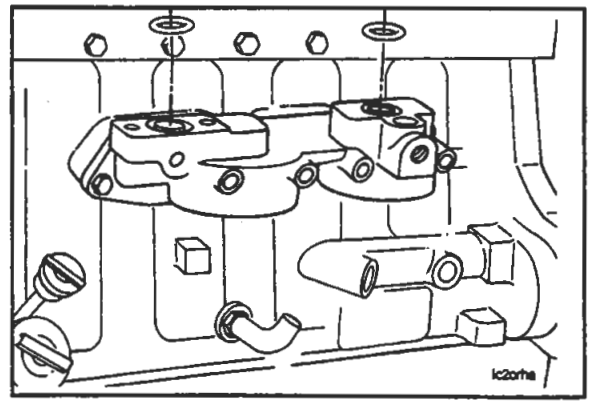
Loosen the hose clamps (1) and (2).

Remove the four capscrews (3) and the oil cooler.



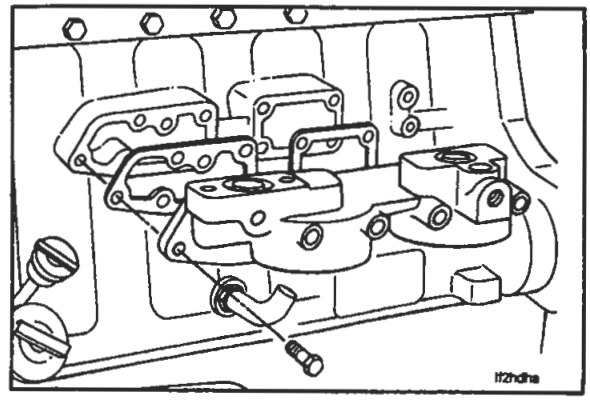
Remove the o-rings from the lubricating oil filter head.

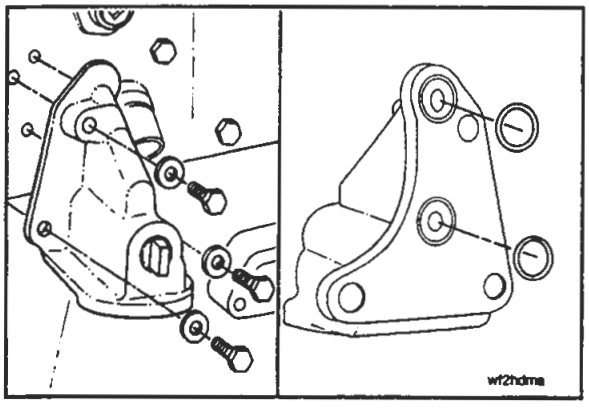
Note: Remove the Jacobs® Engine Brake oil supply line if equipped.



Lubricating Oil Filter Head - Remove

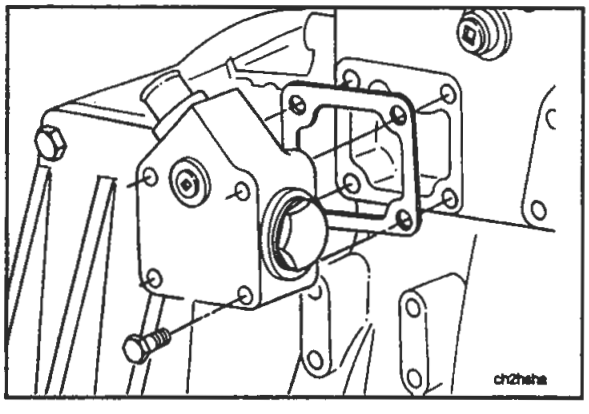
Remove the nine capscrews and the oil filter head.





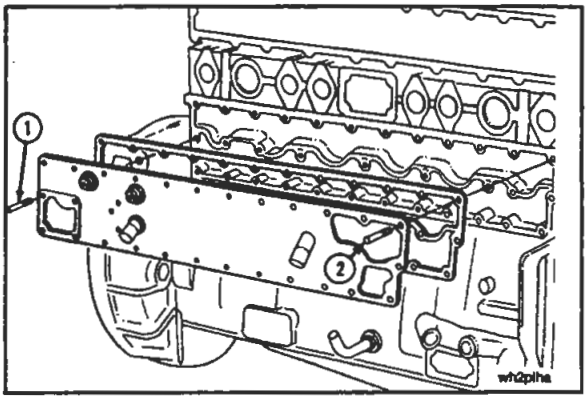
Water Filter Head - Remove

Remove the coolant filter, the three capscrews, filter head and the two o-rings.



Water Heater Housing - Remove

Remove the four capscrews, housing and gasket.

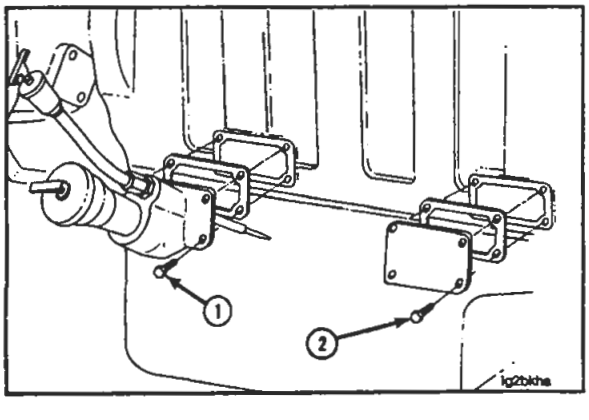


Water Header Plate - Remove

Remove capscrews (1) and (2), and install two Part No. 3376488 Guide Pins.

Remove the remaining 18 capscrews beginning at the ends and moving toward the center of the plate.

Remove the water header plate, gasket and guide pins.



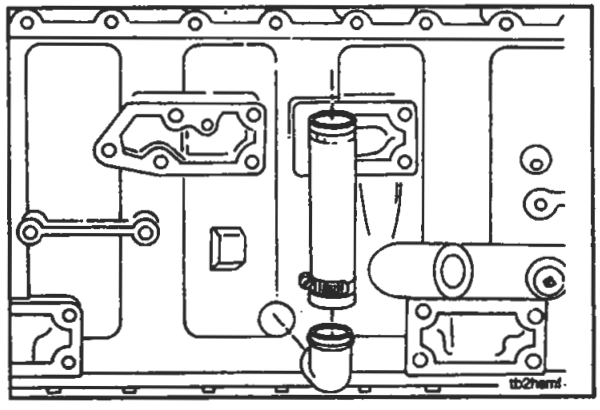
Hand Hole Cover and Dipstick Tube Bracket - Remove

Remove the four capscrews (1), the dipstick tube bracket and gasket.

Remove the four capscrews (2), the hand hole cover and gasket.

Turbocharger Oil Drain Connection - Remove

Remove the oil drain connection fitting and hose.

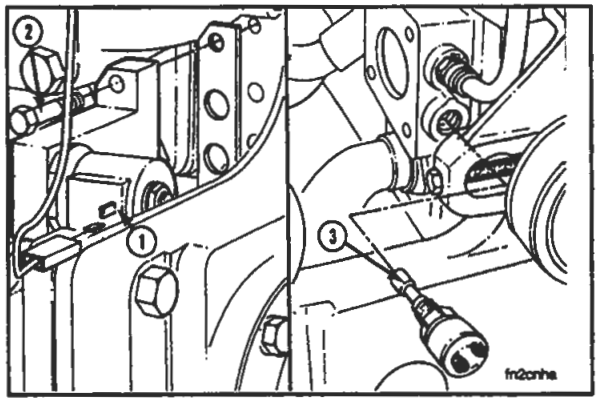


Gear Driven Fan Clutch Control Valve and Sensor (If Equipped) - Remove

Remove the electrical wire from the solenoid (1).

Remove the two capscrews (2) and the solenoid valve.

Remove the sensor (3) from the thermostat support.

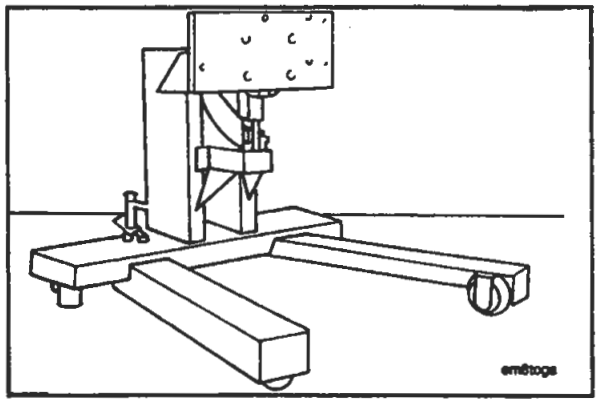


Engine - Install on the Rebuild Stand

Note: Use the Part No. 3375194 Engine Rebuild Stand and the Part No. 3376432 Adapter Plate.

Use ten (5/8—11 X 1 3/4 inch) grade 5 capscrews to install the adapter plate to the rebuild stand.

Torque Value: 45 N•m [35 ft-lb]

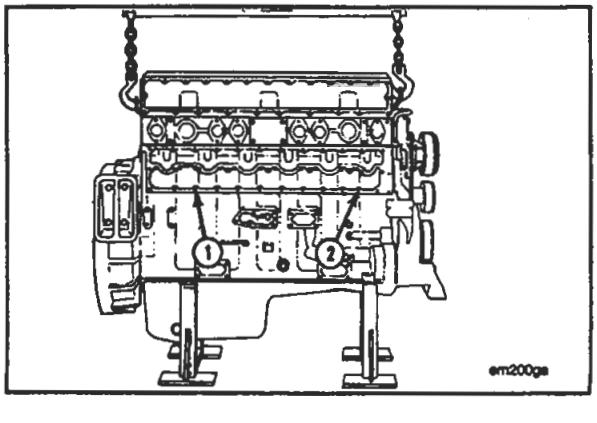


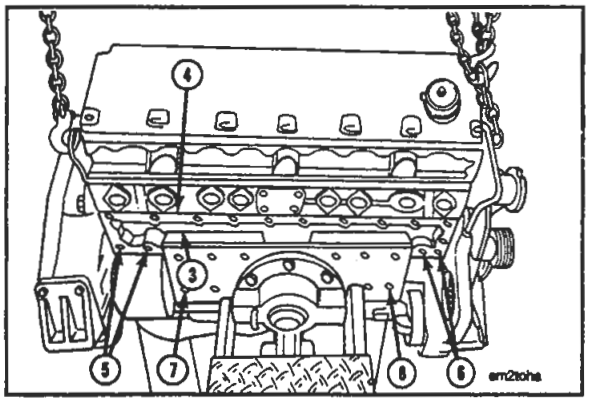
Install two Part No. 3376488 Guide Pins in the water header plate mounting capscrew holes at points (1) and (2).

Warning: The engine weighs approximately 855 kg [1950 lb]. Personal injury can result.

Use the Part No. 3822512 Engine Lifting Fixture to lift the engine.

Install the exhaust side of the engine to the adapter plate of the rebuild stand.





Align the top of the adapter plate (3) to the top row of the water header plate mounting capscrews holes (4).

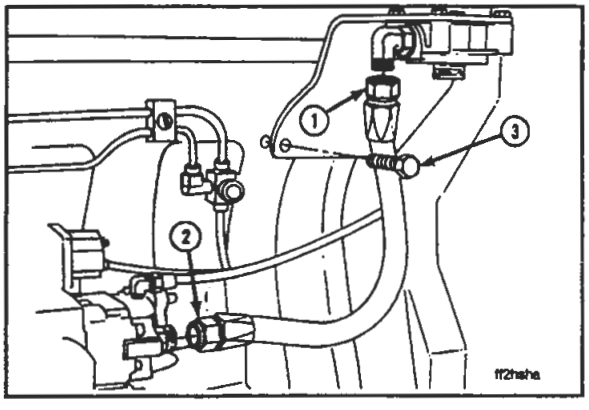
Adjust the engine so that the guide pins are aligned with the bottom adapter plate holes at points (5) and (6).

Use eight Part No. 3376434 Capscrews to install the adapter plate to the engine block.

Torque Value: 45 N•m [35 ft-lb]

Remove the guide pins and install two Part No. 3376434 Capscrews.

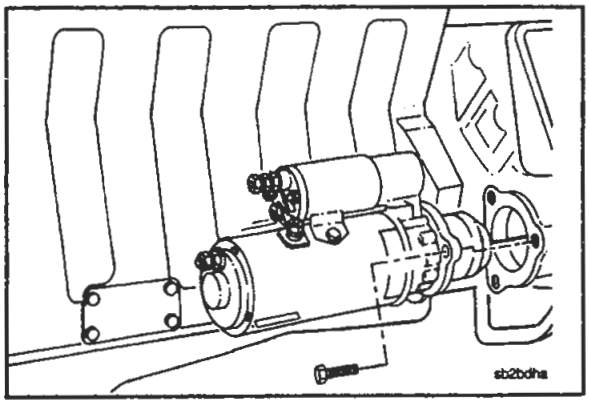
Torque Value: 45 N•m [35 ft-lb]



Fuel Supply Hose, Fuel Filter Head and Bracket - Remove

Remove the fuel supply hose at points (1) and (2).

Remove the three fuel filter head bracket capscrews (3) and the bracket.

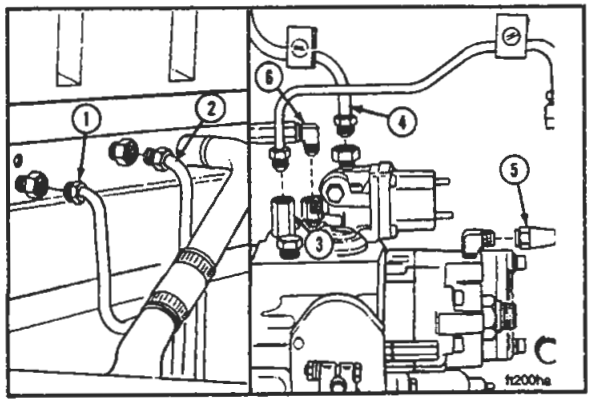


Starting Motor - Remove

The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Note: The starter mounting capscrews can be one of several different sizes. These sizes could be in millimeters or inches. Use the correct wrench size to avoid damage to the capscrews.

Remove the three capscrews and the starting motor.



Fuel and Air Lines - Remove

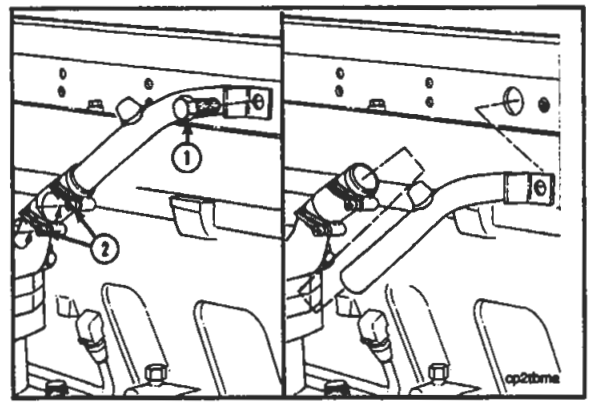
Remove the fuel supply tube (1) and the fuel drain tube (2) from the cylinder head.

Remove the following:

- AFC vent tube (3)
- Fuel rail supply tube (4)
- Fuel pump gear pump cooling tube (5)
- AFC air supply hose (6).

Air Compressor Air Supply Tube - Remove

Remove capscrew (1), loosen the two hose clamps (2) and remove the tube.

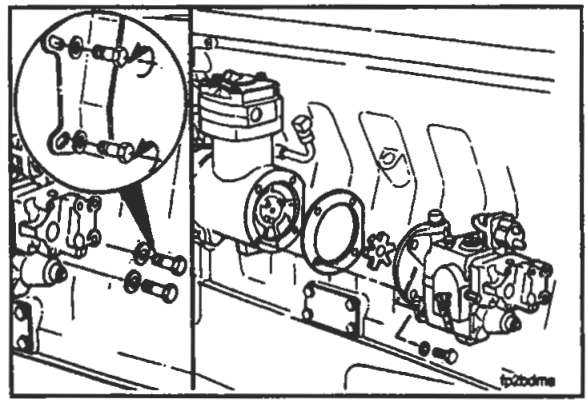


Fuel Pump - Remove

Remove the two support bracket capscrews.

Remove the four fuel pump mounting capscrews and the fuel pump.

Remove the coupling spider.

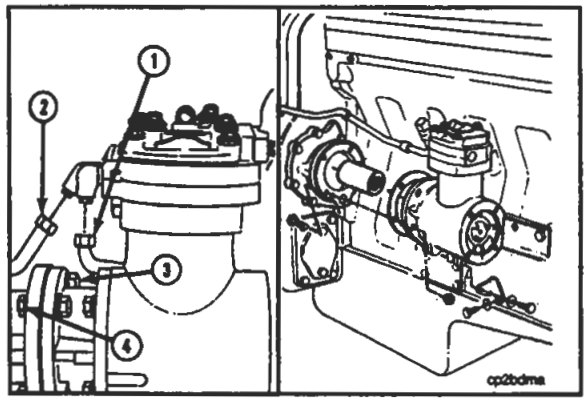


Air Compressor - Remove

Remove the coolant inlet tube (1) and coolant outlet tube (2).

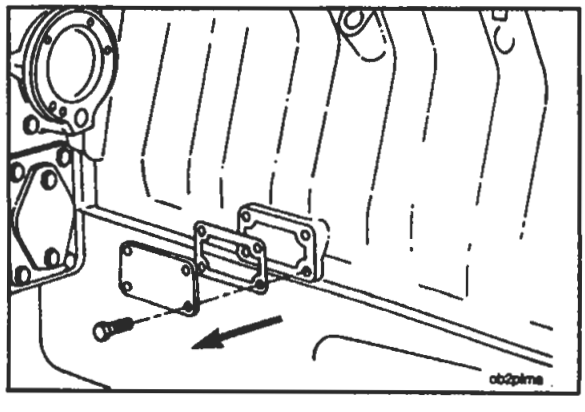
Remove the support bracket capscrew and washer from the hand hole cover on the cylinder block (early production engines only).

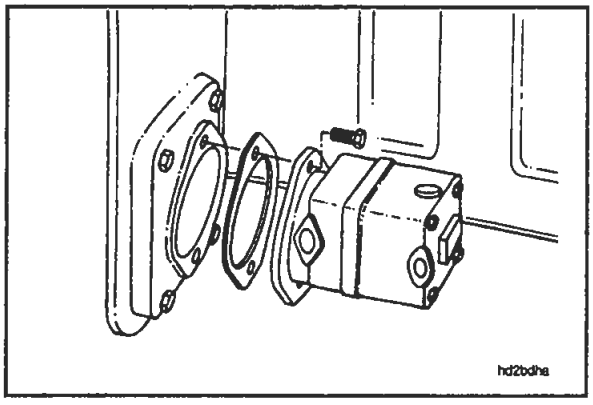
Remove the four air compressor mounting capscrews (3), nuts (4), the air compressor, and splined coupling.



Hand Hole Cover (Fuel Pump Side) - Remove

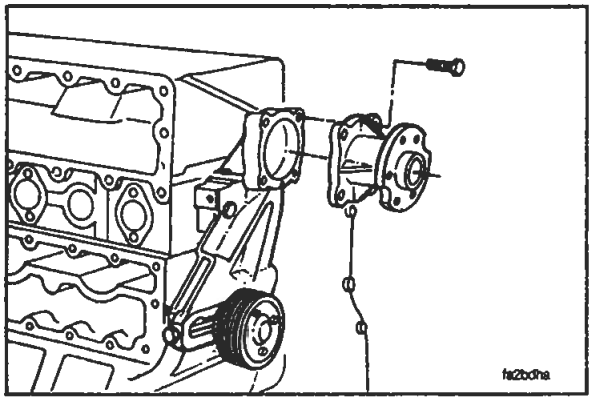
Remove the four capscrews, the cover and gasket.





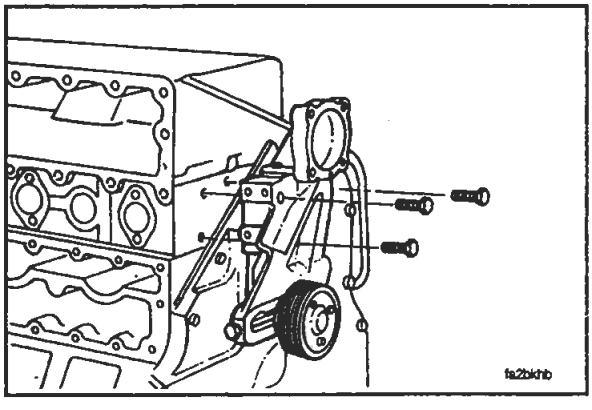
Hydraulic Pump (If Equipped) - Remove

Remove the two capscrews, the pump and gasket.



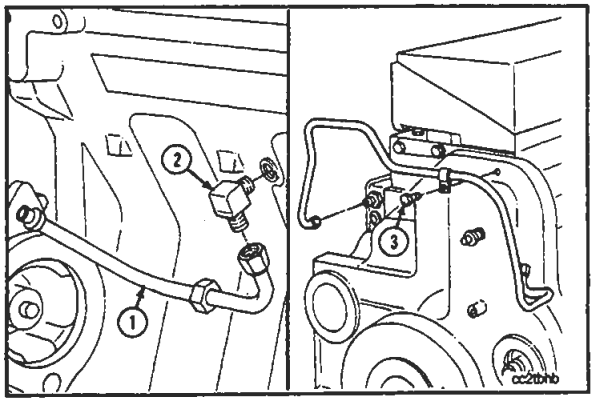
Fan Hub - Remove

Remove the four capscrews and the fan hub.



Fan Hub Support - Remove

Remove the three capscrews and the support.



Air Compressor Coolant Tubes - Remove

Remove the inlet tube (1) and fitting (2).

Remove the outlet tube clamp capscrew (3) and the tube.

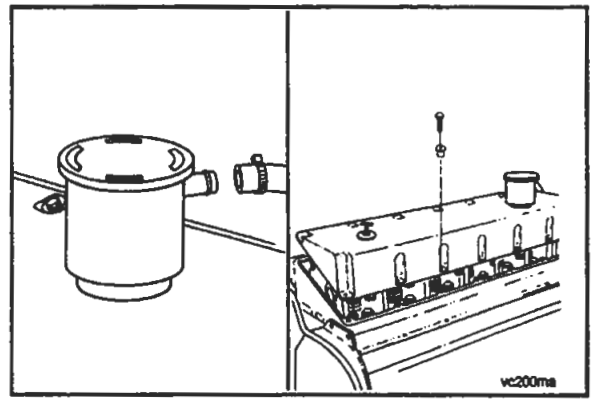
Rocker Lever Cover - Remove

Remove the hose from the crankcase breather.

Remove the 14 capscrews and the cover.

Remove the 14 isolators from the cover.

Note: Early production engines used a gasket with multiple piece fasteners. **Do not** allow the fasteners to fall into the engine.

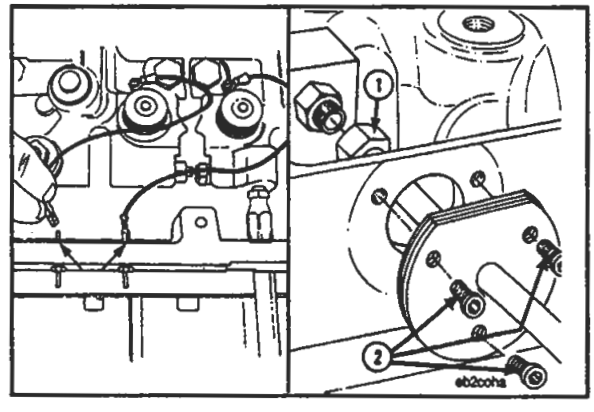


Rocker Lever Housing Spacer (If Equipped with a Jacobs® Brake) - Remove

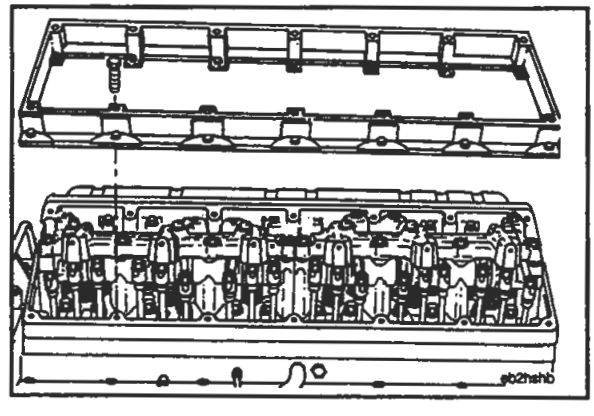
Disconnect the two electrical connections from the terminals on the inside of the spacer.

Disconnect the oil supply hose connection (1).

Remove the three capscrews (2) and the oil supply hose.



Remove the 14 capscrews, the spacer and gasket.

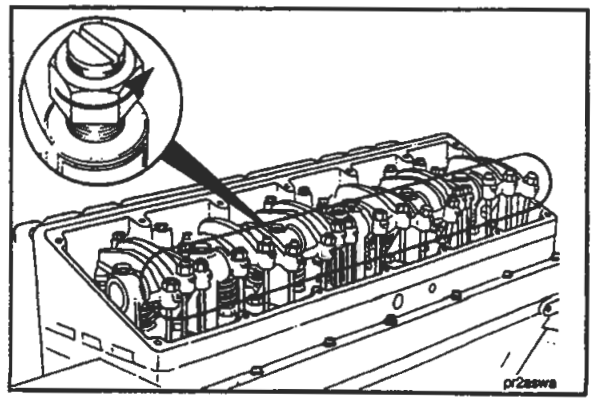


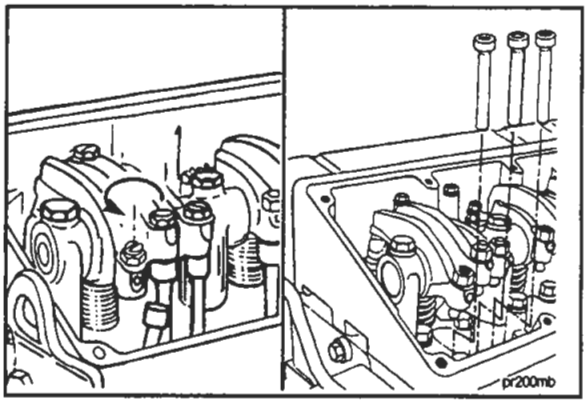
Push Rods - Remove

Note: For engines equipped with Jacobs® Brakes, refer to the following page.

Note: Some push rods are under compression due to the valves being open. Rotate the crankshaft **clockwise** with the accessory drive pulley to relieve the spring tension.

Loosen the adjusting screw locknut on each rocker lever.

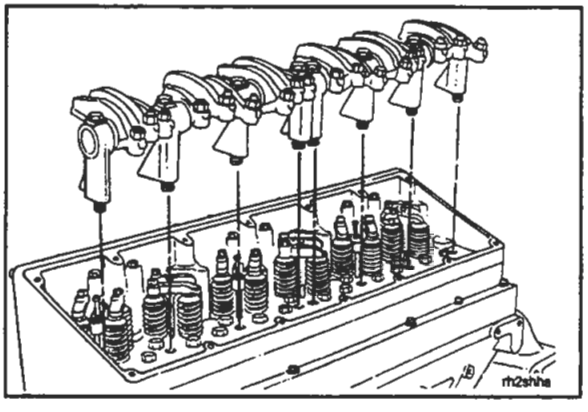




Note: Hold the push rod with one hand to prevent it from falling into the engine.

Loosen each adjusting screw and remove the push rod.

Number each push rod with the cylinder number as it is removed.

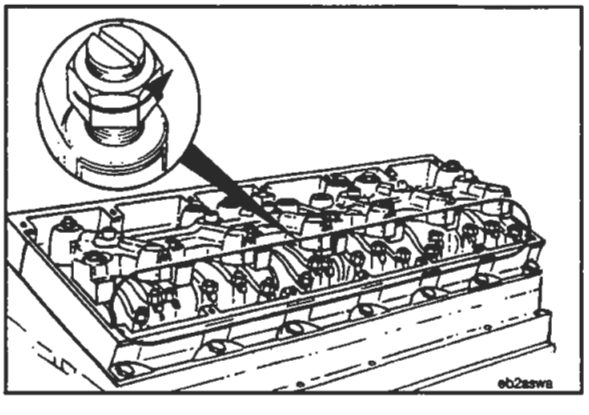


Rocker Lever Assemblies - Remove

Note: For engines equipped with Jacobs® Brakes, refer to the following procedure.

Loosen the eight capscrews and remove the rocker lever assemblies.

Note: Do not remove the capscrews from the rocker lever assemblies. The capscrews aid in removal and installation.

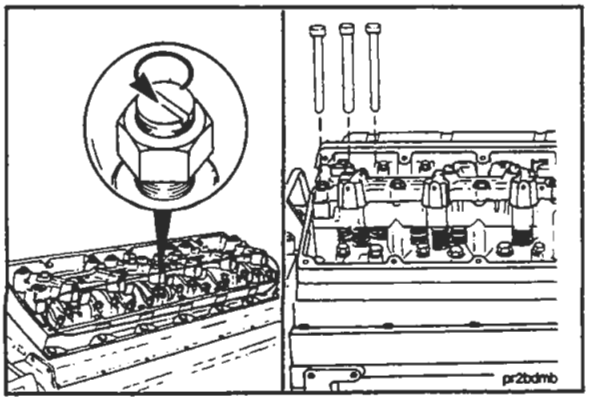


Rocker Lever Assemblies (If Equipped with a Jacobs® Brake) - Remove

Note: The push rods **must be** removed before removing the Jacobs® Brake housing to prevent the push rods from falling in the engine.

Note: Some push rods are under compression due to the valves being open. Rotate the crankshaft **clockwise** with the accessory drive pulley to relieve the spring tension.

Loosen the adjusting screw locknut on each rocker lever.



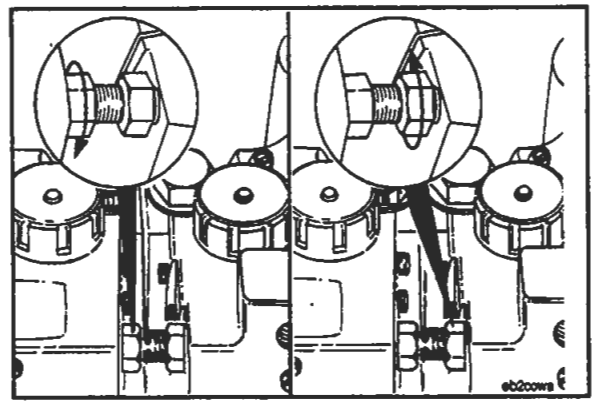
Note: Hold the push rod with one hand to prevent it from falling into the engine.

Loosen each adjusting screw and remove the push rod.

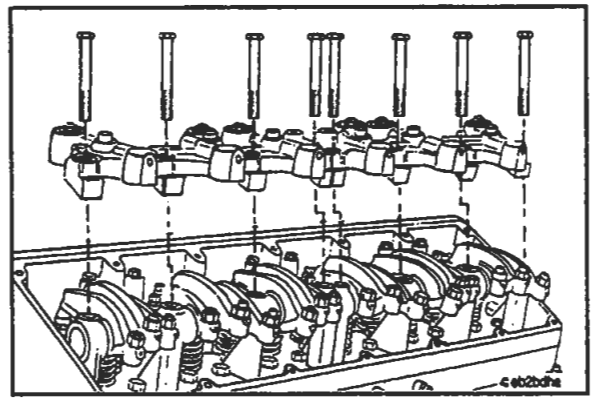
Number each push rod with the cylinder number as it is removed.

Loosen the oil connector screw locknut.

Turn the oil connector screw **clockwise** by hand until it no longer contacts the rear Jacobs® Brake housing.

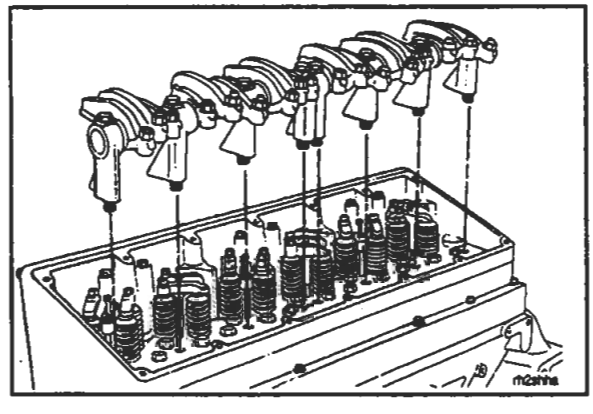


Remove the eight Jacobs® Brake housing capscrews and both housings.



Install a rocker lever mounting capscrew into the front and rear rocker lever supports. The capscrews will aid in removing the rocker lever assemblies.

Remove both rocker lever assemblies.

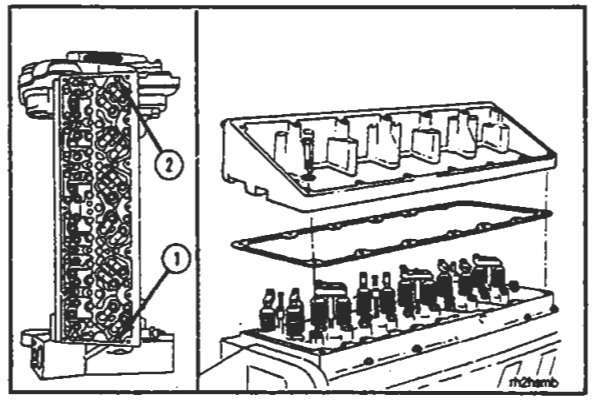


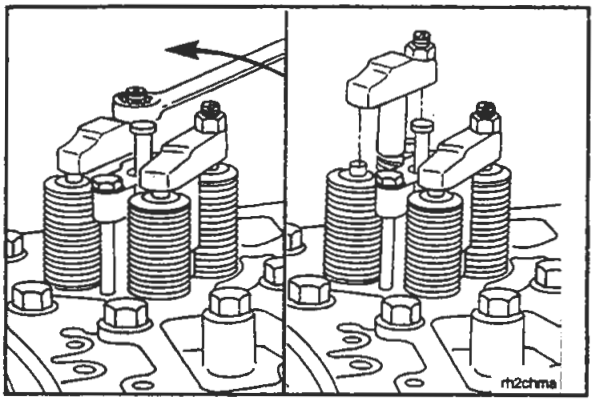
Rocker Lever Housing - Remove

Note: Earlier production engines used 12 point capscrews at points (1) and (2). Present production engines use hex head capscrews at these points.

Note: Do not drop the capscrew washers into the engine.

Remove the 24 capscrews, washers and rocker lever housing.

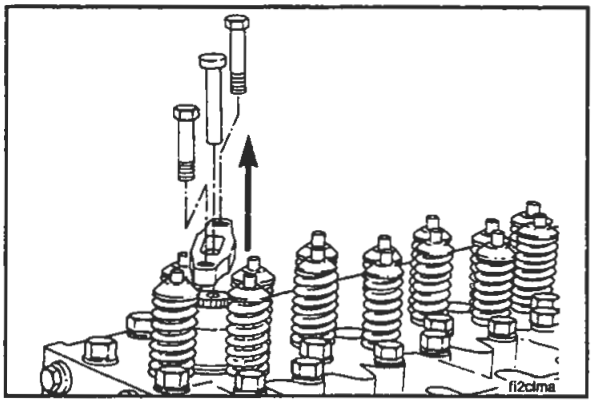




Crossheads - Remove

Loosen the crosshead adjusting screw locknuts and remove the crossheads.

Number each crosshead with the cylinder number and position as it is removed.

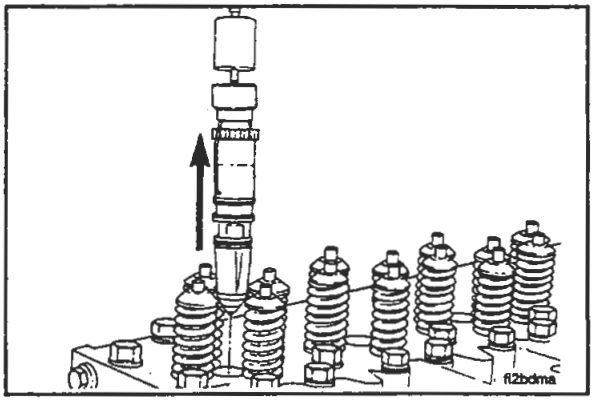


Injectors - Remove

Remove the injector plunger links.

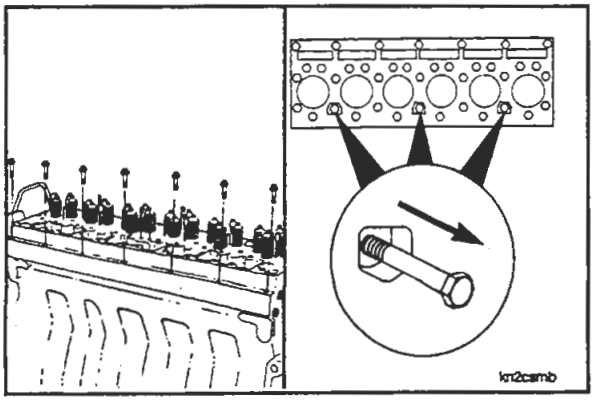
Number each link with the cylinder number as it is removed.

Remove the injector clamp capscrews and clamps.



Use the Part No. 3376872 Universal Injector Puller to remove the injectors.

Number each injector with the cylinder number as it is removed.



Cylinder Head - Remove

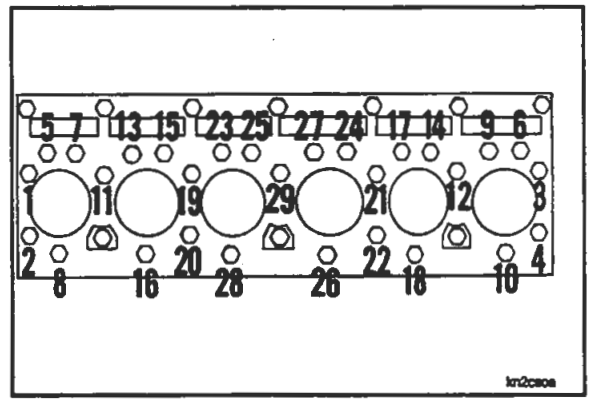
Remove the seven 12 point capscrews.

Note: Do not allow the washers from the three capscrews inside the intake ports to fall into the engine.

Remove the three capscrews inside the intake ports.

Remove the remaining 29 capscrews starting from the ends and moving toward the center.

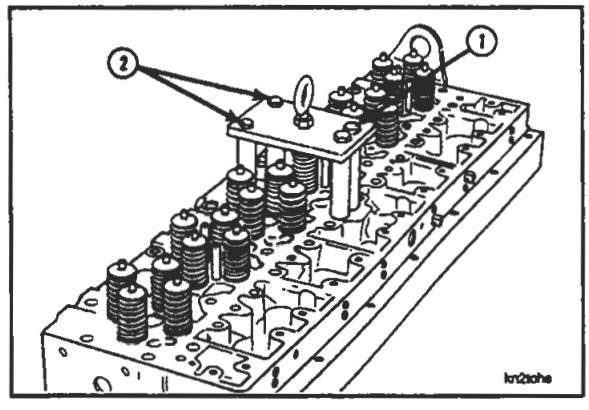
Note: Capscrew removal is in the reverse order of the assembly tightening sequence.



Install the Part No. 3822479 Cylinder Head Lifting Bracket on the center of the cylinder head.

Note: If the capscrews are **not** available from the kit, install two (M14—2.00 X 135) rocker lever support capscrews (1) and two (M10—1.50 X 115) rocker lever housing capscrews (2).

Torque Value: 45 N•m [35 ft-lb]

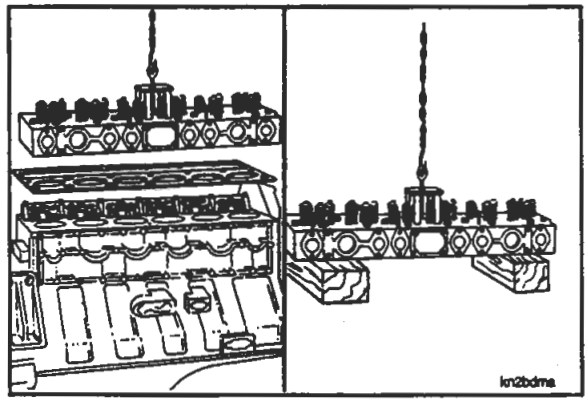


The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Note: To prevent damage to the cylinder head, lift it straight up. The cylinder head is doweled to the cylinder block. To prevent damage to the combustion face of the cylinder head, place it on wooden blocks after removal.

Use a hoist or hydraulic arm to remove the cylinder head.

Remove the gasket.



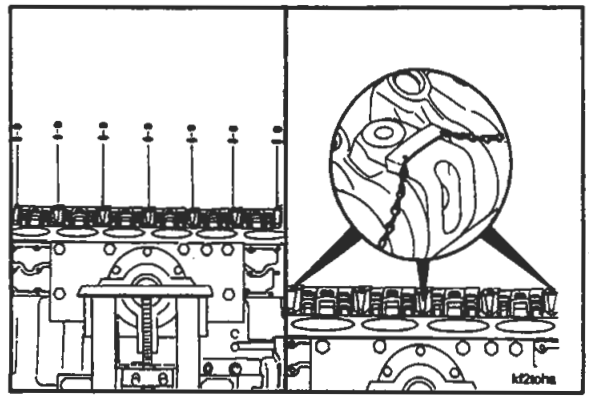
Cam Follower Assemblies - Remove

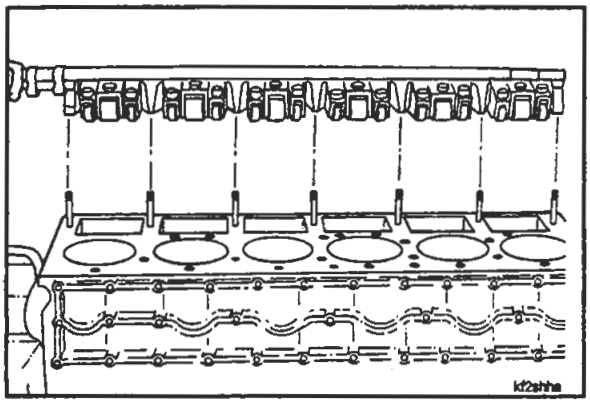
Note: Do not allow the nuts or washers to fall into the engine.

Remove the nuts and washers from the seven supports.

Install the Part No. 3376639 Shim Assembly over the Nos. 2, 4 and 6 supports.

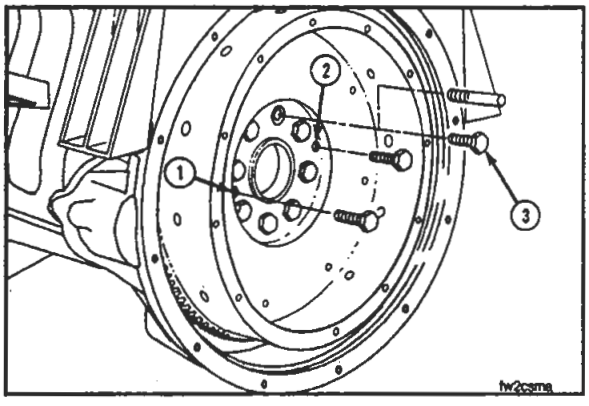
Note: The cam follower assembly consist of two shaft assemblies with a common center support.





Install the Part No. 3376645 Cam Follower Clamping Fixture to hold the cam follower assemblies together before removal.

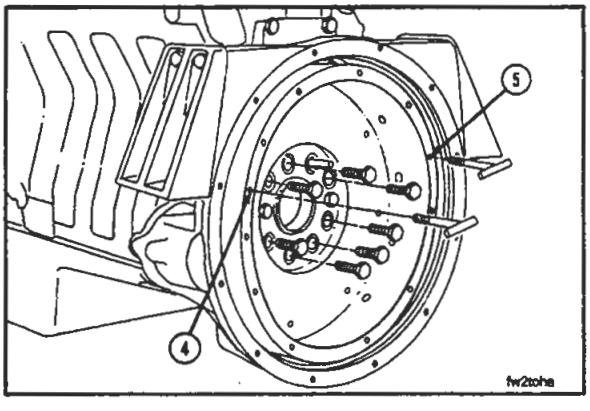
Lift the cam follower assemblies at each end to remove.



Flywheel - Remove

Install two (M10—1.50 X 40) capscrews at points (1) and (2).

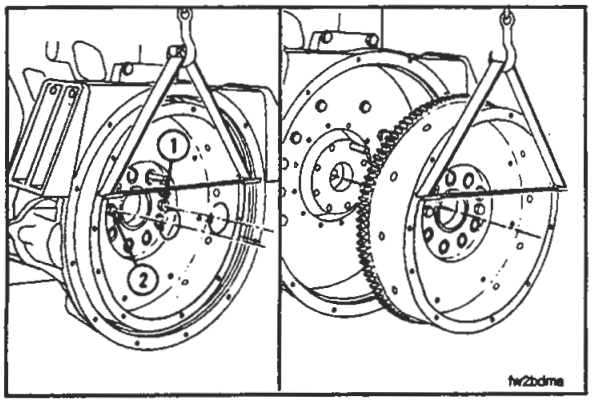
Remove capscrew (3) and install a Part No. 3376696 Guide Pin.



Note: The clutch pressure plate capscrew holes can be in inches or millimeters. Make sure to measure a pressure plate mounting capscrew before installing the "T-handles" for lifting to prevent damage to the flywheel.

Install two "T-handles" (4) and (5) into the flywheel.

Remove the remaining seven capscrews from the flywheel.



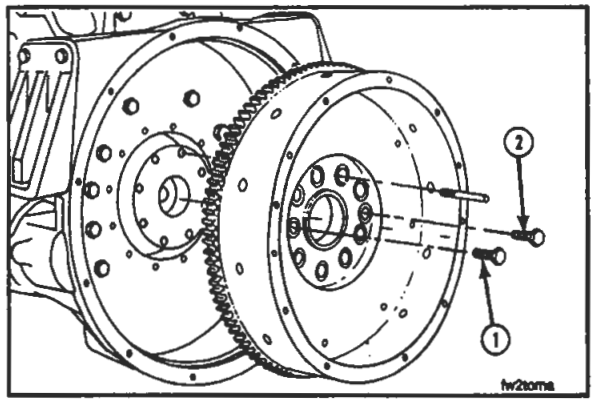
The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Install the Part No. 3375957 Nylon Lifting Sling on the two "T-handles" and attach a hoist to the lifting sling.

Tighten capscrews (1) and (2) in alternating sequence to loosen the flywheel.

Use a hoist to remove the flywheel.

Remove the capscrews (1) and (2) and the guide pin.



Lubricating Oil Pan - Remove

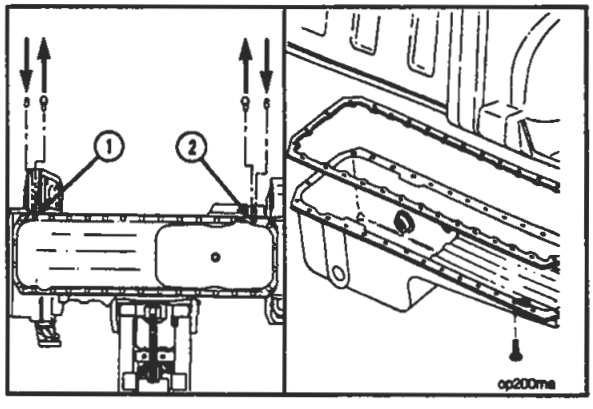
Rotate the engine on the rebuild stand to position the engine on its side.

Remove two capscrews at points (1) and (2) and install two Part No. 3376488 Guide Pins.

Remove the remaining 32 capscrews.

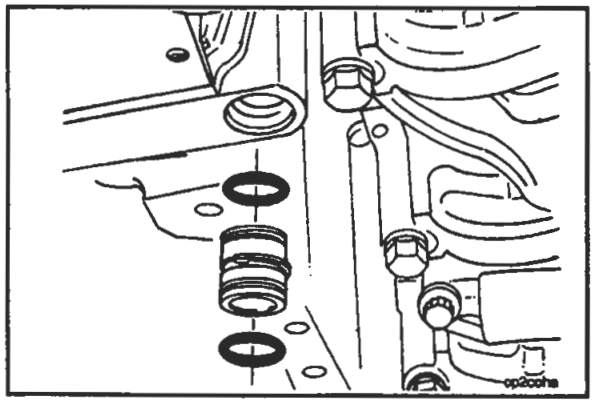
NOTE: Use a rubber hammer to loosen the oil pan if it is stuck.

Remove the guide pins.



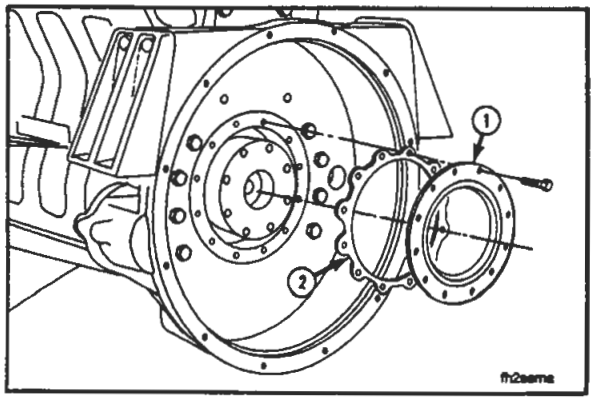
Remove the oil transfer tube from the cylinder block.

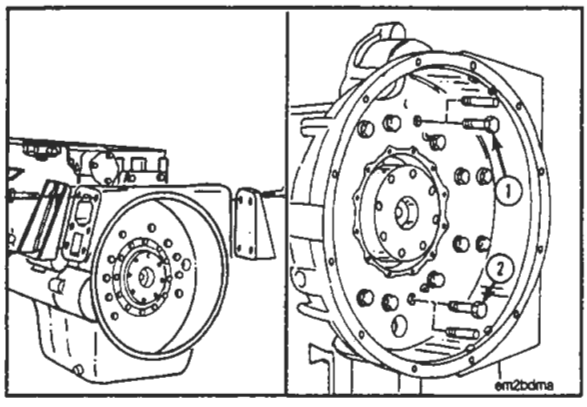
Remove and discard the two o-rings from the transfer tube.



Crankshaft Rear Oil Seal - Remove

Remove the 12 capscrews, washers, seal clamping plate (if applicable), oil seal (1), gasket (2).

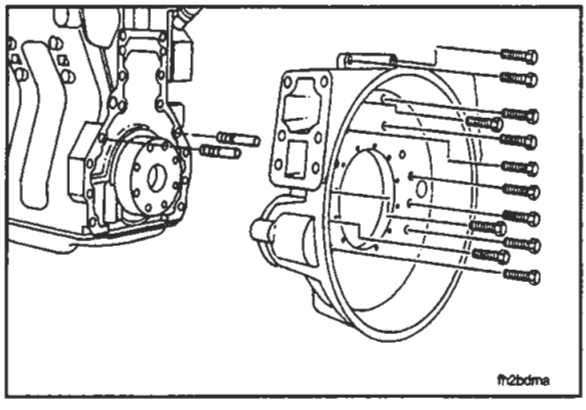




Flywheel Housing - Remove

Remove the capscrews and both rear engine mounts.

Remove capscrews (1) and (2) and install two Part No. 3376697 Flywheel Housing Guide Pins.

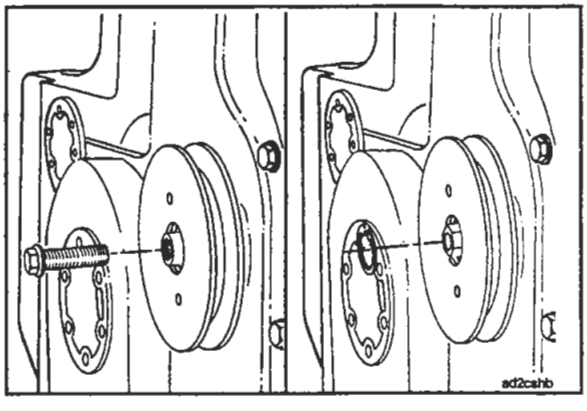


The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Remove the remaining 12 capscrews and the flywheel housing.

Note: Use a rubber hammer to loosen the housing if it is stuck.

Remove the guide pins.

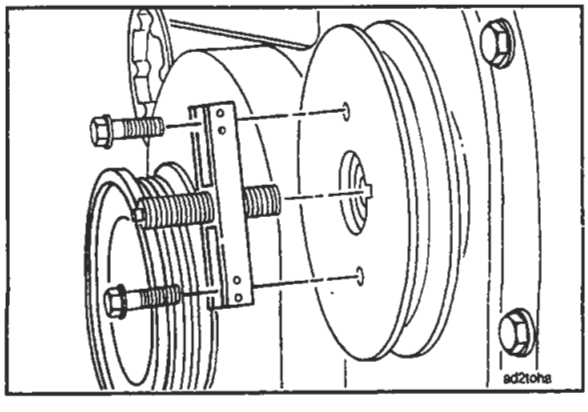


Accessory Drive Pulley - Remove

Note: Earlier production engines use a retainer snap ring and no capscrew.

Remove the pulley retainer capscrew or snap ring.

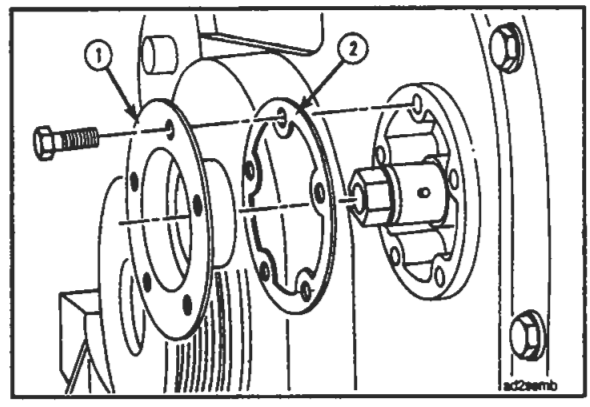
Note: The crankshaft **must be** held in position to allow the pulley retainer capscrew to be removed.



Use the Part No. ST-647 Standard Puller and two Part No. 3376104 (M10-1.50x50) Capscrews to remove the pulley.

Accessory Drive Oil Seal - Remove

Remove the five capscrews, seal clamping plate (if applicable), seal (1) and gasket (2).

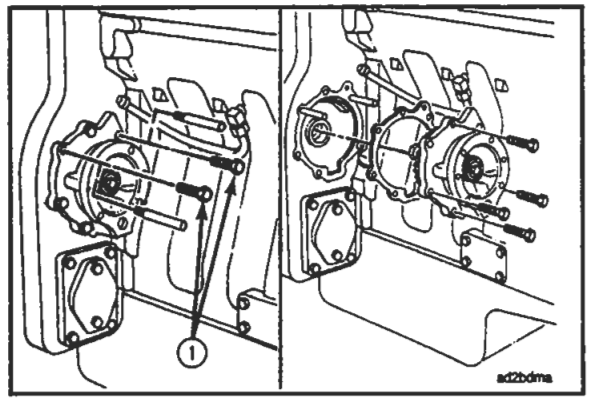


Accessory Drive Assembly - Remove

Remove the two capscrews (1) and install two Part No. 3376488 Guide Pins.

NOTE: The guide pins prevent the accessory drive front support from falling free when the gear cover is removed.

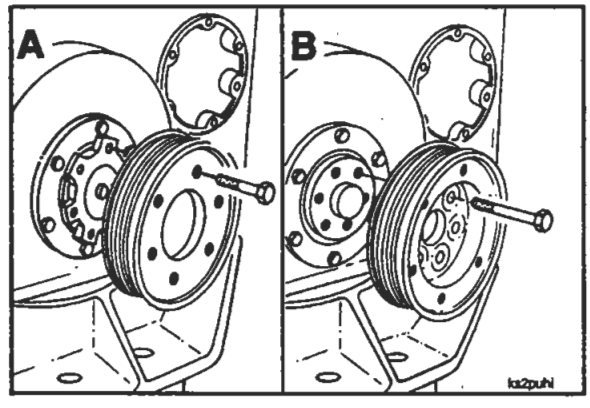
Remove the four remaining capscrews and the accessory drive assembly.



Crankshaft Pulley - Remove

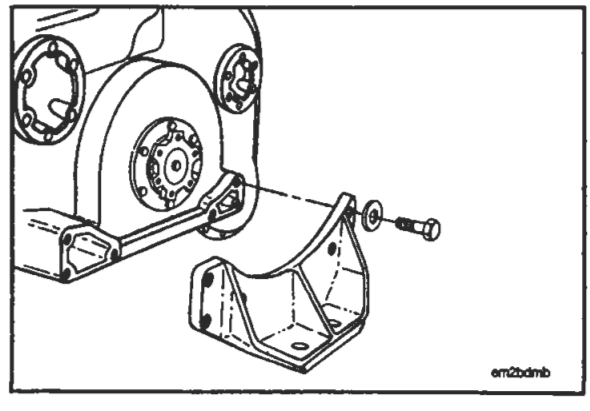
Remove the six capscrews and the pulley.

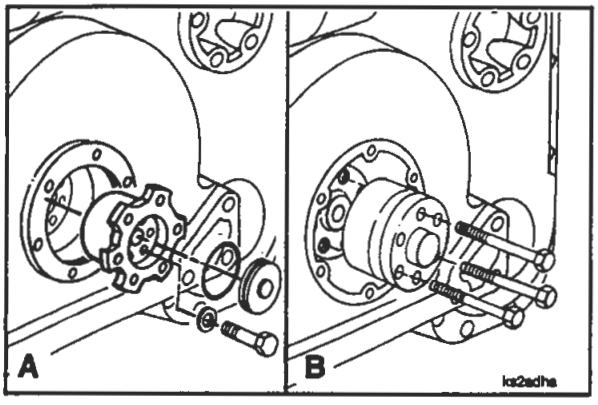
- Flanged crankshaft adapter style pulley and mounting (A).
- Non-Flanged crankshaft adapter style pulley and mounting (B).



Front Engine Support Bracket - Remove

Remove the six capscrews and bracket.





Crankshaft Adapter (Belt Driven Fan Only) - Remove

Flanged Style (A)

Remove the capscrew cover and o-ring.

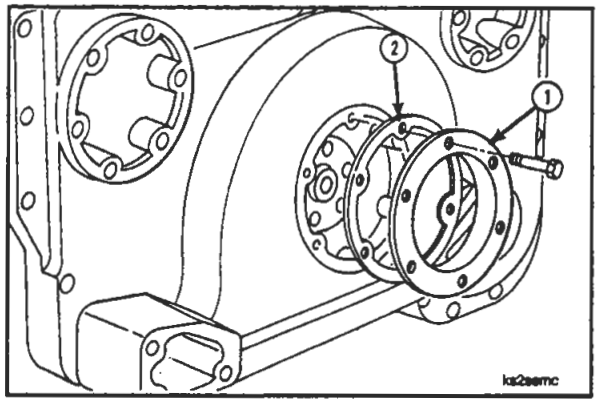
NOTE: Use a rubber hammer to loosen the cover if it is stuck.

Remove the six capscrews and the adapter.

Non-Flanged Style (B)

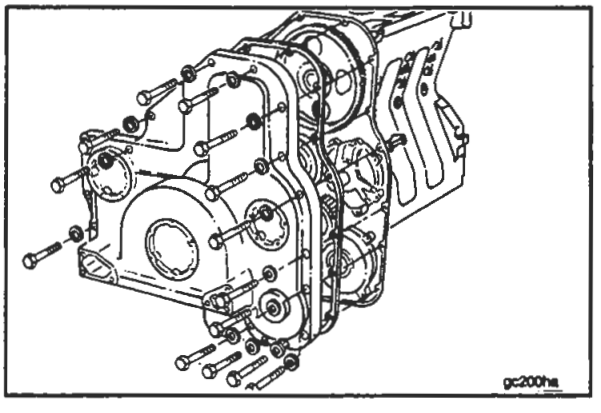
Remove the adapter.

NOTE: The capscrews were removed with the pulley.



Crankshaft Front Oil Seal (Belt Driven Fan Only) - Remove

Remove the six capscrews, the oil seal (1) and gasket (2).

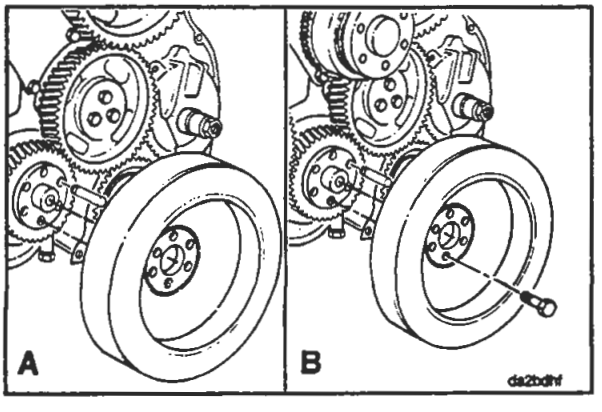


Gear Cover - Remove

NOTE: Six of the gear cover capscrews were removed with the front support bracket.

Remove the remaining 14 capscrews and the gear cover.

NOTE: Hit the cover with a rubber hammer to loosen it, if it is stuck.



Vibration Damper - Remove

Belt Driven Fan (A)

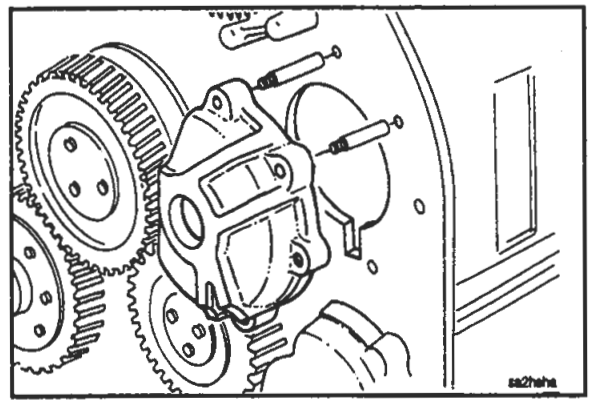
Use both hands to remove the damper.

Gear Driven Fan (B)

Remove the six capscrews and the damper.

Accessory Drive Front Support - Remove

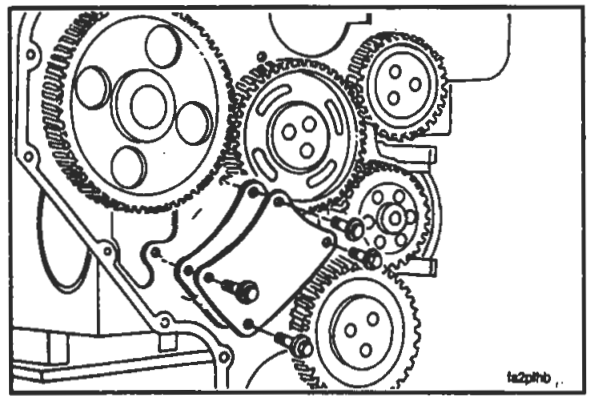
Remove the support and the two guide pins.



Fan Drive Cover Plate (Belt Driven Fan) - Remove

Note: The fan drive cover plate is used only on earlier production engines. Present production engines use a cup plug installed in the gear plate.

Remove the four capscrews, the cover plate and gasket.



Gear Driven Fan Clutch - Remove

Low Mount (A)

Remove the three capscrews (1) and one 12 point capscrew (2).

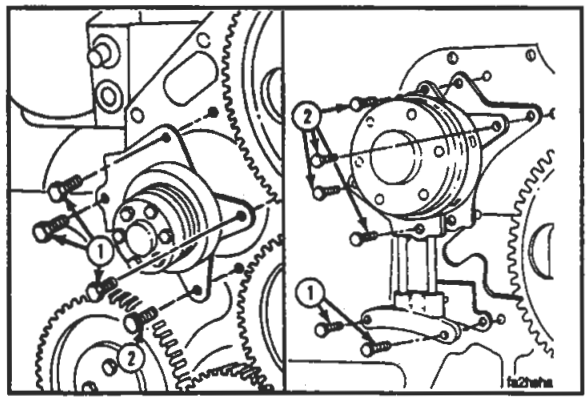
Remove the fan clutch and gasket.

High Mount (B)

Remove the two oil transfer bracket capscrews (1).

Remove the four capscrews (2).

Remove the fan clutch and oil transfer tubes as an assembly and remove the gaskets.



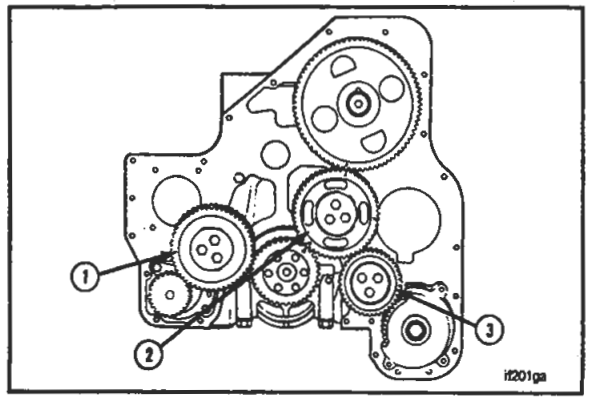
Idler Gear Assemblies - Remove

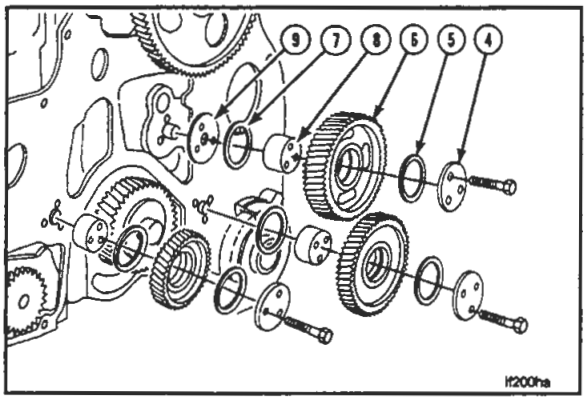
Three idler gear assemblies are used:

Oil pump idler gear (1)

Camshaft idler gear (2)

Hydraulic pump idler gear (3)



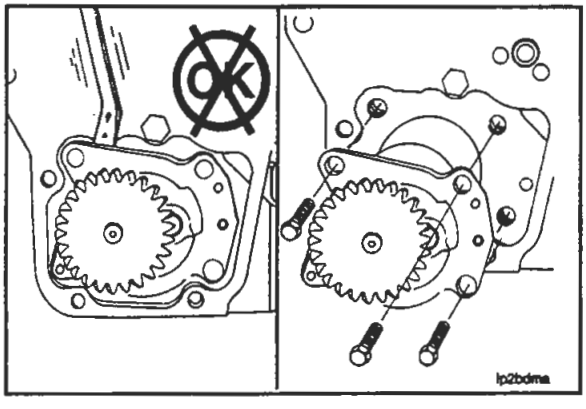


To remove each idler gear assembly, remove:

The three capscrews
The cover plates (4)
The front thrust bearing (5)
The idler gears (6)
The rear thrust bearing (7)
The idler gear shafts (8)

Note: If SAE "B" hydraulic drive is used, mark the idler gear shafts for position as they are removed. Each shaft **must be** installed in the same position it was removed from.

Note: The camshaft idler gear assembly includes a wear plate (9).

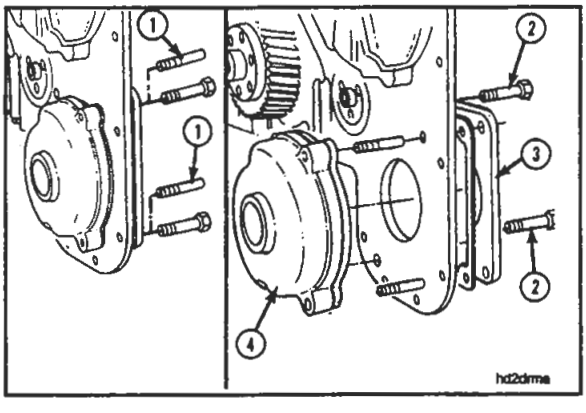


Lubricating Oil Pump - Remove

Caution: Do not pry on the gear or oil pump flange. The oil pump can be damaged.

Note: Present production engines use two threaded puller holes in the flange of the pump to remove it by alternately turning in two (M8 X 1.25) capscrews.

Remove the three capscrews and use both hands or the puller holes to remove the pump.



Hydraulic Pump Drive - Remove

Remove the two capscrews and install two Part No. 3376488 Guide Pins (1).

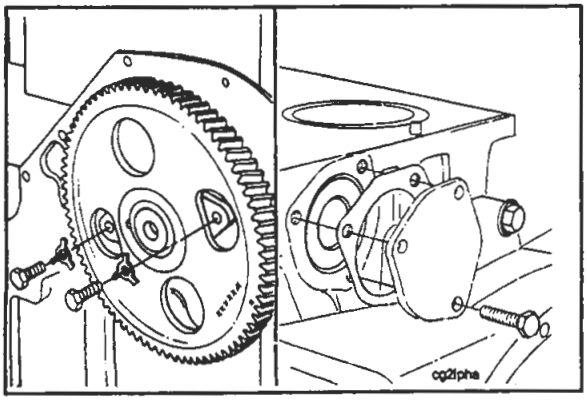
Remove the remaining two capscrews (2).

Note: Hit the adapter plate with a rubber hammer to loosen it, if it is stuck.

Remove the rear adapter (3).

Caution: Remove the front support assembly (4) as a unit so the gear does not fall.

Remove the guide pins.



Camshaft - Remove

Rotate the camshaft to align the holes in the camshaft gear with the thrust support capscrews.

Remove the two capscrews.

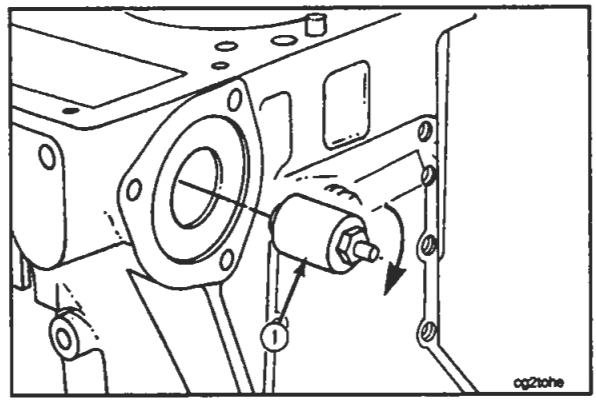
Remove the three capscrews, the rear cover plate and gasket.

Install the Part No. 3376388 Camshaft Installation Pilot.

a. Install the expander (1) in the camshaft through the rear cover plate opening.

Note: The Part No. 3376876 Expander is used for **hollow** camshafts and the Part No. 3376923 Expander is used for **solid** camshafts.

b. Turn the nut to expand the swell plug.

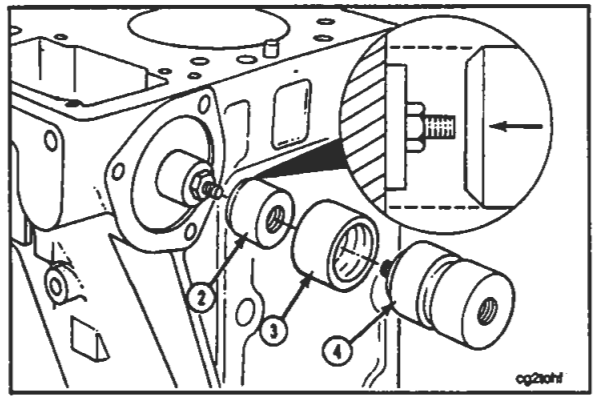


c. Install the alignment arbor (2) to the swell plug.

Note: The beveled edge **must** face the cylinder block.

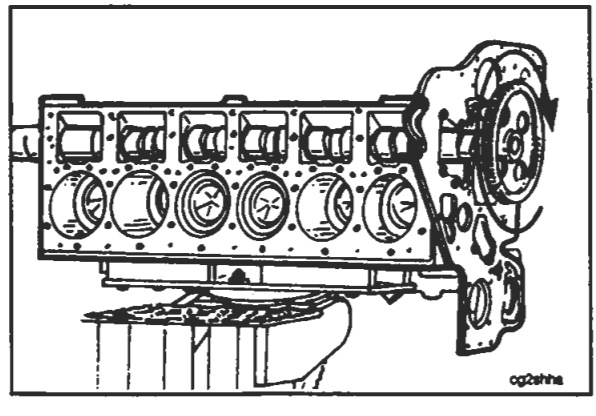
d. Install the arbor sleeve (3) over the swell plug and alignment arbor.

e. Install the locating pilot extensions (4) to the alignment arbor.



Use one hand to slowly rotate and pull the camshaft from the cylinder block and the other hand to balance the camshaft as it is removed.

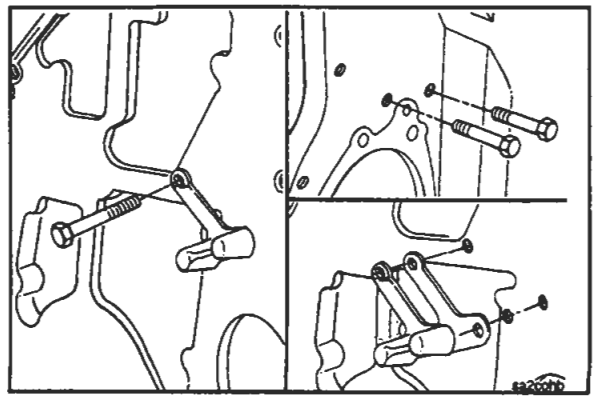
Remove the camshaft pilot tool.

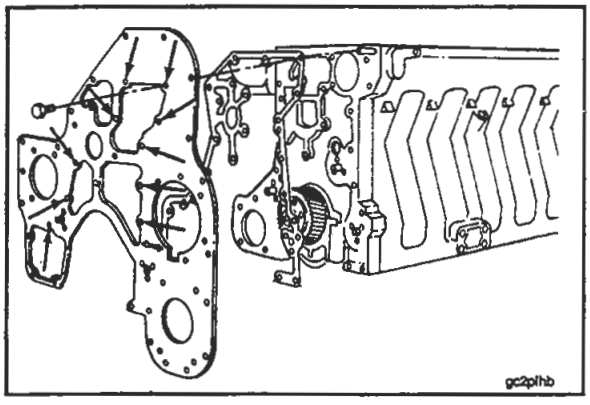


Accessory Drive Oil Transfer Connection - Remove

Remove the capscrew from the front of the gear plate.

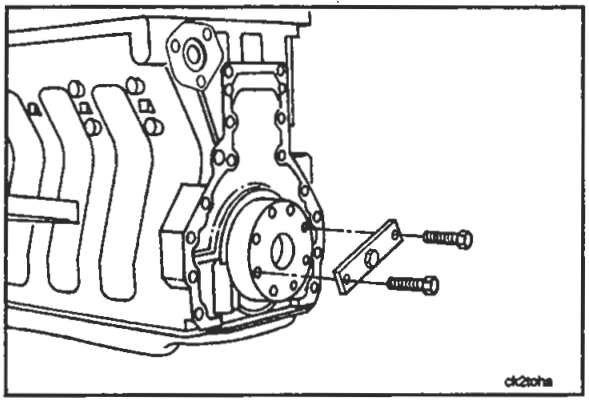
Remove the two capscrews from the rear of the gear plate and remove the connection and gasket.





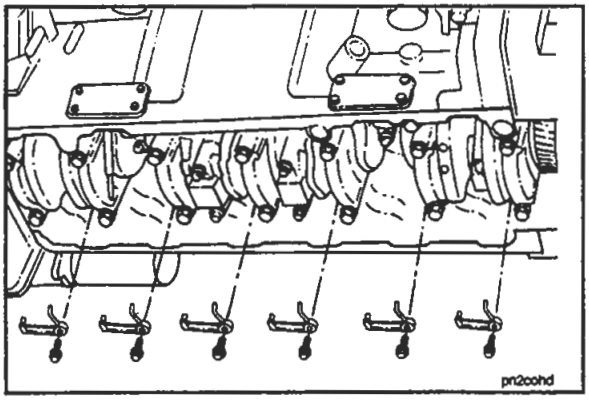
Gear Support Plate - Remove

Remove the 10 capscrews, the gear plate and gasket.



Engine Barring Tool - Install

Use two (M14—1.50 X 40) flywheel mounting capscrews to install the Part No. 3376601 Engine Barring Tool to the flywheel end of the crankshaft.

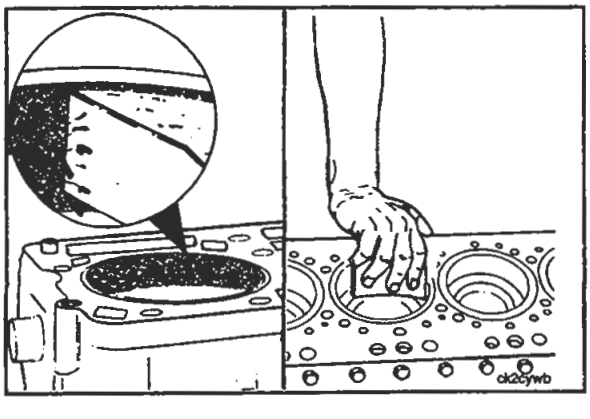


Piston Cooling Nozzles - Remove

Caution: The nozzles must be removed before the piston and rod assemblies to avoid damage to the nozzles.

Note: The crankshaft must be rotated to allow access to remove all the nozzles.

Remove the capscrew and each nozzle.



Cylinder Liner Carbon Deposits - Remove

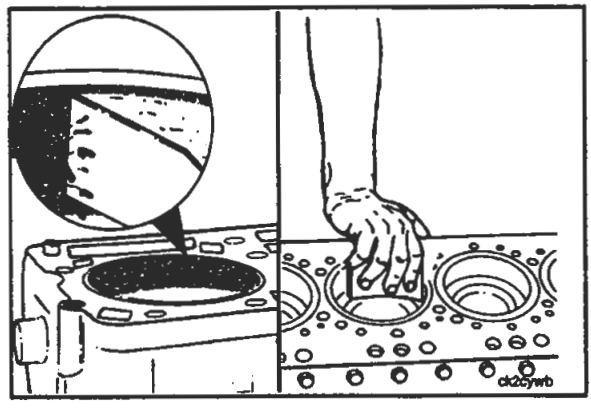
Caution: Do not use emery cloth or sandpaper to remove carbon from the cylinder liners and cylinder block cylinder head mounting surface. Aluminum oxide or silicon particles from emery cloth or sandpaper can cause serious engine damage.

Rotate the crankshaft to expose the carbon ridge above the ring travel area in the cylinder liner.

Caution: Do not use any abrasives in the ring travel area of the cylinder liner. The liner can be damaged.

Use a gasket scraper to remove the carbon ridge.

Use a fine fibrous abrasive pad such as; Scotch-Brite® 7448 or equivalent to remove the remaining carbon.

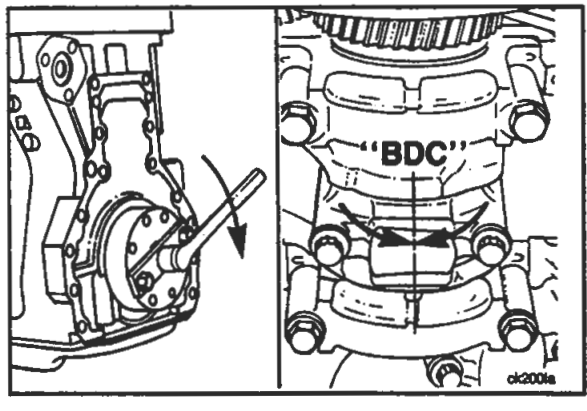


Pistons and Connecting Rods - Remove

Use the barring tool to rotate the crankshaft to position the rod caps at "BDC" for removal.

Loosen the connecting rod capscrews.

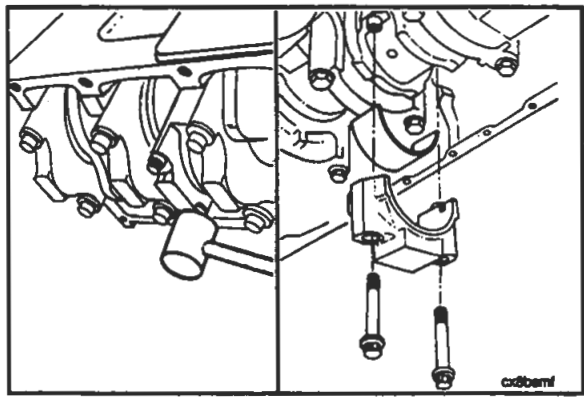
Note: Do not remove the capscrews from the rods until the caps have been loosened.



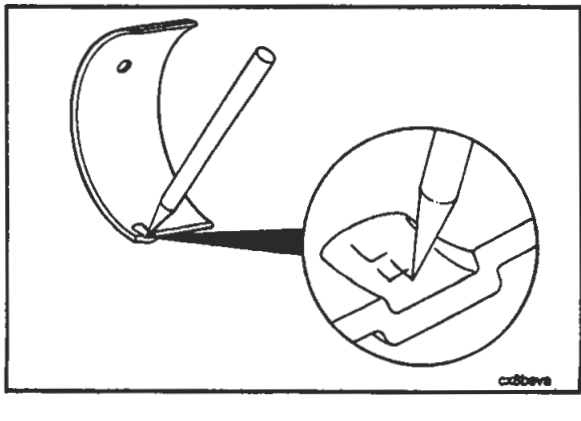
Hit the heads of connecting rod capscrews with a rubber hammer to loosen the caps from the dowel rings.

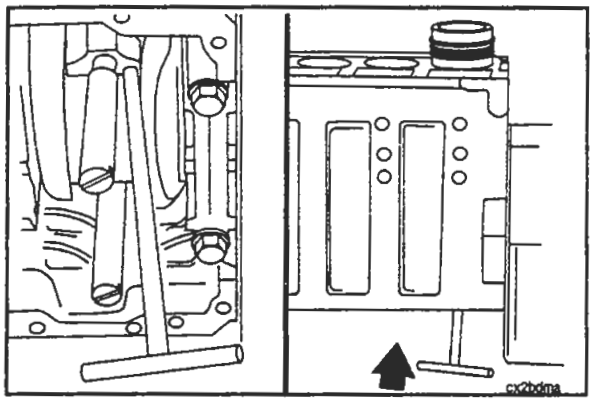
Note: Do not drop the bottom bearing shell when the cap is removed.

Remove the connecting rod capscrews and caps.



Mark the cylinder number and the letter "L" in the flat surface of the bearing tangs.

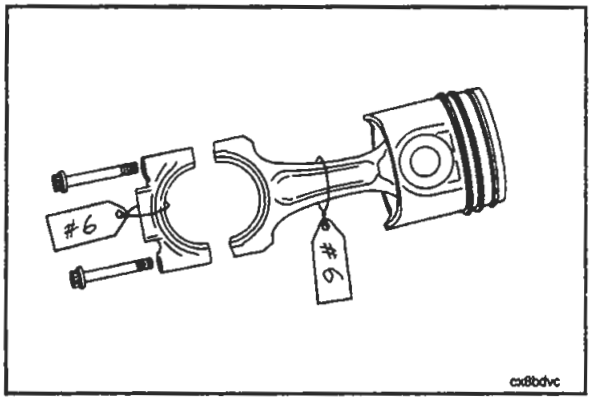




Install two Part No. 3376038 Connecting Rod Guide Pins in the rod capscrews holes.

Use a "T-handle" piston pusher to push the rod away from the crankshaft.

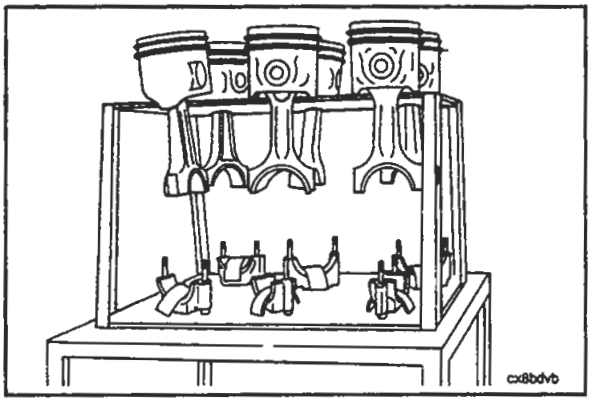
Push the rod until the piston rings are outside of the block.



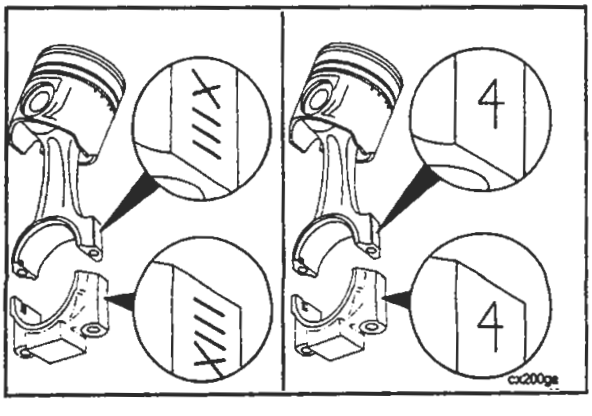
Use both hands to remove the piston and rod assembly.

Note: The piston and connecting rod assemblies **must be** installed in the same cylinder number they were removed from to insure proper fit of worn mating surfaces if parts are used again.

Use a tag to mark the cylinder number each piston and rod assembly was removed from.



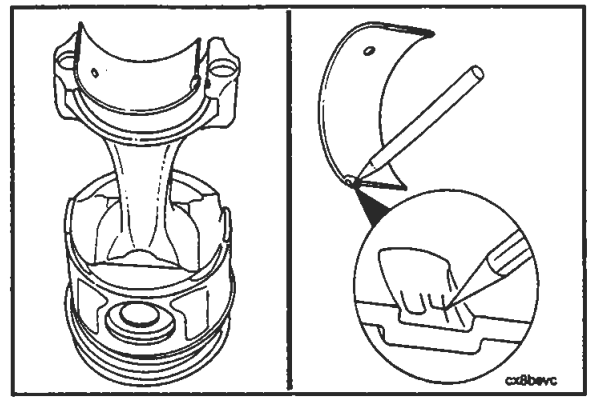
Place the rod and piston assemblies into a container to protect them from damage.



Note: Present production engines have a unique number (not cylinder number) stamped on the connecting rod and matching cap. Earlier production engines have the cylinder number stamped on the rod and cap. When the rods and caps are installed in the engine, the numbers on the rods and caps **must** match and be installed on the same side of the engine.

Remove the upper rod bearing.

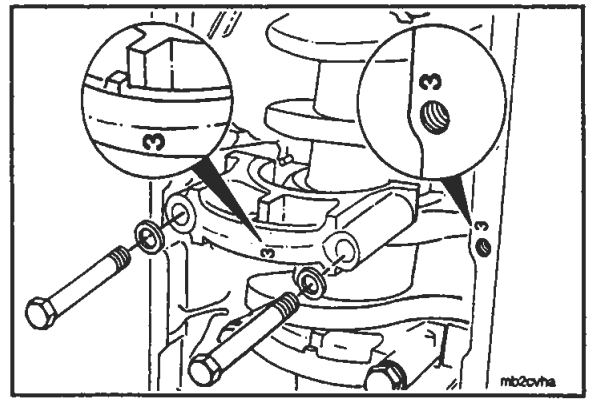
Mark the cylinder number and the letter "U" in the flat surface of the bearing tangs.



Main Bearing Caps, Lower Bearing Shells and Thrust Bearings - Remove

Note: The main bearing caps **must be** marked for position as shown. The caps **must be** installed with the number toward the camshaft side of the cylinder block and on the bearing saddle with the same number. The bearing saddle number is located on the cylinder block oil pan flange.

Use a steel stamp to mark any caps without a number before the cap is removed.



Rotate the engine on the rebuild stand to position the oil pan mounting flange facing up.

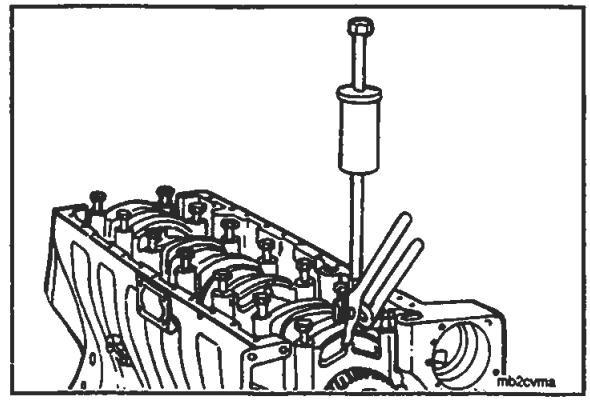
Remove the main bearing cap capscrews.

Caution: The number "4" main bearing cap is dowled to the block. To avoid damage to the cylinder block, do not rock the cap to remove, pull straight up.

Use the Part No. ST-1178 Main Bearing Cap Puller to remove the main bearing caps.

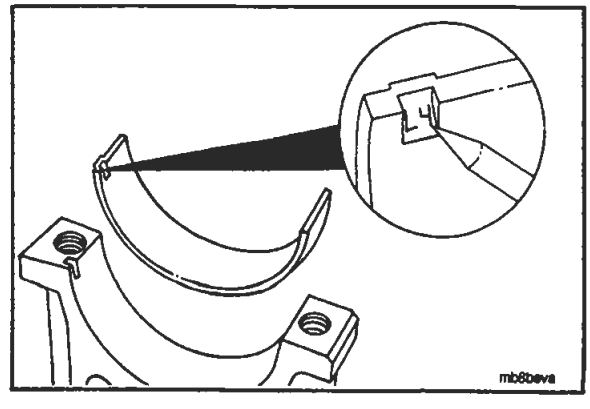
The tool **must be** centered on the cap. Pull straight up to remove the cap.

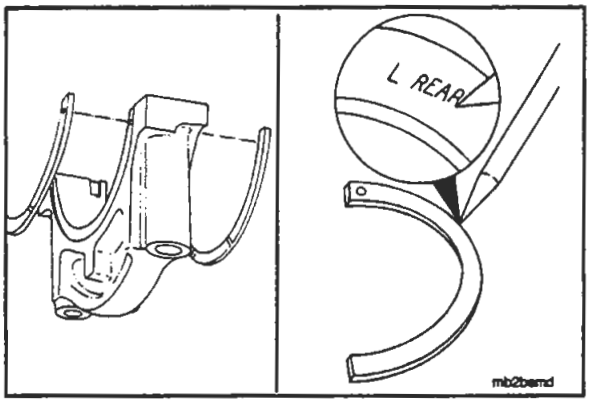
Note: The No. 4 main bearing cap has thrust bearings.



Remove the lower main bearing shells from the caps.

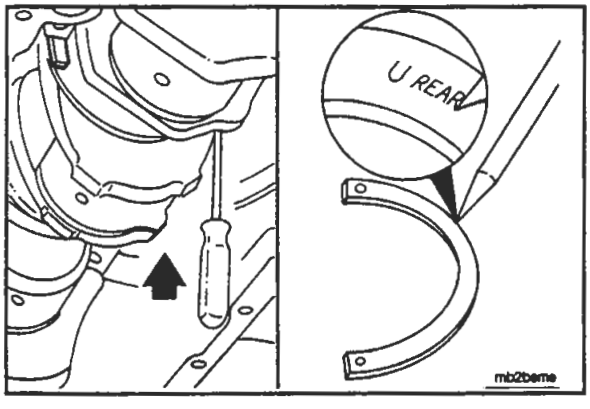
Mark the bearing shells with the letter "L", and the journal number they were removed from in the flat surface of the bearing tang.





Remove the thrust bearings from the number "4" cap.

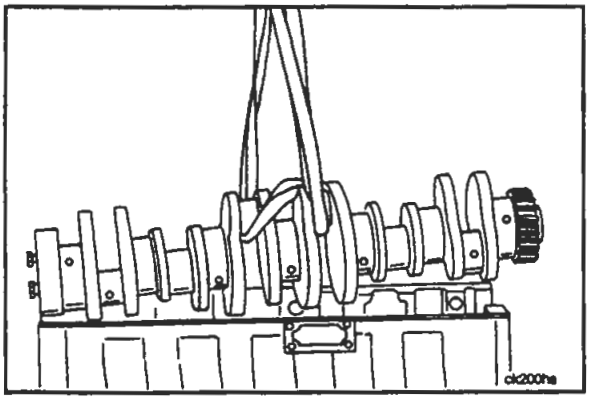
Mark the thrust bearings with the letter "L" and front or rear on the back on the bearing.



Caution: Do not damage the crankshaft when removing the thrust bearings.

Use a blunt tool to remove the upper thrust bearings from the number "4" main bearing journal.

Mark these bearings with the letter "U" and front or rear.



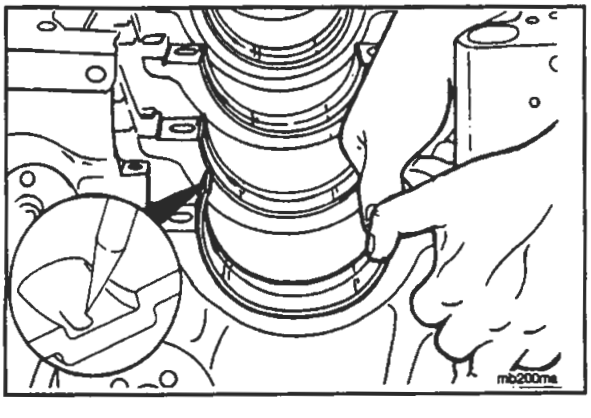
Crankshaft and Upper Main Bearing Shells - Remove

The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Note: Lift the crankshaft straight up to avoid damage to the crankshaft or cylinder block.

Install the Part No. 3375957 Nylon Lifting Sling around the number "3" and "4" rod bearing journals.

Attach the sling to a hoist and remove the crankshaft.



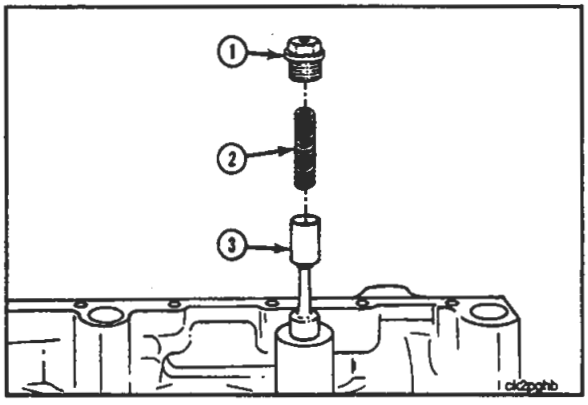
Use both thumbs to remove the upper bearing shells.

Mark these bearing shells with the letter "U", and the journal number they were removed from in the flat surface of the bearing tang.

Main Oil Pressure Regulator - Remove

Warning: Use caution while removing the retainer plug (1). The pressure regulator spring (2) is under compression. Personal injury can result.

Remove the retainer plug (1), the pressure regulator spring (2) and plunger (3).

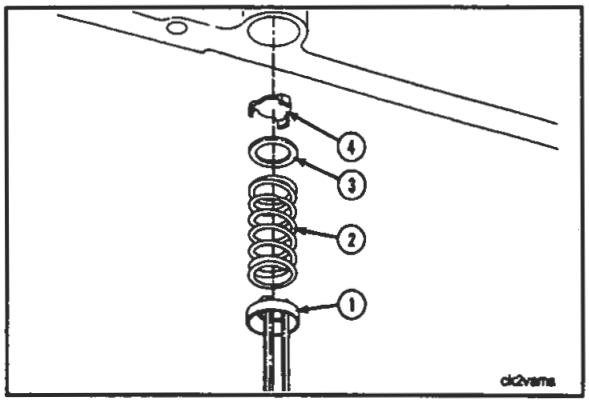


High Oil Pressure Regulator - Remove

Warning: Use caution while removing the retainer plug (1). The pressure regulator spring (2) is under compression. Personal injury can result. Wear face and eye protection.

Use the Part No. 3375784 Light Duty Puller Kit to remove the retainer plug (1).

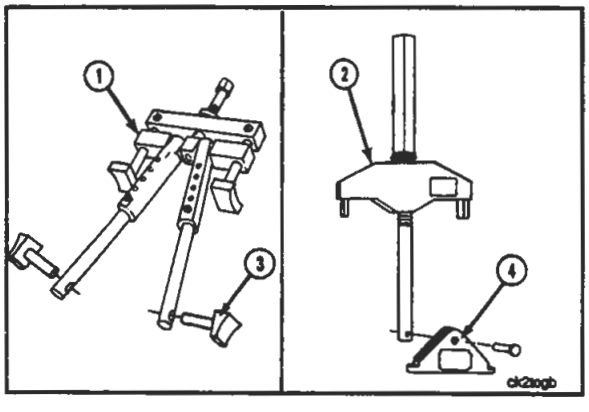
Remove the pressure regulator spring (2), washer (3), and valve disc (4).



Cylinder Liners - Remove

Two service tools are available to remove the cylinder liners:

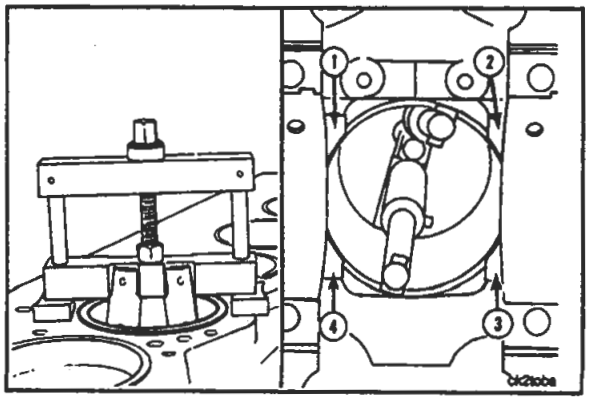
- Part No. 3376015 (1) or Part No. 3375629 (2) Universal Liner Puller.
- Part No. 3376649 Liner Puller Arm Extension Feet (3) or Part No. 3376049 Liner Puller Plate (4).

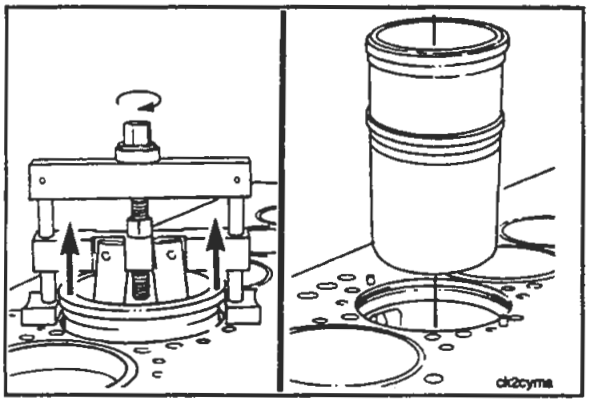


Remove the liners with Part No. 3376015 Universal Liner Puller

Note: Refer to the next procedure to use the Part No. 3375629 Universal Liner Puller.

Caution: The liner puller must be installed and used as described to avoid damage to the cylinder block. The puller must not contact the cylinder block casting at points (1), (2), (3) and (4).

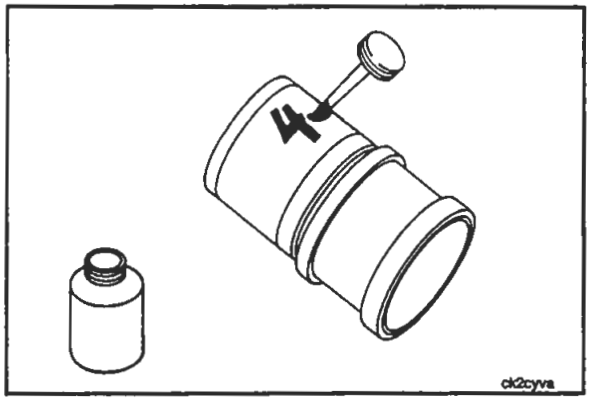




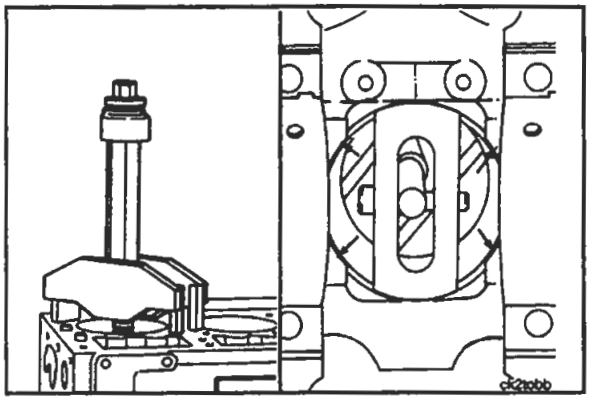
Note: The liner puller **must be** centered on the top of the cylinder block to prevent damage to the cylinder block.

Turn the puller jackscrew **clockwise** to loosen the liner from the cylinder block.

Use both hands to remove the liners.

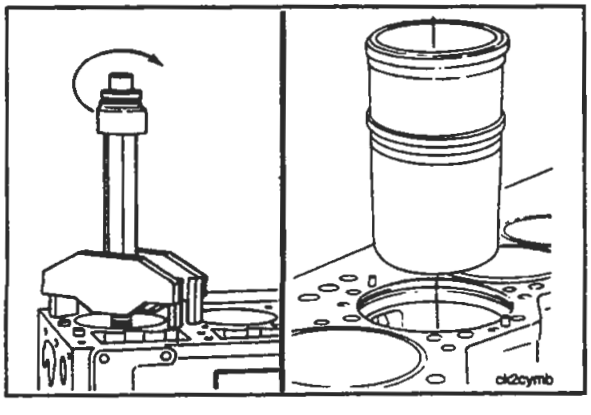


Use Dykem® or equivalent to mark the cylinder number of each liner.



Remove the liners with Part No. 3375629 Universal Liner Puller

Note: The liner puller **must be** installed and used as described to avoid damage to the cylinder block. The puller plate **must be** parallel to the main bearing saddles and **must not** overlap the liner outside diameter.

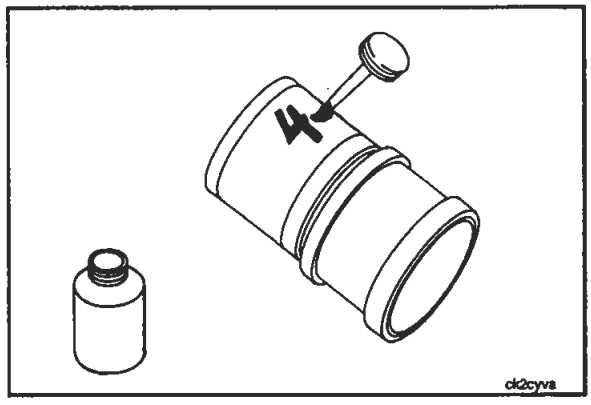


Note: The liner puller **must be** centered on the top of the cylinder block to prevent damage to the cylinder block.

Turn the puller jackscrew **clockwise** to loosen the liner from the cylinder block.

Use both hands to remove the liners.

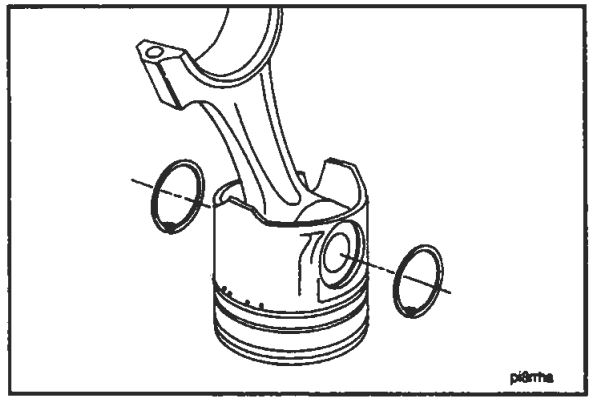
Use Dykem® or equivalent to mark the cylinder number of each liner.



Pistons from the Connecting Rods - Remove

Caution: The piston pin can fall from the piston assembly when the retainer snap rings are removed. The piston and pin can be damaged.

Use internal snap ring pliers to remove the retainer snap rings from both sides of the piston.



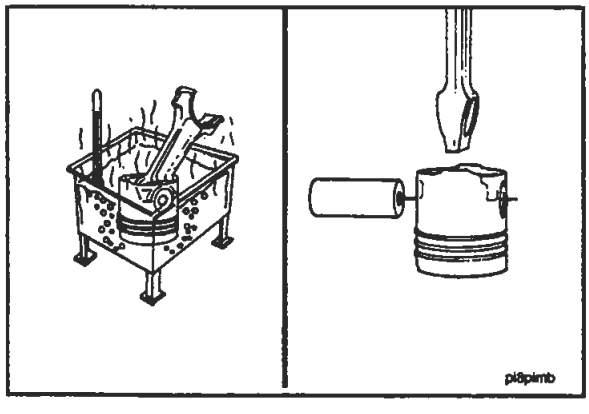
Caution: Wear protective gloves to prevent personal injury when handling hot parts.

Caution: Do not use a hammer to remove the piston pins. The piston can distort and cause the piston to seize in the liner.

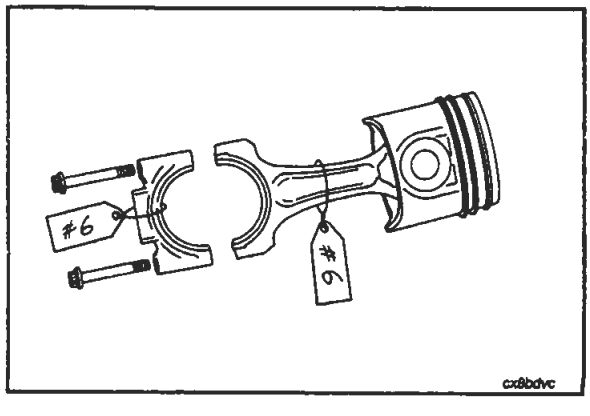
Install the piston and rod assembly into a container of water.

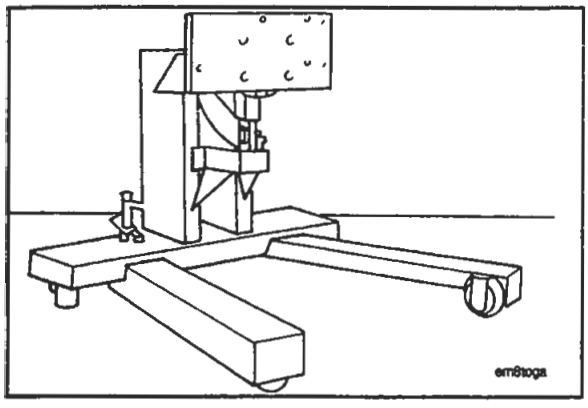
Heat the pistons in boiling water for 15 minutes.

Use a blunt tool to push the piston pin from the piston and rod assembly.



Mark the cylinder number the pistons were removed from on the piston to **make sure** they are installed in the correct cylinder if they are used again.





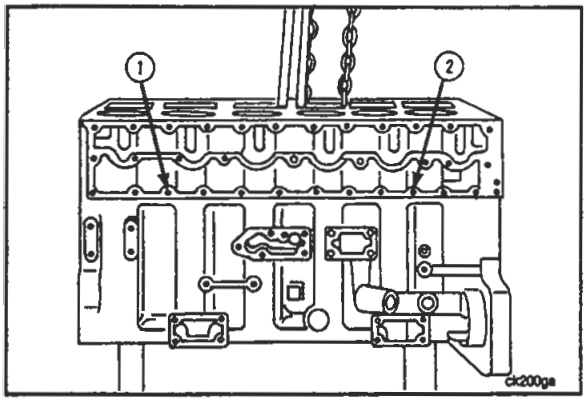
Engine Assembly (00-02)

Cylinder Block - Install on the Rebuild Stand

Use the Part No. 3376432 Adapter Plate with the Part No. 3375194 Engine Rebuild Stand.

Use ten (5/8-11 X 1 3/4 inch) grade 5 capscrews to install the adapter plate to the rebuild stand.

Torque Value: 45 N•m [35 ft-lb].

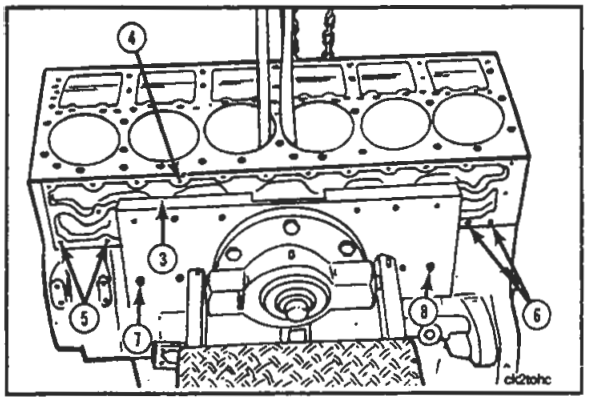


Install two Part No. 3376488 Guide Pins into the water header plate mounting capscrew holes (1) and (2).

The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Use a hoist and the Part No. 3375957 Engine Lifting Sling to lift the cylinder block.

Install the exhaust side of the cylinder block to the adapter plate of the rebuild stand.



Align the top of the adapter plate (3) with the top row of water header plate mounting capscrew holes (4).

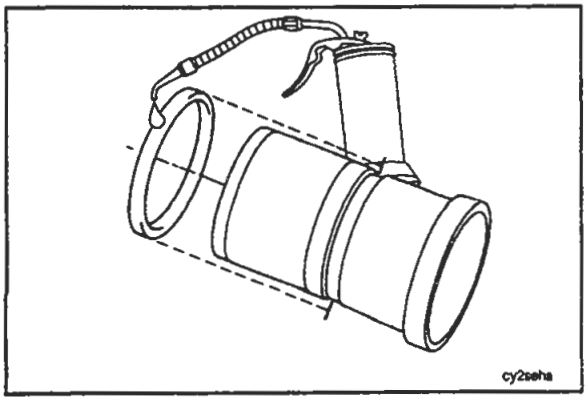
Note: The cylinder block **must be** positioned so two capscrew holes in the bottom row will show on each side of the adapter plate (5) and (6).

Align the guide pins with the bottom row of holes in the adapter plate at points (7) and (8).

Use eight Part No. 3376434 Capscrews to install the adapter plate to the cylinder block.

Remove the guide pins and install two Part No. 3376434 Capscrews.

Torque Value: 45 N•m [35 ft-lb].



Cylinder Liners - Install

Note: Make sure the cylinder block and all parts are clean.

Caution: Do not let the oil remain on the crevice seals for more than 12 hours before the liners are installed. The crevice can be damaged when installing the liner.

Install the crevice seal on the liner and use clean 15W-40 oil to coat the crevice seals.

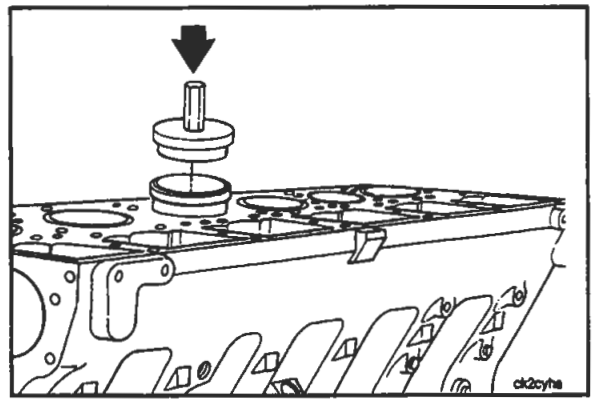
Note: When installed correctly, the clearance between the top and bottom leading edges of the crevice seal and the top and bottom leading edges of the liner crevice seal area will be 0.76 mm [0.029 inch].

Note: If the cylinder liners that were removed are used again, they **must be** installed into the same cylinder number they were removed from.

Install the liner into the cylinder block.

Use the Part No. 3376056 Cylinder Liner Driver and a leather mallet to drive the liner into the cylinder block bore.

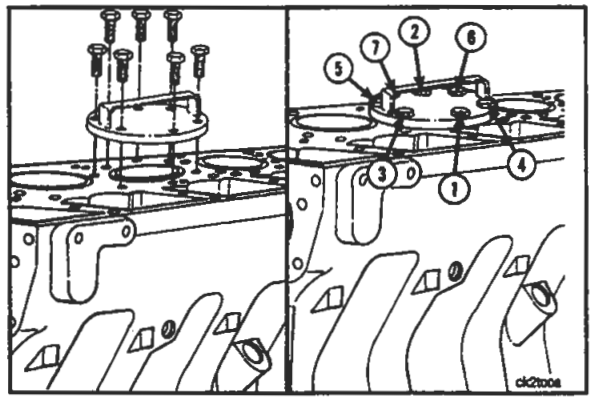
Note: If the liner does not rest on the cylinder block counterbore seat, remove the liner. Inspect the counterbore seat and liner for nicks, burrs, or dirt. Install the liner again.



Use the Part No. 3376472 Cylinder Liner Clamping Kit to push the sealing edge of the liner into the bore of the cylinder block.

Follow the sequence marked on the clamping plate to tighten the capscrews.

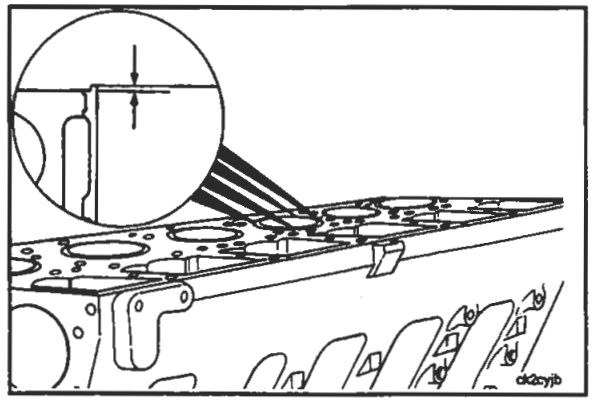
Cylinder Liner Clamping Plate Torque Values		
N•m	Step	ft-lb.
50	1	35
100	2	70
140	3	105



Inspection

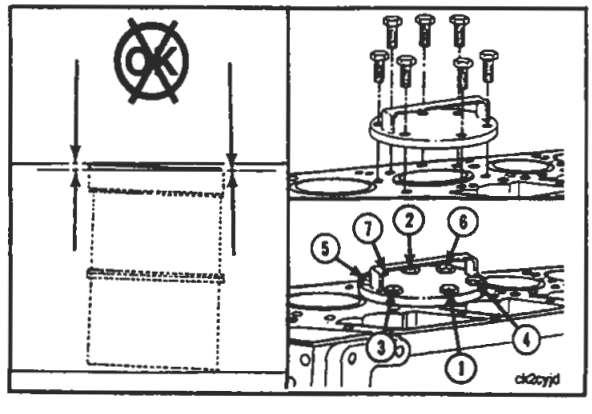
Measure the liner protrusion at four points 90 degrees apart.

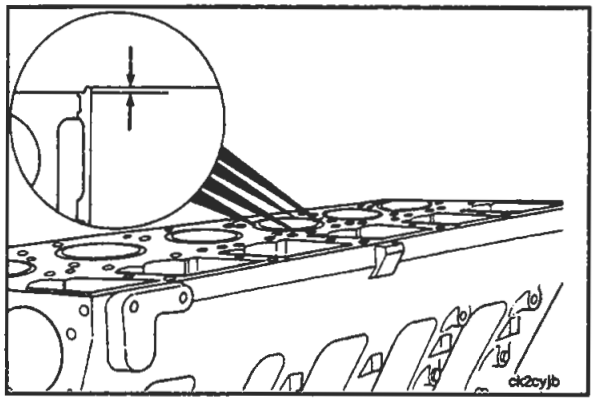
Cylinder Liner Protrusion		
mm		in
0.00	MIN	0.000
0.13	MAX	0.005



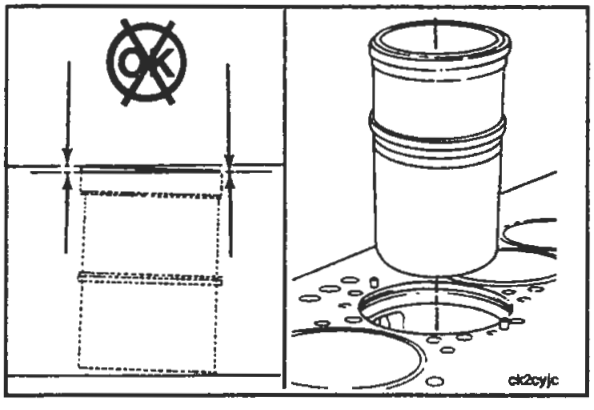
Note: If the liner protrusion varies more than 0.025 mm [0.0010 inch] for 180 degrees:

- Install and tighten the clamping plate again.



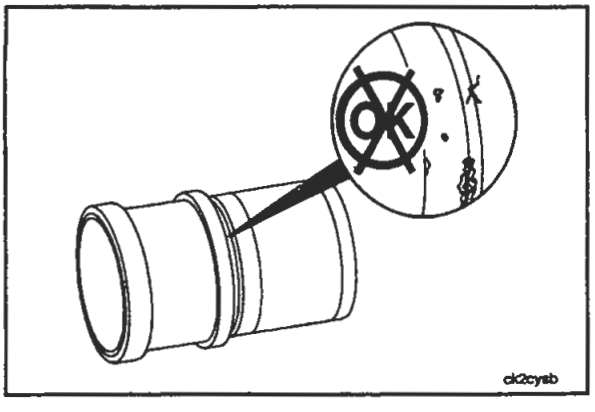


- Inspect the liner protrusion again.

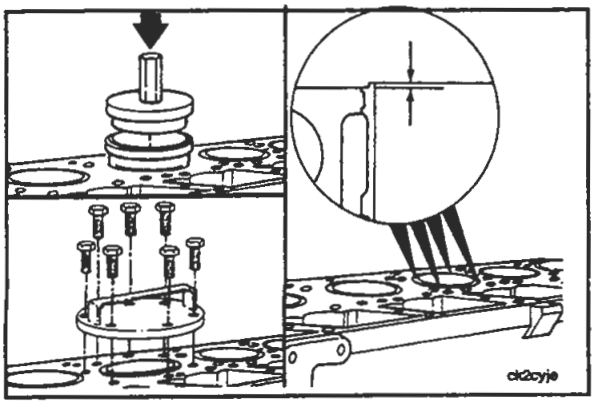


Note: If the protrusion still varies more than 0.025 mm [0.0010 inch]:

- Remove the liner.



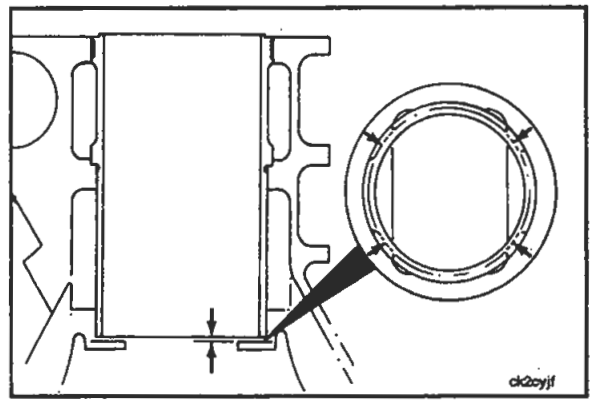
- Inspect the liner sealing edge for burrs, dirt or damage.
- Replace the liner if it is damaged.



- Install the liner again.
- Inspect the liner protrusion.

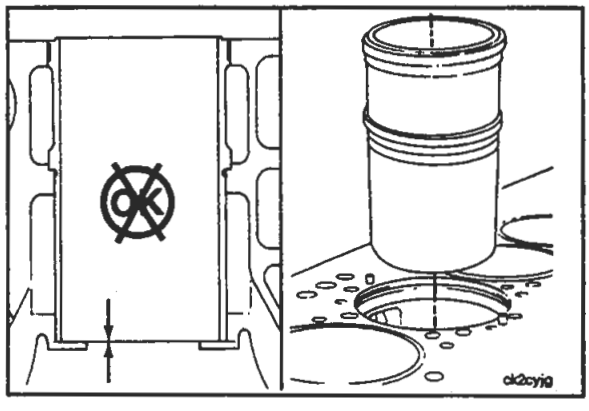
Note: If the liner protrusion still does not meet the specifications, use the Part No. 3377367 Counterbore Ledge Tool to cut the cylinder block liner bore for shims. Refer to the Alternative Repair Manual, Bulletin No. 3810310 for the correct procedure.

Use a feeler gauge to measure the liner to block clearance at the four block casting points. The clearance **must be** 0.25 mm [0.010 inch] minimum.

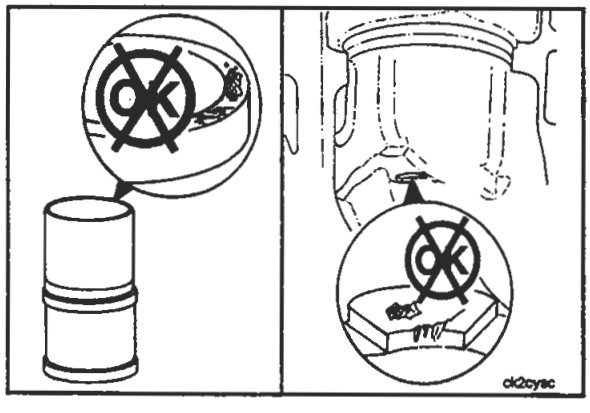


Note: If the clearance is less than 0.25 mm [0.010 inch]:

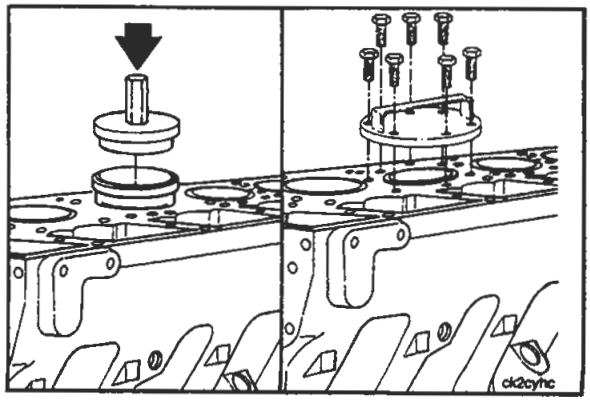
- Remove the liner.

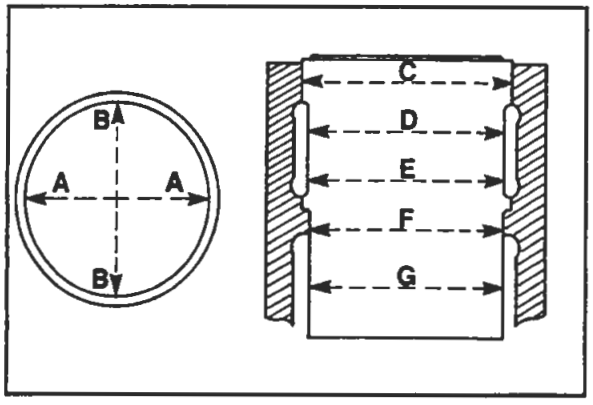


- Inspect the liner and cylinder block for dirt or damage.



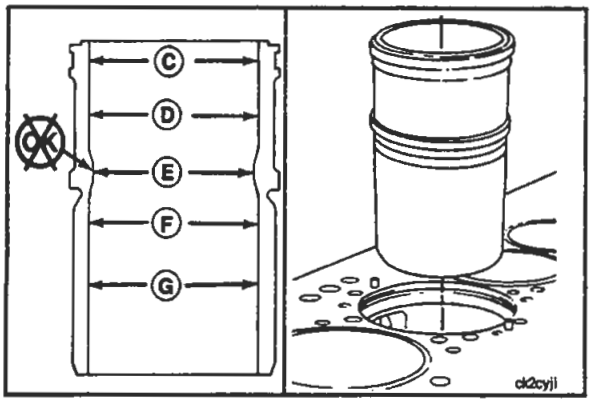
- Replace the liner if it is damaged.
- Install the liner again.





Measure the liner bore for out-of-roundness at points "C", "D", "E", "F" and "G". Measure each point in the direction "AA" and "BB". The bore **must not be** more than 0.10 mm [0.004 inch] out-of-round.

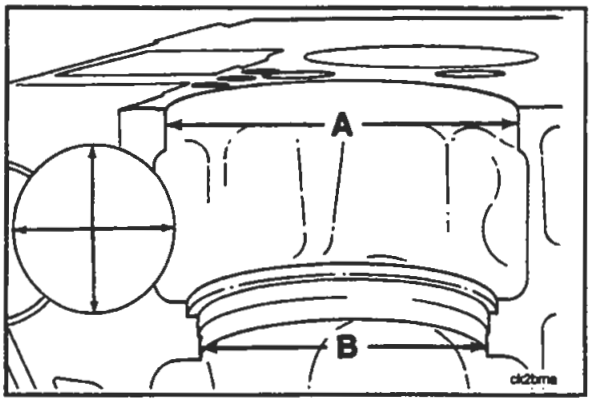
Note: The cylinder block can be distorted when mounted on the engine rebuild stand. If the liner bore does not meet the specifications, remove the engine from the engine rebuild stand and set it on a clean flat surface. Measure the liner bore out-of-roundness again.



Note: If the liner bore is more than 0.10 mm [0.004 inch] out-of-round with the engine on a flat surface:

- Remove the liner so the cylinder block liner bore can be measured.

Note: The diameters above and below the cylinder block counterbore area are not critical dimensions and **do not** need to be measured.

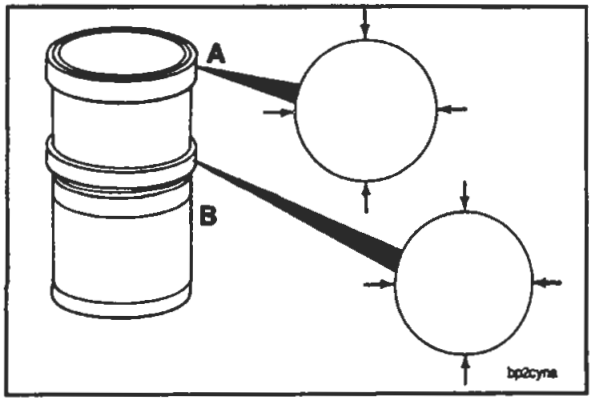


- Measure the cylinder block upper liner bore.

Cylinder Block Upper Liner Bore I.D. (A)		
mm		in
145.90	MIN	5.744
146.05	MAX	5.750

- Measure the cylinder block liner seal seat bore 8.0 to 13.5mm [0.32 to 0.53 inch] below the counterbore.

Cylinder Block Liner Seal Seat Bore I.D. (B)		
mm		in
138.063	MIN	5.4355
138.113	MAX	5.4375

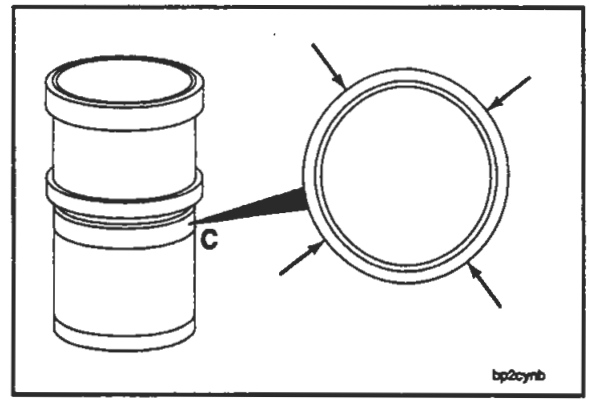


- Measure the liner outside diameter.

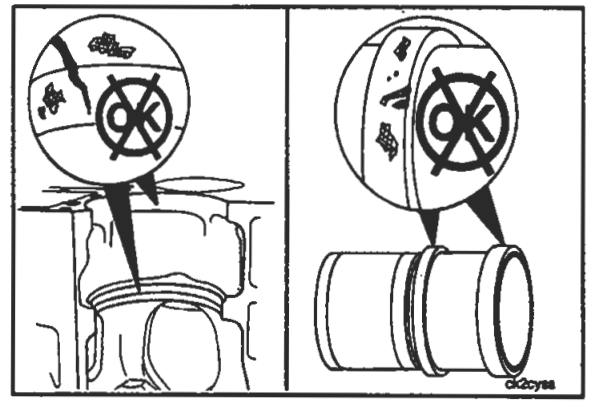
Cylinder Liner Top Press Fit O.D. (A)		
mm		in
145.962	MIN	5.7465
146.000	MAX	5.7480

Note: The cylinder block liner counterbore flange diameter (B) is not a critical dimension and **does not** need to be measured.

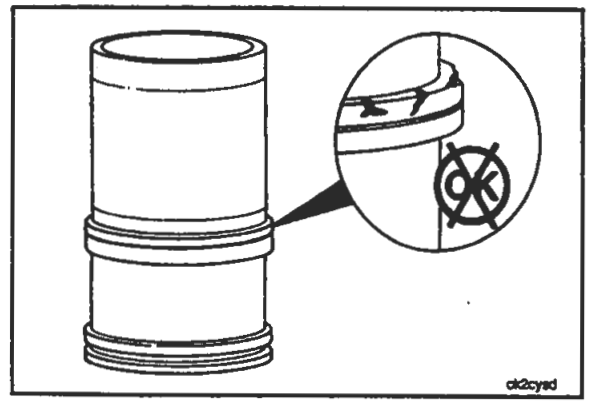
Cylinder Liner Lower Press Fit O.D. (C)		
mm		in
137.937	MIN	5.4305
138.013	MAX	5.4336



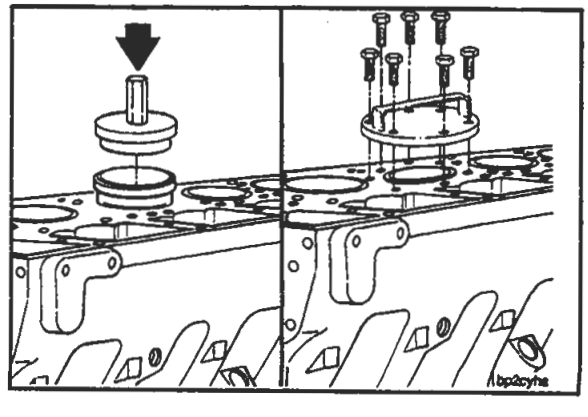
- Inspect the cylinder block liner bore and liner for burrs, dirt or damage.

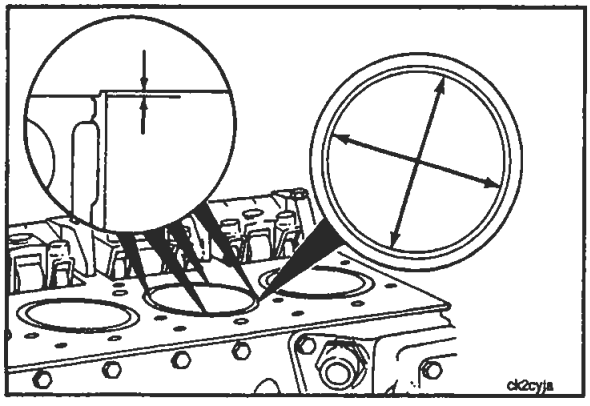


- Inspect the liner crevice seal for dirt or damage.
- Replace the crevice seal if it is damaged.



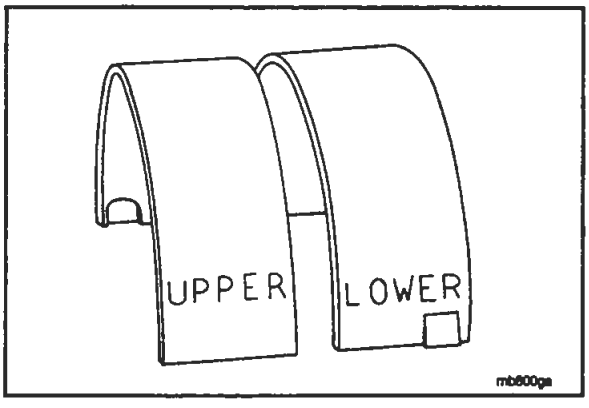
- Replace the liner if it is damaged.
- Install the liner again.





Inspect the liner bore and protrusion again.

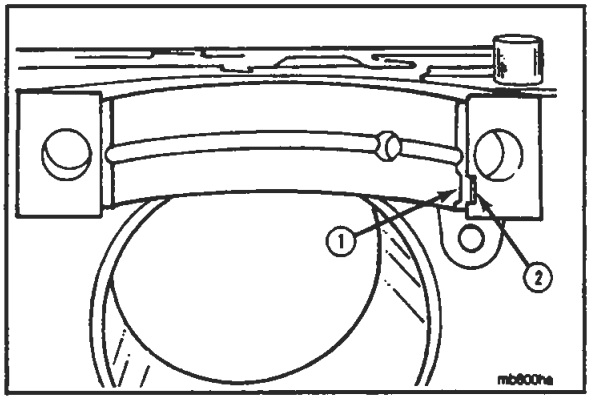
Note: Replace the liner if it **does not** meet the specifications.



Upper Main Bearing Shells - Install

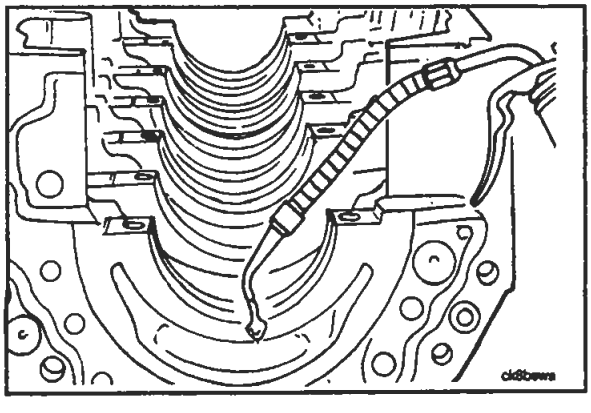
Caution: The bearing shells are marked with the words "upper" and "lower". Each must be installed in the correct location to prevent engine damage.

Note: If used bearing shells are to be installed, each **must be** installed in its original location in the engine. The bearing journal numbers should have been marked in the bearing tangs during disassembly.



Caution: The tang (1) on the bearing shell must be in the slot (2) of the bearing saddle to correctly position the bearing and prevent engine damage.

Install the upper main bearing shells.



Use clean 15W-40 oil to coat the bearings.

Crankshaft - Install

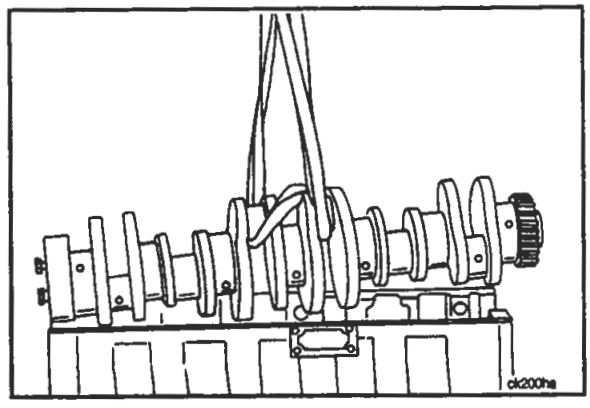
The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Use a hoist and the Part No. 3375957 Nylon Lifting Sling.

Install the sling around the numbers "3" and "4" rod bearing journals.

Note: Do not damage or move the bearing shells when the crankshaft is installed.

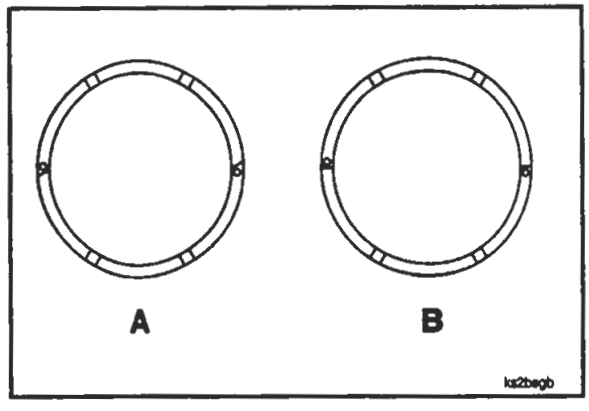
Install the crankshaft.



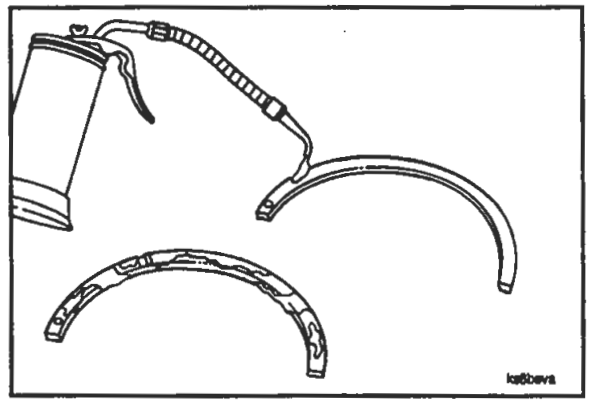
Thrust Bearings, Lower Bearing Shells and Main Bearing Caps - Install

Two styles of thrust bearings have been used on L10 engines. The present production thrust bearings (A), Part No. 3822062, include an interlocking design to make sure the bearings are installed correctly. Earlier production thrust bearings (B), Part No. 3028107, do not use the interlocking design.

Note: 0.25 mm [0.010 inch] oversize thrust bearings, Part No. 3050589, are available if required.



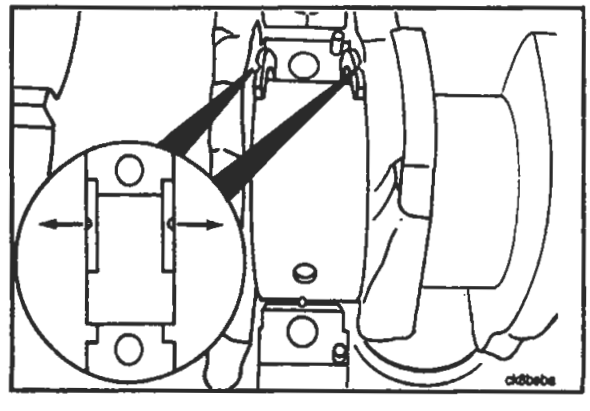
Use clean 15W-40 oil to coat the upper thrust bearings.

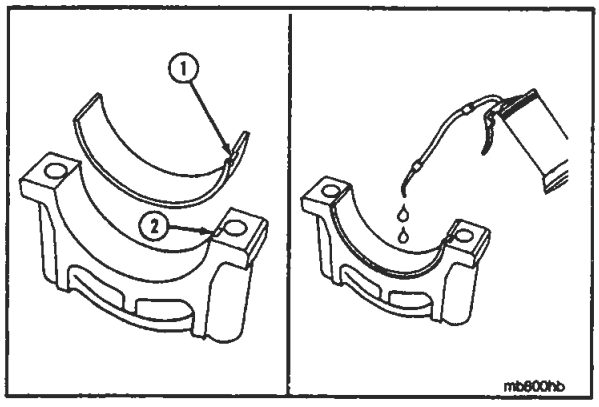


Note: Push the crankshaft toward the rear of the engine to install the front thrust bearing, and to the front to install the rear thrust bearing.

Note: The grooves in the thrust bearings **must be** toward the crankshaft to prevent damage to the crankshaft and cylinder block during engine operation.

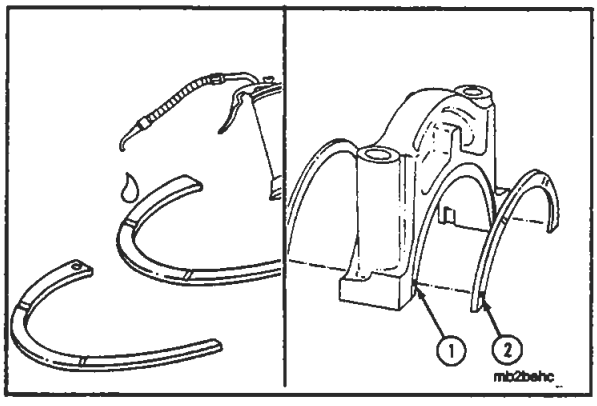
Install the upper thrust bearings into the number "4" main bearing saddle.





Install the lower main bearing shells with the tang (1) in the slot (2) of the main bearing cap.

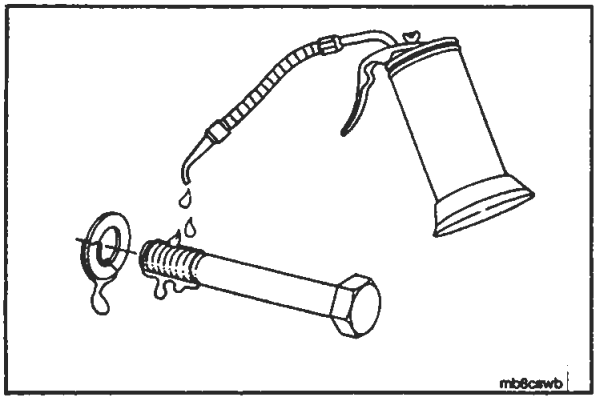
Use clean 15W-40 oil to coat the bearing shells.



Use clean 15W-40 oil to coat the lower thrust bearings.

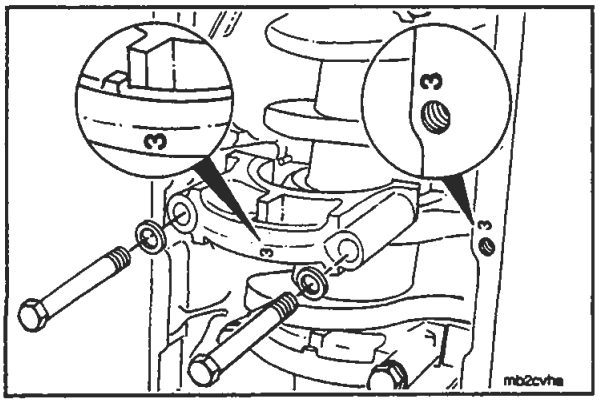
Caution: The grooves of the thrust bearing must be facing out from the bearing cap to prevent damage to the crankshaft and cylinder block during engine operation. The locating dowels (1) must not protrude above the thrust bearing surface (2).

Install the thrust bearings to the number "4" main bearing cap.



Note: Drain the excess oil from the capscrews before installing them in the cylinder block to prevent hydraulic lock and possible engine damage during engine operation.

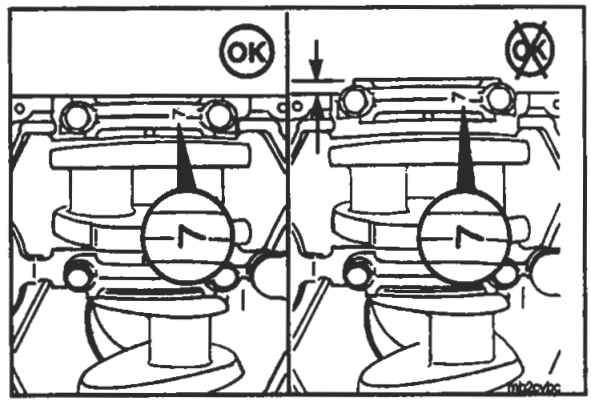
Use clean 15W-40 oil to coat the main bearing capscrew threads and the flat washers.



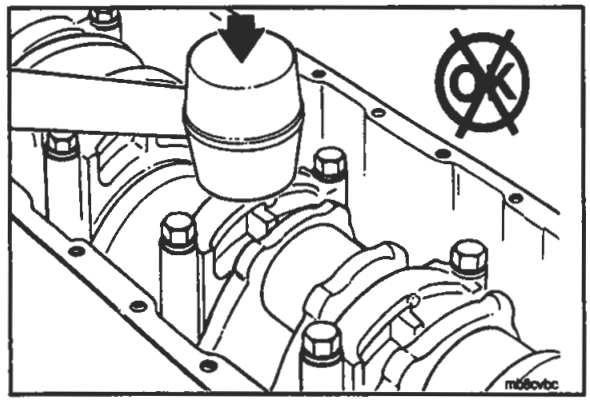
Note: The main bearing caps are numbered. The caps **must be** installed with the number toward the camshaft side of the cylinder block and on the bearing saddle with the same number to prevent cylinder block damage. The bearing saddle number is located on the cylinder block oil pan flange.

Install the main bearing caps.

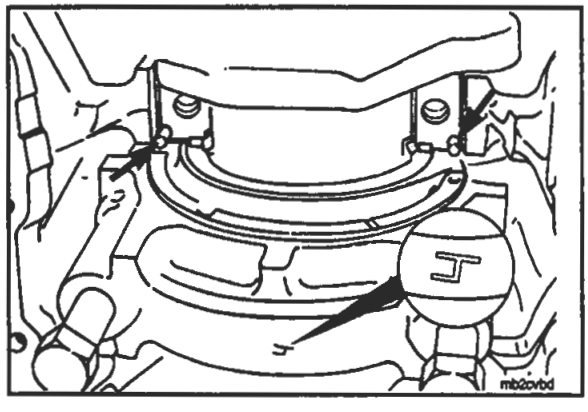
Note: The rear surface of the number "7" main bearing cap **must not** protrude beyond the bearing saddle surface. If the cap protrudes, the flywheel housing will **not** align with the crankshaft and will cause an oil leak.



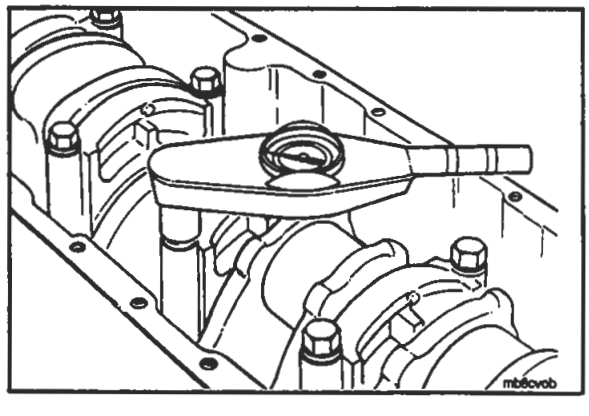
Caution: Do not hit the main bearing caps with a hammer. The main bearing cap and bearings can be damaged.

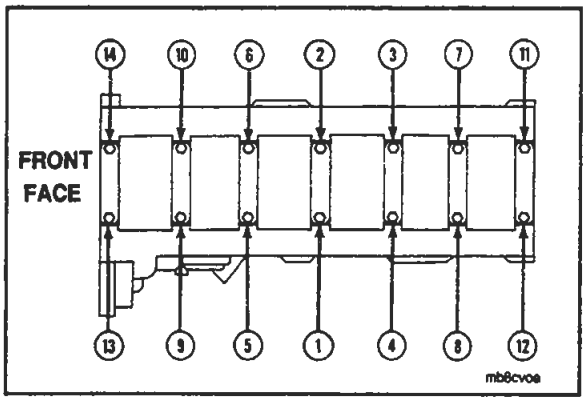


Caution: The number "4" main bearing cap must be aligned with the dowel pins in the bearing saddle. If the dowel pins and main bearing cap are not in alignment, the cylinder block and main bearing cap will be damaged when the capscrews are tightened.



Caution: Do not use an impact wrench to tighten the capscrews; the capscrews must be tightened alternately and evenly in specific steps to the correct torque values to prevent damage to the cylinder block, main bearing caps and crankshaft.

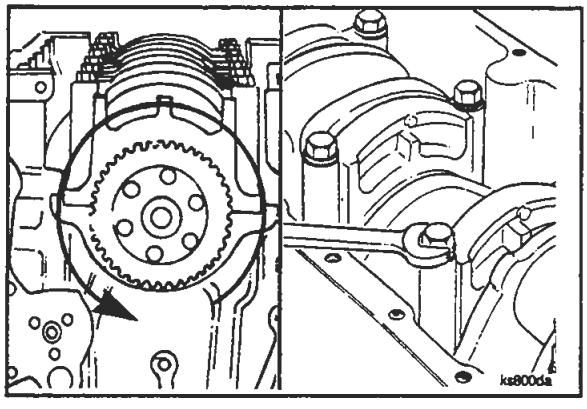




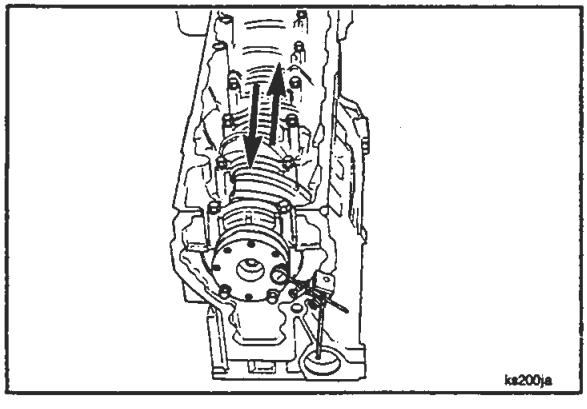
Complete the following steps to tighten the capscrews in the sequence shown:

Main Bearing Capscrew Torque Values

N•m	Step	ft-lb
70	1	50
140	2	105
210	3	155
Loosen	4	Loosen
70	5	50
140	6	105
210	7	155



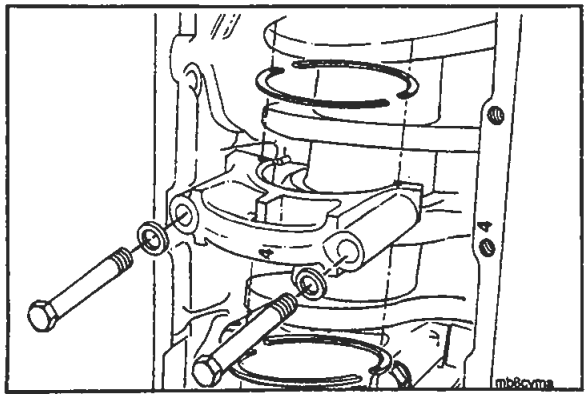
Use your hands to turn the crankshaft, if it **does not** turn freely, loosen the main bearing capscrews one at a time to locate the bearing that is too tight.



Use a dial indicator to measure the crankshaft end clearance.

Crankshaft End Clearance

mm		in
0.10	MIN	0.004
0.55	MAX	0.022

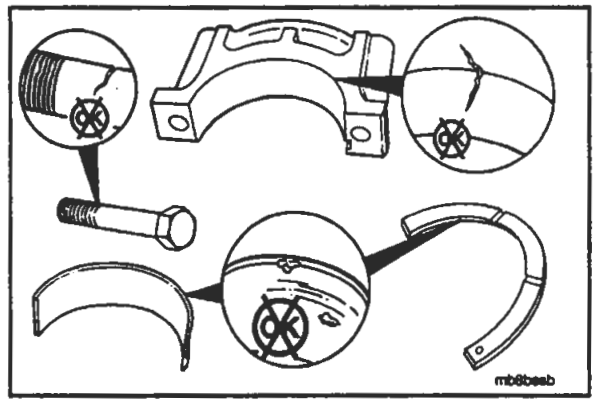


If the end clearance is not within specifications, complete the following steps:

- Remove the number "4" main bearing cap and thrust bearings.

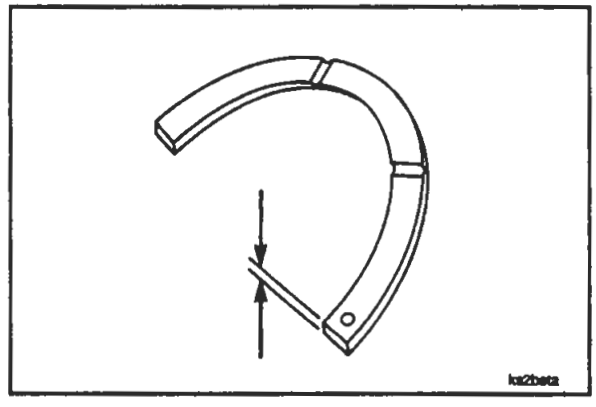
Inspect for burrs, dirt or damage.

If nicks or burrs cannot be removed with fine crocus cloth, the cap and bearings must be replaced.



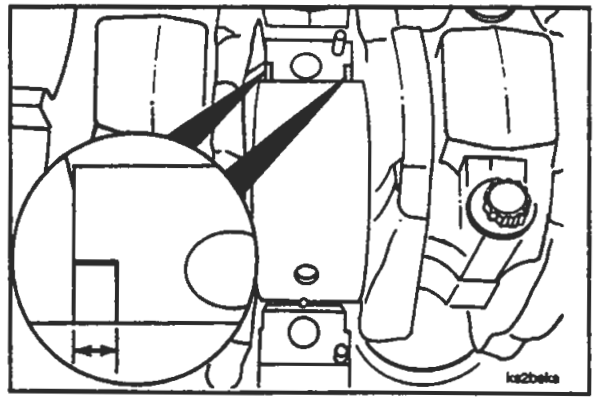
Measure the thrust bearing thickness and replace the bearings if they **are not** within specifications.

Crankshaft Thrust Bearing Thickness		
mm		in
4.83	MIN	0.190
4.89	MAX	0.192



Measure the crankshaft thrust bearing surface and replace the crankshaft if it **does not** meet the specifications.

Crankshaft Thrust Bearing Surface		
mm		in
49.975	MIN	1.9675
50.100	MAX	1.9724

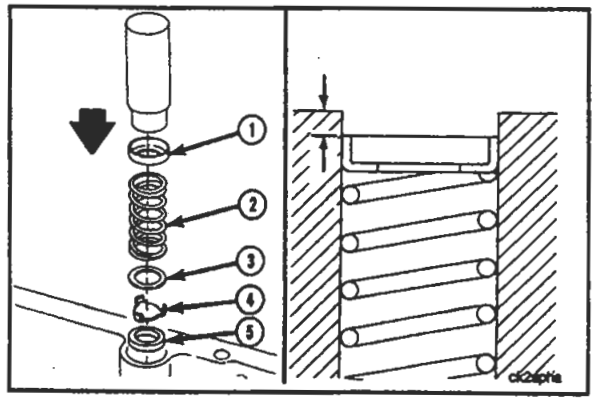


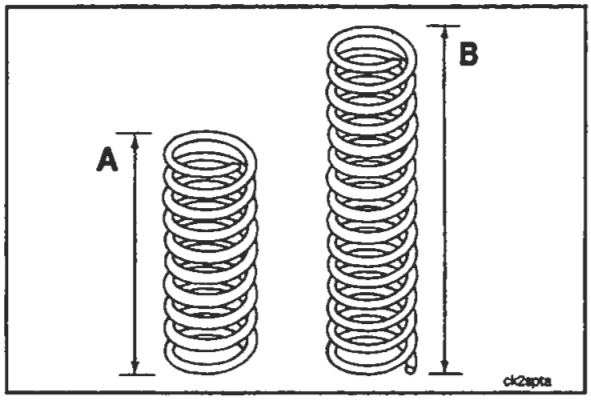
High Oil Pressure Regulator - Install

Install the seat insert (5), valve disc (4), washer (3) and regulator spring (2).

Warning: The regulator spring must be compressed to install the retainer plug (1). Personal injury can result. Wear face and eye protection.

Use the Part No. 3376489 Regulator Retainer Plug Driver to install the retainer plug (1) to a depth of 8.28 mm [0.326 inch] from the cup plug lower lip.



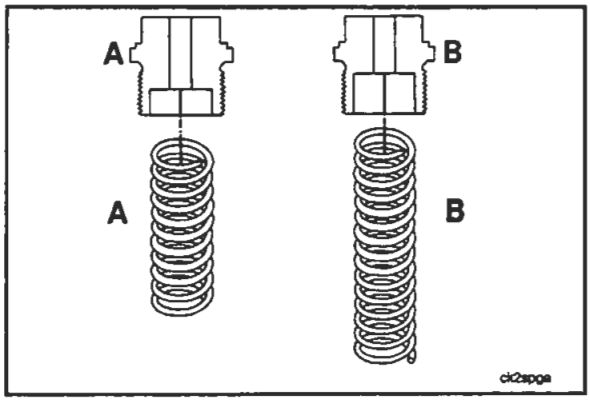


Main Oil Pressure Regulator - Install

Note: Two different pressure regulator springs have been used.

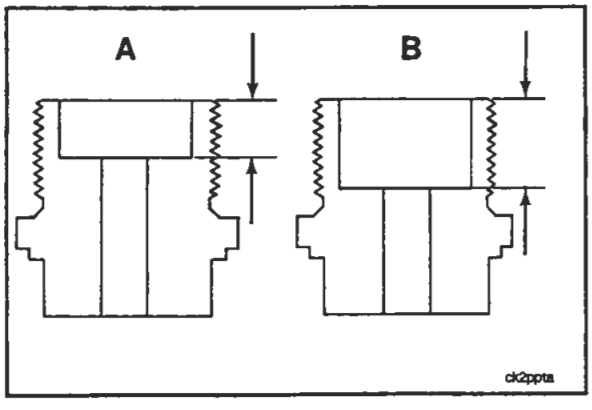
Measure the free length of the regulator spring to determine which spring is being used.

Main Oil Pressure Regulator Spring Free Length			
Part No.	mm	Spring	in
3009449	58.9	A	2.32
3010146	84.1	B	3.31



Note: Two different retainer plugs have also been used.

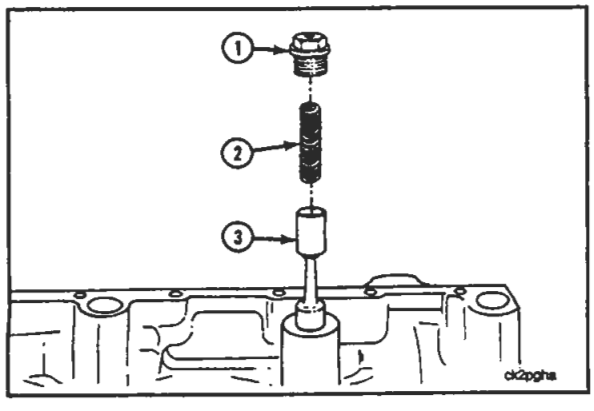
Use plug "A" with spring "A" and plug "B" with spring "B". **Do not** mix the plugs and springs.



Measure the retainer plug to determine which plug is being used. The dimension of the plug which determines spring compression is shown.

Main Oil Pressure Regulator Retainer Plugs					
mm	Plug "A"	in	mm	Plug "B"	in
7.1	MIN	0.28	11.1	MIN	0.44
8.4	MAX	0.33	13.4	MAX	0.53

Note: Plug "A" Part No. 3025308. Plug "B" Part No. 3037589.



Install the plunger (3) and spring (2).

Warning: The regulator spring must be compressed to install the retainer plug (1). Personal injury can result. Wear face and eye protection.

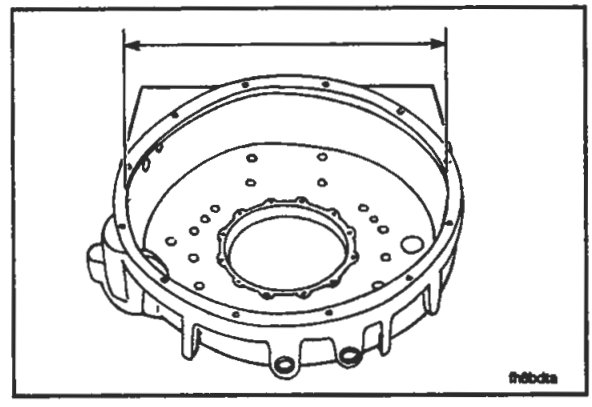
Install and tighten the retainer plug (1).

Torque Value: 75 N•m [55 ft-lb]

Flywheel Housing - Install

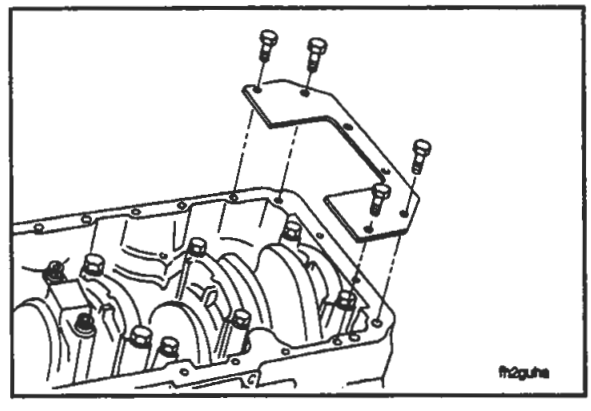
Measure the inside diameter of the housing bore to determine the SAE number and size of the housing being used.

Flywheel Housing Maximum Bore I.D.		
mm	SAE No.	in
787.7	00	31.01
648.0	0	25.51
584.4	1/2	23.01
511.3	1	20.13
447.8	2	17.63
409.7	3	16.13



Use four oil pan capscrews (M10-1.50 X 25) to install the Part No. 3376606 Flywheel Housing Alignment Plate to the oil pan flange at the rear of the cylinder block.

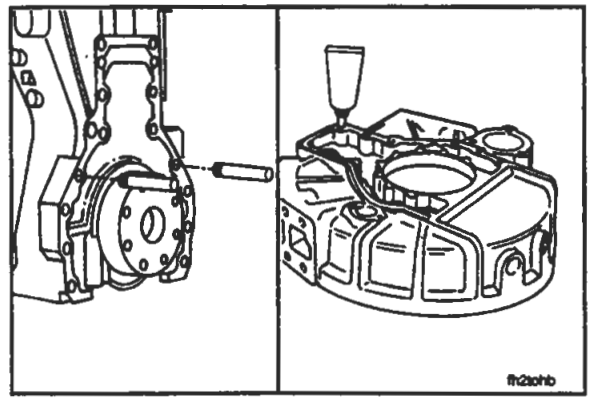
Torque Value: 45 N•m [35 ft-lb]



Rotate the engine on the rebuild stand to position the cylinder head mounting surface facing up.

Install two Part No. 3376697 Guide Pins into the cylinder block.

Apply a 2 mm [1/16 inch] bead of Part No. 3801048 Cummins Sealant on the mounting surface of the housing and around each of the mounting capscrew holes.



Install the flywheel housing over the guide pins.

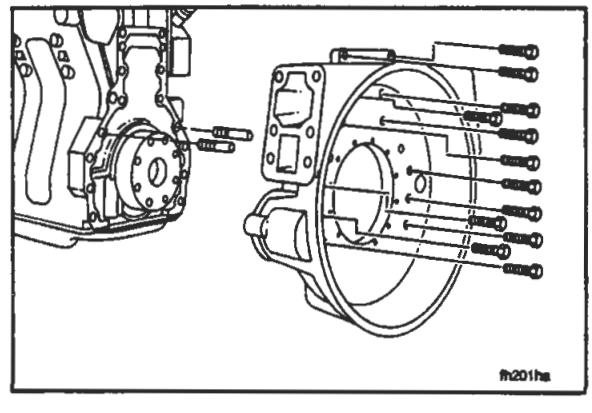
Note: The flywheel housing bore **must be** aligned with the crankshaft. **Do not** tighten the capscrews to the final torque value until the flywheel housing is aligned.

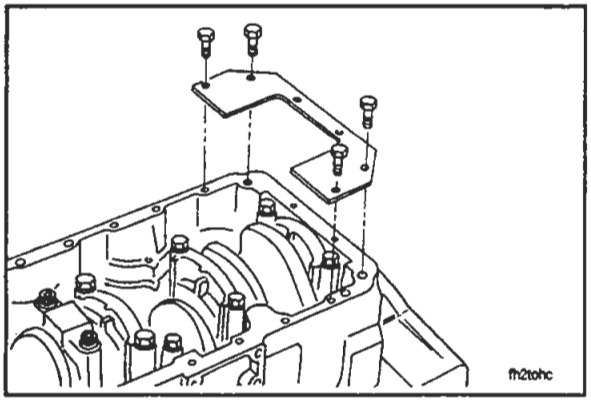
Install the ten (M16-2.00 X 55) capscrews.

Remove the guide pins and install the remaining two (M16-2.00 X 55) capscrews.

Tighten the two capscrews.

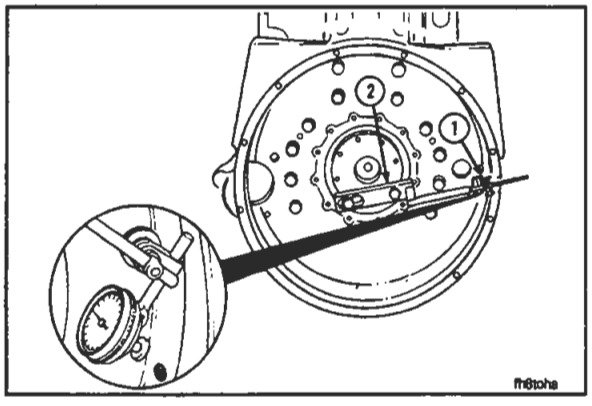
Torque Value: 7 N•m [60 in-lb]





Remove the four alignment plate capscrews and the Alignment plate.

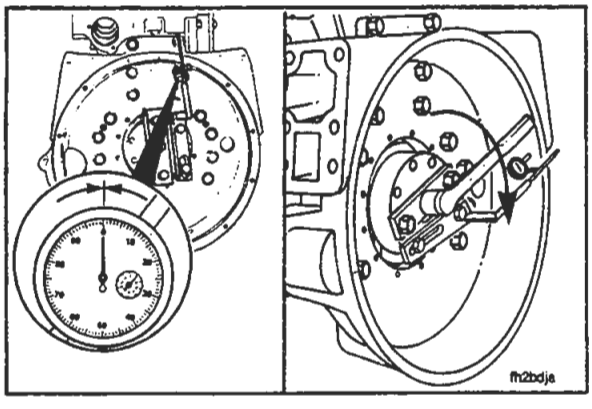
Note: Installation instructions for the rear mounted power take off (P.T.O.) assembly are in Bulletin No. 3810301.



Measure the Flywheel Housing Bore Alignment

Use the Part No. 3376050 Dial Indicator Gauge (1) and the Part No. ST-1325 Dial Gauge Attachment (2) to measure the bore alignment.

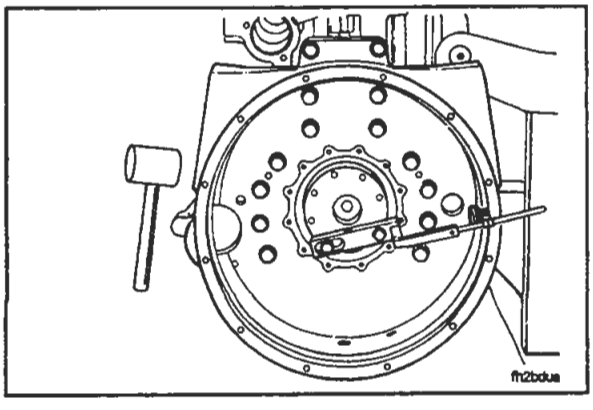
Install the attachment and gauge as shown.



Position the indicator at the 12 o'clock position. Adjust the gauge dial to "0" (zero).

Rotate the crankshaft one complete revolution (360 degrees) and record the TIR.

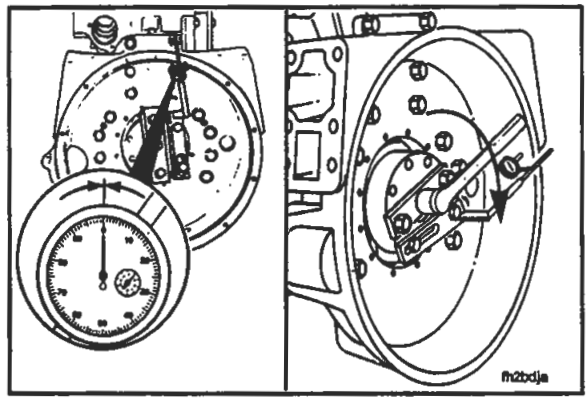
Flywheel Housing Bore Alignment Maximum TIR		
mm	SAE No.	in
0.31	00	0.012
0.25	0	0.010
0.25	1/2	0.010
0.20	1	0.008
0.20	2	0.008
0.20	3	0.008



If the maximum bore alignment **does not** meet the specifications, use a rubber hammer to move the housing in the necessary direction.

Repeat the above steps until the maximum bore TIR is within specifications for the determined housing size.

Note: If the bore alignment is not within specifications and the bore is not round, the housing must be replaced.



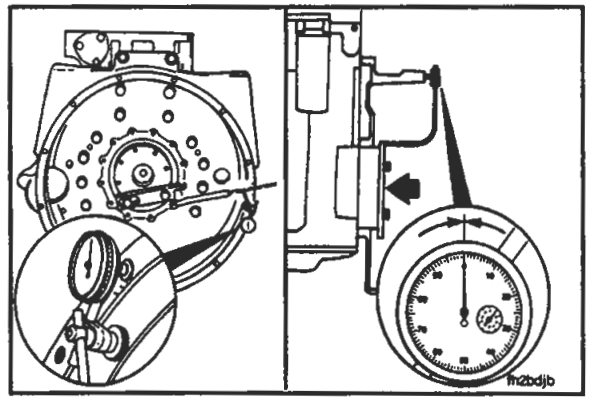
Measure the Flywheel Housing Face Alignment

Caution: The tip of the gauge must not enter the cap-screw holes or the gauge will be damaged.

Position the contact tip of the gauge against the housing face.

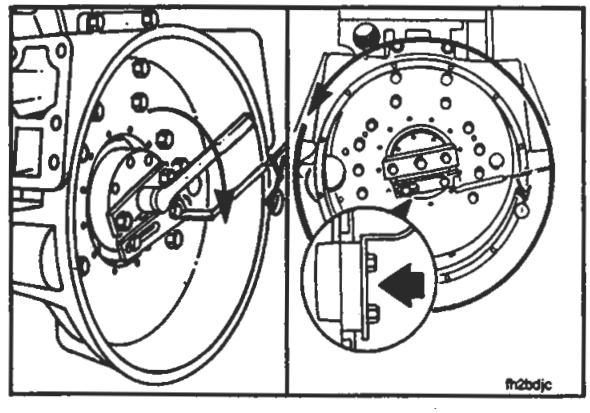
Push the crankshaft toward the front of the engine.

Adjust the gauge dial to "0" (zero).

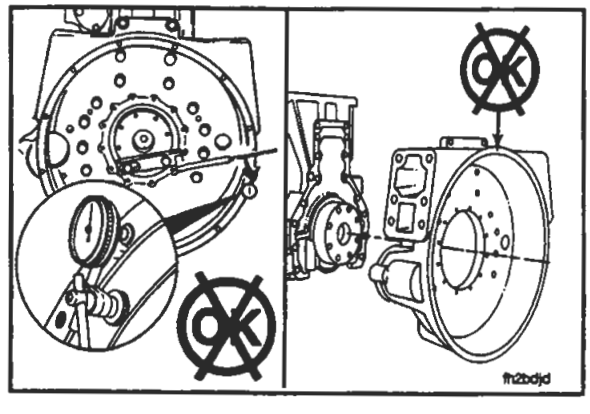


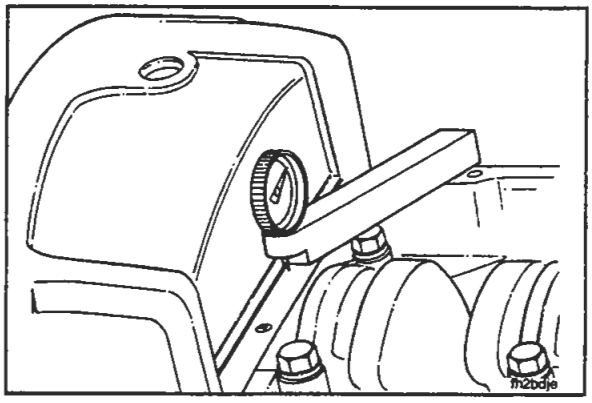
Rotate the crankshaft one complete revolution (360 degrees) and record the TIR.

Flywheel Housing Face Alignment Maximum TIR		
mm	SAE No.	in
0.31	00	0.012
0.25	0	0.010
0.25	1/2	0.010
0.20	1	0.008
0.20	2	0.008
0.20	3	0.008



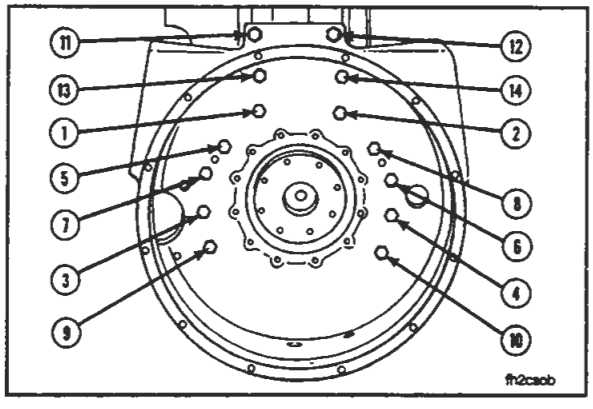
If the maximum face alignment **does not** meet the specifications, the housing **must be** replaced.





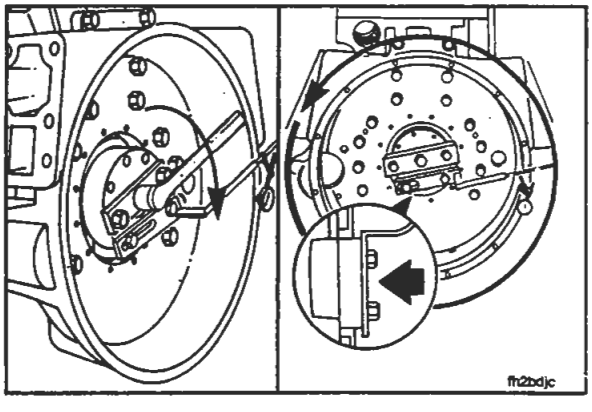
Use the Part No. 3376220 Gauge Block to measure the alignment of the oil pan mounting flange of the housing with the oil pan mounting flange of the cylinder block.

The housing flange **must** be even with the cylinder block flange within ±0.15 mm [0.006 inch].



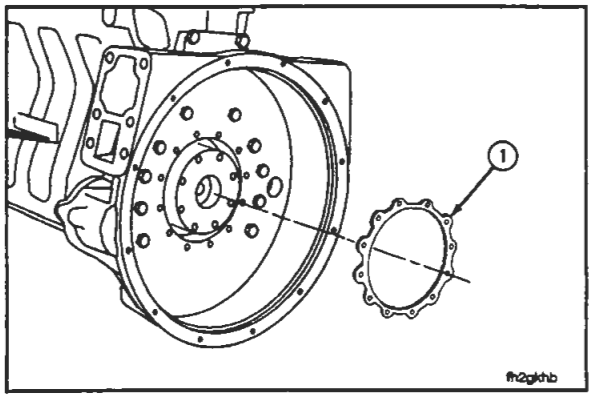
Complete the following steps to tighten the capscrews in the sequence shown:

Flywheel Housing Capscrew Torque Values		
N•m	Step	ft-lb
65	1	50
130	2	95
195	3	145



Measure the bore and face alignment again.

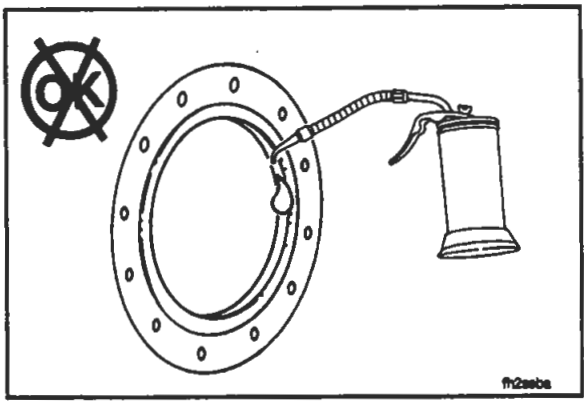
Note: If the bore and face alignment does not meet the specification, loosen the housing capscrews, tighten the capscrews again and measure the bore and face alignment again.



Crankshaft Rear Oil Seal - Install

Install a new gasket (1) on the flywheel housing

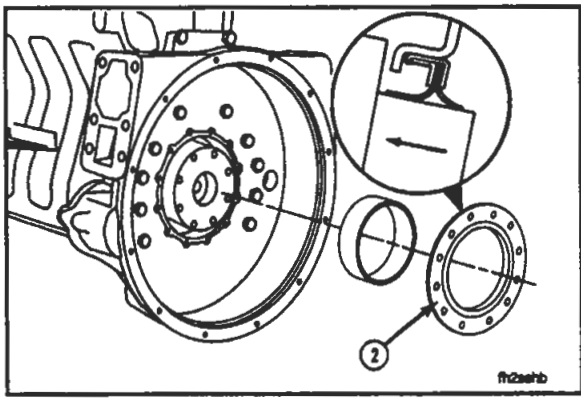
Note: Do not use any kind of lubricant. The oil seal **must be** installed with the lip of the seal and the crankshaft clean and dry to provide a proper oil sealing surface.



Note: Service replacement oil seals have an assembly tool which protects the seal lip during shipment and assembly. If the replacement seal does **not** have the assembly tool, use the Part No. 3376076 Oil Seal Guide.

Note: The yellow dust seal **must be** facing out to prevent an oil leak.

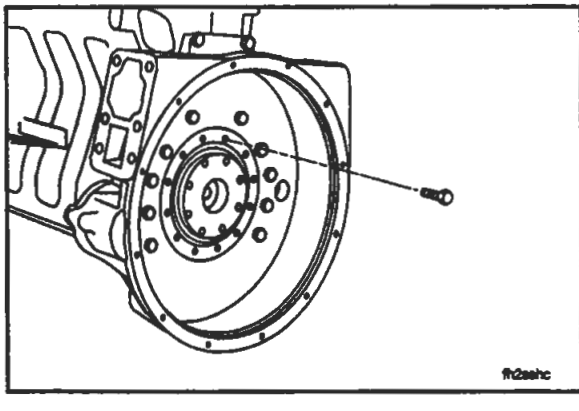
Use the installation sleeve provided with the seal or the oil seal guide to install the seal (2) on the crankshaft.



Install the 12 capscrews and tighten in a star pattern.

Torque Value: Step one 7 N•m [60 in-lb]

Torque Value: Step two 19 N•m [170 in-lb]



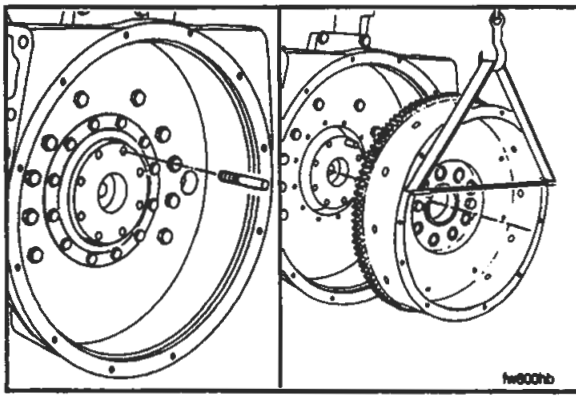
Flywheel - Install

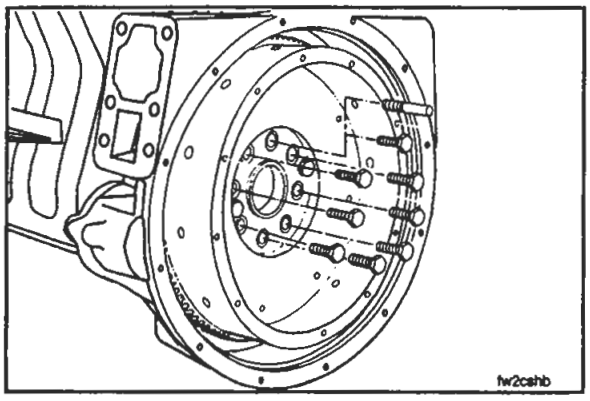
Install one Part No. 3376696 Guide Pin into the crankshaft flange.

The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Note: Make sure the crankshaft flange is clean and not damaged.

Install the flywheel on the guide pin.



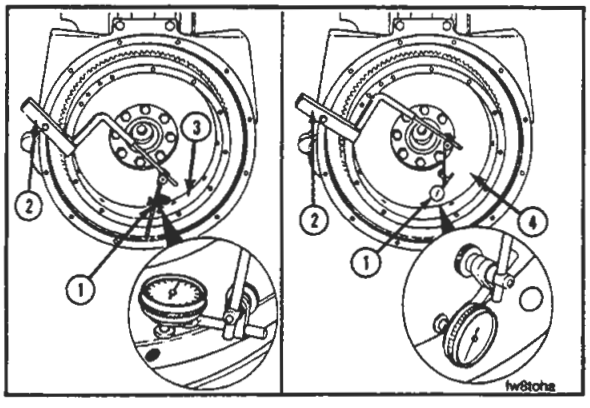


Install the seven capscrews.

Remove the guide pin and install the one remaining capscrew.

Tighten the capscrews in a star pattern.

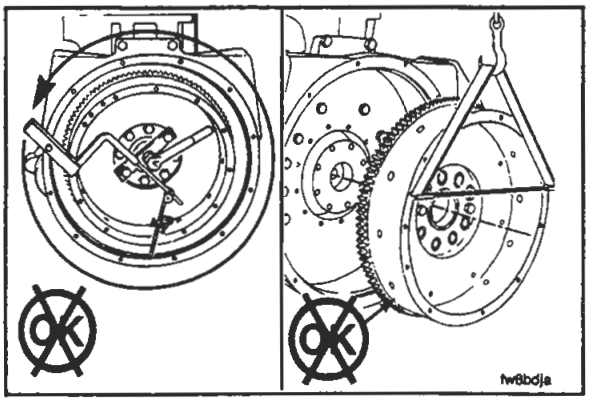
Torque Value: 185 N•m [135 ft-lb]



Measure the Flywheel Bore Runout

Use the Part No. 3376050 Dial Indicator Gauge (1) and the Part No. ST-1325 Dial Gauge Attachment (2) to inspect the flywheel bore (3) and face (4) runout.

Install the attachment to the flywheel housing. Install the gauge on the attachment. Install the contact tip of the indicator against the inside diameter of the flywheel bore.

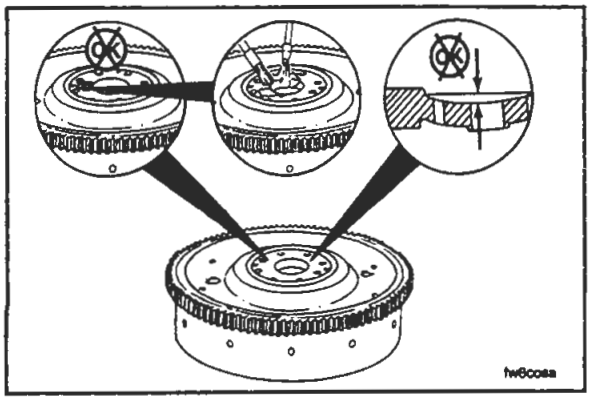


Rotate the crankshaft one complete revolution (360 degrees).

The maximum TIR **must not** exceed 0.127 mm [0.0050 inch].

Note: If the TIR exceeds the specifications:

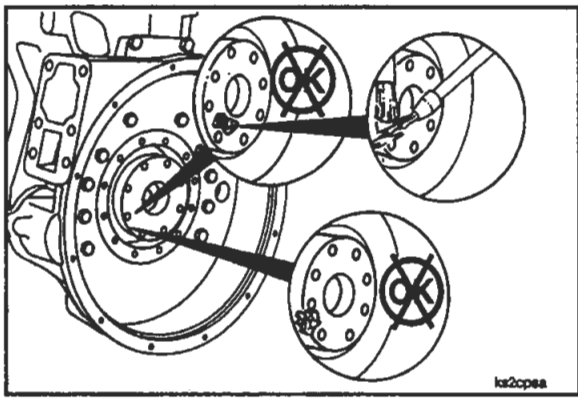
- Remove the flywheel.



- Inspect the flywheel mounting surface for burrs, dirt or damage.
- If burrs cannot be removed with fine crocus cloth or the flywheel is damaged, it **must be** replaced.

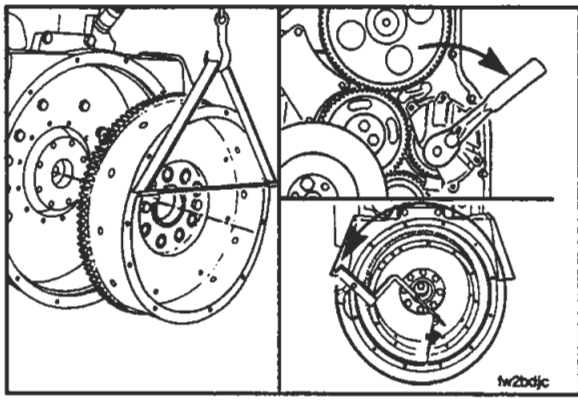
Inspect the crankshaft flange for burrs, dirt or damage.

If burrs cannot be removed with fine crocus cloth or the crankshaft is damaged, it **must be** replaced.

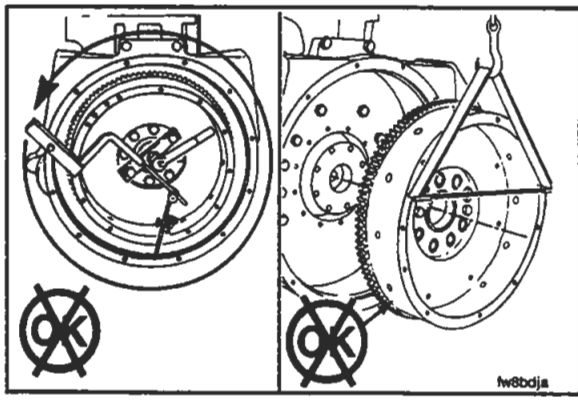


Install the flywheel and tighten the capscrews to the correct torque value.

Measure the bore runout again.



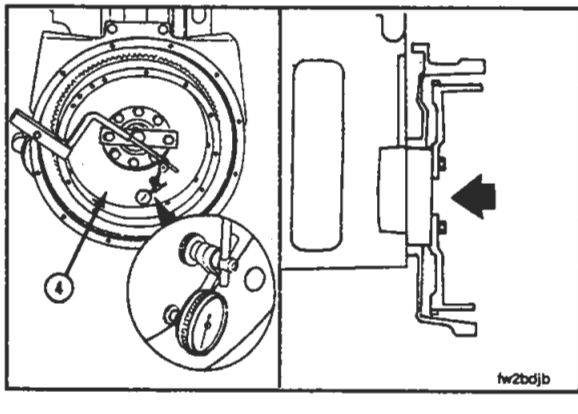
Note: If the TIR still exceeds the specification, the flywheel **must be** replaced.

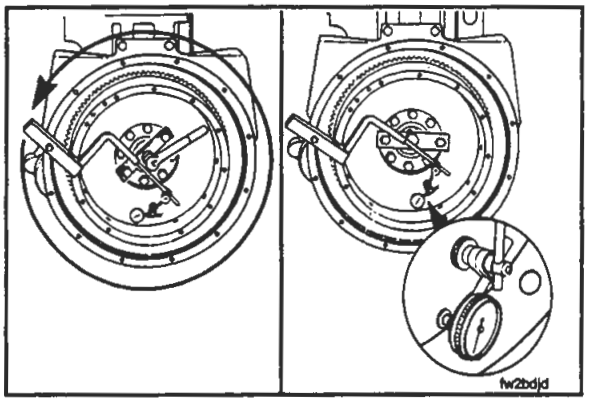


Measure the Flywheel Face Runout

Install the contact tip of the indicator against the flywheel face as close as possible to the outside diameter to measure the face (4) runout.

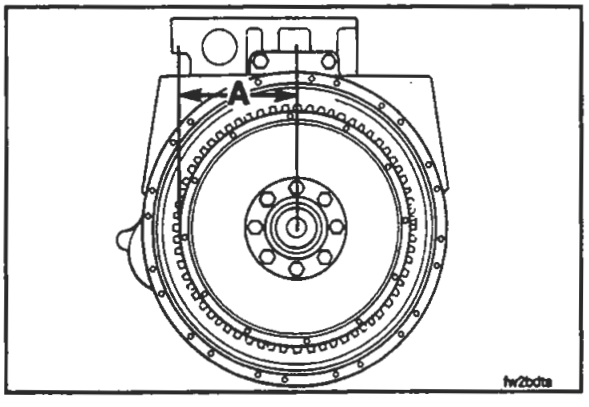
Push the flywheel forward to remove the crankshaft end thrust.





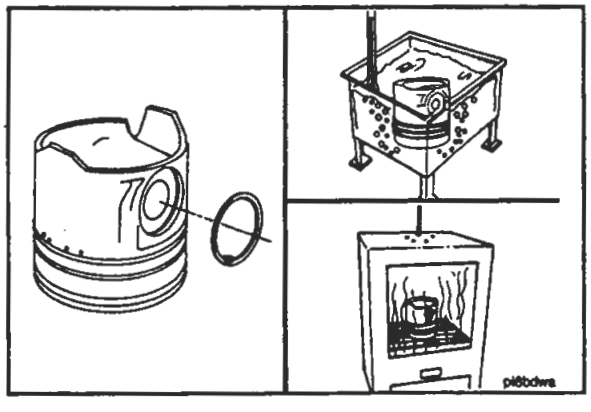
Rotate the crankshaft one complete revolution (360 degrees).

The maximum TIR **must not** exceed the following specifications.



Flywheel Face Runout			
Radius (A)		Maximum TIR	
mm	in	mm	in
203	8	0.203	0.008
254	10	0.254	0.010
305	12	0.305	0.012
356	14	0.356	0.014
406	16	0.406	0.016

Note: If the face runout does not meet these specifications, the flywheel **must be** replaced.

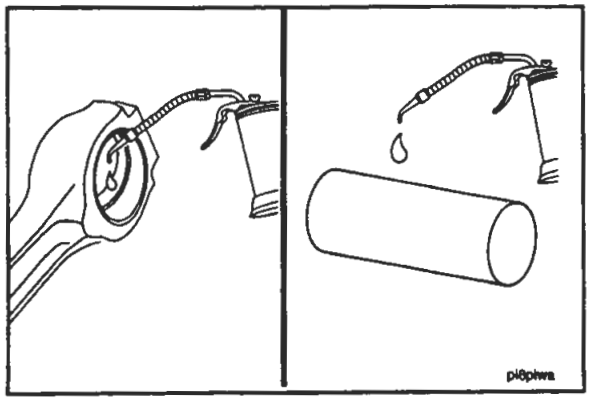


Pistons on the Connecting Rods - Install

Note: The following instructions apply to all six piston and rod assemblies.

Install a new retainer snap ring into the piston pin bore of each piston.

Heat the pistons in boiling water for 15 minutes, or in an oven for 30 minutes at 100°C [212°F].



Use clean 15W-40 oil to coat the connecting rod piston pin bore and the piston pin.

Caution: Do not use a hammer to install the piston pin. This will cause distortion of the piston and the piston to seize in the cylinder liner.

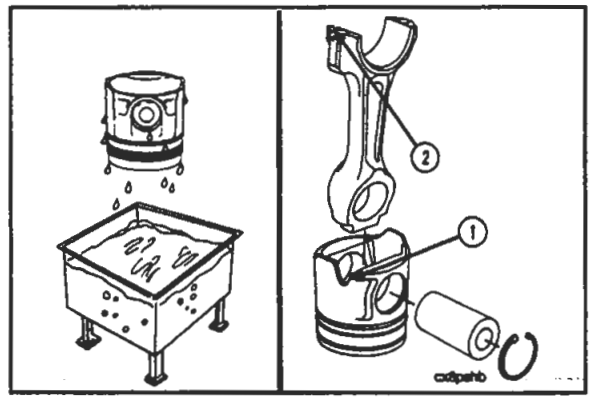
Caution: The notch in the piston skirt (1) must be toward the bearing tang (2) side of the connecting rod to prevent engine damage during engine operation.

Warning: Always wear protective gloves when handling heated parts. Personal injury can result.

Remove the piston from the heated water or oven.

Align the pin bore of the rod with the pin bore of the piston.

Install the piston pin.

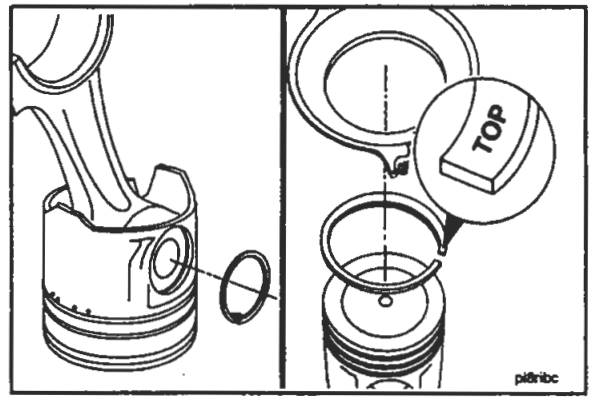


Note: The retainer snap ring **must be** seated completely in the piston pin groove to prevent engine damage during engine operation.

Install a new retainer snap ring into the piston pin bore.

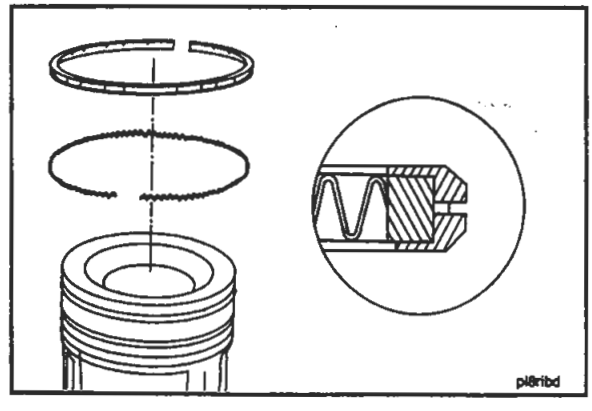
Caution: One side of the piston ring has a mark or the word "TOP". Install the rings with this side toward the top of the piston to make sure the rings function properly during engine operation.

Use the Part No. ST-821 Piston Ring Expander to install the rings on the piston.



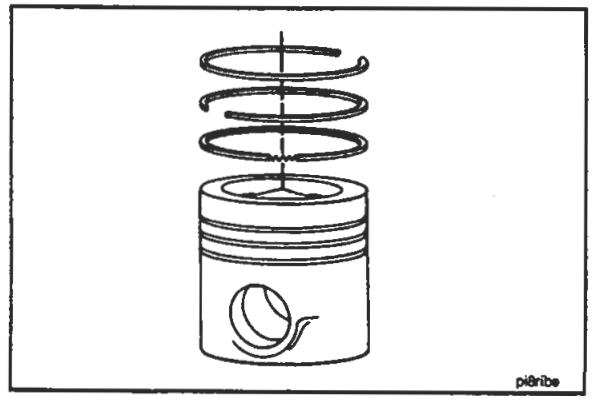
Note: The two-piece oil control ring **must be** installed with the expander ring gap 180 degrees from the gap of the oil ring. **Do not** overlap the ends of the expander ring. These two precautions will prevent an oil ring malfunction during engine operation.

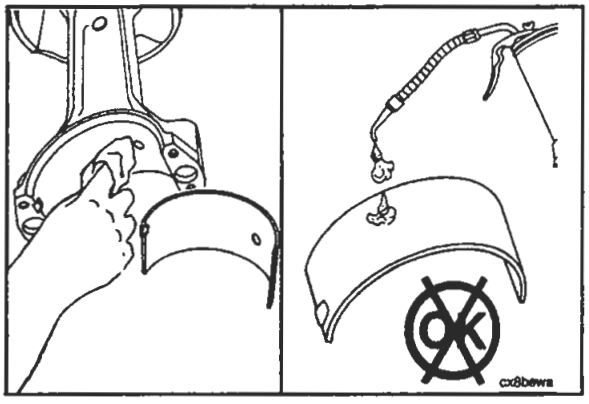
A cross-sectioned view of an oil control ring is shown.



Note: The ring gaps **must not be** aligned with the piston pin bore. If the ring gaps are **not** aligned correctly, the rings will **not** seal properly.

Rotate the rings to position the gaps as shown.

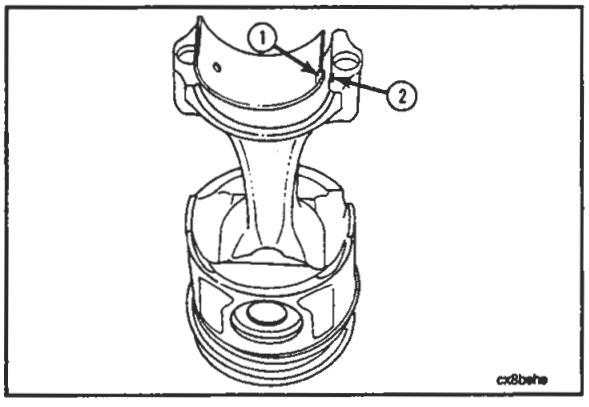




Pistons and Connecting Rods - Install in the Cylinder Block

Use a clean "lint free" cloth to clean the connecting rods and bearing shells.

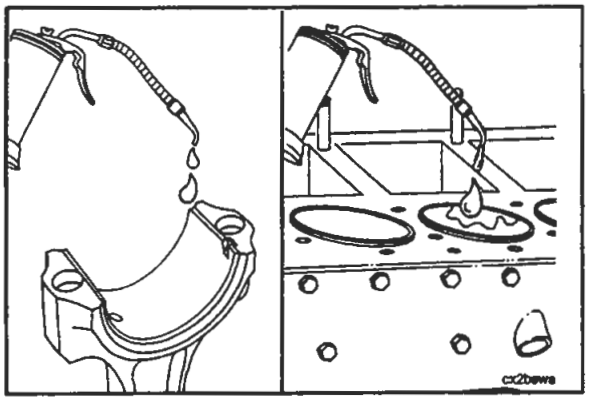
Note: Do not lubricate the back of the bearing shells. The operating clearance of the bearing will be reduced and the bearing can be damaged during engine operation.



Note: If new bearings are **not** used, the used bearings **must be** installed on the same connecting rod they were removed from.

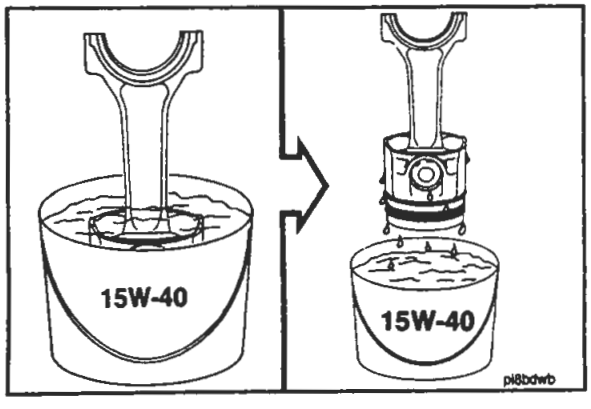
Install the upper bearing shell into the connecting rod.

The tang (1) of the bearing shell **must be** in the slot (2) of the rod. The end of the bearing **must be** even with the cap mounting surface.



Use clean 15W-40 oil to coat the bearing shell.

Apply a heavy film of 15W-40 oil to the cylinder liner.



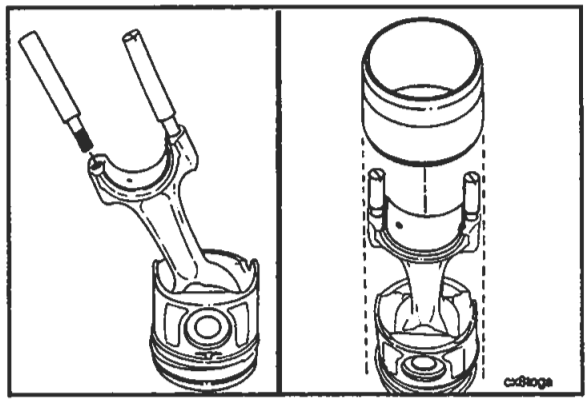
Install the piston and ring assembly into a container of clean 15W-40 oil.

Remove the piston and ring assembly from the container and let the excess oil drain from the piston.

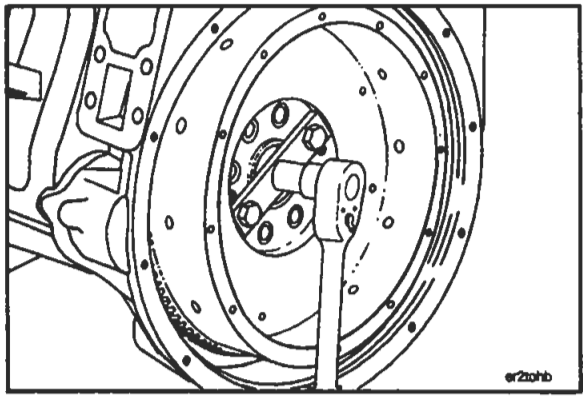
Install the Part No. 3376038 Connecting Rod Guide Pins into the connecting rod.

Note: The piston rings **must be** correctly located in the grooves in the piston to avoid damage to the rings, piston and cylinder liner.

Use the Part No. 3376046 or Part No. 3376877 Piston Ring Compressor to compress the rings.

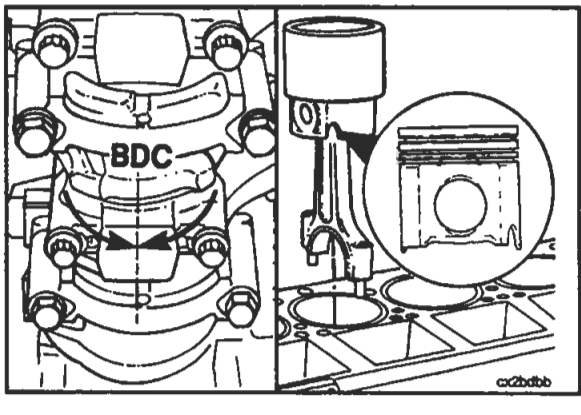


Install the Part No. 3376601 Engine Barring Tool to the flywheel.



Rotate the crankshaft to position the connecting journal for the connecting rod being installed at "BDC".

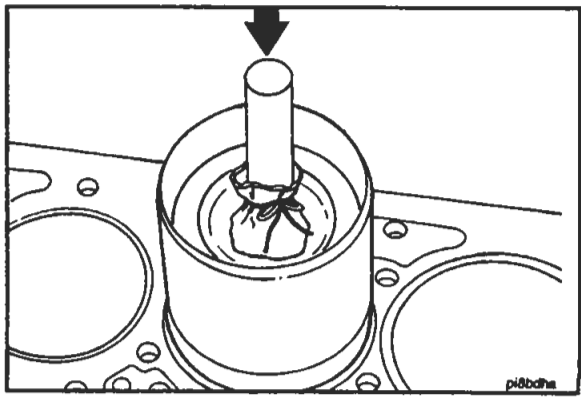
Note: The notch in the piston skirt **must be** toward the camshaft side of the engine to prevent damage to the engine and the piston cooling nozzles during engine operation.

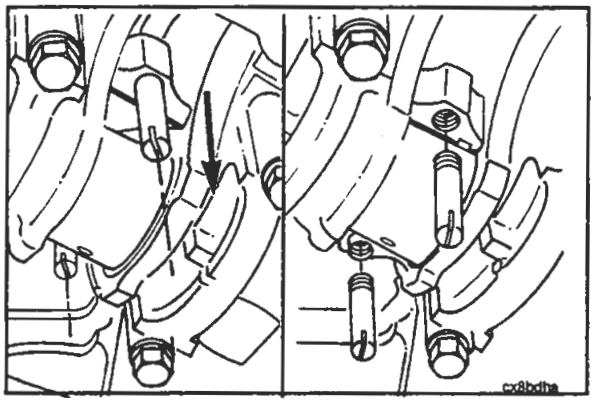


Caution: Do not use a metal object to push the piston into the liner. The piston, rings or cylinder liner can be damaged.

Hold the ring compressor against the cylinder block. Push the piston through the ring compressor and into the cylinder liner. Push the piston until the top ring is completely in the cylinder liner.

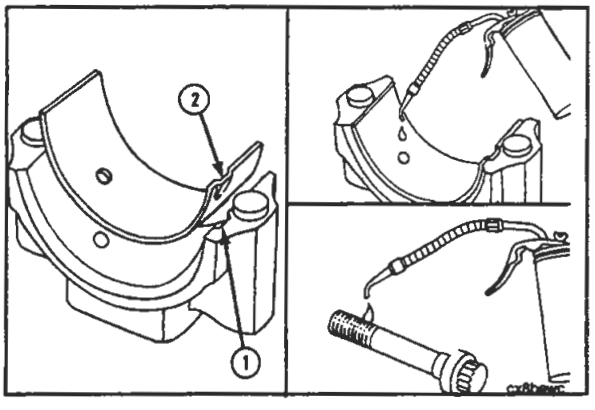
Note: If the piston **does not** move freely, remove the piston and inspect for broken or damaged rings.





Use the nylon guide pins to pull the connecting rod into position against the crankshaft.

Remove the nylon guide pins.

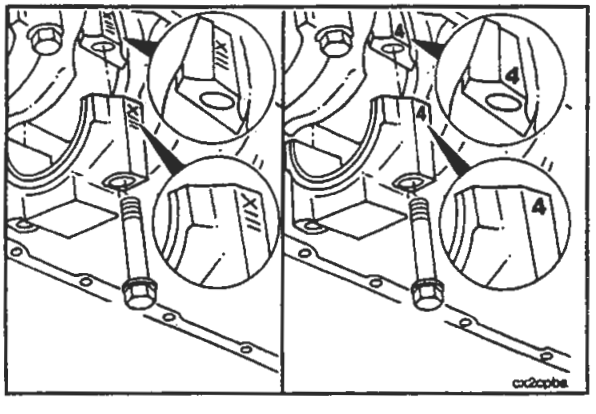


Note: The correct cap **must be** installed to each connecting rod to prevent engine damage during engine operation. The numbers marked on the cap and connecting rod **must be** the same with the slot in the cap and rod on the same side.

Install the bearing in the connecting rod cap.

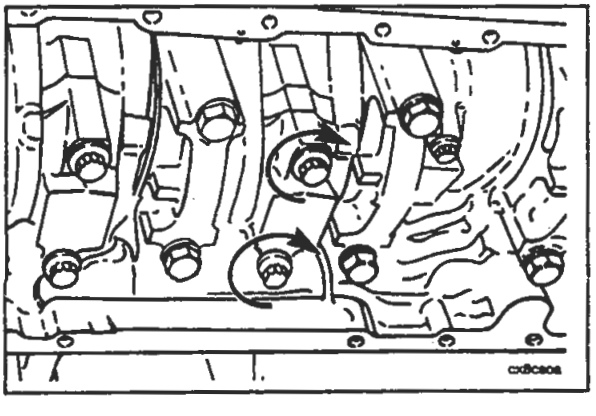
The tang (2) of the bearing **must be** in the slot (1) of the cap.

Use clean 15W-40 oil to coat the bearing shell and the connecting rod capscrews.



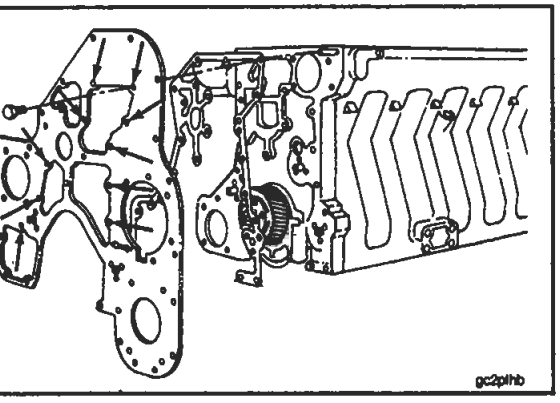
Note: The connecting rod and cap **must** have the same number and **must be** installed in the proper cylinder. The connecting rod cap and rod number **must be** on the same side of the connecting rod to prevent engine damage during engine operation.

Install the connecting rod caps and capscrews.



Complete the following steps to tighten the capscrews in alternating sequence:

Connecting Rod Capscrew Torque Values		
N•m	Step	ft-lb
70	1	50
140	2	105
210	3	155
Loosen	4	Loosen
70	5	50
140	6	105
210	7	155

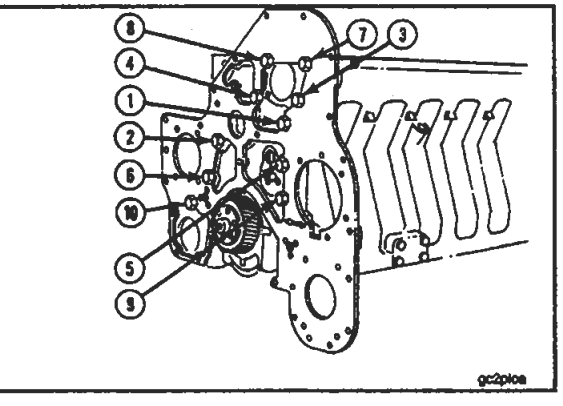


Install the new gasket on the cylinder block.

Note: All the capscrew holes in the gasket **must** align with the capscrew holes in the cylinder block.

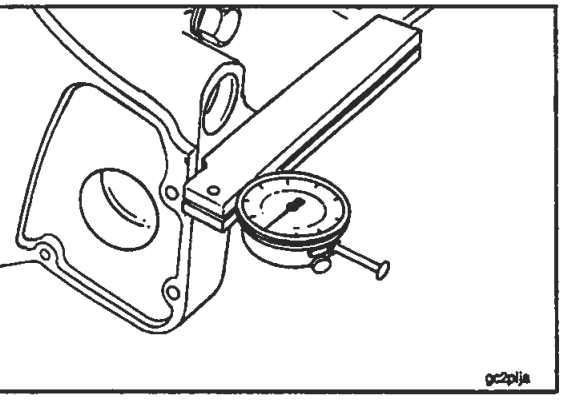
Install the support plate and eight (M10-1.50 X 25) capscrews.

Remove the two guide pins and install the two remaining (M10-1.50 X 25) capscrews.



Tighten the capscrews in a star pattern starting with a capscrew toward the center.

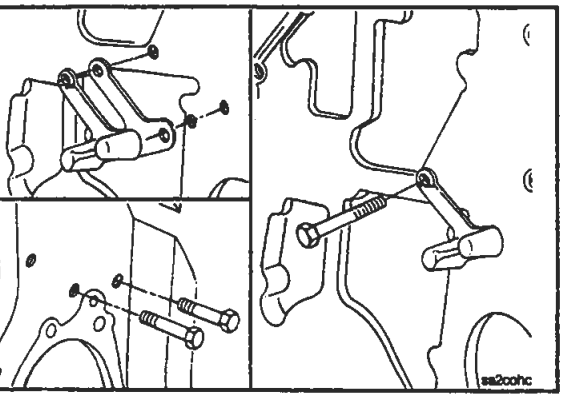
Torque Value:	45 N•m	[35 ft-lb]	Grade 8.8 capscrews
Torque Value:	65 N•m	[50 ft-lb]	Grade 10.9 capscrews



Measure the support plate protrusion below the cylinder block oil pan rail.

The maximum allowable protrusion is 0.15 mm [0.006 inch].

If the protrusion is greater than the maximum allowable, loosen the support plate capscrews and use a non-metallic hammer to adjust the support plate to the required specifications. Tighten the capscrews again.



Accessory Drive Oil Transfer Connection - Install

Install a new gasket and the transfer connection on the gear support plate.

Install the two (M8-1.50 X 20) capscrews through the back of the support plate and into the transfer connection.

Torque Value: 16 N•m [144 in-lb]

Install the one remaining (M10-1.50 X 30) capscrew into the transfer connection at the front of the support plate.

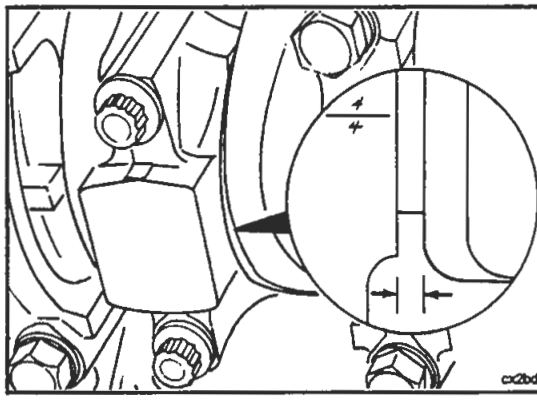
Torque Value: 45 N•m [35 ft-lb]

Measure Connecting Rod Side Clearance

Use a feeler gauge to measure the connecting rod side clearance.

Connecting Rod Side Clearance		
mm		in
0.10	MIN	0.004
0.30	MAX	0.012

The rod **must** move freely from side-to-side.



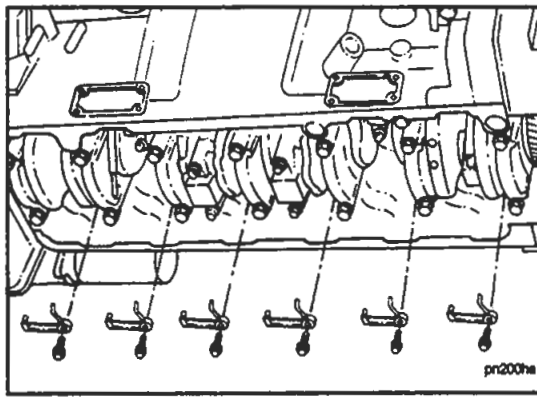
Piston Cooling Nozzles - Install

Note: The piston and connecting rod assemblies **must be** installed before the piston cooling nozzles are installed.

Rotate the crankshaft to position the connecting rod journal toward the exhaust side of the engine.

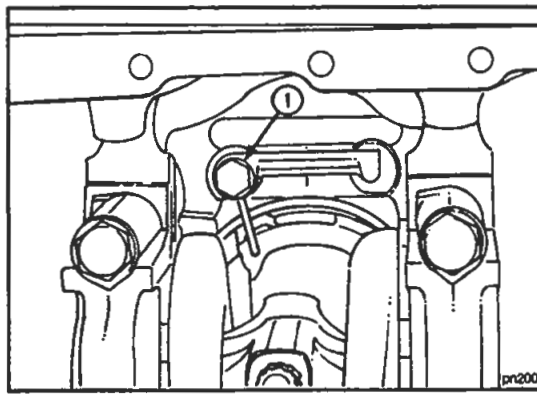
Install the nozzles, washers, and the special capscrews.

Torque Value: 27 N•m [18 ft-lb]



The nozzle **must** be in alignment with the center of the notch in the piston skirt (1).

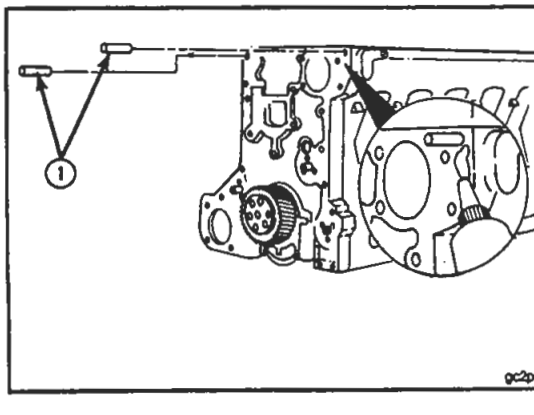
Note: Rotate the crankshaft to be sure the pistons do not hit the nozzles. If the pistons hit the nozzles, the nozzles and engine will be damaged during engine operation.

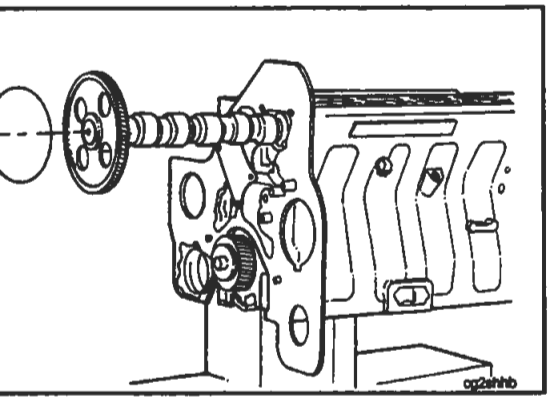


Gear Support Plate - Install

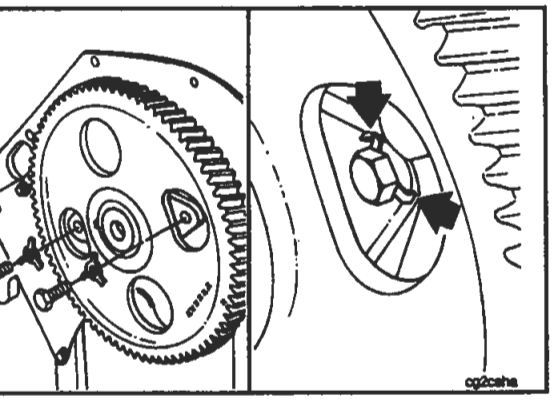
Install two Part No. 3376488 Guide Pins (1) into the cylinder block.

Apply a light coat of grease to the gasket mounting surface to hold the gasket in place.





Rotate the camshaft slowly as it is being installed into the cylinder block.



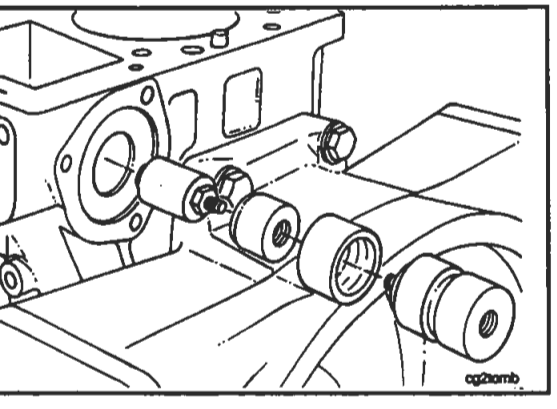
Rotate the camshaft to align the holes in the camshaft gear with the thrust plate capscrew holes in the cylinder block.

Align the capscrew holes in the thrust plate with the cylinder block capscrew holes.

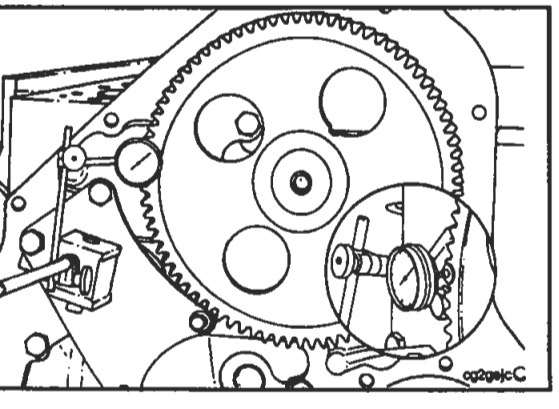
Install the lockplates and two (M10-1.50 X 25) capscrews.

Torque Value: 45 N•m [35 ft-lb]

Bend one tang of the lockplate down over the thrust plate and one tang up against the capscrew.



Remove the camshaft pilot.



Use a dial indicator gauge and a magnetic base to measure the camshaft end clearance.

Place the contact tip of the gauge against the face of the gear.

Camshaft End Clearance

mm		In
0.13	MIN	0.005
0.33	MAX	0.013

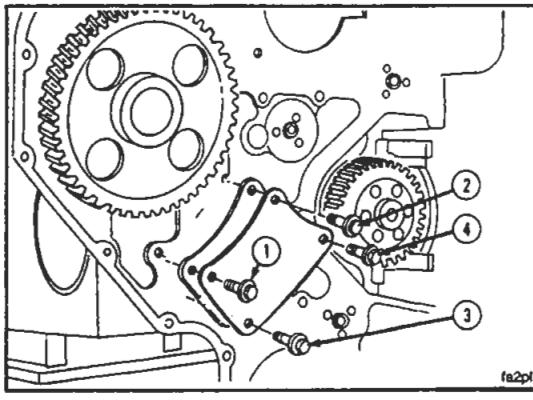
Cover Plate for the Belt Driven Fan Drive (Early Production Style Gear Support Plate) - Install

Install a new gasket and the cover plate on the gear support plate.

Install two (M10-1.50 X 30) 12 point capscrews (1) and (2) and two (M10-1.50 X 25) hexagon head capscrews (3) and (4).

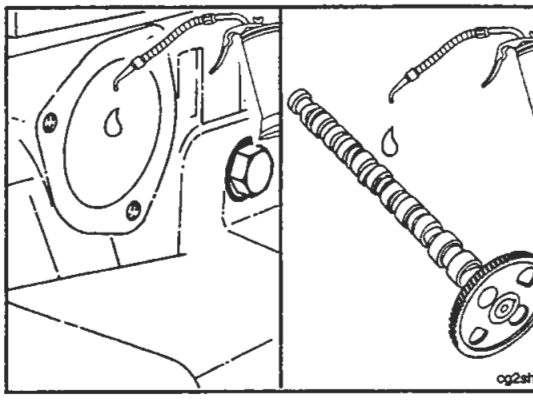
Torque Value: 45 N•m [35 ft-lb]

Note: Present production style gear support plates use a cup plug installed in the support plate if the belt driven fan is used. A cover plate is **not** necessary.



Camshaft and Gear Assembly - Install

Use clean 15W-40 oil to coat the camshaft bushings and camshaft.

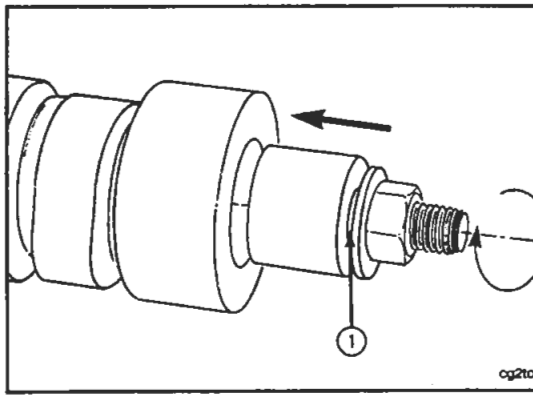


Install the Part No. 3376388 Camshaft Installation Pilot.

- Install the expander (1).

Note: The Part No. 3376876 Expander is used for **hollow** camshafts and the Part No. 3376923 Expander is used for **solid** camshafts.

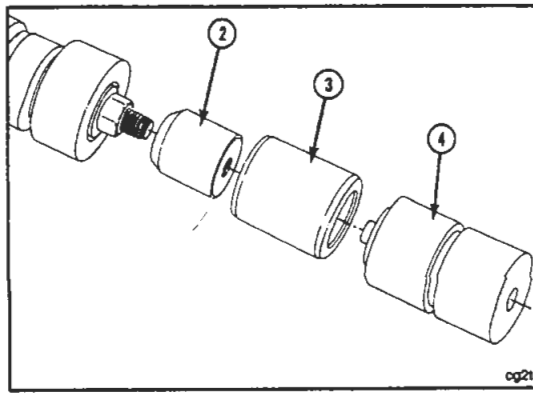
- Turn the nut to expand the swell plug.



- Install the alignment arbor (2) to the swell plug.

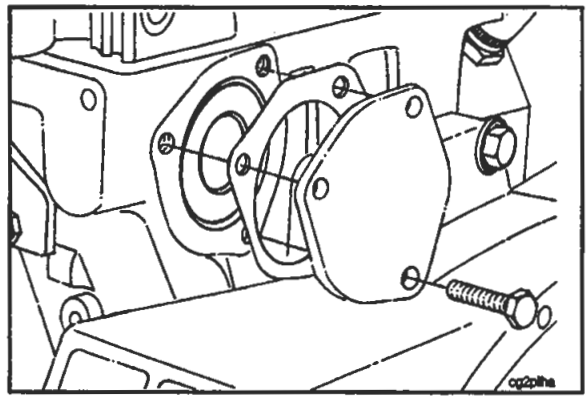
Note: The beveled edge **must** face the cylinder block.

- Install the arbor sleeve (3) over the swell plug and alignment arbor.
- Install the locating pilot extensions (4) to the alignment arbor.



Install a new gasket, the rear cover plate and the three (M10-1.50 X 15) capscrews.

Torque Value: 45 N•m [35 ft-lb]



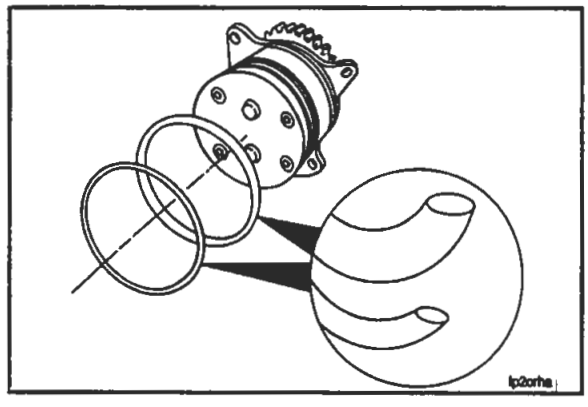
Lubricating Oil Pump - Install

If the lube pump body is coated with lubrite, use Scotch-Brite to remove the lubrite from the block side of the mounting flange.

NOTE: Do not lubricate the two oil pump body o-rings. The o-rings will swell and the pump **cannot** be installed.

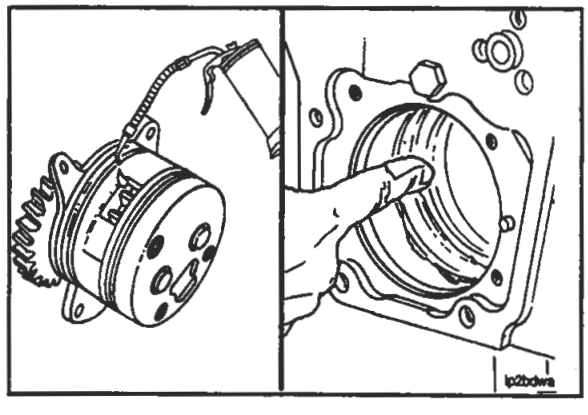
Install two new o-rings on the oil pump body.

Install the thickest o-ring into the groove nearest to the oil pump drive gear.



Use clean 15W-40 oil to lubricate the oil pump gears.

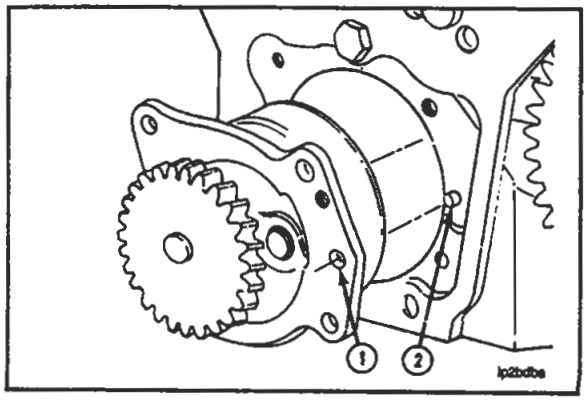
Apply a film of grease to the oil pump bore in the cylinder block.

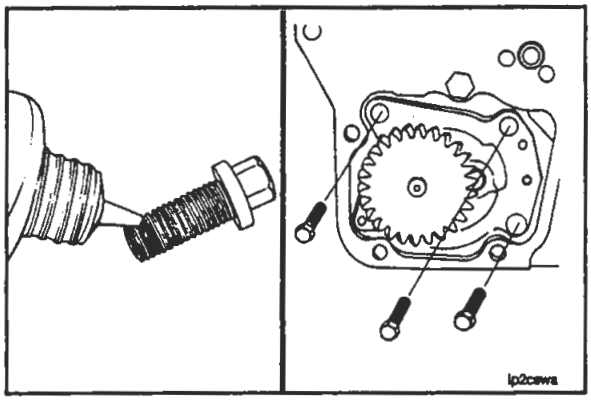


Caution: The dowel pin bore in the oil pump flange (1) must be aligned with the dowel pin (2) in the cylinder block to prevent damage to the oil pump flange during installation.

Caution: Do not use the mounting capscrews to pull the oil pump into the bore. This can damage the mounting flange of the oil pump.

Install the oil pump by hand.





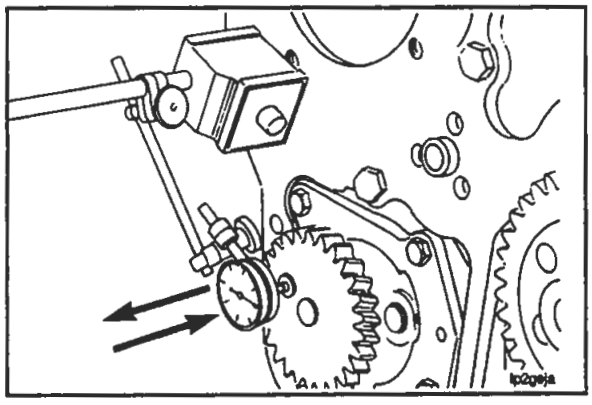
Sealant **must** be used on the capscrew threads to prevent air from being drawn past the capscrews during engine operation.

NOTE: Three M8-1.25 X 25 flangehead capscrews, grade 10.9, are required for mounting the lube pump. If the capscrews are not new with preapplied loctite, the threads **must** be cleaned and loctite 272, or equivalent, **must** be applied.

Install and tighten the three capscrews.

Torque Value: 35 N•m [25 ft-lb]

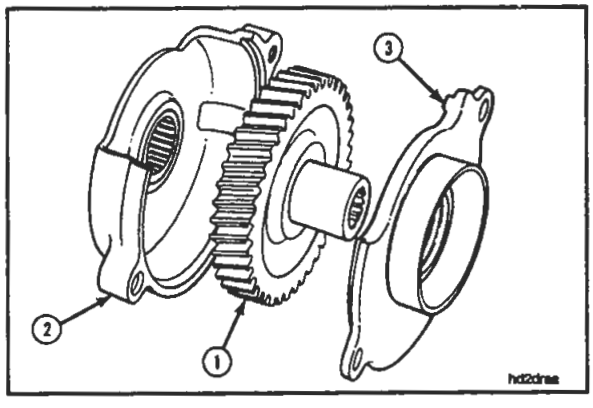
NOTE: This torque value is for capscrews 10.9 grade or higher.



Use a dial indicator gauge and a magnetic base to measure the oil pump gear end clearance.

Place the contact tip of the gauge against the face of the oil pump drive gear.

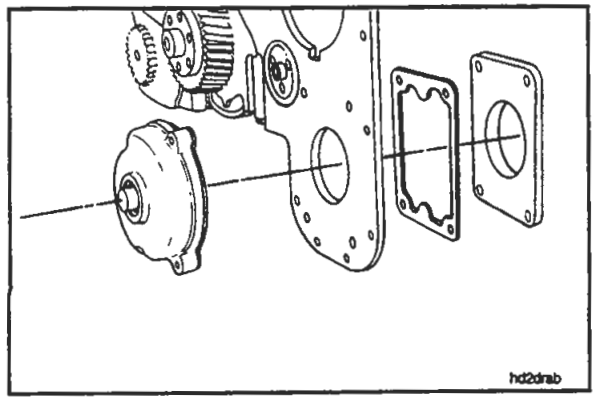
Lubricating Oil Pump Gear End Clearance		
mm		In
0.064	MIN	0.0025
0.270	MAX	0.0106



Hydraulic Pump Drive - Install

Install the hydraulic pump gear (1) to the front support (2).

Install the front support and gear to the rear support (3).



Install the drive assembly into the gear support plate.

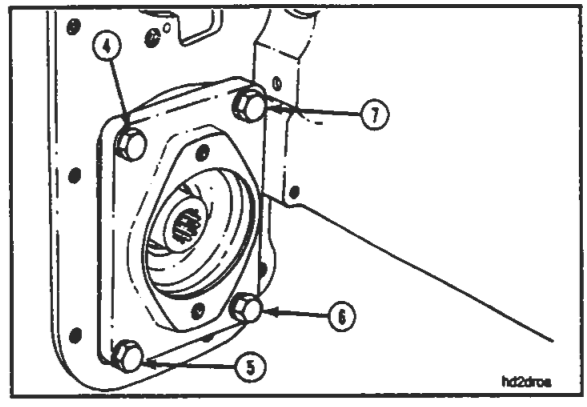
Install a new gasket and the hydraulic pump adapter plate to the back of the gear support plate.

Install three (M10-1.50 X 50) capscrews and new aluminum sealing washers at points (4), (5) and (6).

Install one (M10-1.50 X 25) capscrew and a new aluminum sealing washer at point (7).

Torque Value: 45 N•m [35 ft-lb]

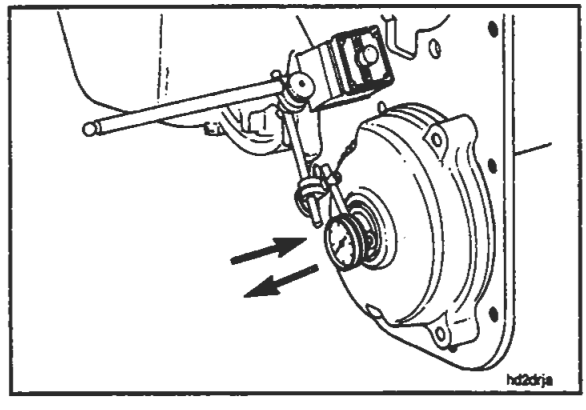
Note: The aluminum sealing washers **must be** replaced when removed.



Use a dial indicator gauge with a magnetic base to measure the drive gear end clearance.

Place the contact tip of the gauge against the end of the gear shaft.

Hydraulic Pump Drive Gear End Clearance		
mm		in
0.076	MIN	0.003
0.635	MAX	0.025



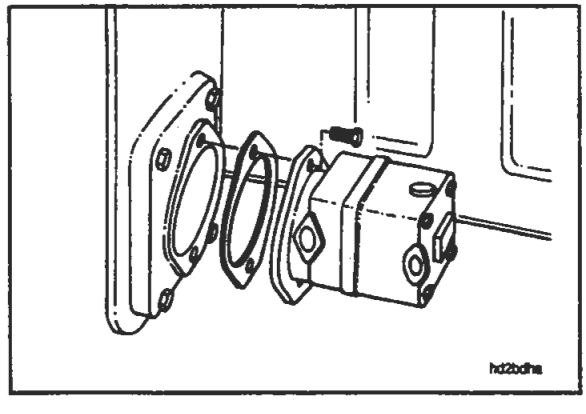
Hydraulic Pump (If Equipped) - Install

Install a new gasket on the drive flange.

Note: To determine the correct hydraulic pump to use, count the number of teeth on the splined drive gear.

Install two (M10-1.50 X 30) capscrews.

Torque Value: 45 N•m [35 ft-lb]



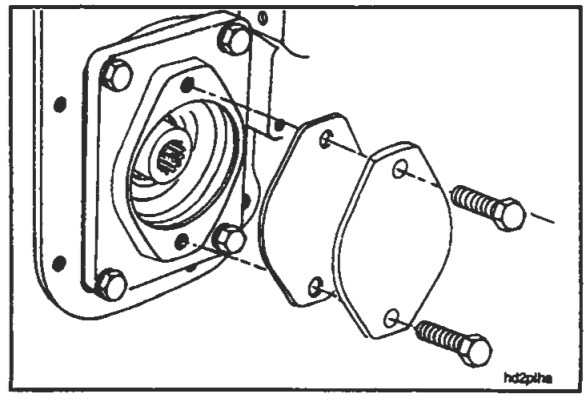
Hydraulic Pump Drive Cover Plate (If Equipped) - Install

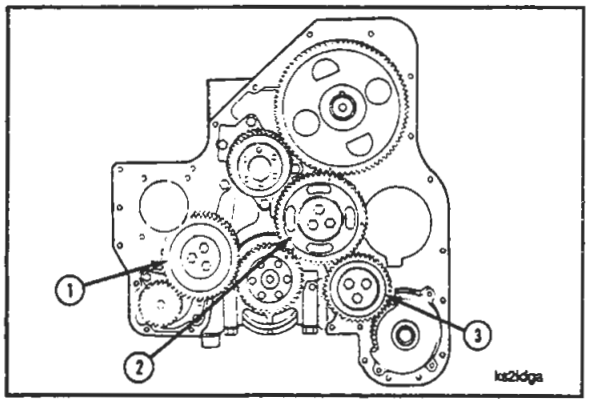
Note: The cover plate is used when the hydraulic pump is **not** installed.

Install a new gasket to the hydraulic pump adapter.

Use two (M10-1.50 X 20) capscrews to install the cover plate to the hydraulic pump adapter.

Torque Value: 25 N•m [20 ft-lb]

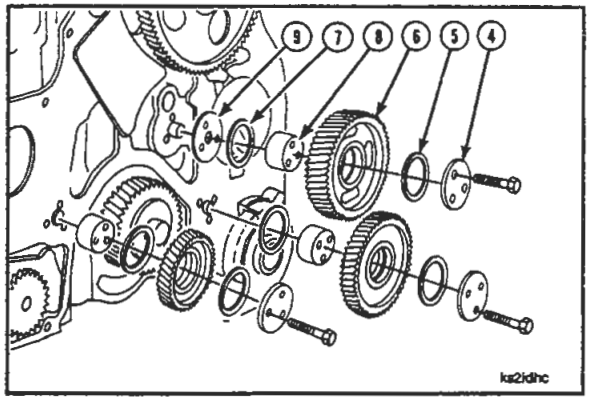




Idler Gear Assemblies - Install

Three idler gear assemblies are used:

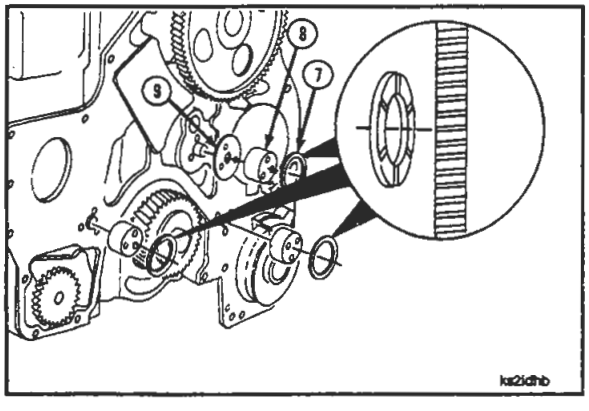
- Oil pump idler gear (1)
- Camshaft idler gear (2)
- Hydraulic pump idler gear (3)



Each idler gear assembly consist of:

- Three capscrews
- Cover plate (4)
- Front thrust bearing (5)
- Idler gear (6)
- Rear thrust bearing (7)
- Idler gear shaft (8)

Note: The camshaft idler gear assembly includes a wear plate (9).

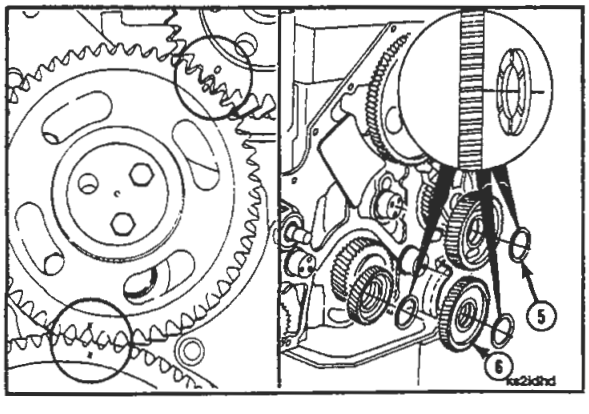


Install the camshaft idler gear wear plate (9).

Caution: The grooved side of the rear thrust bearing must be facing toward the gear to prevent damage to the gear and engine during engine operation.

Install the idler gear shafts (8) and rear thrust bearings (7).

Note: If S.A.E. "B" hydraulic pump is used, the letters "HYD" are stamped on the hydraulic idler gear shaft. Make sure the correct shaft is installed in the proper location.



Caution: The grooved side of the front thrust bearing must be facing toward the gear to prevent damage to the gear and engine during engine operation.

Note: The timing marks on the camshaft idler gear **must** align with the timing marks on the crankshaft and camshaft gears to make sure the engine timing is set correctly.

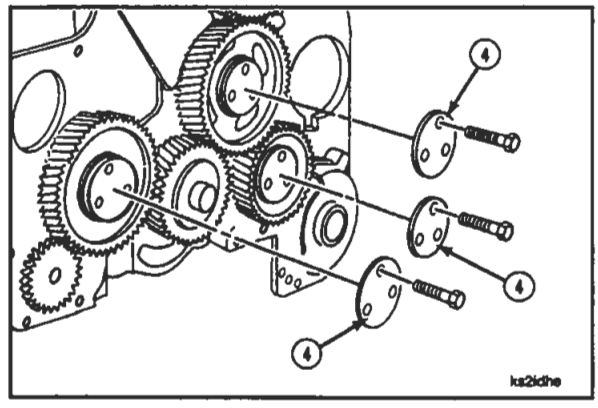
Install the idler gears (6) and front thrust bearings (5).

NOTE: Some models have 10.9 grade capscrews and some have 12.9 grade capscrews.

Install the cover plates (4) and the three (M10-1.50 X 60) capscrews.

Torque Value:

12.9 Grade	60 N•m	[45 ft-lb] plus 60 degrees
10.9 Grade	65 N•m	[50 ft-lb]

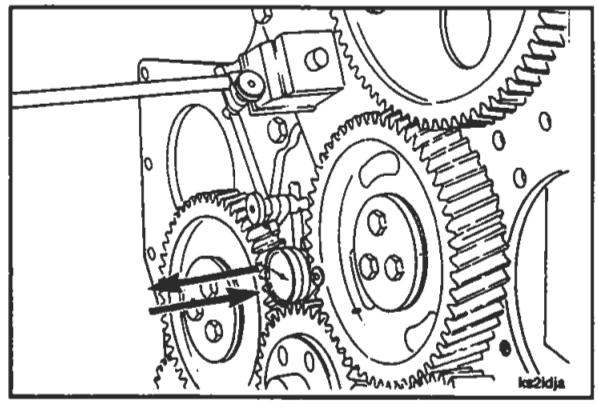


Use a dial indicator gauge with a magnetic base to measure the idler gear end clearance.

Place the contact tip of the gauge against the face of the idler gear.

Idler Gear End Clearance

mm		in
0.30	MIN	0.012
0.53	MAX	0.021



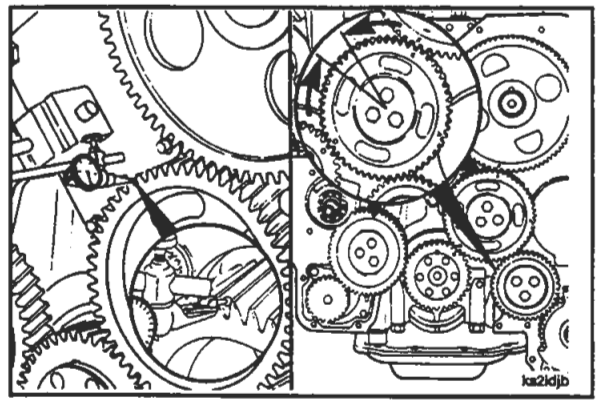
Use a dial indicator gauge with a magnetic base to measure the idler gear backlash.

Place the contact tip of the gauge against a tooth on the idler gear.

NOTE: Do not allow the mating gears to move while measuring the backlash.

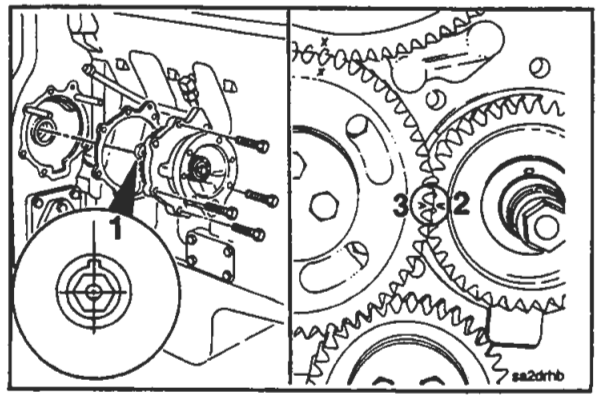
Idler Gear Backlash

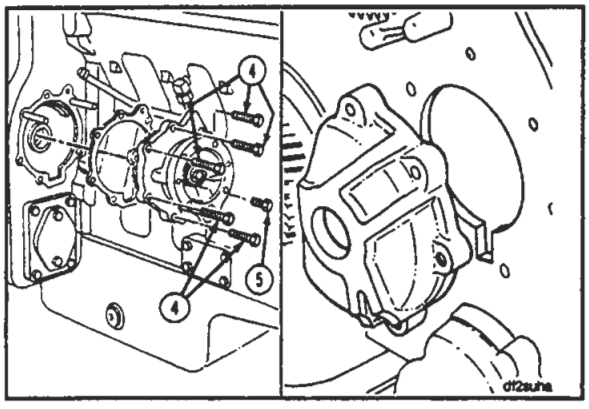
mm		in
0.08	MIN	0.003
0.41	MAX	0.016



Accessory Drive Assembly - Install

NOTE: The accessory drive shaft dowel pin (1) **must be** at the 12:00 o'clock position when the accessory drive is installed. The timing mark on the accessory drive gear (2) **must** align with the timing mark on the camshaft idler gear (3). Check the position of the dowel pin and gear timing mark before the capscrews are tightened.



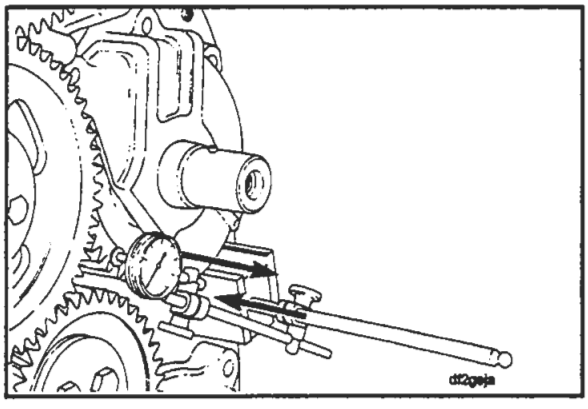


Use a new gasket and install the accessory drive assembly.

Install the front support on the accessory drive shaft.

Use five (M10-1.50 X 50) capscrews (4), one (M10-1.50 X 30) capscrew (5) and new sealing washers to install the assembly.

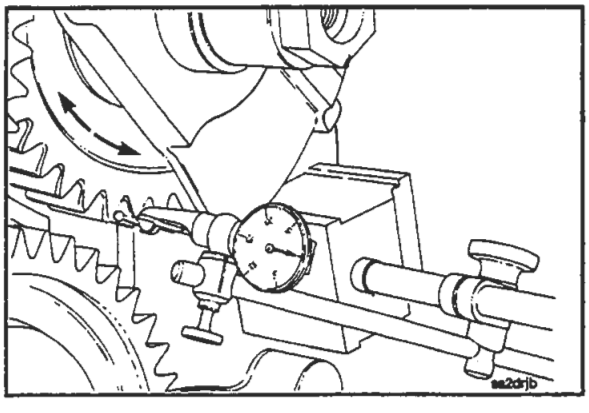
Torque Value: 45 N•m [35 ft-lb]



Use a dial indicator gauge and a magnetic base to measure the drive gear end clearance.

Place the contact tip of the gauge against the face of the accessory drive gear.

Accessory Drive Gear End Clearance		
mm		in
0.10	MIN	0.004
0.30	MAX	0.012

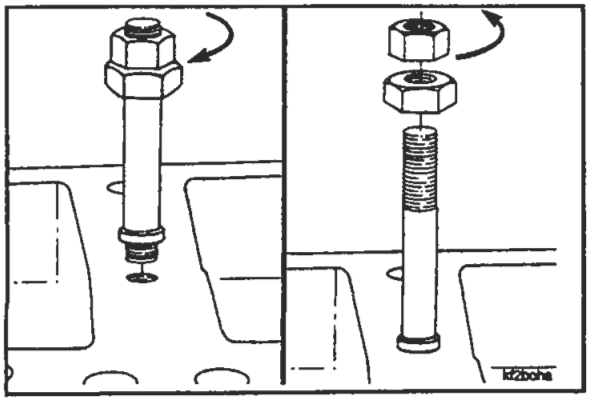


Use a dial indicator gauge with a magnetic base to measure the drive gear backlash.

Place the contact tip of the gauge against a tooth of the accessory drive gear.

NOTE: Do not allow the mating gear to rotate while measuring the backlash.

Accessory Drive Gear Backlash		
mm		in
0.08	MIN	0.003
0.41	MAX	0.016



Cam Follower Assemblies - Install

NOTE: The dowel pins **must be** installed into the cylinder block for the number one, four and seven cam follower supports.

Install the seven cam follower studs with two (M10 X 1.5) nuts tightened together.

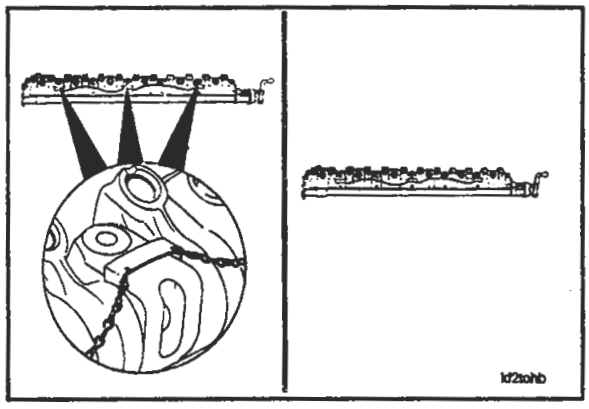
Torque Value: 35 N•m [25 ft-lb]

Remove the two nuts after the studs are installed and tightened.

Install With Service Tools

Install the Part No. 3376639 Shim Assembly over the numbers two, four and six supports.

Install the Part No. 3376645 Cam Follower Clamping Fixture.

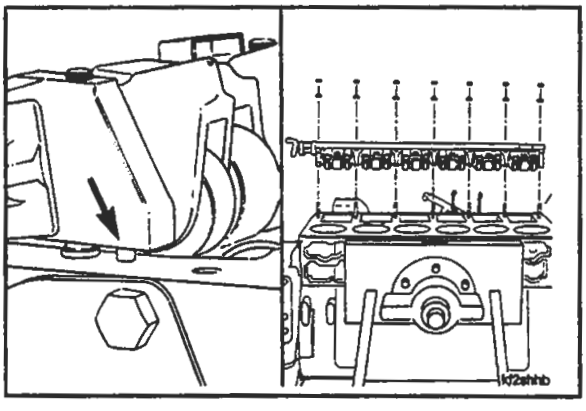


Note: The dowel holes in the supports **must** align with the dowel pins in the cylinder block.

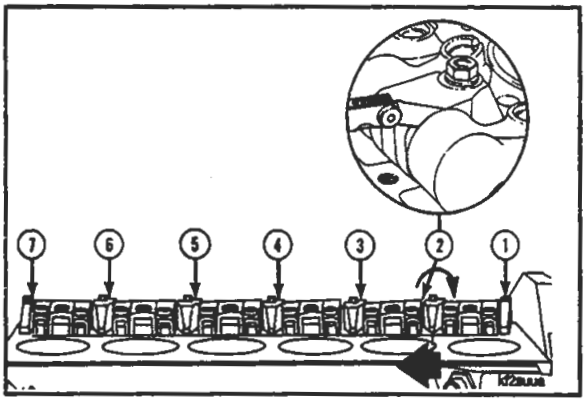
Install the cam follower assemblies on the studs.

Install the washers and (M10 X 1.5) nuts on each stud.

Torque Value: 45 N•m [35 ft-lb]



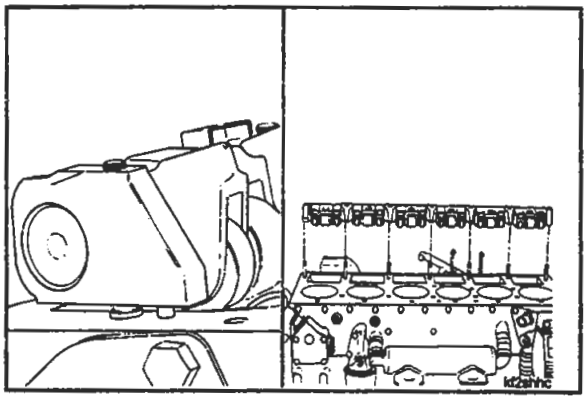
Measure the side clearance of the levers. The total minimum clearance between each support **must be** 0.76 mm [0.030 inch].

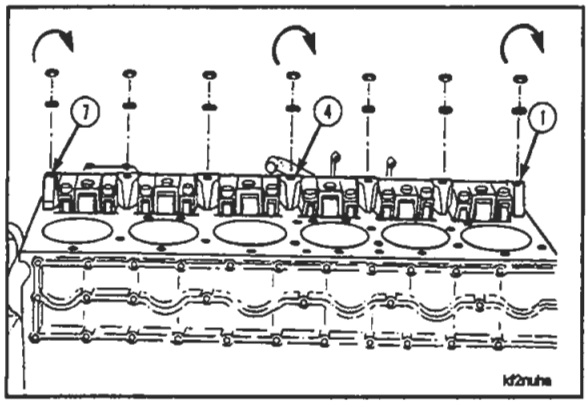


Install Without Service Tools

Note: The supports **must** align with the dowel pins in the cylinder block.

Install the two cam follower assemblies separately on the studs and dowel pins.

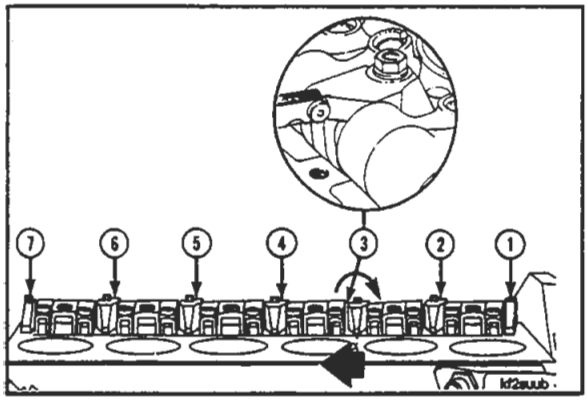




Install the washers and (M10 X 1.5) nuts on each stud.

Tighten the numbers **one, four** and **seven** support nuts.

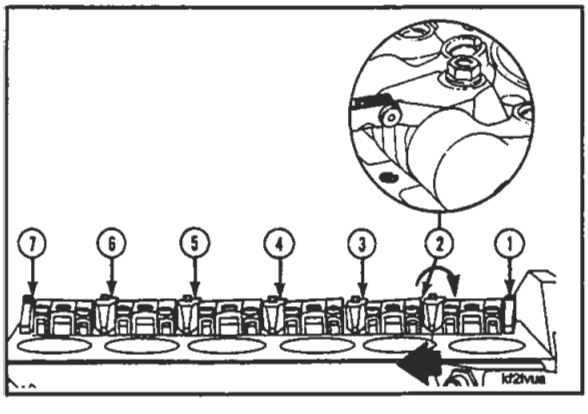
Torque Value: 45 N•m [35 ft-lb]



Install a 0.76 mm [0.030 inch] feeler gauge between the lever and the number three support. Push the number three support toward the number four support.

Tighten the number **three** support nut.

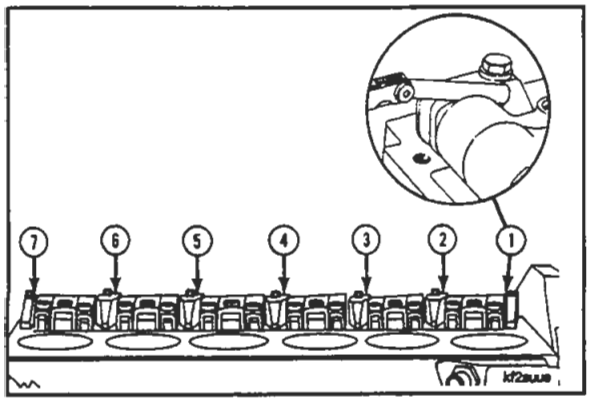
Torque Value: 45 N•m [35 ft-lb]



Install a 0.76 mm [0.030 inch] feeler gauge between the lever and the number two support. Push the number two support toward the number three support.

Tighten the number **two** support nut.

Torque Value: 45 N•m [35 ft-lb]

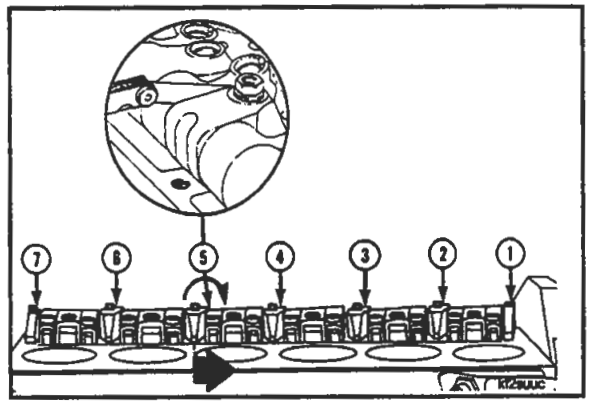


Measure the side clearance between the number one and two supports. The clearance **must be** 0.76 mm [0.030 inch] minimum.

Install the 0.76 mm [0.030 inch] feeler gauge between the lever and the number five support. Push the number five support toward the number four support.

Tighten the number **five** support nut.

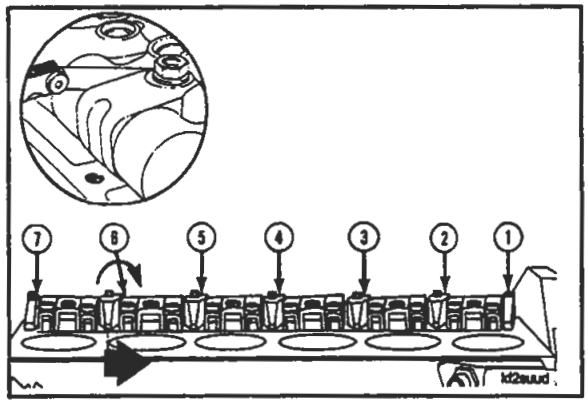
Torque Value: 45 N•m [35 ft-lb]



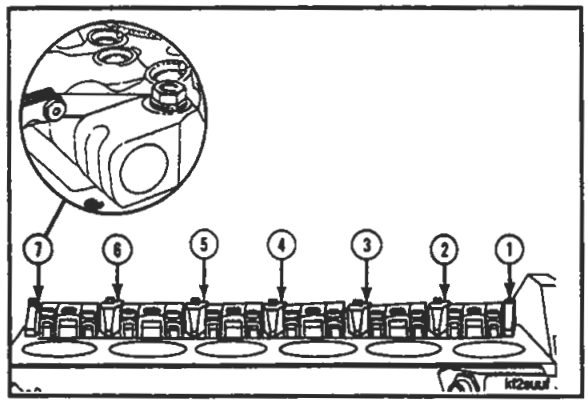
Install the 0.76 mm [0.030 inch] feeler gauge between the lever and the number six support. Push the number six support toward the number five support.

Tighten the number **six** support nut.

Torque Value: 45 N•m [35 ft-lb]



Measure the side clearance between the number six and seven supports. The clearance **must be** 0.76 mm [0.030 inch] minimum.

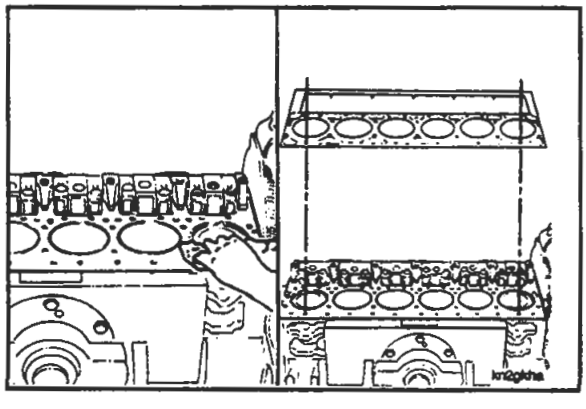


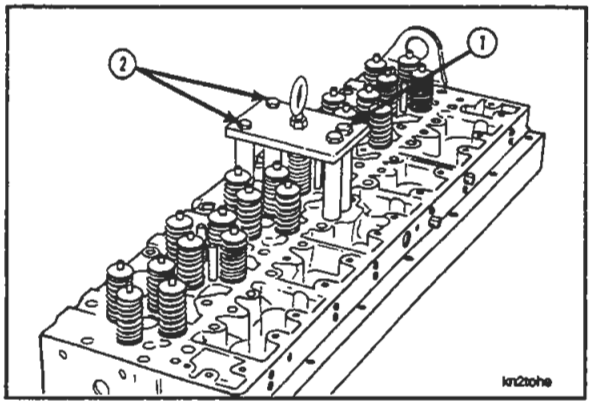
Cylinder Head - Install

Use a "lint-free" cloth to clean and dry the cylinder head surfaces.

Install a new cylinder head gasket on the dowel pins in the cylinder block.

Note: The gasket can be installed with either side up.

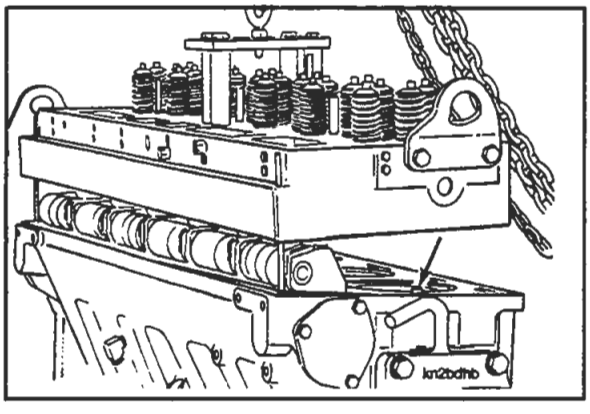




Install the Part No. 3822479 Cylinder Head Lifting Bracket on the center of the cylinder head.

Note: If the capscrews are not available from the kit, install two (M14-2.00 X 135) rocker lever support capscrews (1) and two (M10-1.50 X 125) rocker lever housing capscrews (2).

Torque Value: 45 N•m [35 ft-lb]

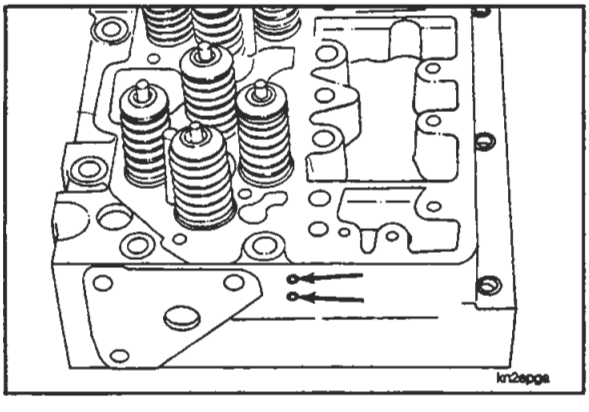


The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

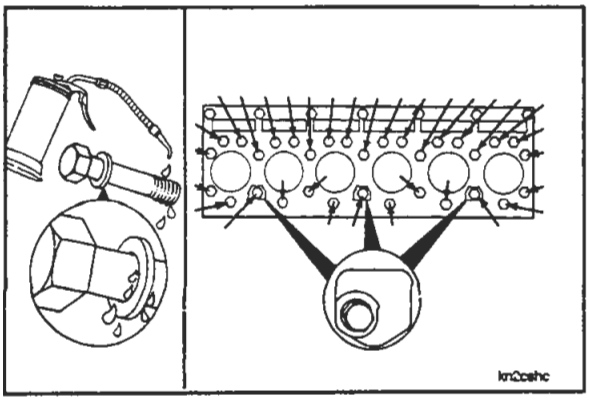
Note: The dowels holes in the cylinder head **must** align with the dowels pins in the cylinder block.

Caution: Do not drop the cylinder head on the cylinder head gasket, the gasket material can be damaged.

Use a hoist or hydraulic arm to lift the cylinder head to the cylinder block.



Note: The pipe plugs in the front end of the cylinder head **must be** even with or below the surface of the cylinder head.



Use clean 15W-40 oil to coat the cylinder head capscrews and both sides of the flat washers.

Allow the excess oil to drain from the capscrew threads.

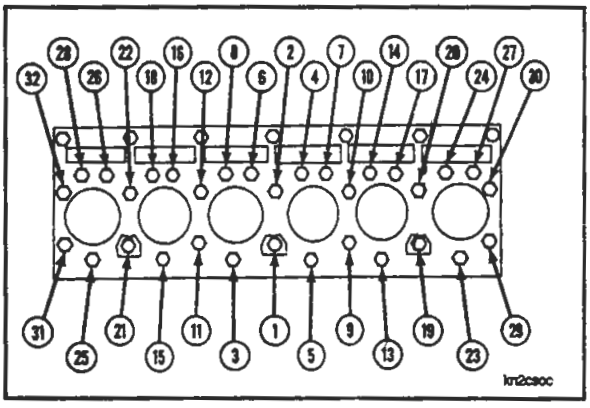
Note: Make sure to install the three (M14-1.50 X 75) capscrews into the intake ports.

Install the 32 capscrews into the cylinder head.

Note: Use 29 (M14-1.50 X 140) capscrews and three (M14-1.50 X 75) capscrews.

Complete the following steps to tighten the capscrews in the sequence shown:

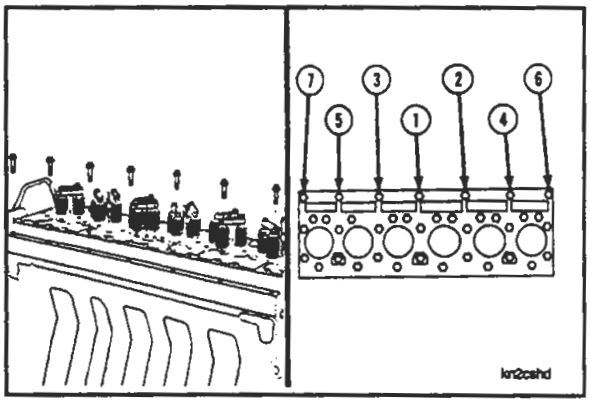
Cylinder Head Capscrew Torque Values		
N•m	Step	ft-lb
100	1	75
175	2	125
235	3	175
Loosen	4	Loosen
100	5	75
175	6	125
235	7	175



Use new aluminum sealing washers and install the seven (M10-1.50 X 75) 12 point capscrews on the fuel pump side of the cylinder head.

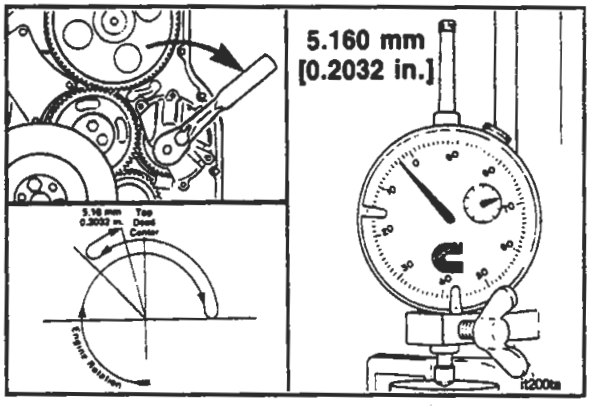
Tighten the capscrews, in the sequence shown.

Torque Value: 45 N•m [35 ft-lb]

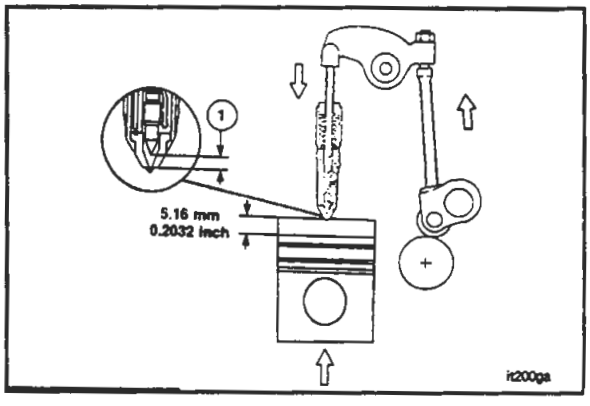


Injection Timing - General Information

The injection timing **must be** correct to achieve the best performance, fuel economy and lowest emissions. The injection timing **must be** checked when the engine is rebuilt and when a component of the gear train is replaced or removed and installed again.

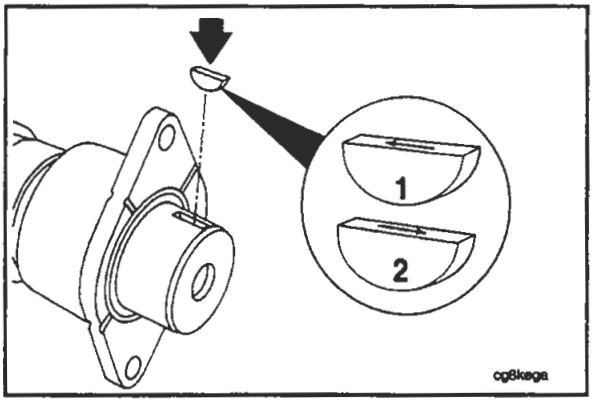


Injection timing refers to injecting fuel in the combustion chamber at the correct time during the compression stroke. The timing **must be** checked when the piston is on the compression stroke at 5.160 mm [0.2032 inch] Before Top Dead Center. When the piston is at this position, measure the amount of travel left in the injector push rod with the Part No. 3375522 Injector Timing Tool. The amount of push rod travel establishes the amount of injector plunger travel in the injector (1).



Timing Code	Push Rod Travel @ 5.161 mm [0.2032 in.] BTDC Piston Travel Position
CX	1.98 - 2.08 mm [0.078 - 0.082 inch]
CY	1.85 - 1.96 mm [0.073 - 0.077 inch]
FC	2.11 - 2.21 mm [0.083 - 0.087 inch]
FJ	2.03 - 2.13 mm [0.080 - 0.084 inch]
FN	2.36 - 2.46 mm [0.093 - 0.097 inch]
FO	2.44 - 2.79 mm [0.096 - 0.100 inch]
FS	2.24 - 2.34 mm [0.088 - 0.092 inch] it200gc

To verify the correct injection timing for a particular engine, check the Control Parts List (CPL) number on the engine dataplate, then refer to the CPL Bulletin No. 3379133. Timing codes are listed as two letter alpha characters, for example, a "CX" code indicates a nominal setting of -2.032 mm [-0.080 inch]. Refer to the accompanying chart.



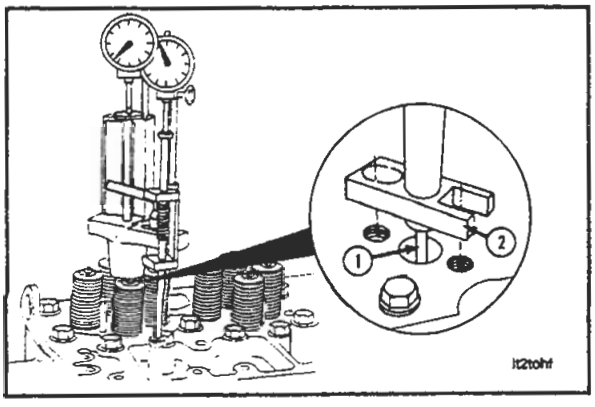
L10 injection timing can be adjusted by removing the camshaft gear and changing the camshaft key. The camshaft key controls the position of the camshaft lobes during the operating cycles of the engine.

Note: If an offset camshaft key is installed with the arrow marked on the top of the key pointing toward the engine (1), the timing will be **retarded**. If the offset key is installed with the arrow pointing away from the engine (2), the timing will be **advanced**.

Retarded timing (1) begins the fuel injection process **later** and advanced timing (2) begins the fuel injection process **earlier** relative to the "TDC" position of the piston.

Offset Camshaft Key Part Number	Degree of Offset to the Camshaft	Change in Push Rod Travel	
		mm	in
3009953 (Standard)	0.00	0.000	0.0000
3030893	0.25	0.051	0.0020
3009948	0.50	0.102	0.0040
3030894	0.75	0.152	0.0060
3009949	1.00	0.203	0.0080
3030895	1.25	0.254	0.0100
3009950	1.50	0.305	0.0120
3030896	1.75	0.356	0.0140
3009951	2.00	0.406	0.0160
3030897	2.25	0.457	0.0180
3030898	2.50	0.508	0.0200

Refer to the accompanying chart for a list of offset keys by part number and degree of offset.



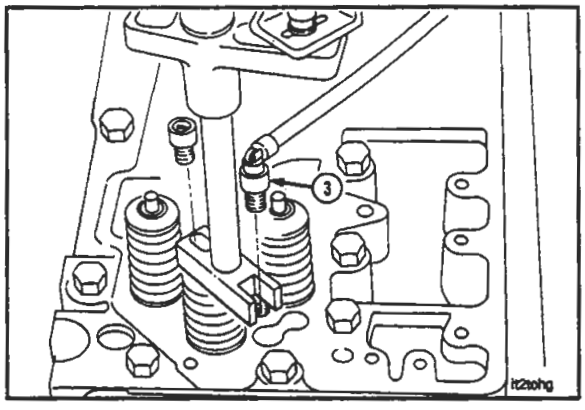
Injection Timing - Adjust

Install the piston plunger rod (1) of the Part No. 3375522 Injection Timing Tool into the injector bore of the number one cylinder.

The open end of the mounting foot (2) **must be** toward the camshaft.

Install the threaded adapters into the injector hold-down capscrew holes through the mounting foot.

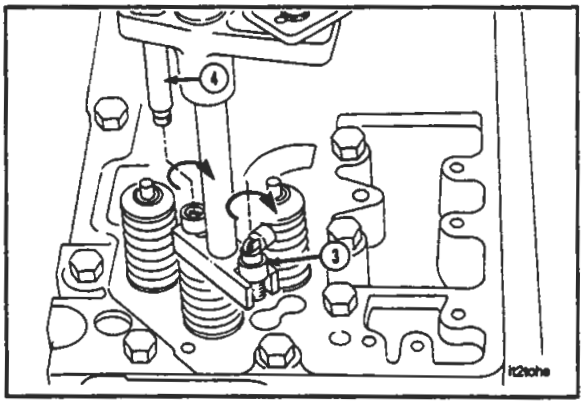
Install the swivel threaded adapter (3) into the open end of the mounting foot.



Note: Do not tighten the threaded adapters too tight. The adapters can be damaged. Tighten the adapters enough to hold the timing fixture rigid.

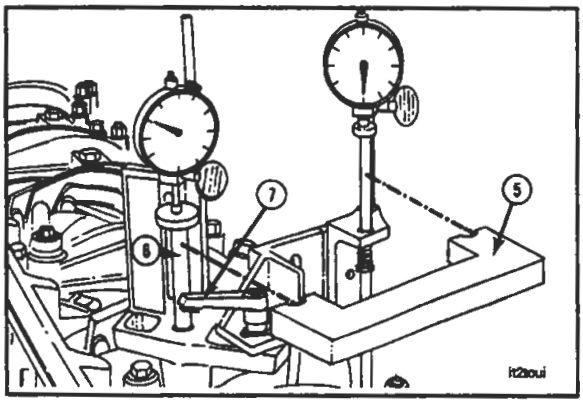
Use the tightening rod (4) to tighten the straight threaded adapter.

Use a 3/8 inch drive ratchet to tighten the swivel threaded adapter (3).

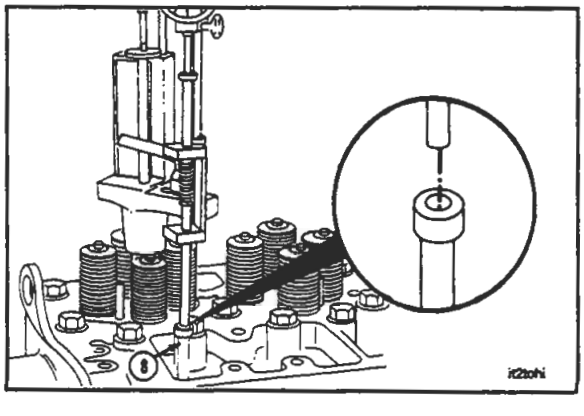


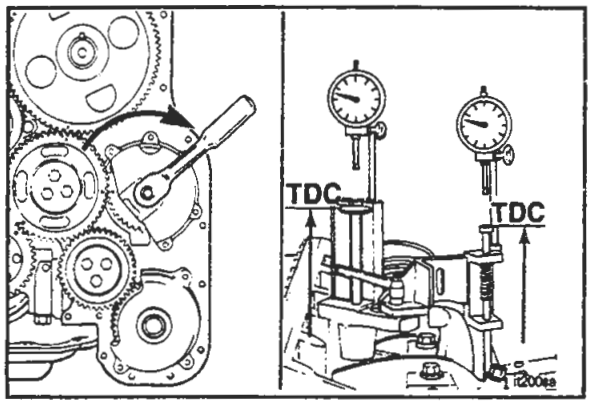
Use the alignment tool (5) to align the push rod plunger rod (6).

Note: Make sure to tighten the clamp handle (7) after the plunger rod is aligned and remove the alignment tool.



Install the injector push rod (8) between the injector camshaft follower and the plunger rod.

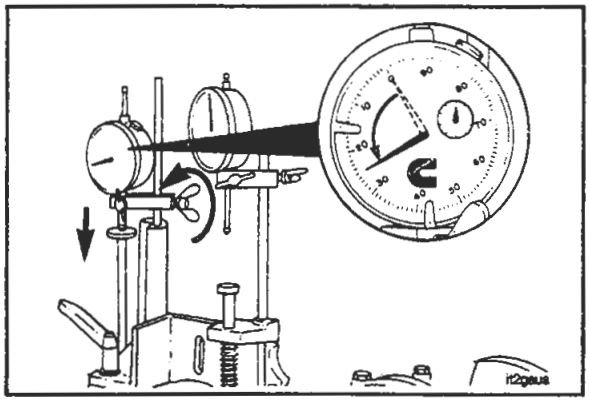




Caution: Always use the accessory drive shaft to rotate (bar) the crankshaft. Using any other method will cause an error in the injection timing or can damage the engine.

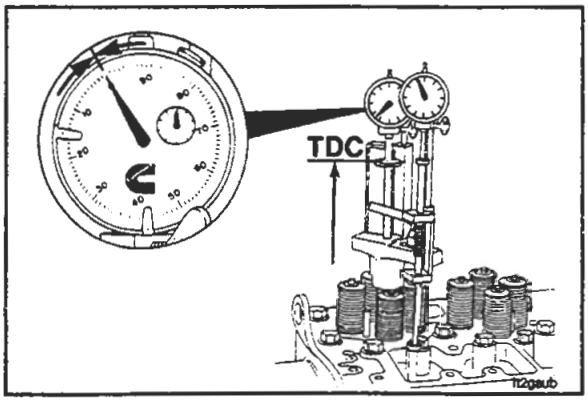
Determine the piston top dead center ("TDC") on the compression stroke by rotating the accessory drive shaft **clockwise**.

The piston is on the compression stroke when both plungers move in an upward direction at the same time. TDC is indicated by the maximum **clockwise** indicator position of the piston travel indicator pointer.

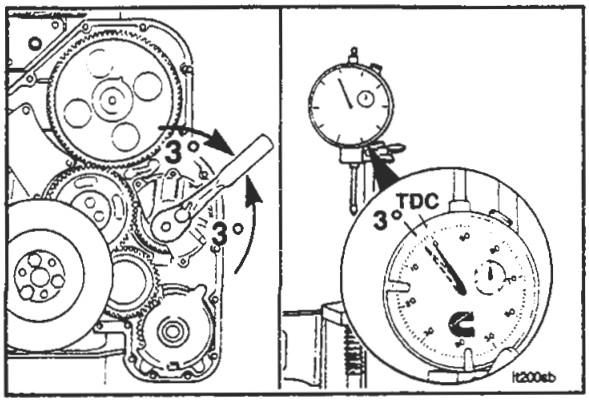


Caution: Both indicators must have a travel range of at least 6.35 mm [0.250 inch] or the indicators will be damaged.

Position the gauge contact tip in the center of the plunger rod and lower the gauge to within 0.63 mm [0.025 inch] of the fully compressed position.



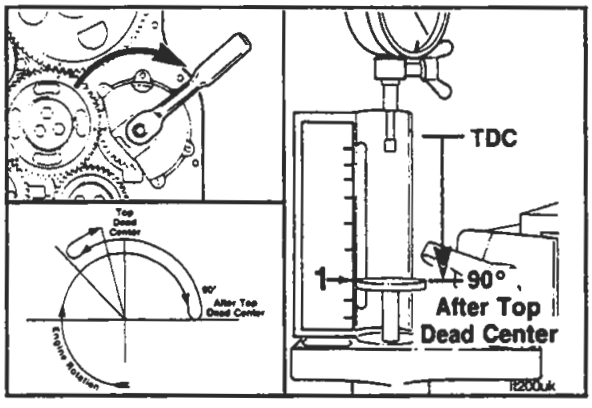
Set the dial indicator over the piston plunger rod to "0" (zero) when the piston plunger rod has reached maximum upward movement ("TDC").



Rotate the accessory drive shaft back and forth, before and after the zero "0" indicator reading, for approximately 3 degrees to be sure the piston is at "TDC".

Rotate the accessory drive shaft **clockwise** to 90 degrees after top dead center ("ATDC").

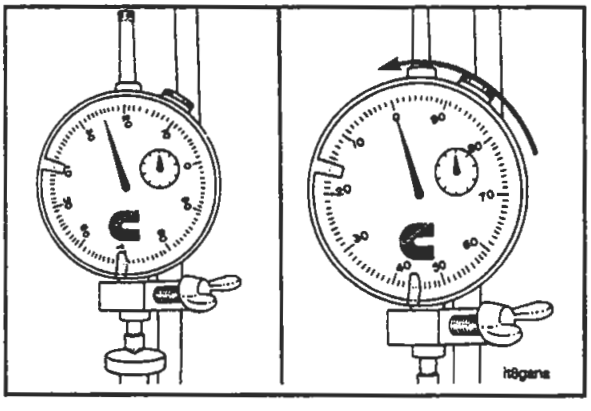
The piston plunger will be at the "L10 90 degree" mark (1) on the timing fixture.



Position the push rod dial indicator contact tip in the center of the push rod plunger rod and lower the gauge to within 0.63 mm [0.025 inch] of the fully compressed position.

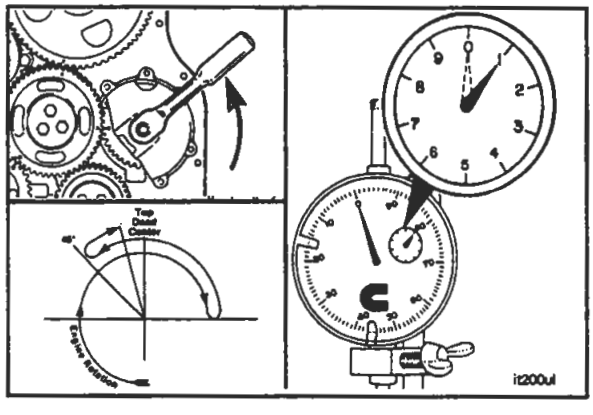
Set the push rod dial indicator to "0" (zero).

Rotate the accessory drive shaft **counterclockwise** to "TDC".



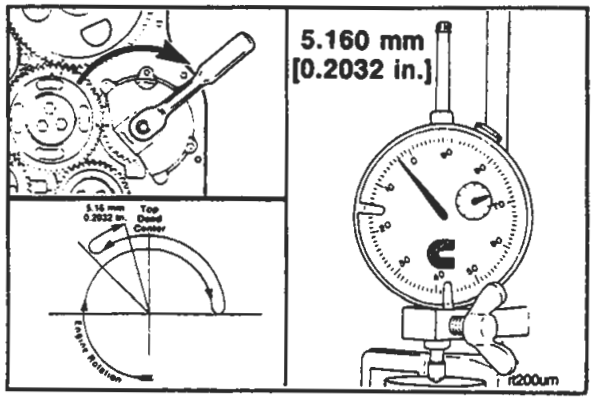
Continue to rotate the accessory drive shaft **counterclockwise** until the crankshaft is at 45 degrees before top dead center ("BTDC").

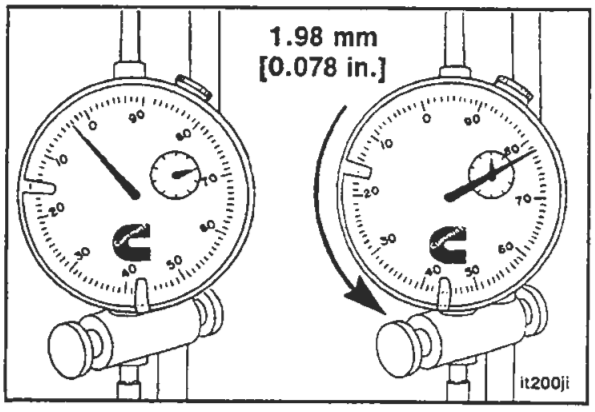
This step is necessary to remove gear backlash in the engine. When rotating the crankshaft **counterclockwise** near the "TDC" position, the push rod indicator will move from "0" (zero) to 0.13 to 0.38 mm [0.005 to 0.015 inch] in a **clockwise** direction. This movement is caused by the camshaft lobe nose crush.



Rotate the accessory drive shaft **clockwise** slowly until the piston travel gauge is at 5.160 mm [0.2032 inch] "BTDC".

If the crankshaft is rotated beyond the 5.160 mm [0.2032 inch] "BTDC" position, the crankshaft **must** be rotated **counterclockwise** back to the 45 degrees "BTDC" mark.

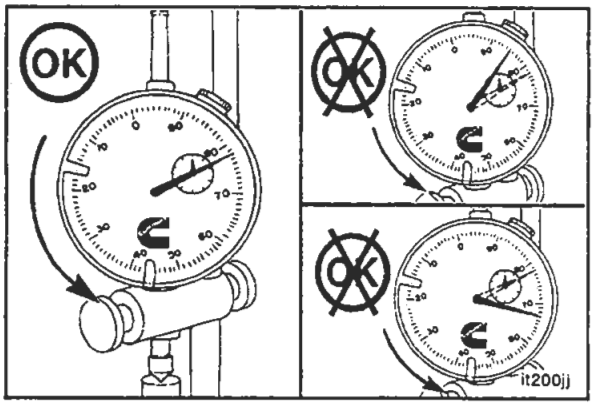




Read the push rod travel gauge **counterclockwise** from "0" (zero). This travel represents the injection timing value. In the example shown, the value is 1.98 mm [0.078 inch].

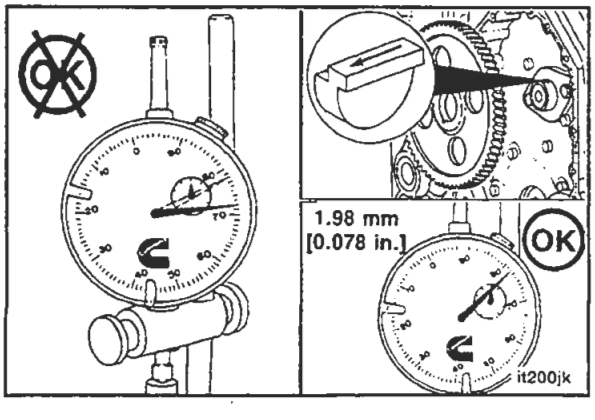
Timing Code	Push Rod Travel @ 5.161 mm [0.2032 in.] BTDC Piston Travel Position
CX	1.98 - 2.08 mm [0.078 - 0.082 inch]
CY	1.85 - 1.96 mm [0.073 - 0.077 inch]
FC	2.11 - 2.21 mm [0.083 - 0.087 inch]
FJ	2.03 - 2.13 mm [0.080 - 0.084 inch]
FN	2.36 - 2.46 mm [0.093 - 0.097 inch]
FO	2.44 - 2.79 mm [0.096 - 0.100 inch]
FS	2.24 - 2.34 mm [0.088 - 0.092 inch] it200gc

Refer to the engine dataplate for the correct injection timing code and the accompanying chart for the correct injection timing specifications.



If the indicator reading is lower than the specification, the timing is **advanced**.

If the indicator reading is higher than the specification, the timing is **retarded**.



Injection timing can be changed by removing the camshaft gear and installing an offset key.

Refer to the camshaft gear replace procedure to remove and install the camshaft gear and to "Injection Timing General Information" for a list of the offset keys.

Gear Driven Fan Clutch Assembly (If Equipped) - Install

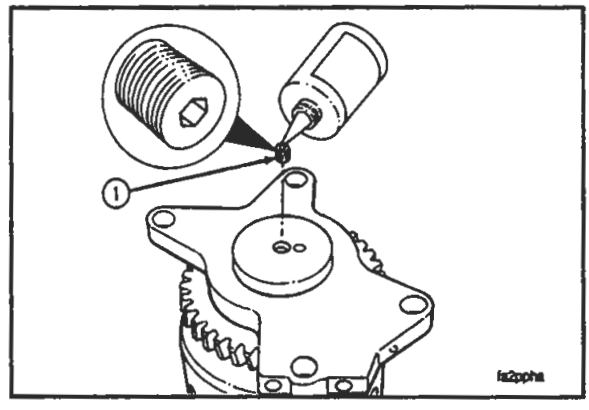
Low Mount

Caution: Do not plug the oil drilling in the set screw, the fan will be damaged.

Use Loctite 242® or equivalent to coat the threads of the 6mm orificed set screw.

Install the set screw (1) into the center of the housing and tighten.

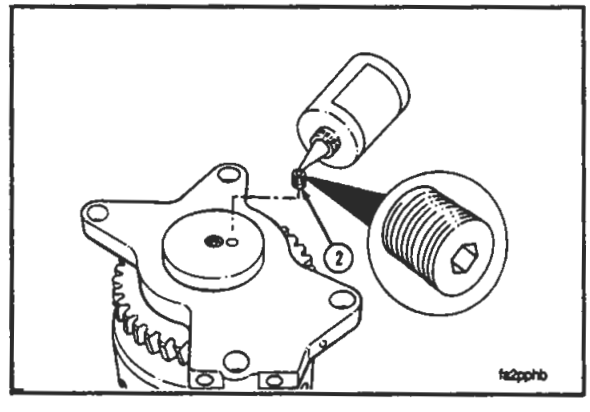
Torque Value: 5 N•m [40 in-lb]



Use Loctite 242® or equivalent to coat the threads of the 6mm solid set screw.

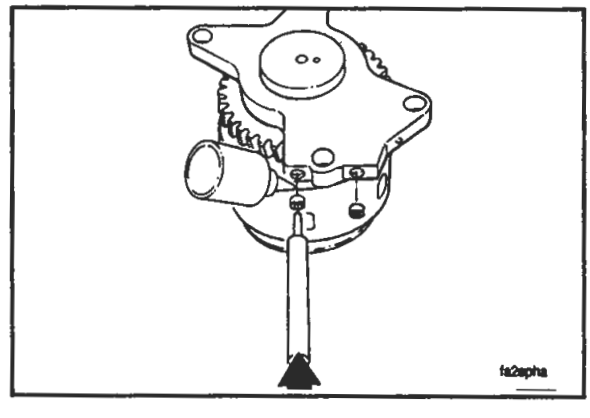
Install the set screw (2) into the offset hole and tighten.

Torque Value: 5 N•m [40 in-lb]



Use Loctite 277® or equivalent to coat the outside diameter of the two 9.38 mm [0.387 inch] cup plugs.

Use the Part No. 3376048 Cup Plug Driver to install the two cup plugs into the oil jumper holes of the housing.

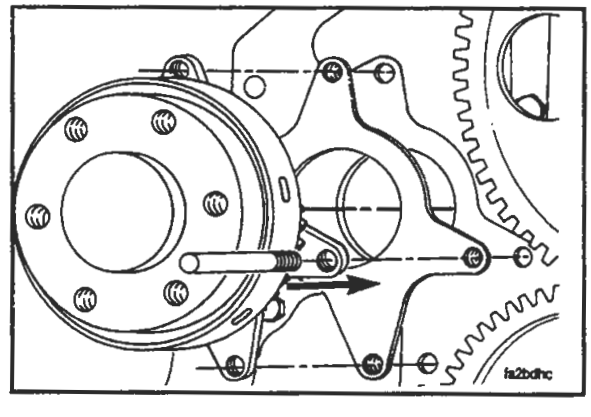


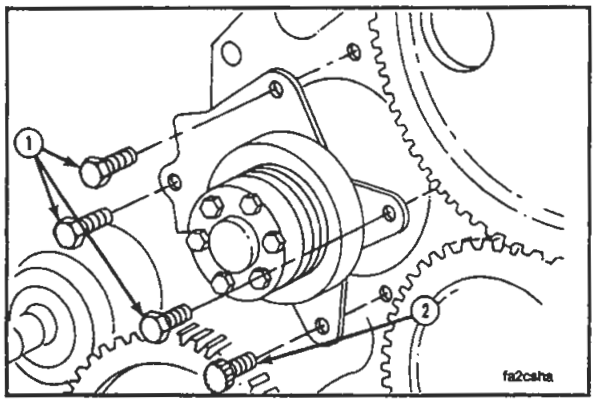
Install two (M10-1.50 X 50) guide pins into the gear plate.

Install a new fan drive gasket on the gear plate.

Note: The print-o-seal surface of the gasket **must** be facing toward the gear plate.

Install the fan clutch assembly on the gear plate.

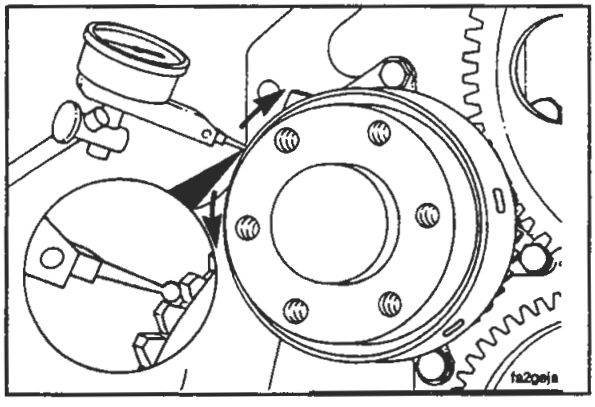




Install three (M10-1.50 X 35) capscrews (1) into the top mounting holes and one (M10-1.50 X 40) 12 point capscrews (2) into the bottom mounting hole.

Tighten the capscrews in a star pattern.

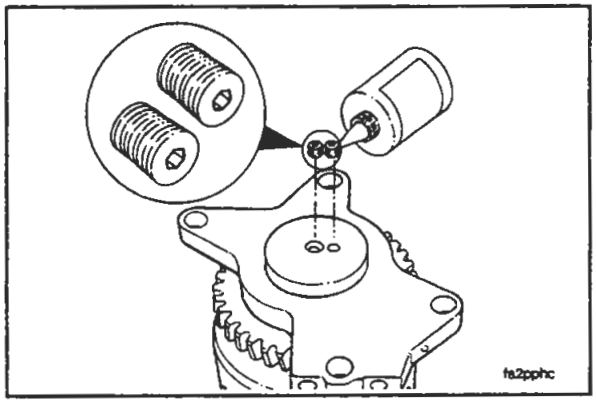
Torque Value: 45 N•m [35 ft-lb]



Measure the gear backlash.

Gear Driven Fan Clutch Gear Backlash		
mm		in
0.08	MIN	0.003
0.41	MAX	0.016

If the gear backlash does not meet these specifications, remove and install the fan clutch again or replace it.

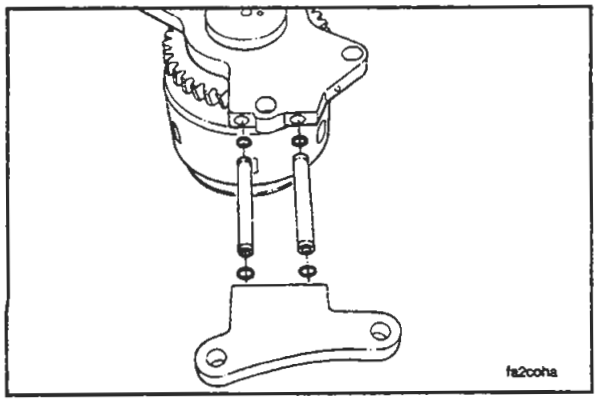


High Mount

Use Loctite 242® or equivalent to coat the threads of the two 6mm solid set screws.

Install the two set screws into the center of the housing.

Torque Value: 5 N•m [40 in-lb]



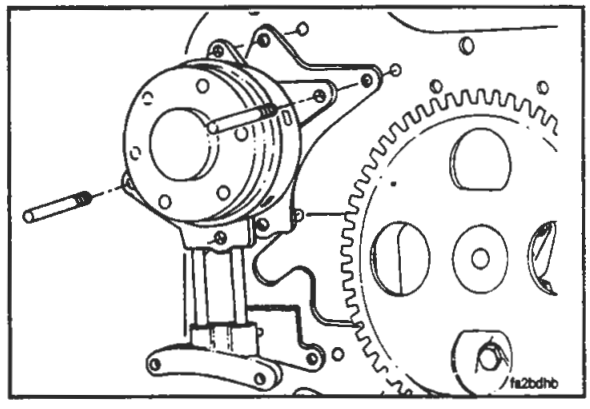
Install the four new o-rings on the two oil jumper tubes.

Install the oil jumper tubes into the oil transfer connection and the fan clutch assembly.

Install two (M10-1.50 X 50) guide pins into the gear plate.

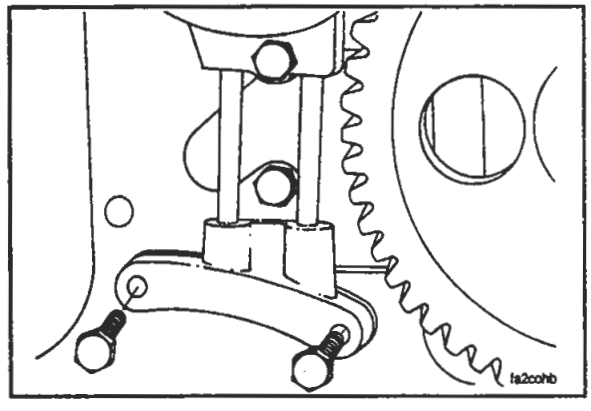
Install a new gasket and the fan clutch assembly on the gear plate.

NOTE: The print-o-seal surface of the gasket must be facing toward the gear plate.



Use two (M10-1.50 X 35) capscrews to install the gasket and oil transfer connection to the gear plate.

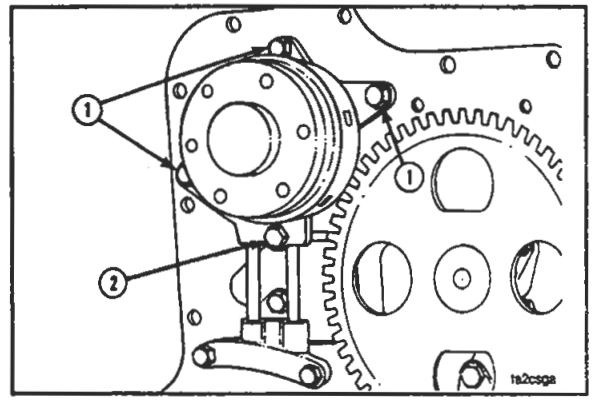
Torque Value: 45 N•m [35 ft-lb]



Install three (M10-1.50 X 22) capscrews (1) into the top mounting holes and one (M10-1.50 X 35) capscrew (2) into the bottom mounting hole.

Tighten the capscrews in a star pattern.

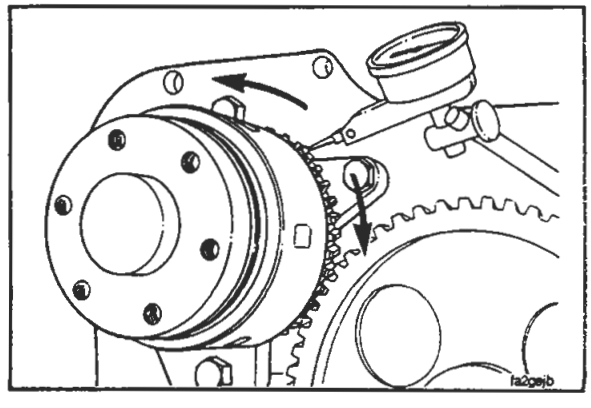
Torque Value: 45 N•m [35 ft-lb]

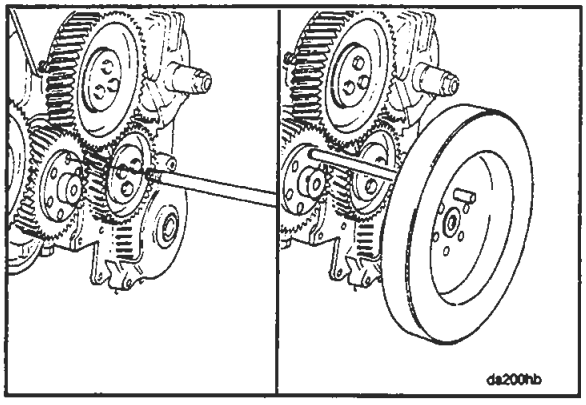


Measure the gear backlash.

Gear Driven Fan Clutch Gear Backlash		
mm		In
0.08	MIN	0.003
0.41	MAX	0.016

If the gear backlash does not meet these specifications, remove and install the fan clutch again or replace it.

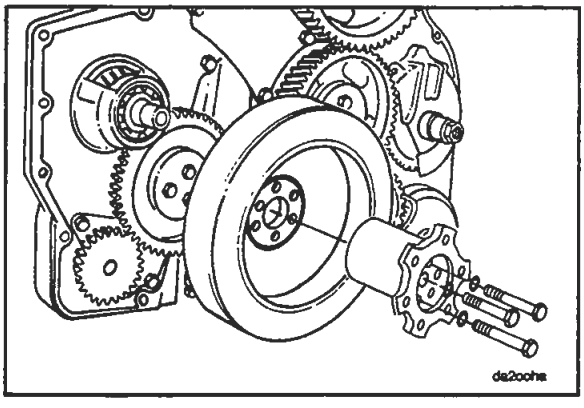




Vibration Damper and Crankshaft Adapter (Belt Driven Fan) - Install

Install a Part No. 3376638 (M12-1.25 X 150) Guide Pin into the crankshaft.

Install the vibration damper on the guide pin.



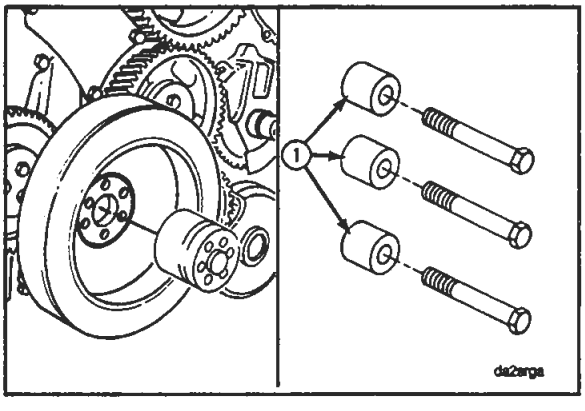
Flanged Style Adapter

NOTE: The gear cover **must be** installed before the current production style adapter is installed permanently. Complete the following steps to check the vibration damper for correct installation.

Install the crankshaft adapter.

Install three (M12-1.25 X130) capscrews and tighten in a star pattern.

Torque Value: 150 N•m [110 ft-lb]

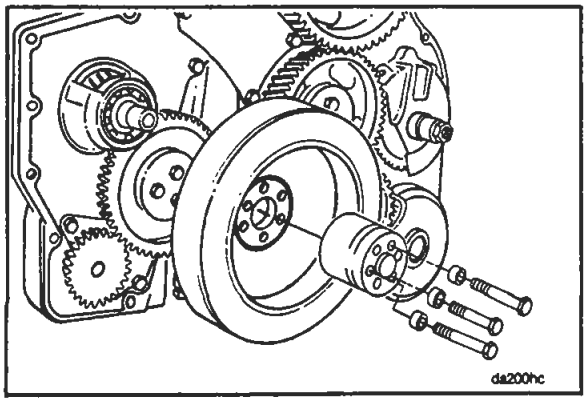


Non-Flanged Style Adapter

Install the crankshaft adapter.

Caution: The capscrews must not hit the bottom of the threaded holes in the crankshaft. The crankshaft and capscrews can be damaged.

Install three 31.75 mm [1.250 inch] thick spacers (1) on three of the vibration damper (M12-1.25 X 130) capscrews.



Install the capscrews and spacers into the adapter and tighten in a star pattern.

Torque Value: 150 N•m [110 ft-lb]

Do not remove the capscrews until the gear cover is installed.

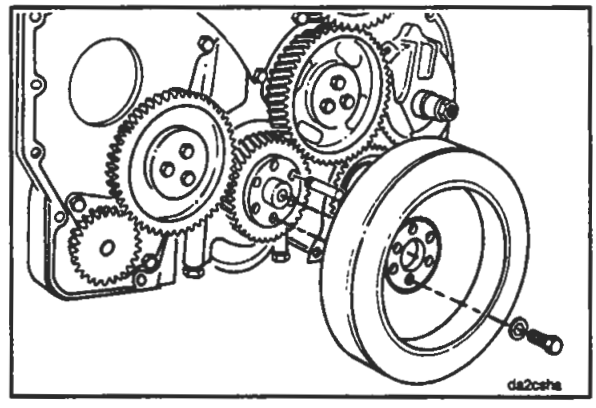
Vibration Damper and Crankshaft Adapter (Gear Driven Fan) - Install

Install the damper on the crankshaft.

Install the six (M12-1.25 X 50) capscrews and six flat washers.

Tighten the capscrews in a star pattern.

Torque Value: 150 N•m [110 ft-lb]



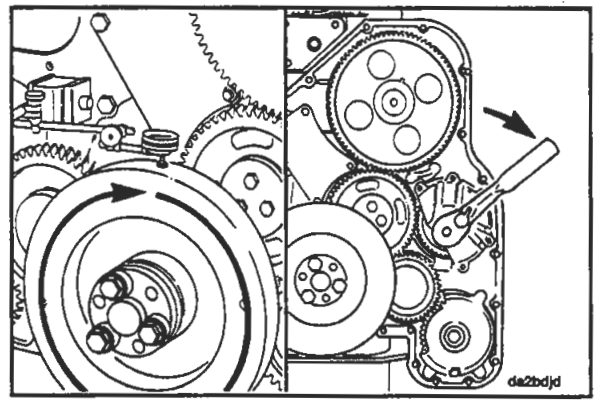
Vibration Damper Eccentricity - Measure

Install a dial indicator in the center of the vibration damper outside diameter to measure eccentricity (out-of-round).

Rotate the crankshaft with the accessory drive shaft one complete revolution (360 degrees).

Maximum eccentricity **must not** exceed 6.87 mm [0.011 inch] TIR.

Replace the damper if the eccentricity exceeds these specifications.



Vibration Damper Face Alignment ("Wobble") - Measure

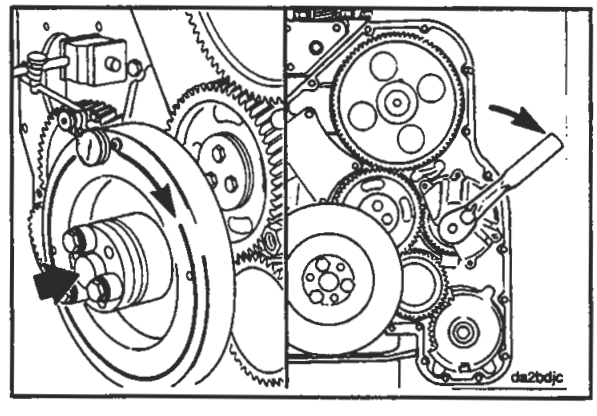
Install a dial indicator gauge against the face of the vibration damper to measure the "wobble".

Push the crankshaft toward the rear of the engine.

Rotate the crankshaft with the accessory drive shaft one complete revolution (360 degrees).

Maximum "wobble" **must not** exceed 6.87 mm [0.011 inch] TIR.

Replace the damper if the "wobble" exceeds the specifications.

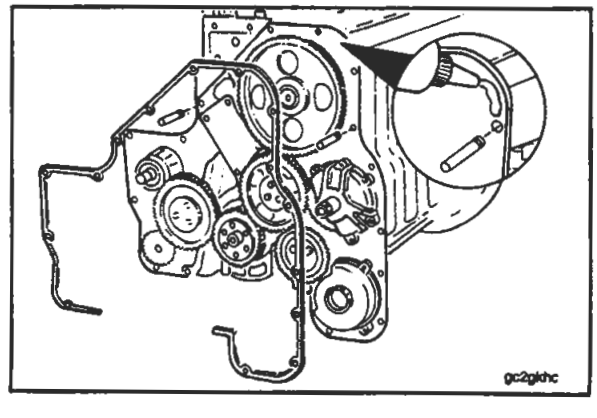


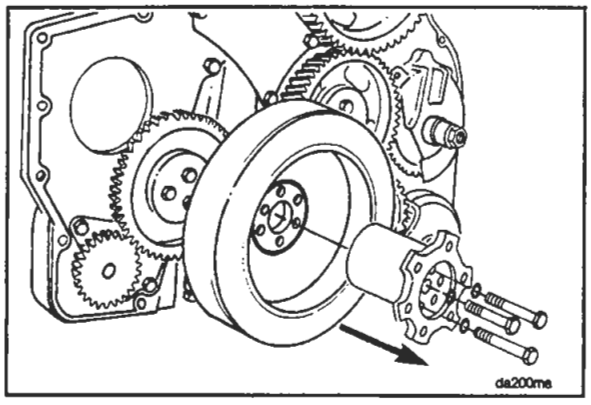
Gear Cover - Install

Install two Part No. 3376696 (M10-1.50 X 100) Guide Pins into the gear support plate.

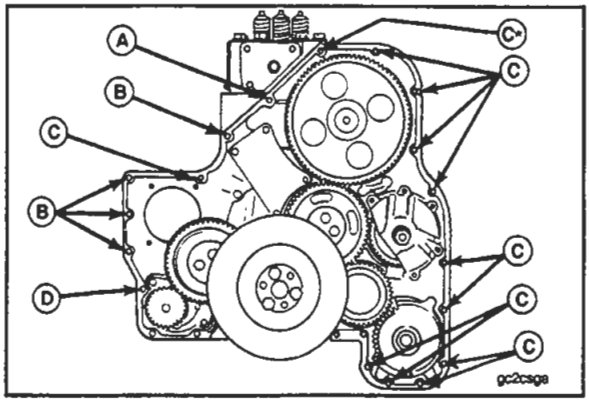
Use grease to coat the gear cover gasket to hold it in place while installing the gear cover.

Install the new gasket on the gear support plate and align the gasket and gear plate capscrew holes.





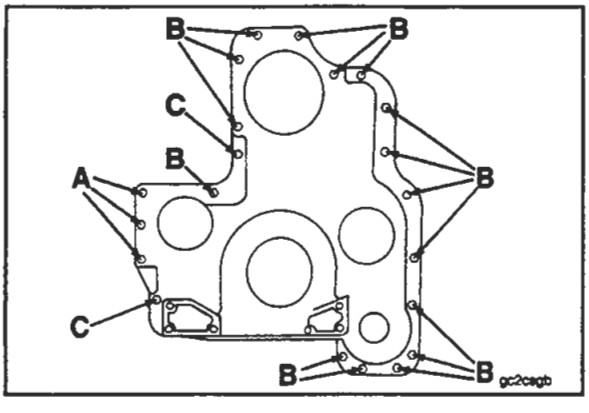
Note: If the present style crankshaft adapter is used, the adapter **must be** removed before installing the gear cover. **Do not** remove the vibration damper.



Use the following capscrews to install the belt driven fan gear cover and low mount gear driven fan.

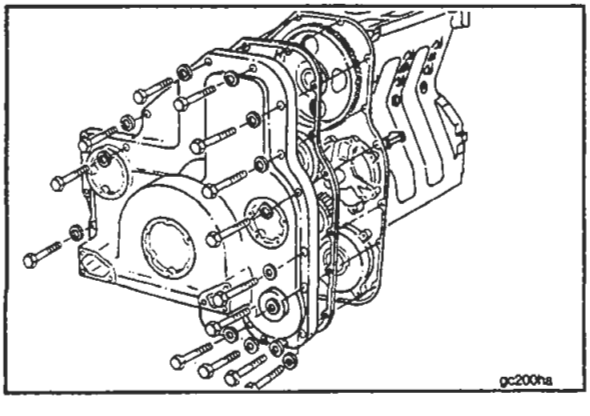
Capscrew Size	Point	Quantity
M10-1.50 X 30	A	1
M10-1.50 X 50	B	4
M10-1.50 X 60	C	12
M10-1.50 X 70	D	1

Note: Install a 5 mm [0.19 inch] thick spacer with the capscrew at the point marked with an asterisk (*).



Use the following capscrews to install the high mount gear driven fan gear cover.

Capscrew Size	Point	Quantity
M10-1.50 X 50	A	3
M10-1.50 X 60	B	16
M10-1.50 X 70	C	2

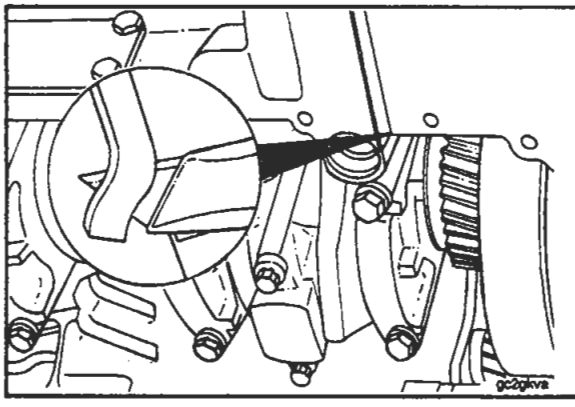


Install the gear cover and mounting capscrews.

Torque Value: 10 N•m [90 in-lb]

Note: This is not the final capscrew torque value.

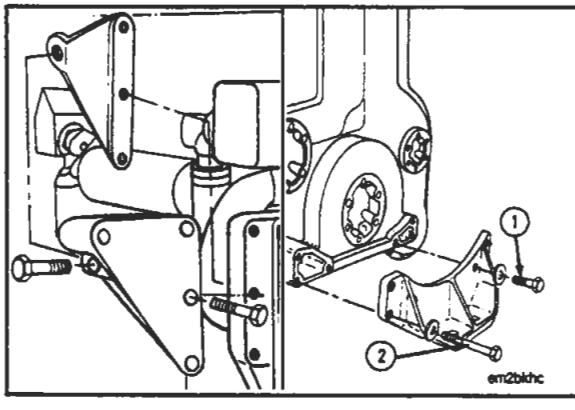
Cut off the ends of the gasket to be even with the oil pan mounting flange.



Install the alternator bracket and the three capscrews.

Torque Value: 10 N•m [90 in-lb]

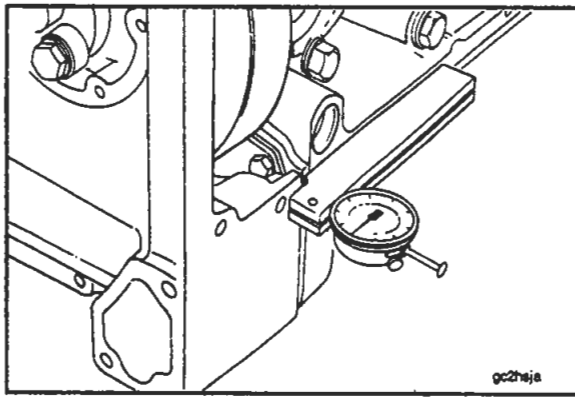
Install the front engine support using two (M10-1.50 X 35) capscrews (1) and four (M10-1.50 X 170) capscrews (2).



Use the Part No. 3376220 Gauge Block to measure the alignment of the gear cover oil pan mounting flange with the cylinder block oil pan mounting flange.

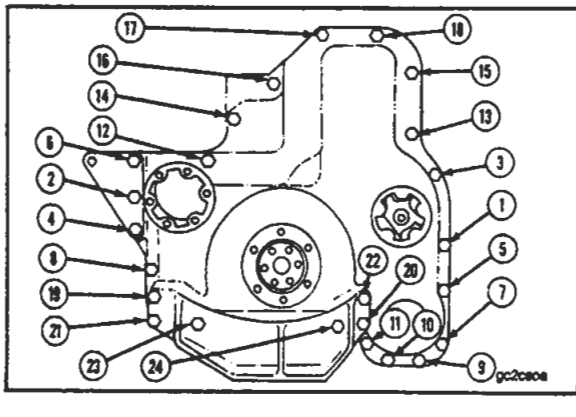
Gear Cover Alignment with Oil Pan Mounting Flange		
mm		in
- 0.15	MIN	- 0.006
+0.15	MAX	+0.006

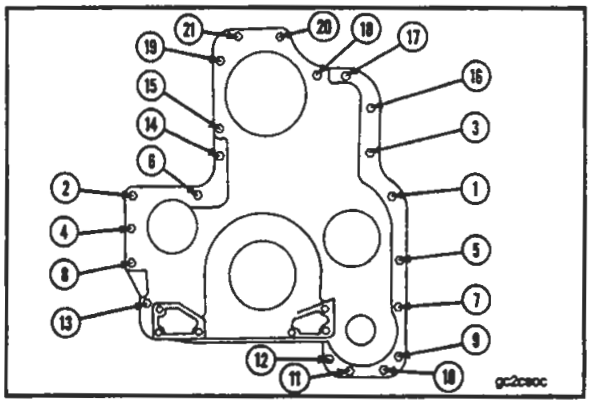
Use a rubber hammer to adjust the gear cover as necessary to meet these specifications.



Tighten the belt driven and low mount gear driven fan gear cover capscrews in the sequence shown.

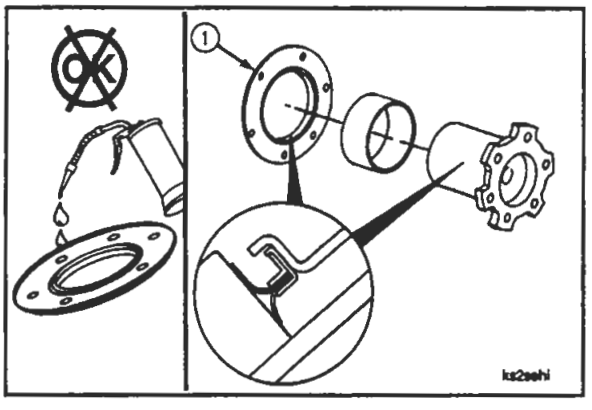
Torque Value: 45 N•m [35 ft-lb]





Tighten the high mount gear driven fan gear cover capscrews in the sequence shown.

Torque Value: 45 N•m [35 ft-lb]



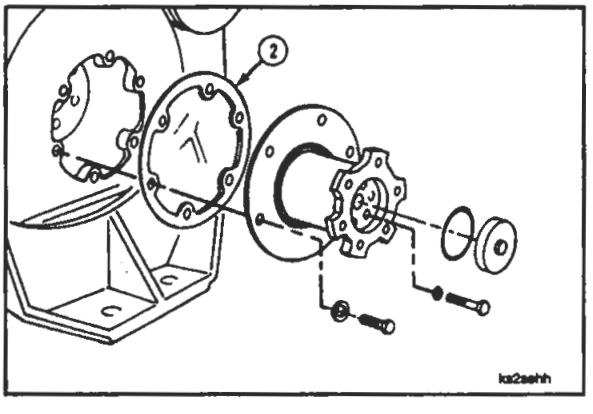
Front Crankshaft Oil Seal - Install

Flanged Style Crankshaft Adapter

NOTE: Do not use any kind of lubricant. The oil seal **must be** installed with the lip of the seal and the crankshaft spacer clean and dry to provide a proper oil sealing surface and provide maximum engine life.

NOTE: The yellow dust seal lip **must be** facing the spacer pulley mounting flange to prevent an oil leak.

Use the seal installation sleeve provided with the new seal or the Part No. 3376496 Oil Seal Guide to install the new seal (1) on the adapter.



Install a new gasket (2), the adapter and seal.

Install the six (M12-1.25 X 130) spacer mounting capscrews and tighten in a star pattern.

Torque Value: 150 N•m [110 ft-lb]

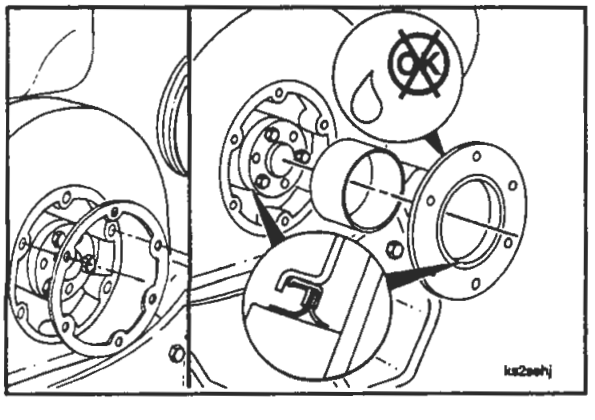
Install the six seal (M8-1.25 X 16) capscrews and washers.

Tighten the capscrews in a star pattern in two steps.

Torque Value: Step one 7 N•m [60 in-lb]

Torque Value: Step two 19 N•m [170 in-lb]

Use a new o-ring and install the capscrew cover into the adapter.



Non-Flanged Style Crankshaft Adapter

Install a new oil seal gasket on the gear cover.

NOTE: Do not use lubricant to install the seal. the oil seal **must be** installed with the lip of the seal and the spacer clean and dry to provide a proper oil sealing surface and provide maximum engine life.

NOTE: The yellow dust lip of the seal **must be** facing out to prevent an oil leak.

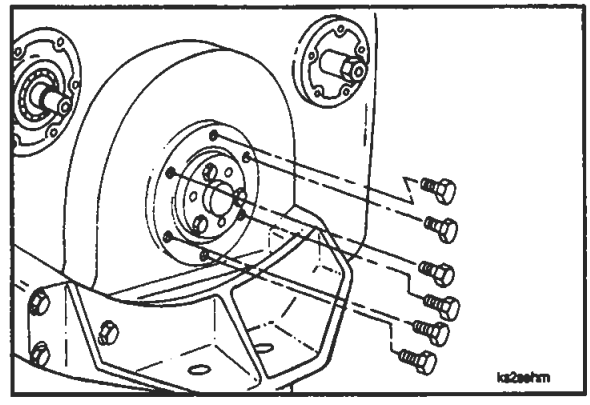
Use the seal installation sleeve provided with the new seal or the Part No. 3376496 Oil Seal Guide to install the new seal on the gear cover.

Install the six seal (M8-1.25 X 16) capscrews and washers.

Tighten the capscrews in a star pattern in two steps.

Torque Value: Step one 7 N•m [60 in-lb]

Torque Value: Step two 19 N•m [170 in-lb]



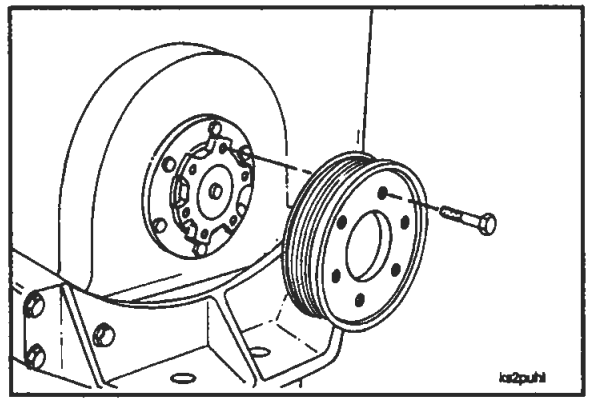
Crankshaft Pulley - Install

Flanged Crankshaft Adapter Style Pulley

Install the pulley and the six (M10-1.50 X 30) capscrews.

Tighten the capscrews in a star pattern.

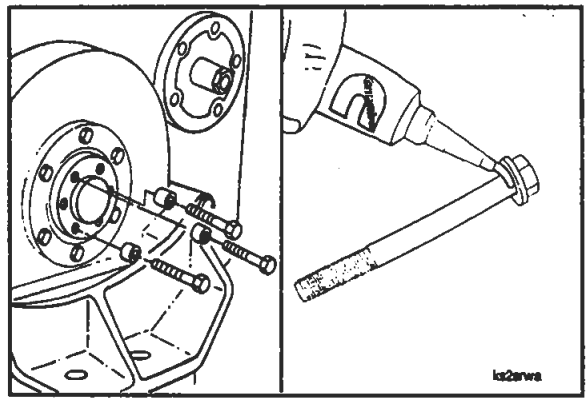
Torque Value: 65 N•m [50 ft-lb]



Non-Flanged Crankshaft Adapter Style Pulley

Remove the three capscrews and spacers from the crankshaft adapter.

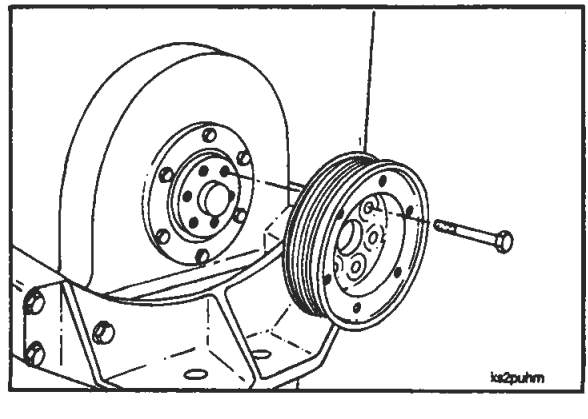
Apply a bead of RTV® around the six (M12-1.25 X 130) capscrew washers.

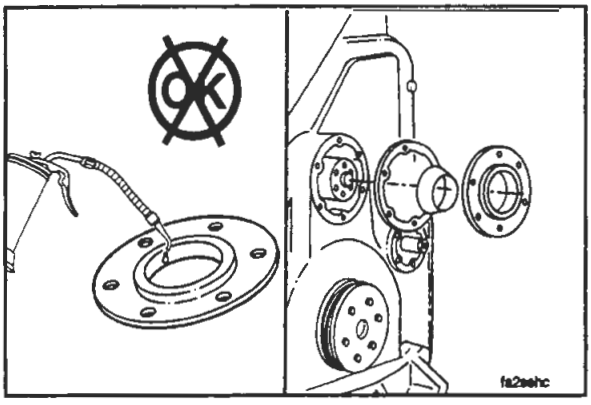


Install the pulley and the six capscrews.

Tighten the capscrews in a star pattern.

Torque Value: 150 N•m [110 ft-lb]





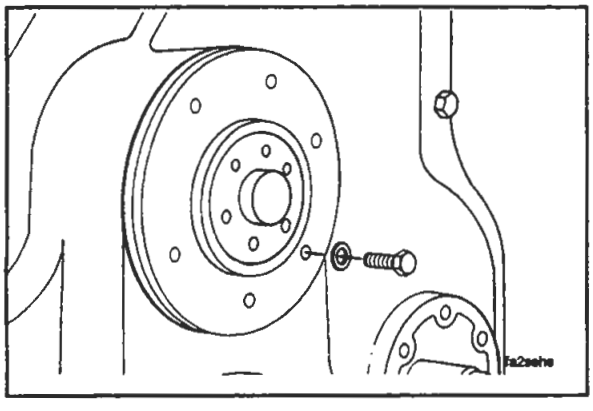
Gear Driven Fan Clutch Seal (If Equipped) - Install

Note: Do not lubricate the seal. The oil seal **must be** installed with the lip of the seal and the shaft clean and dry to provide a proper oil sealing surface and provide maximum engine life.

Note: The yellow dust lip of the seal **must be** facing out to prevent an oil leak.

Install a new gasket on the gear cover.

Use the installation sleeve provided with the new seal or the Part No. 3376098 Oil Seal Guide to install the seal.

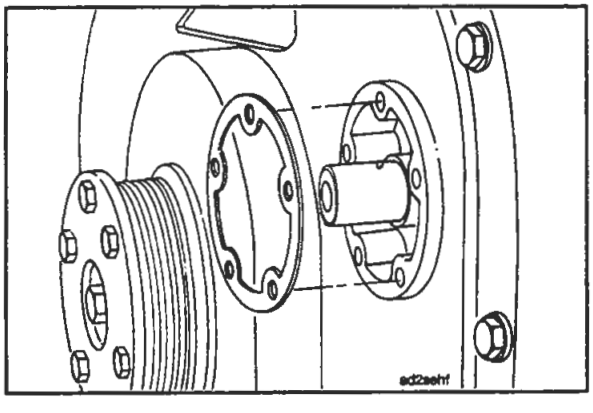


Install the six (M8-1.25 X 16) capscrews and washers.

Tighten the capscrews in a star pattern in two steps.

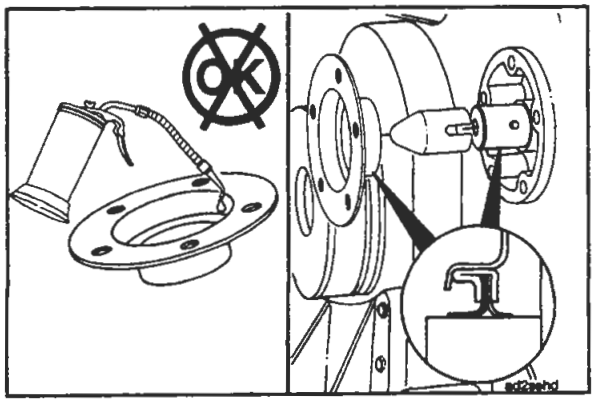
Torque Value: Step one 7 N•m [60 in-lb]

Torque Value: Step two 19 N•m [170 in-lb]



Accessory Drive Oil Seal - Install

Install a new gasket on the gear cover.



Note: Do not use lubricant to install the seal. The oil seal **must be** installed with the lip of the seal and the shaft clean and dry to provide a proper oil sealing surface and provide maximum engine life.

Note: The yellow dust lip of the seal **must be** facing out to prevent an oil leak.

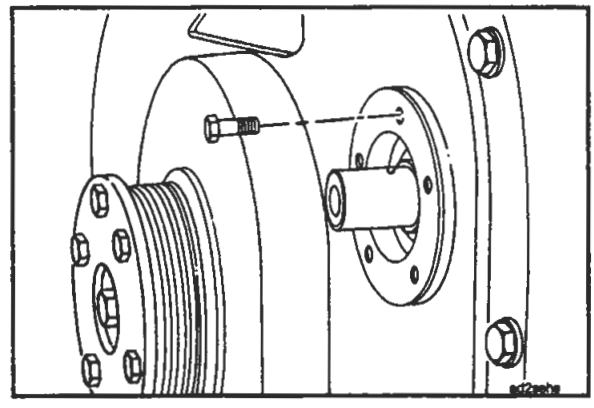
Use the installation sleeve provided with the new seal or the Part No. 3376099 Oil Seal Guide to install the seal.

Install the five (M8-1.25 X 16) capscrews and washers.

Tighten the capscrews in a star pattern in two steps.

Torque Value: Step one 6 N•m [60 in-lb]

Torque Value: Step two 19 N•m [170 in-lb]



Accessory Drive Pulley - Install

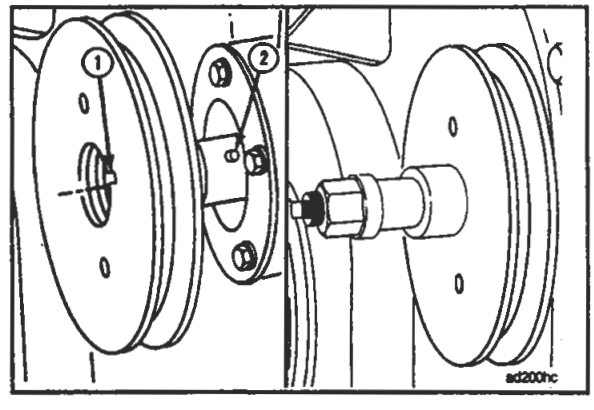
Caution: The slot (1) in the pulley must align with the dowel pin (2) in the shaft or the pin will be damaged.

NOTE: The timing marks on the pulley **must be** facing away from the engine.

Install the pulley on the shaft by hand.

Use the Part No. 3377453 Pulley Pusher Adapter and the Part No. 3376326 Pulley Installation Tool to install the pulley.

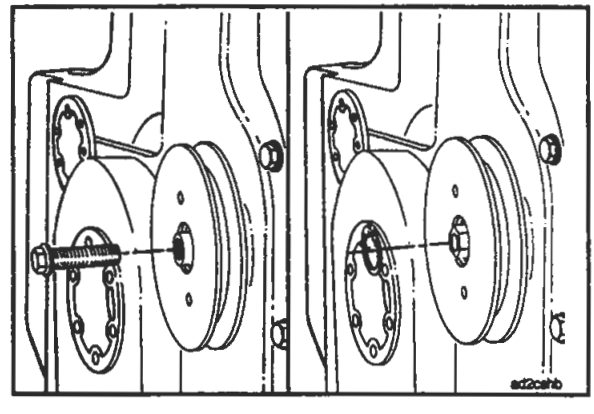
NOTE: Use the Part No. 3376383 Pulley Pusher Adapter on earlier production engines.



Install the (M20-2.50 X 45) pulley retainer capscrew.

Torque Value: 540 N•m [400 ft-lb]

NOTE: Earlier production engines use a retainer snap ring and no capscrew.



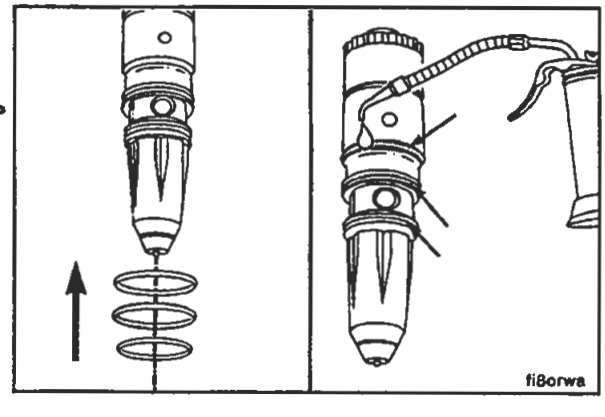
Injectors and Injector Plunger Links - Install

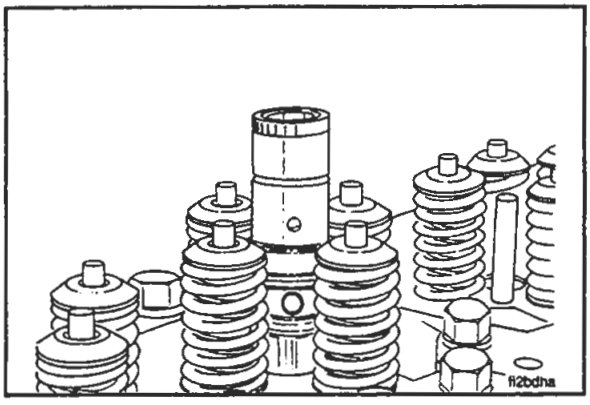
NOTE: If the engines is equipped with "top-stop" injectors, the injector plunger travel **must be** adjusted before the injectors are installed in the engine. Refer to Bulletin No. 3379071-06 "Injectors PT (all types)" to adjust the injector plunger travel.

NOTE: Do not stretch the o-rings as they are installed. The o-rings **must be** correctly installed in the grooves to prevent leaks.

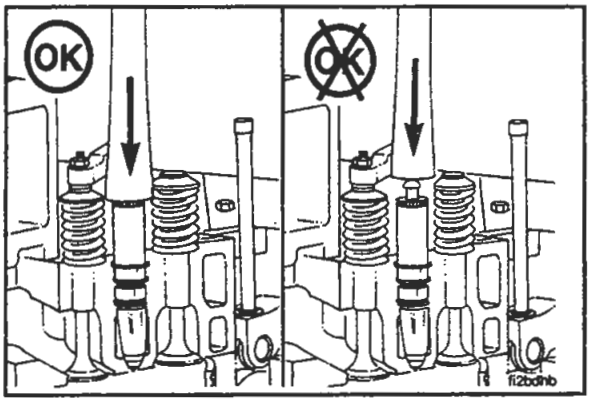
Install the new o-rings on the injector.

Use clean 15W-40 oil to lubricate the o-rings.



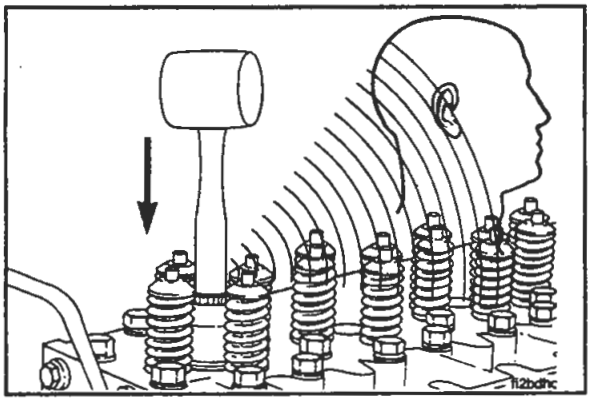


Install the injector into the cylinder head injector bore with the oil drain hole toward the camshaft side of the engine. The screen on the fuel inlet hole will be toward the exhaust side of the engine.



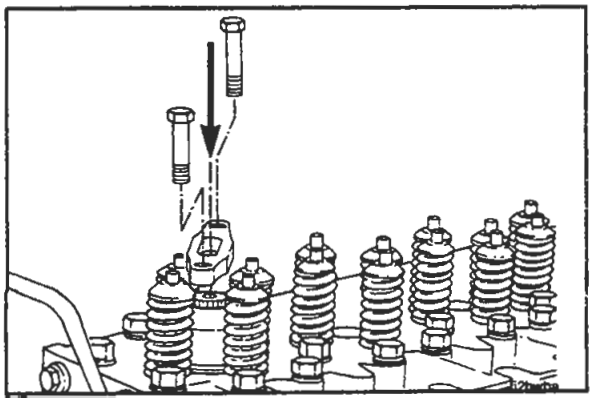
Caution: Make sure to place the instrument used to install the injectors on the body of the injector, not on the plunger. The plungers will be damaged.

Use a clean blunt instrument to seat the injector in the bore.



A "snap" will be heard and felt as the injector is seated.

Note: If the injector does not seat, remove it and check the o-rings for damage. Replace damaged o-rings.



Use two (M8-1.25 X 80) capscrews to install the injector hold-down clamp.

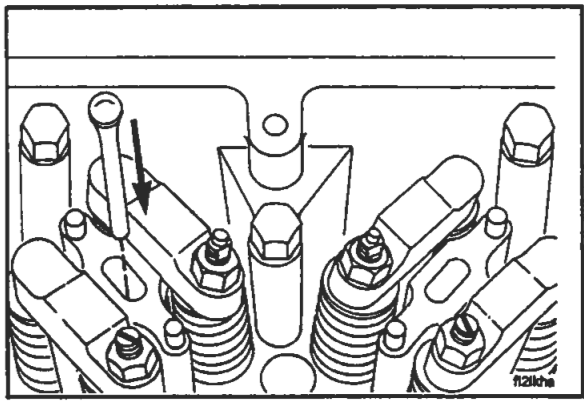
Tighten the capscrews alternately and evenly in the following steps:

Injector Hold-Down Clamp Capscrew Torque Value		
N•m	Step	in-lb
5	1	45
10	2	90
15	3	130

Install the injector plunger link into each injector.

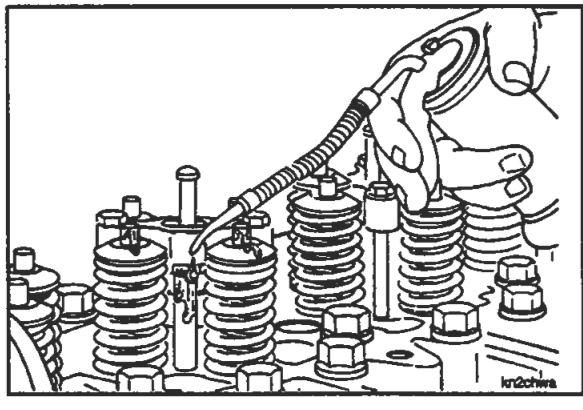
Inspect the injector plunger links for free movement. Raise the link approximately 1/3 of its length. Let the link fall into the injector.

Note: If the link does **not** move freely, loosen the clamp capscrews. Then, tighten the capscrews and check the free movement of the link again.



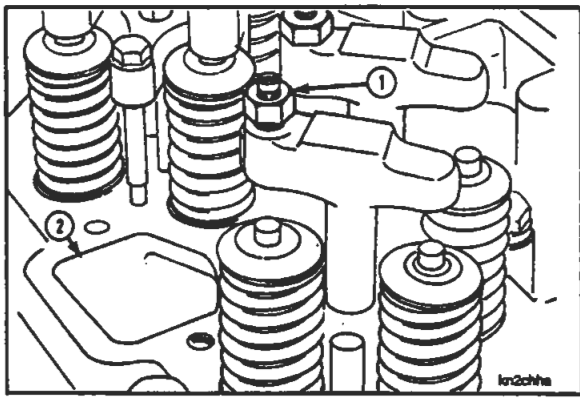
Crossheads - Install

Use clean 15W-40 oil to lubricate the end of the valve stems and crosshead guides.



Note: The adjusting screw (1) **must be** toward the intake ports (2) of the cylinder head to avoid contacting the rocker levers.

Install the crossheads on the crosshead guides.



Crossheads - Adjust

Note: Use the following procedure to adjust both intake and exhaust valve crossheads.

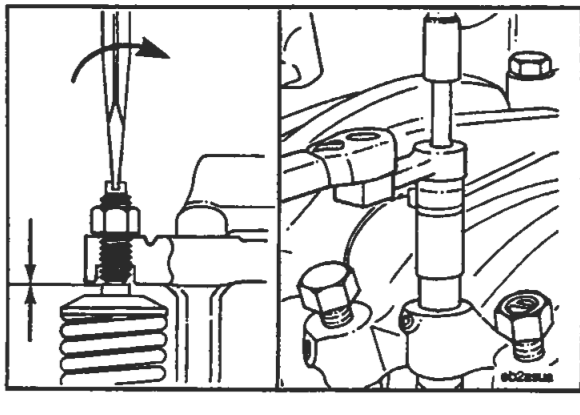
Hold the crosshead in position and turn the adjusting screw down until it touches the top of the valve stem.

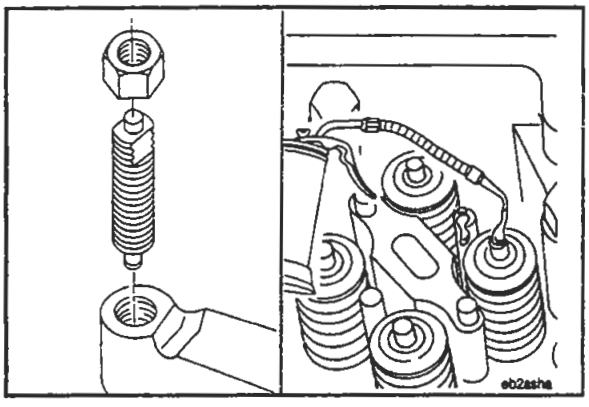
Hold the adjusting screw in position and tighten the locknut.

Torque Value: 40 N•m [30 ft-lb]

Note: When the Part No. ST-669 Torque Wrench Adapter is used to tighten the locknut, reduce the torque.

Torque Value: 30 N•m [25 ft-lb]



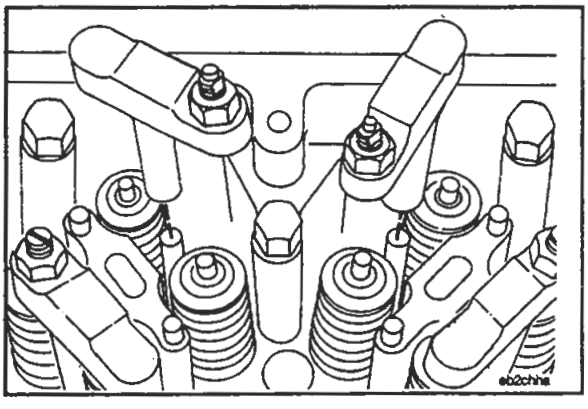


Crossheads for Jacobs® Brake - Install

Install the Cummins locknuts on the Jacobs® Brake adjusting screws used in the exhaust valve crossheads.

Install the adjusting screw assemblies into the exhaust valve crossheads.

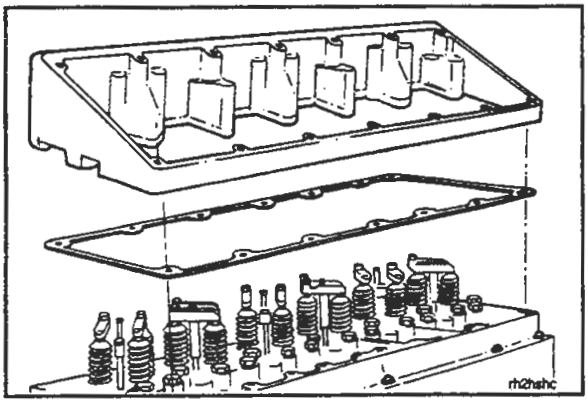
Use clean 15W-40 oil to lubricate the valve stems and crosshead guides.



Install the intake crossheads.

Install the exhaust valve crossheads 180 degrees from the original position with the adjusting screw toward the camshaft side of the engine.

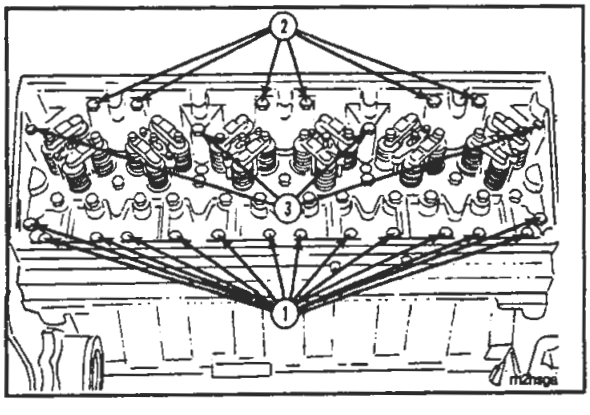
Adjust the crossheads. Refer to the previous procedure.



Rocker Lever Housing - Install

Note: The gasket print-o-seal surface **must be** installed toward the rocker lever housing to prevent leaks.

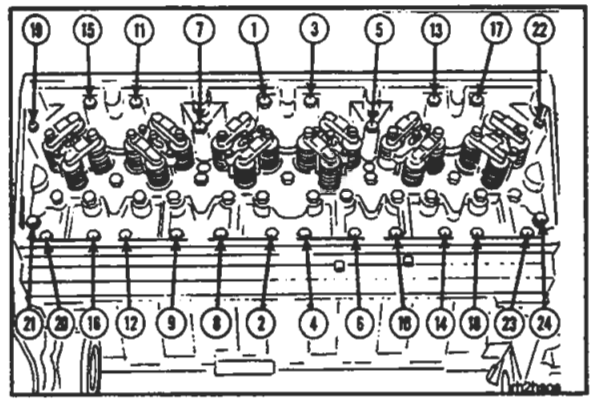
Use a new gasket and install the rocker lever housing.



Install 14 (M10-1.50 X 35) capscrews at points (1), six (M10-1.50 X 125) capscrews at points (2) and four (M10-1.50 X 100) capscrews at points (3).

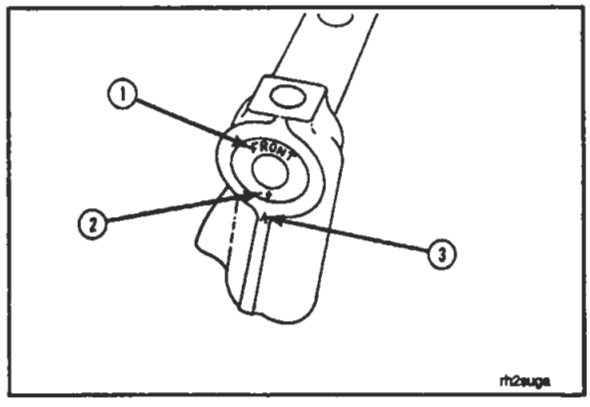
Tighten the capscrews, in the sequence shown.

Torque Value: 45 N•m [35 ft-lb]



Rocker Lever Assemblies - Install

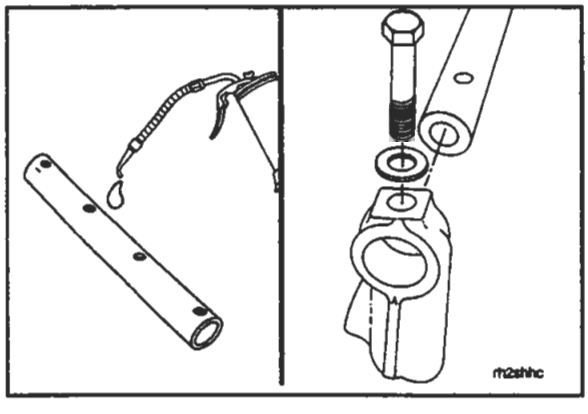
Note: The rocker lever shafts are labeled front and rear on the end of the shafts (1). The shaft and supports have arrows (2) stamped in them to align with arrows (3) stamped in the ends of both rocker lever shafts. The arrows on the shafts and the shaft end supports **must be** aligned to be installed correctly. The shaft end supports are **not** interchangeable.



Use clean 15W-40 oil to lubricate both shafts.

Install the correct end support on each shaft.

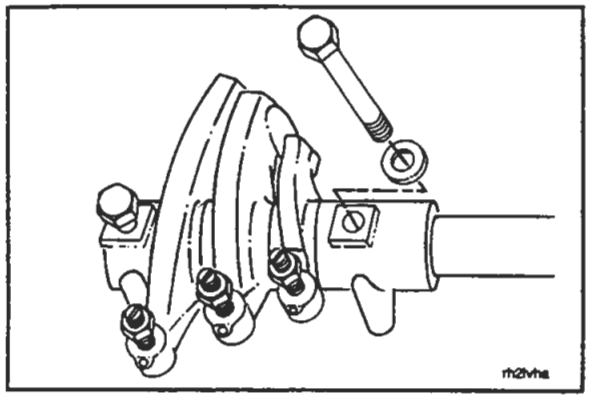
Install the washers and (M14-2.00 X 135) capscrews through the end supports.

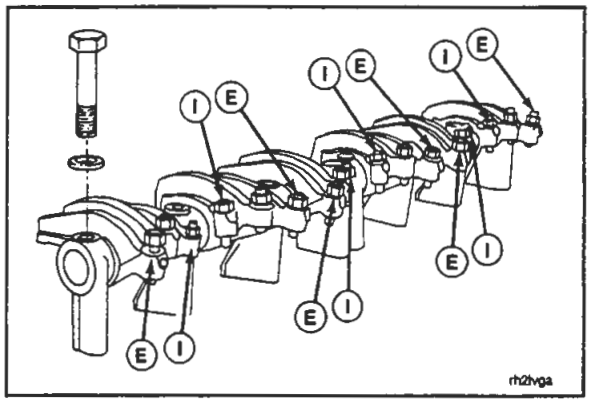


Install the rocker levers in the correct sequence as shown.

Install one of the two shaft center supports on the shaft.

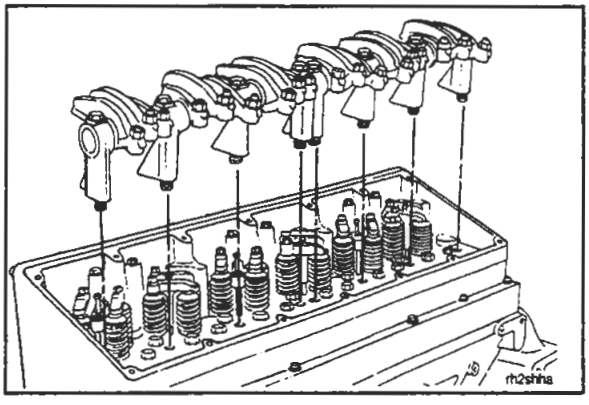
Install the (M14-2.00 X 135) capscrew and washer through the center support.





Install the remaining levers and supports with the intake (I) and exhaust (E) valve levers in the correct position as shown.

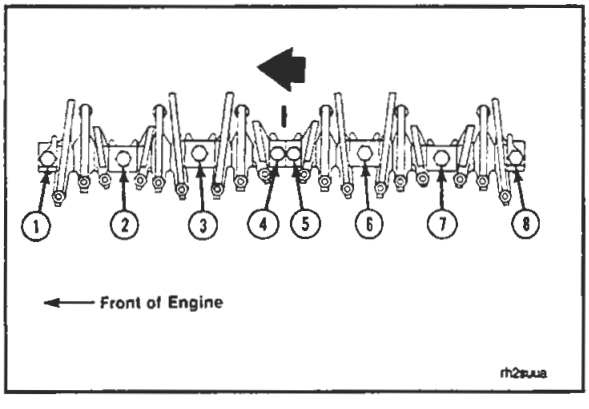
Install the remaining (M14-2.00 X 135) capscrews and washers.



Install the assemblies on the engine.

Note: Do not tighten the capscrews to more than 5 N•m [45 in-lb] torque at this time. The rocker lever side clearance **must be** adjusted before the capscrews are tightened to their final torque value.

Note: For engines equipped with Jacobs® Brakes, refer to "Install the Jacobs® Engine Brake" following the next procedure.



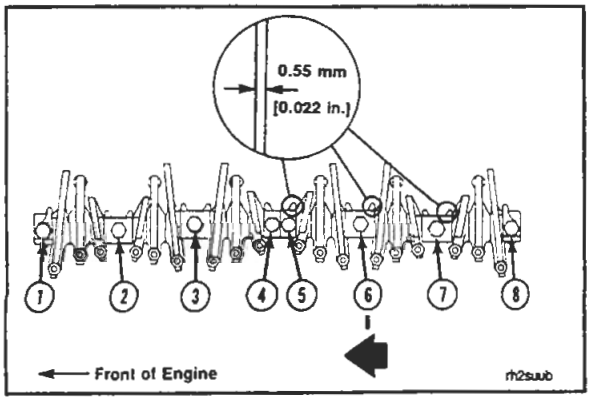
Adjust the Rocker Lever Side Clearance

Note: The specifications given for the rocker lever side clearance is the minimum allowable.

Cylinder Numbers Four, Five and Six

Push the number "5" rocker lever support toward the **front** of the engine and tighten the capscrew.

Torque Value: 125 N•m [90 ft-lb]



Install a 0.55 mm [0.022 inch] feeler gauge between rocker lever support numbers "5", "6" and "7" and the intake valve levers for cylinders four, five and six.

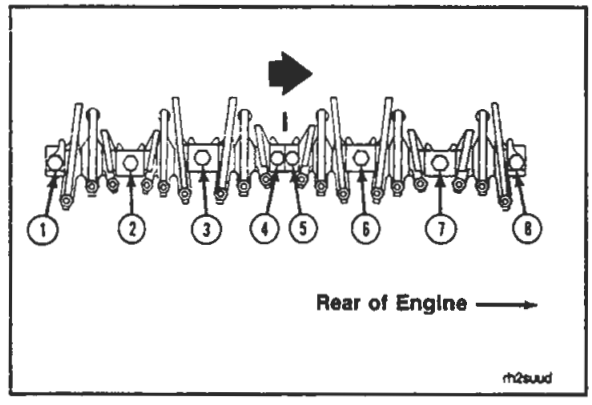
Push support numbers "6", "7" and "8" toward the front of the engine and tighten the capscrews.

Torque Value: 125 N•m [90 ft-lb]

Cylinder Numbers One, Two and Three

Push the number "4" rocker lever support toward the rear of the engine and tighten the capscrew.

Torque Value: 125 N•m [90 ft-lb]

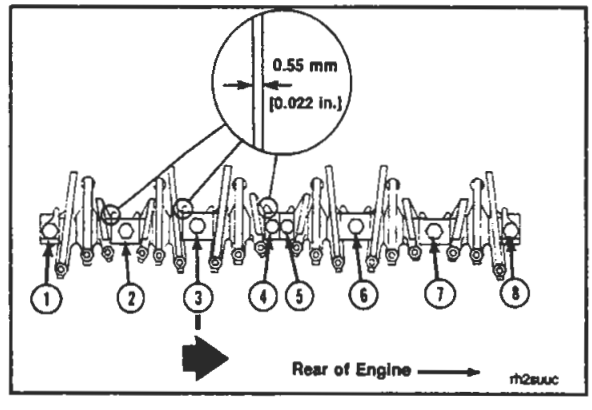


Install a 0.55 mm [0.022 inch] feeler gauge between rocker lever support numbers "2", "3" and "4" and the intake valve levers for cylinders one, two and three.

Push support numbers "1", "2" and "3" toward the rear of the engine and tighten the capscrews.

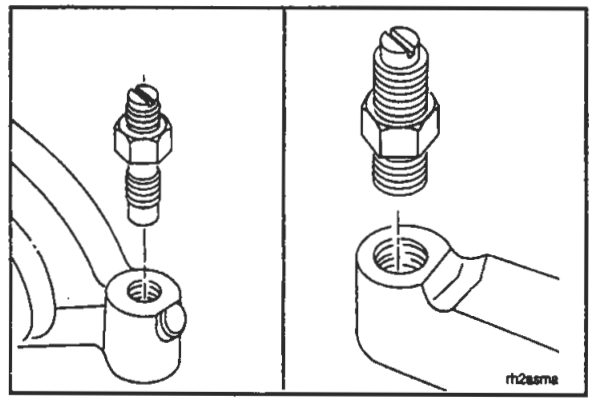
Torque Value: 125 N•m [90 ft-lb]

Note: Measure the front and rear rocker lever assemblies for correct clearance. Check the support capscrews for the correct torque value.

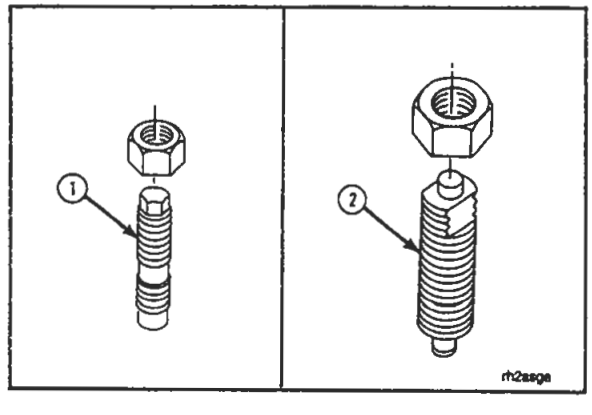


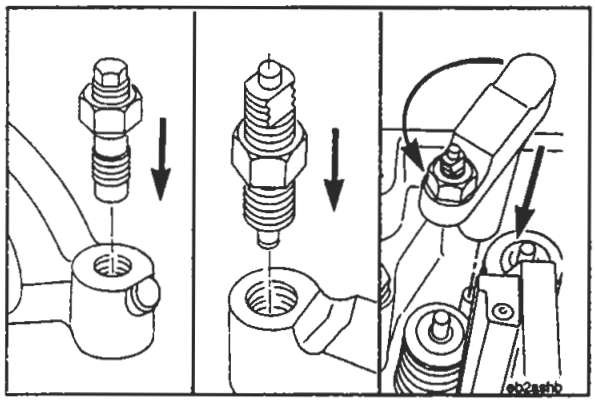
Jacobs® Engine Brake (If Equipped) - Install

New Jacobs® Brake installations require removing the adjusting screws from the injector rocker levers and the exhaust valve crossheads.



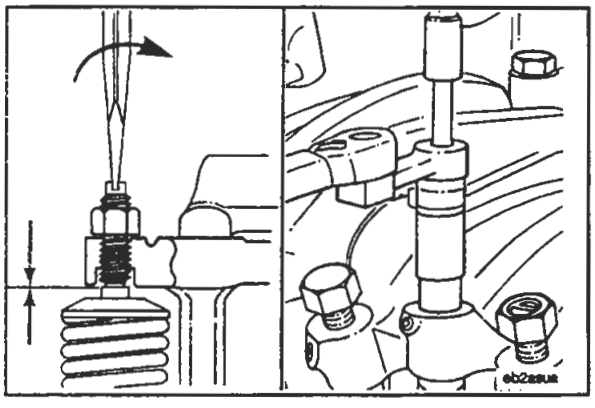
Install the Cummins locknuts on the Jacobs® adjusting screws for the injector rocker levers (1) and the exhaust valve crossheads (2).





Install the adjusting screw assemblies into the rocker levers and crossheads.

Remove the exhaust valve crossheads and turn them 180 degrees. Install the crossheads again with the adjusting screws toward the camshaft side of the engine.



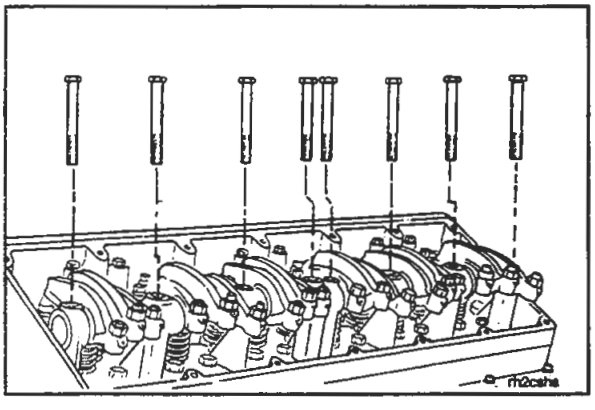
Hold the crosshead in position and turn the crosshead adjusting screw down until it touches the top of the valve stem.

Hold the adjusting screw in position and tighten the locknut.

Torque Value: 40 N•m [30 ft-lb]

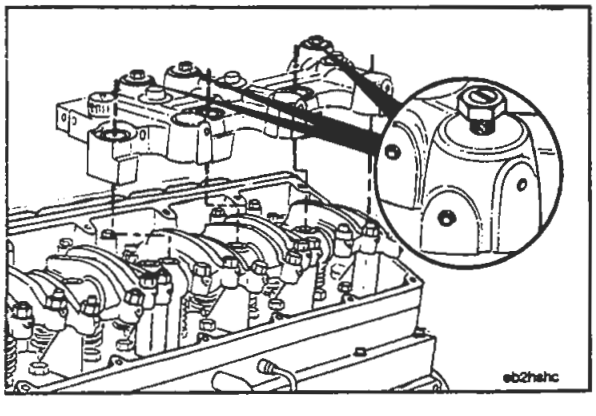
Note: When the Part No. ST-669 Torque Wrench Adapter is used to tighten the locknut, reduce the torque.

Torque Value: 30 N•m [25 ft-lb]



Note: The rocker lever housing **must be** installed before installing the Jacobs® Brake.

Remove the rocker lever support capscrews. These capscrews are replaced by capscrews provided with the Jacobs® Brake assembly.



Loosen the locknuts on the Jacobs® Brake slave pistons.

Note: Make sure the slave pistons are fully retracted.

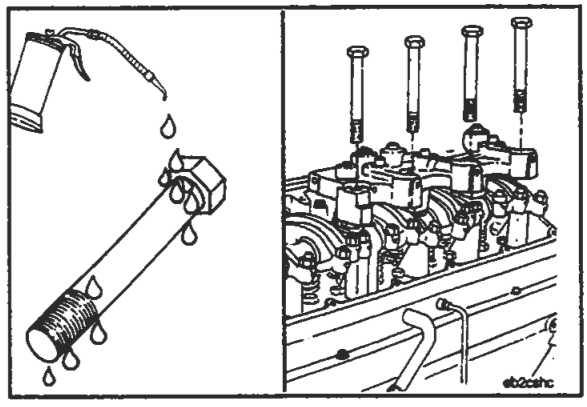
Install the rear Jacobs® Brake housing on the rear rocker lever supports.

Use clean 15W-40 oil to coat the bottom of the capscrew heads and the threads.

Note: Washers are not used with the capscrews.

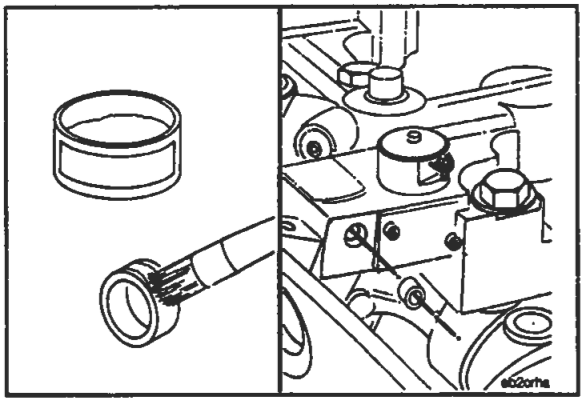
Install the Jacobs® capscrews into the rocker lever supports.

Note: Do not tighten the capscrews.



Apply a film of grease to the oil connector seal.

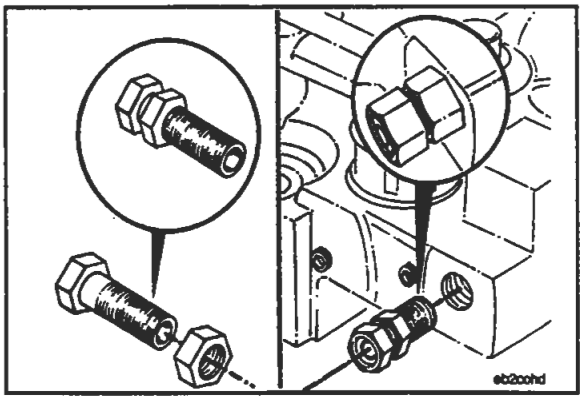
Install the seal into the rear housing.



Install the locknut on the oil connector screw and turn the locknut in as far as possible.

Install the oil connector screw into the front housing.

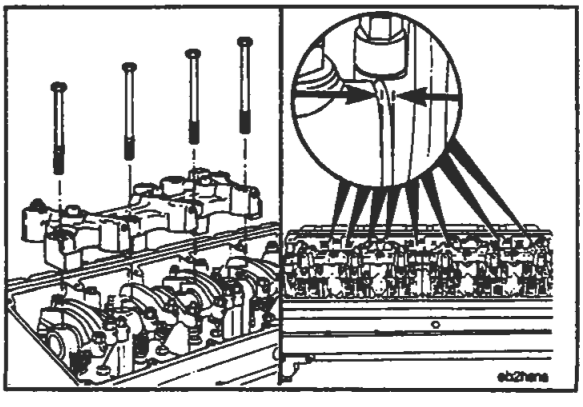
Turn the connector in as far as possible by hand.

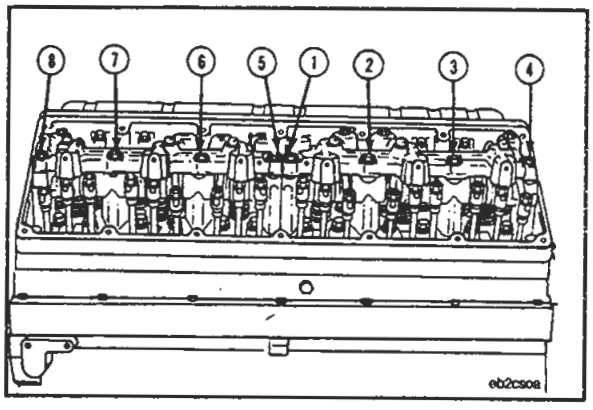


Install the front Jacobs® Brake housing on the front rocker lever supports.

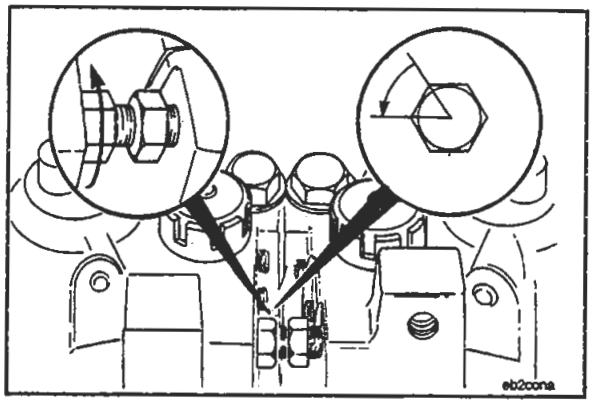
Note: Do not tighten the capscrews.

Adjust the rocker lever side clearance. Refer to the preceding procedure ("Adjust the Rocker Lever Side Clearance").



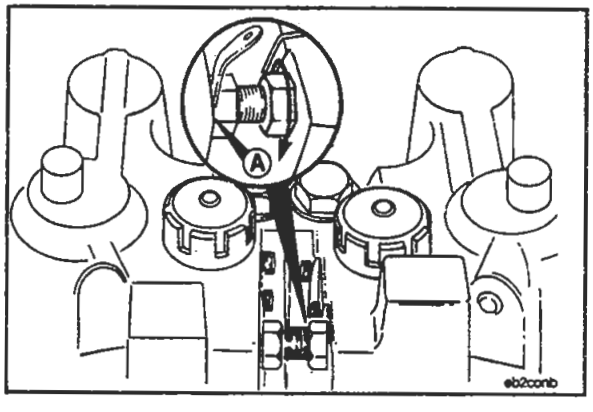


Tighten the rocker lever assembly support capscrews in the sequence shown as the rocker lever side clearance is adjusted.



Turn the oil connector in the front housing **counterclockwise**, until it contacts the rear housing.

Turn the oil connector screw **clockwise** 60 degrees (one hex position on the screw).

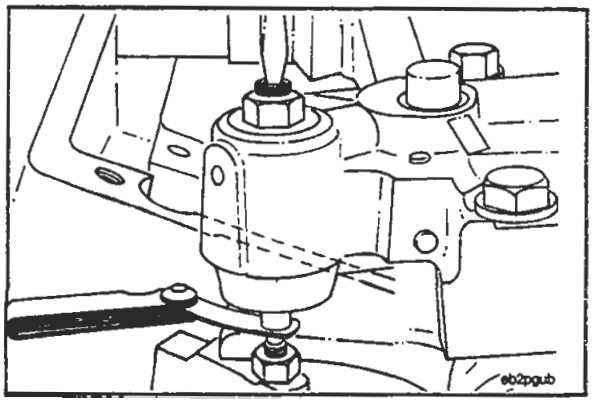


Use a feeler gauge to measure the clearance (A) between the head of the oil connector screw and the rear housing.

Jacobs® Brake Oil Connector Screw Clearance		
mm		In
0.13	MIN	0.005
0.38	MAX	0.015

Tighten the locknut.

Torque Value: 35 N•m [25 ft-lb]



Adjust the Slave Piston Clearance

NOTE: To make sure maximum brake operating efficiency is achieved, and prevent engine damage by piston-to-valve contact, complete the following instructions carefully.

Install the correct feeler gauge between the slave piston and the actuating pin in the crosshead adjusting screw.

Jacobs Brake Slave Piston Clearance			
	mm		In
All Non-CARB Engines (49 States)	0.46	MIN	0.018
All CARB (California)	0.38	MIN	0.015
All 88 L10 (50 State)	0.38	MIN	0.015

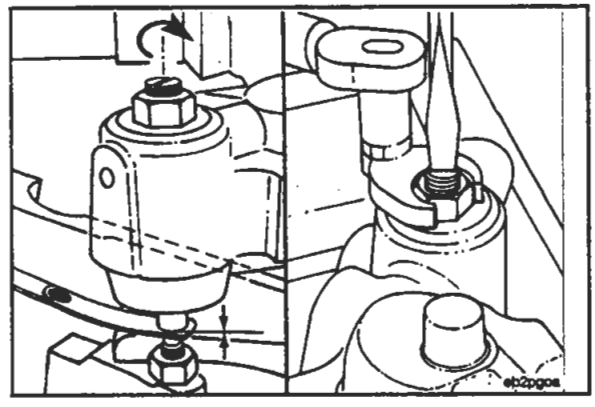
Turn the slave piston adjusting screw down until it touches the feeler gauge.

Hold the adjusting screw in position and tighten the locknut.

Torque Value: 50 N•m [40 ft-lb]

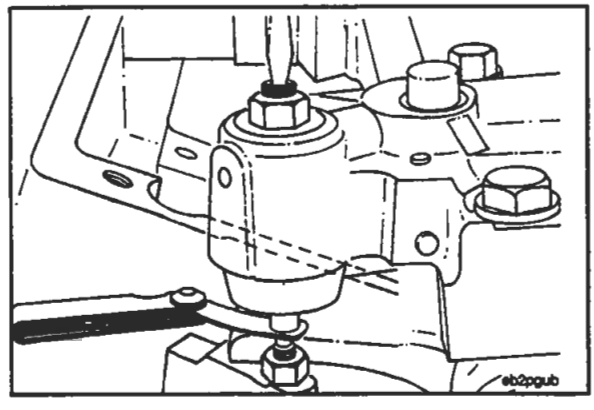
Note: If the Part No. St-669 Torque Wrench Adapter is used to tighten the locknut, reduce the torque.

Torque Value: 45 N•m [35 ft-lb]



Note: Do not tighten the slave piston adjusting screws too tight, the engine can be damaged.

After the slave piston adjusting screw locknut is tightened to the correct torque value, measure the clearance with a feeler gauge again.

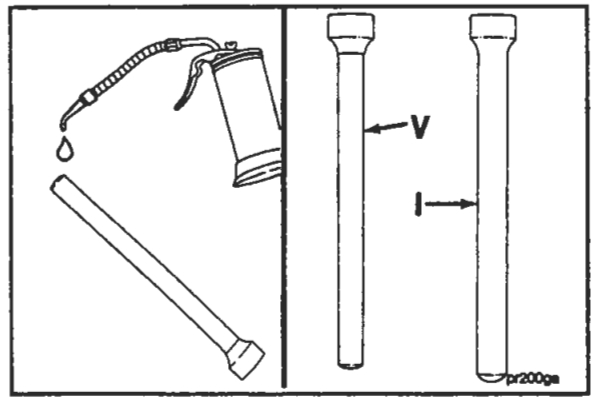


Push Rods - Install

Note: If the engine is equipped with a Jacobs® Brake, the brake **must be** installed and the slave pistons adjusted before the push rods are installed. Refer to the preceeding procedure ("Install the Jacobs® Engine Brake").

Use clean 15W-40 oil to coat the ball end of the push rods.

Note: The injector push rods (I) are larger in diameter and longer than the valve push rods (V).



Note: Do not allow the push rods to fall into the engine. The push rods can be damaged.

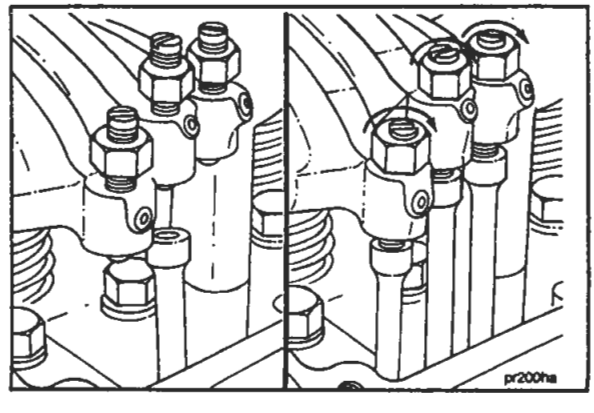
Note: The crankshaft **must be** rotated to install all the push rods.

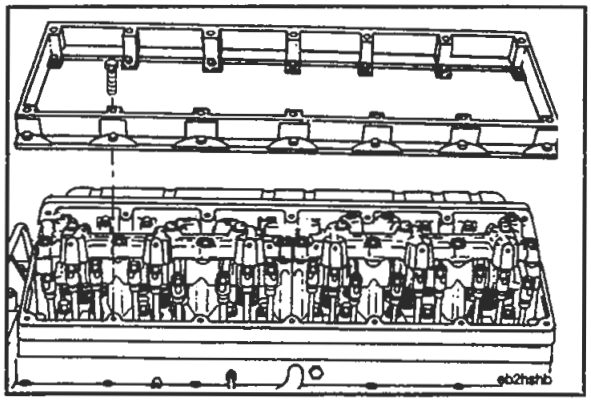
Install the injector push rods.

Install the valve push rods.

Position the push rods under the rocker lever adjusting screws.

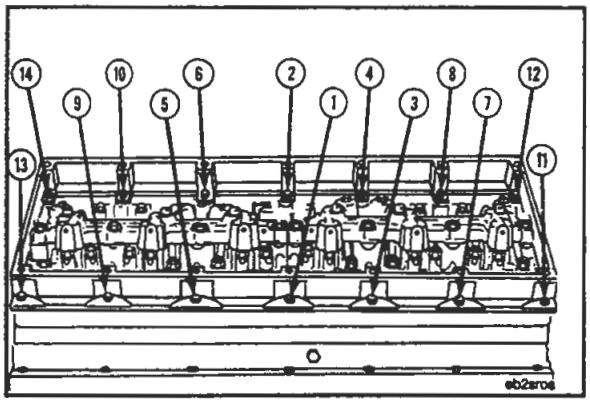
Tighten the adjusting screws enough to hold the push rods in position.





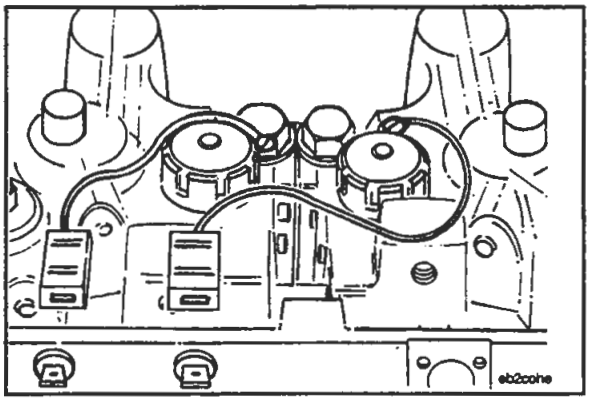
Jacobs® Brake Housing Spacer (If Equipped) - Install

Install the gasket, spacer and the 14 (M8-1.25 X 25) capscrews and washers provided with the Jacobs® Brakes.



Tighten the capscrews in the sequence shown.

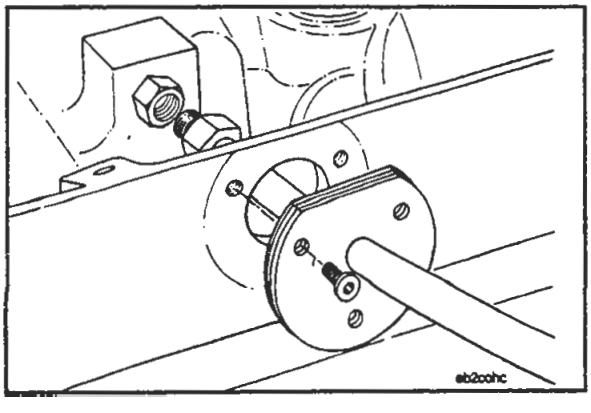
Torque Value: 25 N•m [18 ft-lb]



Install the Jacobs® terminal lead outs in the spacer.

Note: This step required on new installations only.

Connect the two solenoid electrical wires to the terminals on the inside of the spacer.



Install the oil connector supply hose and the three (M6-1.00 X 10) capscrews in the spacer.

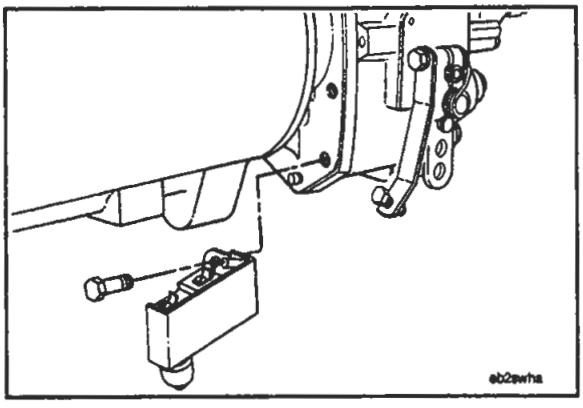
Torque Value: 15 N•m [130 in-lb]

Install and tighten the oil supply hose fitting to the front brake housing.

Note: Install the oil supply hose to the lubricating oil filter head after the filter head is installed.

Install the fuel pump switch following the procedures described in the Jacobs® Engine Brake Installation Manual Model 404.

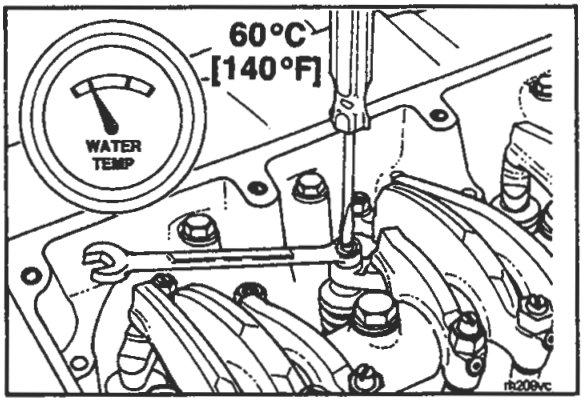
NOTE: This step required for new installations only.



Injectors and Valves - Adjust

Cummins Engine Co., Inc. recommends:

- All overhead (crosshead, valve and injector) adjustments **must be** made when the engine is cold (any stabalized coolant temperature at 60°C [140°F] or below).

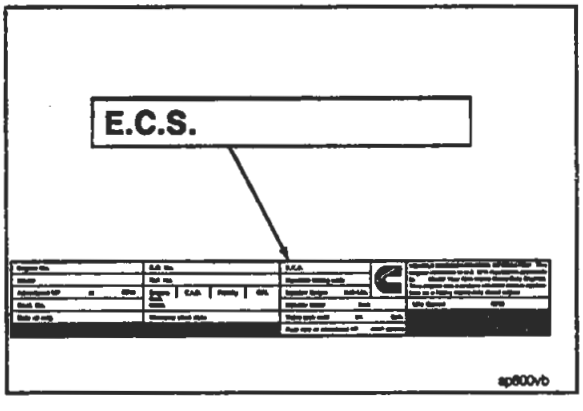


Adjust the Injectors

Some engines are equipped with top-stop injectors and some engines were equipped with non-top-stop injectors.

Engines equipped with top-stop injectors will have "T.S. zero lash" stamped in the injector plunger travel space on the dataplate.

If earlier production engines have had non-top-stop injectors replaced with top-stop injectors, the dataplate plate will be stamped with "FF-104" in the E.C.S. space.



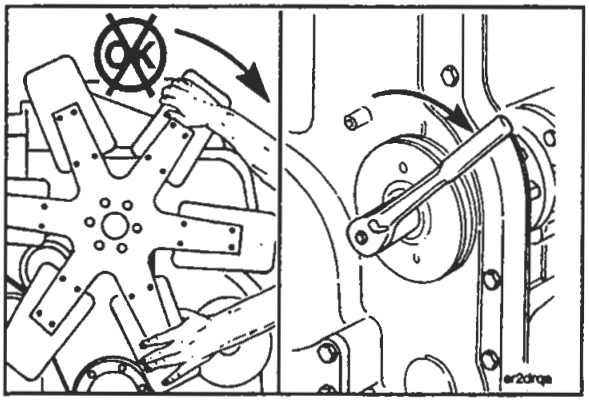
The instructions using cylinder number three to begin the injector adjustments are for illustration purposes. Adjustments can begin with any of the cylinders as shown in the table. Adjust both the injector and valves on the appropriate cylinder at each accessory drive pulley position. Refer to the following procedure ("Adjust the Valves") to adjust the intake and exhaust valves on each cylinder.

VALVE AND INJECTOR ADJUSTMENT SEQUENCE

Bar Engine	Pulley Position	Valves Closed on Cylinder No.	Set Cylinder Valve	Set No. Injector
Start	A	5	5	—
Advance To	B	3	3	6
Advance To	C	6	6	2
Advance To	A	2	2	4
Advance To	B	4	4	1
Advance To	C	1	1	5
Advance To	A	5	—	3

Engine Firing Order 1-5-3-6-2-4

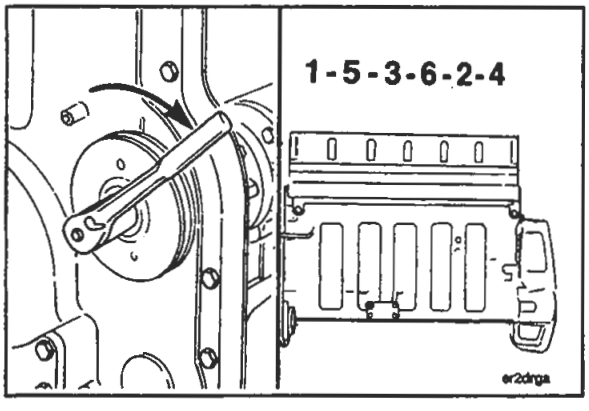
Direction of Engine Rotation: Clockwise (viewed from the front of the engine).



Warning: Do not pull or pry on the fan to rotate the crankshaft; doing so can damage the fan blades. Damaged fan blades can cause premature fan failures which can result in serious personal injury or property damage.

Caution: Inspect the push rods when rotating the crankshaft. Make sure the push rods are in the sockets of the camshaft followers and that the rocker lever adjusting screws are not too tight to prevent damage to the push rods.

Use the accessory drive shaft to rotate the crankshaft.

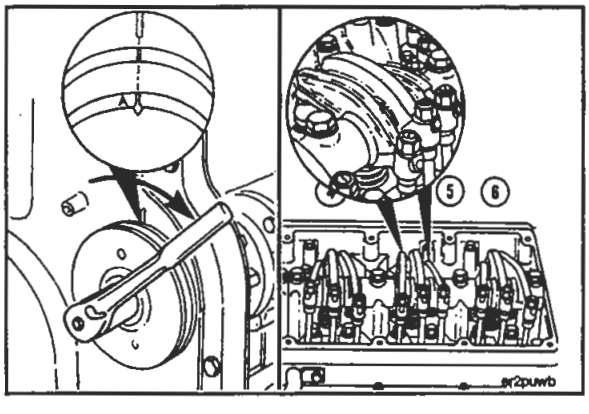


Engine Crankshaft Rotation:

- **Clockwise** (viewed from the front of the engine)

Engine Firing Order:

- 1-5-3-6-2-4



Rotate the crankshaft **clockwise** to align the "A" mark on the accessory drive pulley with the pointer on the gear cover.

Check the valve rocker levers on cylinder number five to see if both valves are closed.

Note: Both valves are closed when both rocker levers are loose and can be moved from side-to-side. If both valves are not closed, rotate the accessory drive pulley one complete revolution and align the "A" mark on the pulley with the pointer on the gear cover again.

VALVE AND INJECTOR ADJUSTMENT SEQUENCE

Bar Engine	Pulley Position	Valves Closed on Cylinder No.	Set Cylinder Valve	Set No. Injector
Start	A	5	5	—
Advance To	B	3	3	6
Advance To	C	6	6	2
Advance To	A	2	2	4
Advance To	B	4	4	1
Advance To	C	1	1	5
Advance To	A	5	—	3

Engine Firing Order 1-5-3-6-2-4

Direction of Engine Rotation: Clockwise (viewed from the front of the engine).

rh200vb

Adjust the injector and valves on cylinder number three first.

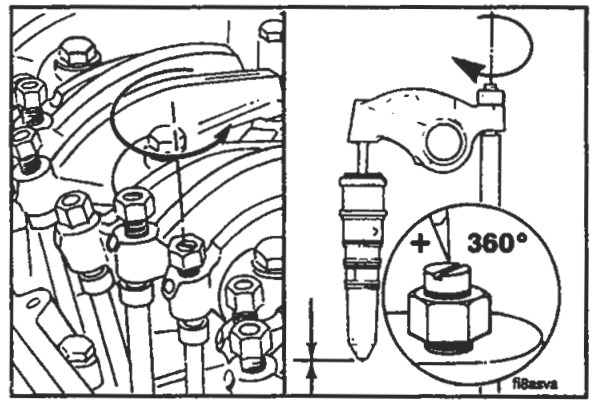
Refer to the accompanying chart for injector adjustment sequence.

Top-Stop Injector Adjustment

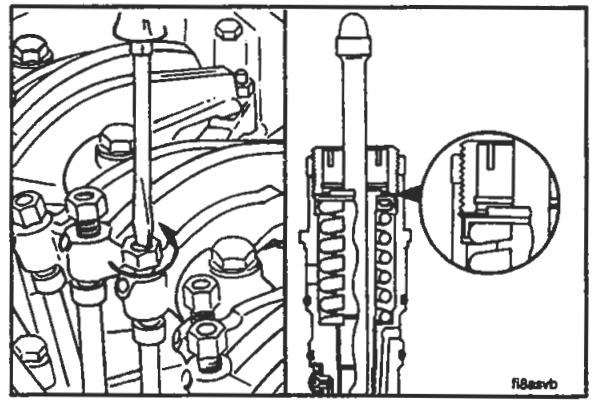
Loosen the locknut on the injector adjusting screw on cylinder number three.

Tighten the adjusting screw until all clearance is removed from the injector train.

Turn the adjusting screw one additional turn to seat the link correctly.

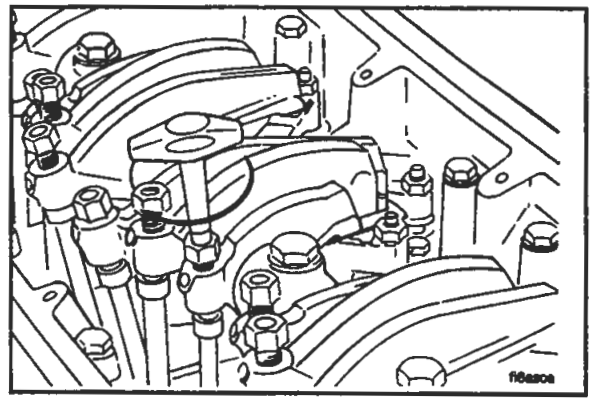


Loosen the adjusting screw until the injector spring retainer washer touches the top-stop screw.



Use the Part No. 3376592 Torque Wrench to tighten the adjusting screw.

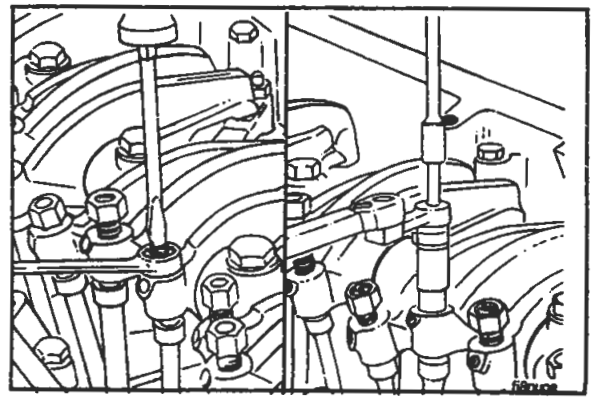
Torque Value: 0.56 to 0.68 N•m [5 to 6 in-lb]

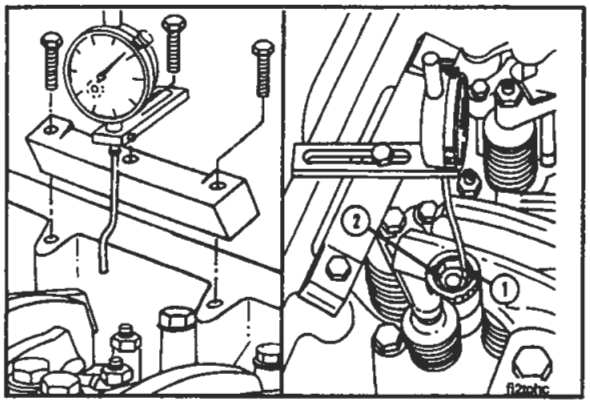


Hold the adjusting screw in this position and use the Part No. ST-669 Torque Wrench Adapter to tighten the locknut.

Torque Value: 45 N•m [35 ft-lb]

Note: If the Part No. ST-669 Torque Wrench Adapter is not used, increase the torque value to 60 N•m [45 ft-lb].





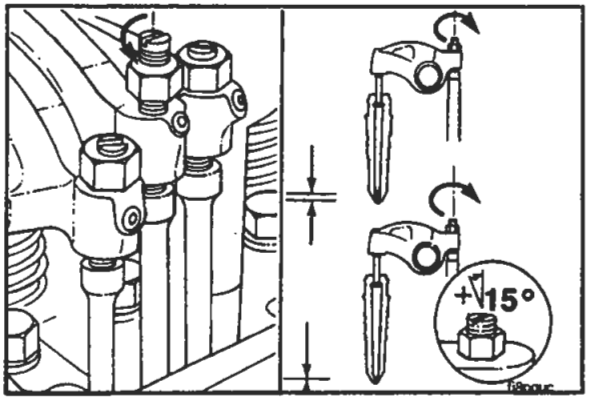
Non-Top-Stop Injector Adjustment

Install the Part No. 3376648 Injector Travel Adjustment Kit on the cylinder to be adjusted with two (M8-1.25 x 30) capscrews.

Note: The Part No. 3376648 Injector Travel Adjustment Kit has two indicator extensions. The long stem extension **must be** used with engines equipped with Jacobs® Engine Brakes.

Place the stem of the dial indicator (1) on the top of the injector plunger (2).

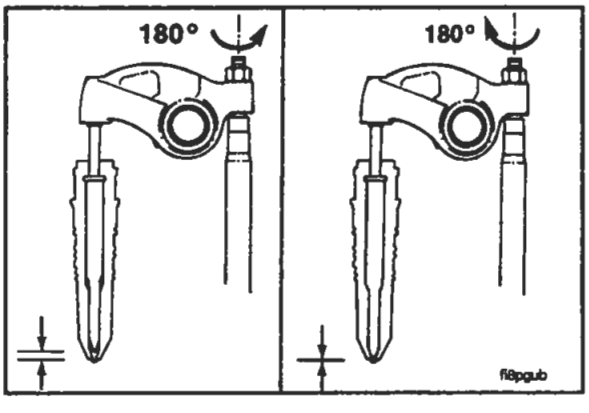
Note: The extension **must be** installed vertically and **not** touching the rocker lever, injector hold-down clamp or engine brake components. The extension **must** move freely.



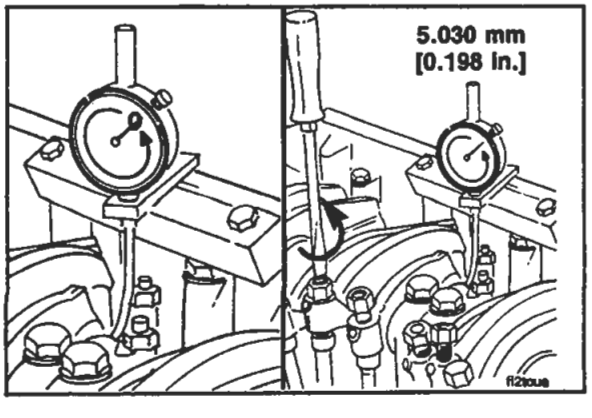
Loosen the locknut on the injector rocker lever adjusting screw.

Use a screwdriver to turn the adjusting screw down until the injector plunger touches the injector cup.

Turn the adjusting screw an additional 15 degrees to squeeze all of the fuel from the cup.



Loosen the adjusting screw one half (1/2) tum and turn the adjusting screw down again.



Set the dial indicator to "0" (zero).

Turn the adjusting screw **counterclockwise** to adjust the injector plunger to the following dial indicator readings.

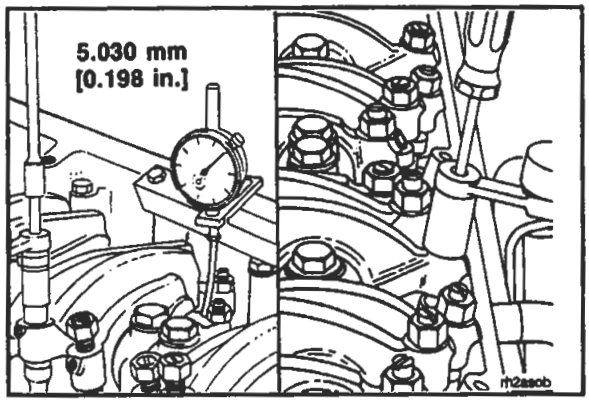
Injector Plunger Travel	
mm	in
5.030	0.198

Hold the adjusting screw in this position and tighten the locknut.

Torque Value: 60 N•m [45 ft-lb]

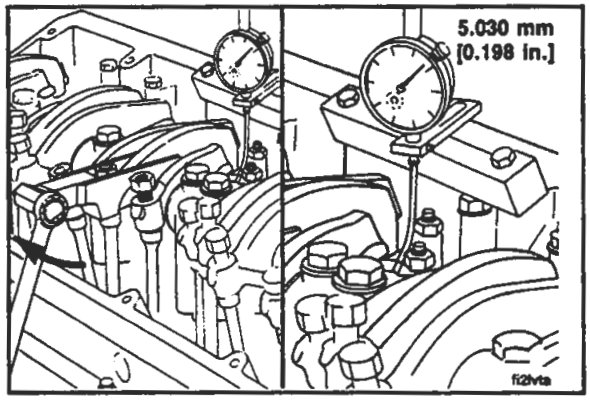
NOTE: If the Part No. ST-669 Torque Wrench Adapter is used, reduce the torque.

Torque Value: 45 N•m [35 ft-lb]

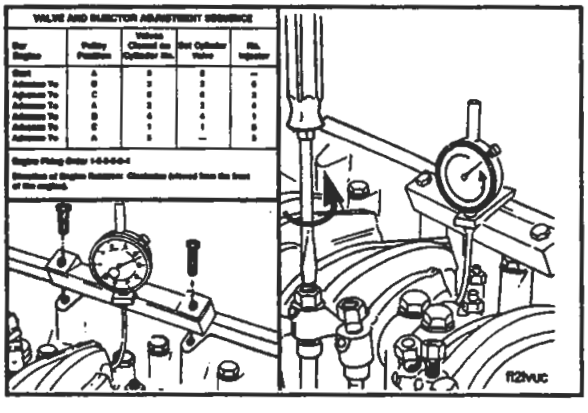


Use the Part No. 3375790 Rocker Lever Actuator to actuate the rocker lever at least two times to make sure the adjustment is within specifications.

Adjust the intake and exhaust valves on this cylinder before moving to the next pulley position. Refer to the following procedures ("Adjust the Valves").



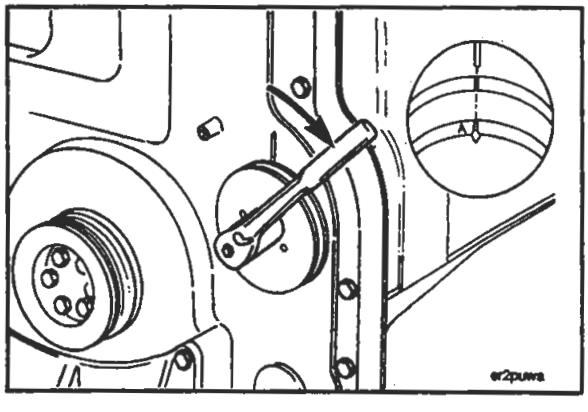
Continue to adjust the remaining injectors and valves by following the adjustment sequence shown in the accompanying chart.

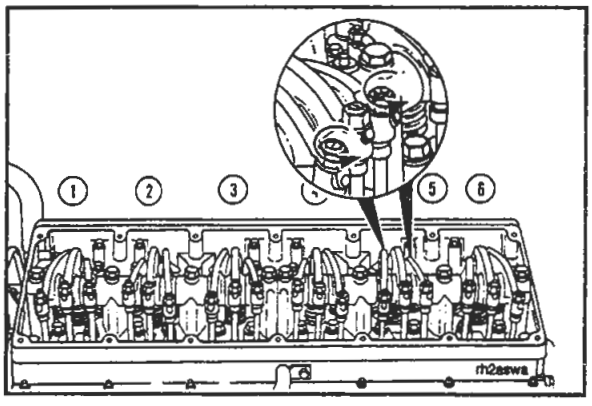


Adjust the Valves

NOTE: Adjust the injectors and valves at each pulley position. Refer to the preceeding procedure ("Adjust the Injectors") to adjust the injectors on each cylinder.

Use the accessory drive shaft to rotate the crankshaft and align the "A" mark on the accessory drive pulley with the pointer on the gear cover.

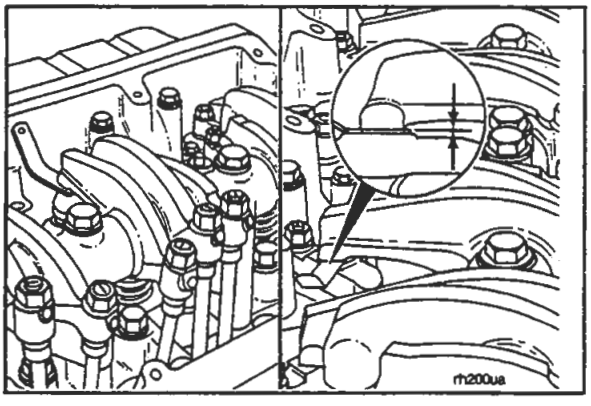




Check the valve rocker levers on cylinder number five to see if both valves are closed.

NOTE: Both valves are closed when both rocker levers are loose and can be moved from side-to-side. If both valves are not closed, rotate the accessory drive pulley one complete revolution and align the "A" mark on the pulley with the pointer on the gear cover again.

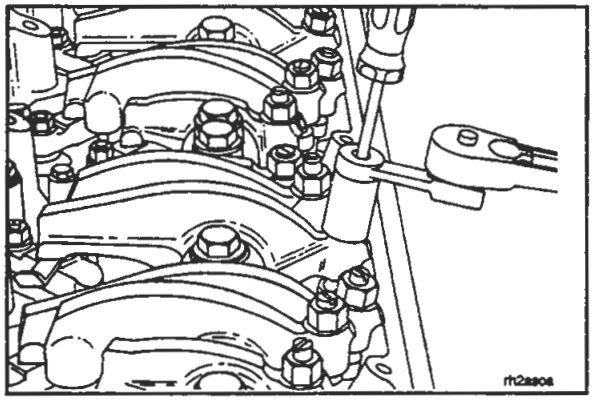
Loosen the adjusting screw locknuts on the valve rocker levers.



Insert a feeler gauge between the rocker lever and the crosshead.

Valve Clearance			
Intake		Exhaust	
mm	in	mm	in
0.36	0.014	0.69	0.027

Turn the adjusting screw down until the rocker lever touches the gauge.



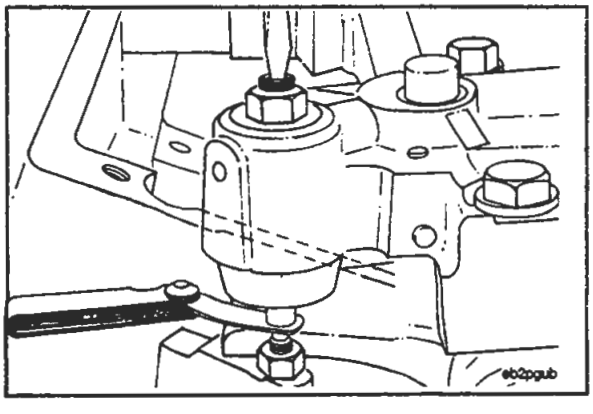
Hold the adjusting screw in position and tighten the locknut.

Torque Value: 60 N•m [45 ft-lb]

NOTE: If the Part No. ST-669 Torque Wrench Adapter is used, reduce the torque.

Torque Value: 45 N•m [35 ft-lb]

NOTE: After the adjusting screw locknuts are tightened, measure the valve clearance again to make sure it is correct.



NOTE: If the engine is equipped with Jacobs® Engine Brakes, make sure the slave piston clearance is set correctly. Refer to "Install the Jacobs® Engine Brake" to adjust the slave piston clearance.

Adjust the remaining injectors and valves in the sequence shown in the accompanying chart.

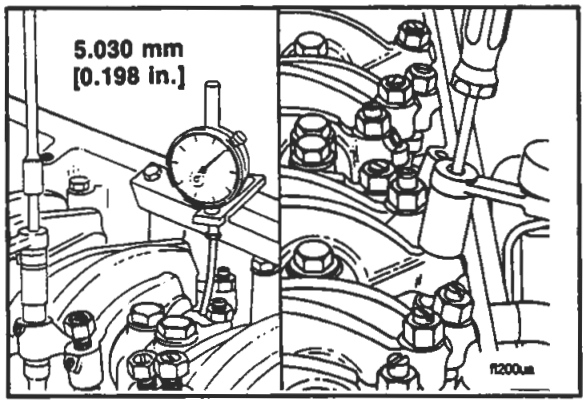
VALVE AND INJECTOR ADJUSTMENT SEQUENCE				
Bar Engine	Pulley Position	Valves Closed on Cylinder No.	Set Cylinder Valve	Set No. Injector
Start	A	5	5	—
Advance To	B	3	3	6
Advance To	C	6	6	2
Advance To	A	2	2	4
Advance To	B	4	4	1
Advance To	C	1	1	5
Advance To	A	5	—	3

Engine Firing Order 1-5-3-6-2-4

Direction of Engine Rotation: Clockwise (viewed from the front of the engine).

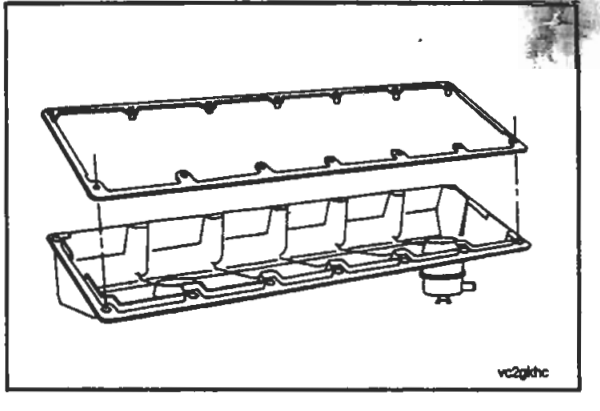
rh200vb

After all injectors and valves have been adjusted, refer to the valve and injector adjustment sequence table to measure the injector and valve adjustments on at least two cylinders and adjust again if necessary to compensate for any camshaft or rocker lever deflection that can have occurred since the initial adjustments.



Rocker Lever Cover - Install

Install a new gasket on the cover.

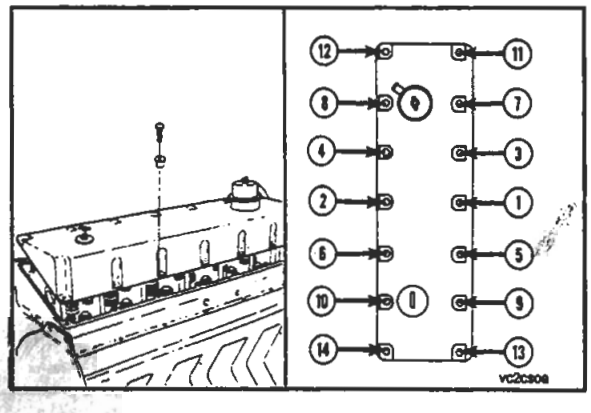


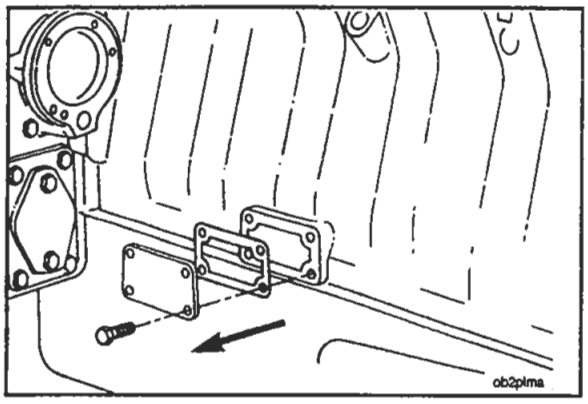
Install the cover on the rocker lever housing.

Install the 14 isolators and (M8-1.25 X 30) capscrews in the cover.

Tighten the capscrews in the sequence shown.

Torque Value: 15 N•m [130 in-lb]

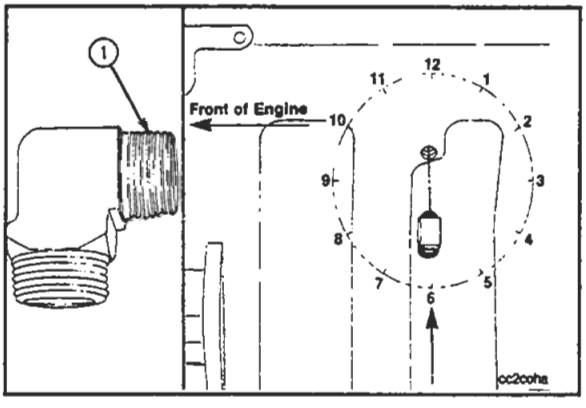




Hand Hole Cover (Fuel Pump Side of Engine) - Install

Use a new gasket and install the hand hole cover and the four (M10-1.50 X 20) capscrews.

Torque Value: 45 N•m [35 ft-lb]

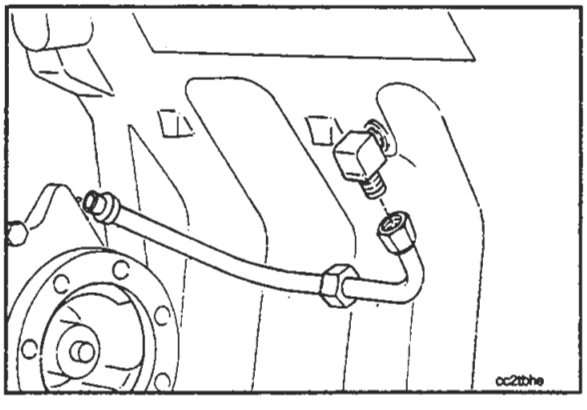


Air Compressor Coolant Inlet Tube Fitting - Install

Apply a thin coat of Part No. 3375066 Pipe Sealant to the threads (1)of the 90 degree fitting.

Install and tighten the fitting into the cylinder block.

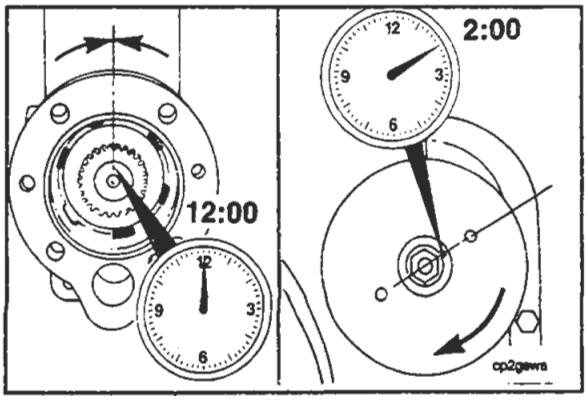
Note: The fitting must be installed with the threaded end at the 6:00 o'clock position.



Note: Make sure the rubber grommets are **not** cut or torn when they are installed on the coolant inlet tube. Coolant leaks will result.

Install new rubber grommets on the air compressor coolant inlet tube.

Install and tighten the coolant inlet tube on the fitting.



Air Compressor - Install

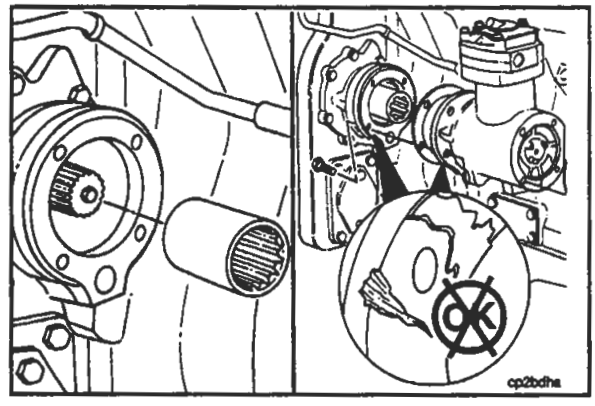
Note: To reduce noise and vibration, the air compressor **must be** timed with the accessory drive.

Position the timing mark on the air compressor crankshaft at the 12:00 o'clock position.

Position the accessory drive shaft dowel pin at the 2:00 o'clock (accessory drive pulley at "TDC") position as viewed from the front of the engine.

Install the spline coupling on the accessory drive shaft.

Make sure the gasket surfaces of the accessory drive and air compressor are clean and **not** damaged.



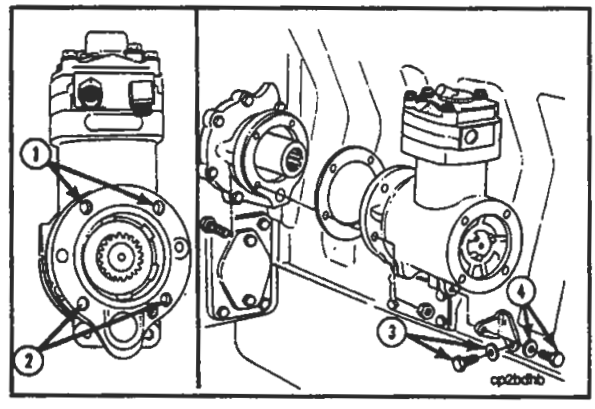
Use a new gasket and install the air compressor with two (7/16-14 X 1.75) capscrews and nuts at position (1) and two (7/16-14 X 1.50) capscrews and nuts at position (2).

Torque Value: 65 N•m [50 ft-lb]

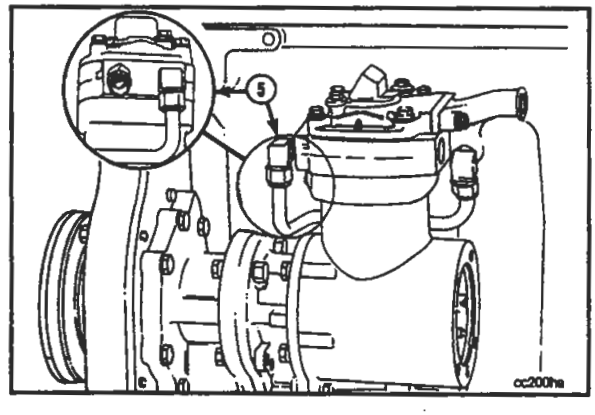
Install the support bracket with one (3/8-16 X 1) capscrew (3) and washer and one (M10-1.50 X 30) capscrew (4) and washer.

Torque Value: 45 N•m [35 ft-lb]

Note: The air compressor support bracket is **not** required on present production engines.



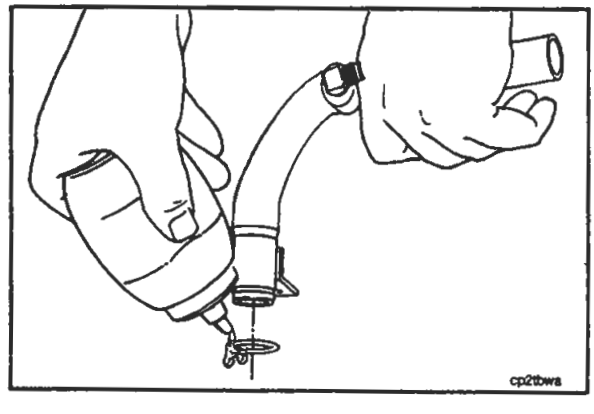
Install the coolant inlet tube on the air compressor fitting (5) and tighten.

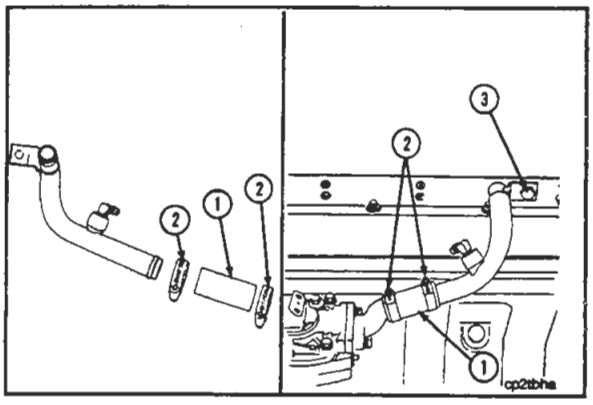


Air Compressor Air Supply Tube - Install

Install the o-ring on the air supply tube.

Use vegetable oil to lubricate the o-ring.





Install a new hose (1) and two new 1 3/4 inch hose clamps (2) on the tube.

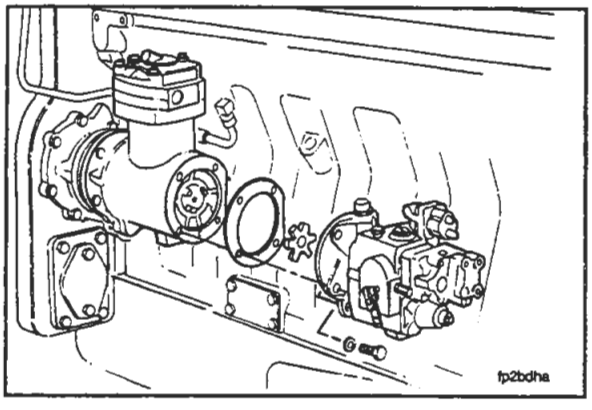
Use one (M10-1.50 X 20) capscrew (3) to install the tube into the cylinder head.

Torque Value: 45 N•m [35 ft-lb]

Install the hose (1) on the air compressor air supply connection.

Tighten the hose clamps (2).

Torque Value: 5 N•m [40 in-lb]



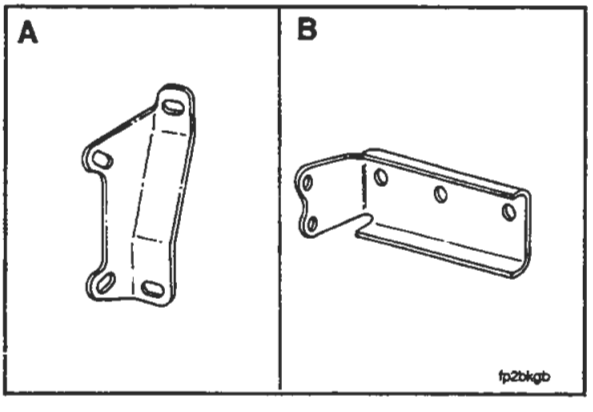
Fuel Pump (with Air Compressor) - Install

Install the spider coupling to the end of the air compressor crankshaft.

Use a new gasket to install the fuel pump.

Install the four (7/16-14 X 1 1/4) 12 point capscrews and tighten.

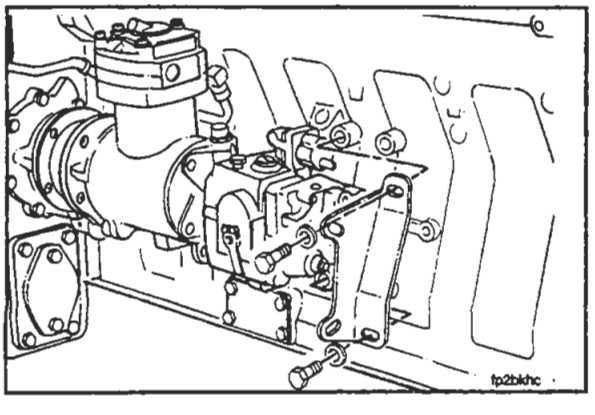
Torque Value: 45 N•m [35 ft-lb]



Two styles of fuel pump support brackets are being used:

- Style (A)
- Style (B)

NOTE: Use of style (A) bracket requires the present production style fuel pump housing and cylinder block. The new hardware went into production January 1985 with engine serial number 34515379.



Install Style "A" Fuel Pump Support Bracket

Install the support bracket to the cylinder block with two (M10-1.50 X 25) capscrews with washers.

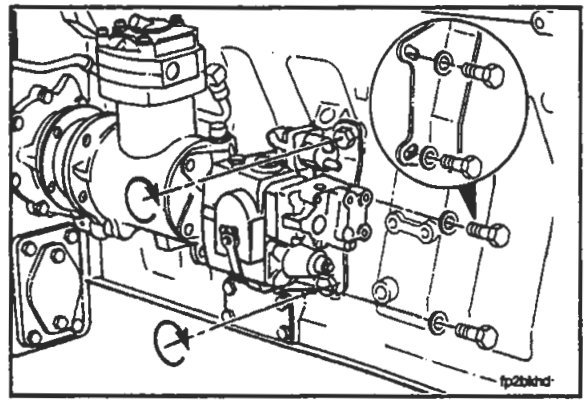
NOTE: Do not tighten the capscrews until the support bracket capscrews are installed and tightened into the fuel pump housing.

Install two (1/4-20 X 7/8) support capscrews with washers into the fuel pump housing.

Torque Value: 11 N•m [95 in-lb]

Tighten the two (M10-1.50 X 25) capscrews into the cylinder block.

Torque Value: 45 N•m [35 ft-lb]

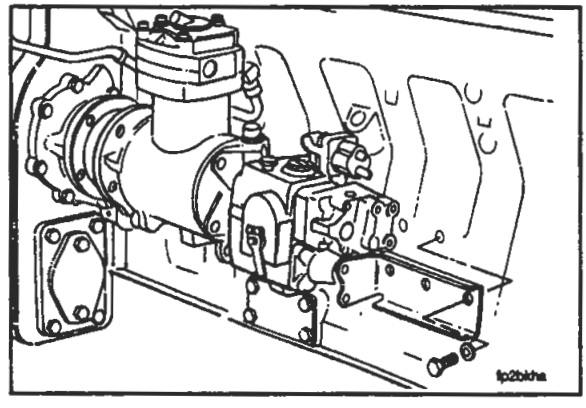


Install Style "B" Fuel Pump Support Bracket

Install the support bracket to the cylinder block with two (M10-1.50 X 25) capscrews with washers.

NOTE: Do not tighten the capscrews until the support bracket capscrews are installed and tightened in the fuel pump housing.

Remove the two spring pack capscrews from the fuel pump.

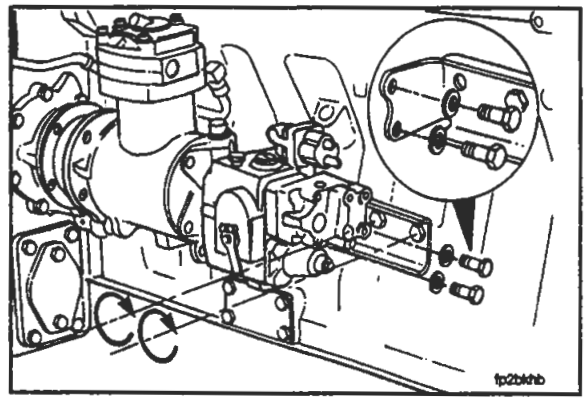


Use two (1/4-20 X 3/4) capscrews with washers to install the support bracket to the fuel pump.

Torque Value: 15 N•m [130 in-lb]

Tighten the two (M10-1.50 X 25) capscrews into the cylinder block.

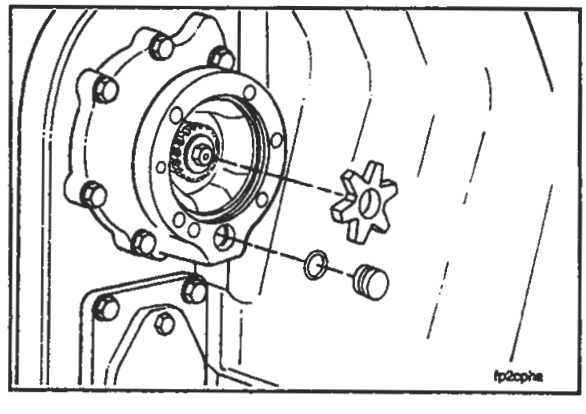
Torque Value: 45 N•m [35 ft-lb]

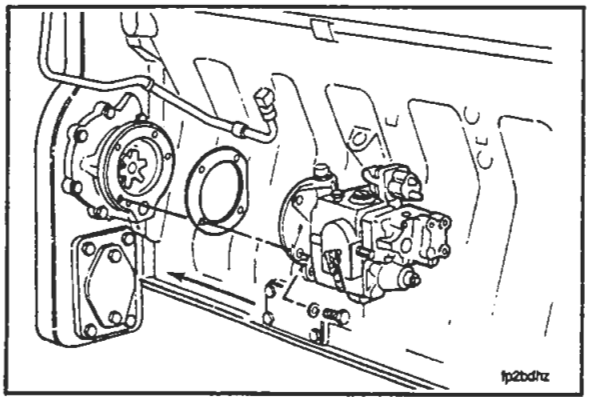


Fuel Pump (without Air Compressor) - Install

Install the spider coupling to the end of the accessory drive shaft.

Install the new o-ring on the accessory drive oil drain plug and install the plug into the accessory drive.

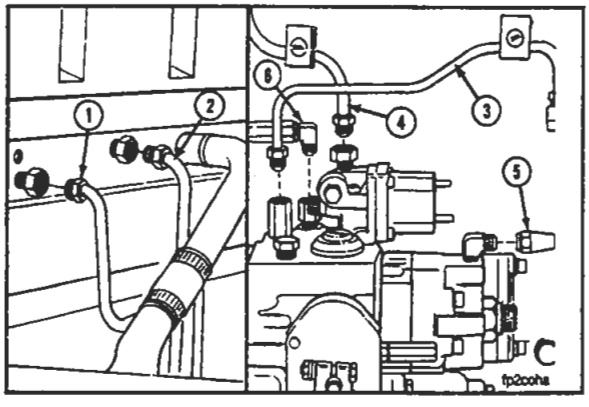




Use a new gasket and install the fuel pump on the accessory drive.

Install four (M10-1.50 X 45) capscrews and four (M10-1.50) nuts.

Torque Value: 45 N•m [35 ft-lb]



Fuel Pump Plumbing - Install

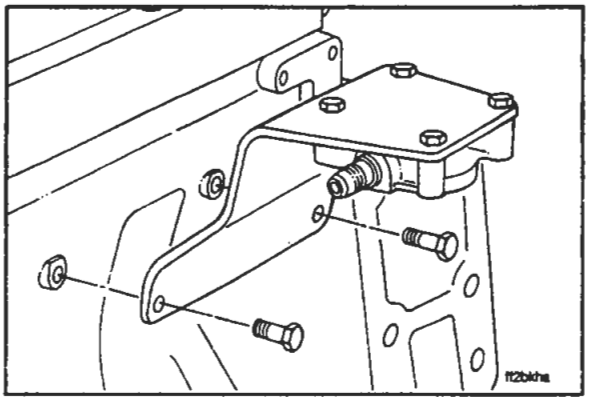
Install the fuel supply tube (1) to the fitting in the cylinder head.

Install the fuel drain tube to the fitting in the cylinder head (2) and to the fitting in the fuel pump (3).

Install the fuel rail supply tube (4) to the fitting in the fuel pump.

Install the fuel gear pump cooling tube (5) to the fitting in the gear housing.

Install the AFC air supply hose (6) to the fitting in the air compressor air supply tube.



Fuel Filter Head and Bracket - Install

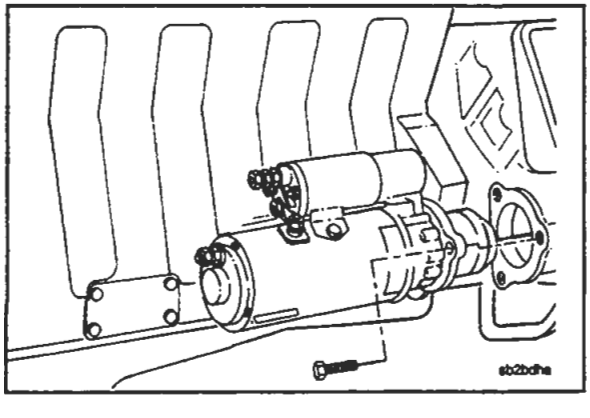
Use three (M10-1.50 X 30) capscrews to install the bracket to the cylinder block.

Torque Value: 45 N•m [35 ft-lb]

Use four (3/8-16 X 1.0) capscrews to install the filter head to the bracket.

Torque Value: 45 N•m [35 ft-lb]

Install the fuel supply hose to the filter head and the fuel pump.



Starting Motor - Install

Note: The mounting capscrews for the starting motor will be metric (M16-2.00 X 45 12 point) or U.S. Customary (5/8-11 X 3/4 hex head) depending on the flywheel housing used. Make sure to use the correct capscrews to avoid damage to the threaded holes in the flywheel housing.

Note: Install the spacer if required.

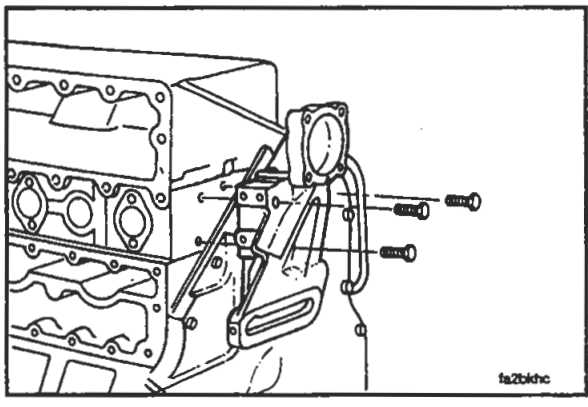
Install the starting motor into the flywheel housing bore with the three capscrews.

Torque Value: 190 N•m [140 ft-lb]

Fan Hub Support (Belt Driven Fan) - Install

Install the fan hub support with three (M12-1.75 X 80) capscrews.

Torque Value: 75 N•m [55 ft-lb]

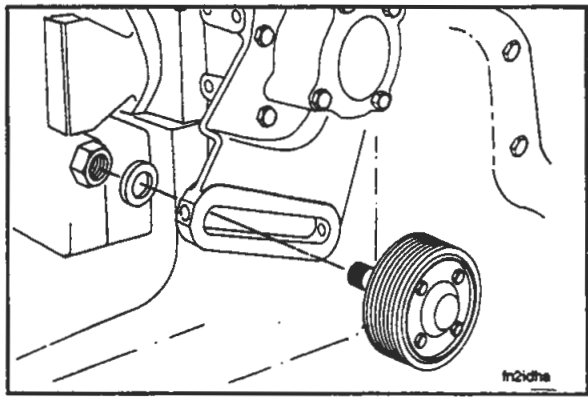


Fan Idler Pulley (Belt Driven Fan) - Install

Install the idler pulley into the fan hub support bracket.

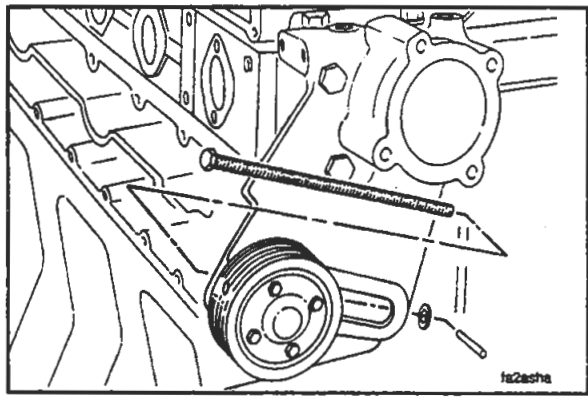
Install the washer and locknut on the idler pulley shaft.

Note: Do not tighten the locknut until the fan drive belt has been installed and adjusted.



Install the (M10-1.50 X155) adjusting screw into the idler pulley shaft.

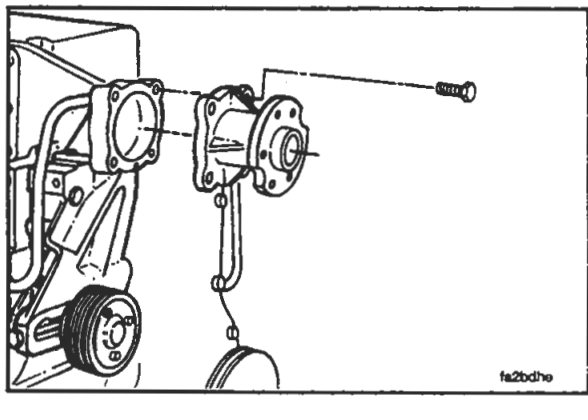
Turn the adjusting screw in far enough to install the washer and roll pin into the shaft at the bottom of the fan hub support bracket.

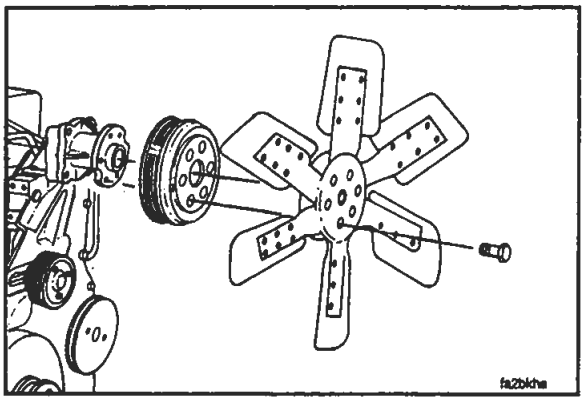


Fan Hub (Belt Driven Fan) - Install

Install the fan hub on the fan hub support bracket with four (M10-1.50 X 35) capscrews.

Torque Value: 45 N•m [35 ft-lb]





Fan Pulley and Fan - Install

Note: Use six (3/8-16 X 1.25) capscrews to install the pulley on the fan hub if a fan is not installed.

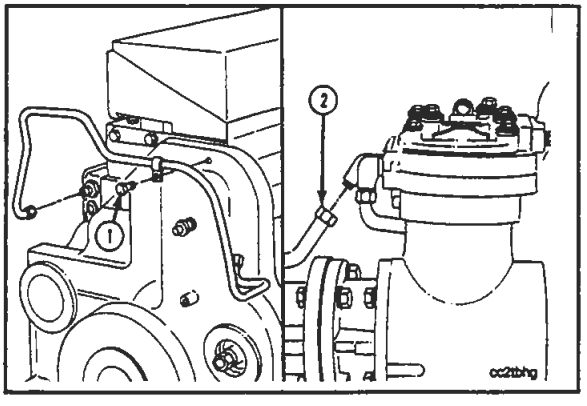
Install the fan on the fan clutch assembly if equipped.

Tighten the mounting nuts to the fan clutch manufacturer's specifications.

Install the fan assembly and pulley on the fan hub with six (3/8-16) minimum SAE grade 8 capscrews.

Note: Capscrew length will vary with the type of fan assembly used.

Torque Value: 45 N•m [35 ft-lb]



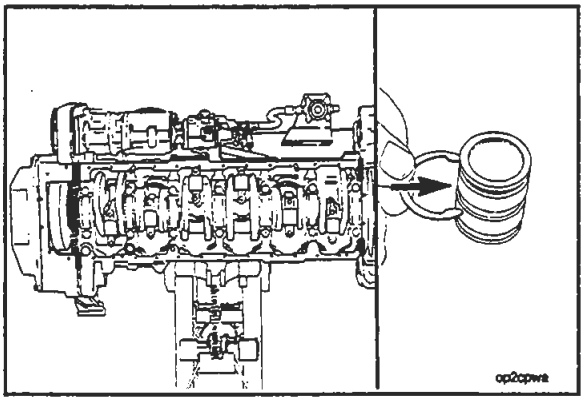
Air Compressor Coolant Outlet Tube - Install

Remove capscrew (1) from the gear cover.

Use the capscrew to install the coolant outlet clamp and tube to the engine.

Torque Value: 45 N•m [35 ft-lb]

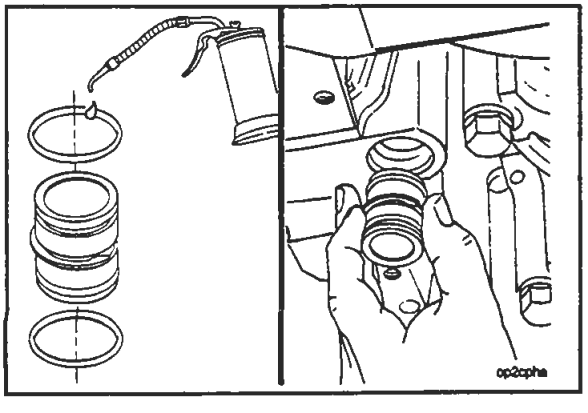
Install and tighten the tube connection to the air compressor fitting (2).



Lubricating Oil Pan - Install

Rotate the engine on the rebuild stand.

Install the spring clip on the oil transfer tube.



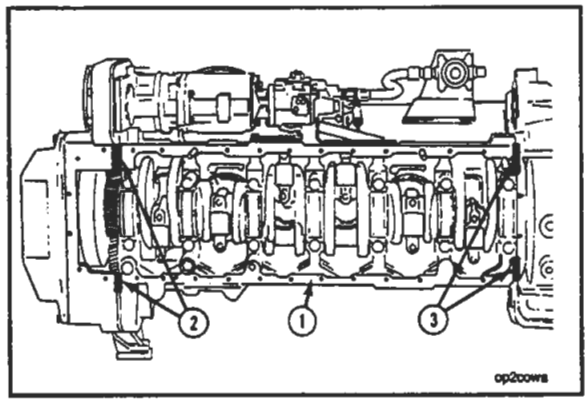
Install two new o-rings on the oil transfer tube.

Use clean 15W-40 oil to lubricate the o-rings.

Install the oil transfer tube into the cylinder block.

Apply a bead of Part No. 3801048 Cummins Sealant to the oil pan mounting surfaces of the cylinder block (1), gear support plate (2) and flywheel housing (3).

Install two Part No. 3376488 Guide Pins into the cylinder block.

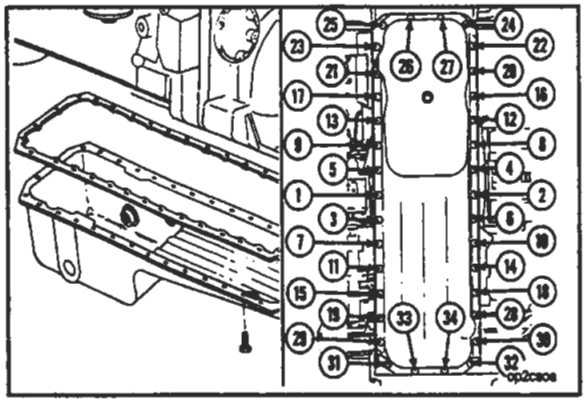


Note: Make sure the transfer tube is aligned with the oil pan suction tube when installing the oil pan.

Use a new gasket and install the oil pan.

Install and tighten the 34 (M10-1.50 X 25) capscrews in the sequence shown.

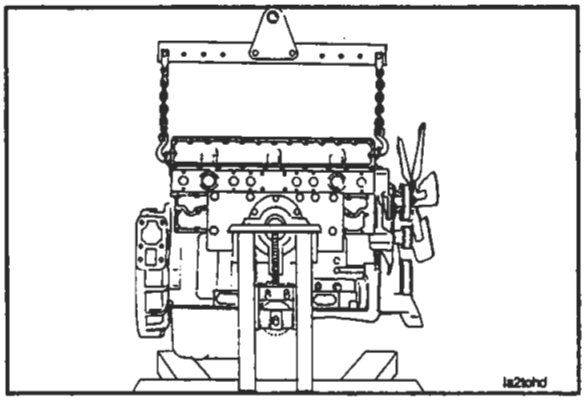
Torque Value: 45 N•m [35 ft-lb]



Engine - Remove from the Rebuild Stand

Warning: The engine weighs approximately 855 kg [1950 lb]. Personal injury can result.

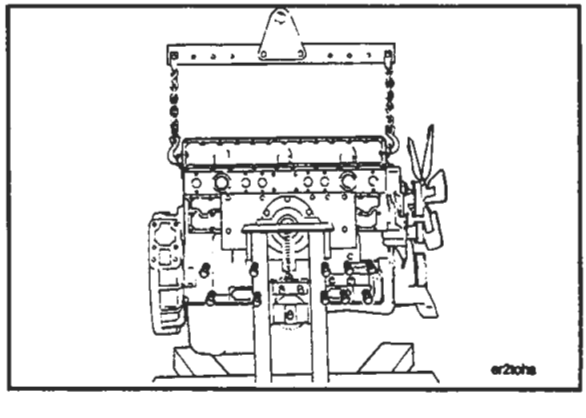
Use the Part No. 3822512 Lifting Fixture and a hoist with a minimum lifting capacity of 1.8 M ton [2.0 tons] to lift the engine.

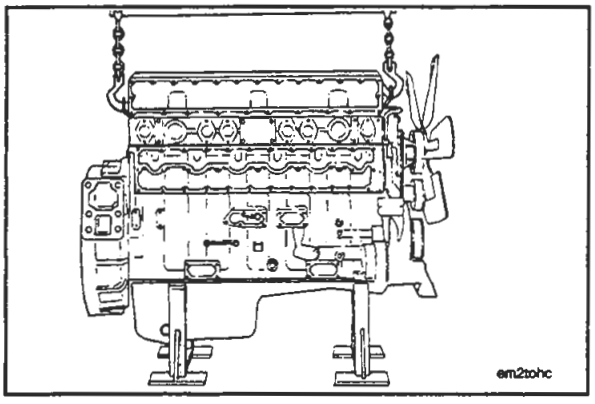


Warning: The engine can move or drop a small distance as it is removed from the rebuild stand. Personal injury can result.

Use the hoist and lifting fixture to apply lifting tension to the engine.

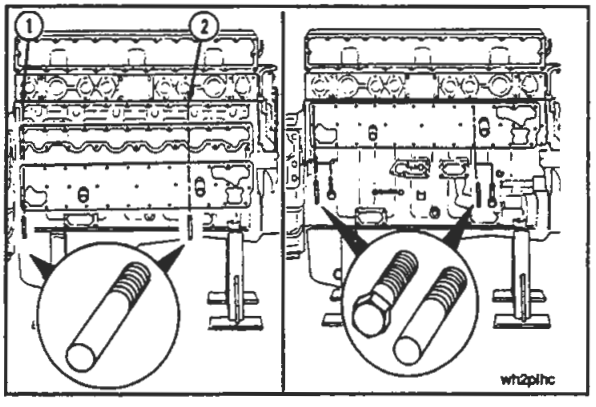
Remove the ten capscrews that hold the engine to the adapter plate.





Lower the engine to the Part No. 3376057 Engine Support Stands or a shipping skid with the hoist.

Remove the hoist and lifting fixture from the engine.



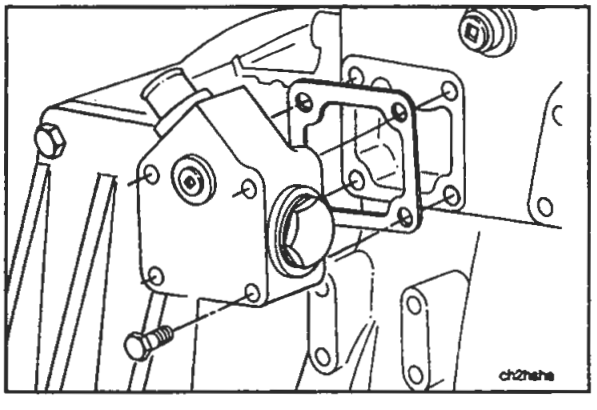
Water Header Plate - Install

Install two Part No. 3376488 Guide Pins at points (1) and (2).

Use a new gasket and install the water header plate with 18 (M10-1.50 X 22) capscrews as shown.

Note: The capscrews are not tightened to their final torque value at this time.

Torque Value: 20 N•m [15 ft-lb]

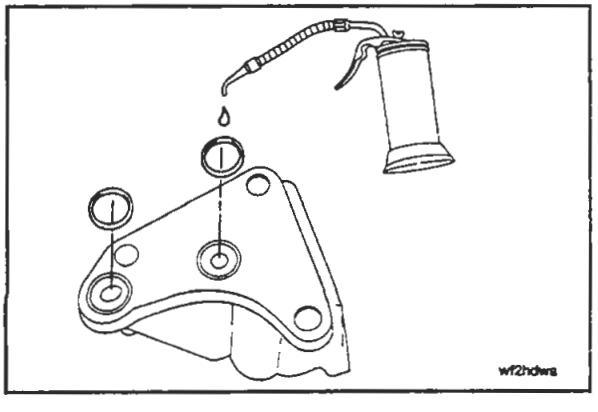


Water Heater Housing - Install

Use a new gasket and install the water heater housing with four (M10-1.50 X 90) capscrews.

Note: The capscrews **are not** tightened to their final torque value at this time.

Torque Value: 20 N•m [15 ft-lb]



Water Filter Head - Install

Use clean 15W-40 oil to lubricate the two new O-rings.

Install the o-rings into the filter head.

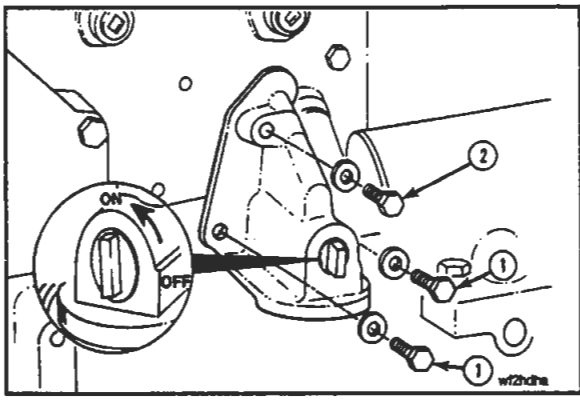
Install the filter head with two (M10-1.50 X 35) capscrews at points (1) and one (M10-1.50 X 65) capscrew at point (2).

Note: The capscrews **are not** tightened to their final torque value at this time.

Torque Value: 20 N•m [15 ft-lb]

Caution: The control valve must be in the "on" position to prevent engine damage.

Turn the control valve to the "on" position.



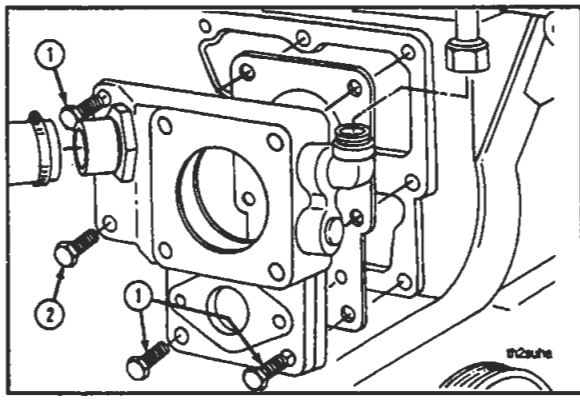
Thermostat Housing Support (Conventional Aftercooling Only) - Install

Use a new gasket and install the support with three (M10-1.50 X 35) capscrews at points (1) and one (M10-1.50 X 50) capscrew at point (2).

Note: The capscrews **are not** tightened to their final torque value at this time.

Torque Value: 20 N•m [15 ft-lb]

Install the air compressor water outlet tube to the fitting on the thermostat housing support.

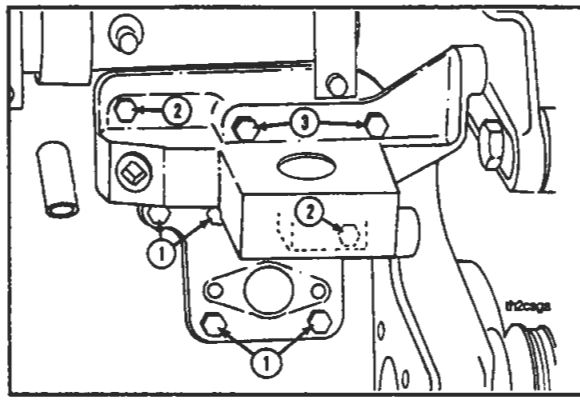


Thermostat Housing (Optimized Aftercooling) - Install

Use a new gasket and install the thermostat housing with four (M10-1.50 X 35) capscrews (1), two (M10-1.50 X 65) capscrews (2) and two (M10-1.50 X 85) capscrews (3).

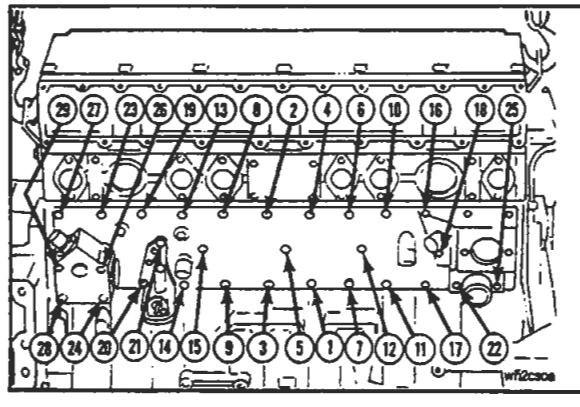
Note: The capscrews **are not** tightened to their final torque value at this time.

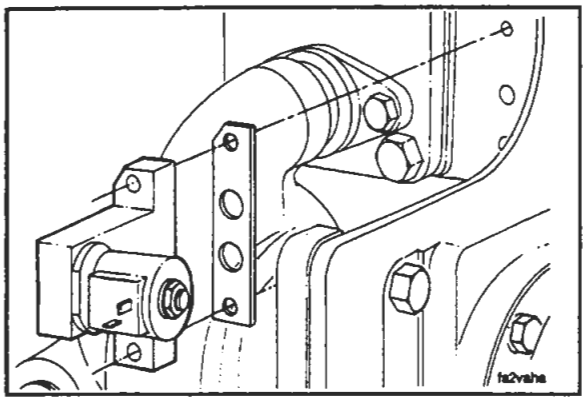
Torque Value: 20 N•m [15 ft-lb]



Tighten the water header plate capscrews in the sequence shown.

Torque Value: 55 N•m [40 ft-lb]

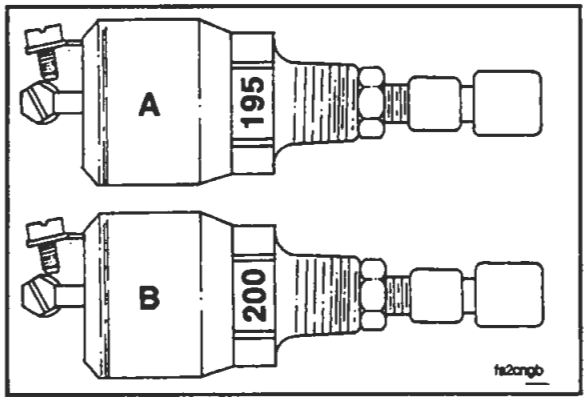




Control Valve and Sensor for the Gear Driven Fan (If Equipped) - Install

Use a new gasket and install the control valve on the cylinder block with two (M6-1.00 X 20) capscrews.

Torque Value: 10 N•m [90 in-lb]

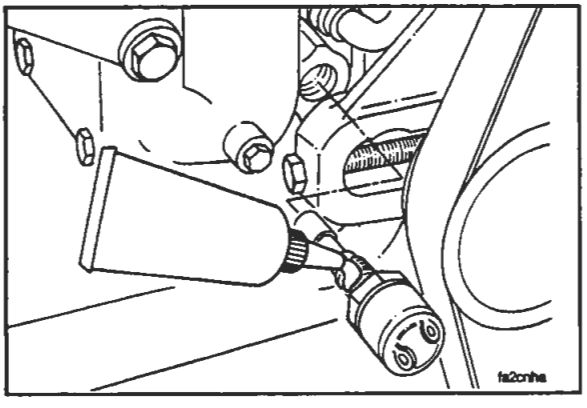


The temperature sensor used on L10 engines has a nominal temperature setting of:

A. Conventional Aftercooling, 91°C [195°F]

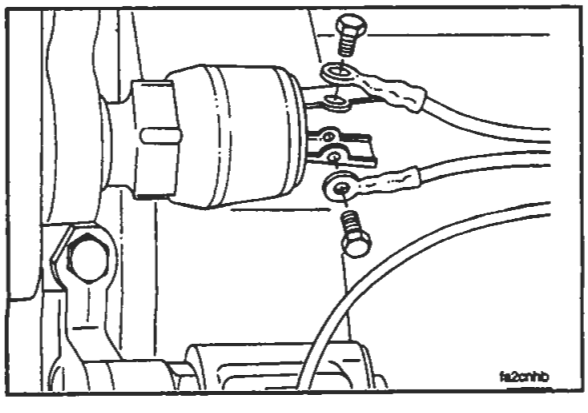
B. Optimized Aftercooling, 93°C [200°F]

The nominal temperature is stamped on the brass hex portion of the sensor.



Use liquid teflon to coat the threads of the sensor.

Install and tighten the sensor.



Connect the electrical wire from the solenoid valve to the "NC" terminal of the sensor.

Connect the power supply wire to the "C" terminal of the sensor.

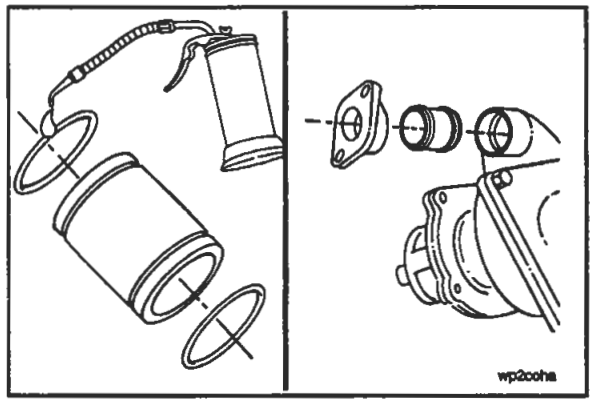
Water Pump - Install

Install new o-rings on the water transfer tube.

Apply a film of clean 15W-40 oil to the o-rings.

Install the transfer tube into the water pump.

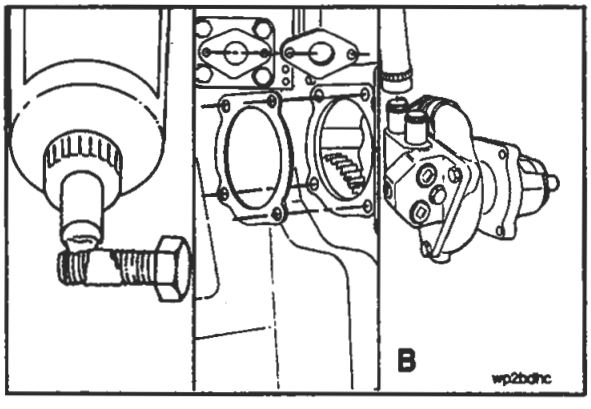
Install the water transfer connection on the transfer tube.



Apply a film of pipe sealant, Part No. 3375066, to the capscrew threads.

Install new gaskets on the water transfer connection and water pump mounting flange.

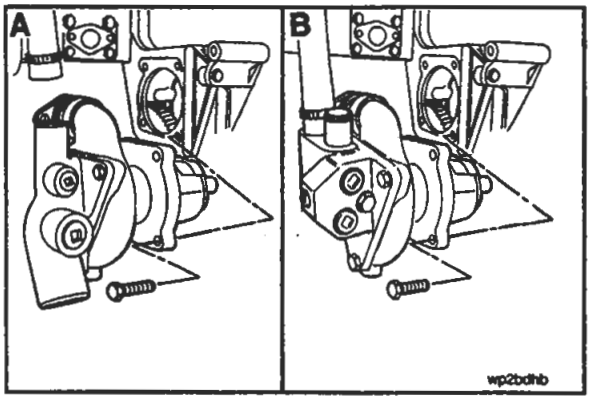
Note: Install the thermostat housing-to-water pump hose on the optimized aftercooling water pump (B) with two new hose clamps.



Install the water pump and the four (M10-1.50 X 30) capscrews.

- Conventional Aftercooling (A)
- Optimized Aftercooling (B)

Torque Value: 45 N•m [35 ft-lb]

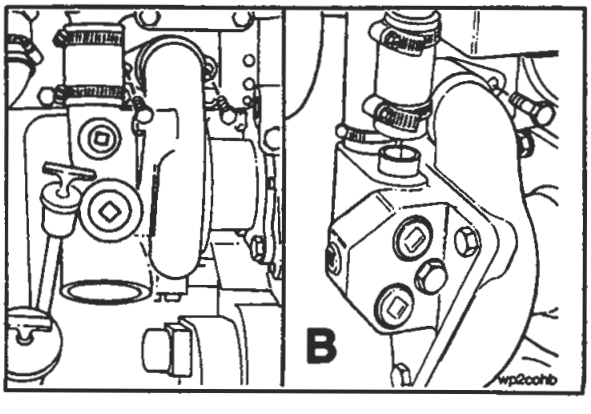


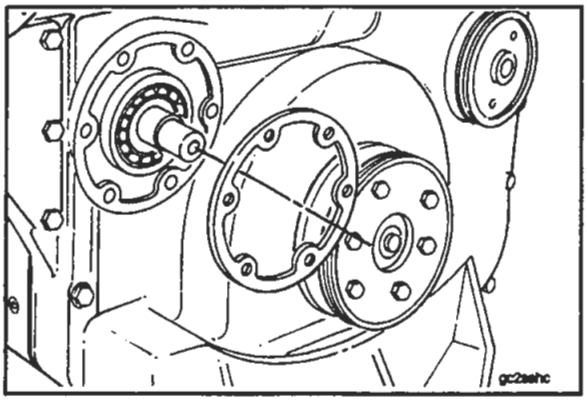
Install and tighten the two (M8-1.25 X 25) water transfer connection capscrews.

Torque Value: 25 N•m [20 ft-lb]

Tighten the hose clamps on the optimized aftercooling water pump to thermostat housing connection (B).

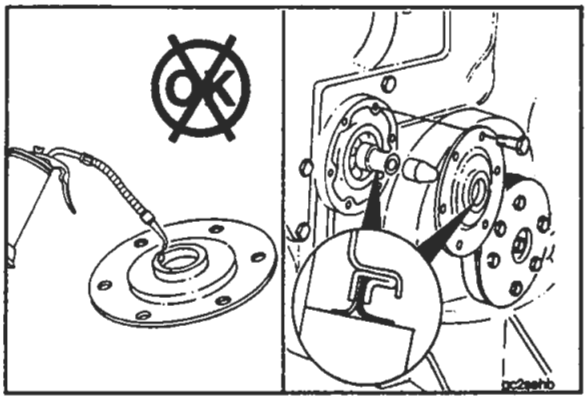
Torque Value: 5 N•m [40 in-lb]





Water Pump Oil Seal - Install

Install a new gasket on the gear cover.



Note: Do not use lubricant to install the seal. The oil seal **must be** installed with the lip of the seal and the shaft clean and dry to provide the proper oil sealing surface.

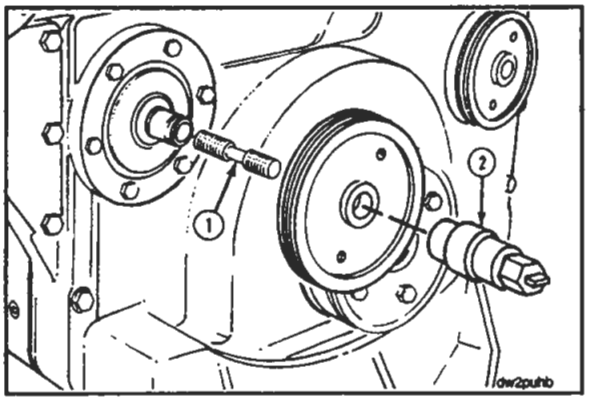
Note: The yellow dust lip of the seal **must be** facing out to prevent an oil leak.

Use the installation sleeve provided with the seal or the Part No. 3376386 Oil Seal guide to install the new seal with six (M8-1.25 X 16) capscrews.

Tighten the capscrews in a star pattern in two steps.

Torque Value: Step one 7 N•m [60 in-lb]

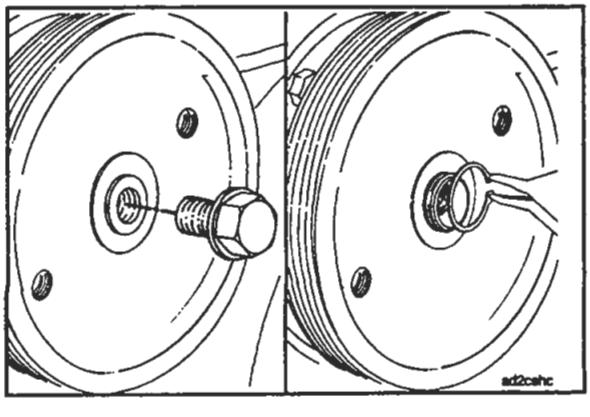
Torque Value: Step two 19 N•m [170 in-lb]



Alternator Drive Pulley - Install

Use the Part No. 3377401 Pulley Pusher Adapter (1) and the Part No. 3376326 Pulley Installation Tool (2) to install the pulley.

Note: Use the Part No. 3376383 Pulley Pusher Adapter on earlier production engines.



Install the (M12-1.75 X 40) pulley retainer capscrew.

Torque Value: 115 N•m [85 ft-lb]

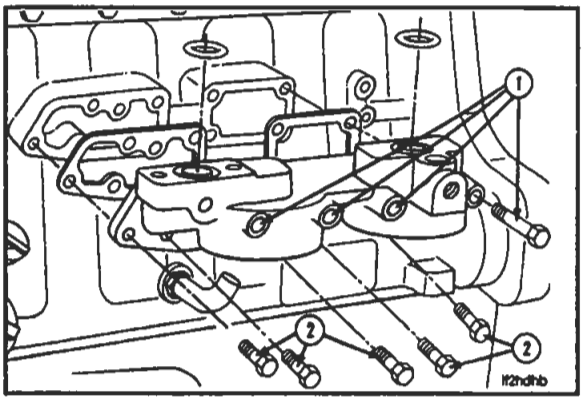
Note: Earlier production engines use a retainer snap ring and no capscrew.

Oil Filter Head - Install

Use a new gasket and install the filter head with four (M10-1.50 X 150) capscrews at points (1) and five (M10-1.50 X 30) capscrews at points (2).

Torque Value: 45 N•m [35 ft-lb]

Install two new o-rings into the filter head.

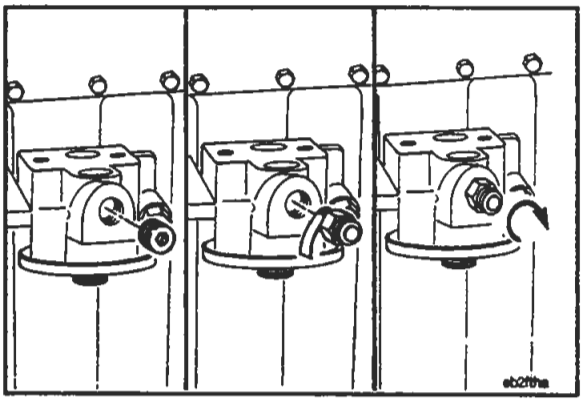


Jacobs® Brake Oil Supply Hose (If Equipped) - Install

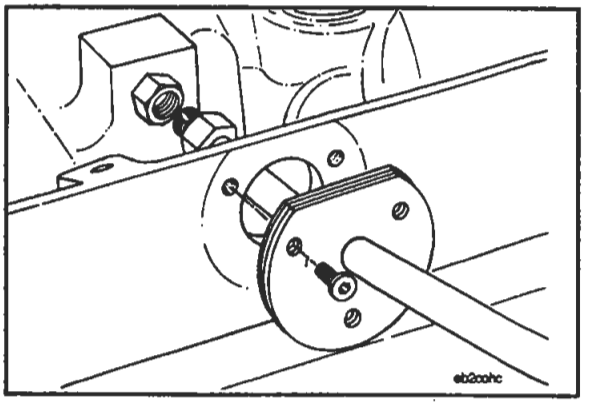
Remove the 3/8 inch pipe plug from the lubricating oil filter head above the bypass filter.

Wrap Teflon® tape around the threads of the Jacobs® oil connection.

Install and tighten the oil connection into the lubricating oil filter head.



Install and tighten the oil hose on the oil filter head and Jacobs® Brake connections.

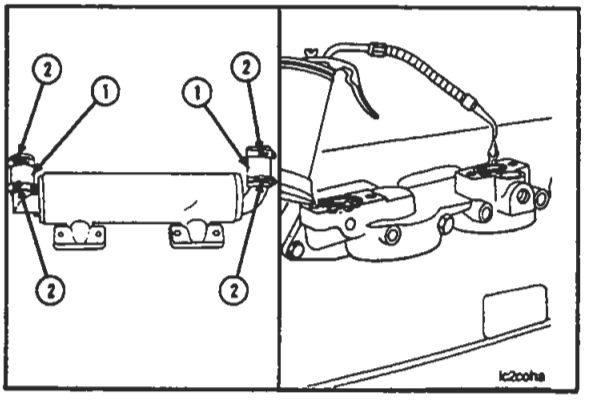


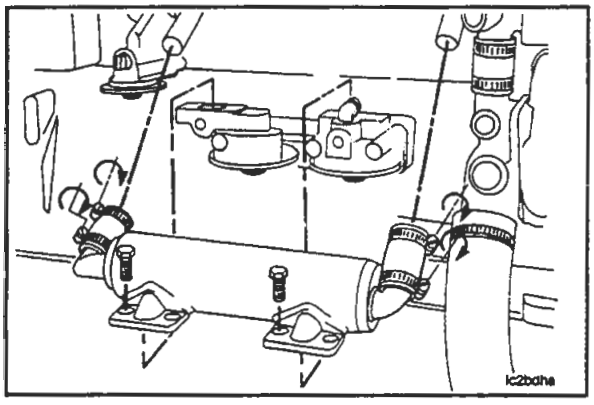
Lubricating Oil Cooler - Install

Install two new hoses (1).

Install four new hose clamps (2).

Use clean 15W-40 oil to lubricate the o-rings in the oil filter head.





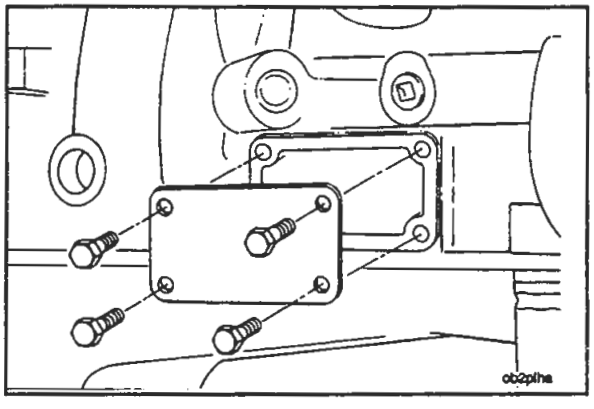
Install the hoses on the connections in the water header plate.

Use four (M10-1.50 X 30) capscrews to install the oil cooler to the oil filter head.

Torque Value: 45 N•m [35 ft-lb]

Tighten the hose clamps.

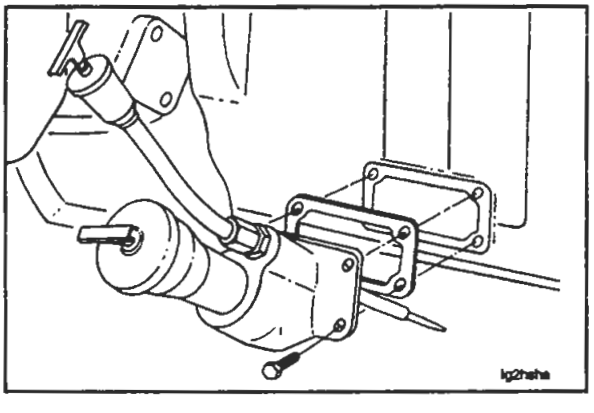
Torque Value: 5 N•m [40 in-lb]



Hand Hole Cover (Exhaust Side of Engine) - Install

Use a new gasket and install the cover with four (M10-1.50 X 20) capscrews.

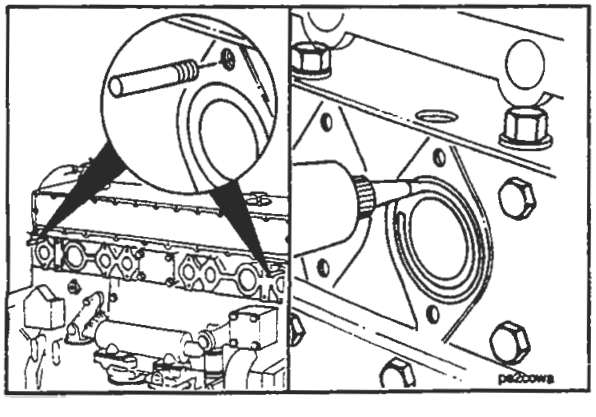
Torque Value: 45 N•m [35 ft-lb]



Dipstick Tube and Housing - Install

Use a new gasket and install the tube and housing with four (M10-1.50 X 25) capscrews.

Torque Value: 45 N•m [35 ft-lb]



Exhaust Manifold - Install

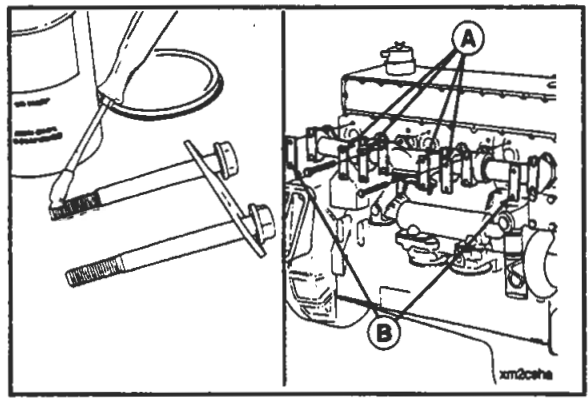
Install two Part No. 3376488 Guide Pins into the cylinder head.

Use an adhesive to hold the gaskets in place on the cylinder head.

Note: The gaskets can be installed with either side facing out.

Use high temperature anti-seize compound to coat the capscrew threads, this will aid future capscrew removal.

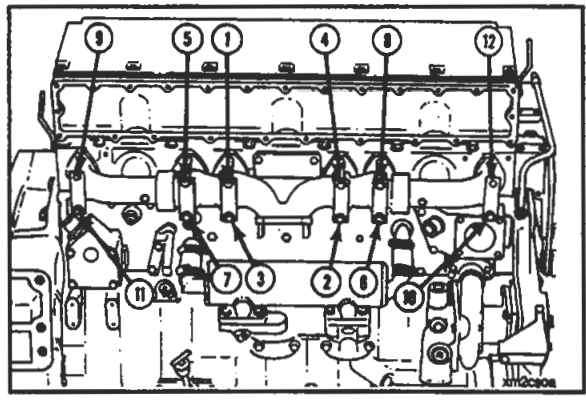
Install the exhaust manifold with eight (M10-1.50 X 125) capscrews and four clamping plates at points (A) and four (M10-1.50 X 105) capscrews and two clamping plates at points (B).



Caution: Do not use an air wrench to tighten the capscrews, the self-locking threads can be damaged.

Tighten the capscrews in the sequence shown.

Exhaust Manifold Capscrew Torque		
N•m	Step	ft-lb
35	1	25
65	2	50

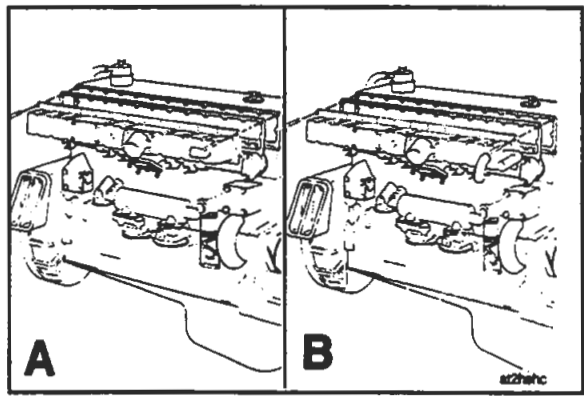


Aftercooler Housing - Install

Install two Part No. 3376488 Guide Pins into the rocker lever housing.

Use a new gasket and install the aftercooler.

- Conventional Aftercooling (A)
- Optimized Aftercooling (B)

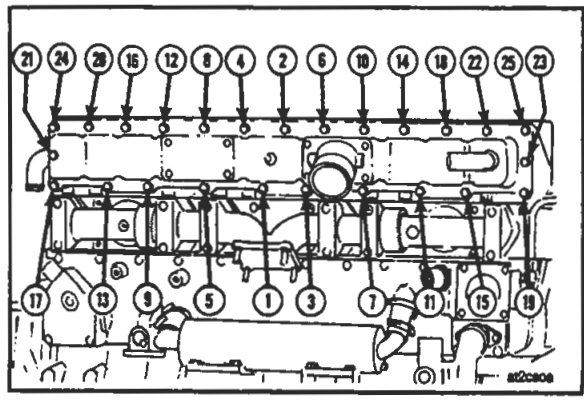


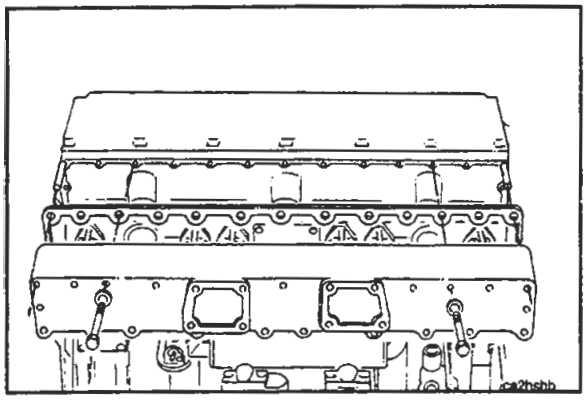
Install 23 (M10-1.50 X 20) socket head capscrews.

Remove the two guide pins and install the remaining two (M10-1.50 X 20) socket head capscrews.

Tighten the capscrews in the sequence shown.

Torque Value: 45 N•M [35 ft-lb]

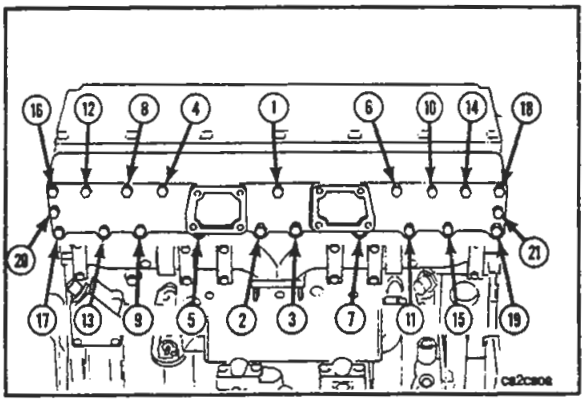




Air Manifold Side Cover (Non-Aftercooled Engines Only) - Install

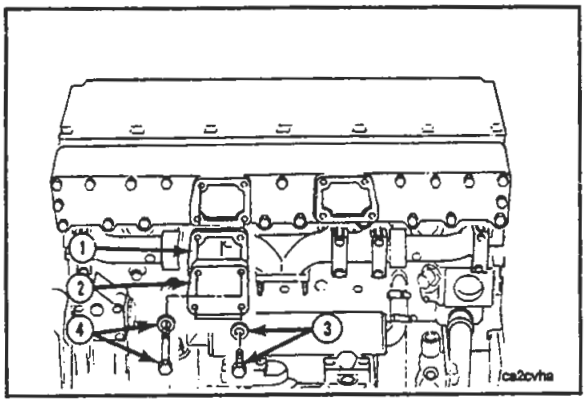
Install two Part No. 3376696 Guide Pins into the rocker lever housing.

Use a new gasket and install the air manifold with 25 (M10-1.50 X 70) capscrews and washers.



Tighten the capscrews in the sequence shown.

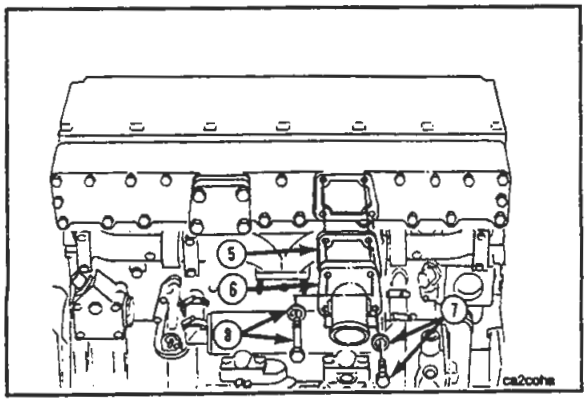
Torque Value: 45 N•m [35 ft-lb]



Install the cover plate gasket (1) and cover plate (2) on the side cover.

Install two (M10-1.50 X 25) capscrews (3) and washers, and two (M10-1.50 X 70) capscrews (4) and washers.

Torque Value: 45 N•m [35 ft-lb]



Install the air connection gasket (5) and air connection (6) on the side cover.

Install two (M10-1.50 x 35) capscrews (7) and washers, and two (M10-1.50 X 75) capscrews (8) and washers.

Torque Value: 45 N•m [35 ft-lb]

Aftercooler Coolant Inlet Tube - Install

Conventional Aftercooling

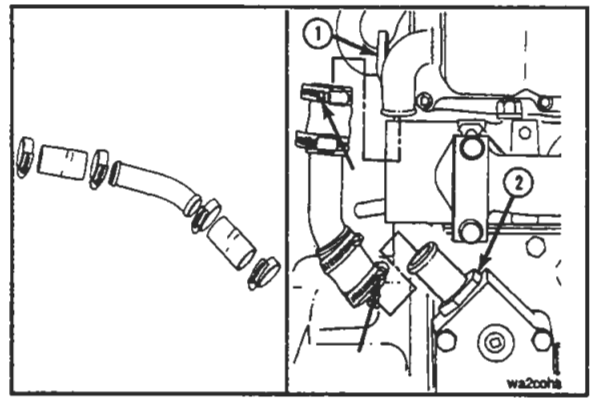
Install two new hoses and four new hose clamps on the inlet tube.

Install the inlet tube assembly on the aftercooler connection (1) and the water heater housing (2).

Note: Install the hose with the same amount of hose on both connections.

Tighten all hose clamps.

Torque Value: 5 N•m [40 in-lb]



Optimized Aftercooling

Install a new hose and two new hose clamps on the bypass tube.

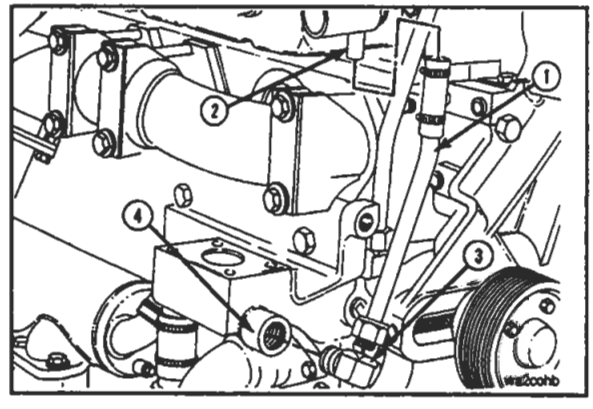
Install the inlet bypass tube assembly (1) on the aftercooler coolant inlet connection (2).

Install and tighten the coolant bypass 90 degree fitting (3) into the thermostat housing (4).

Install and tighten the inlet bypass tube to the connection.

Tighten the hose clamps.

Torque Value: 5 N•m [40 in-lb]

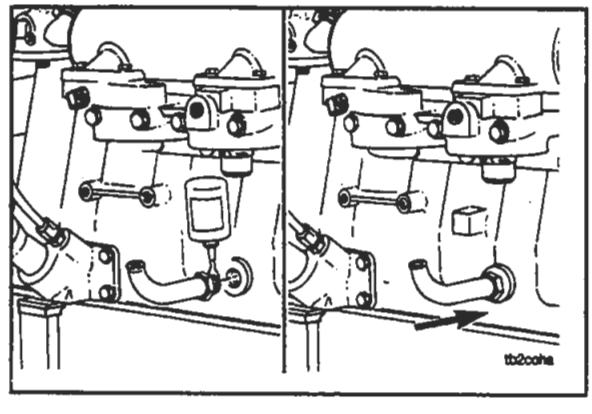


Turbocharger Drain Fitting - Install

Apply a film of pipe sealant, Part No. 3375066, to the threads of the drain fitting.

Caution: Always use the hex portion of the fitting to tighten the fitting. Never apply turning force to the elbow; the elbow can be damaged and cause an oil leak.

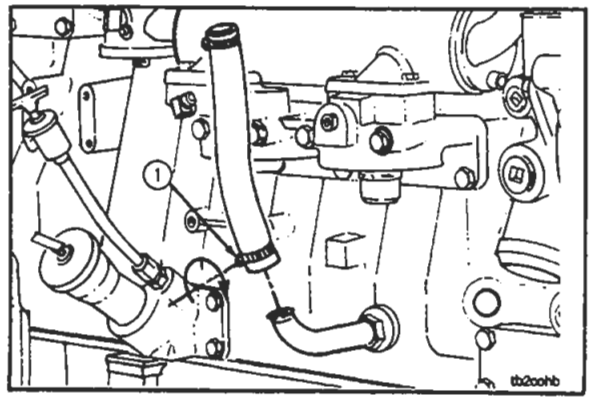
Install and tighten the fitting into the cylinder block.

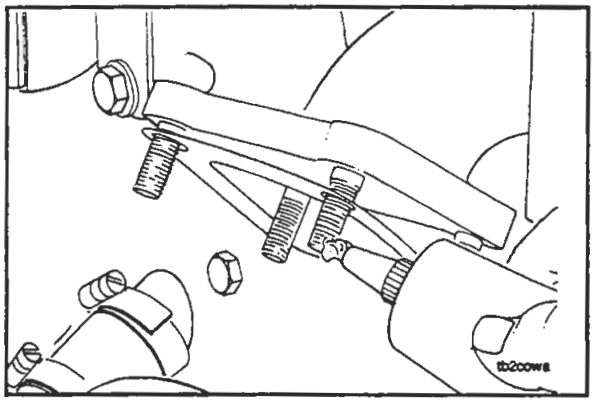


Install the flexible hose and two new hose clamps on the fitting.

Tighten the hose clamp (1).

Torque Value: 5 N•m [40 in-lb]



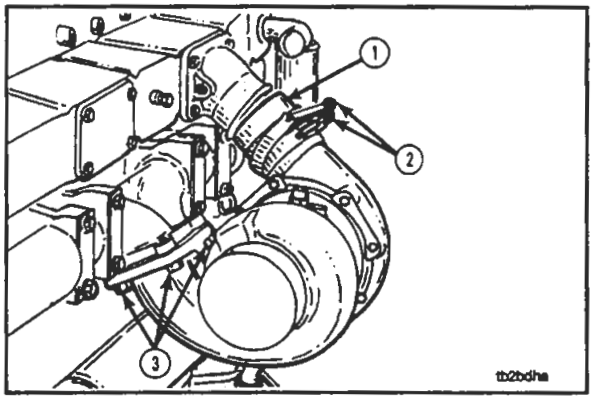


Turbocharger - Install

Install a new gasket on the exhaust manifold.

Note: The bead on the gasket **must be** toward the turbocharger to prevent exhaust gas leaks.

Apply a coating of high temperature anti-seize compound to the threads of the mounting studs.



Install a new hose (1) and two new "T-bolt" clamps (2) on the turbocharger compressor housing outlet.

Use four (M10-1.25) nuts (3) to install the turbocharger to the exhaust manifold.

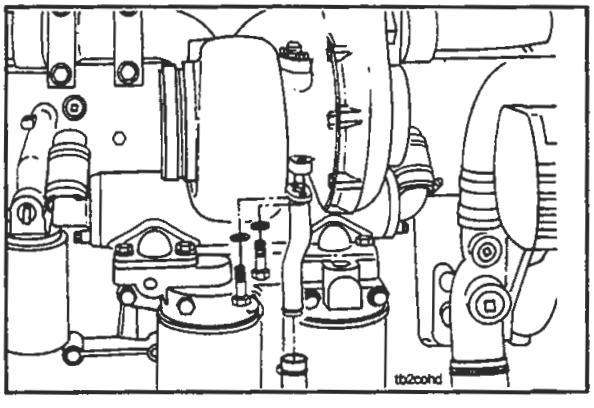
Torque Value: 60 N•m [45 ft-lb]

Install the hose (1) on the aftercooler connection.

Note: Make sure that the same amount of hose is on the compressor inlet and the aftercooler connections to prevent air leaks.

Tighten the "T-bolt" clamps (2).

Torque Value: 8 N•m [72 in-lb]

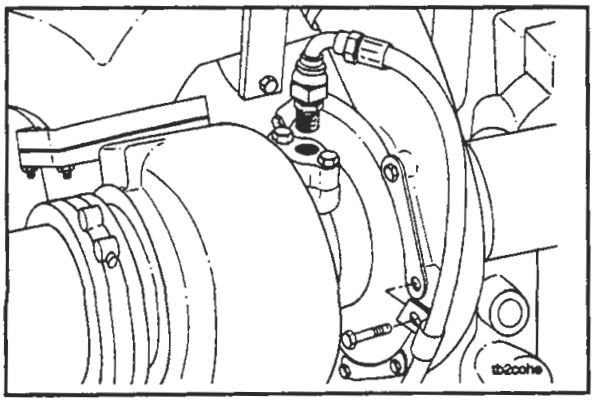


Install the oil drain connection to the turbocharger with two (M8-1.25 X 16) capscrews.

Torque Value: 25 N•m [20 ft-lb]

Install the oil drain hose on the oil drain tube and tighten the hose clamp.

Torque Value: 5 N•m [40 in-lb]



Install the oil supply line to the fittings on the turbocharger and oil filter head and tighten.

Caution: The oil supply line must be installed and clamped to the turbocharger compressor housing to prevent the line from breaking and causing the turbocharger to malfunction.

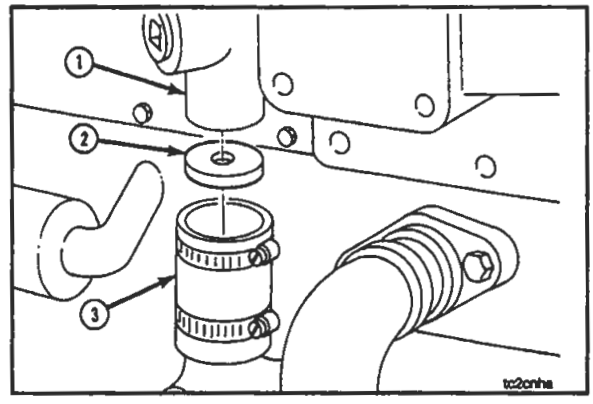
Install the oil supply line and clamp to the turbocharger compressor housing with one (M8-1.25 X 16) capscrew.

Torque Value: 7 N•m [60 in-lb]

Torque Convertor Cooler Disc (Conventional Aftercooling Only) - Install

Install the disc into the thermostat housing to water pump bypass hose.

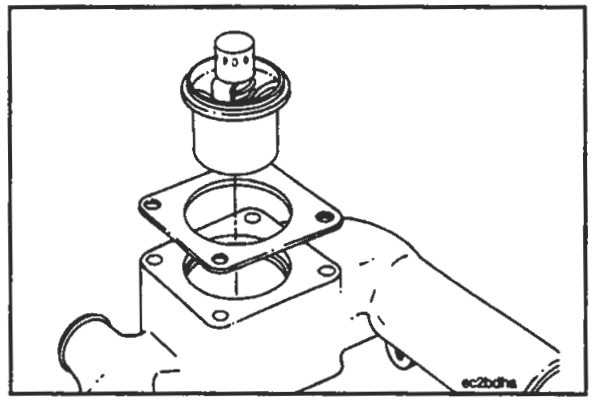
- Thermostat housing bypass connection (1)
- Orificed restriction disk (2)
- Water pump inlet bypass connection (3)



Thermostat Housing (Conventional Aftercooling Only) - Install

Install the sleeve of the thermostat through the seal in the housing.

Install a new gasket on the housing.



Install a new hose and two new hose clamps on the water bypass connection of the housing.

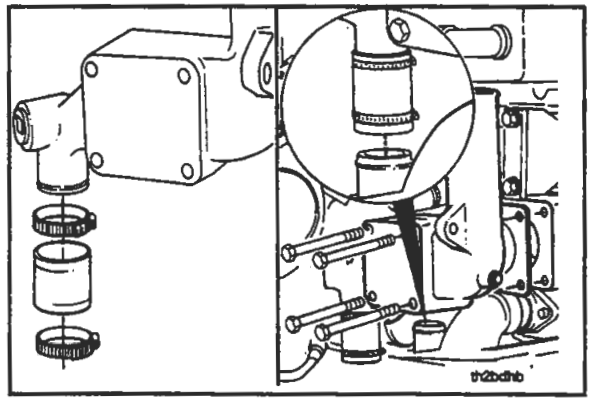
Install the housing with four (M10-1.50 X 145) capscrews.

Torque Value: 45 N•m [35 ft-lb]

Install the hose on the water pump connection with the same amount of hose on the thermostat connection and water pump connection

Tighten the hose clamps.

Torque Value: 5 N•m [40 in-lb]

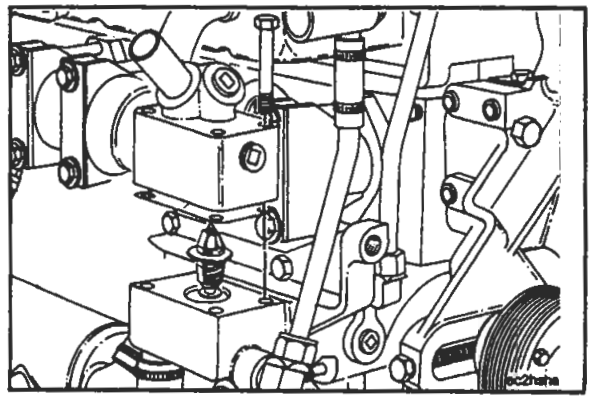


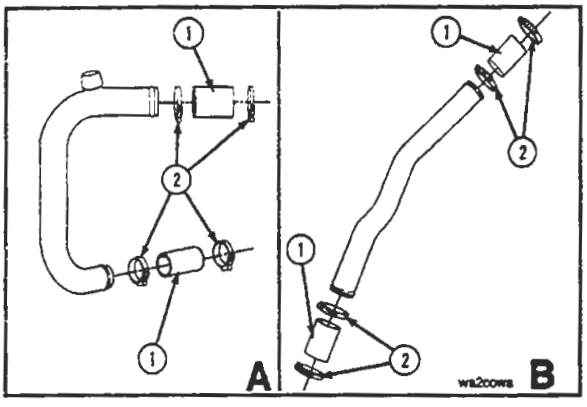
Thermostat (Optimized Aftercooling) - Install

Install the gasket, thermostat and cover on the thermostat housing.

Install the four (M10-1.50 X 70) capscrews and tighten.

Torque Value: 45 N•m [35 ft-lb]

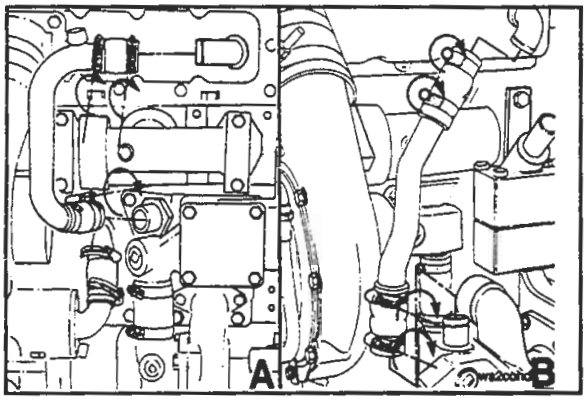




Aftercooler Coolant Outlet Tube - Install

Install two new hoses (1) and four new hose clamps (2) on the outlet tube.

- Conventional Aftercooling (A)
- Optimized Aftercooling (B)



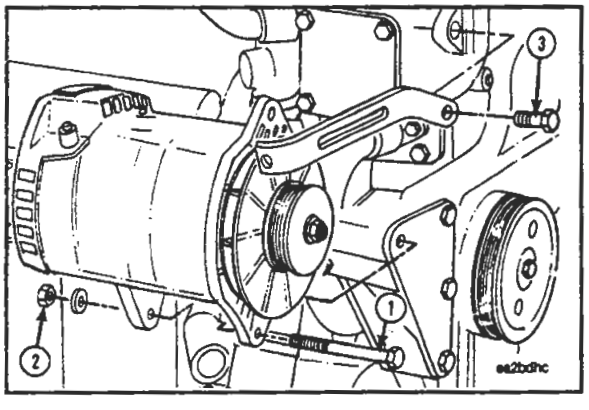
Install the outlet tube assembly on the aftercooler connection and the connection in the thermostat housing support for conventional aftercooling (A).

Note: Install the hoses with the same amount of hose on both connections.

Install the outlet tube assembly on the aftercooler connection and the water pump connection for optimized aftercooling (B).

Tighten the hose clamps.

Torque Value: 5 N•m [40 in-lb]



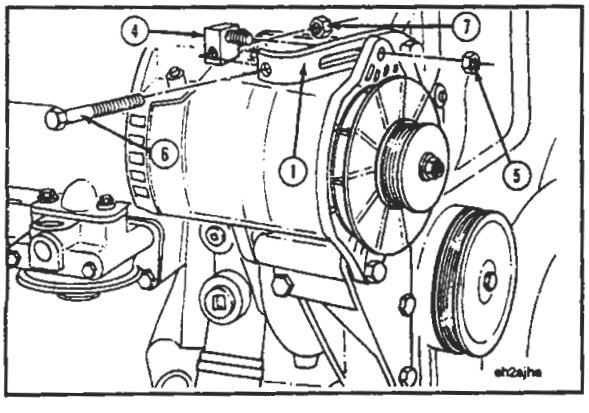
Alternator - Install

Install the alternator with one (1/2-20 X 6.0) capscrew (1) and a (1/2 X 20) nut (2) with washer.

Note: Do not tighten the capscrew and nut to the final torque value until the alternator belt is installed and adjusted.

Install the adjusting link to the thermostat housing with one (M12-1.75 X 30) capscrew (3).

Torque Value: 45 N•m [35 ft-lb]



Install the adjusting screw retainer (4) through the adjusting link and alternator mounting support.

Install a (3/8 X 24) nut (5) on the retainer (4) and tighten by hand.

Install the (1/2-13 X 5.75) adjusting screw (6) into the adjusting link (1) and retainer (4).

Install a (1/2 X 13) locknut (7) on the adjusting screw (6).

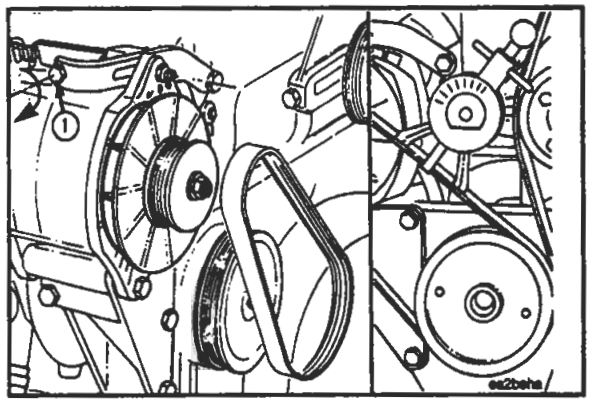
Alternator Belt - Install

Install a new belt on the water pump and alternator pulleys.

Turn the adjusting screw (1) **clockwise** to increase the belt tension.

Use the Part No. ST-1293 Belt Tension Gauge to measure the belt tension.

Alternator Belt Tension		
Newtons		Pounds
445	MIN	100
490	MAX	110



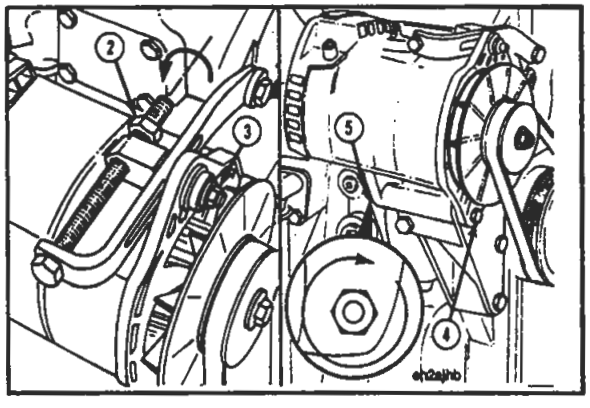
Tighten the adjusting screw locknut (2) against the retainer.

Tighten nut (3).

Torque Value: 80 N•m [60 ft-lb]

Tighten capscrew (4) and nut (5).

Torque Value: 45 N•m [35ft-lb]



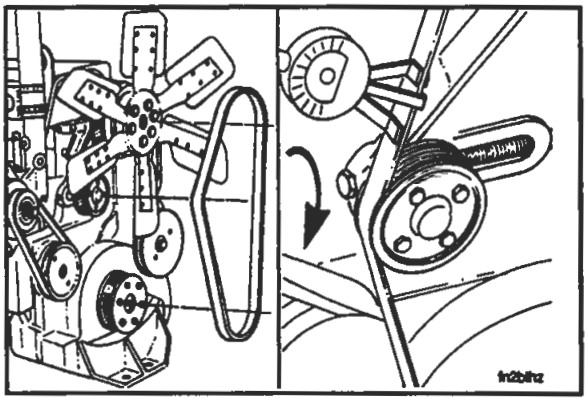
Fan Belt - Install

Install a new belt on the crankshaft and fan drive pulleys.

Use the Part No. ST-1293 Belt Tension Gauge to measure the belt tension.

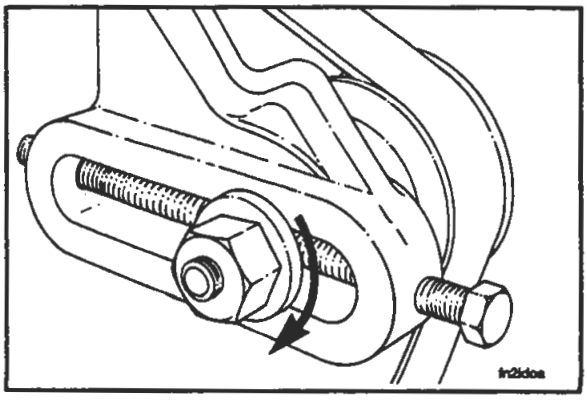
Turn the idler pulley adjusting screw **clockwise** to increase the belt tension.

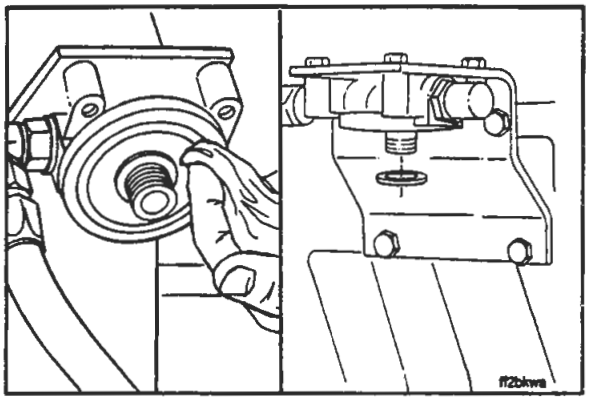
Fan Belt Tension	
Newtons	Pounds
890	200



Tighten the idler pulley shaft locknut.

Torque Value: 190 N•m [140 ft-lb]

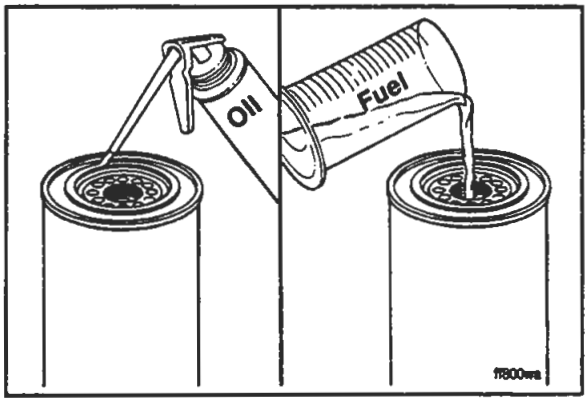




Fuel Filter - Install

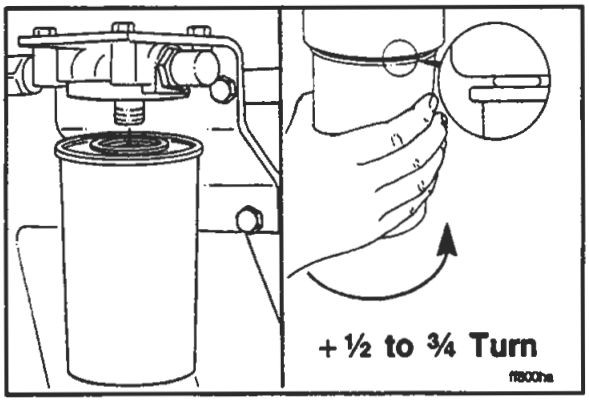
Use a clean, "lint-free" towel to clean the filter head gasket surface.

Install a new o-ring on the filter head fitting.



Use clean 15W-40 oil to lubricate the filter gasket surface.

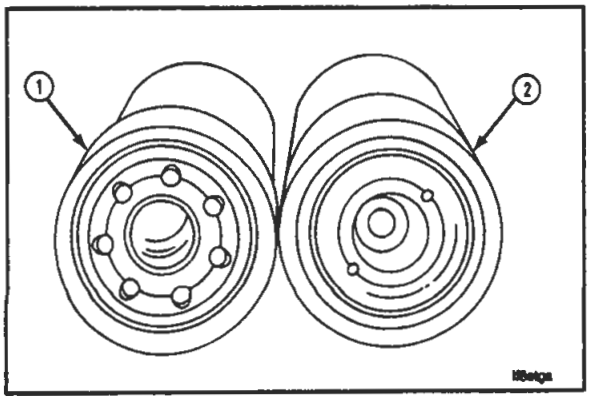
Use clean No. 2 diesel fuel to fill the filter.



Install the filter by hand.

Tighten the filter until the gasket contacts the filter head surface.

Tighten the filter an additional one-half to three-fourths (1/2 to 3/4) turn after the gasket contacts the filter head surface.

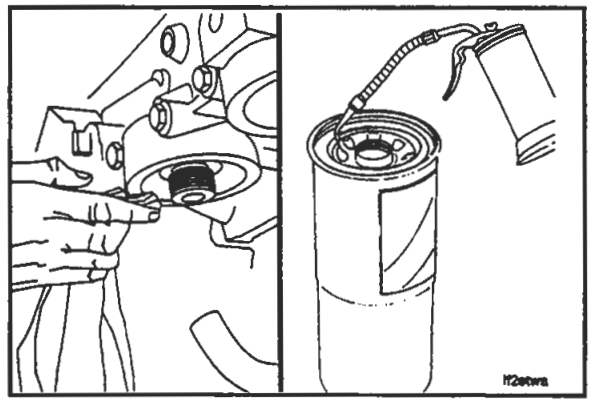


Lubricating Oil Filters - Install

The external appearance of the full-flow (1) and bypass (2) filters is the same. The accompanying picture identifies the difference between the two filters.

Use a clean "lint-free" cloth to clean the oil filter head surfaces.

Use clean 15W-40 oil to lubricate the gasket surface of the filters.

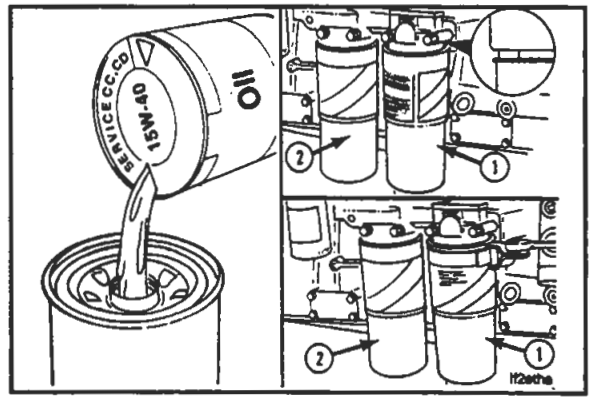


Fill the filters with clean 15W-40 oil.

Install the filters on the filter head with the full-flow (1) toward the front of the engine and bypass (2) toward the rear.

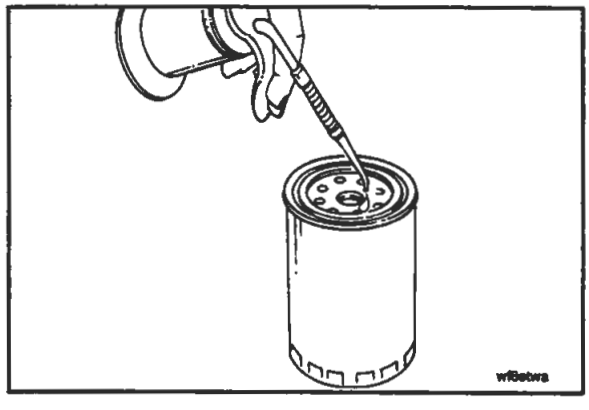
Tighten the filters until the gasket contacts the filter head surface.

Use the Part No. 3375049 Oil Filter Wrench to tighten the filters an additional three-fourths to one (3/4 to 1) turn or follow the instructions supplied with the filters.



Coolant Filter - Install

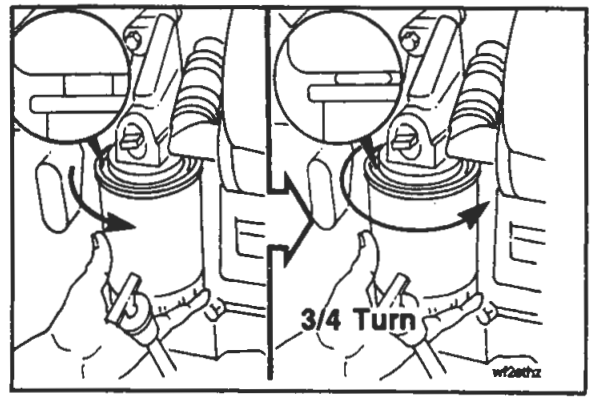
Use clean 15W-40 oil to lubricate the filter sealing ring.

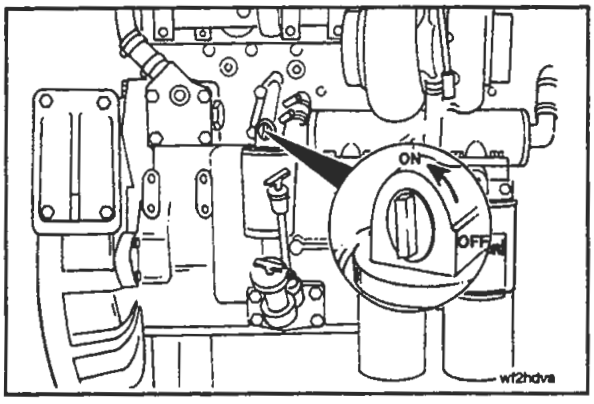


Caution: Mechanical over-tightening can distort the filter threads or damage the filter head.

Install the new filter and tighten until the sealing ring contacts the filter head surface.

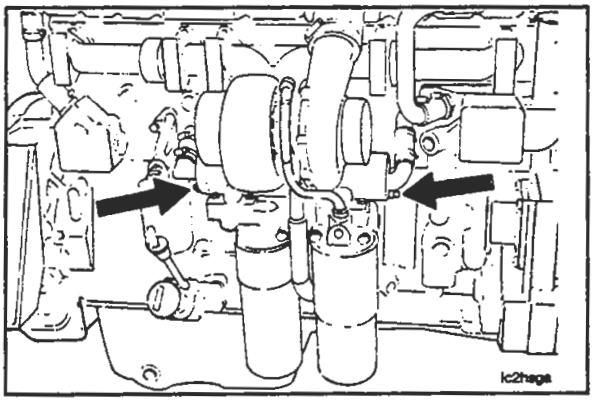
Tighten the filter an additional one-half to three-fourths (1/2 to 3/4) turn or refer to the filter manufacturer's instructions.





Caution: The valve on the filter head must be in the "on" position to prevent engine damage.

Turn the valve on the filter head to the "on" position.

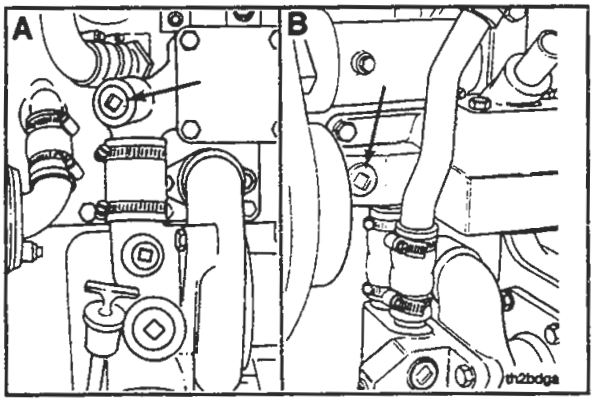


Drain Plugs - Inspect

Inspect the coolant and oil drain plugs to make sure they are tightened to the correct torque value.

Tighten the plugs in both ends of the lubricating oil cooler.

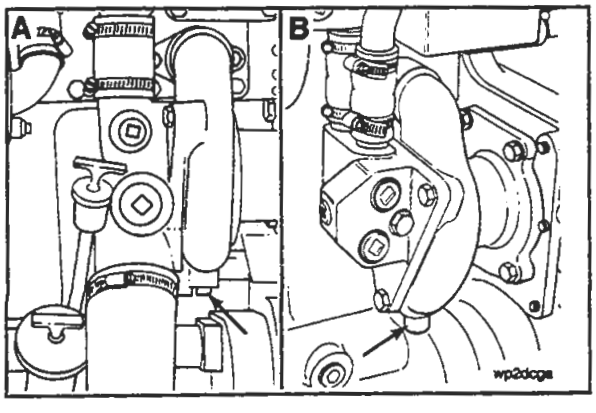
Torque Value: 20 N•m [15 ft-lb]



Tighten the plug in the thermostat housing.

- Conventional Aftercooling (A)
- Optimized Aftercooling (B)

Torque Value: 20 N•m [15 ft-lb]



Tighten the plug in the bottom of the water pump housing.

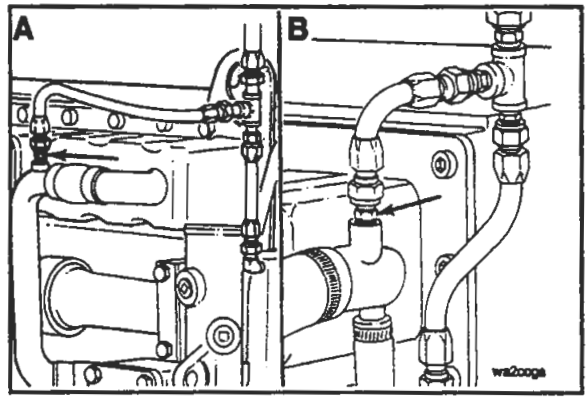
- Conventional Aftercooling (A)
- Optimized Aftercooling (B)

Torque Value: 20 N•m [15 ft-lb]

Tighten the plug in the aftercooler outlet tube.

- Conventional Aftercooling (A)
- Optimized Aftercooling (B)

Torque Value: 20 N•m [15 ft-lb]



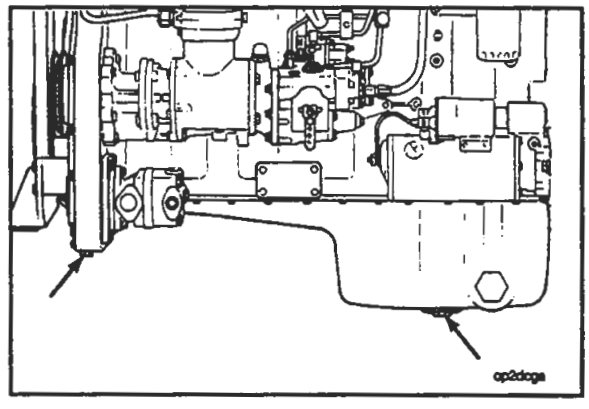
Tighten the drain plug in the oil pan.

Torque Value: 95 N•m [70 ft-lb]

Tighten the drain plug in the bottom of the gear cover.

Torque Value: 16 N•m [144 in-lb]

NOTE: Refer to "Engine Test" (14-01) or "Engine Storage" (14-07 or 14-08) after engine is assembled.



Cylinder Block - Group 01

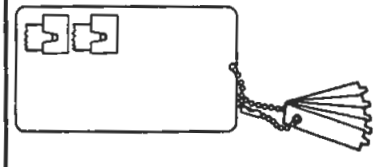
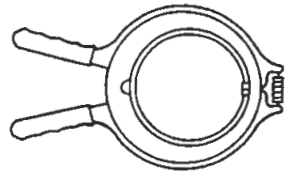
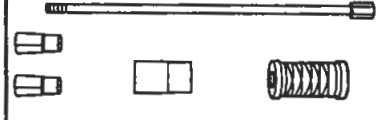
Contents

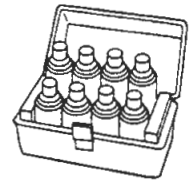
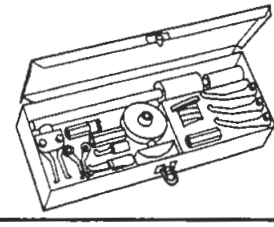
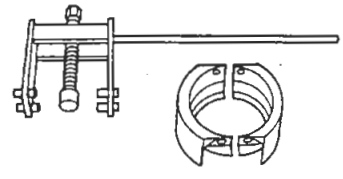
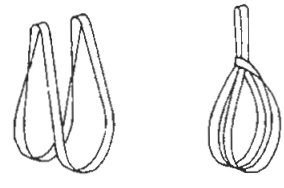
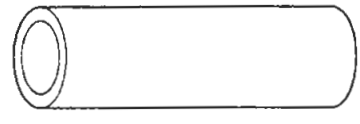
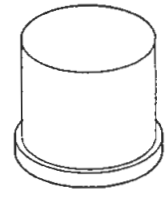
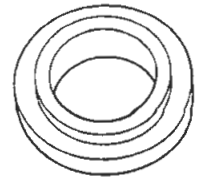
Contents (Continued)

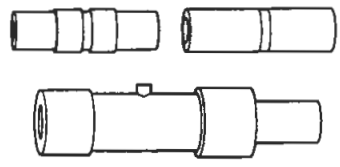
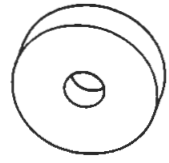
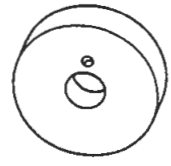
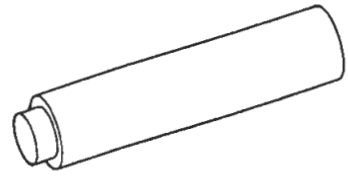
Page

Cylinder Block - Service Tools

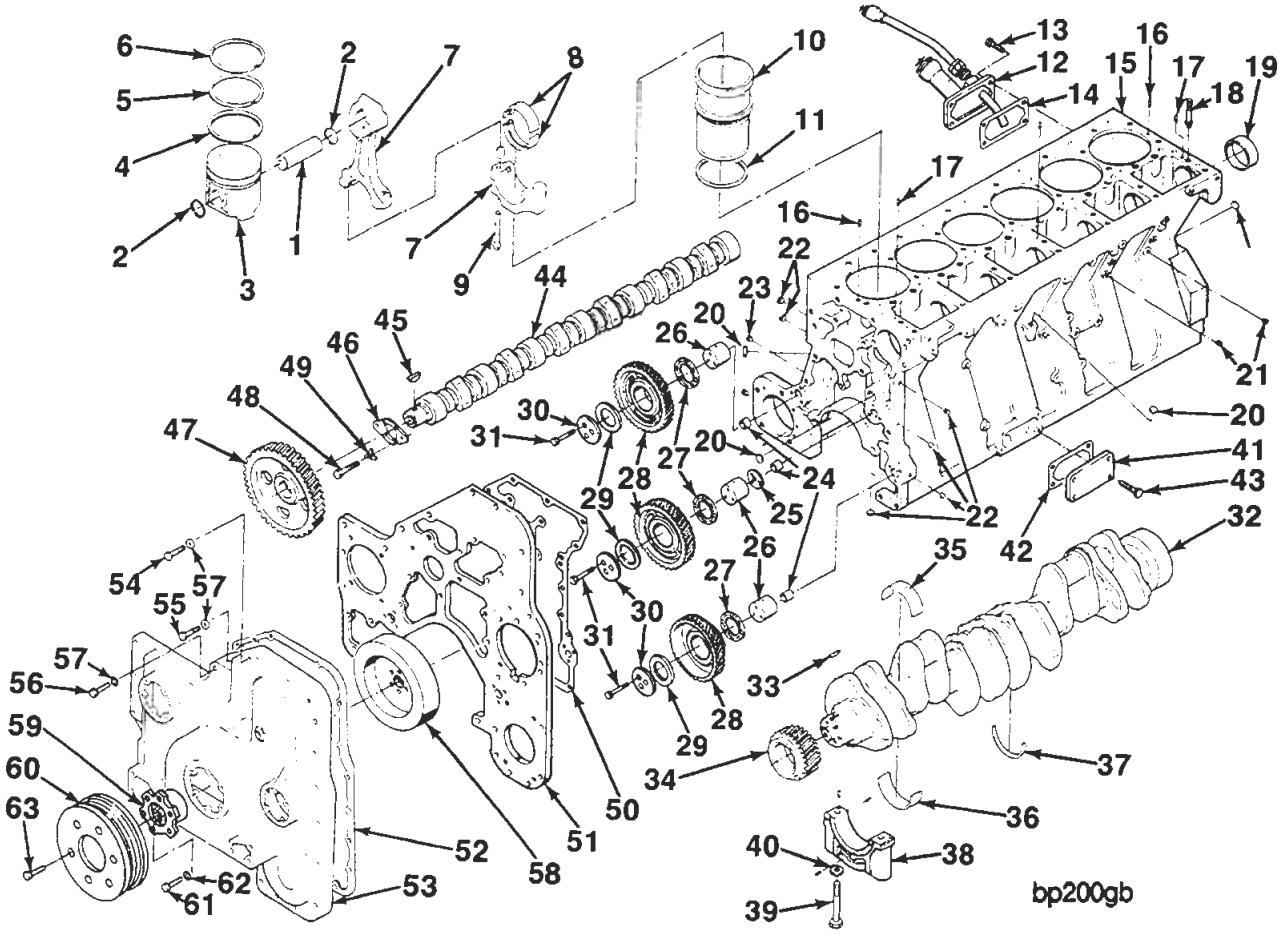
The following special tools are recommended to perform the procedures in Group 01. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

Tool No.	Tool Description	Tool Illustration
ST-560-6	**Piston Ring Groove Wear Gauge** Measure piston ring groove width.	
ST-561	**Connecting Rod Checking Fixture** Measure connecting rod bend and twist.	
ST-821	**Piston Ring Expander** Replace piston rings on pistons.	
ST-1134	**Dowel Pin Extractor** Remove dowel pins.	
ST-1177-16	**Checking Bar** Check cylinder block main bearing bore alignment.	
ST-1228	**Camshaft Bushing Driver Set** Replace cylinder block camshaft bushings.	

Tool No.	Tool Description	Tool Illustration
3375021	**Threaded Insert Kit** Repair damaged threads.	
3375432	**Crack Detection Kit** Inspect components for cracks.	
3375784	**Puller Kit** Remove the idler gear ring dowels.	
3375840	**Gear Puller** Remove the crankshaft gear. Requires Part No. 3375839 Jaw to be used.	
3375957	**Lifting Strap** Lift the cylinder block or crankshaft.	
3376069	**Guide** Replace cylinder block camshaft bushings.	
3376070	**Mandrel** Replace cylinder block camshaft bushings.	
3376576	**Master Ring Gauge** Use to set dial indicator gauge to measure cylinder block main bearing bore.	

Tool No.	Tool Description	Tool Illustration
3376690	**Connecting Rod Mandrel Set** Used to measure bend and twist with Part No. ST-561 Connecting Rod Checking Fixture. Part No. 3376691 Mandrel used for crankshaft end of connecting rod. Part No. 3376692 Mandrel used for piston pin end without bushing. Part No. 3376693 Mandrel used for piston pin end with bushing.	
3376781	**Centering Rings** Used to check cylinder block main bearing bore alignment. Used with Part No. ST-1177-16 Checking Bar.	
3376811	**Checking Ring** Used to check cylinder block main bearing bore alignment. Used with Part No. ST-1177-16 Checking Bar.	
3376816	**Expansion Plug Driver** Install expansion plugs.	
3822372	**Expansion Plug Driver** Install expansion plugs.	

Cylinder Block - Exploded View



Ref. No.	Description	Qty.
1	Pin, Piston	6
2	Ring, Retaining	12
3	Piston	6
4	Ring, Oil	6
5	Ring, Compression	6
6	Ring, Compression	6
7	Rod, Connecting	6
8	Bearing, Connecting Rod	12
9	Capscrew, 12 points [14-1.5x91.25]	12
10	Liner, Cylinder	6
11	Seal, Crevice	6
12	Housing, Dipstick	1
13	Capscrew [10-1.50x26]	4
14	Gasket, Dipstick Housing	1
15	Cylinder Block	1
16	Dowel, Pin [7/16x1 inch]	2
17	Dowel, Pin [6.000x12.00]	3
18	Stud [10-1.50]	7
19	Bushing, Camshaft	7
20	Plug, Expansion [1.01 Dia]	5
21	Plug, Pipe [1.4-18]	2

Ref. No.	Description	Qty.
22	Plug, Expansion (9.83 mm) [0.387 inch]	8
23	Plug, Pin [1/8 inch]	1
24	Dowel, Ring [19.23]	3
25	Plate, Thrust Bearing Wear	1
26	Shaft, Idler	3
27	Bearing, Thrust	3
28	Assembly, Idler Gear	3
29	Bearing, Thrust	3
30	Plate, Gear Cover	3
31	Capscrew [10-1.50x60]	9
32	Assembly, Crankshaft	1
33	Key, Plain Woodruff	1
34	Gear, Crankshaft	1
35	Bearing, Main (upper)	7
36	Bearing, Main (lower)	7
37	Bearing, Thrust (No. 4 Main)	4
38	Cap, Main Bearing	7
39	Capscrew, Main Bearing	14
40	Washer, Plain	14
41	Cover, Hand Hole	2
42	Gasket, Hand Hole	2

Ref. No.	Description	Qty.
43	Capscrew, [10-1.50x20]	8
44	Assembly, Camshaft	1
45	Key, Offset	1
46	Support, Camshaft Thrust	1
47	Gear, Camshaft	1
48	Capscrew	2
49	Lockplate	2
50	Gasket, Gear Cover Plate	1
51	Plate, Gear Cover	1
52	Gasket, Gear Cover	1
53	Cover, Gear	1
54	Capscrew [10-1.50x60]	12
55	Capscrew [10-1.50x30]	1
56	Capscrew [10-1.50x50]	1
57	Washer, Plain	15
58	Damper, Vibration	1
59	Adapter, Crankshaft	1
60	Pulley, Crankshaft	1
61	Capscrew [12-1.25x130]	6
62	Washer, Plain	6
63	Capscrew [10-1.50x30]	6

Cylinder Block - General Information

These procedures apply to all L10 engines. Since the introduction of the engine, design changes have been made. The differences in engine designs are included in the instructions where necessary. Omit the steps that do not apply to the engine being rebuilt.

1. A WARNING statement is included for any component or assembly that weighs more than 23 kg [50 lb]. To avoid personal injury, use a hoist or get assistance from more than one person when removing or installing these parts.
2. Most of the capscrews used on the L10 engine are metric. All fasteners have right-hand threads unless a CAUTION states that a fastener has left-hand threads.

Discard all gaskets, seals and o-rings. Keep these parts if they are needed for a failure analysis.

Label, tag, or mark the parts for location as the parts are removed. This will help find all of the parts that can be involved in a failure, and simplify the assembly procedure. Some parts can also be used again.

Force must be used to remove certain parts. A mallet must be used when force is required. All of the fasteners must be removed before using force.

Avoid as much dirt as possible during disassembly. The accumulation of dirt will make it more difficult to clean the components.

Torque values are listed in each assembly step. If a torque value is not specified, use the chart listed in the specifications section, group 18, to determine the correct torque value.

Many of the gaskets and o-rings are manufactured from a material designed to absorb oil. These gaskets will enlarge and provide a tight seal after coming in contact with oil. Use only a recommended contact adhesive or a vegetable based oil to install these parts.

Always use a capscrew of the same system, metric or U.S.Customary, the same dimension and the same grade as the capscrew removed. The use of a longer capscrew than the capscrew that is listed can result in damage to the engine.

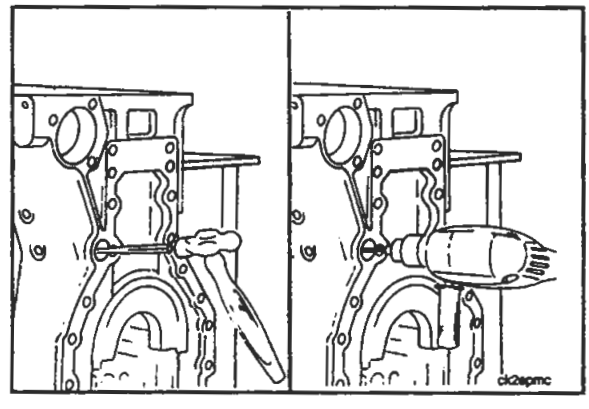
Cylinder Block - Clean for Reuse (01-01)

Cup Plugs - Remove

Use the following procedure to remove all cup plugs from the cylinder block.

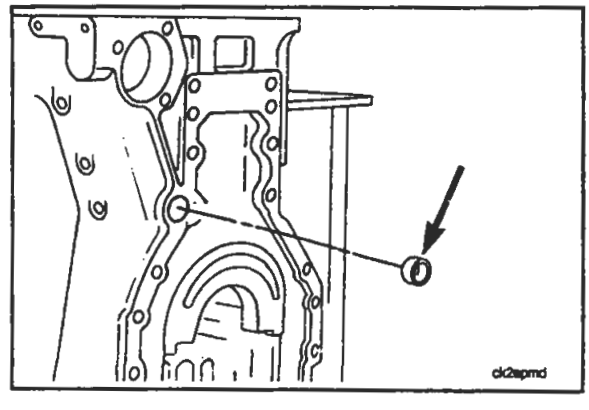
Use a center punch to mark the cup plugs for drilling.

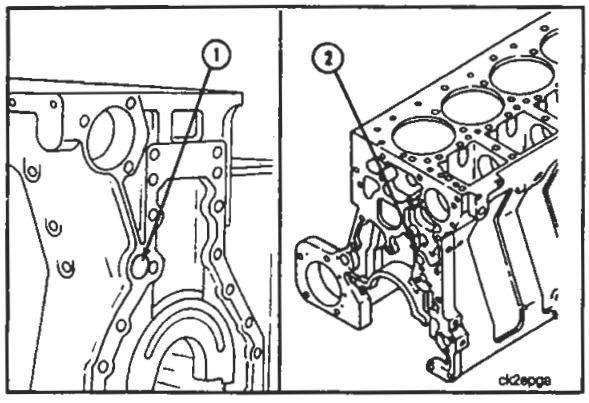
Drill a 3mm [1/8 inch] hole in the cup plugs.



Use a dent puller to remove the cup plugs.

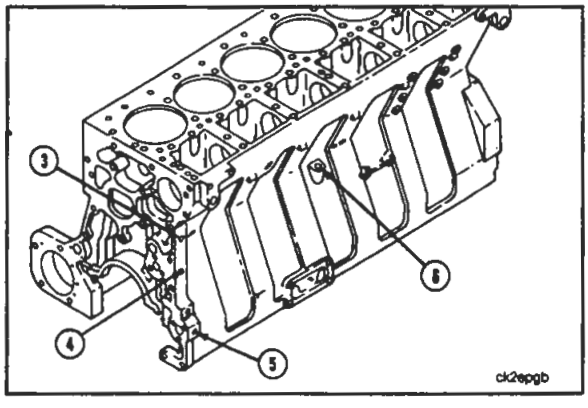
Note: Discard all used cup plugs.





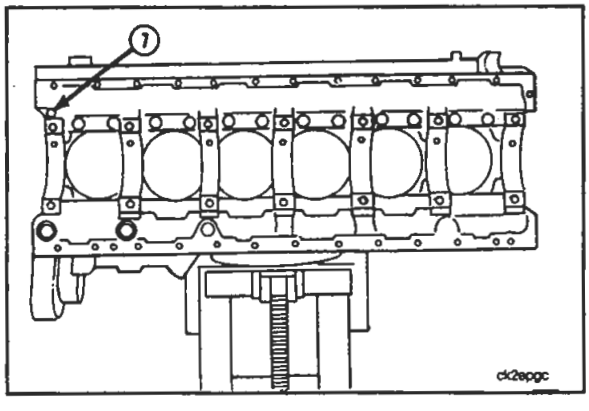
Remove the cup plugs from the following locations:

Plugs (1) and (2)

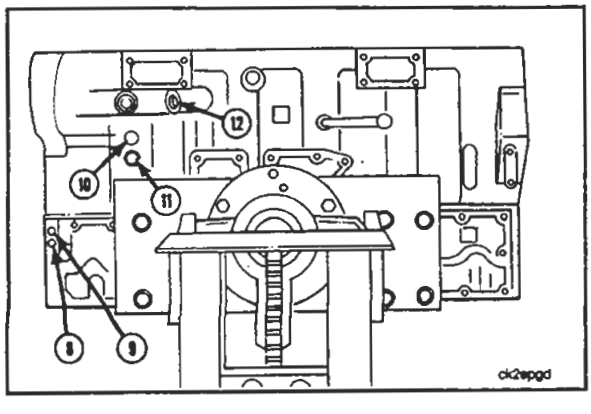


Plugs (3), (4), (5), and (6)

Note: Plug "4" is found on present production engines only.



Plug (7)



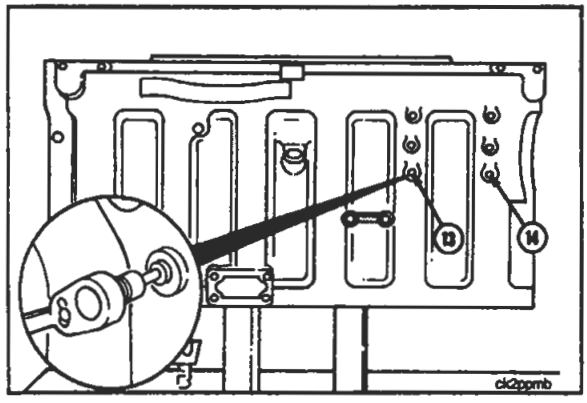
Plugs (8), (9), (10), (11), and (12)

Pipe Plugs - Remove

Note: If the engine is equipped with Compuchek® adapters, refer to page i-13 for plug locations and sizes.

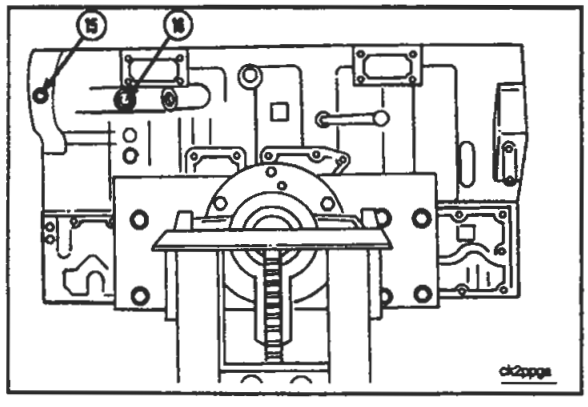
Use the following size allen head wrench to remove the pipe plugs:

1/4 inch, plugs (13) and (14)



3/16 inch, plug (15), earlier production engines only.

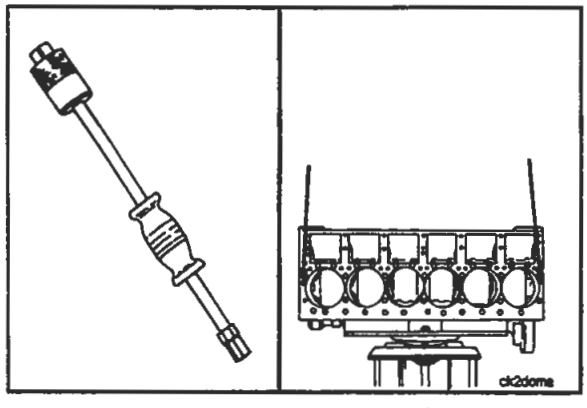
3/8 inch, plug (16)



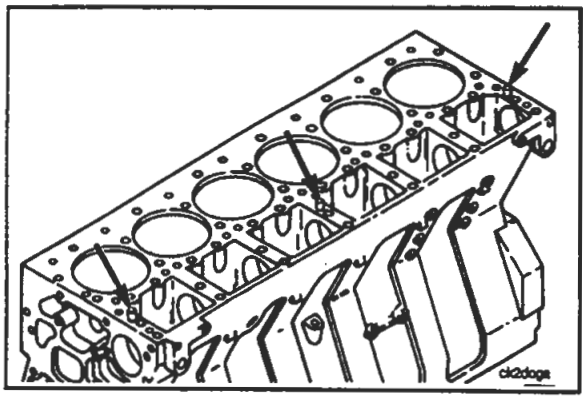
Dowel Pins - Remove

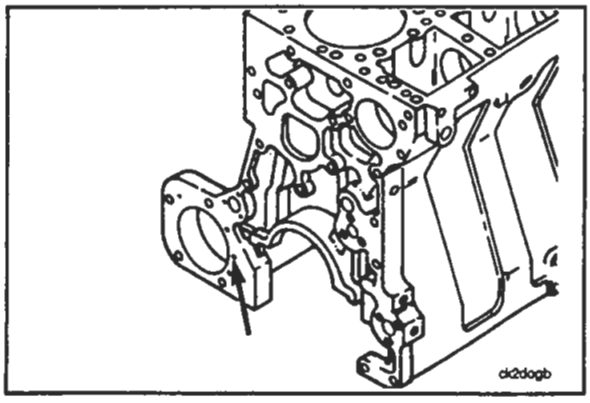
Use the Part No. ST-1134 Dowel Pin Extractor to remove the following dowel pins:

Two cylinder head alignment dowel pins

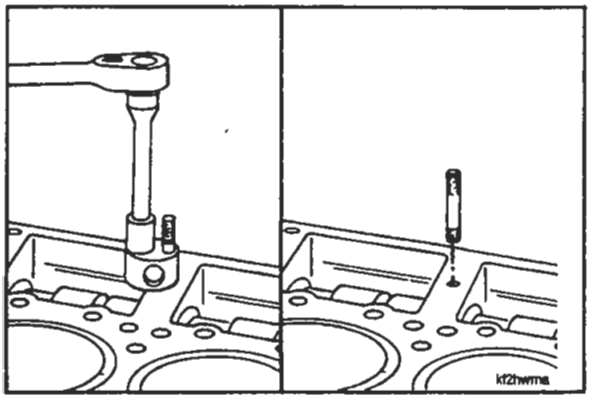


Three cam follower dowel pins



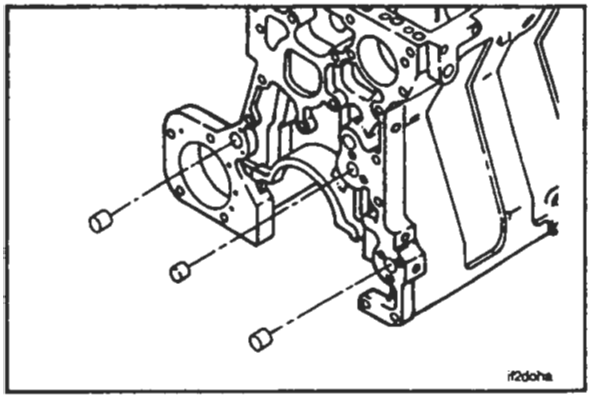


Lubricating oil pump dowel pins



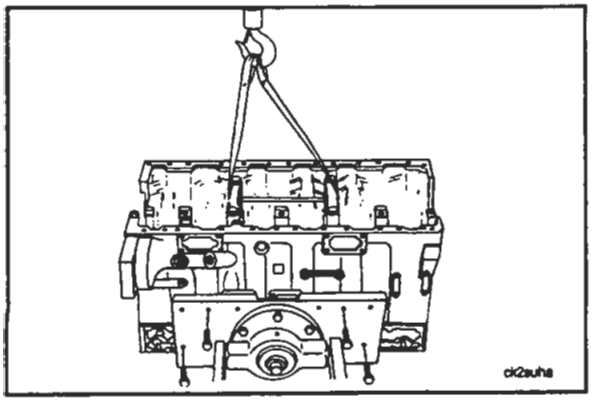
Cam Follower Studs - Remove

Use a 11 to 13 mm [7/16 to 1/2 inch] stud extractor to remove the seven studs.



Idler Shaft Ring Dowels - Remove

Use the Part No. 3375784 Puller Kit to remove the three ring dowels.



Cylinder Block - Remove from the Rollover Stand

The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Install the numbers "3" and "5" main bearing caps and tighten the capscrews.

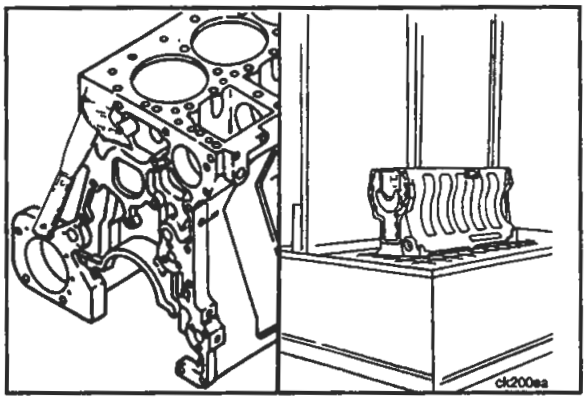
Use the Part No. 3375957 Lifting Strap and a hoist to support the cylinder block.

Remove the twelve capscrews holding the cylinder block to the rollover stand adapter plate.

Cylinder Block - Clean

Use a gasket scraper to remove all gasket material and heavy dirt.

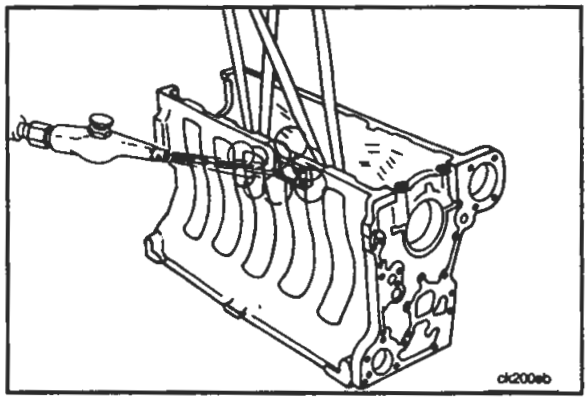
Install the cylinder block into a cleaning or soak tank.



Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Steam clean the cylinder block and dry with compressed air.

Note: Make sure to blow out all oil drillings, pipe plug bores, and capscrew threads.

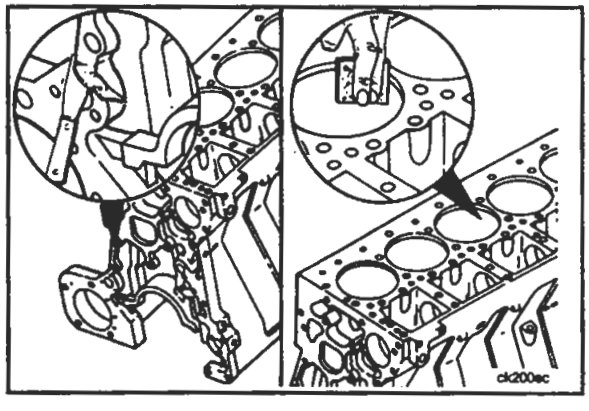


Caution: Do not damage the machined surfaces when using a wire brush or gasket scraper.

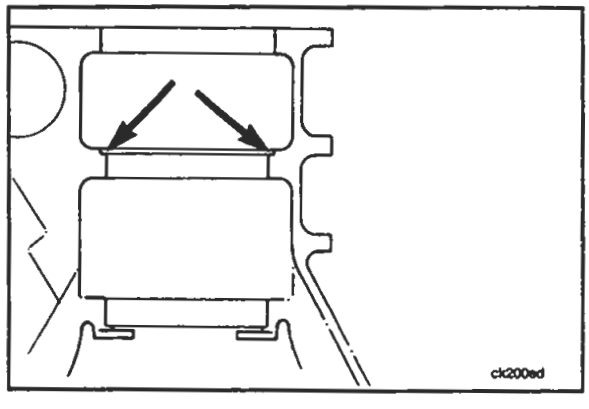
Use a Scotch-Brite® pad, emery cloth, or gasket scraper to clean the following cylinder block areas:

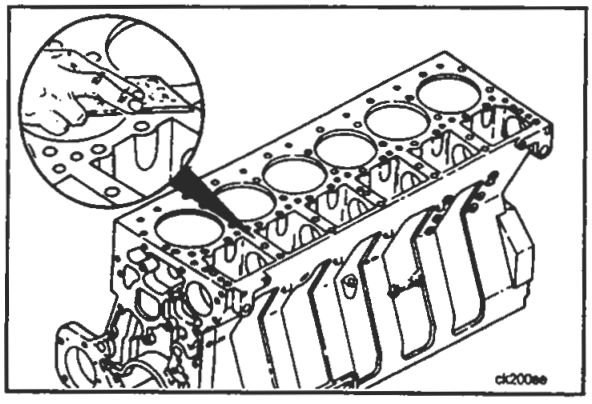
a. Gasket surfaces

b. Cylinder Liner counter bores

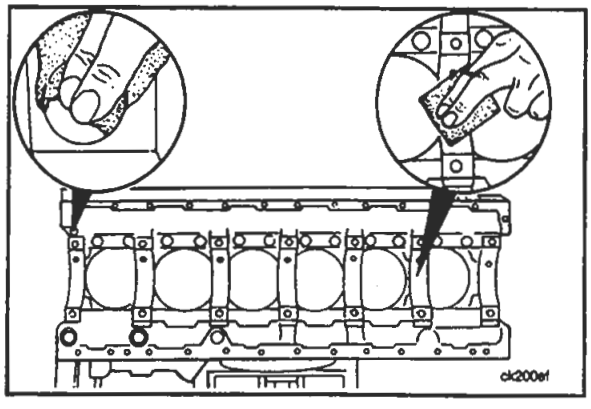


c. Cylinder liner sealing ring bores





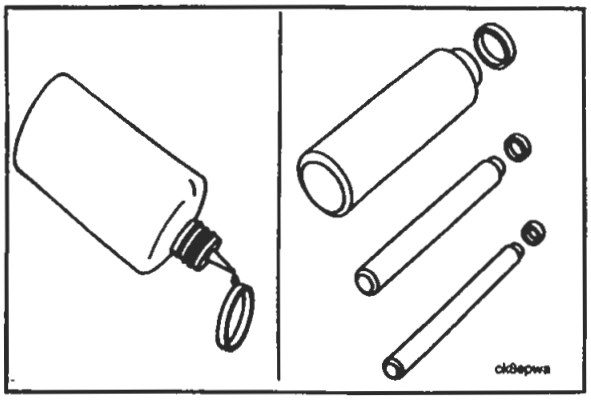
d. Cylinder head deck surface



e. Main bearing saddles and caps

f. Cup plug bores

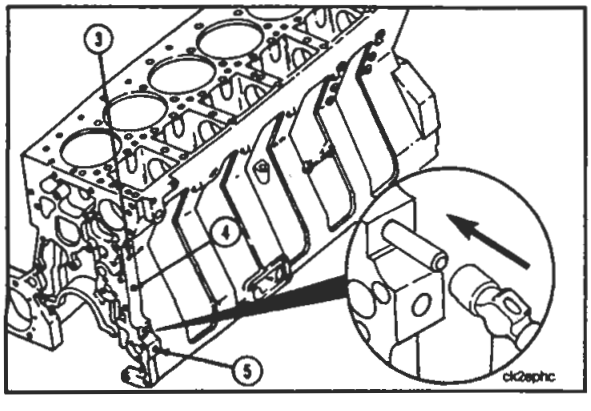
Note: If the cylinder block is **not** going to be used immediately, apply a coating of light preservative oil to prevent rust. Cover the block to prevent dirt from sticking to the oil.



Cup Plugs - Install

Note: Do not install any cup or pipe plugs until the inspection and any necessary repair procedures are completed. This will prevent dirt from being trapped in the oil passages.

Use Part No. 3375068 Cup Plug Sealant to coat the outside diameter of the cup plugs.

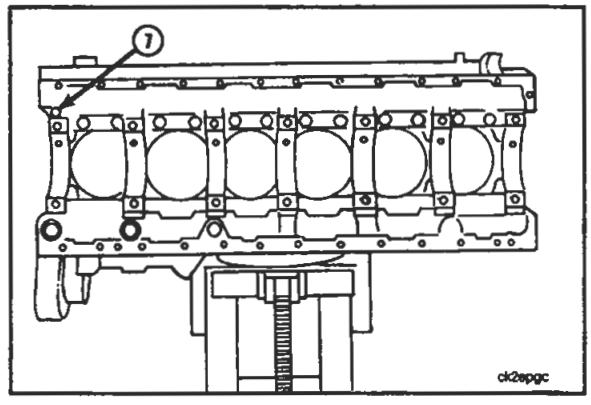


Use the Part No. 3822372 Expansion Plug Driver to install the following cup plugs:

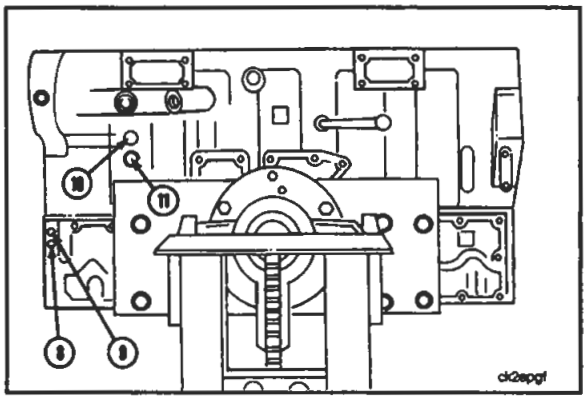
Plugs (3), (4), and (5)

Note: Plug "4" is found on present production engines only.

Plug (7)

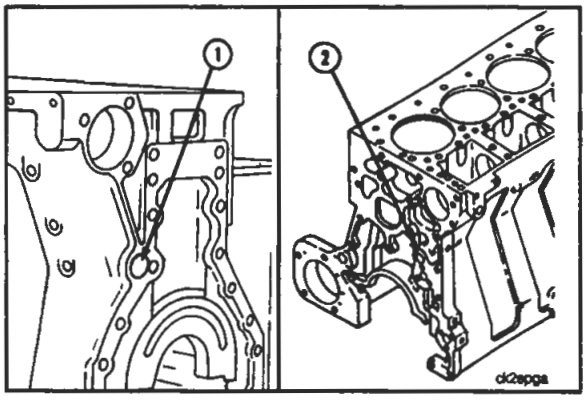


Plugs (8), (9), (10), and (11)

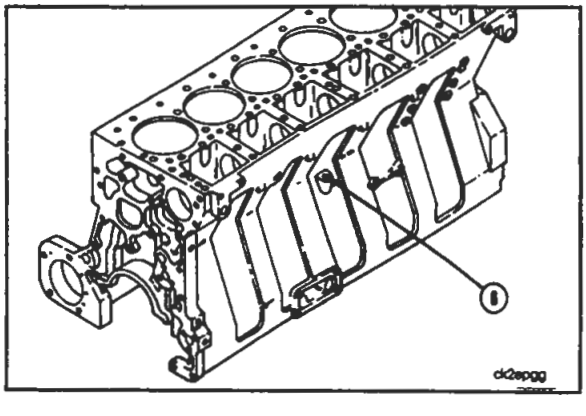


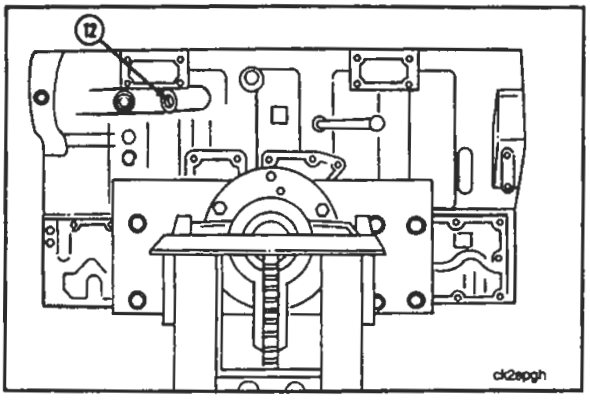
Use the Part No. 3376816 Expansion Plug Driver to install the following cup plugs:

Plugs (1) and (2)

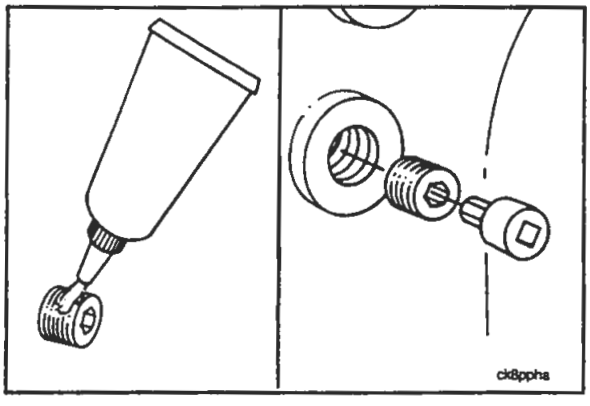


Plug (6)





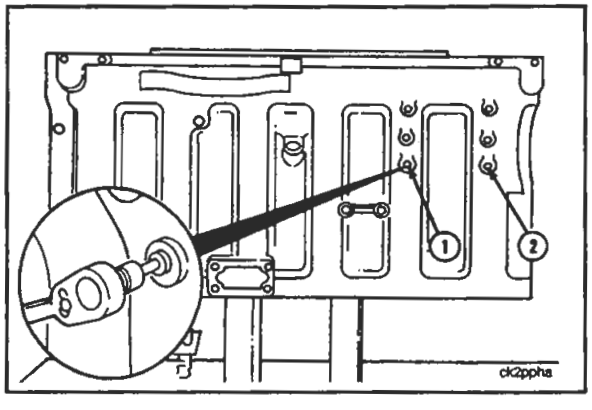
Plug (12)



Pipe Plugs - Install

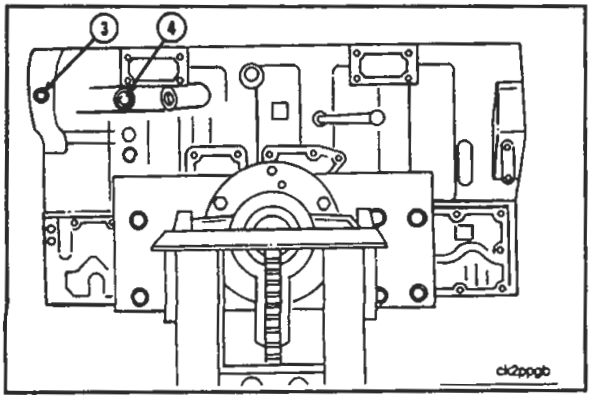
Use part No. 3375066 Pipe Sealant to coat the pipe plug threads.

Note: If the engine is equipped with Compuchek® adapters, refer to page i-13 for plug locations and sizes.



Use a 1/4 inch allen head wrench to install plugs (1) and (2).

Torque Value: 15 N•m [11 ft-lb]



Use a 3/16 inch allen head wrench to install plug (3).

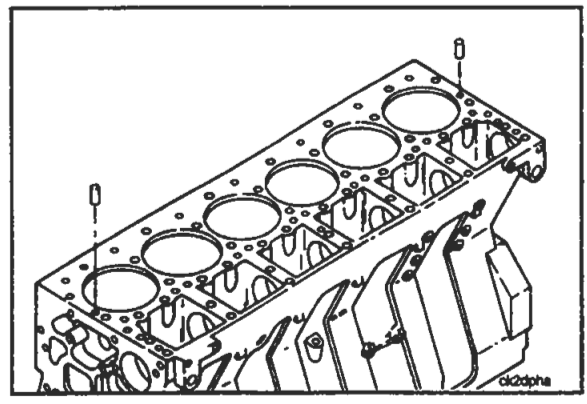
Use a 3/8 inch allen head wrench to install plug (4).

Torque Value: 15 N•m [11 ft-lb]

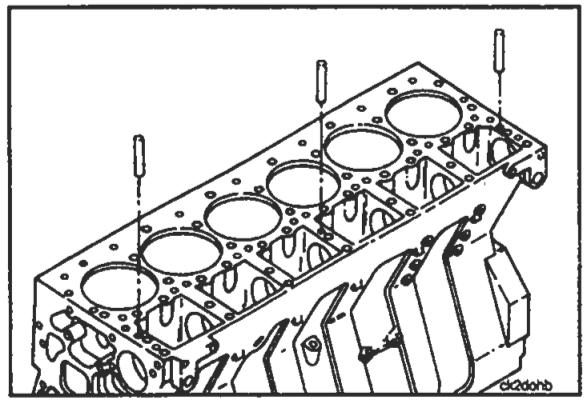
Dowel Pins - Install

Use a hard plastic hammer to install the following dowel pins:

a. Two Cylinder head dowel pins

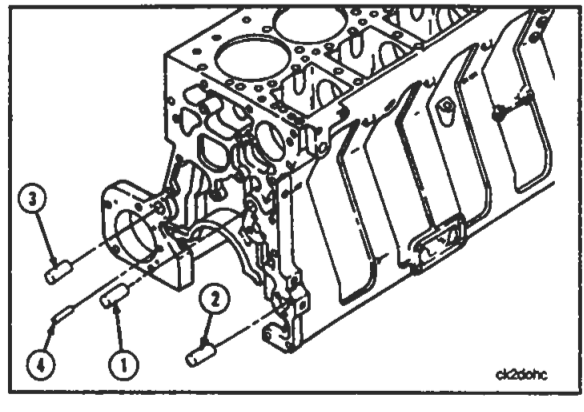


b. Three cam follower support dowel pins



c. Idler gear ring dowels (1), (2), and (3)

d. Lubricating oil pump dowel pin (4)



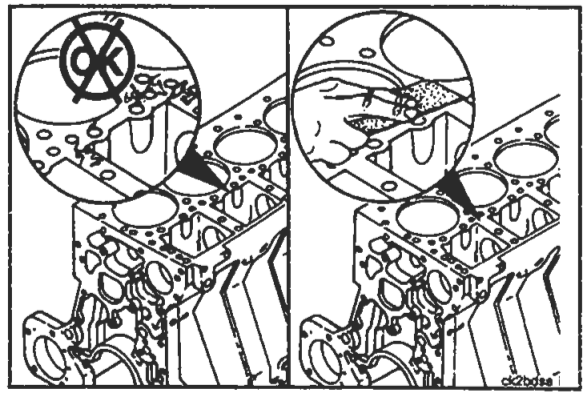
Cylinder Block - Inspect for Reuse (01-02)

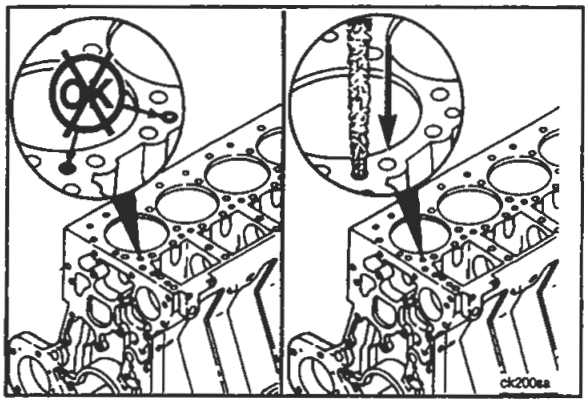
Note: All measurements of the cylinder block **must be** made when the block is positioned on a flat surface. If the block is mounted on the engine stand, the measurements can be wrong because of distortion.

Inspect Gasket Surfaces

Visually inspect for burrs or damage.

Use an Arkansas Hone or crocus cloth to remove burrs.

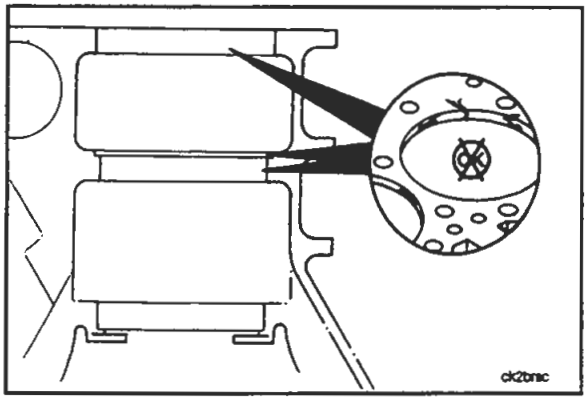




Visually inspect the water passages for rust or restriction.

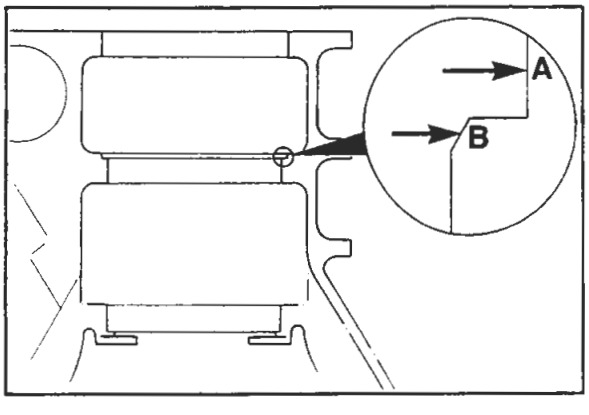
Use bristle brushes to clean the water passages.

NOTE: If rust or restriction cannot be removed with bristle brushes, the cylinder block **must be** cleaned with a chemical bath.

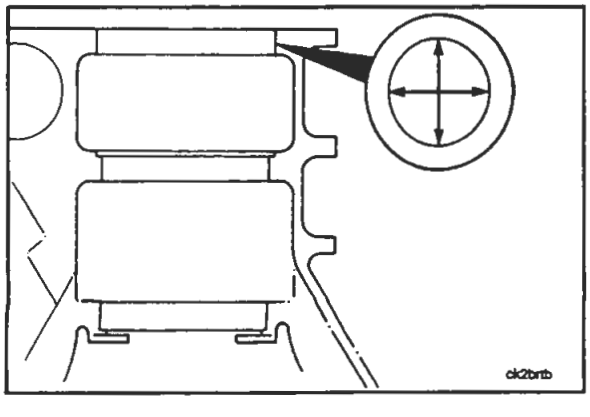


Cylinder Liner Bores - Inspect

Visually inspect the cylinder head mounting surface, upper liner bore, the liner counter bore and the lower liner bore for cracks or damage.



NOTE: The cylinder block liner bore 0 to 8.0 mm [0 to 0.32 inch] above and below the counterbore (A) and (B), are **not** critical dimensions and **do not** need to be measured. Dimension (A) is larger than the liner flange and dimension (B) is a lead-in chamfer for the liner seal seat bore.

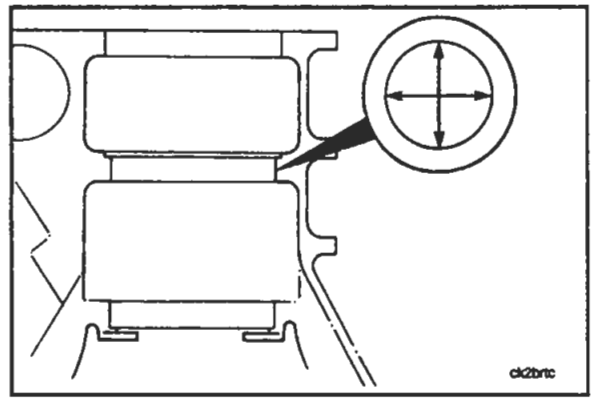


Measure the upper liner bore inside diameter.

Cylinder Block Upper Liner Bore I.D.		
mm		in
145.900	MIN	5.7441
146.027	MAX	5.7491

Measure the liner seal seat bore Inside diameter 8.0 to 13.5 mm [0.32 to 0.53 inch] below the counterbore.

Cylinder Block Liner Seal Seat Bore I.D.		
mm		in
138.063	MIN	5.4355
138.113	MAX	5.4375



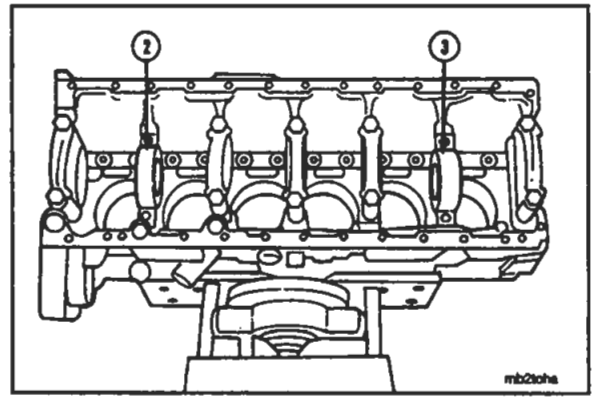
Main Bearing Bore Alignment - Inspect

Install main bearing cap numbers "1", "3", "4", "5", and "7".

Note: The main bearing caps are numbered. The numbers **must** match the numbers stamped on the camshaft side of the cylinder block oil pan mounting surface (1). The numbers on the main bearing caps **must be** toward the camshaft side of the engine.

Install the Part No. 3376781 Centering Rings in the numbers "2" and "6" main bearing saddles (2) and (3).

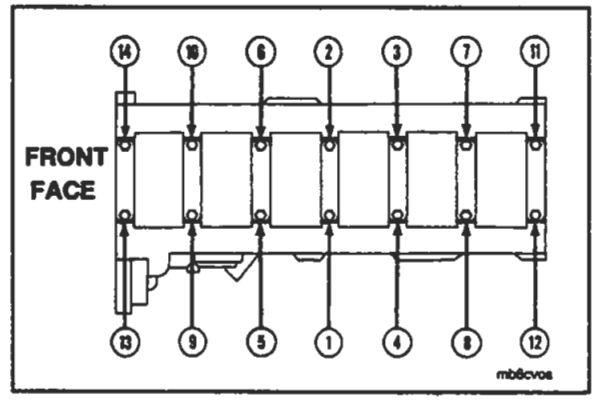
Install the main bearing caps numbers "2" and "6".



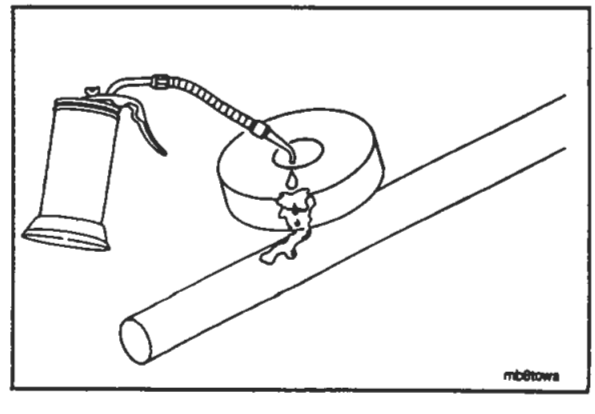
Tighten the main bearing caps in the sequence shown.

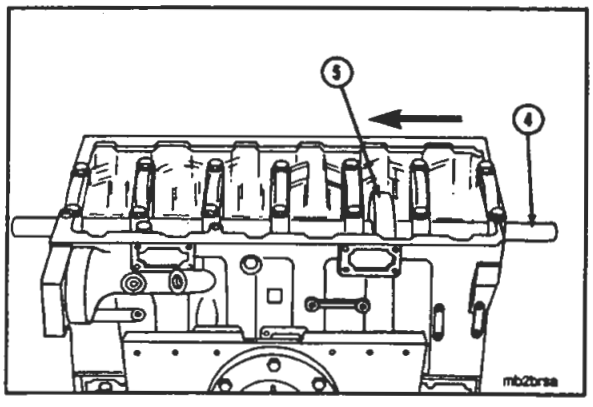
Torque Value: Main Bearing Capscrews

N•m	Step	ft-lb
70	1	50
140	2	105
210	3	155
Loosen	4	Loosen
70	5	50
140	6	105
210	7	155



Use clean 15W-40 oil to lubricate the Part No. 3376811 Checking Ring and the Part No. ST-1177-16 Checking Bar.



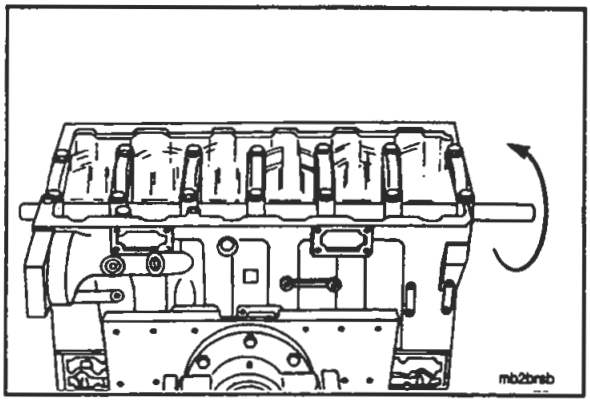


Install the checking bar (4) and the checking ring (5) through the main bearing bores.

The checking ring **must** pass through each bore with slight resistance.

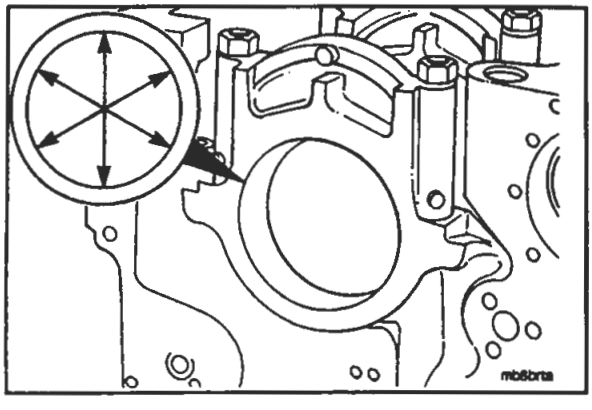
NOTE: If the checking ring passes through any bore without any resistance, the bore is oversize and **must be** repaired.

NOTE: If the checking ring binds in any bore, inspect the bore for burrs and the cap for correct alignment. If the ring still binds in the bore, the bore is undersized and **must be** repaired.



The checking bar must turn easily when the checking ring is in the bore.

NOTE: If the checking bar will not turn easily, the alignment is incorrect and the cylinder block **must be** repaired.

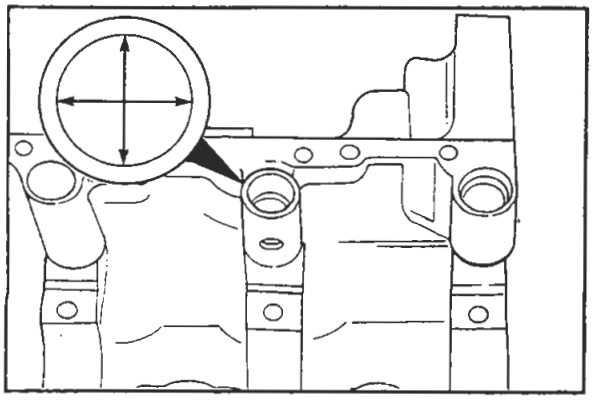


Main Bearing Bore Inside Diameter - Measure

Use the Part No. 3376576 Master Ring Gauge to set up the dial bore gauge.

Measure the inside diameter of all seven bores at three points.

Main Bearing Bore I.D.		
mm		In
121.990	MIN	4.8028
122.015	MAX	4.8037



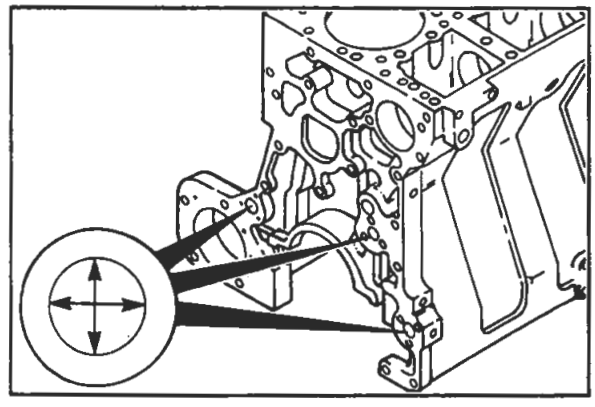
Main Oil Pressure Regulator Valve Bore - Measure

Main Oil Pressure Regulator Valve Bore I.D.		
mm		In
22.226	MIN	0.8750
22.301	MAX	0.8780

NOTE: The relief valve seat depth must be 71.4 mm [2.81 inch] maximum.

Idler Gear Ring Dowel Bores - Measure

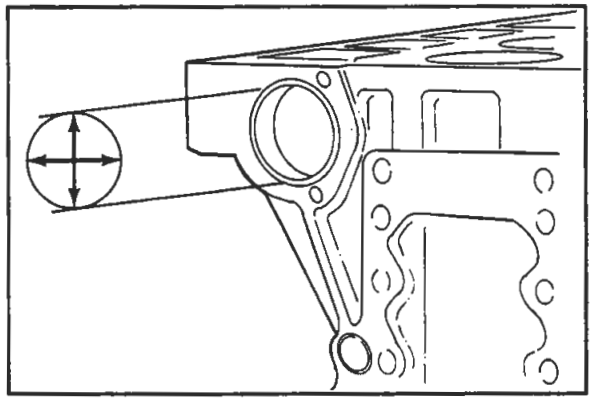
Idler Gear Ring Dowel Bore I.D.		
mm		In
19.175	MIN	0.7549
19.215	MAX	0.7565



Camshaft Bushing Inside Diameters - Measure

Camshaft Bushing I.D. Installed		
mm		In
72.078	MIN	2.8377
72.142	MAX	2.8402

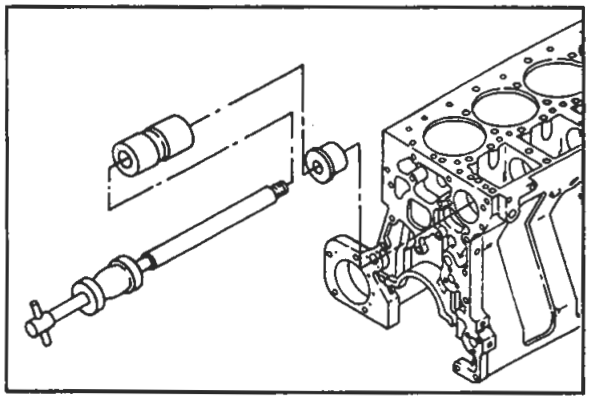
NOTE: If one of the bushings exceeds the maximum specifications, all bushings **must be** replaced.



Camshaft Bushings - Replace (01-03)

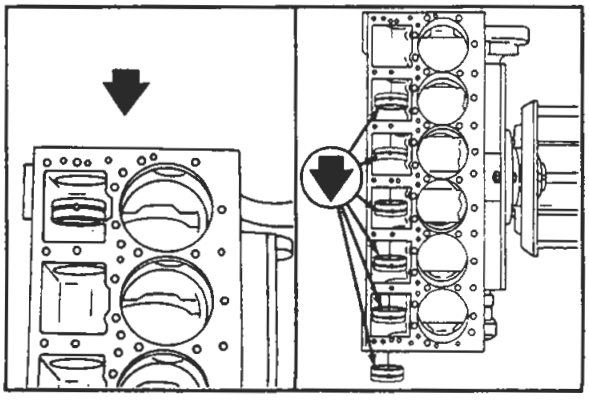
Camshaft Bushings - Remove

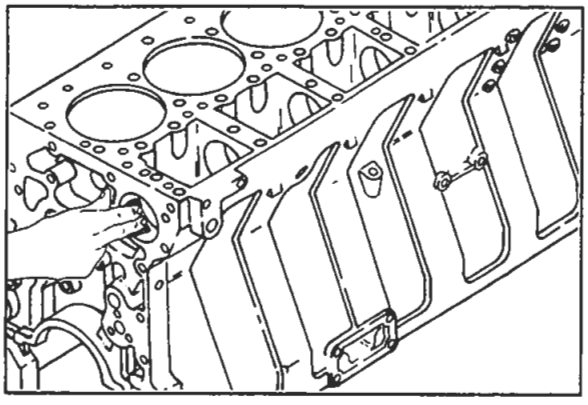
Use the Part No. ST-1228 Camshaft Bushing Driver Set, Part No. 3376070 Mandrel, and the Part No. 3376069 Guide to remove the camshaft bushings.



Remove the number one bushing first.

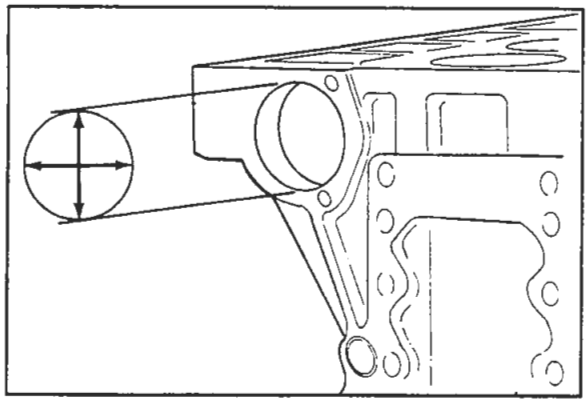
Remove the six remaining bushings.





Camshaft Bushing Bores - Clean

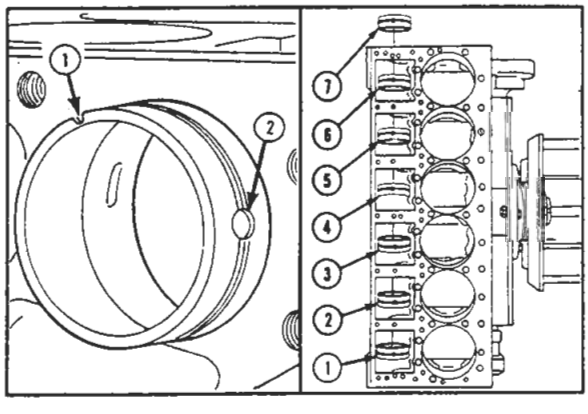
Use fine emery cloth to remove burrs and sharp edges from the bore.



Camshaft Bushing Bores - Inspect

Measure the cylinder block camshaft bore inside diameter.

Cylinder Block Camshaft Bore I. D.		
mm		in
76.987	MIN	3.0310
77.040	MAX	3.0331



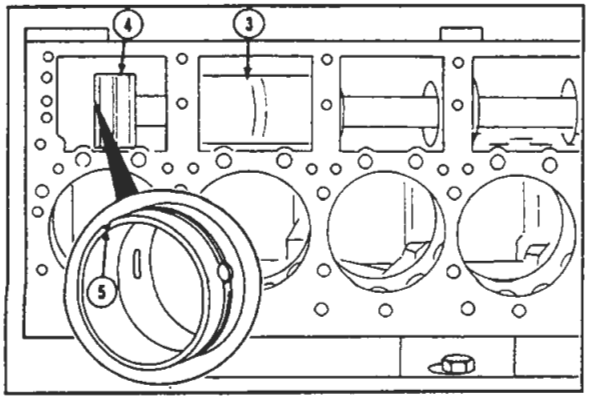
Camshaft Bushings - Install

Caution: Remove any metal chips from the camshaft bushing oil groove to prevent the lubricating system from being contaminated and causing engine damage.

Use the Part No. ST-1228 Camshaft Bushing Driver Set and the Part No. 3376070 Mandrel to install the camshaft bushings.

Note: The notch (1) in the bushing **must** face toward the front of the engine. The oil hole (2) in the bushing **must** be at the 3 O'clock position viewed from the front of the engine.

Install the bushings in the following order; number "7", "6", "5", "4", "3", "2", and "1".



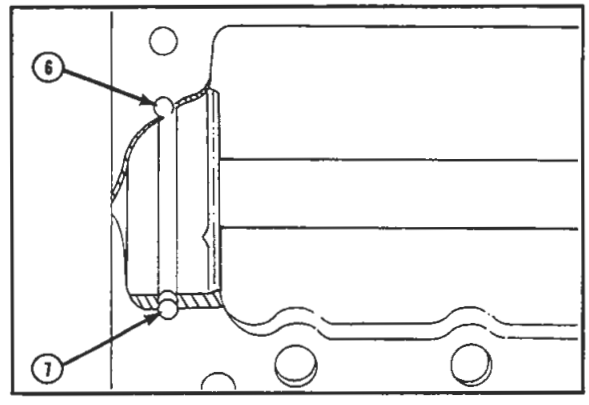
To install the number "7" bushing, install the Part No. 3376069 Guide (3) between the number "6" and "5" bore.

Install a new bushing (4) on the mandrel with the notch (5) toward the front of the engine and the oil hole at the 3 O'clock position viewed from the front of the engine.

Drive the bushing in the bore.

Caution: The bushing oil groove must be visible in both block oil drillings (6 and 7) to prevent engine damage. The oil drillings are not in alignment with each other.

Visually inspect the bushing oil groove alignment with the two oil drillings in the block as the bushing is installed.

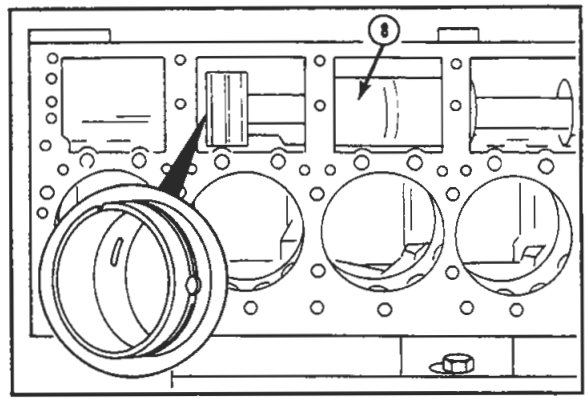


Use the same procedure to install the numbers "6", "5", "4", "3", and "2" bushings.

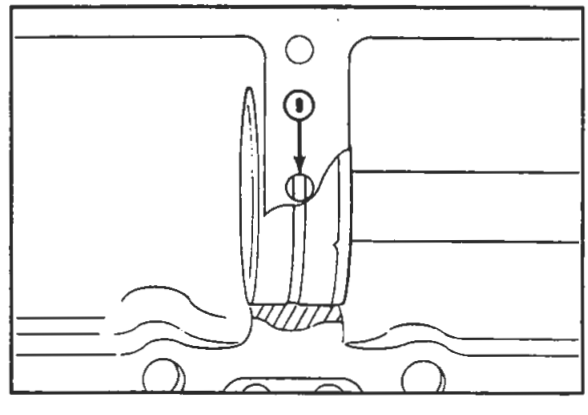
Install the guide (8) into the correct position.

Install the bushing on the mandrel with the notch toward the front of the engine and the oil hole at the 3 O'clock position viewed from the front of the engine.

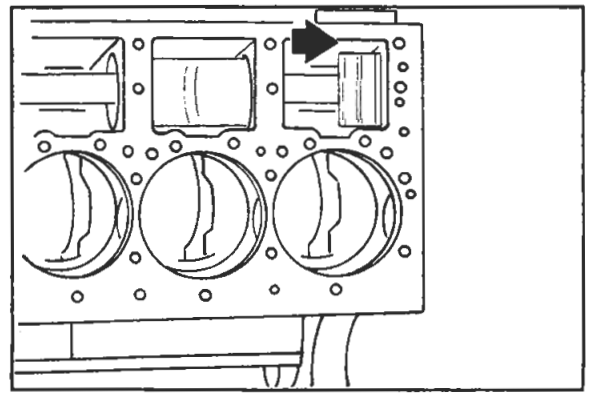
Drive the bushing in the bore.

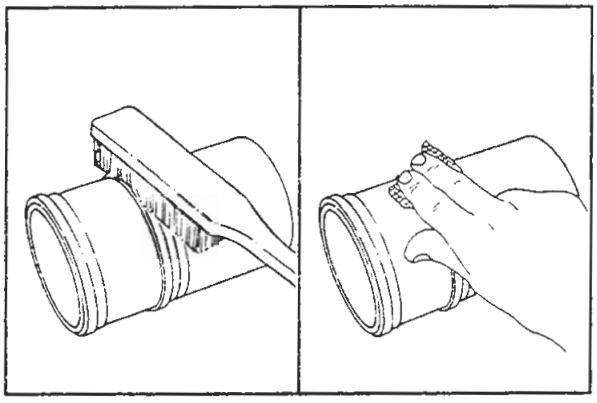


Caution: Visually inspect the position of the camshaft bushing oil groove through the cam follower stud holes (9). The bushing oil groove must be visible to prevent engine damage.



Follow the procedure used to install the number "7" bushing to install the number "1" bushing.





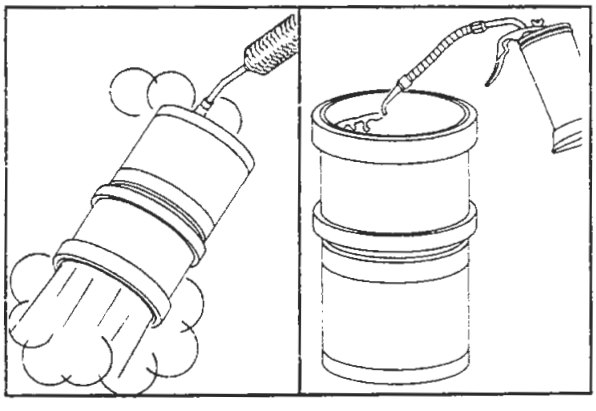
Cylinder Liners - Clean and Inspect for Reuse (01-04)

Cylinder Liners - Clean

Caution: Do not use any abrasives in the ring travel area of the liner. The liner can be damaged.

Use a soft wire brush to clean the flange seating area.

Use a fine fibrous abrasive pad such as; Scotch-Brite® 7448 or equivalent to remove the remaining carbon.

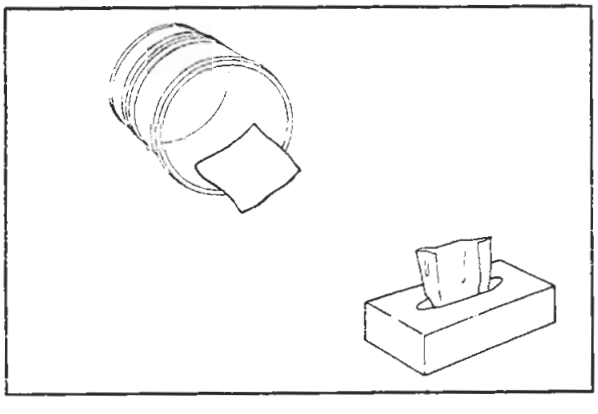


Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use solvent or steam clean the liners and dry with compressed air.

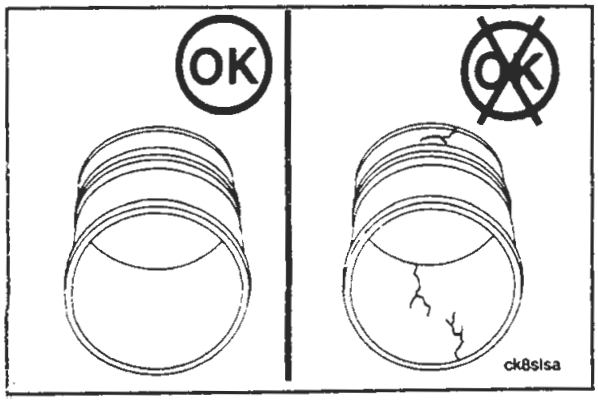
Use clean 15W-40 oil to lubricate the inside diameter of the liners.

Allow the oil to soak in the liner for five to ten minutes.



Note: Use "lint-free" paper towels to wipe the oil from the inside of the liners.

Continue to lubricate the inside of the liners and wipe clean until the paper towel shows no gray or black residue.

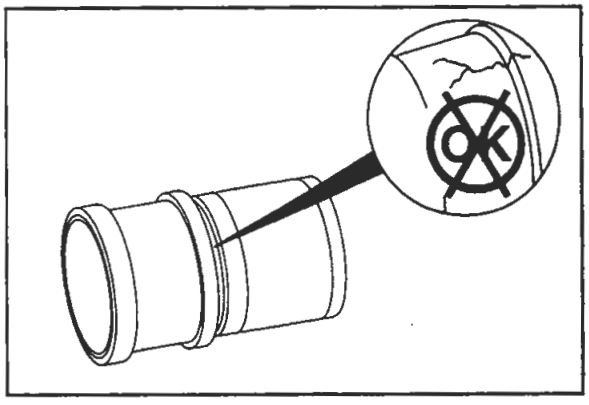


Cylinder Liners - Inspect

Visually inspect for cracks on the inside and the outside of the liner.

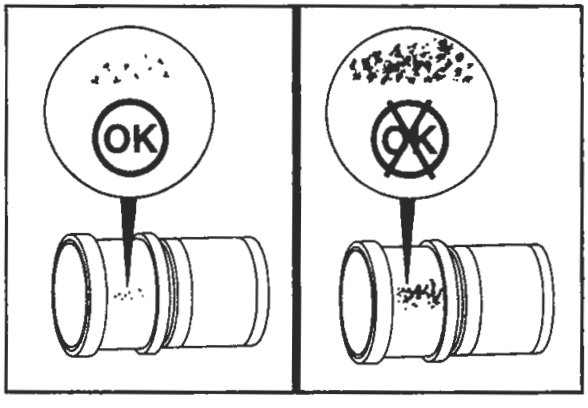
Visually inspect for cracks under the liner flange.

Note: Cracks in the liners can also be detected by using either magnetic inspection or the dye penetrant method.



Visually inspect for pitting on the outside diameter of the liners.

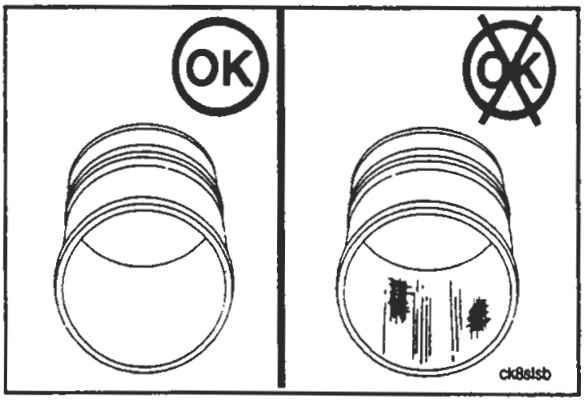
Replace the liner if the pitting is deeper than 1.5 mm [1/16 inch].



Visually inspect the liner inside diameters for vertical scratches deep enough to be felt with a fingernail.

Note: If a fingernail catches in the scratch, the liner **must be** replaced.

Visually inspect the liner inside diameters for scuffing or scoring.

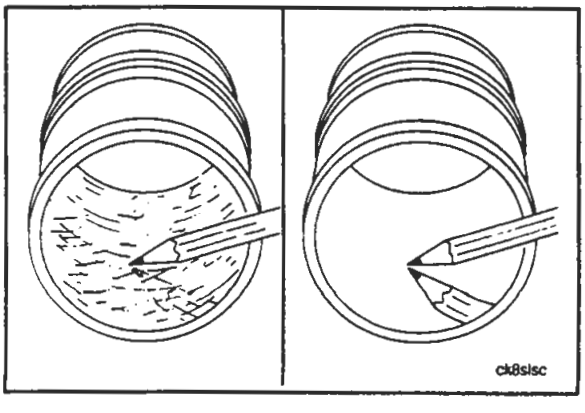


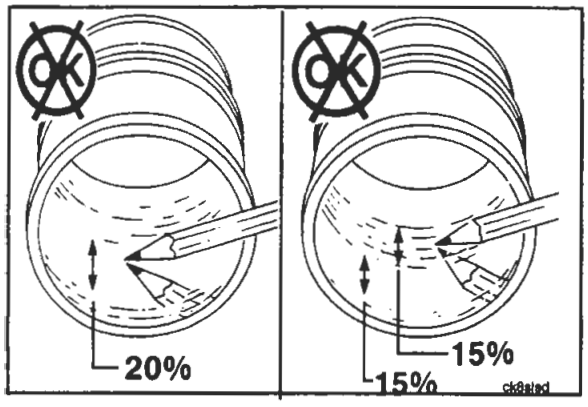
Visually inspect the liner inside diameters for liner bore polishing.

Note: L10 cylinder liners are **not** lubrited.

A Moderate Polish produces a bright mirror finish in the worn area with traces of the original hone marks or an indication of an etch pattern.

A Heavy Polish produces a bright mirror finish in the worn area with no traces of hone marks or an etch pattern.

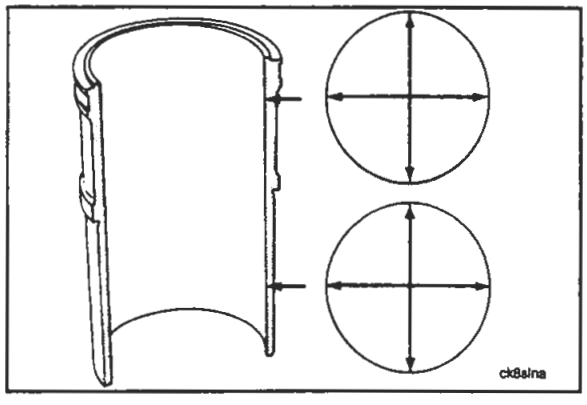




Replace the liner if either of the following conditions apply:

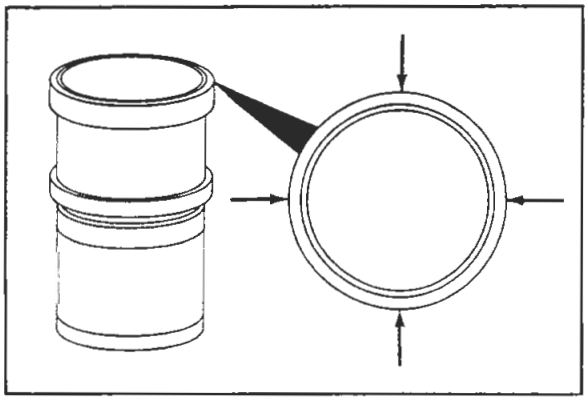
a. A heavy polish is present over 20 percent of the piston ring travel area.

b. 30 percent of the piston ring travel area has both moderate and heavy polish and one half (15 percent) is heavy polish.



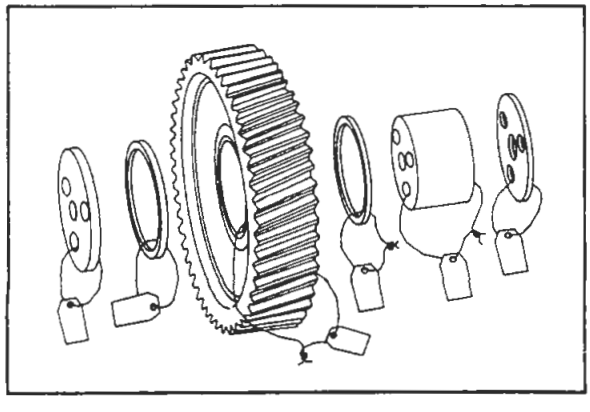
Measure the liner inside diameters in four places 90 degrees apart at the top and bottom of the piston travel area.

Cylinder Liner Inside Diameter		
mm		in
125.00	MIN	4.921
125.14	MAX	4.927



Measure the liner top press fit area outside diameters.

Cylinder Liner Top Press Fit O. D.		
mm		in
145.962	MIN	5.7465
146.000	MAX	5.7480



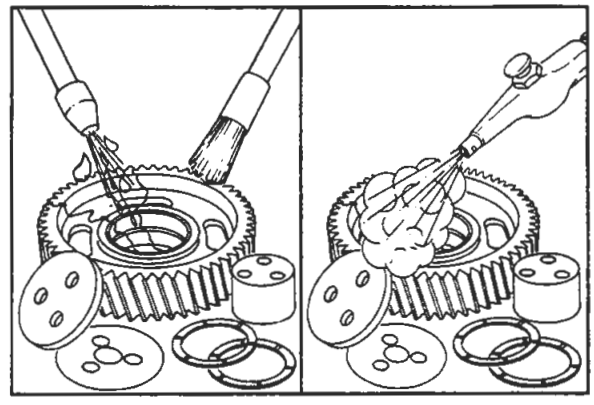
Idler Gear Assemblies - Clean and Inspect for Reuse (01-05)

Note: Use the following procedures to clean and inspect all three Idler gear assemblies.

Note: Keep each individual idler gear assembly tagged together to be sure the assemblies are installed in the correct location.

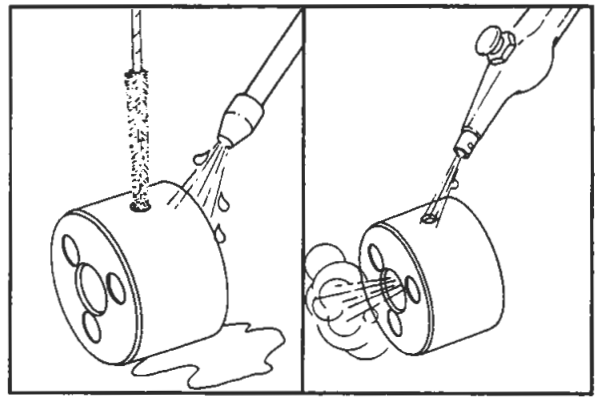
Idler Gear Assemblies - Clean

Use solvent to clean the assemblies and dry with compressed air.



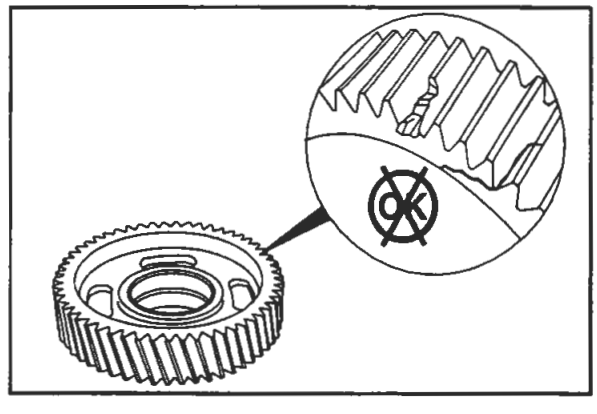
Use a soft bristle brush to clean the oil drilling in the idler gear shafts.

Use compressed air to blow out the oil drillings.



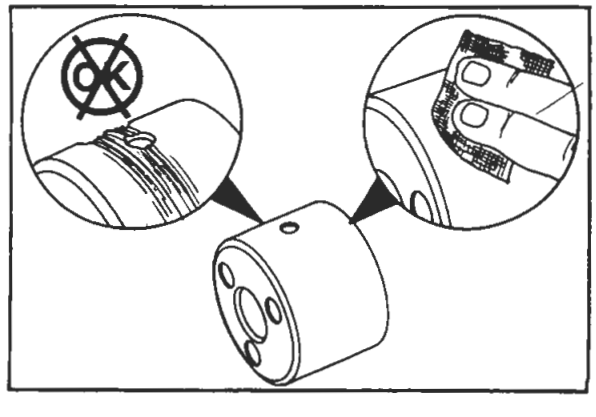
Idler Gears - Inspect

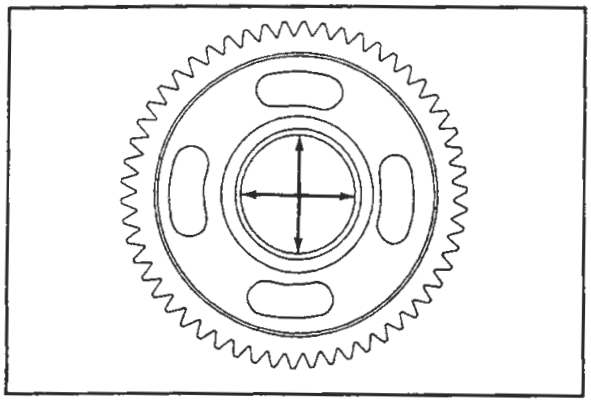
Visually inspect the gears for chipped or broken teeth, and cracks.



Visually inspect the shafts for damage.

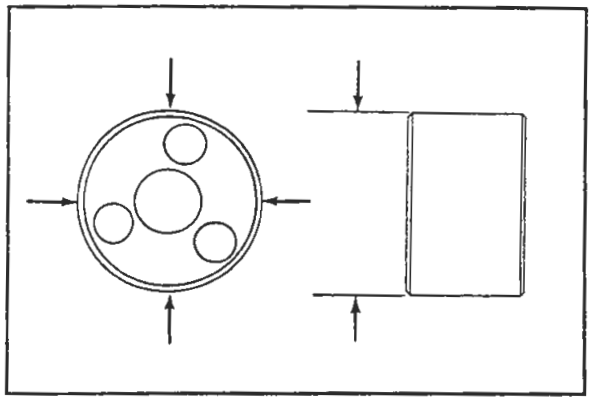
Use fine crocus cloth to remove any burrs.





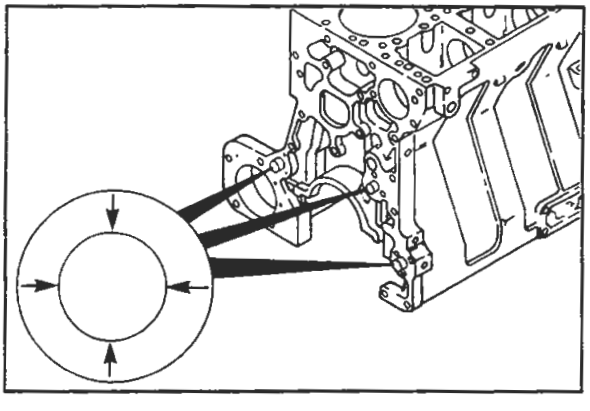
Measure the gear bushing bore inside diameters.

Idler Gear Bushing Bore I. D.		
mm		in
60.045	MIN	2.3640
60.100	MAX	2.3661



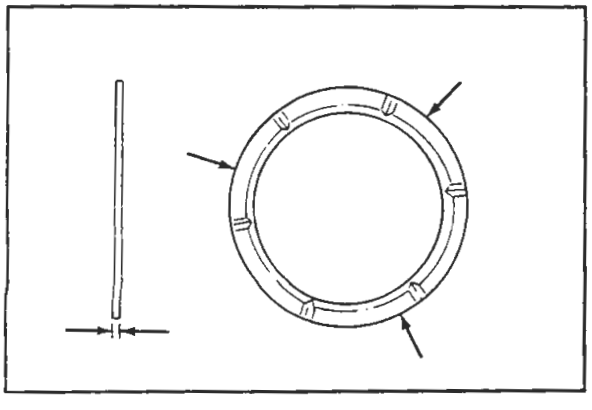
Measure the idler gear shaft outside diameters.

Idler Gear Shaft O. D.		
mm		in
59.975	MIN	2.3612
59.993	MAX	2.3619



Measure the idler gear ring dowel outside diameters.

Idler Gear Ring Dowel O. D.		
mm		in
19.217	MIN	0.7566
19.243	MAX	0.7576



Measure the idler gear thrust washer thickness in three places 120 degrees apart..

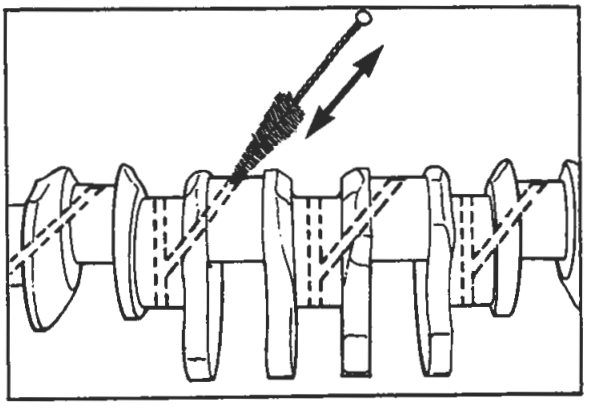
Idler Gear Thrust Washer Thickness		
mm		in
2.400	MIN	0.0945
2.470	MAX	0.0972

Crankshaft - Clean and Inspect For Reuse (01-06)

Crankshaft - Clean

Use fine crocus cloth to polish the machined surfaces.

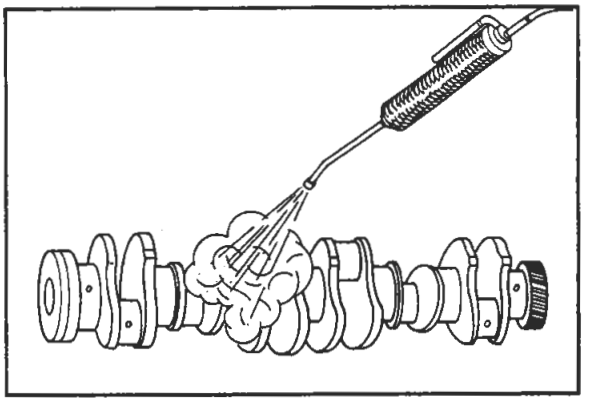
Use a bristle brush to clean the oil drillings.



Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Steam clean the crankshaft and dry with compressed air.

Note: Make sure to blow out the threaded holes on each end of the crankshaft and the oil drillings.

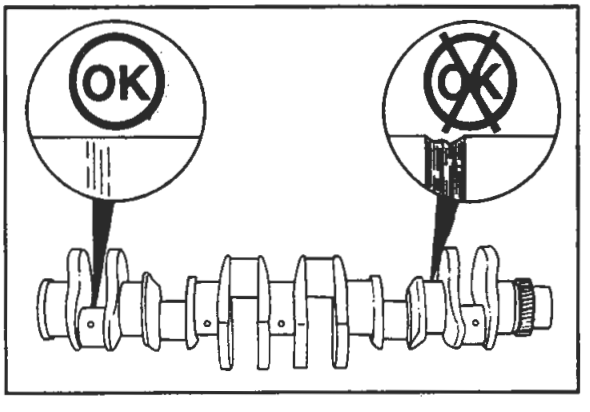


Crankshaft - Inspect

Visually inspect the machined surfaces for scratches or nicks.

Use fine crocus cloth to remove the nicks and scratches.

Note: If scratches or nicks can be felt with a fingernail after the crankshaft has been polished with crocus cloth, the crankshaft **must be** replaced or reconditioned.

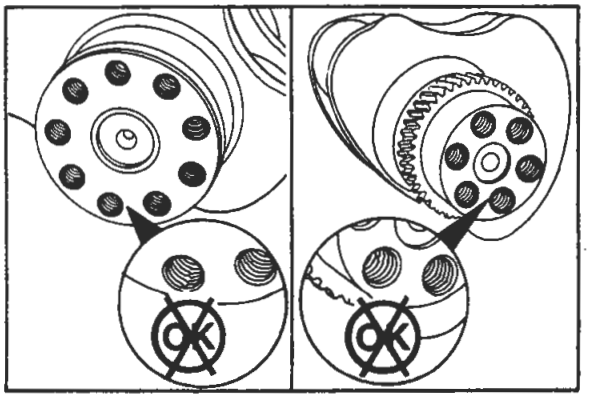


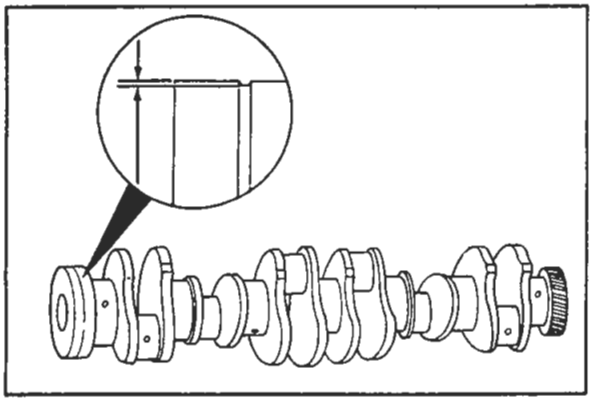
Visually inspect the threaded capscrew holes for damage.

Use one of the following methods to repair any threaded holes:

a. Chase the threads
b. Use the Part No. 3375021 Threaded Insert Kit

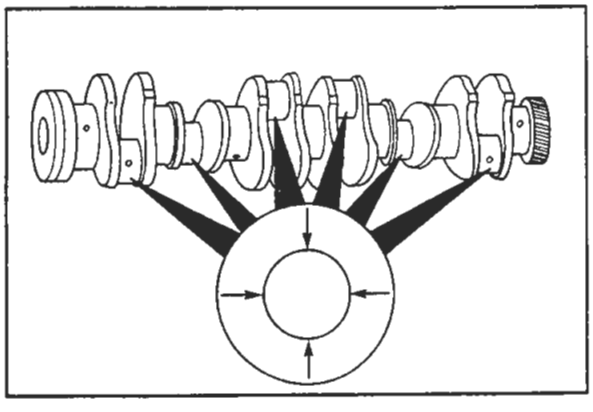
Note: If more than three threaded holes are damaged in one end, the crankshaft **must be** replaced.





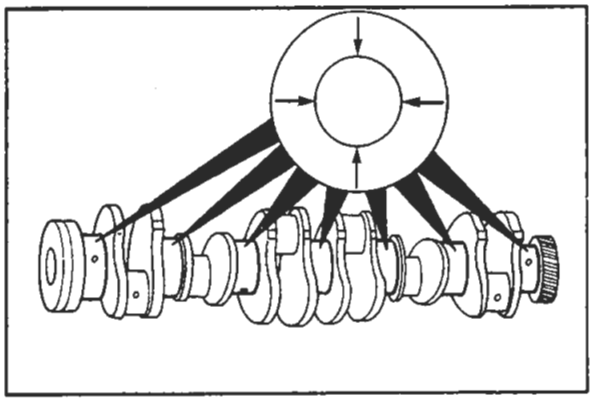
Measure the rear oil seal wear groove.

Crankshaft Rear Oil Seal Wear Groove		
mm		In
0.25	MAX	0.010



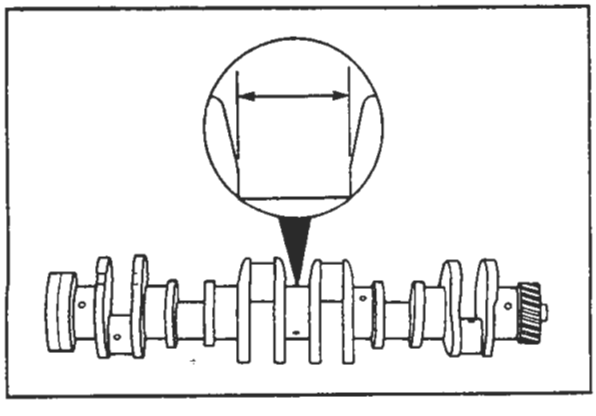
Measure the connecting rod journals outside diameters.

Crankshaft Connecting Rod Journal O.D.		
mm		In
78.950	MIN	3.1083
79.013	MAX	3.1107



Measure the main bearings journals outside diameters.

Crankshaft Main Bearing Journal O.D.		
mm		In
113.990	MIN	4.4878
114.055	MAX	4.4903

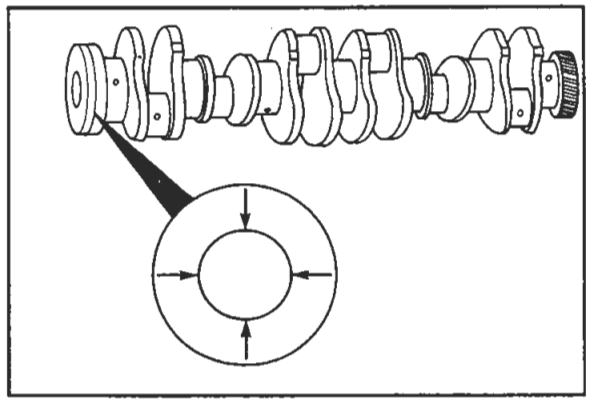


Measure the thrust face width.

Crankshaft Thrust Face Width		
mm		In
49.975	MIN	1.9675
50.100	MAX	1.9724

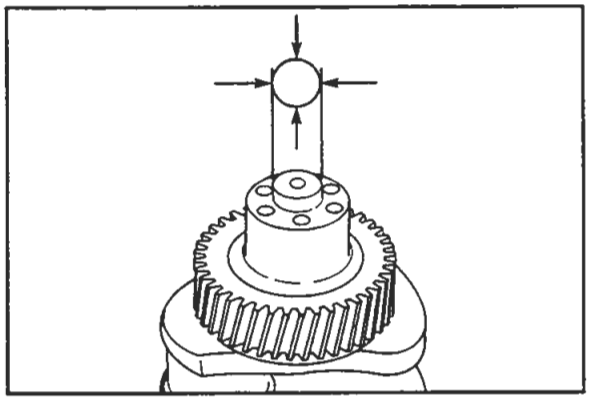
Measure the rear oil seal flange outside diameter.

Crankshaft Rear Oil Seal Flange O.D.		
mm		in
164.965	MIN	6.4947
165.035	MAX	6.4974

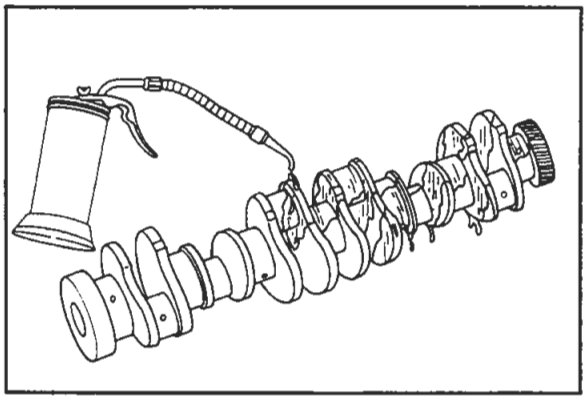


Measure the damper pilot outside diameter.

Crankshaft Damper Pilot O.D. (5 Hole Crankshaft)		
mm		in
32.02	MIN	1.2606
32.05	MAX	1.2618

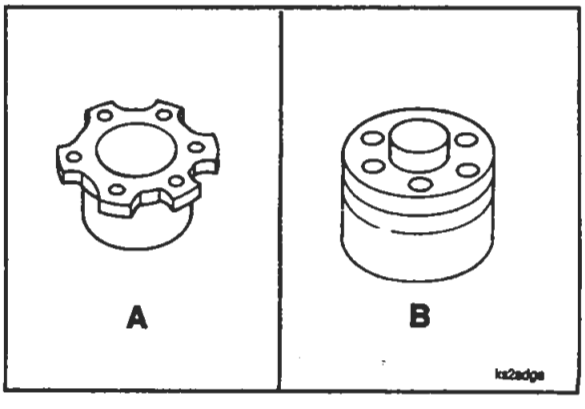


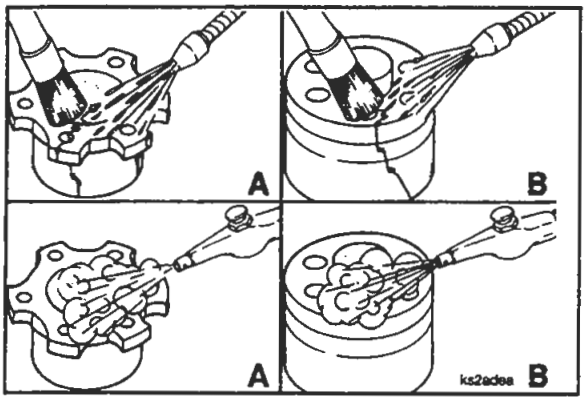
Use clean 15W-40 oil to coat the entire crankshaft to prevent rust.



Crankshaft Adapter - Clean and Inspect for Reuse (01-07)

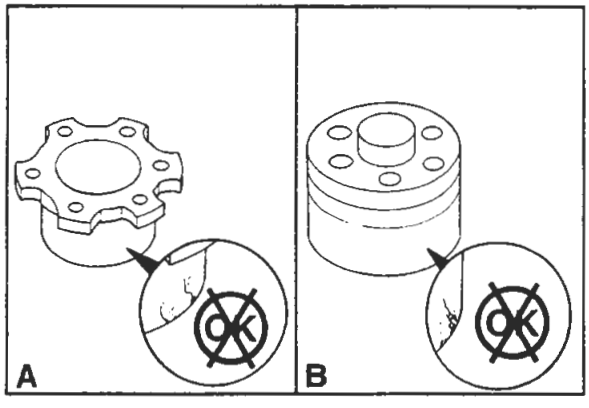
Two styles of crankshaft adapters have been used, present production (A) and earlier production (B). Make sure to install the same style adapter on the engine as the one that was removed.





Crankshaft Adapter - Clean

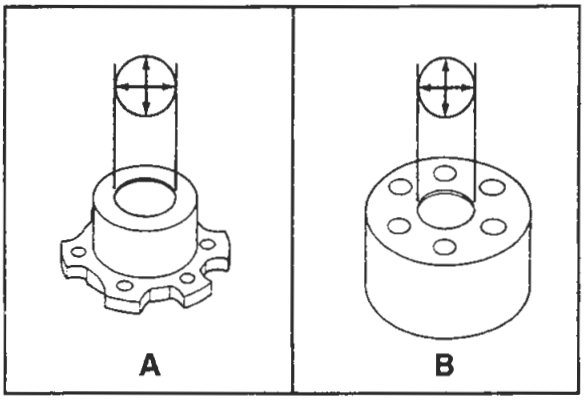
Use solvent and dry with compressed air.



Crankshaft Adapter - Inspect

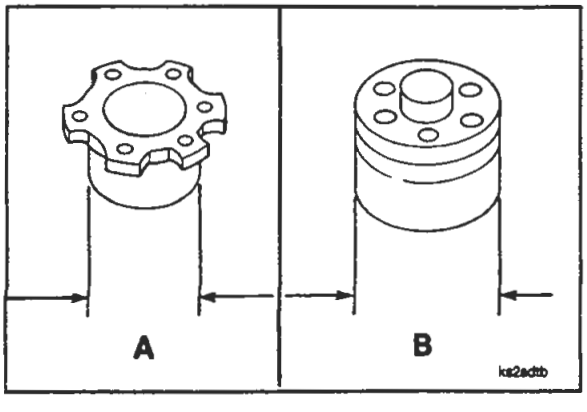
Visually inspect the adapter outside diameter for burrs or damage.

Use fine crocus cloth to remove any burrs.



Measure the adapter crankshaft pilot inside diameter.

Crankshaft Adapter Crankshaft Pilot I.D. (5 Hole Crankshaft)		
mm		in
32.05	MIN	1.2618
32.13	MAX	1.2650



Measure the crankshaft adapter outside diameter as shown, present production (A) and earlier production (B).

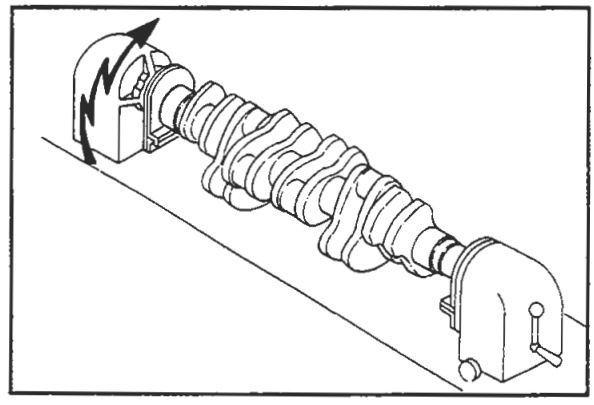
Crankshaft Adapter O.D.		
mm		in
89.975	MIN	3.5423
90.000	MAX	3.5433

Crankshaft - Magnetic Crack Inspection (01-08)

Note: The crankshaft **must be** tested by the 'Continuous Method'. The entire surface **must be** wetted with the magnetic particle suspension before the magnetizing current is applied.

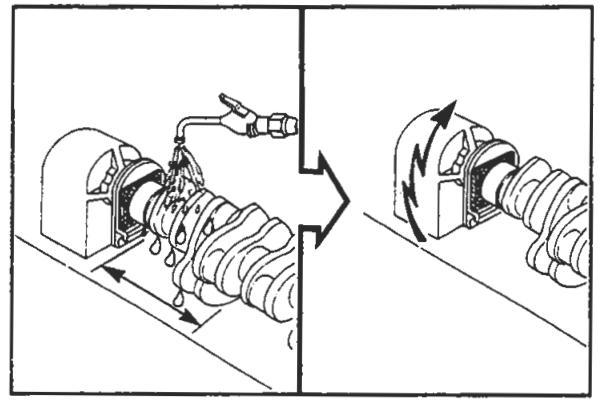
Head Shot (Circular Magnetization)

Apply the magnetic particle suspension to the crankshaft and use 1200 amperes with direct current or rectified A.C. or rectified A.C. equipment to magnetize the crankshaft.

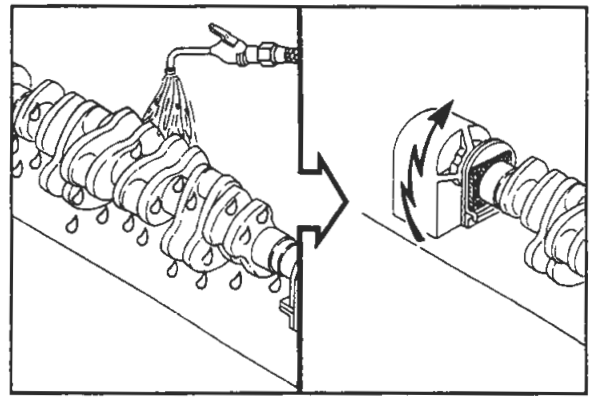


Note: A minimum of three successive head shots are required.

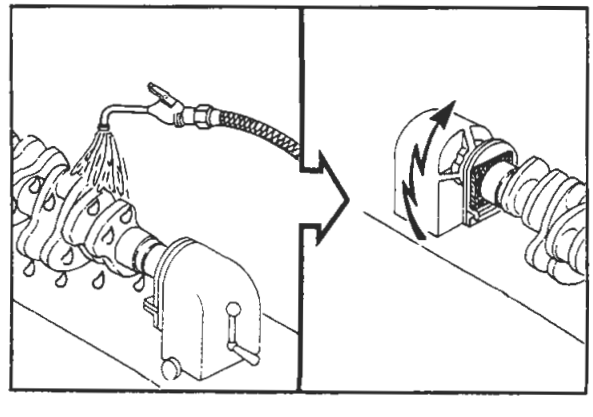
Flow the suspension over the first through third lengths of the crankshaft and apply the magnetizing current.

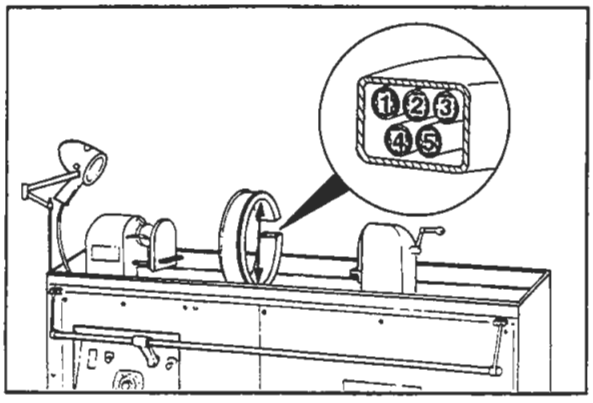


Flow the suspension over the third length of the crankshaft and apply the magnetizing current.



Flow the suspension over the last third lengths of the crankshaft and apply the magnetizing current.

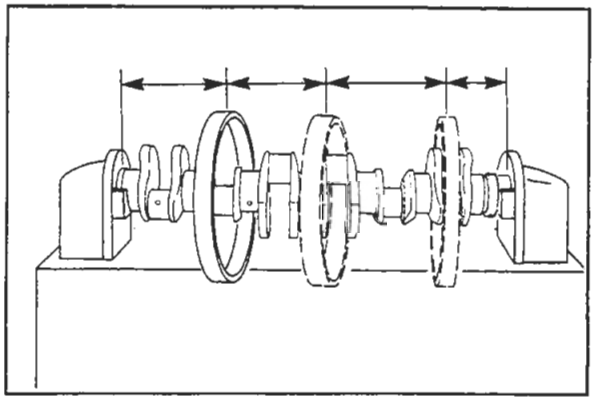




Coil Shot (Longitudinal Magnetization)

Apply the magnetic particle suspension and magnetize the crankshaft in a 514.35 mm [20.249 inch] inside diameter coil or equivalent using 3600 to 4000 ampere-turns with direct current or rectified A.C. equipment.

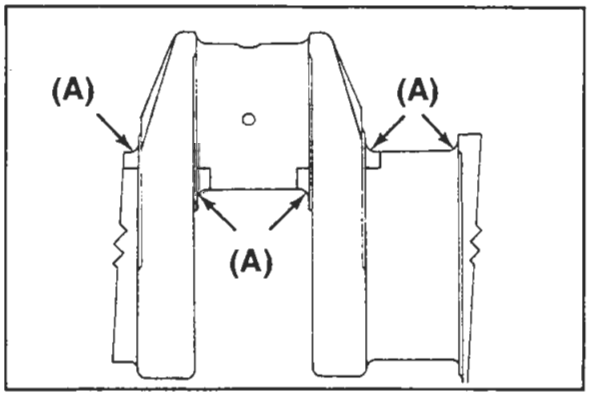
Note: Ampere-turn is the amperage flowing through the coil multiplied by the number of turns in the coil.



Note: Three coil shots are required to correctly magnetize the crankshaft.

Flow the magnetic particle suspension over the crankshaft in one third sections.

Apply a coil shot after each wetting with the coil placed at quarter-length points along the crankshaft.

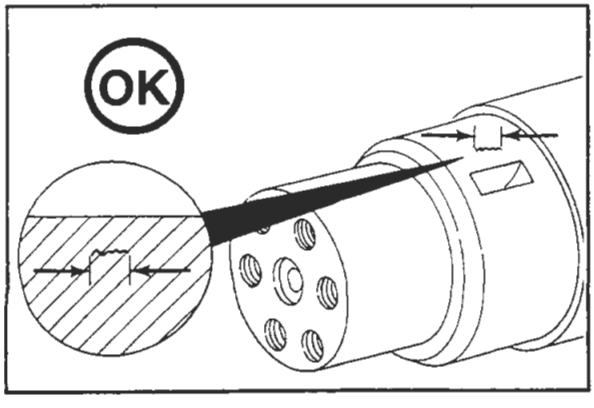


Crankshaft - Magnetic Inspection

Visually inspect for open indications.

Note: An open indication is a wide crack open to the surface and can be seen without using optical enhancement. An open indication can sometimes be felt with a fingernail. Do not mistake forging trim lines for crack indications.

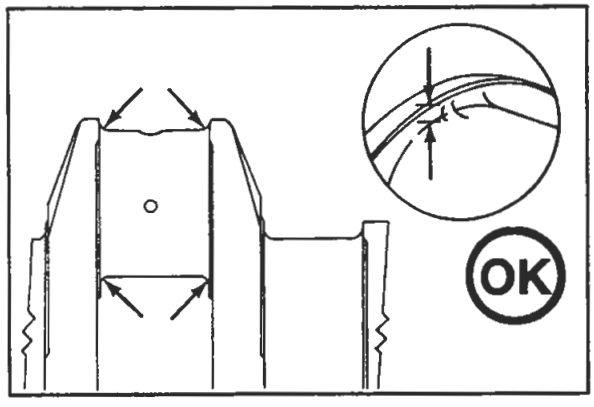
Open indications **must not** be seen in the hardened fillet area or the critical areas shown (A).



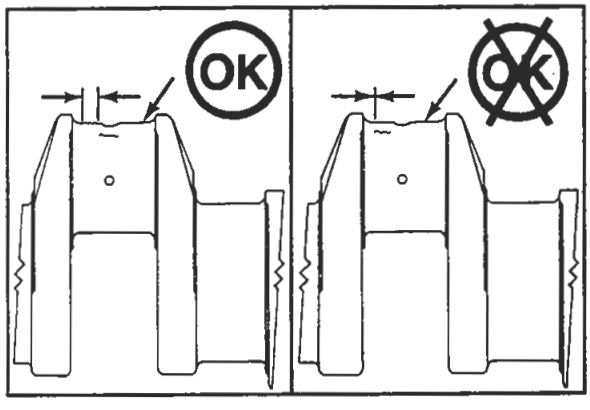
Open indications no more than 6 mm [1/4 inch] long are acceptable.

No more than four indications are allowed.

Open indications no more than 5 mm [3/16 inch] long in, or entering the fillets are acceptable.

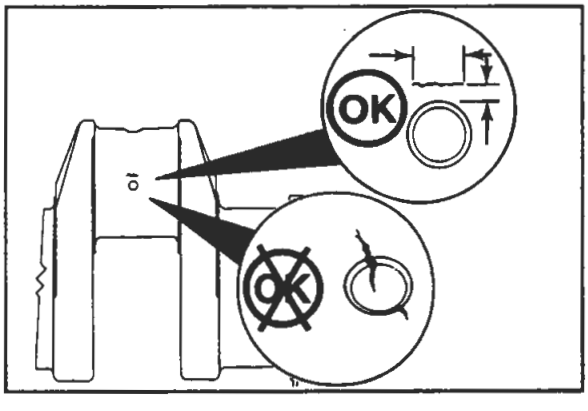


Light open indications on the crankpin or main bearing journal surfaces that extend closer than 3 mm [1/8 inch] to the fillet but **do not** enter the fillet are acceptable.

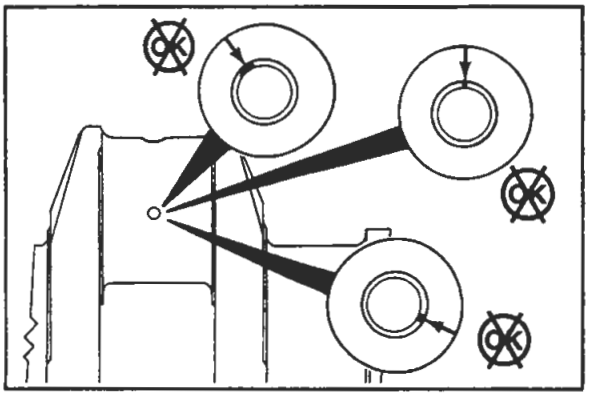


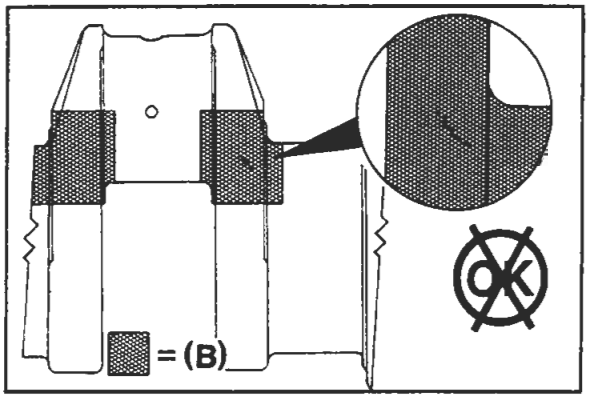
Open indications greater than 16 mm [5/8 inch] long that are not closer than 3 mm [1/8 inch] to the crankpin bearing journal oil hole chamfer are acceptable.

Open indications greater than 16 mm [5/8 inch] long that enter the oil hole chamfer or intersect the oil hole at 45 degrees (plus or minus 10 degrees) **are not** acceptable.

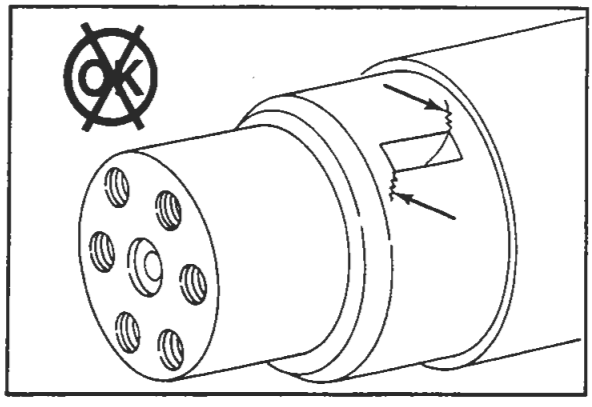


Any indication in the crankpin bearing oil hole entrance chamfer is **not** acceptable.

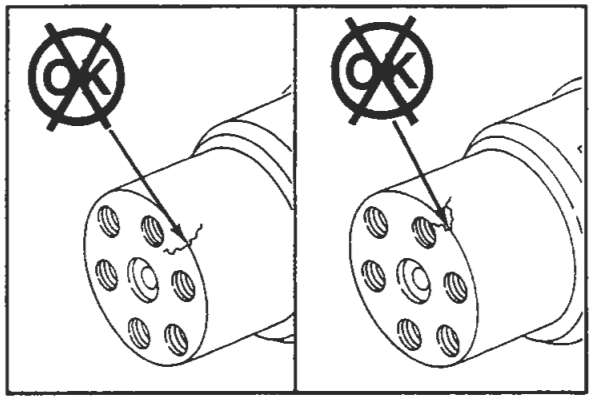




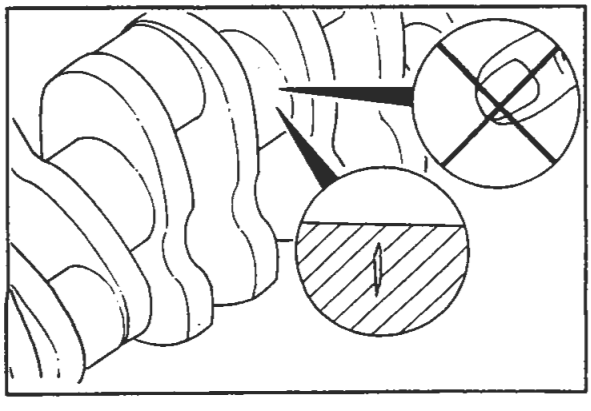
Open indications on the counterweights inside of the critical area (B) **are not** acceptable.



Open indications on the gear step diameter that enter the crankshaft keyway **are not** acceptable.



Open indications that extend over the face of the crankshaft or extends into the damper mounting capscrew holes is **not** acceptable.



Inspect for subsurface indications.

Note: Subsurface indications can not be seen with the naked eye. These are indications of open areas or foreign objects below the surface.

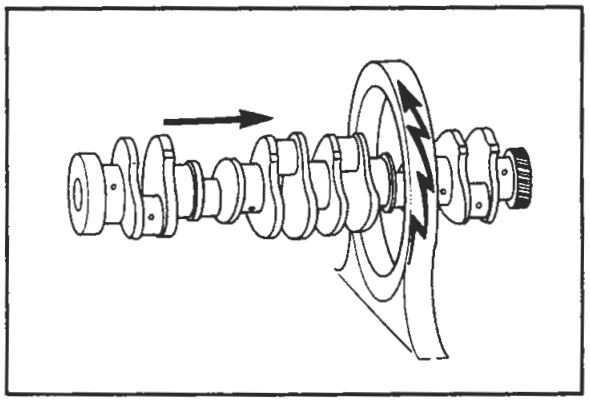
Note: A subsurface indication is not visible after the magnetic particles have been removed.

Caution: ALL magnetism must be removed from the crankshaft completely and cleaned thoroughly. Small metal particles will cause engine damage.

Remove all magnetism from the crankshaft.

The maximum residual magnetic field on any pin or main bearing journal is 8 gauss.

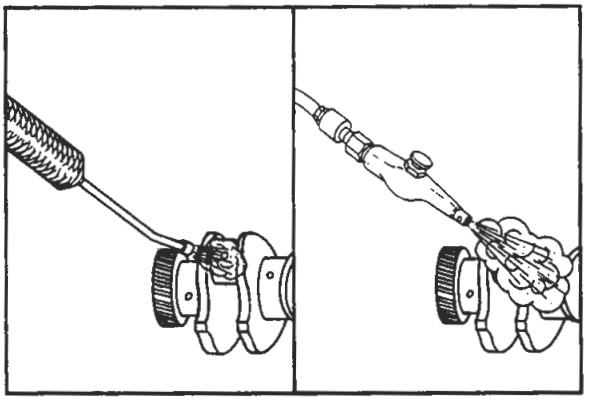
Note: It may be necessary to use reverse D.C.-30 point step down equipment or equivalent to remove the magnetism.



Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

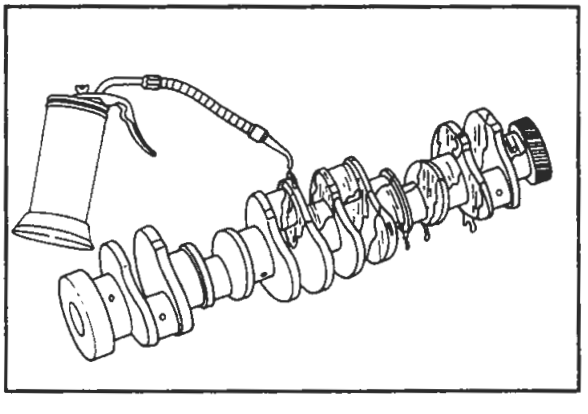
Use steam to clean the crankshaft and oil drillings.

Dry with compressed air.



Use a light preservative oil to lubricate the crankshaft to prevent rust.

Note: Use a light preservative oil if the crankshaft is not going to be used immediately. Protect the part with a plastic cover to prevent dirt from sticking to the oil.



Main Bearings - Clean and Inspect for Reuse (01-09)

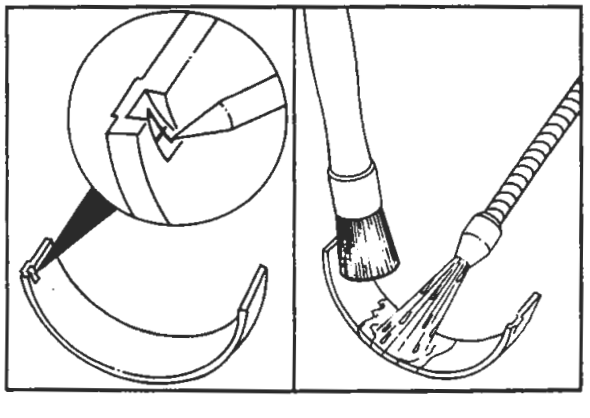
Note: Make sure the bearings are marked for location. The bearings **must be** installed in their original location if used again.

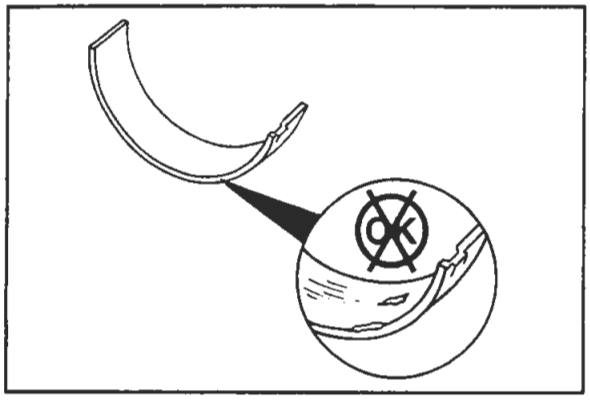
Main Bearings - Clean

Caution: Do not use a scraper or a wire brush. The bearings can be damaged.

Use solvent and a soft bristle brush.

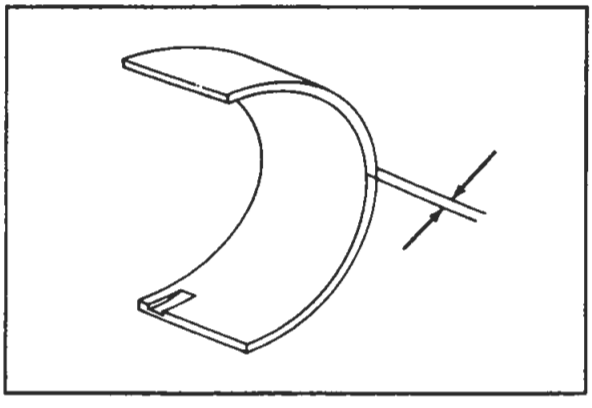
Dry with compressed air.





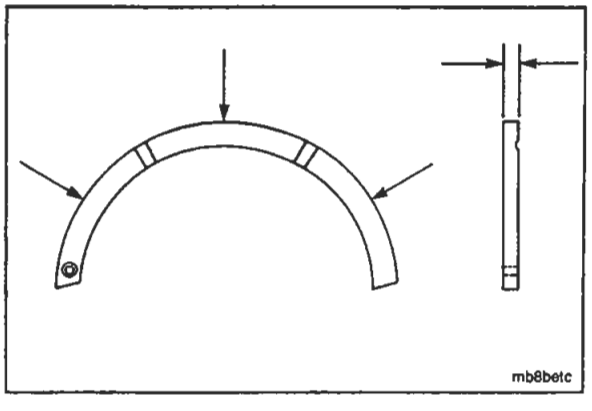
Main Bearings - Inspect

Visually inspect for nicks, scratches or damage.



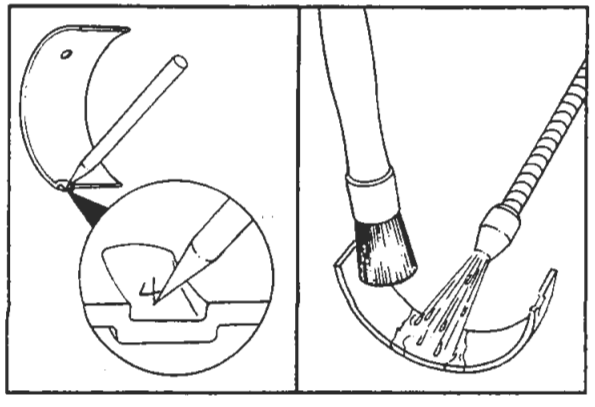
Measure the bearing shell thickness.

Main Bearing Shell Thickness (Standard)		
mm		in
3.895	MIN	0.1533
3.944	MAX	0.1553



Measure the thrust bearing thickness.

Thrust Bearing Thickness		
mm		in
4.75	MIN	0.187
4.89	MAX	0.193



Connecting Rod Bearings - Clean And Inspect for Reuse (01-10)

Note: The bearings **must be** marked for location as they are removed for future identification. Each bearing **must be** installed in its' original location if the bearing is used again.

Connecting Rod Bearings - Clean

Caution: Do not use a scraper or a wire brush. The bearings can be damaged.

Use solvent and a soft bristle brush.

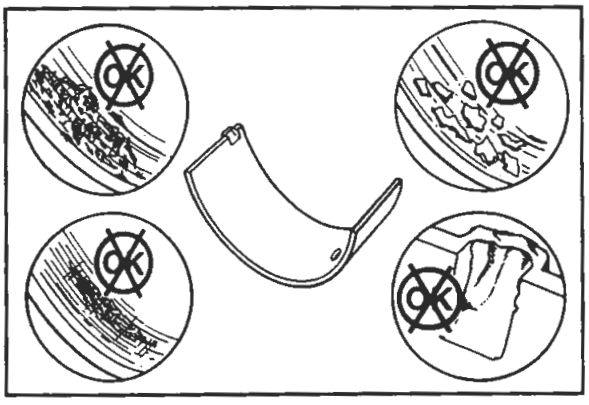
Dry with compressed air.

Connecting Rod Bearings - Inspect

Visually inspect the bearings for damage.

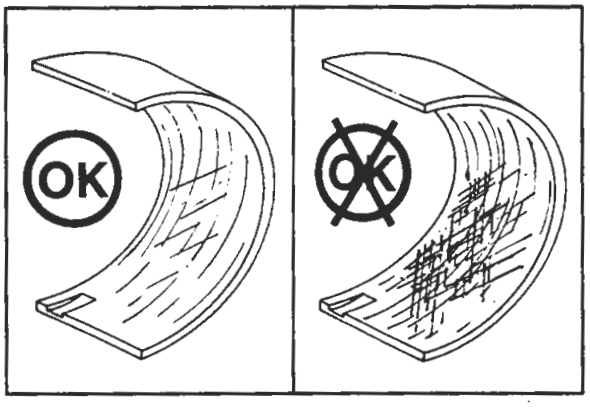
Replace bearings with any of the following damage:

a. Pitting
b. Flaking
c. Corrosion
d. Lock tang damage
e. Scratches (deep enough to be felt with a fingernail)



Note: If large areas of copper lining are visible in the bearings before the engine has accumulated 241,000 kilometers [150,000 miles] or 3,750 hours, inspect the engine for contamination from fine dirt particles and correct the problem to prevent further engine damage.

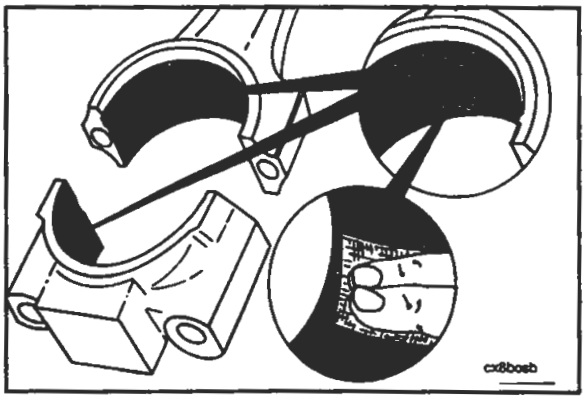
Normal bearing wear produces a smooth finish which will wear into the copper lining. Exposed copper **does not** always indicate worn bearings.



Visually inspect the bearing seating surface for nicks or burrs.

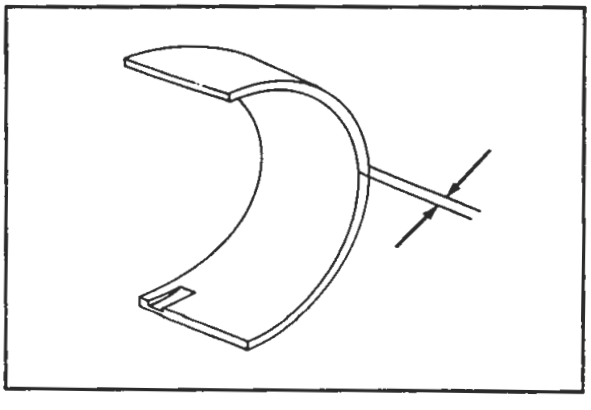
If burrs **cannot** be removed with fine crocus cloth, the bearings **must be** replaced.

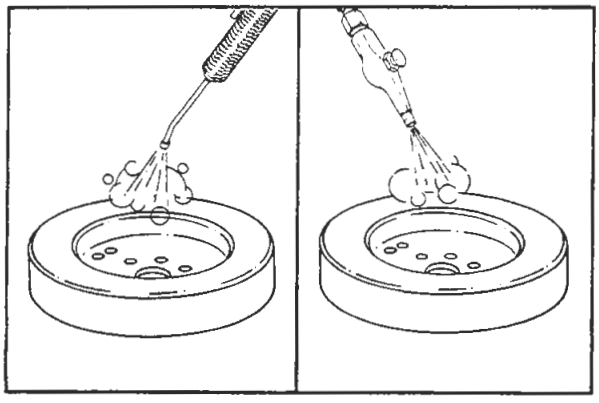
Note: For more detailed information of bearing damage, refer to "Analysis and Prevention of Bearing Failures", Bulletin No. 3387074.



Measure the bearing thickness.

Connecting Rod Bearing Thickness (Standard)		
mm		in
2.430	MIN	0.0957
2.473	MAX	0.0974



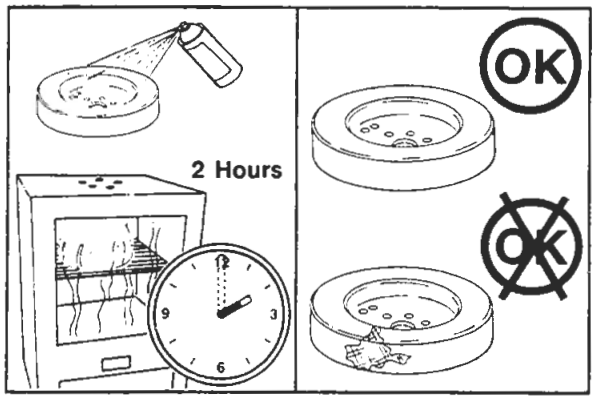


Vibration Damper (Viscous) - Clean and Inspect for Reuse (01-11)

Vibration Damper - Clean

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Steam clean and dry with compressed air.



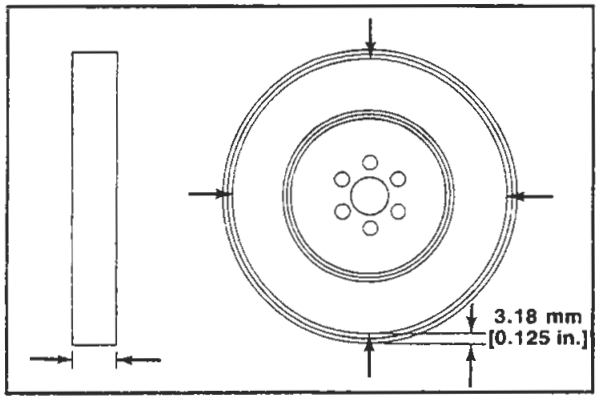
Vibration Damper - Inspect

Caution: Always wear protective gloves when handling heated parts. Personal injury can result.

Apply a spray of spot check developer, type SKD-NF® or equivalent to the damper.

Put the damper into an oven heated to 93°C [200°F] for two hours.

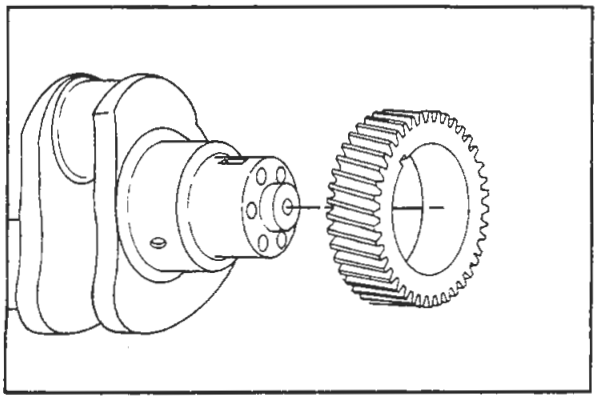
Remove the damper from the oven and visually inspect for oil leaks.



Measure The Vibration Damper Thickness

Measure the thickness in four places 90 degrees apart approximately 3.18 mm [0.125 inch] from the outside diameter as shown.

The difference between any two of the four measurements **must not** exceed 0.25 mm [0.010 inch].

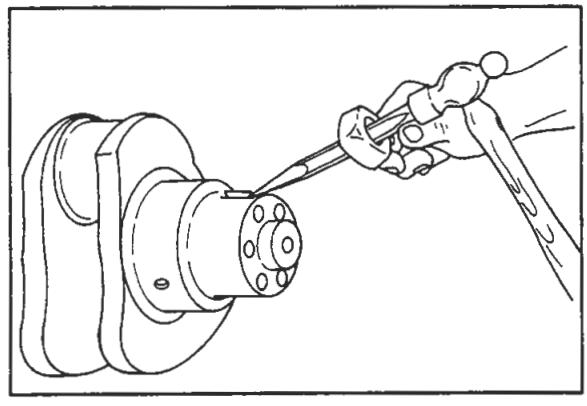


Crankshaft Gear - Replace (01-12)

Crankshaft Gear - Remove

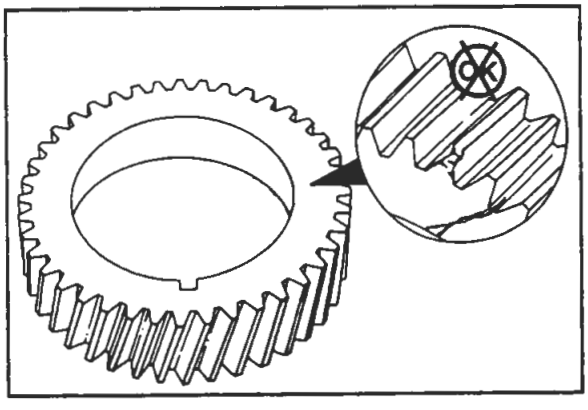
Use the Part No. 3375840 Gear Puller to remove the gear.

Use a flat chisel and a hammer to remove the key.



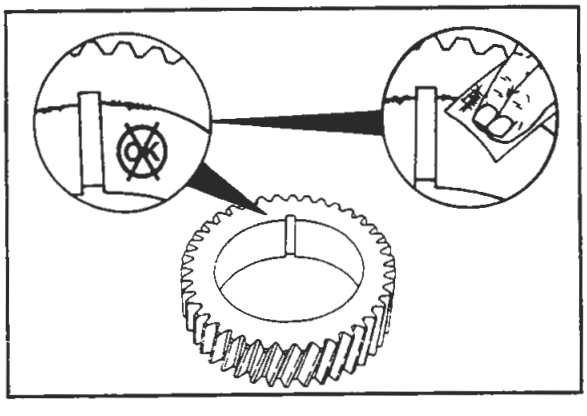
Crankshaft Gear - Inspect

Visually inspect for cracks and broken or chipped teeth.



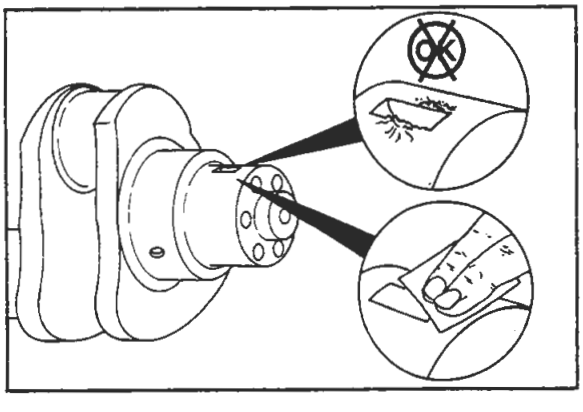
Visually inspect the gear and keyway for nicks or burrs.

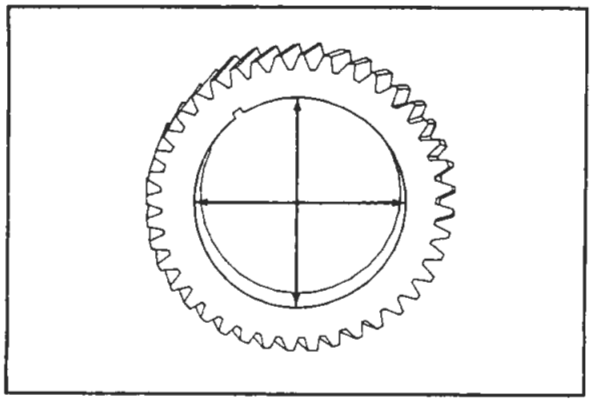
Use fine crocus cloth to remove nicks and burrs.



Visually inspect the crankshaft gear journal for burrs or damage.

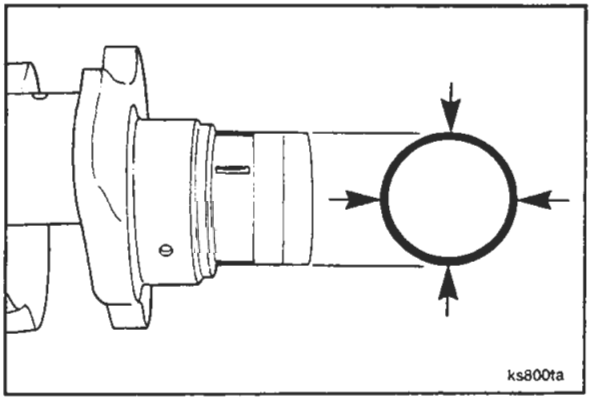
Use fine crocus cloth to remove burrs.





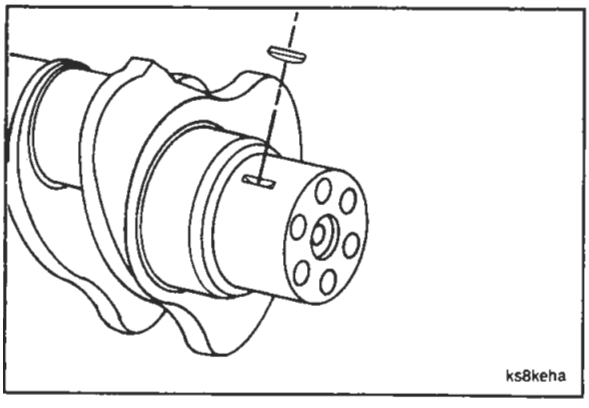
Measure the crankshaft gear inside diameter.

Crankshaft Gear Bore I.D.		
mm		in
85.910	MIN	3.3823
85.935	MAX	3.3833



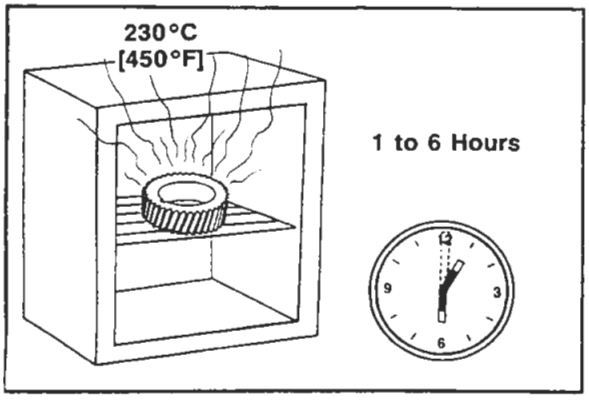
Measure the crankshaft gear journal outside diameter.

Crankshaft Gear Journal O.D.		
mm		in
85.975	MIN	3.3848
86.000	MAX	3.3858



Crankshaft Gear - Install

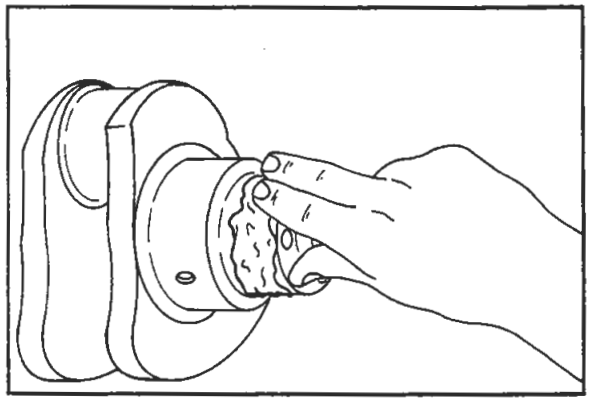
Use a soft hammer to install the key in the crankshaft keyway.



Caution: Do not exceed the specified time or temperature. The crankshaft gear and teeth can be damaged.

Place the gear in an oven heated to 235°C [450°F] for a minimum of one hour, but no more than six hours.

Use Lubriplate® No. 105, or equivalent to lubricate the outside diameter of the crankshaft gear journal.



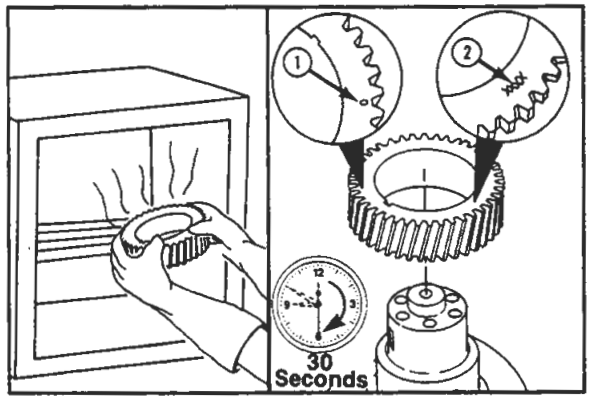
Caution: Always wear protective gloves when handling heated parts. Personal injury can result.

Caution: The timing mark (1) and part number (2) on the gear must be facing away from the crankshaft after the gear is installed. Engine damage can result if the gear is installed backwards.

Remove the gear from the oven.

Align the keyway of the gear with the key in the crankshaft and install the gear within 30 seconds.

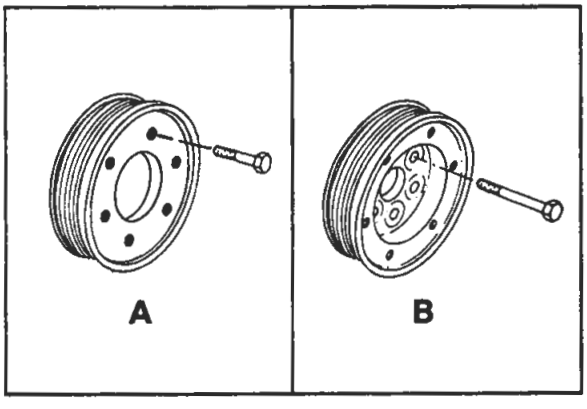
Caution: Do not use water or oil to reduce the cooling time. The gear can crack. Allow the air to cool the gear.



Crankshaft Pulley - Clean and Inspect for Reuse (01-13)

Note: The crankshaft pulley is used on belt driven fan engines only.

Two styles of pulleys have been used, present production (A) and earlier production (B).



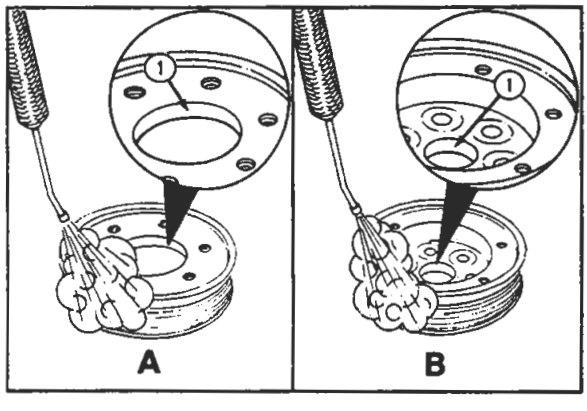
Crankshaft Pulley - Clean

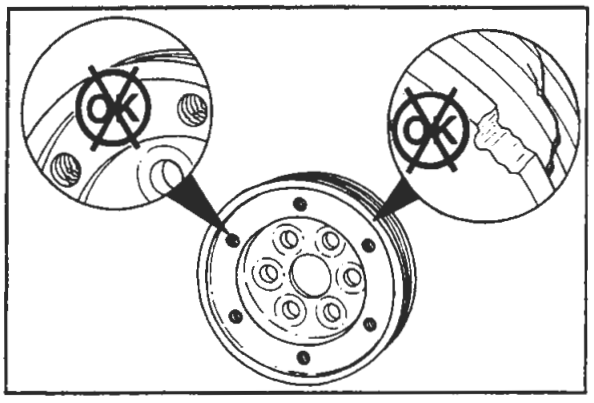
Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Note: Two styles of crankshaft pulleys have been used, present production (A) and earlier production (B).

Use fine crocus cloth to polish the crankshaft pilot bore (1).

Steam clean and dry with compressed air.



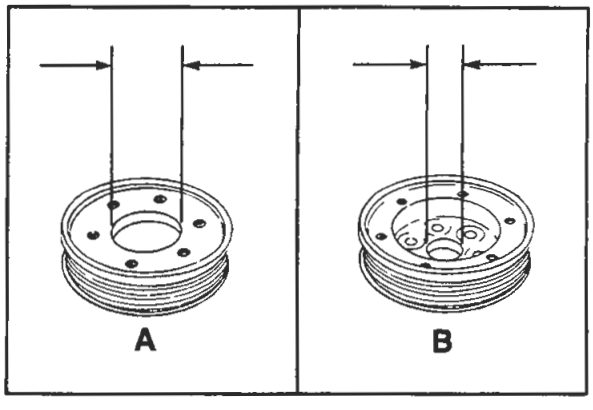


Crankshaft Pulley - Inspect

Visually inspect the threaded capscrew holes for damage (earlier production style only).

Visually inspect the pulley grooves for damage.

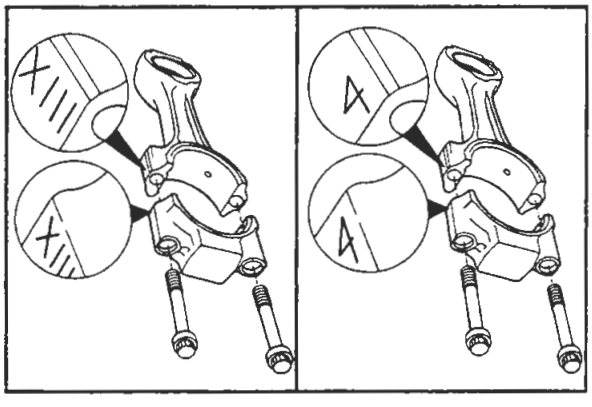
NOTE: Replace the pulley if damage to the grooves **cannot** be removed with fine crocus cloth.



Measure the pulley crankshaft pilot bore inside diameter.

Crankshaft Pulley Crankshaft Pilot Bore I. D. Flanged Crankshaft Adapter Style (A)		
mm		in
49.25	MIN	1.939
50.75	MAX	1.998

Crankshaft Pulley Crankshaft Pilot Bore I. D. Non-Flanged Crankshaft Adapter Style (B)		
mm		in
32.05	MIN	1.2618
32.13	MAX	1.2650

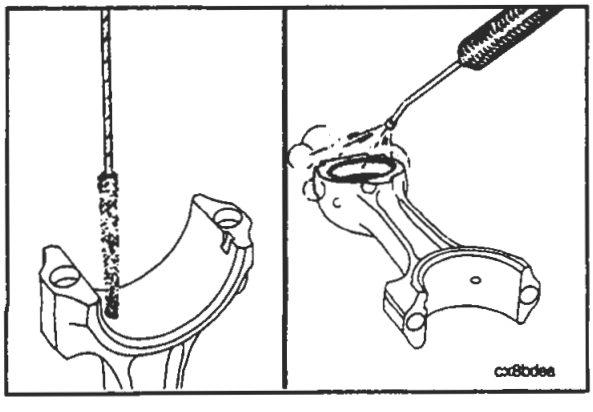


Connecting Rods - Clean and Inspect for Reuse (01-14)

Connecting Rods - Clean

NOTE: The number on the connecting rod cap must be the same as the number on the rod. Do not assemble a new cap to a used rod or a used cap to a new rod.

Remove the capscrews and caps from the rods.



Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use solvent or steam to clean the rods.

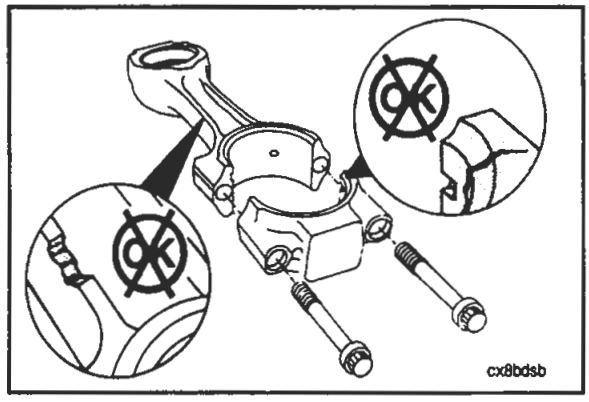
Use a soft bristle brush to clean the oil drilling.

Dry with compressed air.

Connecting Rods - Inspect

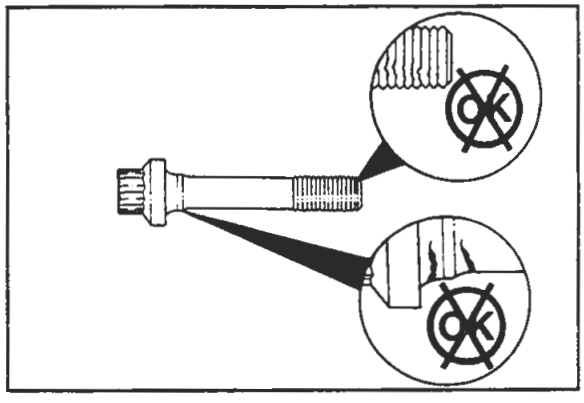
Visually inspect the rods and caps for damage.

Note: Replace the rod if the "I-Beam" is nicked or damaged.



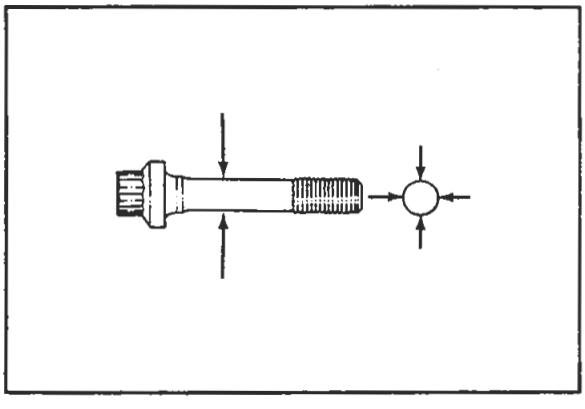
Visually inspect the capscrew threads for damage.

Visually inspect under the capscrew heads for cracks.

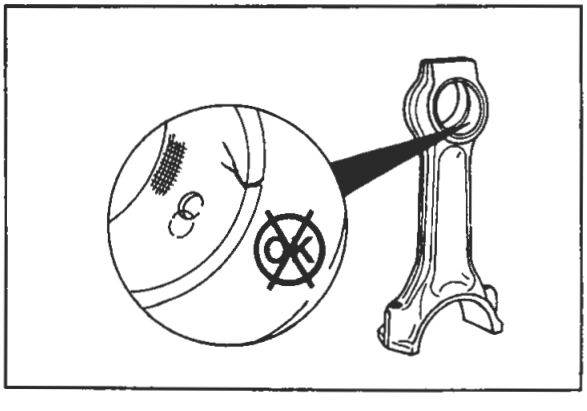


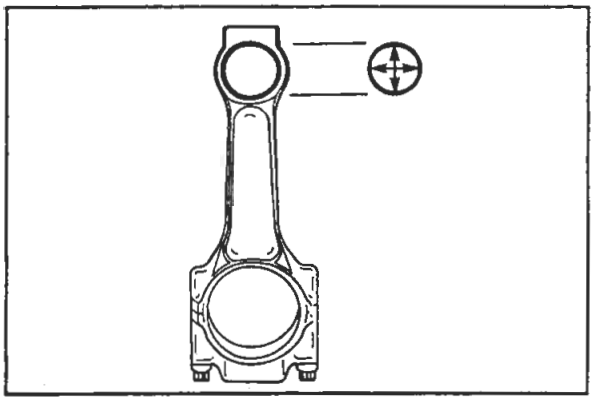
Measure the capscrew outside diameters.

Connecting Rod Capscrew O. D.		
mm		In
12.60	MIN	0.496
12.80	MAX	0.504



Visually inspect the piston pin bore for damage or misalignment of the oil passage and bushing.

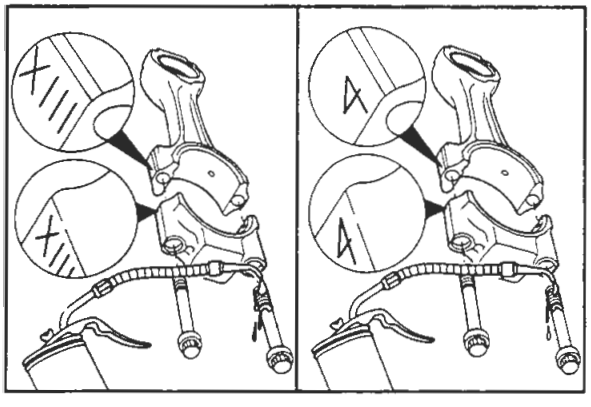




Measure the connecting rod piston pin bushing installed inside diameter.

Connecting Rod Piston Pin Bushing I. D. (Installed)		
mm		in
54.054	MIN	2.1281
54.100	MAX	2.1299

Note: The bushing **must be** precision machined after installation. If machining capability is available, the bushing can be replaced. Refer to the Alternative Repair Manual, Bulletin No. 3379035.

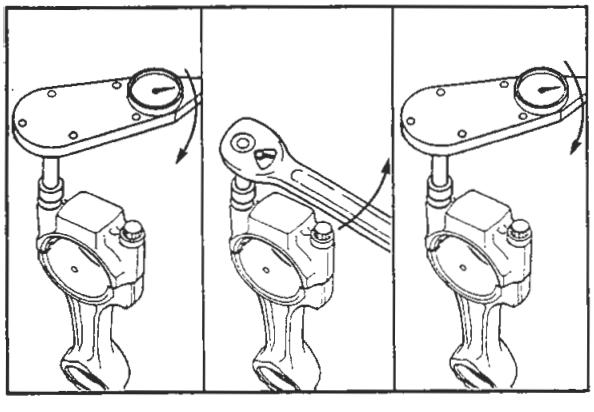


Caution: Use a vise with brass jaws to hold the rod. Notches, scratches, or dents in the "I-Beam" will cause engine failure.

Caution: The number on the connecting rod must be the same as the number on the rod cap. Never assemble a new cap to a used rod or a used cap to a new rod. The engine can be damaged.

Use clean 15W-40 oil to lubricate the connecting rod capscrews.

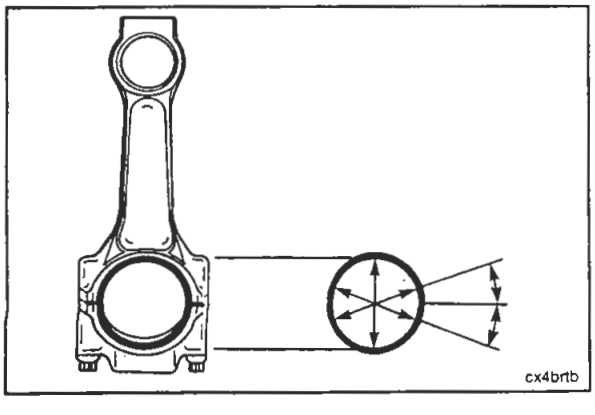
Assemble the rod, cap, and capscrews.



Tighten the capscrews in the following sequence to the specified torque values:

Torque Value: Connecting Rod Capscrews

N•m	Step	[ft-lb]
70	1	50
140	2	105
210	3	155
Loosen	4	Loosen
70	5	50
140	6	105
210	7	155

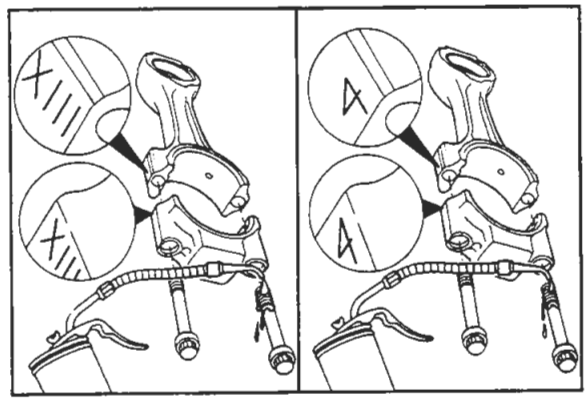


Measure the connecting rod bearing bore inside diameter within a 20 degree arc from each side of the parting line and at 90 degrees from the parting line.

Connecting Rod Bearing Bore I. D.		
mm		in
83.987	MIN	3.3066
84.013	MAX	3.3076

If any of the three measurements **are not** within the specifications, the rod **must be** repaired or replaced.

Note: Always stamp a new connecting rod with the cylinder number of the rod being replaced. The connecting rod **must be** assembled with the capscrews tight-ened to specifications before stamping the cylinder number on the rod.



Connecting Rods - Magnetic Inspection (01-15)

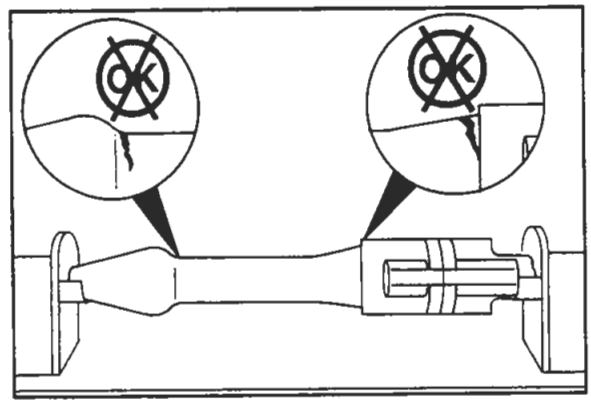
Use a magnetic particle testing machine.

Note: The connecting rod and cap **must be** assembled.

Use the residual method and apply head shot amperage.

Apply the amperage to 1500 ampere D.C. or rectified A.C..

Visually inspect for cracks.

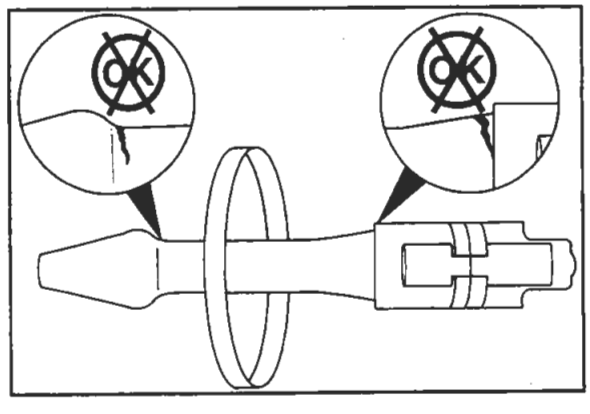


Use the residual method and apply coil shot amperage.

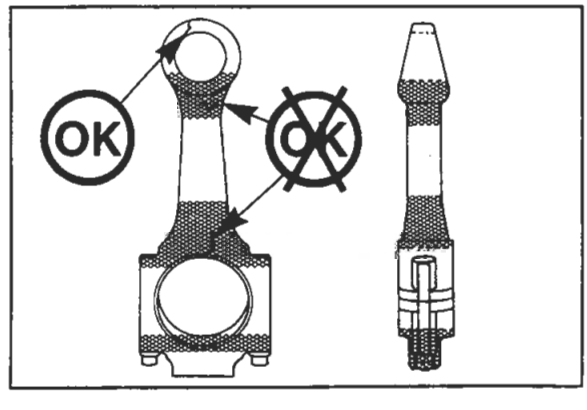
	Amperage (Amperage Turns)
MIN	2600 D.C. or rectified A.C.
MAX	2800 D.C. or rectified A.C.

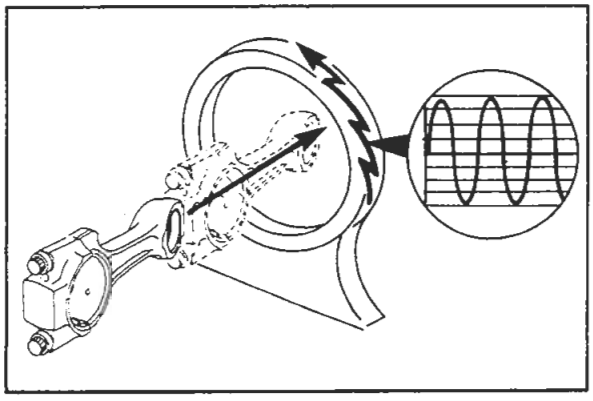
Note: Ampere turn is an electrical current of one ampere flowing through the coil, multiplied by the number of turns in the coil.

Visually inspect for cracks.



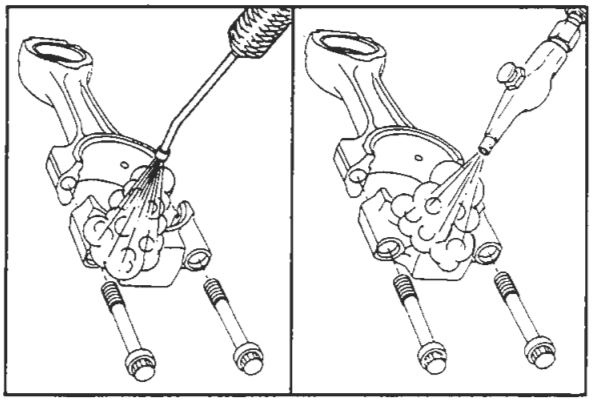
The connecting rod **must be** replaced if any indications are visible in the critical areas shown.





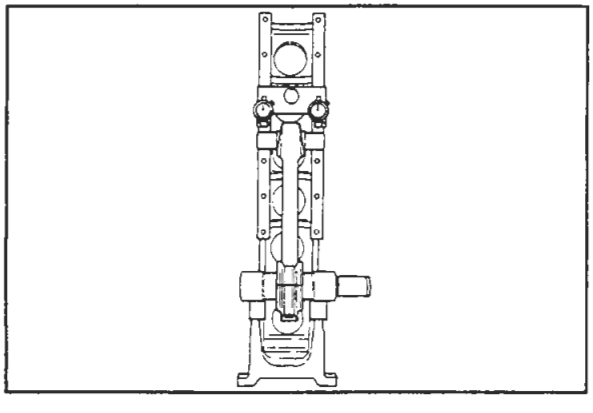
Note: The rod must have all magnetism removed completely and cleaned thoroughly.

Remove all magnetism from the connecting rods.



Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use solvent or steam clean the rods and dry with compressed air.



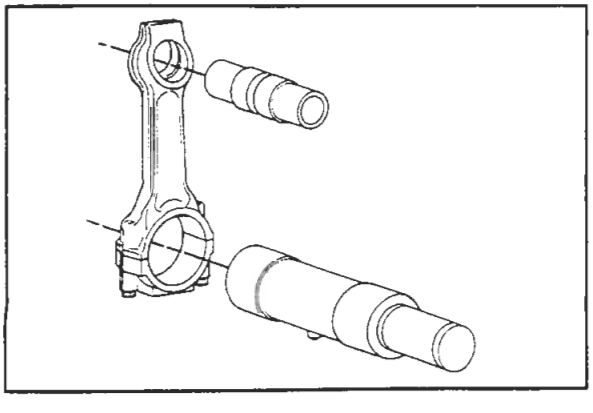
Connecting Rods - Bend and Twist Inspection (01-16)

Calibrate Fixture

Use the Part No. ST-561 Connecting Rod Checking Fixture and the Part No. 3376690 Connecting Rod Mandrel Set to inspect the bend and twist of the rods.

Calibrate the checking fixture with a new rod that has been measured for correct center to center length, 217.975 to 218.025 mm [8.5817 to 8.5836 inch].

Note: Assemble the connecting rod cap to the rod as described in procedure 01-14.



Install the piston pin mandrel from the Part No. 3376690 Connecting Rod Mandrel Set into the piston pin bore.

Note: Use the Part No. 3376692 Mandrel if the piston pin bushing has been removed or the Part No. 3376693 Mandrel if the bushing is still in place.

Install the Part No. 3376691 Mandrel in the piston crankshaft bore and expand the mandrel.

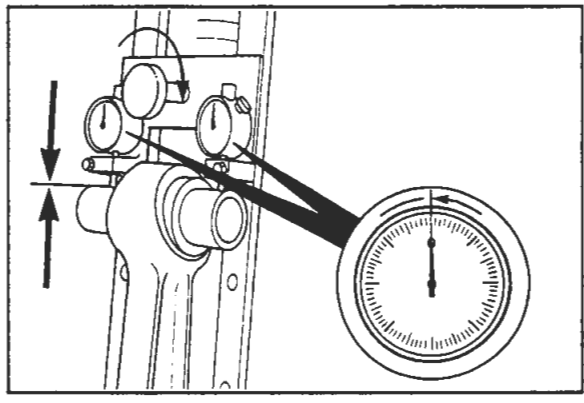
Note: Make sure the pin on the mandrel is down and locked in position in the center of the connecting rod.

Install the connecting rod into the fixture.

Move the dial holder to position the contact points of the indicators on the mandrel in the piston pin bore.

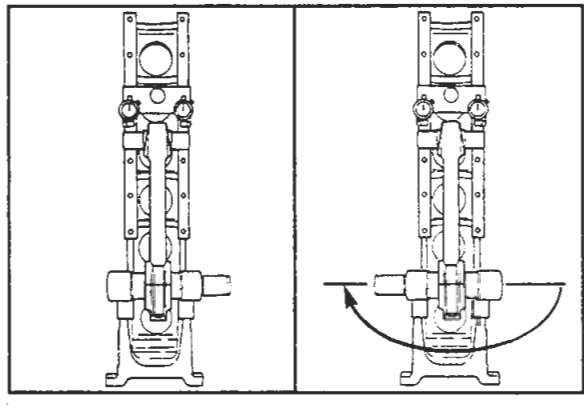
Tighten the bracket to hold the indicators in position.

Set the dial indicators to zero, "O".



Remove the connecting rod from the fixture.

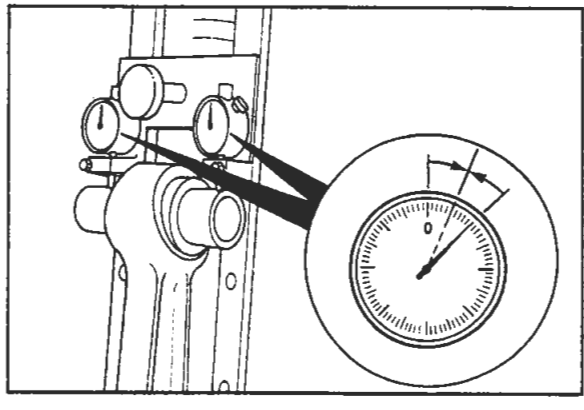
Turn the rod 180 degrees horizontally and install the rod into the fixture again.



Check the dial indicators for zero, "O" position again.

If the dial indicators show any change from zero, "O", adjust the dials to half the indicated reading.

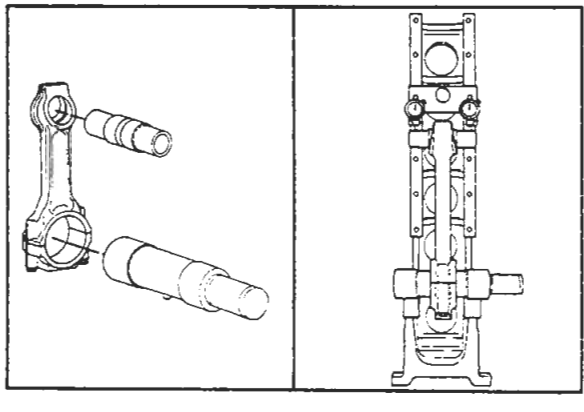
The fixture is now calibrated to allow the connecting rod to be installed into the fixture in either direction and the dials will indicate an equal deflection on either side of zero, "O".

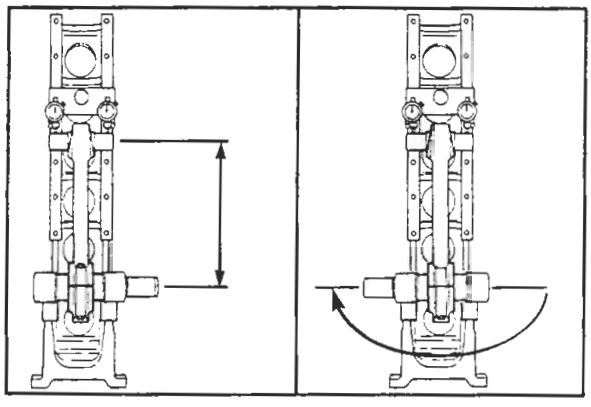


Connecting Rod Alignment - Inspect

Install the mandrel and arbor into the connecting rod to be inspected.

Install the connecting rod into the fixture.

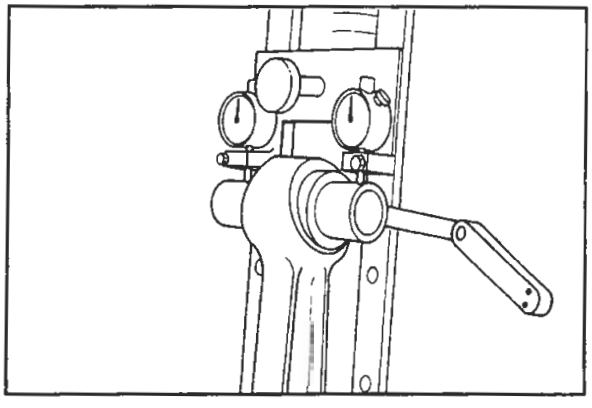




Measure the rod length and bend (alignment).

Connecting Rod Length		
mm		**in**
217.975	MIN	8.5817
218.025	MAX	8.5836

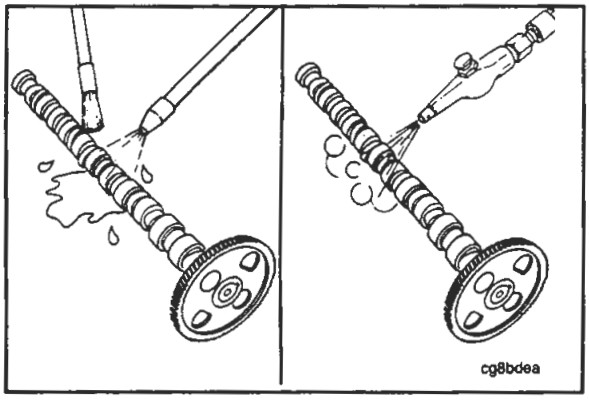
Connecting Rod Alignment			
	mm		in
Bushing Removed	0.25	MAX	0.010
Bushing Installed	0.10	MAX	0.004



Connecting Rod Twist - Inspect

Install a feeler gauge between the mandrel and the dial indicator holding plate as shown.

Connecting Rod Twist			
	mm		in
Bushing Removed	0.50	MAX	0.020
Bushing Installed	0.25	MAX	0.010

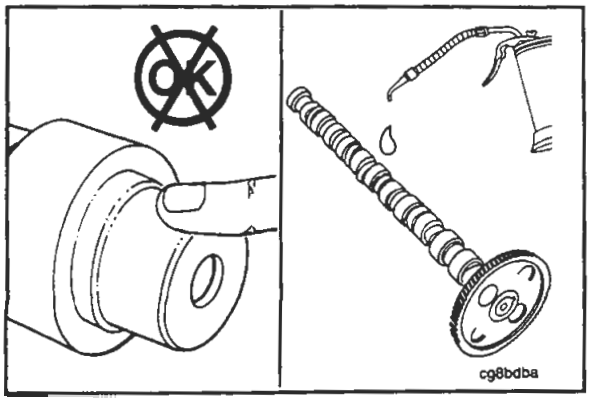


Camshaft - Clean and Inspect for Reuse (01-17)

Camshaft - Clean

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use solvent or steam clean the camshaft and dry with compressed air.



Note: After the camshaft has been steam cleaned, do not touch the machined surfaces with bare hands, this will cause rust to form.

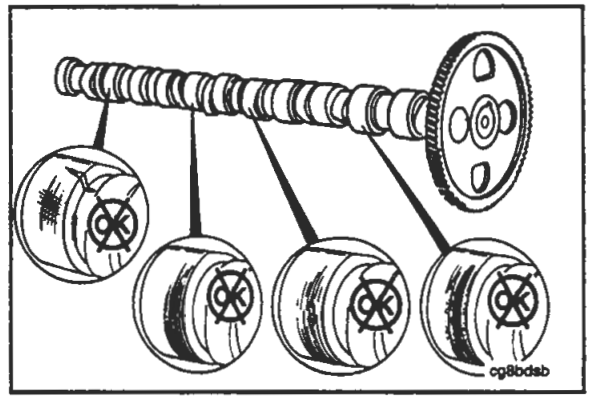
Use clean 15W-40 oil to lubricate the camshaft.

Camshaft - Inspect

Visually inspect the valve and injector lobes for damage.

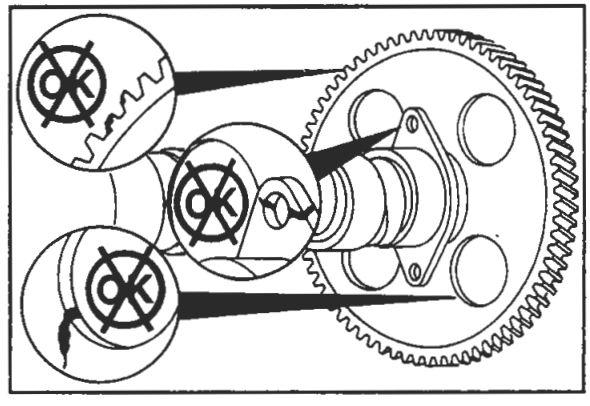
Note: Cummins Engine Co., Inc., **does not** recommend repairing camshafts by grinding the valve or injector lobes.

If the camshaft is damaged, it **must be** replaced.



Visually inspect the gear for broken or chipped teeth, and cracks.

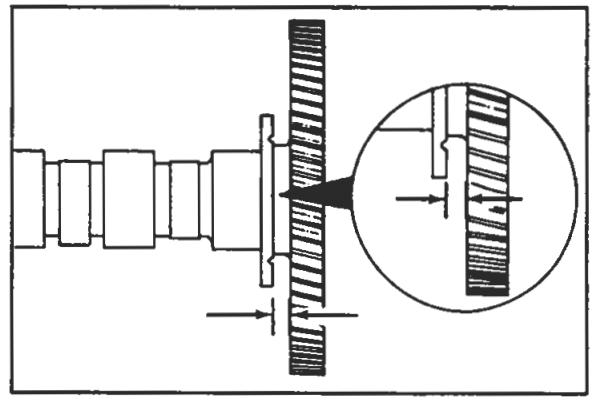
Visually inspect the thrust bearing for cracks.



Measure the camshaft thrust plate clearance.

Camshaft Thrust Plate Clearance		
mm		in
0.13	MIN	0.005
0.33	MAX	0.013

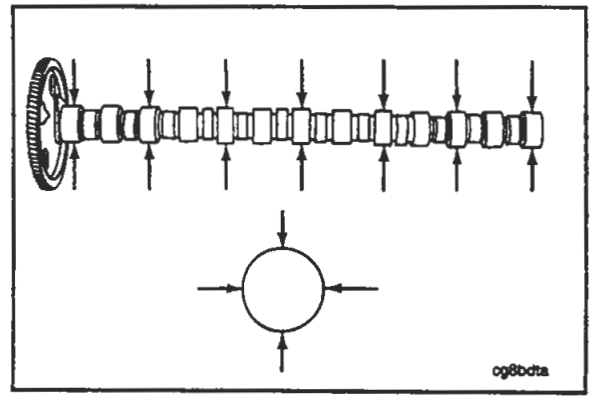
If the clearance is **not** within specifications, the gear **must be** removed.

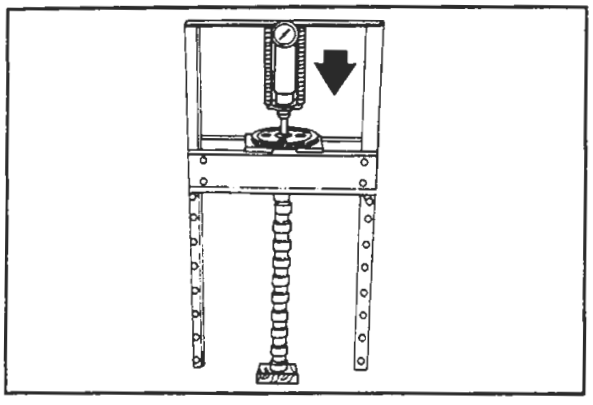


Measure the seven camshaft bushing journals.

Camshaft Bushing Journal O. D.		
mm		in
71.987	MIN	2.8341
72.013	MAX	2.8352

If the bushing journal outside diameters **are not** within specifications, the camshaft **must be** replaced.



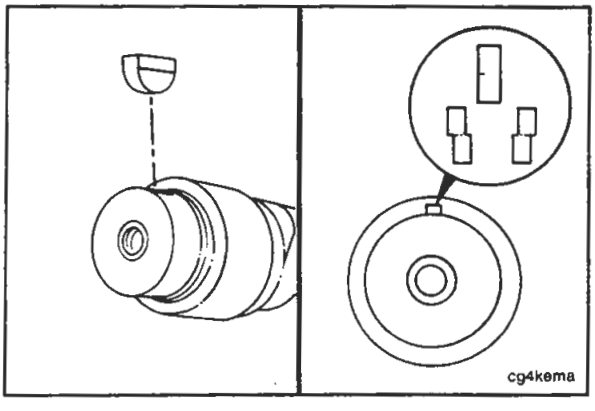


Camshaft Gear - Replace (01-18)

Caution: Place a wooden block under the camshaft to avoid damage to the camshaft as it drops free from the gear.

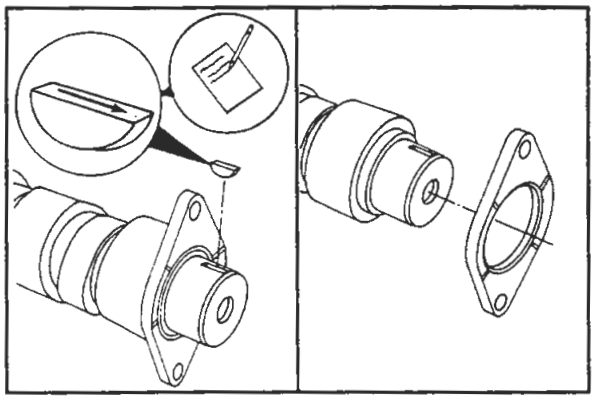
Install the camshaft assembly into a hydraulic press.

Push the shaft from the gear.



Camshaft keys are available in different sizes (amount of offset). Injection timing is controlled by the following:

a. Camshaft key selection.
b. Key offset direction compared to camshaft gear rotation.
c. Amount of key offset.

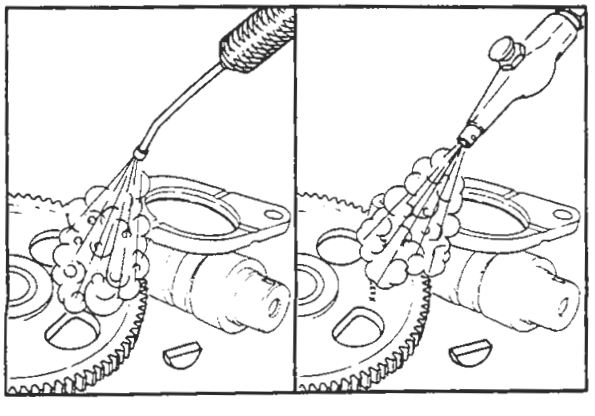


Record the size (amount of offset) and part number of the key.

Record the direction the arrow on the key is pointed (toward or away from the camshaft) for future reference.

Use a flat chisel and hammer to remove the camshaft key.

Remove the thrust plate.



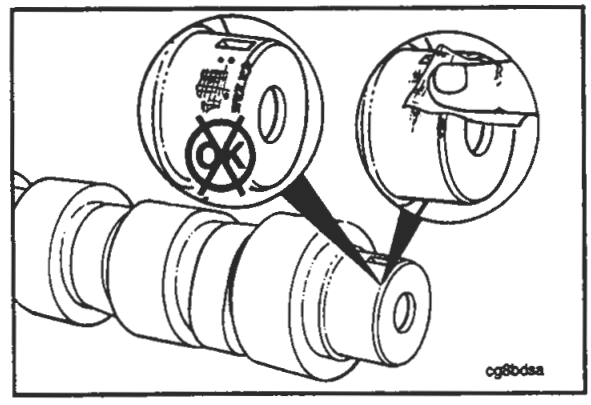
Camshaft Gear - Clean

Use solvent to clean the parts and dry with compressed air.

Camshaft Gear - Inspect

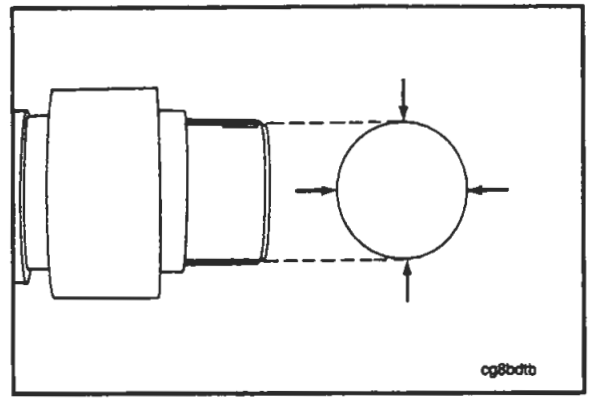
Visually inspect the camshaft nose for fretting or burrs.

Note: The camshaft **must be** replaced if the fretting damage is more than 3 mm [1/8 inch] wide.



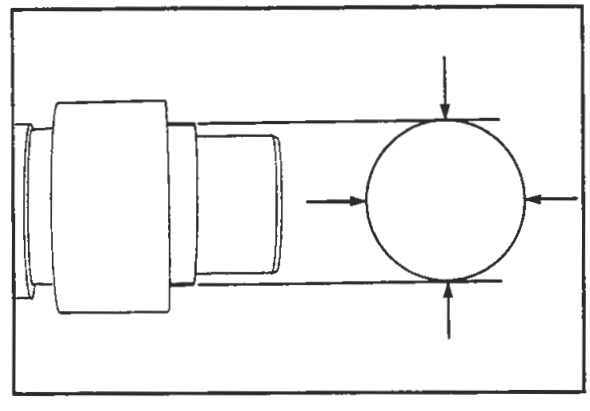
Measure the camshaft nose (gear mounting surface) outside diameter.

Camshaft Gear Mounting Surface O.D.		
mm		in
46.987	MIN	1.8499
47.013	MAX	1.8509



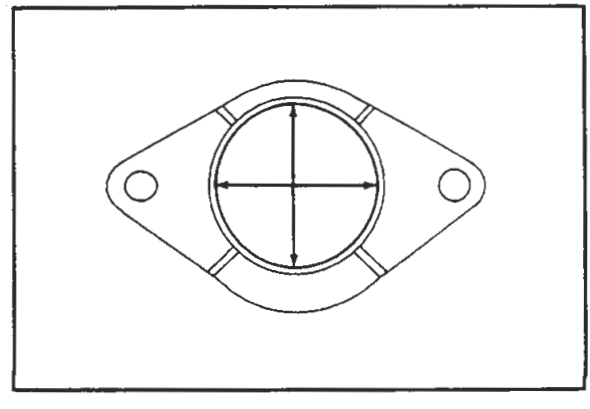
Measure the camshaft thrust bearing journal outside diameter.

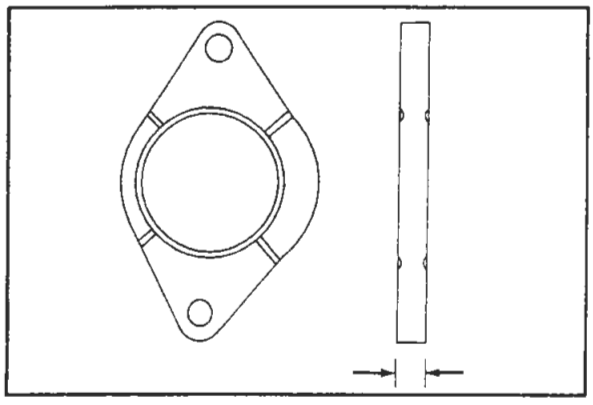
Camshaft Thrust Bearing Journal O.D.		
mm		in
54.80	MIN	2.157
55.20	MAX	2.173



Measure the camshaft thrust plate inside diameter.

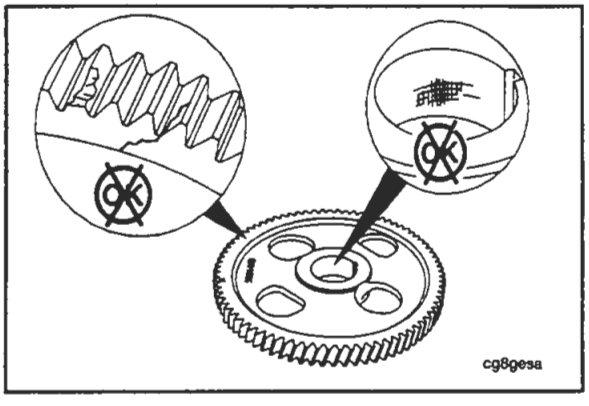
Camshaft Thrust Plate I.D.		
mm		in
55.60	MIN	2.189
56.61	MAX	2.229





Measure the camshaft thrust plate thickness.

Camshaft Thrust Plate Thickness		
mm		in
8.92	MIN	0.351
9.04	MAX	0.356

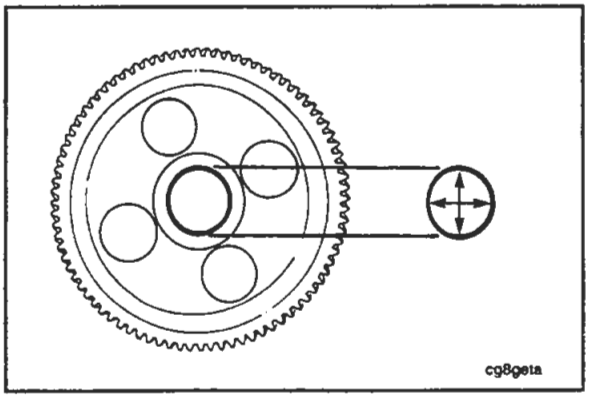


Visually inspect the camshaft gear for cracks and chipped or broken teeth.

Visually inspect the gear bore and keyway for fretting or burrs.

Use fine crocus cloth to remove burrs.

Note: The gear **must be** replaced if the fretting is more than 3 mm [1/8 inch] wide.



Measure the camshaft gear bore inside diameter.

Camshaft Gear bore I.D.		
mm		in
46.912	MIN	1.8469
46.938	MAX	1.8480

Offset Camshaft Key

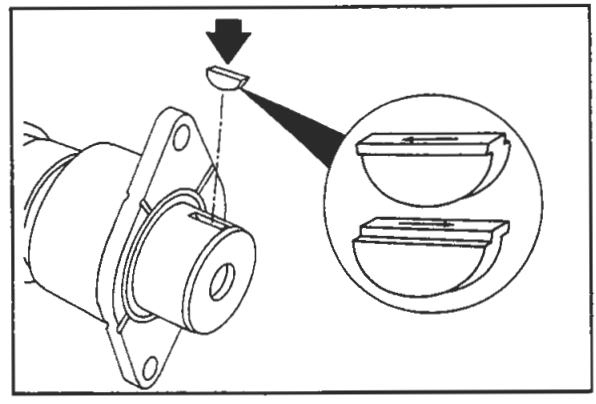
	Degree of Offset	Change in Push Rod Travel	
Key Part Number	(To The Camshaft)	mm	in
3030893	0.25	0.051	0.0020
3009948	0.50	0.102	0.0040
3030894	0.75	0.152	0.0060
3009949	1.00	0.203	0.0080
3030895	1.25	0.254	0.0100
3009950	1.50	0.305	0.0120
3030896	1.75	0.356	0.0140
3009951	2.00	0.406	0.0160
3030897	2.25	0.457	0.0180
3030898	2.50	0.508	0.0200

Camshaft Gear - Install

Note: If the same camshaft and gear are used again, install a key with the same part number as the one that was removed. Make sure the arrow on the key is pointing in the same direction as it was when it was removed. Refer to the "Injection Timing" section in group "O" if the injection timing is to be changed. Refer to the following list of offset keys to change injection timing.

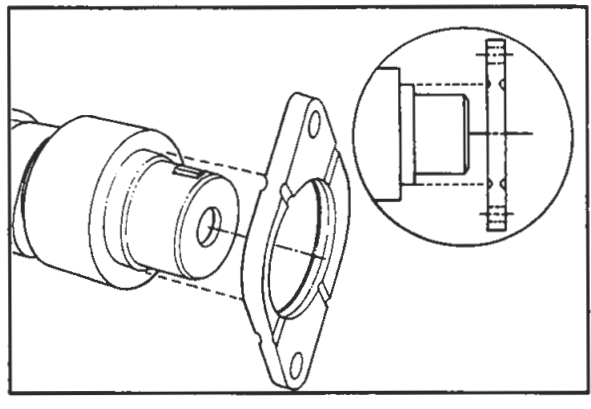
The accompanying table list offset keys by part number and degree of offset.

Use a soft hammer to install the camshaft key.



Caution: If the thrust plate with slots on one side only is used, the flat surface must be toward the camshaft to prevent engine damage. The thrust plate with slots on both sides can be installed either way.

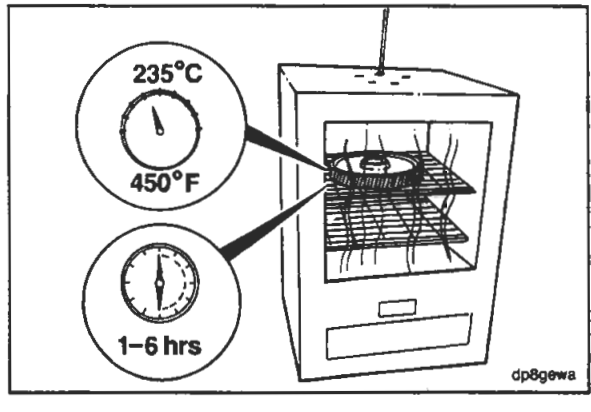
Install the thrust plate on the camshaft.



Put the camshaft gear into an oven.

Caution: Do not exceed the temperature or time limits with the gear in the oven. The gear will be damaged.

Heat the gear to 235°C [450°F] for a minimum of one hour but no longer than six hours.



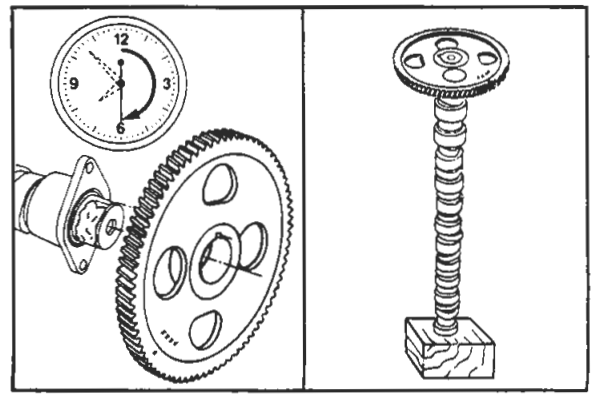
Caution: Wear asbestos gloves when handling heated parts. Hot parts can cause serious personal injury.

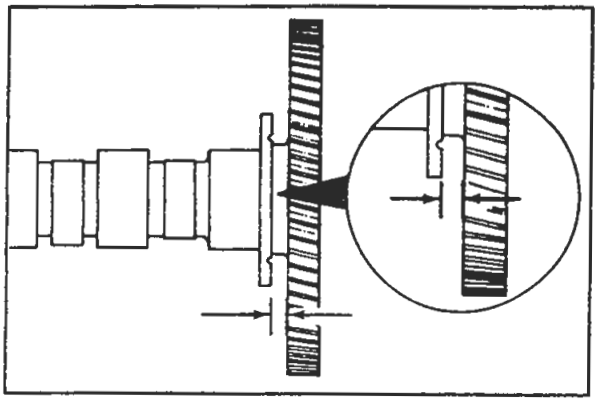
Caution: The timing marks and part number on the gear must be facing away from the camshaft when the gear is installed to prevent engine damage.

Use Lubriplate® No. 105, or equivalent to lubricate the camshaft gear mounting surface.

Caution: Keep the camshaft in a vertical position until the gear has cooled. Do not use water to reduce the cooling time, the gear will crack.

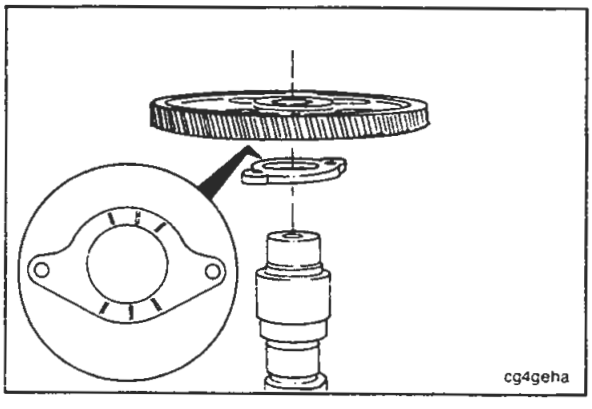
Remove the gear from the oven, align the keyway in the gear with the key in the camshaft and install the gear on the camshaft within 30 seconds.





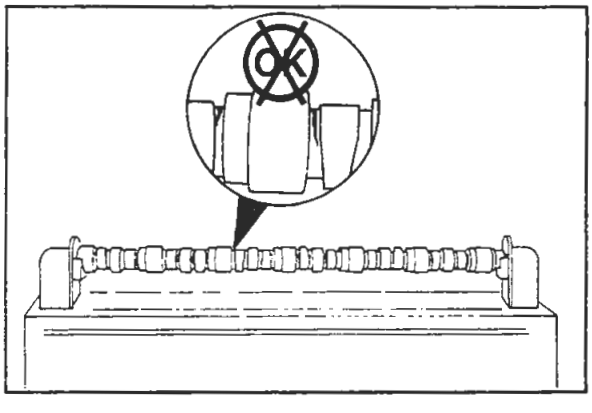
Measure the camshaft thrust plate clearance.

Camshaft Thrust Plate Clearance		
mm		in
0.13	MIN	0.005
0.33	MAX	0.013



Camshaft - Magnetic Crack Inspection (01-19)

Note: The camshaft gear and thrust plate **must be** removed before performing this inspection. Refer to the previous procedure, 01-18, to remove the gear and thrust plate.



Use a magnetic particle testing machine.

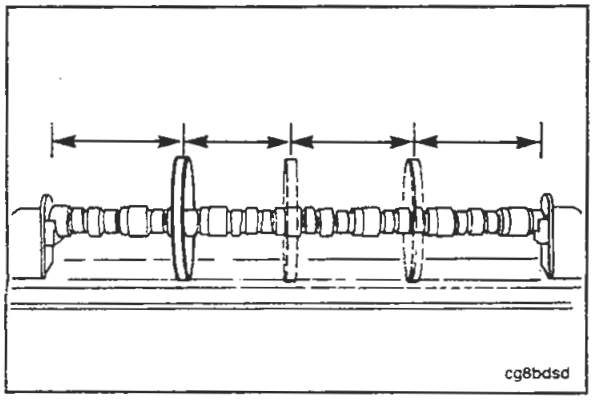
Use the head shot method.

Adjust the machine to 2000 ampere D.C. or rectified A.C..

Use the continuous method.

Note: Do not wet more than one-third of the camshaft at a time.

Visually inspect the camshaft for cracks.



Use the coil shot method.

Note: Use a coil shot that is a minimum of 305 mm [12 inch].

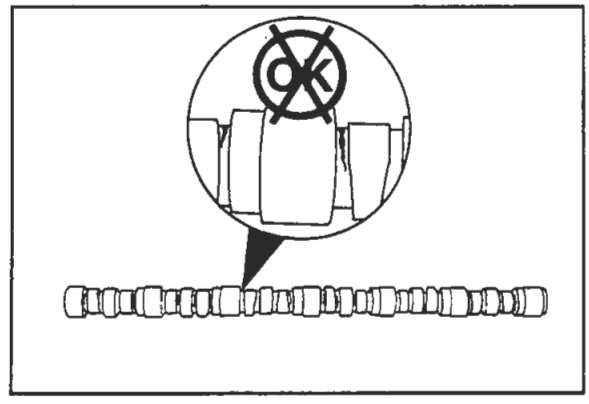
Apply the coil shot.

Use the continuous method.

	Amperage (Amperage Turn)
MIN	3600 D.C. or rectified A.C.
MAX	4000 D.C. or rectified A.C.

Note: Ampere turn is an electrical current of one ampere flowing through the coil, multiplied by the number of turns in the coil.

Visually inspect the camshaft for cracks.

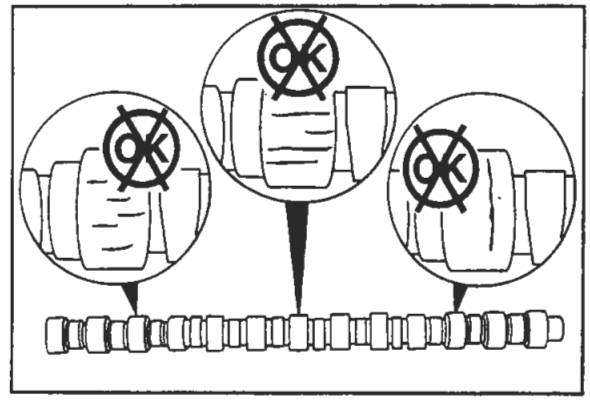


Bearing Journal - Limits of Acceptance

Do not use the camshaft if:

a. More than four open indications in an axial direction on one of the bearing journals.
b. More than one-half of the open indications extend more than half the distance across the bearing journals.
c. An open indication in a circumferential direction.

Note: The camshaft can be used if there are indications below the surface.

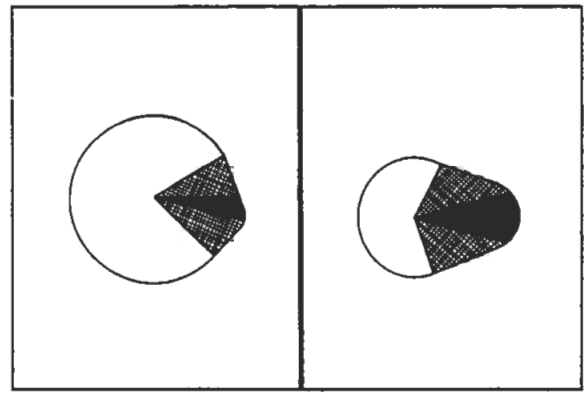


Open Indications - Limits of Acceptance

An open indication is visible after the suspension has been removed. An indication below the surface is **not** visible after the suspension has been removed.

Do not use the camshaft if:

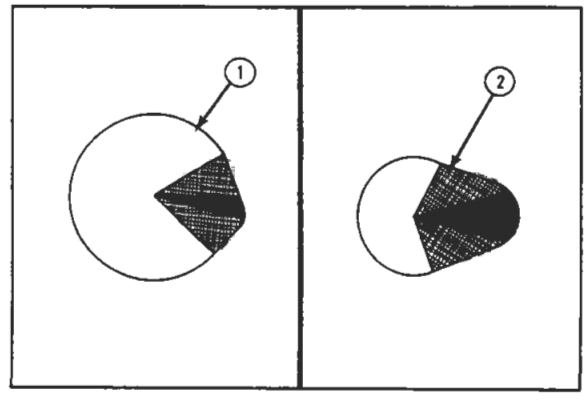
a. An indication in a circumferential direction.
b. An indication in the black or shaded areas shown.
c. An indication longer than 6 mm [1/4 inch].
d. An indication closer than 5 mm [3/16 inch] from the edge.
e. More than two indications on one of the lobes.

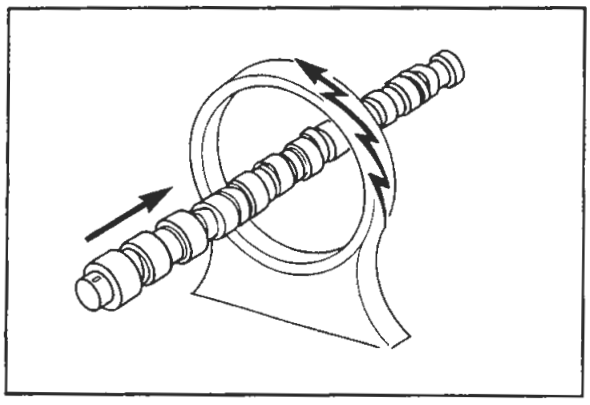


Indications Below the Surface - Limits of Acceptance

Do not use the camshaft if:

a. More than two indications in the shaded area shown.
b. An indication in the shaded area shown longer than 16 mm [5/8 inch].
c. More than three indications in the white area shown.
d. An indication in the black area on the injector lobe (1).
e. More than two indications in the black area on the valve lobe (2).
f. An indication in the black area on the valve lobe longer than 3 mm [1/8 inch].



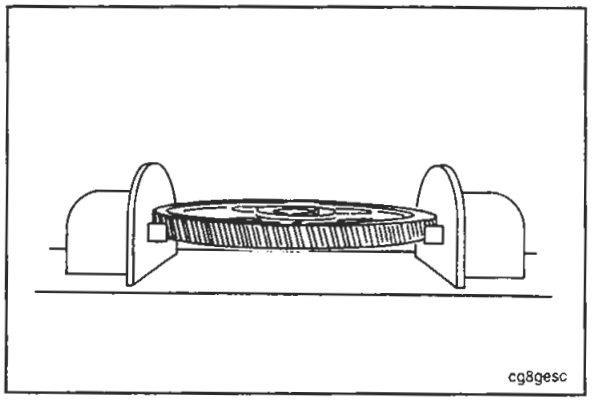


Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Caution: The camshaft must have all magnetism removed completely and cleaned thoroughly. Small metal particles will cause engine damage.

Remove all magnetism from the camshaft.

Use solvent or steam clean the camshaft and dry with compressed air.



Camshaft or Idler Gear - Magnetic Crack Inspection (01-20)

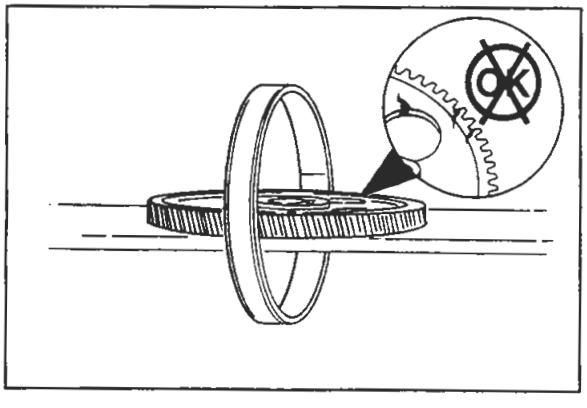
Caution: Use a copper braid contact that has neoprene covers to avoid burning the teeth of the gear.

Note: Position the gear keyway toward one of the contacts when inspecting.

Use a magnetic particle testing machine.

Use the residual method.

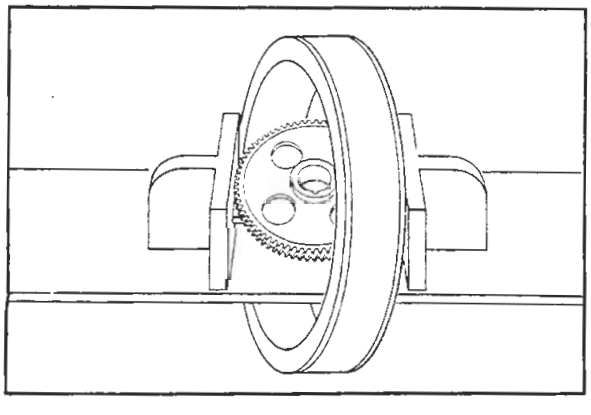
Apply head shot amperage.



Adjust the amperage to the specified value.

Gear O. D.	Amperage D.C.
Less than 101 mm [4 inch]	1000
101 to 203 mm [4 to 8 inch]	1500
Greater than 203 mm [8 inch]	2000

Visually inspect the gear for cracks.



Note: Position the gear keyway toward one of the contacts when inspecting.

Use the residual method.

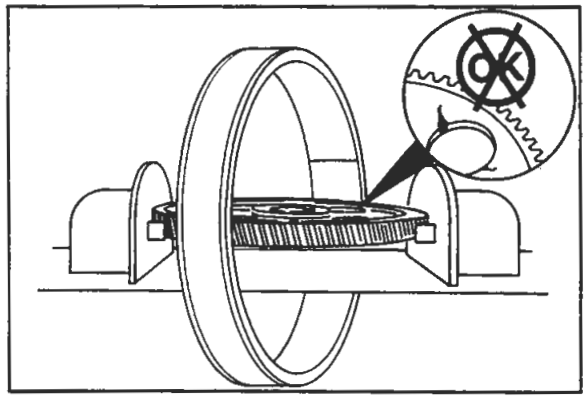
Apply coil shot amperage.

Adjust the amperage to the specified value.

Gear O.D.	Ampere Turns
Less than 101 mm [4 inch]	4000
101 to 203 mm [4 to 8 inch]	6000
Greater than 203 mm [8 inch]	8000

Note: Ampere turn is an electrical current of one ampere flowing through the coil, multiplied by the number of turns in the coil.

Visually inspect the gear for cracks.

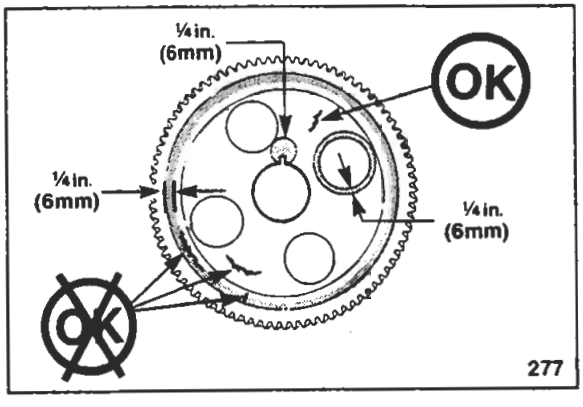


Machined Surfaces - Limits of Acceptance

An open indication is visible after the suspension has been removed. An indication below the surface is **not** visible after the suspension has been removed.

Do not use the gear if:

a. There is an open indication.
b. There is an open indication below the surface that is in the shaded area as shown.
c. There is an open indication below the surface that is longer than 6 mm [1/4 inch].

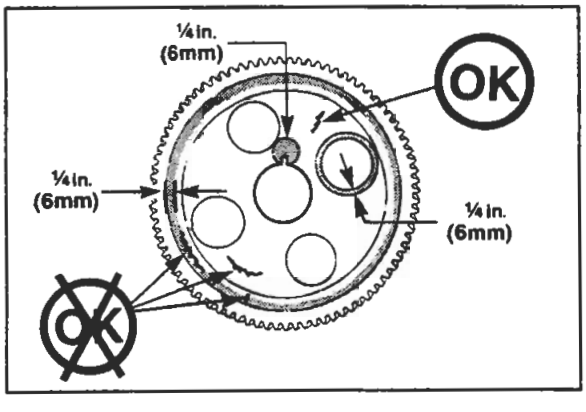


Forged Surfaces - Limits of Acceptance

Do not use the gear if:

a. There is an open indication that is in a circumferential direction.
b. There is an open indication that is longer than 9.5 mm [3/8 inch].
c. There is an indication below the surface that is in the shaded area.

An indication below the surface in a radial direction is acceptable if it is in the area that is **not** shaded.

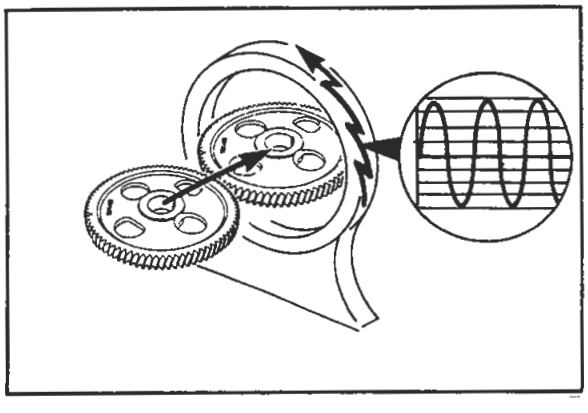


Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

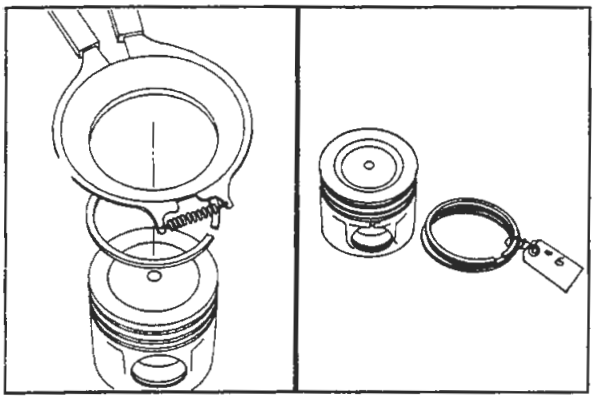
Caution: The gear must have all magnetism removed completely and cleaned thoroughly. The small metal particles will cause engine damage.

Remove all magnetism from the gear.

Use solvent or steam to clean the gear and dry with compressed air.



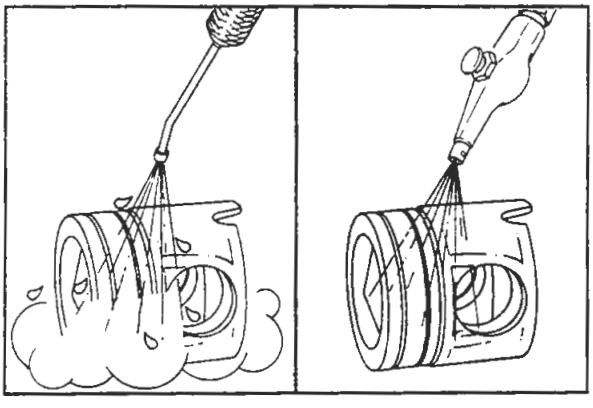
Pistons - Clean and Inspect for Reuse (01-21)



Piston Rings - Remove

Use the Part No. ST-821 Piston Ring Expander to remove the piston rings.

Place a tag on the rings and record the cylinder number of the piston on the tag.



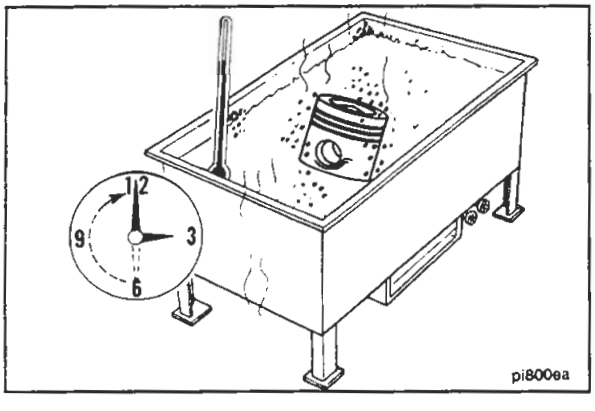
Pistons - Clean

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Caution: Do not use the bead blast method to clean the ring grooves or the skirt. The piston will be damaged by the blast material embedded in the aluminum. Bead blast can be used to clean the top of the piston if the ring grooves and skirt are covered completely.

Use steam to clean the carbon from the pistons.

Note: A plastic bead media Part No. 3822735 has been released for cleaning the piston dome or crown and the ring grooves. **Do not** bead blast the piston skirt.



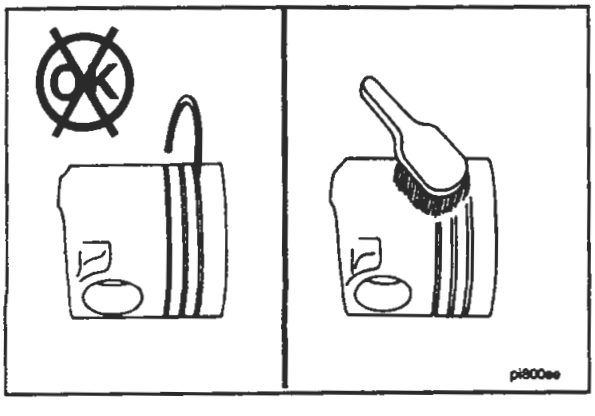
Caution: The cleaning solvent must be approved for aluminum to prevent damage to the pistons.

Use a kerosene emulsion based solvent that can be heated to 95°C [200°F] and a cleaning tank that will constantly mix and filter the solvent.

Note: Do not use a solvent that has a pH higher than 9.5, or a solvent that contains chlorinated hydrocarbons with cresols, phenols, or cresylic components.

Put the pistons into the solvent and allow them to soak for a minimum of 30 minutes.

Note: Soak the pistons several hours or overnight for best results.



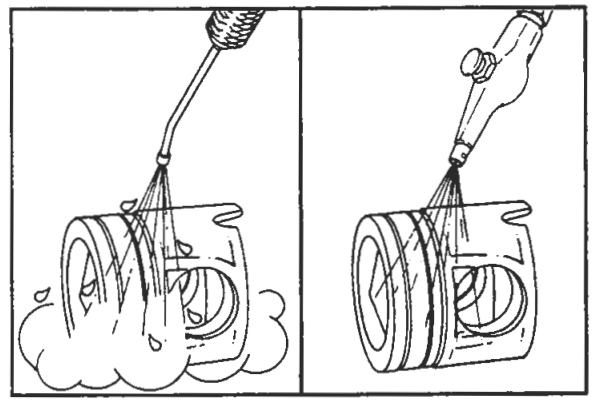
Caution: Do not use a metal brush to clean the pistons. The ring grooves will be damaged.

Use a non-metallic brush to clean the piston ring grooves.

Repeat the soaking and scrubbing process until the piston is cleaned thoroughly.

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

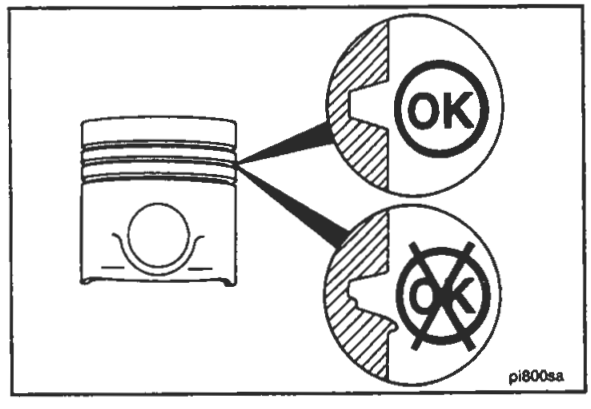
Use steam to clean the solvent from the pistons and dry with compressed air.



Pistons - Inspect

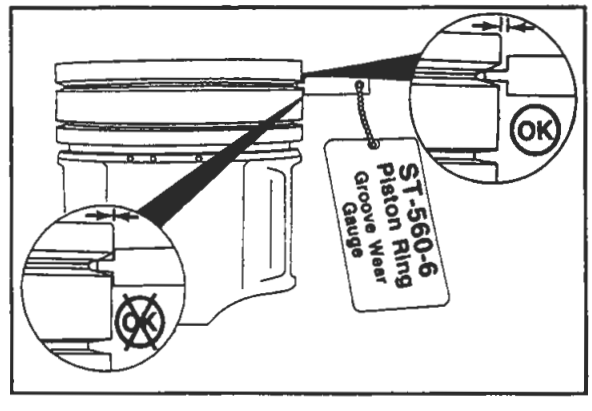
Visually inspect the piston ring grooves for damage.

Replace the piston if there is a visible ridge in the back of the groove or a lip has formed on the outside diameter of the groove.



Use the Part No. ST-560-6 Piston Ring Groove Wear Gauge to inspect the top and second (compression rings) grooves.

Note: The piston **must be** replaced if the widest part of the gauge touches the piston.

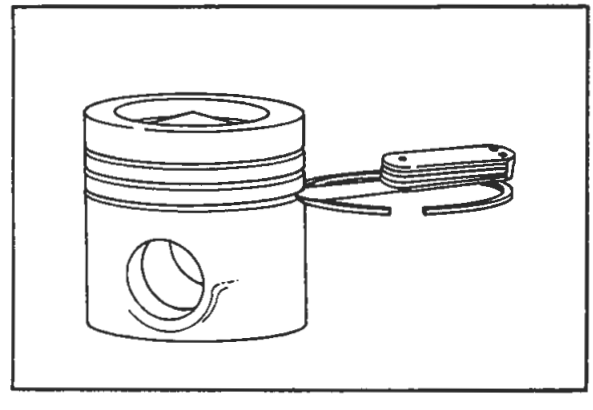


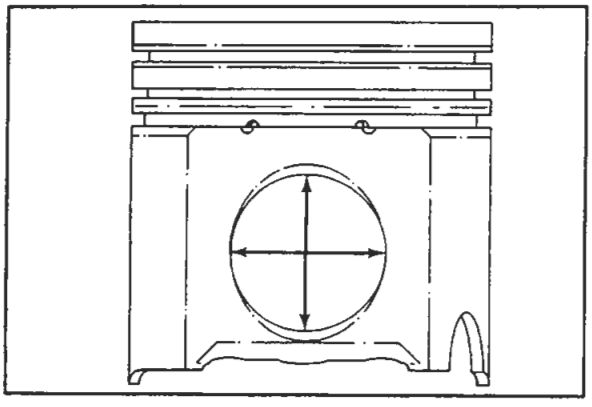
Measure the oil ring groove.

Note: The ring groove can be inspected with a new ring and a feeler gauge.

Hold a new ring in the groove and insert a 0.152 mm [0.0060 inch] feeler gauge.

If the feeler gauge inters the the groove without resistance, there is too much wear. The piston **must be** replaced.



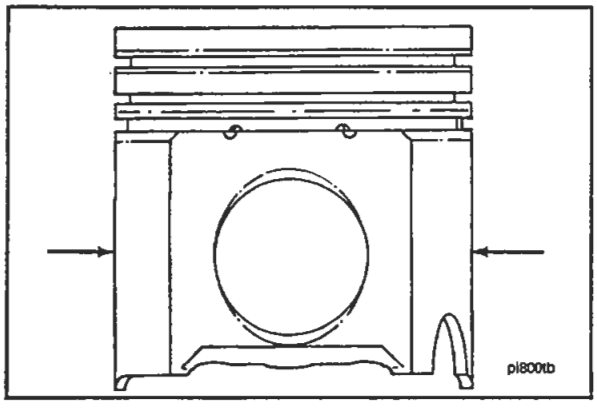


Measure the piston pin bore at a room temperature of approximately 21°C [70°F] in the directions shown.

Piston Pin Bore I.D. (Part No. 3037820 Piston)		
mm		in
53.989	MIN	2.1255
54.030	MAX	2.1272

Piston Pin Bore I.D. (Part No. 3044448 Piston)		
mm		in
54.007	MIN	2.1263
54.015	MAX	2.1266

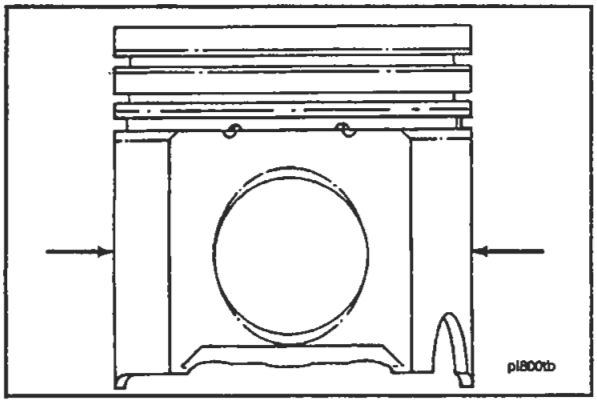
NOTE: C.A.R.B. Part Nos.. Earlier production, 3037977, present production, 3045907.



Measure the piston skirt outside diameter at a room temperature of 21°C [70°F] in the location as shown.

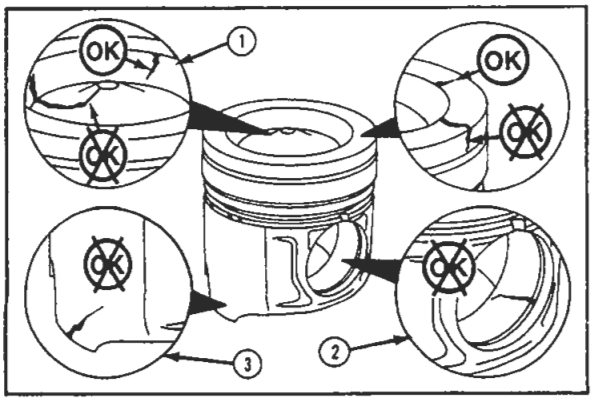
Part No. 3037820 Piston Skirt O.D.		
mm		in
124.772	MIN	4.912
124.789	MAX	4.913

NOTE: C.A.R.B. production Part No. 3037977.



Part No. 3044448 Piston Skirt O.D.		
mm		in
124.824	MIN	4.914
124.856	MAX	4.916

NOTE: C.A.R.B. production Part No. 3045907.

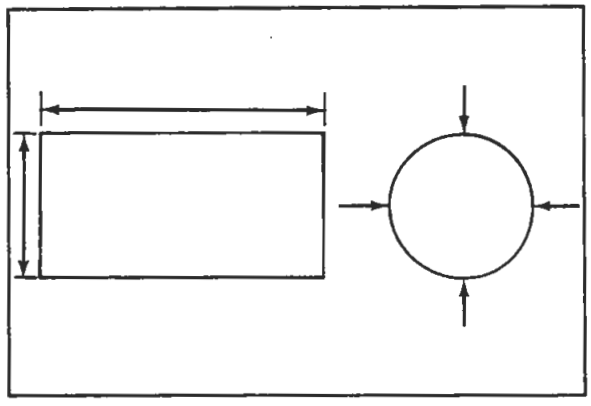


Use the Part No. 3375432 Crack Detection Kit or equivalent to check for cracks on the top of the piston and in the piston pin bore.

NOTE: Do not use pistons with dome cracks larger than one half (1/2) the rim width or with cracks which extend over the rim toward the ni-resist insert.

Visually inspect for cracks in the piston bowl (1), pin bore (2), and the skirt (3).

Measure the length and outside diameter of the piston pin.



Piston Pin Length and O.D.

	mm		in
Length	98.150	MIN	3.8600
	98.350	MAX	3.8700
O.D.	53.997	MIN	2.1258
	54.003	MAX	2.1260

Gear Support Plate - Clean and Inspect for Reuse (01-22)

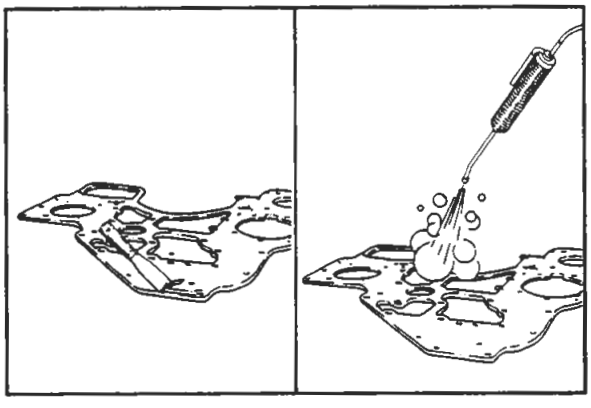
Gear Support Plate - Clean

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

Use a gasket scraper to remove the gasket material.

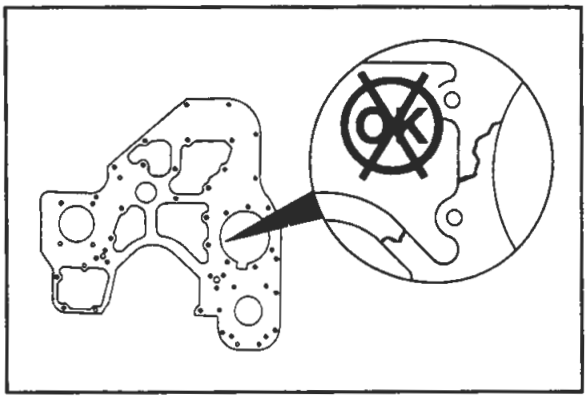
Use medium crocus cloth to remove burrs from the cap-screw holes and gasket surface.

Steam clean the support plate and dry with compressed air.

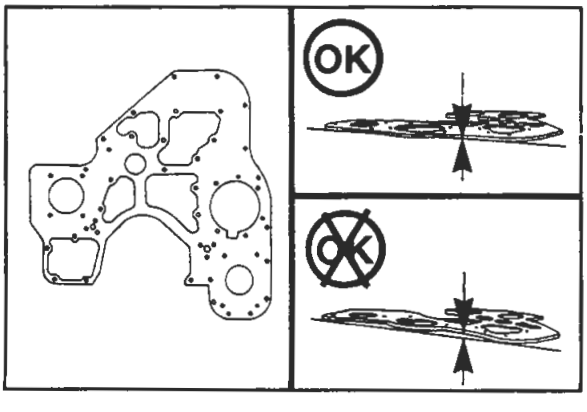


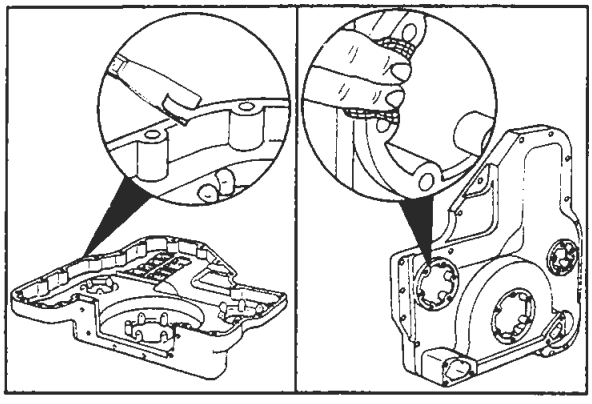
Gear Support Plate - Inspect

Visually inspect the support plate for cracks or damage.



Visually inspect the support plate for flatness.



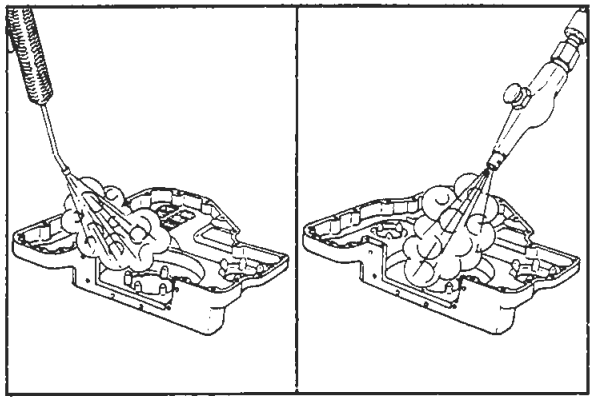


Gear Cover - Clean and Inspect for Reuse (01-23)

Gear Cover - Clean

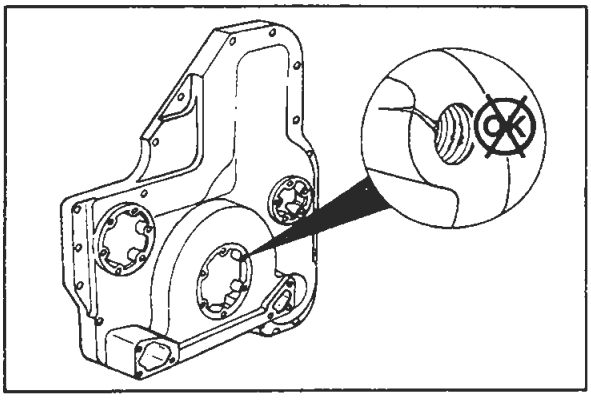
Use a gasket scraper to remove all gasket material.

Use medium crocus cloth to remove burrs from the cap-screw holes and gasket surface.



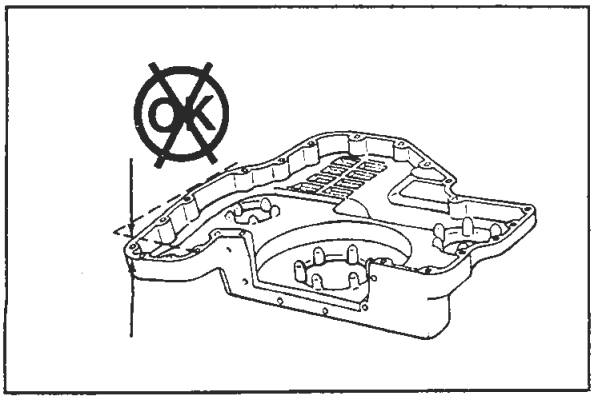
Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

Steam clean the gear cover and dry with compressed air.



Gear Cover - Inspect

Visually inspect the gear cover for cracks or damage.



Visually inspect the gear cover for flatness.

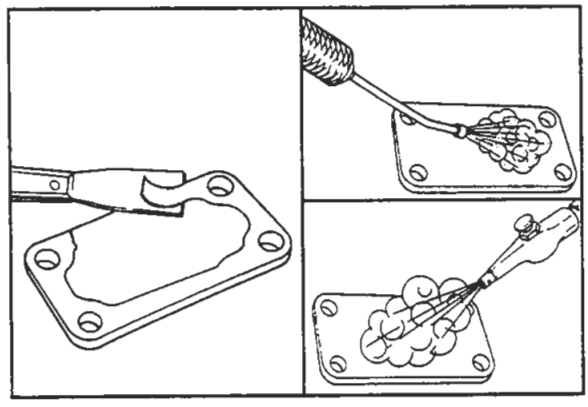
Hand Hole Covers - Clean and Inspect for Reuse (01-24)

Hand Hole Covers - Clean

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

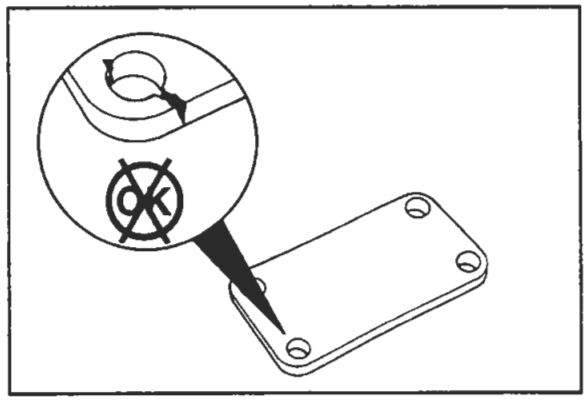
Use a gasket scraper to remove all gasket material.

Steam clean the covers and dry with compressed air.

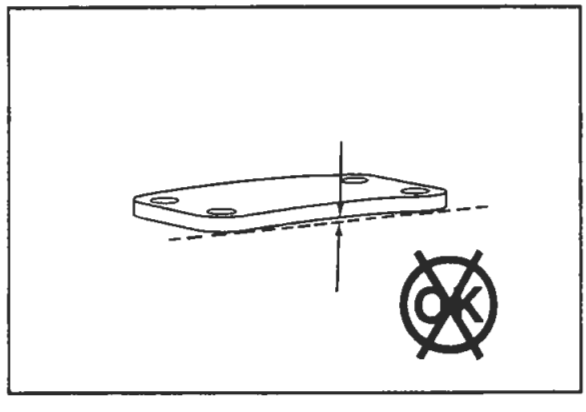


Hand Hole Covers - Inspect

Visually inspect the covers for cracks or damage.



Visually inspect the covers for flatness.



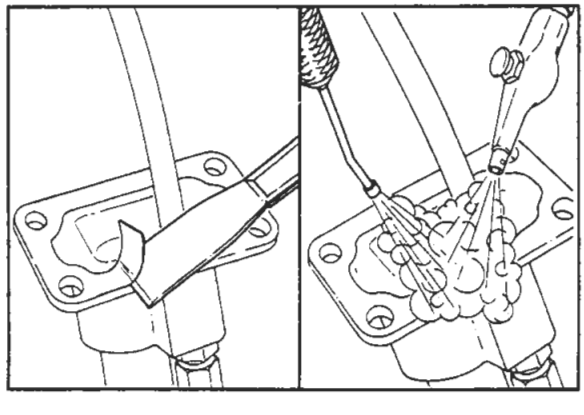
Oil Gauge Bracket - Clean and Inspect for Reuse (01-25)

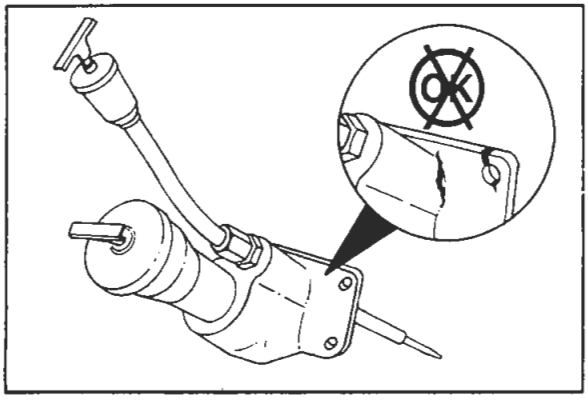
Oil Gauge Bracket - Clean

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

Use a gasket scraper to remove all gasket material.

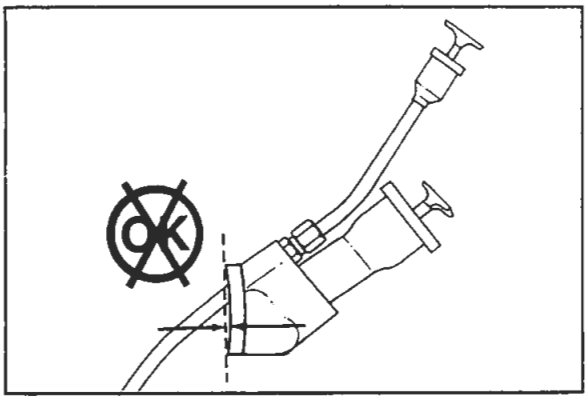
Steam clean the bracket and dry with compressed air.





Oil Gauge Bracket - Inspect

Visually inspect the bracket for cracks or damage.



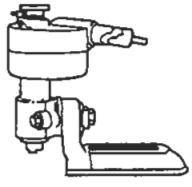
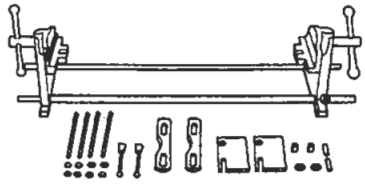
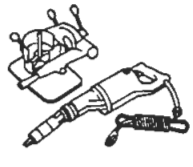
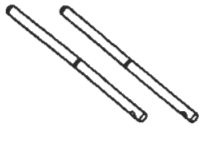
Visually inspect the bracket for flatness.

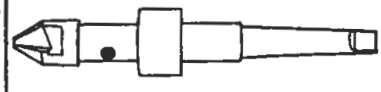
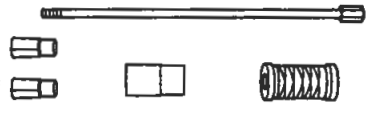
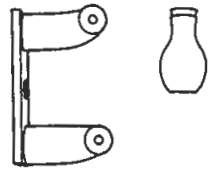
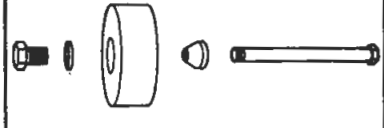
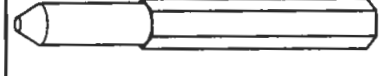
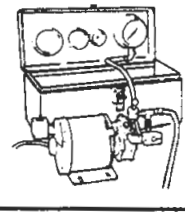
Cylinder Head - Group 02

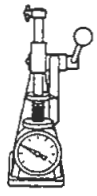
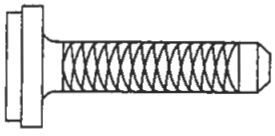
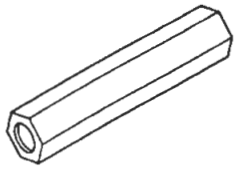
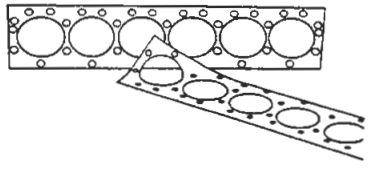
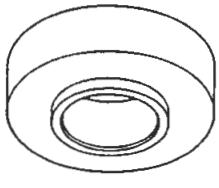
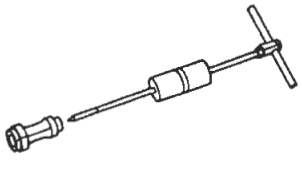
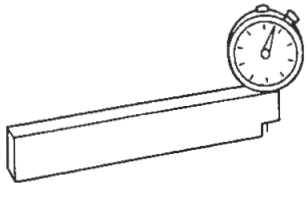
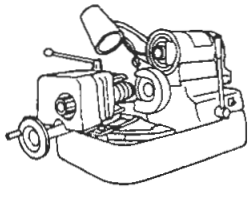
Contents

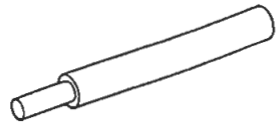
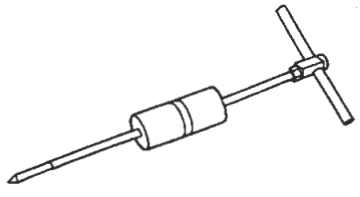
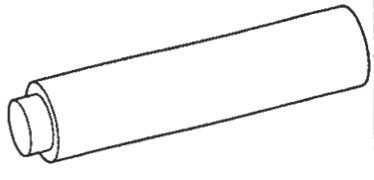
Cylinder Head - Service Tools

The following special tools are recommended to perform the procedures in Group 02. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

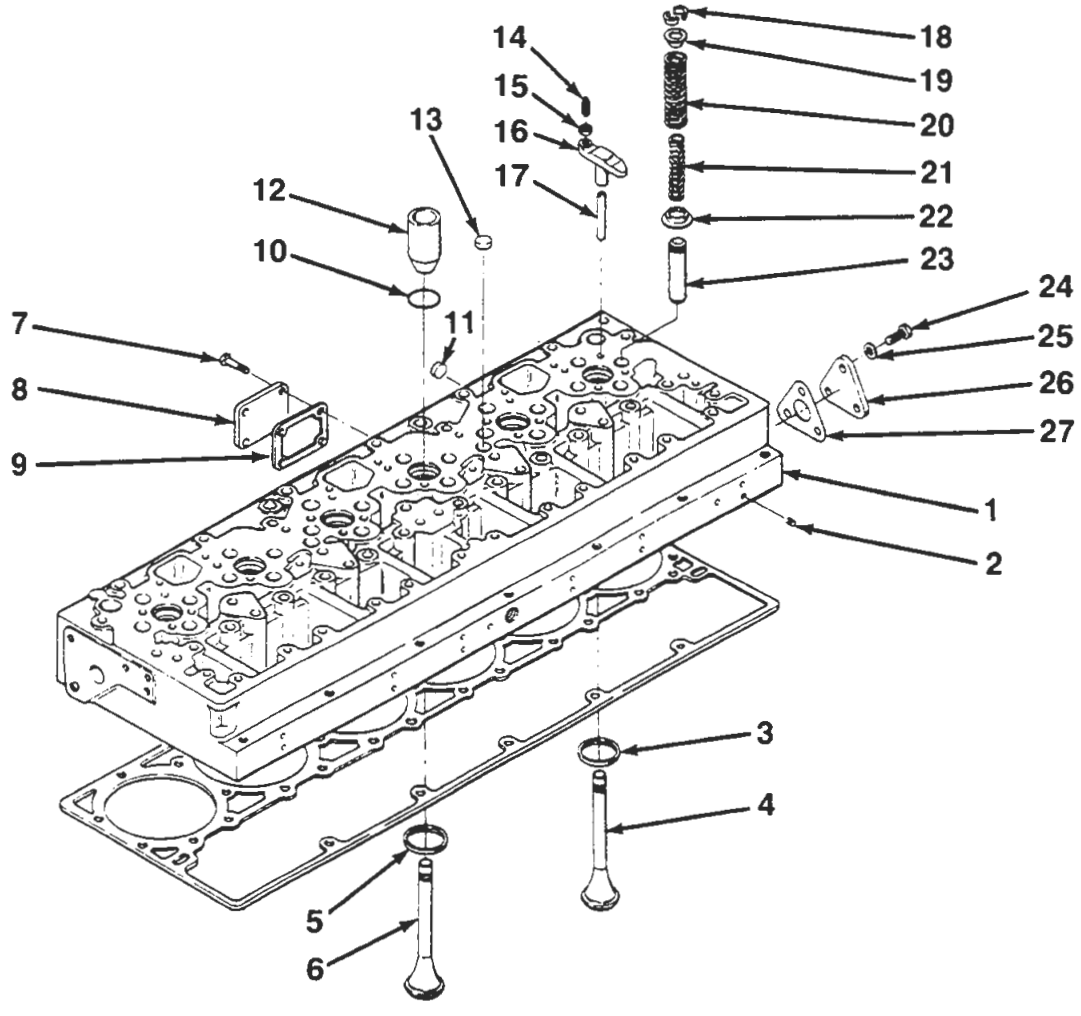
Tool No.	Tool Description	Tool Illustration
ST-257	**Valve Seat Insert Tool** Cut valve seat counterbores for oversize valve seat inserts. Used with Part No. ST-804 Valve Guide Set and Part No. 3376595 Valve Seat Insert Cutter.	
ST-448	**Valve Spring Compressor** Used with the Part No. 3376850 Threaded Adapter and Part No. 3376851 Adapter to compress the valve spring while removing or installing the valve collets.	
ST-583	**Head Holding Fixture** Hold and revolve the cylinder head during repair and assembly.	
ST-633	**Crosshead Guide Spacer** Install the crosshead guides to the proper assembled height in the cylinder head.	
ST-685	**Valve Seat Grinding Machine** Grind the valve seats in the cylinder head. Used with Part No. ST-804 Valve Guide Arbor Set and Part No. 3376077 Valve Seat Grinding Wheel.	
ST-804	**Valve Guide Arbor Set** Used with the Part No. ST-257 Valve Seat Insert Tool and Part No. ST-685 Valve Seat Grinding Machine. ST-804-1 Arbor (3/8 in. + .006 in.) ST-804-2 Arbor (3/8 in. + .007 in.)	

Tool No.	Tool Description	Tool Illustration
ST-876	**Fuel Passage Cleaning Brush** Clean the internal fuel passages in the cylinder head.	
ST-880	**Injector Sleeve Expander** Roll and seal the upper portion of the injector sleeve in the cylinder head.	
ST-884-1	**Injector Seat Cutter** Used with the Part No. ST-379-2 Pilot and ST-884-3 Cutter to machine the injector sleeve seat to the proper depth to allow the specified injector protrusion through the cylinder head.	
ST-1134	**Dowel Pin Extractor** Remove the dowel pins and crosshead guides from the cylinder head.	
ST-1166	**Magnetic Crack Detector** Used to inspect the cylinder head combustion face for cracks in the injector bore and valve seat areas. The kit includes Part No. ST-1166-7 Powder Spray Bulb used for spraying the ST-1166-8 Metal Powder.	
ST-1179	**Injector Sleeve Holding Tool** Hold the injector sleeve in place when rolling the upper portion of the sleeve and testing the cylinder head.	
ST-1227	**Injector Sleeve Driver** Install the injector sleeve into the cylinder head.	
ST-1257	**Valve Vacuum Tester** Vacuum test the cylinder head to determine if the valves are properly seated.	

Tool No.	Tool Description	Tool Illustration
3375182	**Valve Spring Tester** Measure the cylinder head valve spring tension.	
3376058	**Expansion Plug Driver** Install the 2.263 inch diameter expansion plugs in the cylinder head.	
3376061	**Valve Guide Driver** Install the valve guides to the proper assembled height in the cylinder head.	
3376082	**Cylinder Head Water Test Fixture** The test fixture contains the Part No. 3376083 Nuts, the Part No. 3376084 Gasket, and Part No. 3376658 Test Plate used perform a leak check to the cylinder head.	
3376105	**Valve Seat Driver Mandrel** Used with the adapter sleeve and seat driver in the Part No. ST-257 Valve Seat Insert Tool	
3376146	**Valve Seat Extractor** Remove the valve seat inserts from the cylinder head.	
3376220	**Gauge Block** Used with the Part No. ST-547-3 Indicator to measure the injector protrusion and valve recess in the cylinder head.	
3376256	**Valve Facing Machine** Grind cylinder head valves and resurface valve stems.	

Tool No.	Tool Description	Tool Illustration
3376398	**Valve Guide Driver** Remove the valve guides from the cylinder head.	
3376616	**Injector Sleeve Puller** Remove the injector sleeves from the cylinder head. Consists of: 3375615 Collar, 3375616 Rod, 3375825 Extractor Tip, 3376107 Forming Collar, 3376106 Support Bridge, ST-1244-3 Nut, ST-1244-4 Nut, ST-1244-5 Thrust Washer, ST-1244-8 Driver, and ST-1247 Socket.	
3376617	**Slide Hammer Assembly** Used with the valve seat extractor and sleeve puller to remove the valve seat inserts and injector sleeves from the cylinder head.	
3376816	**Expansion Plug Driver** Install the 1.010 inch diameter expansion plugs in the cylinder head.	

Cylinder Head - Exploded View



Ref. No.	Description	Qty.
1	Cylinder Head	1
2	Pipe Plug	15
3	Valve Insert	12
4	Valve, Exhaust	12
5	Valve Insert	12
6	Valve, Intake	12
7	Capscrew	4
8	Cover Plate	1
9	Cover Plate Gasket	1
10	O-Ring	6
11	Expansion Plug	2
12	Injector Sleeve	6
13	Expansion Plug	8
14	Slotted Set Screw	12

Ref. No.	Description	Qty.
15	Jam Nut	12
16	Crosshead	12
17	Crosshead Guide	12
18	Valve Collet	24
19	Valve Spring Retainer	24
20	Valve Spring, Outer	24
21	Valve Spring, Inner	12
22	Spring Guide	24
23	Valve Stem Guide	24
24	Capscrew	3
25	Plain Washer	3
26	Cover Plate	1
27	Cover Plate Gasket	1

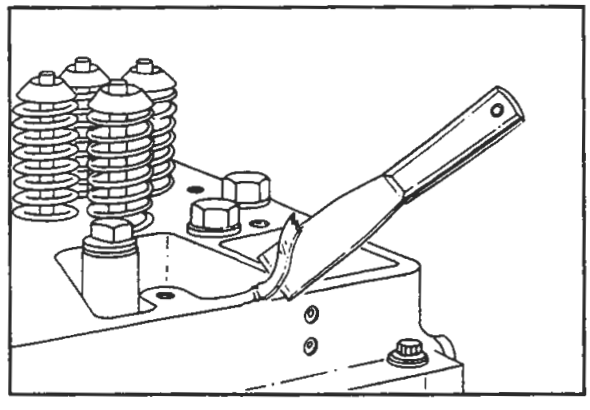
Cylinder Head - General Information

The Cylinder Head Group consists of the cylinder head, valves, valve guides, valve springs, valve seat inserts, crossheads, crosshead guides and the injector sleeves. The exhaust valves use two valve springs and are manufactured from a material that is capable of operating at a higher temperature than the intake valves. The intake spring is the same as the outer exhaust spring. The outer springs are interchangeable. The exhaust valves can be installed in the intake valve location. Do **not** install the intake valves in the exhaust valve location. The valve seat inserts are the same for both the exhaust and intake valves.

Mark, label or tag the cylinder head parts such as crossheads, valves, and valve springs with the cylinder number and location from which they were removed. This practice will be a valuable aid in diagnosing any cylinder head or part failures. Install the acceptable parts in their original locations.

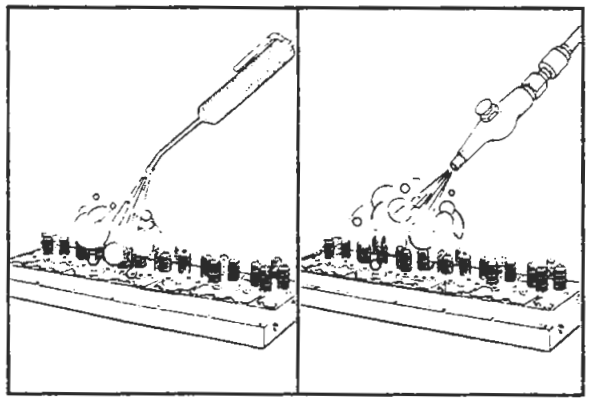
Cylinder Head - Clean and Inspect for Reuse (02-01)

Remove the gasket material from the rocker lever housing surface.

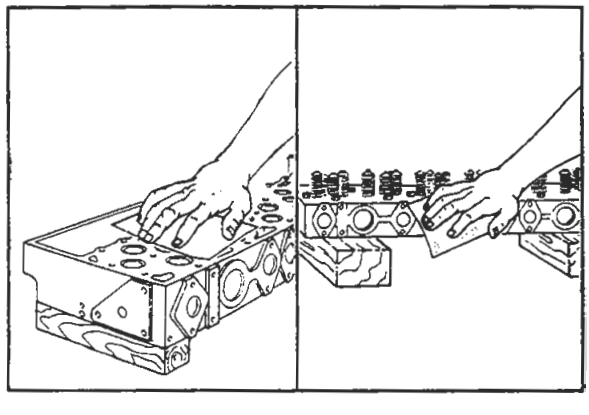


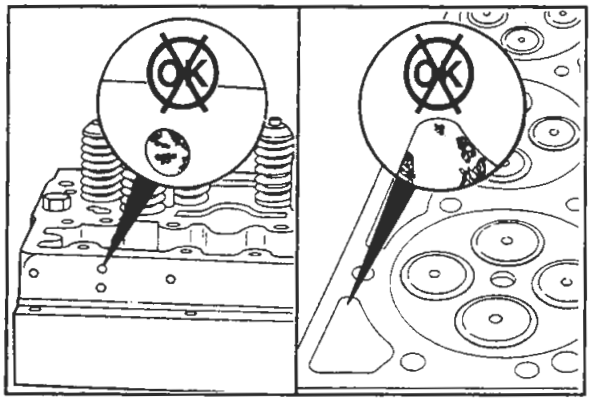
Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use steam to clean the cylinder head. Dry with compressed air.



Use 240 grit emery cloth to clean the cylinder head combustion face and the exhaust manifold gasket surface.

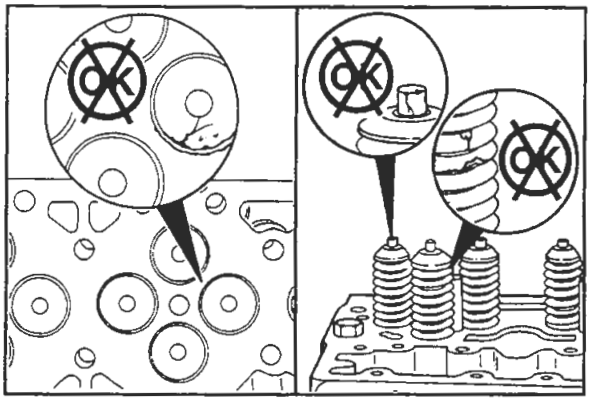




Inspection

Visually inspect the fuel drillings and water passages for restrictions or foreign material.

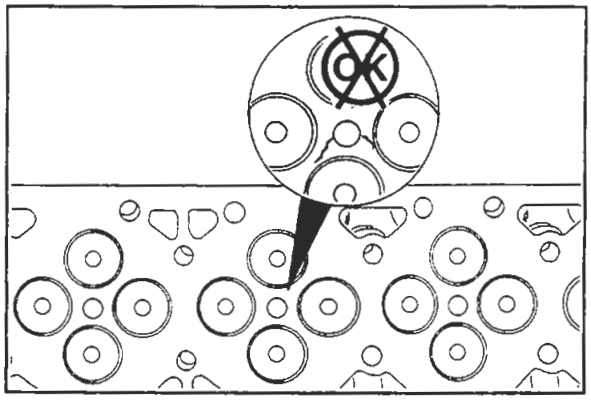
Remove any obstructions.



Visually inspect the valves and valve springs for cracks, bent or broken valve stems, broken valve spring collets or other damage.

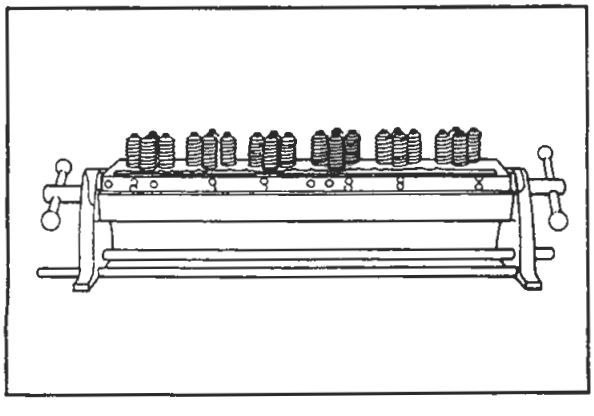
Visually inspect the valves for indications of leakage or burning.

Note: If cracked or damaged parts or indication of leakage or burning are found, the cylinder head **must** be rebuilt. Refer to Cylinder Head - Rebuild (02-02).



Visually inspect the cylinder head for cracks or damage.

Note: If cracks or leaks in the cylinder head are suspected, refer to Cylinder Head - Pressure Test for Reuse (02-09).



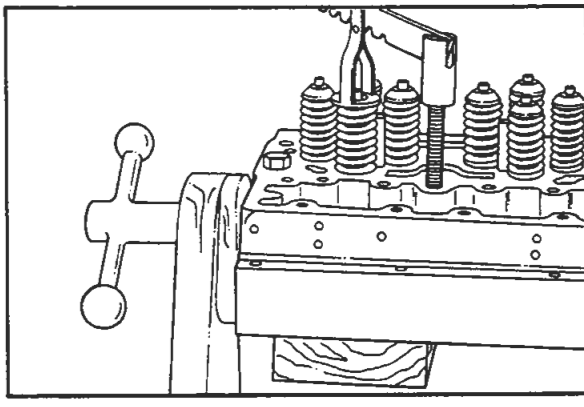
Cylinder Head - Rebuild (02-02)

Disassembly

Install the cylinder head in the Part No. ST-583 Head Holding Fixture as shown.

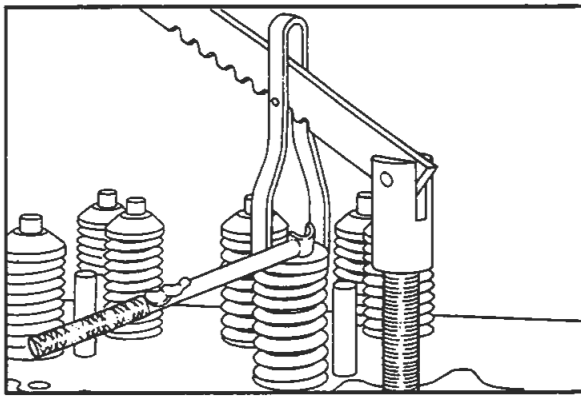
Note: Install a wood block between the valves and head holding fixture to support the valves.

Use the Part No. ST-448 Valve Spring Compressor, the Part No. 3376850 Compressor Threaded Adapter, and the Part No. 3376851 Compressor Adapter to compress the valve springs.



Use a pencil magnet to remove the valve collets. Discard the valve collets.

Slowly release the pressure on the valve spring.

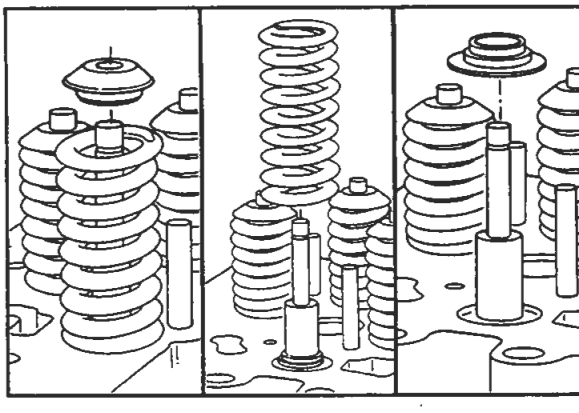


Remove the valve spring retainer.

Remove the valve spring(s).

Note: The exhaust valves use two valve springs.

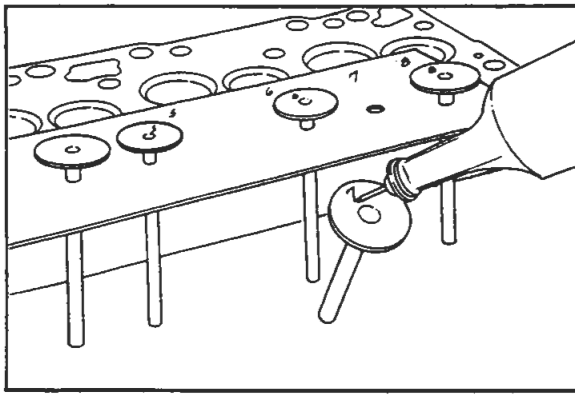
Remove the valve spring wear plate.

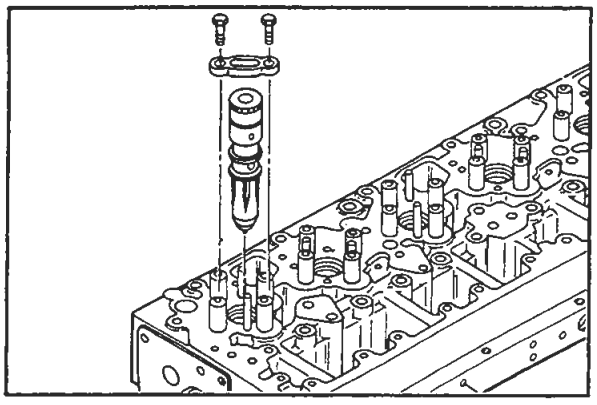


Remove the valve.

Note: Mark the valves with an electric pencil (engraving tool) for location as they are removed. The intake and exhaust valves are manufactured from different materials and are **not** interchangeable.

Repeat the procedure to remove the remaining valve collets, retainers, springs, wear plates and valves.





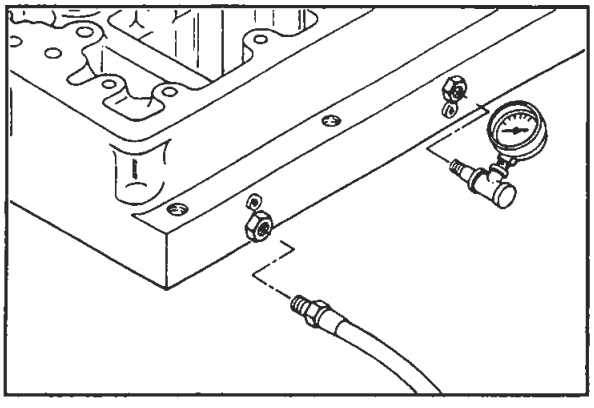
Inspection

Use clean 15W-40 oil to lubricate the injector o-rings.

Install a set of injectors with new o-rings in the cylinder head.

Install the injector hold-down clamps and mounting cap-screws.

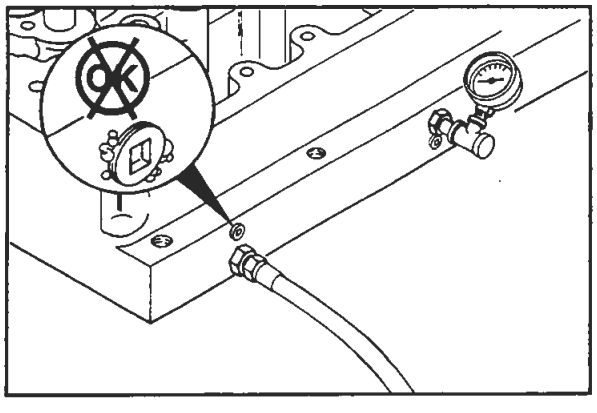
Torque Value: Step one - 5 N•m [45 in-lb]
Step two - 10 N•m [90 in-lb]
Step three - 15 N•m [130 in-lb]



Remove the fuel outlet fitting and install an air gauge.

Install an air supply line to the fuel inlet fitting.

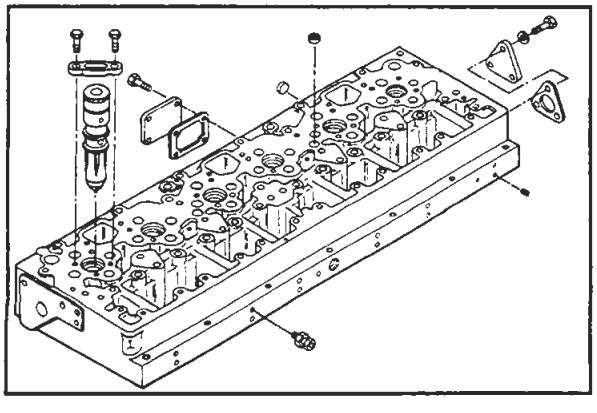
Air Pressure: MIN. 550 kPa [80 psi]
MAX. 690 kPa [100 psi]



Close the air supply valve and visually inspect the fuel passages for leaks.

Record the air pressure on the gauge. The air pressure **must not** decrease on the gauge for at least fifteen seconds.

Note: If the air pressure decreases, use a solution of soap and water on the fuel passage areas and pipe plugs to find the leaks.



Remove the injectors from the cylinder head.

Remove the pipe plugs and fuel fittings from the cylinder head.

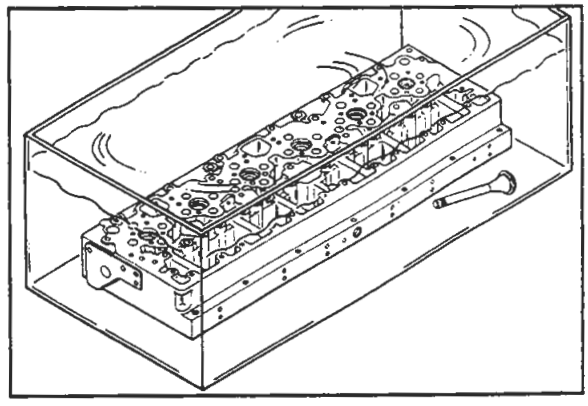
Use a dent puller to remove the expansion plugs

Remove the water cover plate and cam follower shaft cover plate. Discard the gaskets.

Note: Present production cylinder heads do **not** use the cam follower shaft cover plate.

Install the cylinder head and parts in a tank of cleaning solution.

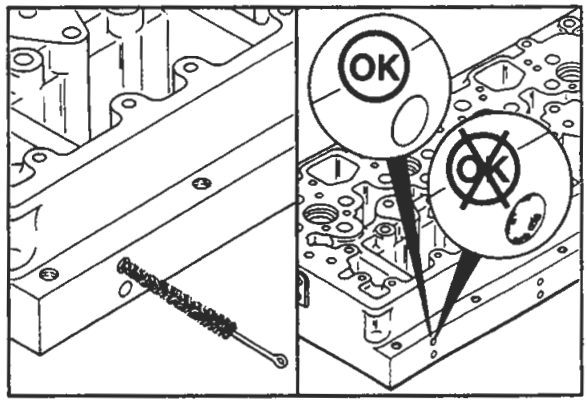
Note: Be sure to follow the cleaning solution manufacturer's instructions when cleaning the parts.



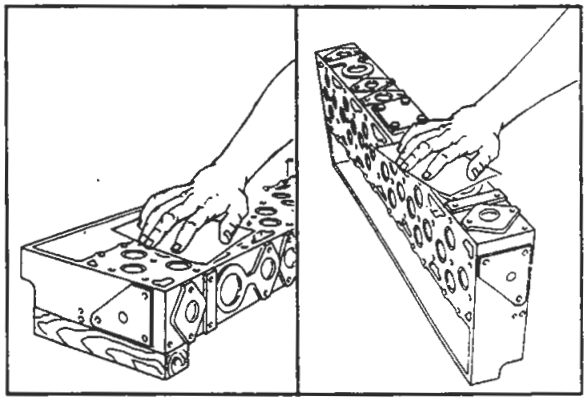
Remove the cylinder head and parts from the cleaning tank.

Use the Part No. ST-876 Fuel Passage Cleaning Brush to clean the fuel and oil passages with solvent. Dry with compressed air.

Visually inspect the fuel and oil passages to make sure they are clean.

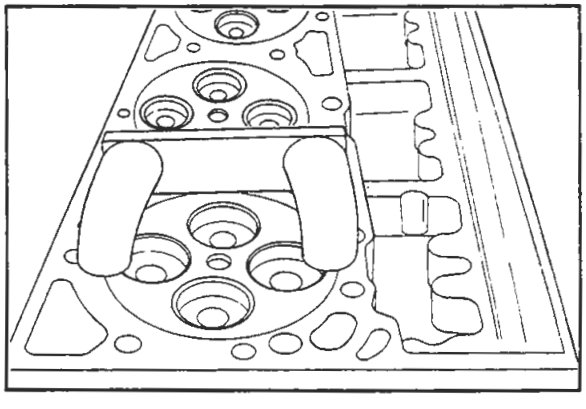


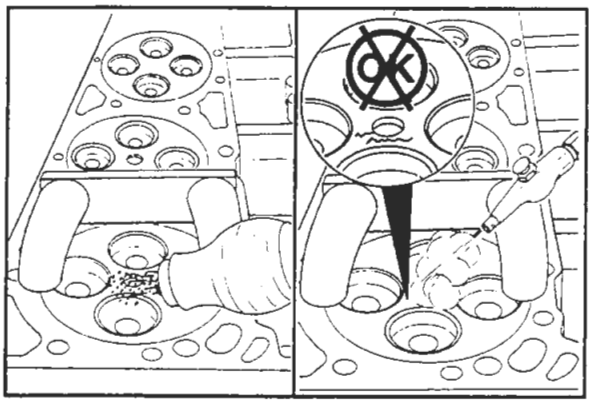
Use 240 grit emery cloth to clean the cylinder head combustion face and the exhaust manifold gasket surface.



Use the Part No. ST-1166 Magnetic Crack Detector, to find cracks in the combustion face, in areas around the valve ports and the injector bores.

Place the magnatizing head on the combustion face as shown, to check for cracks that run across the cylinder head.





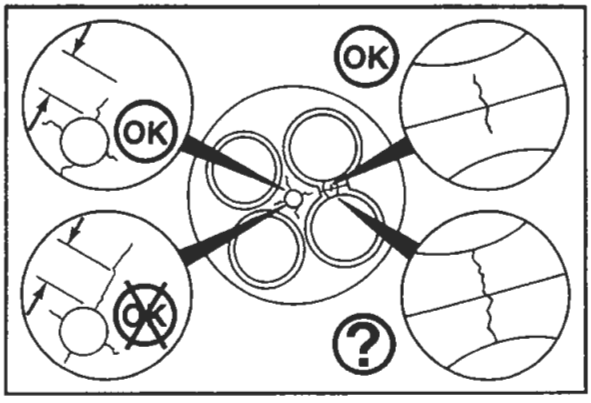
Fill the powder spray bulb one-third (1/3) full with metal powder.

Spray the powder lightly onto the combustion face.

Use compressed air to remove the excess metal powder.

Air Pressure: 276 kPa [40 psi]

Note: The powder will remain in the cracks, if present, and show as a white line.



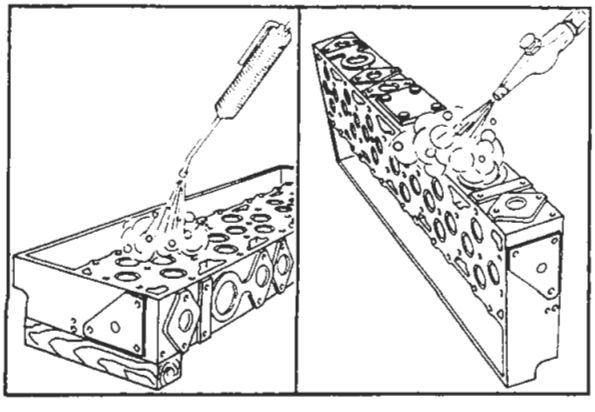
Visually inspect the cylinder head for cracks in the combustion face.

If any of the cracks around the injector bore are longer than 7 mm [1/4 inch], the cylinder head **must** be replaced.

Note: Both ends of a crack between the valves must be visible. If one end of a crack extends into the valve seat insert bore behind the valve seat insert, then the condition of the cylinder head is questionable. To be sure that the cylinder head is in good condition, remove the valve seat insert. Refer to Replace Valve Seat Inserts (02-04).

Place the magnatizing head on the combustion face as shown, to check for cracks that run lengthwise of the cylinder head.

Repeat the procedure as outlined above.



Remove all magnetism and use solvent to clean the cylinder head. Dry with compressed air.

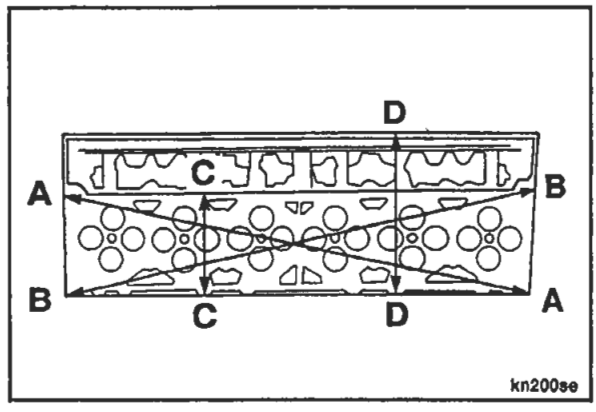
Note: The cylinder head **must** be thoroughly cleaned after using the magnetic crack detector to remove all of the iron fragments.

Measure the flatness of the cylinder head gasket surface.

Cylinder Head Flatness			
	mm	MAX	In
AA and BB (corner to corner)	0.200		0.008
CC (across combustion face)	0.076		0.003
DD (across entire head surface)	0.127		0.005

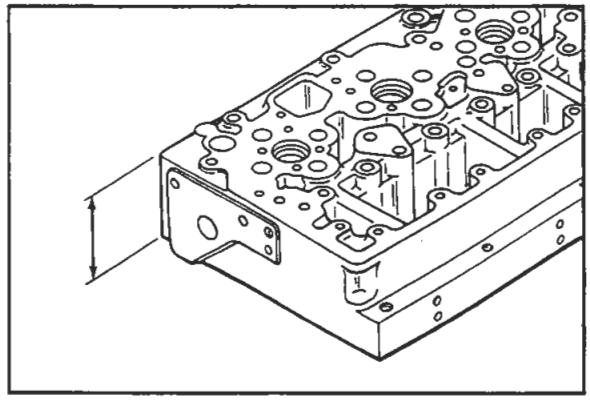
NOTE: Dimensions CC and DD **must** be checked from front to rear of cylinder head.

NOTE: If the cylinder head is pitted or has grooves or wear greater than the maximum specified, the cylinder head surface **must** be machined or cut. Refer to the Alternative Repair Manual, Bulletin No. 3810310.



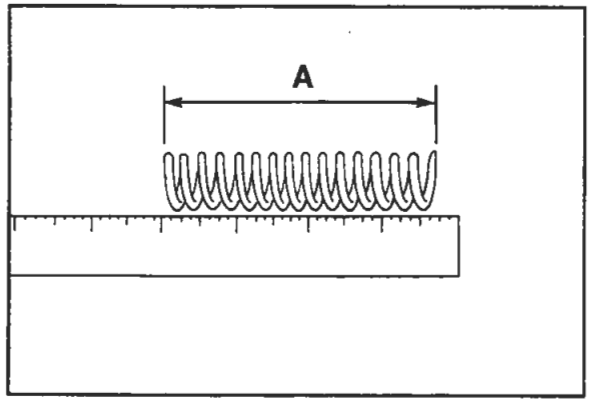
Measure the thickness of the cylinder head.

Cylinder Head Thickness		
mm		In.
99.24	MIN	3.907
100.25	MAX	3.947



Use the Part No. 3375182 Valve Spring Tester to measure the valve spring load at the valve spring working height.

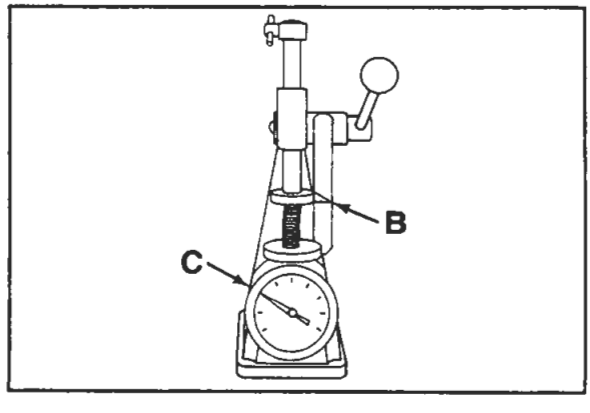
Free Height (A)			
Location	mm		In.
Outer	83.72	Nominal	3.296
Inner	78.71	Nominal	3.099

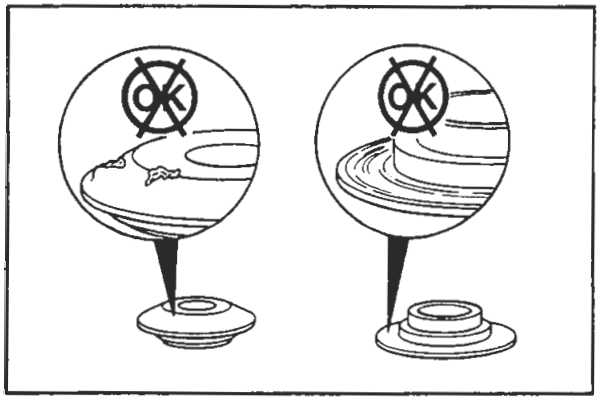


Working Height (B)			
Location	mm		In.
Outer	52.65	Nominal	2.073
Inner	45.29	Nominal	1.783

Load for Working Height (C)			
Location	N		lbf
Outer	977	MIN	219
	1077	MAX	242
Inner	417	MIN	94
	471	MAX	106

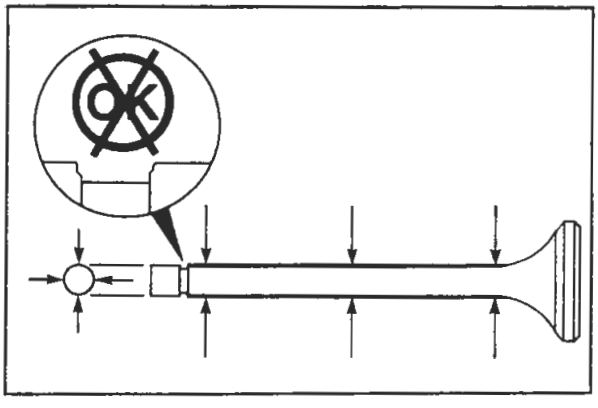
NOTE: If the valve spring load for the working height is less than the minimum specified, the valve spring(s) **must** be replaced.





Visually inspect the valve spring retainers and valve spring guides for damage or worn areas.

Discard damaged and worn parts.

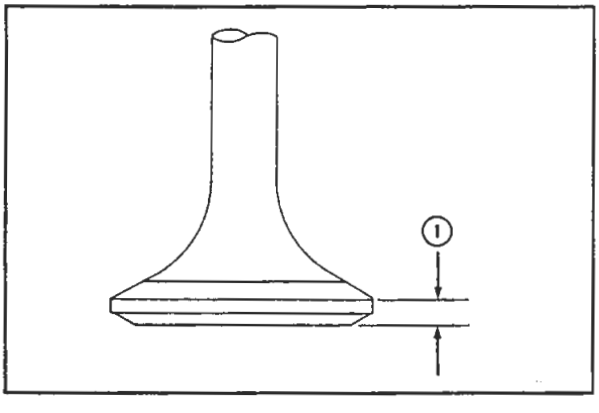


Visually inspect the valves for damage and the collet grooves for wear.

Measure the outside diameter of the valve stem.

Stem O.D.		
mm		in.
9.580	MIN	0.3772
9.633	MAX	0.3793

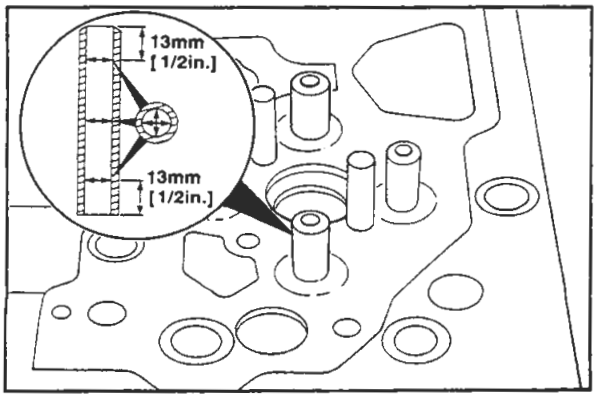
Note: If the valves are damaged or the stems are worn smaller than the minimum specified, the valves **must** be replaced.



Place the valve on a flat surface and measure the head thickness (1) at the outside diameter.

Head Thickness (at O.D.)		
mm		in.
3.15	MIN	0.124
3.62	MAX	0.143

Note: If the valve head is worn thinner than the minimum specified, the valve(s) **must** be replaced.



Visually inspect the valve guides for chips or cracks.

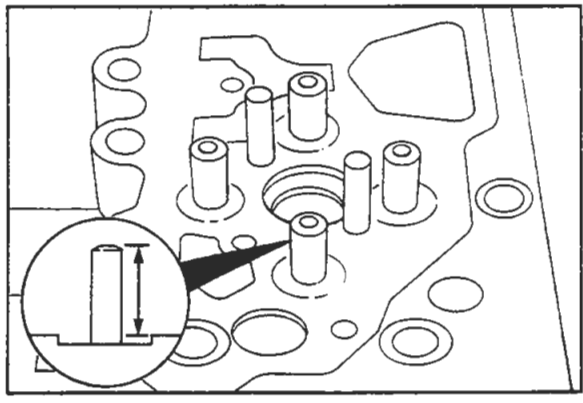
Measure the inside diameter of the valve guides in locations 13mm [1/2 inch] from each end and at the center as shown.

Valve Guide I.D. (Installed)		
mm		in.
9.663	MIN	0.3804
9.730	MAX	0.3831

Measure the valve guide installed height.

Valve Guide Height (Installed)		
mm		in.
36.15	MIN	1.423
36.65	MAX	1.443

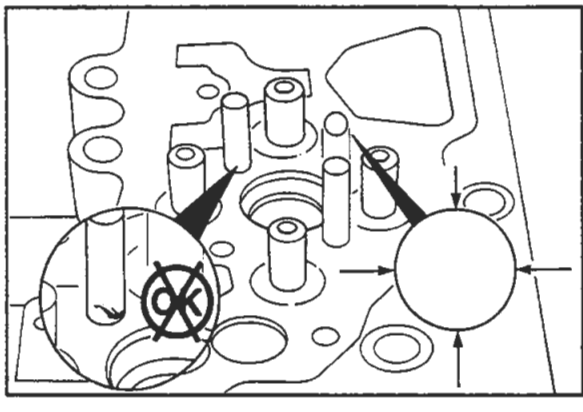
Note: If damage is found or the valve guide(s) do **not** meet the limits specified, the valve guide(s) **must** be replaced. Refer to Cylinder Head - Replace Valve Guides (02-03)



Visually inspect the crosshead guides for cracks or damage.

Measure the outside diameter of the crosshead guides.

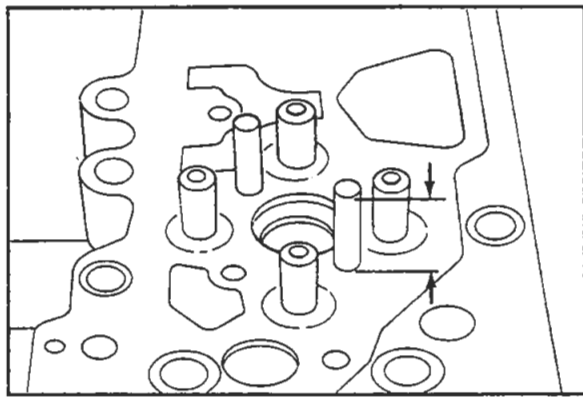
Crosshead Guide O.D.		
mm		in.
10.975	MIN	0.4321
11.011	MAX	0.4335



Measure the installed height of the crosshead guides.

Crosshead Guide Height (Installed)		
mm		In.
47.25	MIN	1.860
47.75	MAX	1.880

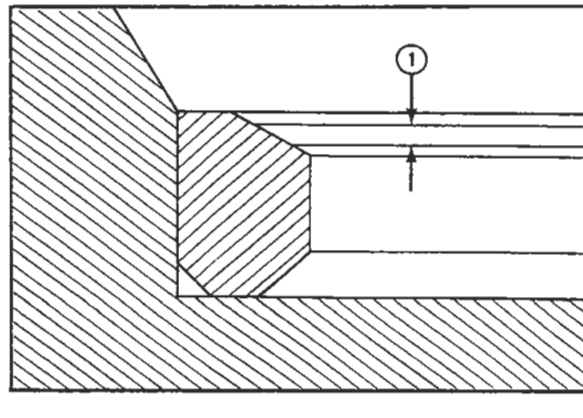
Note: If damage is found or the crosshead guide(s) do **not** meet the limits specified, the crosshead guide(s) **must** be replaced. Refer to Cylinder Head - Replace Crosshead Guides (02-06).

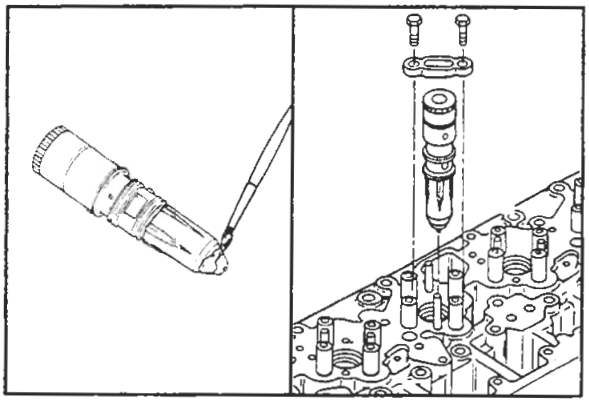


Measure the width of the valve seat area (1) of the valve seat inserts.

Valve Seat Area (Width)		
mm		in.
1.63	MIN	0.064
2.69	MAX	0.106

Note: If the valve seat area is worn wider than the maximum specified, refer to Grind the Valve Seats following or Cylinder head - Replace Valve Seat Inserts (02-04).



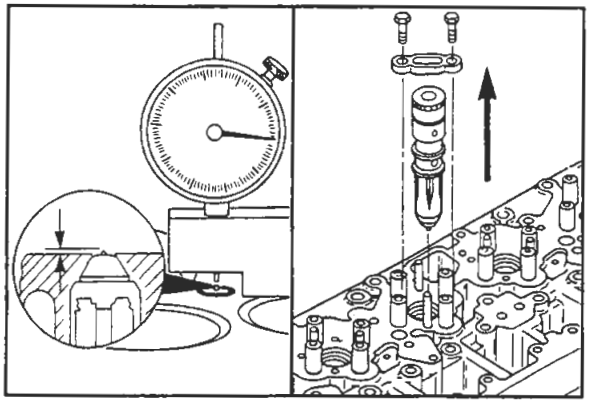


Caution: Support the cylinder head in the Part No. ST-583 Head Holding Fixture to prevent damage to the injector tip that protrudes from the combustion face.

Apply a bluing compound to the outside diameter of the injector at the injector sleeve seat area.

Install the injectors into the cylinder head without o-rings.

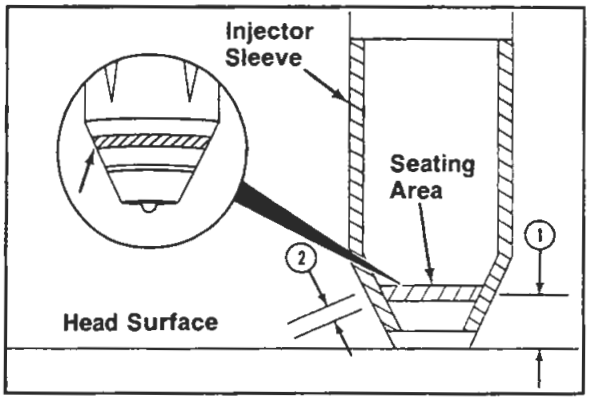
Torque Value: Step one - 5 N•m [45 in-lb]
Step two - 10 N•m [90 in-lb]
Step three - 15 N•m [130 in-lb]



Turn the cylinder head over and use the Part No. 3376220 Gauge Block and Part No. ST-547-3 Indicator to measure the injector tip protrusion.

Injector Tip Protrusion		
mm		in.
2.28	MIN	0.090
2.65	MAX	0.104

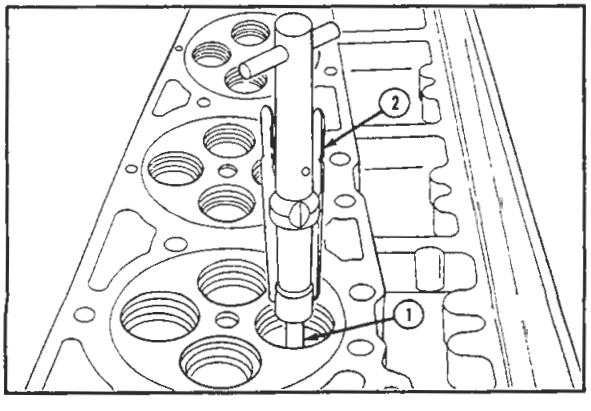
Remove the injectors from the cylinder head.



The bluing pattern of the injector seating area (1) **must** be approximately13 mm [0.50 inch] from the cylinder head surface.

The injector bore seating width (2) **must** be a minimum of 1.52mm [0.060 inch].

Note: If the injector protrusion is **more** than the maximum specified or the injector sleeve bluing pattern does **not** meet the specifications given, the injector sleeve(s) **must** be replaced. Refer to Cylinder Head - Replace Injector Sleeves (02-08).



Grind the Valve Seats

Use the Part No. ST-685 Valve Seat Grinding Machine and the Part No. ST-804 Valve Guide Arbor Set when grinding the valve seat inserts.

Install the valve guide arbor (1) in the valve guide with the arbor puller (2).

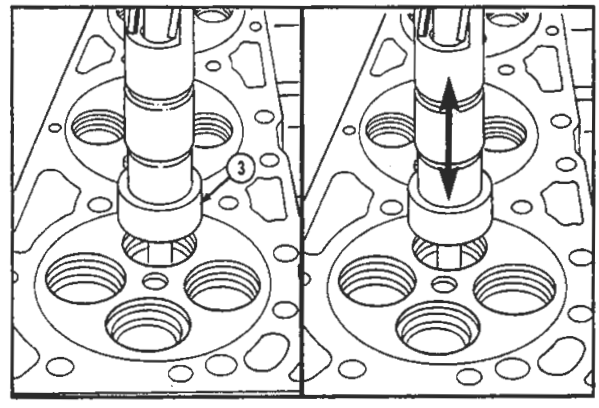
Note: Rotate the arbor to be sure that it is installed correctly.

Install the Part No. 3376077 Valve Seat Grinding Stone (3) on the driver.

Install the grinder unit on the arbor.

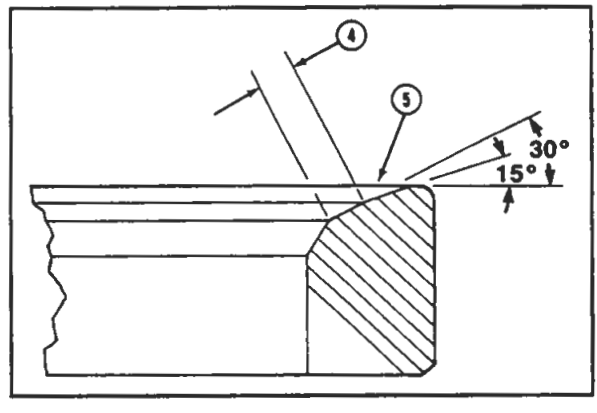
Note: The grinding stone (3) must **not** be touching the valve seat insert when the drive unit motor is started.

Hold the drive unit in a vertical position and use an "up and down" movement of 13mm [0.50 inch] travel and light pressure to grind the insert.



Note: If the area (4) is wider than 2.69mm [0.106 inch], use a grinding stone with a 15 degree angle to narrow the width (5).

Remove the grinder unit from the arbor.

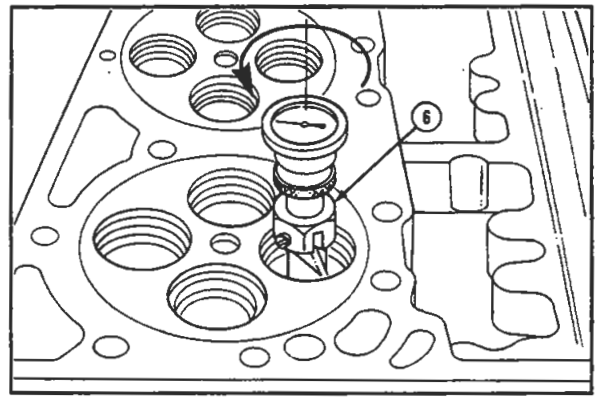


Install the Part No. ST-685-4 Eccentrimeter Gauge (6) on the arbor.

Measure the valve seat to valve guide concentricity.

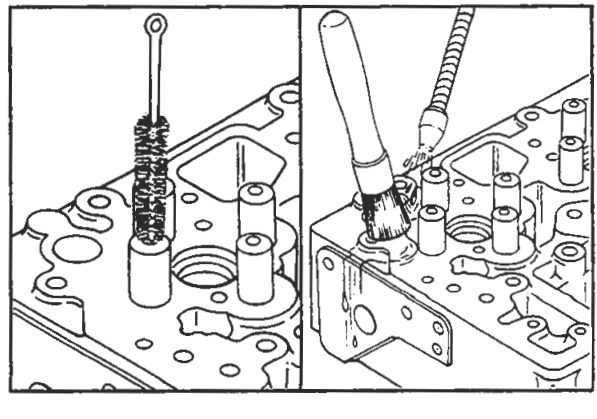
Concentricity (Per 360 Degrees)		
mm		in.
0.05	MAX	0.002

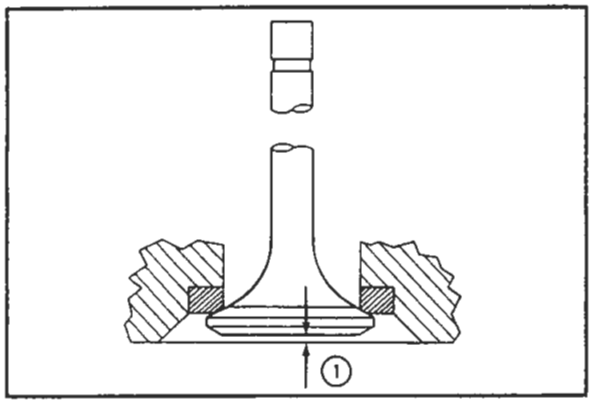
Note: If the valve seat concentricity does **not** meet the specifications, grind the valve seat again. If the specifications **cannot** be met, replace the valve seat insert, refer to Cylinder Head - Replace Valve Seat Inserts (02-04).



After grinding the valve seats, use a 13.0mm [0.50 inch] bristle brush to clean the inside diameter of the valve guides.

Use solvent to clean the cylinder head. Dry with compressed air.



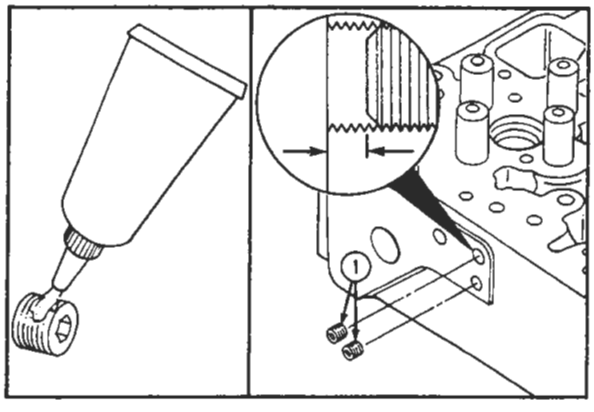


Install a new or reconditioned valve in the valve guide. Hold the valve firmly against the valve seat insert.

Use the Part No. 3376220 Gauge Block and the Part No. ST-547-3 Indicator to measure the valve recess (1) in the cylinder head.

	Valve Recess		
	mm		In.
Built Prior to 1988	0.04	MIN	0.002
	0.46	MAX	0.018
Built 1988 and after	0.76	MIN	0.030
	1.17	MAX	0.046

NOTE: If the valve recess does **not** meet the specifications given, the valve seat **must** be ground again or replaced. Refer to Cylinder Head - Replace Valve Seat Insert (02-04).

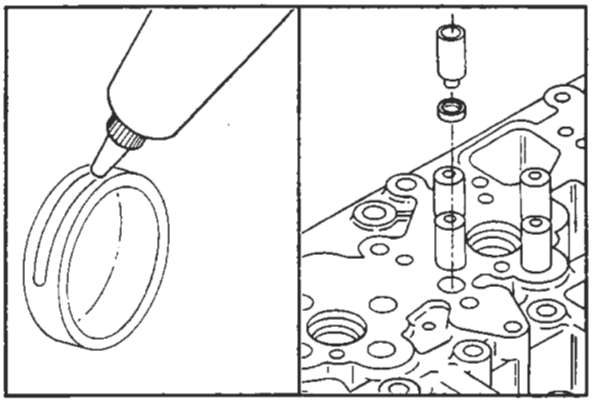


Assembly

Apply a coat of Part No. 3375068 Cup Plug Sealant to the pipe plug threads. Install the pipe plugs.

NOTE: The pipe plugs (1) located in the front of the cylinder head **must** be installed below the surface of the cylinder head.

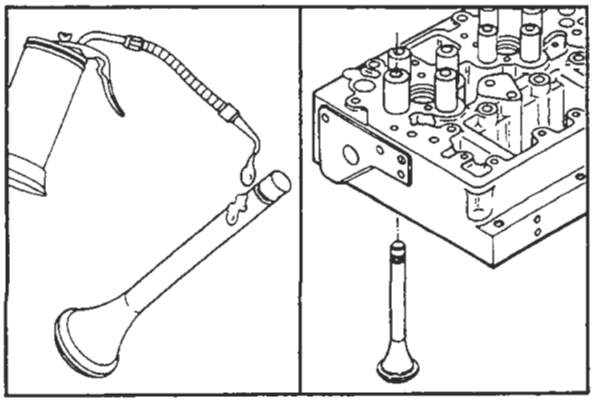
Torque Value: 10 N•m [8 ft-lb]



Apply a coat of Part No. 3375068 Cup Plug Sealant to the outside diameter of the expansion plugs.

Use the Part No's. 3376048, 3376058, and 3376816 Expansion Plug Drivers to install the expansion plugs in the cylinder head.

NOTE: The correct expansion plug driver will install the expansion plugs to the correct depth in the cylinder head.



Use clean 15W-40 oil to lubricate the valve stems.

Install the valves in the valve guides.

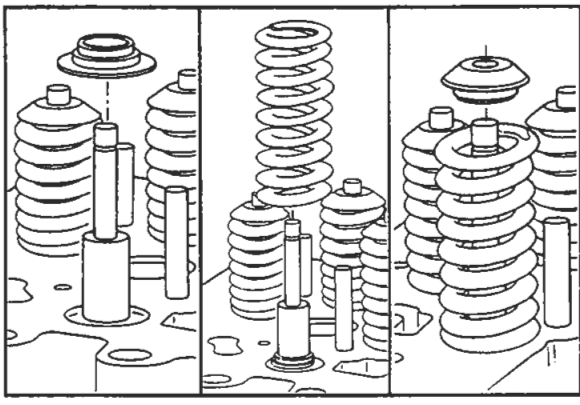
NOTE: After the valves are installed, place the cylinder head on a flat surface that will **not** damage the cylinder head surface.

Install the valve spring wear plates.

Install the valve springs.

Note: The exhaust valves use two valve springs.

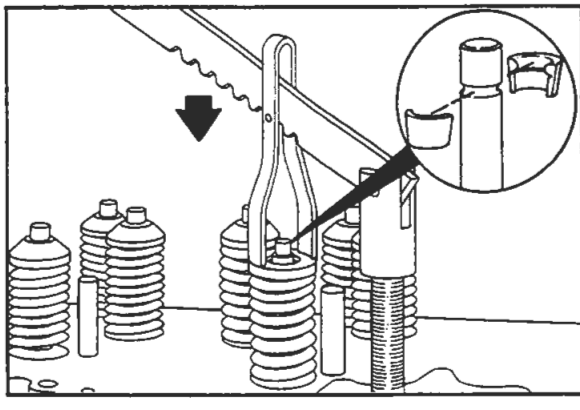
Install the valve spring retainers.



Use the Part No. ST-448 Valve Spring Compressor, the Part no. 3376850 Compressor Thread Adapter, and the Part No. 3376851 Compressor Adapter to compress the valve springs.

Install the new valve spring retainer collets.

Note: Always use new collets when rebuilding the cylinder head.



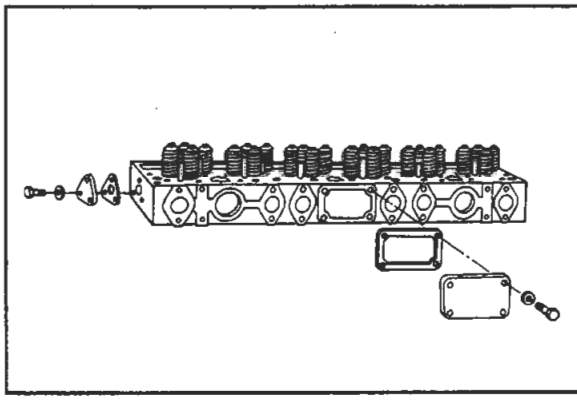
Apply a coat of Part No. 3375066 Pipe Sealant to the water cover plate capscrews.

Install a new gasket, the water cover plate and four capscrews.

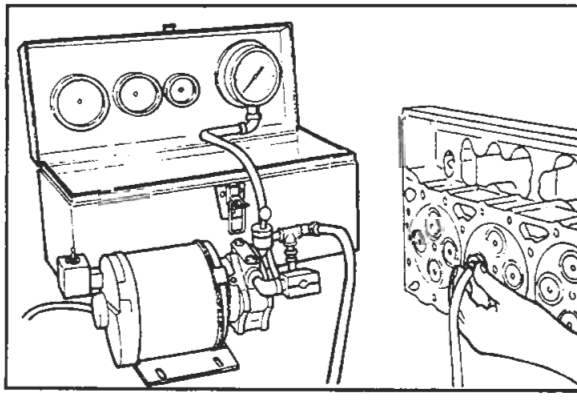
Install a new gasket, the cam follower shaft cover plate and three capscrews.

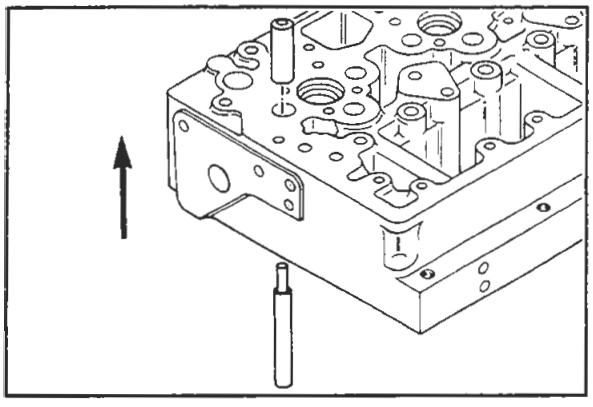
Torque Value: 45 N•m [35 ft-lb]

Note: Present production cylinder heads do **not** use the cam follower shaft cover plate. The water cover plate capscrews used on present production engines are grade 10.9 and are tightened to 65 N•m [50 ft-lb] torque.



Use the Part No. ST-1257 Valve Vacuum Tester to vacuum test the valve seating. Refer to Cylinder Head - Vacuum Test Valve Seating (02-10).

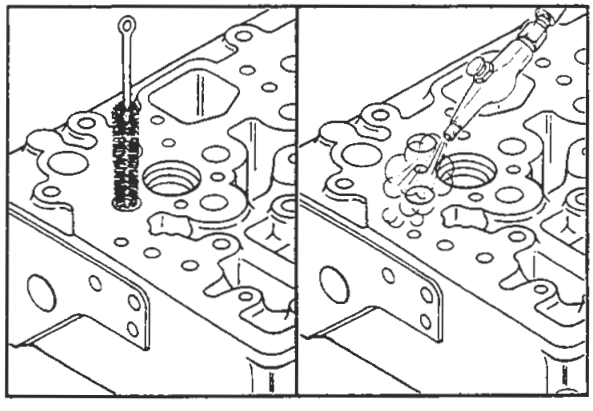




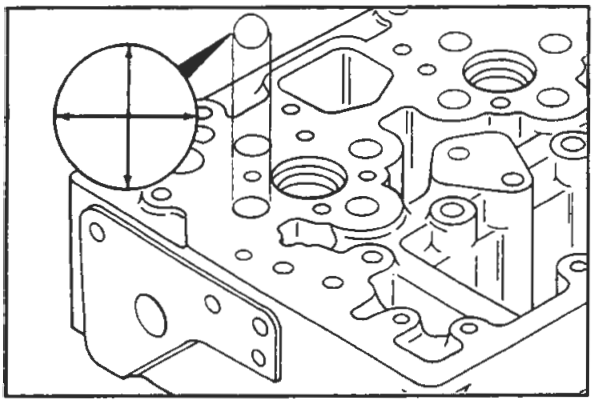
Cylinder Head - Replace Valve Guides (02-03)

Disassembly

Use the Part No. 3376398 Valve Guide Driver (1) to remove the old valve guides.



Use a flexible brush and solvent to clean the valve guide bores in the cylinder head. Dry with compressed air.

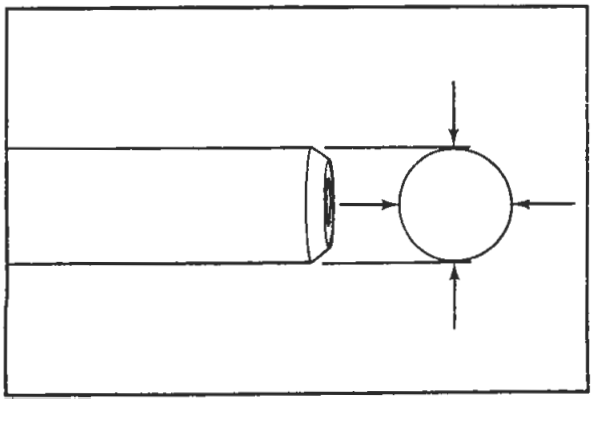


Inspection

Measure the inside diameter of the valve guide bore in the cylinder head.

Valve Guide Bore I.D.		
mm		in.
16.480	MIN	0.6488
16.500	MAX	0.6496

Note: If the valve guide bore is worn larger than the maximum specified, the valve guide bore can be machined and 0.51mm [0.020 inch] oversize valve guide installed. Refer to the Alternative Repair Manual, Bulletin No. 3810310.

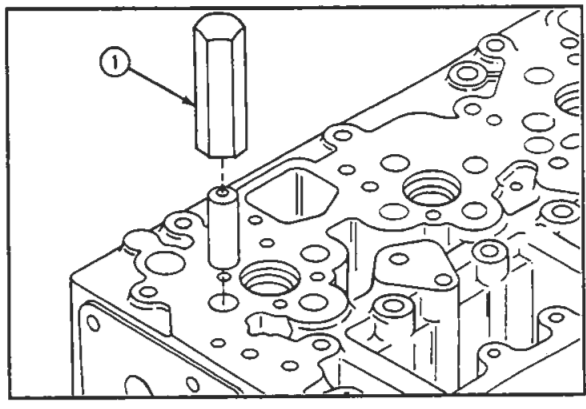


Assembly

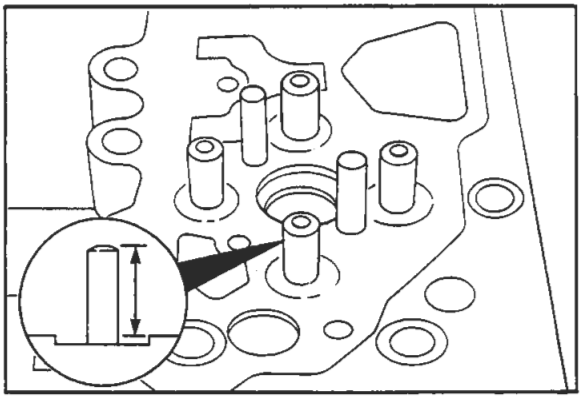
Measure the outside diameter of the new valve guides.

Valve Guide O.D.		
mm		in.
16.513	MIN	0.6501
16.526	MAX	0.6506

Use the Part No. 3376061 Valve Guide Driver (1) to install the new valve guides.

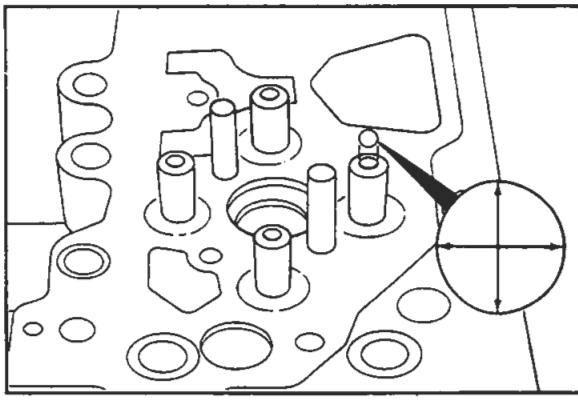


Measure the new valve guide installed height above the cylinder head top deck surface.



Valve Guide Height (Installed)		
mm		in.
36.15	MIN	1.423
36.65	MAX	1.443

Measure the new valve guide inside diameter.



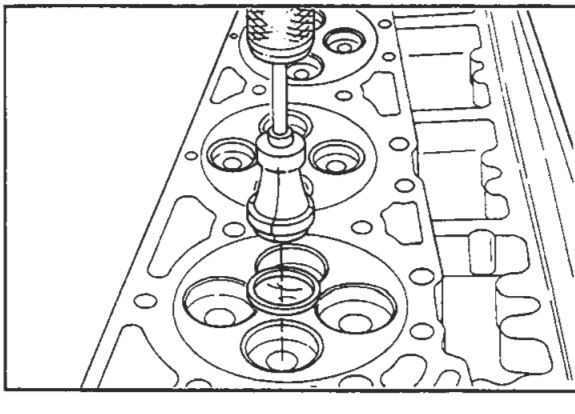
Valve Guide I.D. (Installed)		
mm		in.
9.670	MIN	0.3807
9.695	MAX	0.3817

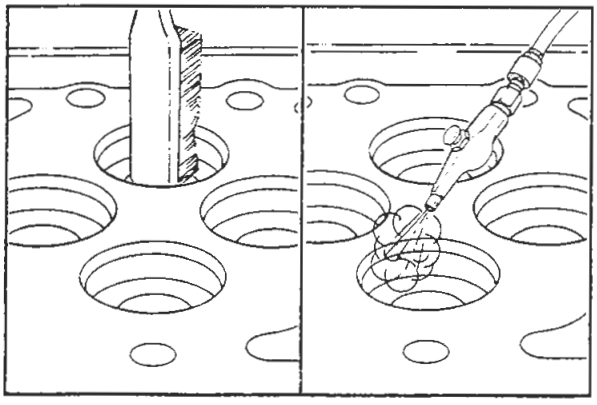
Note: If the valve guide is **not** within the specifications given, the valve guide **must** be removed and a new valve guide installed.

Cylinder Head - Replace Valve Seat Inserts (02-04)

Disassembly

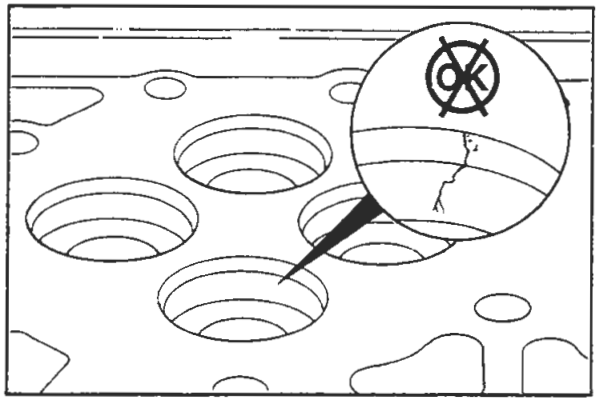
Use the Part No. 3376617 Slide Hammer Assembly and the Part No. 3376146 Valve Seat Extractor to remove the valve seat inserts from the cylinder head.





Use a wire brush and solvent to clean the deposits from the valve seat insert bores.

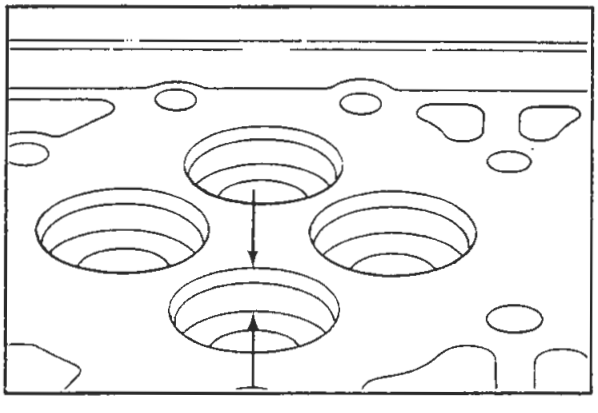
Use solvent to clean the cylinder head. Dry with compressed air.



Inspection

Visually inspect the insert bore for cracks or damage.

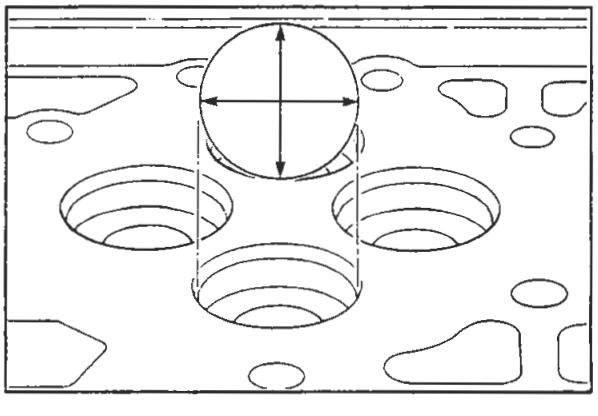
NOTE: If cracks or damage are found it is possible to repair the cylinder head by machining the insert bore for oversize valve seat inserts. Refer to the Alternative Repair Manual, Bulletin No. 3810310.



Measure the valve seat insert bore depth in the cylinder head.

Insert Bore Depth (Standard Insert)			
	mm		In.
Built Prior to 1988	8.71	MIN	0.343
	8.81	MAX	0.347
Built 1988 and after	9.40	MIN	0.370
	9.50	MAX	0.374

NOTE: If the valve seat insert bore depth does **not** meet the specifications given, refer to Cylinder Head - Install Oversize Valve Seat Inserts (02-05).



Measure the inside diameter of the valve seat insert bore in the cylinder head.

Insert Bore I.D. (Standard Insert)		
mm		In.
45.920	MIN	1.8073
45.935	MAX	1.8085

NOTE: If the valve seat insert bore inside diameter does **not** meet the specifications given, refer to Cylinder Head - Install Oversize Valve Seat Inserts (02-05)

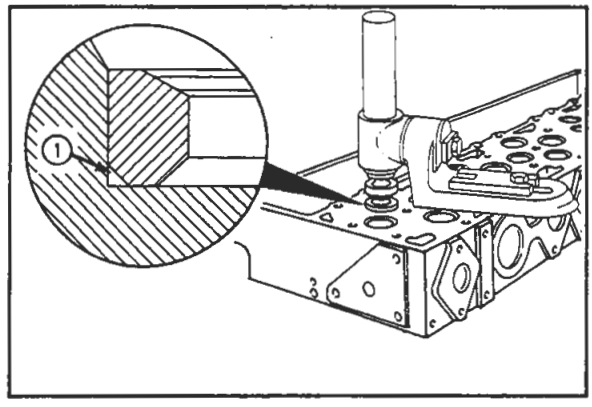
Assembly

Install the base and swivel of the Part No. ST-257 Valve Seat Insert Tool on the cylinder head to guide the valve seat driver. Install the Part No.ST-804-1 Valve Guide Arbor.

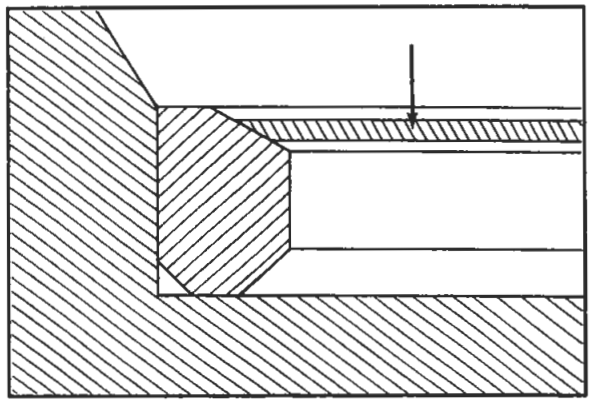
Note: The insert chamfer (1) **must** be installed toward the bottom of the counterbore.

Use the Part No. 3376105 Valve Seat Driver to drive the valve seat insert into the counterbore.

Note: Make sure the insert is at the bottom of the counterbore.



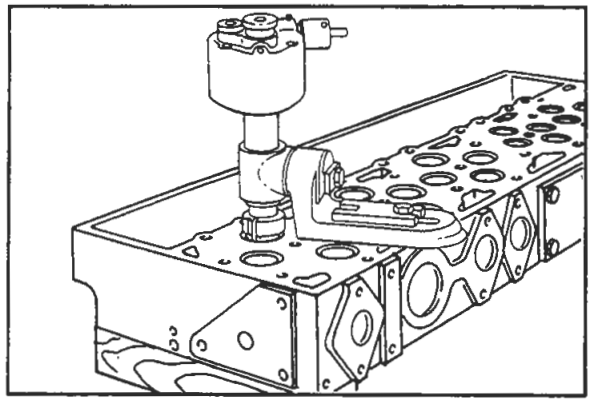
Use the Part No. ST-685 Valve Seat Grinding Machine and Part No. 804 Valve Guide Arbor Set to grind the new valve seat inserts. Refer to Cylinder Head - Rebuild - Grind the Valve Seats (02-02).



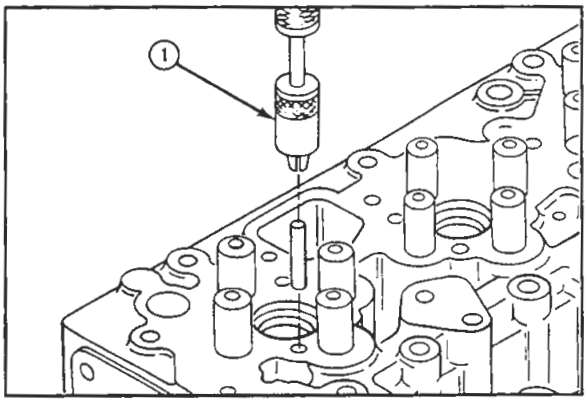
Cylinder Head - Install Oversize Valve Seat Inserts (02-05)

Note: Valve seat inserts that are oversize on both the outside diameter and thickness are available to repair cylinder heads that are worn or damaged in the valve seat insert counterbore. The insert bore depth and inside diameter of the standard and oversize valve seat inserts are listed below. For complete instructions for machining the counterbore for oversize inserts, refer to the Alternative Repair Manual, Bulletin No. 3810310.

The Part No. 3376595 Valve Seat Insert Cutter Set consists of the oversize cutters listed on the following page.



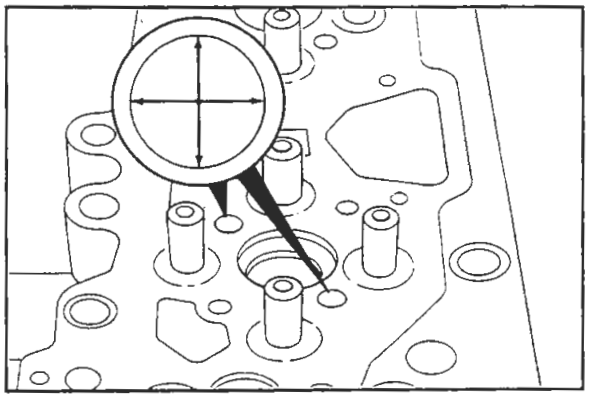
Valve Seat Inserts					
Valve Insert Part No.	Valve Seat Insert Cutter Part No.	Cylinder Head Valve Insert Bore Depth Nominal	Cylinder Head Valve Insert Bore Diameter Nominal	Valve Insert O.D. Oversize	Valve Insert Thickness Oversize
3027060		8.75 mm	45.920 mm	STD mm	STD mm
STD		0.344 in.	1.8079 in.	STD in.	STD in.
3028071	3376596	8.75 mm	46.170 mm	0.25 mm	STD mm
		0.344 in.	1.8177 in.	0.010 in.	STD in.
3028072	3376597	8.88 mm	46.420 mm	0.50 mm	0.13 mm
		0.349 in.	1.8276 in.	0.020 in.	0.005 in.
3028073	3376598	9.00 mm	46.670 mm	0.75 mm	0.25 mm
		0.354 in.	1.8374 in.	0.030 in.	0.010 in.
3028074	3376599	9.13 mm	46.920 mm	1.00 mm	0.38 mm
		0.359 in.	1.8472 in.	0.040 in.	0.015 in.



Cylinder Head - Replace Crosshead Guides (02-06)

Disassembly

Use the Part No. ST-1134 Dowel Puller (1) to remove the crosshead guides.



Inspection

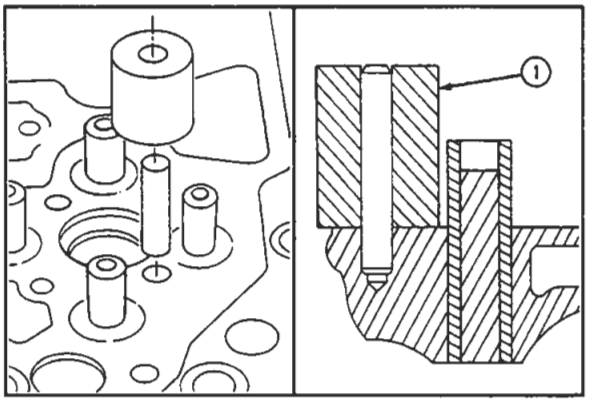
Measure the inside diameter of the crosshead guide bore in the cylinder head.

Guide Bore I.D.		
mm		in.
10.947	MIN	0.4310
10.972	MAX	0.4320

Note: If the crosshead guide bore does **not** meet the specifications given, the cylinder head can be repaired with an oversize replacement crosshead guide. Refer to the Alternative Repair manual, Bulletin No. 3810310.

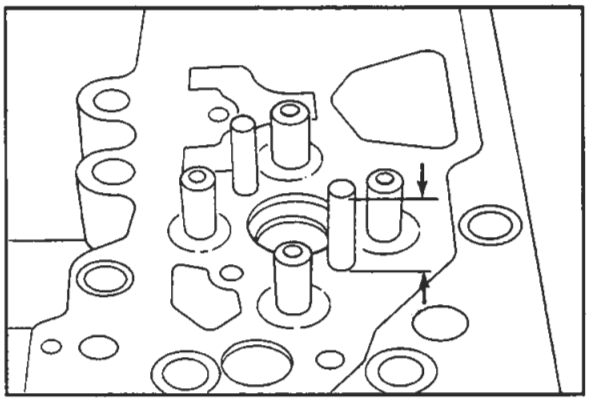
Assembly

Use the Part No. ST-633 Crosshead Guide Spacer (1) to install the new crosshead guide to the correct height.



Final Inspection

Measure the installed height of the crosshead guides.



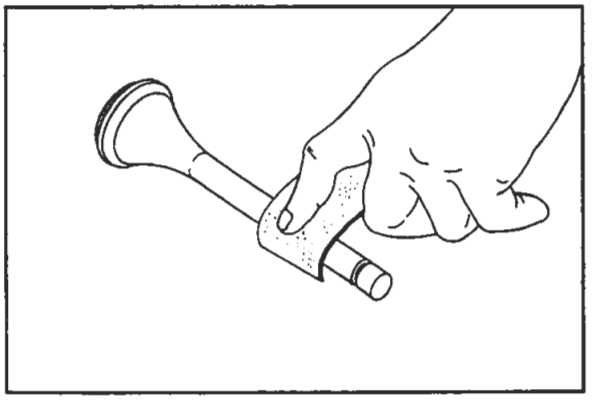
Crosshead Guide Height (Installed)		
mm		in.
47.25	MIN	1.860
47.75	MAX	1.880

Note: If the crosshead guide does **not** meet the specifications given, the guide **must** be removed and installed again.

Cylinder Head - Grind Valves (02-07)

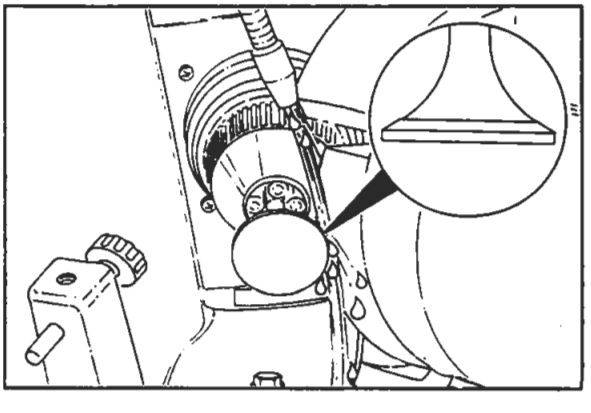
Use 240 grit, or finer, crocus cloth to clean the valve stems. Clean the carbon deposits from the valve face and head.

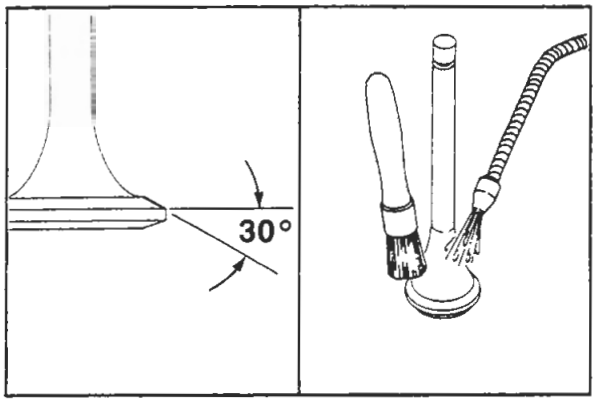
Note: The valves **must** be clean and free of carbon deposits before they are ground. Valves can be cleaned by the bead blasting method in the **head area only**.



Use the Part No. 3376256 Valve Facing Machine to grind the face of the valve.

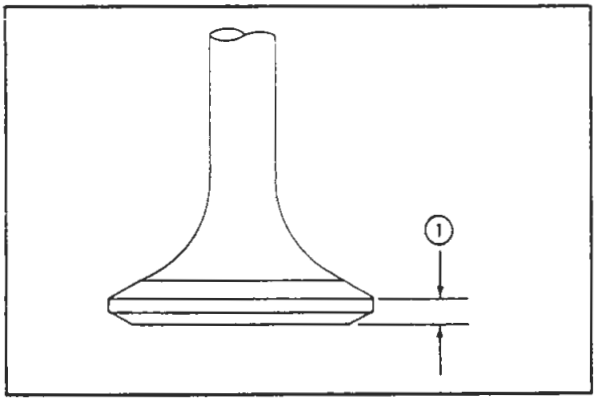
Note: Follow the instructions supplied with valve facing machine for the correct set up before grinding the valves.





Grind the intake and exhaust valves to the angle shown.

Use solvent to clean the metal particles from the valve. Dry with compressed air.

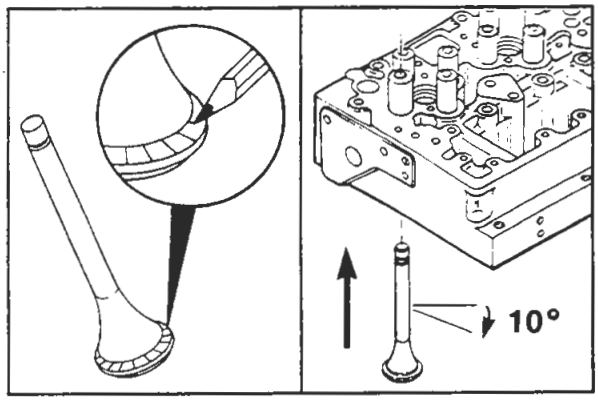


Inspection

Place the valve on a flat surface and measure the head thickness (1) at the outside diameter.

Head Thickness (at O.D.)		
mm		**in.**
3.15	MIN	0.124
3.62	MAX	0.143

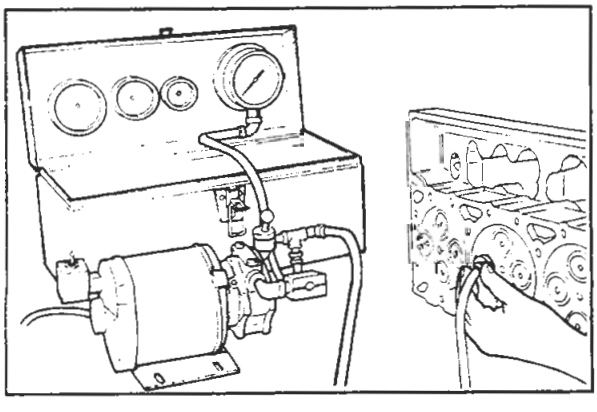
Note: If the valve head is worn thinner than minimum specified, the valve(s) **must** be replaced.



Use a lead pencil to mark across the valve face, as shown. Install the valve into the valve guide.

Hold the valve against the valve seat and rotate the valve at least 10 degrees. Correct contact against the valve seat will break the marks on the valve face.

Note: Valves and valve seats that are correctly machined **do not** require the use of lapping compound to make an air tight seal. If lapping compound is required, inspect the adjustments of the facing machine and the condition of the grinding stone.



Install the valves in the cylinder head. Refer to Cylinder Head - Rebuild - Assembly (02-02)

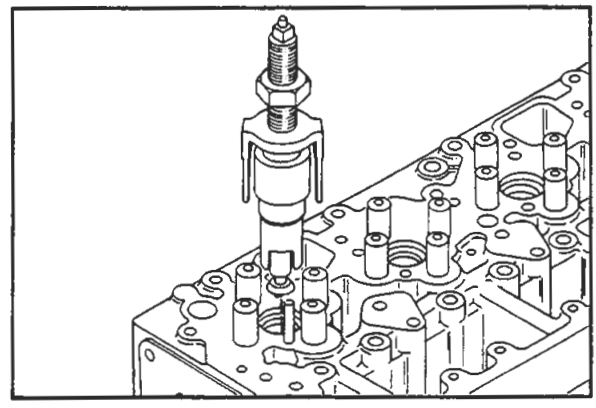
Use the Part No. ST-1257 Valve Vacuum Tester to vacuum test the valve seating. Refer to Cylinder Head - Vacuum Test Valve Seating (02-10).

Cylinder Head - Replace Injector Sleeves (02-08)

Disassembly

Use the Part No. 3376616 Injector Sleeve Puller to remove the injector sleeves from the cylinder head.

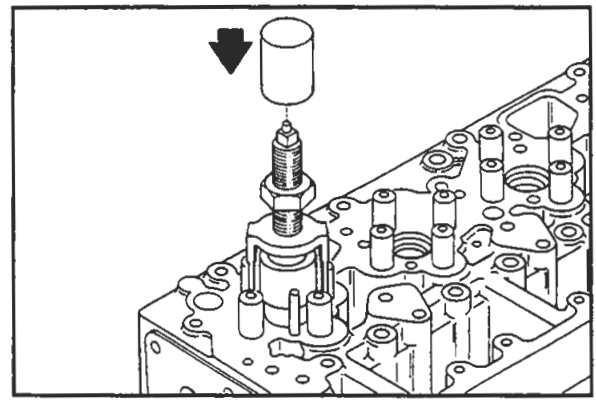
Install the puller into the injector sleeve with the legs of the bridge against the cylinder head.



Install the Part No. ST-1244-8 Driver against the large nut on the puller, as shown.

Hit the driver with a mallet to push the forming collar into the injector sleeve.

Remove the driver from the puller.

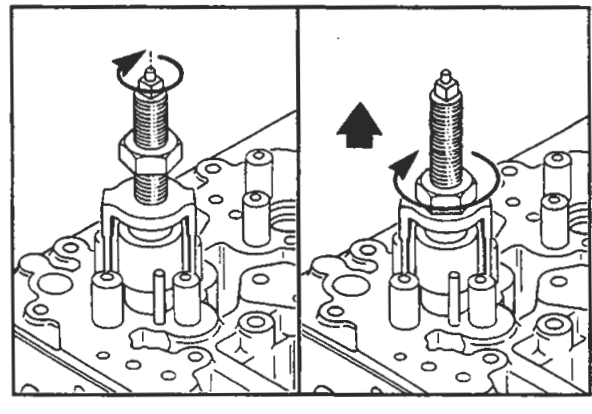


Tighten the small nut.

Torque Value: 65 N•m [50 ft-lb]

Turn the large nut clockwise to pull the injector sleeve from the cylinder head.

Loosen the nuts and remove the old injector sleeve from the puller.



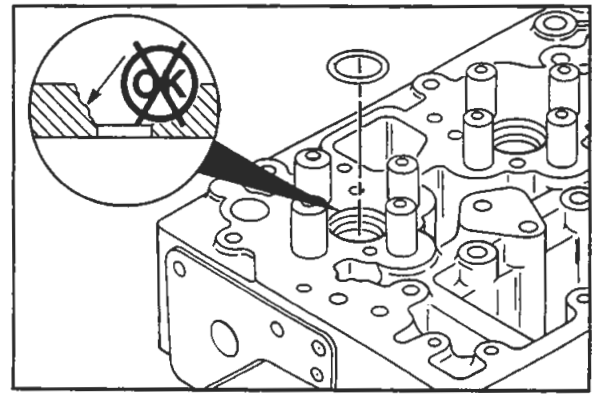
Inspection

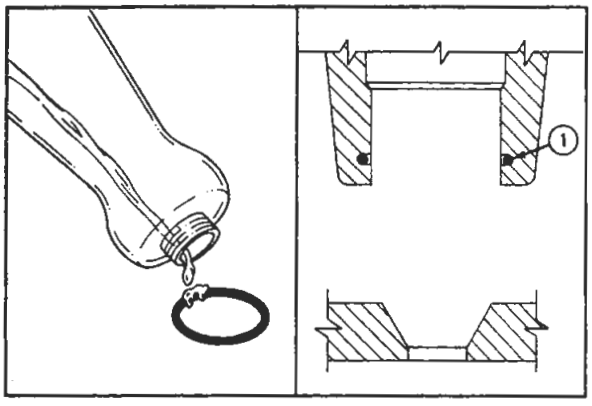
Remove the injector sleeve o-ring from the injector bore in the cylinder head. Discard the o-ring.

Use solvent to clean the injector bore. Dry with compressed air.

Visually inspect the injector seat surface in the bottom of the injector bore.

Note: If the bead in the cylinder head is **not** smooth the injector bore **must** be repaired. Refer to the Alternative Repair Manual, Bulletin No. 3810310.

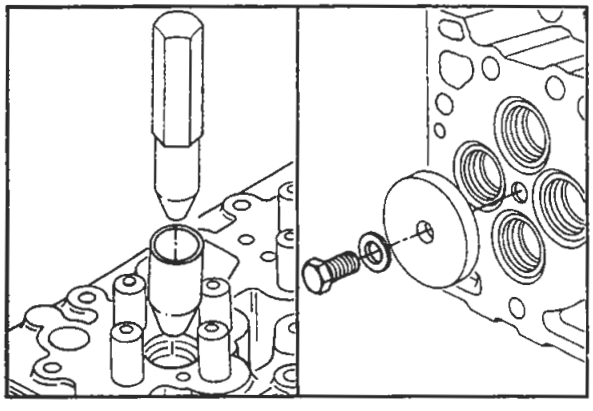




Assembly

Use vegetable oil to lubricate the injector sleeve o-rings.

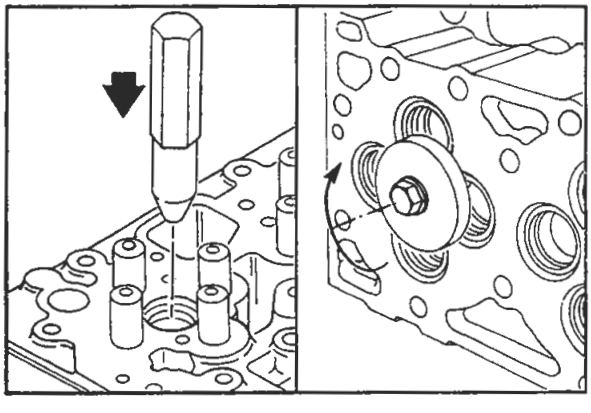
Install the o-ring (1) in the groove of the injector sleeve bore.



Use the Part No. ST-1227 Injector Sleeve Driver to install the injector sleeve into the cylinder head. Remove the sleeve driver.

Install the Part No. ST-1179 Injector Sleeve Holding Tool in the injector sleeve.

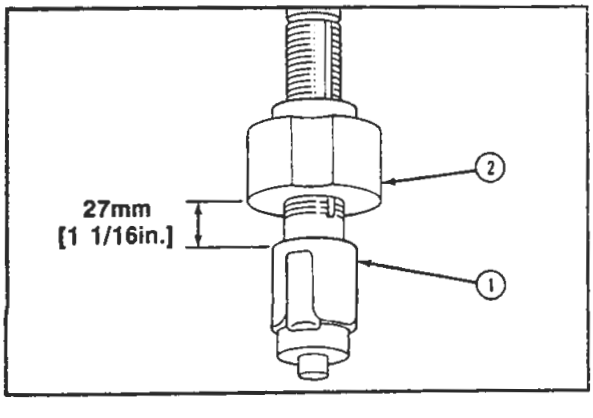
Torque Value: 50 N•m [38 ft-lb]



Install the injector sleeve driver and hit the driver with a mallet to seat the sleeve in the bore.

Remove the driver and tighten the injector sleeve holding tool capscrew again.

Torque Value: 50 N•m [38 ft-lb]



Use the Part No. ST-880 Injector Sleeve Expander to expand the upper section of the injector sleeve.

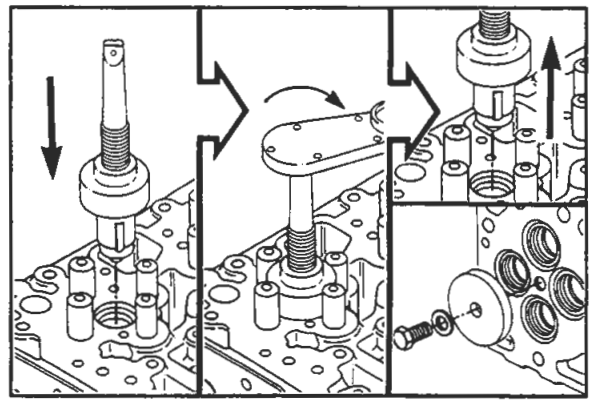
Adjust the expander roller edge (1) and collar (2) to the clearance specified.

Clearance: 27mm [1-1/16 in.].

Install the expander into the injector sleeve and turn the mandrel with an inch pound torque wrench.

Torque Value: 8.5 N•m [75 in-lb]

Remove the expander and holding tool from the injector sleeve.



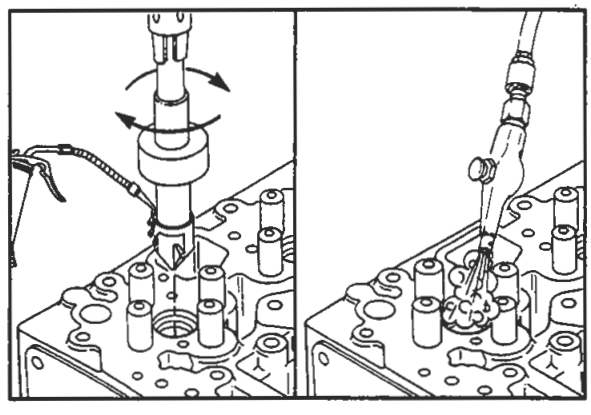
Use the Part No's. ST-379-2 Pilot, ST-844-1 Holder, and ST-844-3 Injector Seat Cutter to cut the injector seat.

Install the injector sleeve cutter and the cylinder head in a drill press.

Use a cutting oil to lubricate the cutter head.

Carefully machine the injector sleeve until the sealing area is smooth.

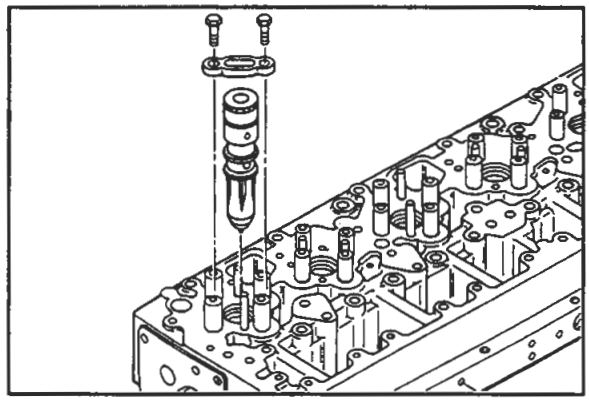
Clean the metal particles from the injector sleeve bore and fuel passages.



Caution: Support the cylinder head in the Part No. ST-583 Head Holding Fixture to prevent damage to the injector tip that protrudes from the combustion face.

Install the injector into the cylinder head without the o-rings.

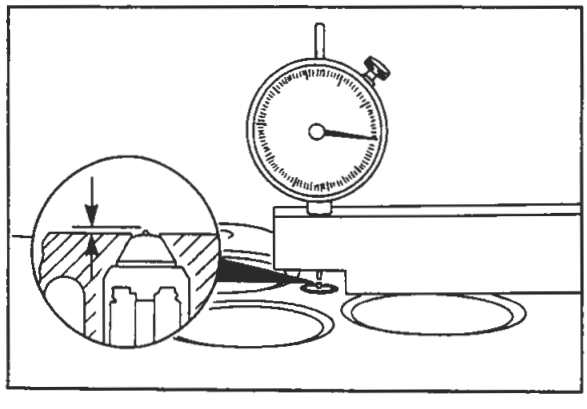
Torque Value: Step one - 5 N•m [45 in-lb]
Step two - 10 N•m [90 in-lb]
Step three - 15 N•m [130 in-lb]

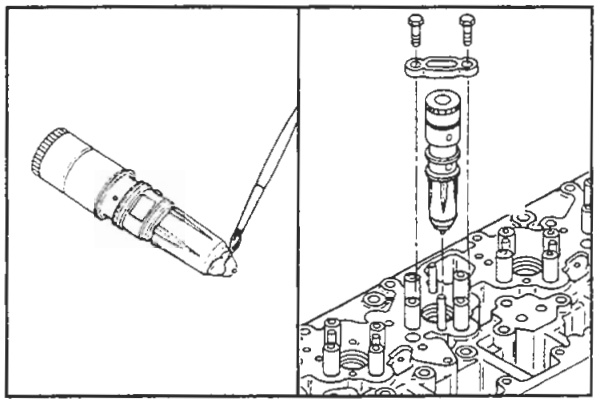


Turn the cylinder head over and use the Part No. 3376220 Gauge Block and Part No. ST-547-3 Indicator to measure the injector tip protrusion.

Injector Tip Protrusion		
mm		in.
2.28	MIN	0.090
2.54	MAX	0.100

Note: If the injector tip protrusion does **not** meet the specifications given, the injector sleeve **must** be machined again.



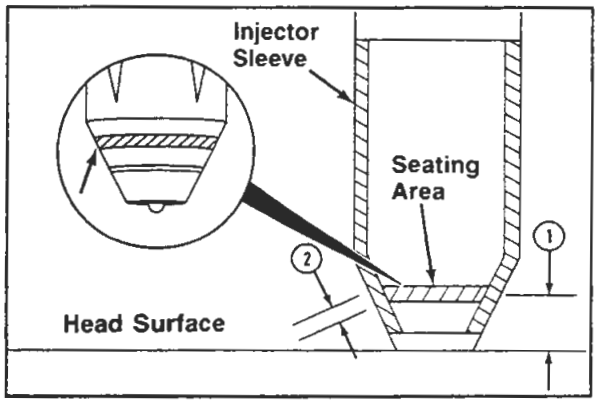


Remove the injectors and apply a bluing compound to the outside diameter of the injector at the injector seat area.

Install the injectors into the cylinder head **without** the o-rings.

Torque Value: Step one - 5 N•m [45 in-lb]
Step two - 10 N•m [90 in-lb]
Step three - 15 N•m [130 in-lb]

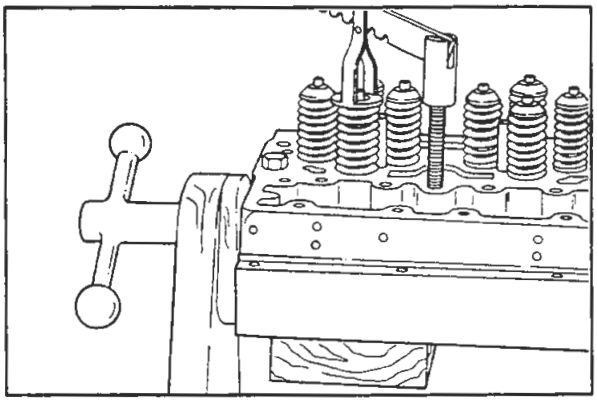
Remove the injectors from the cylinder head.



The bluing pattern of the injector seating area (1) **must** be approximately 13mm [0.50 inch] from the cylinder head surface.

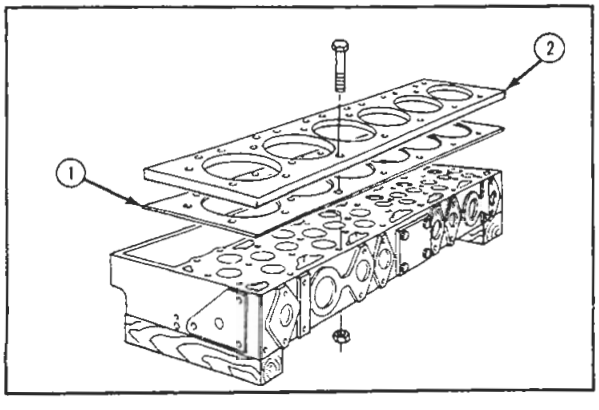
The injector bore seating width (2) **must** be a minimum of 1.52mm [0.060 inch].

Note: Inspect the cylinder head for leaks after the new injector sleeves have been installed. Refer to Cylinder Head - Pressure Test for Reuse (02-09).



Cylinder Head - Pressure Test for Reuse (02-09)

Caution: Do not pressure test the cylinder head with the valves and valve springs installed. Water entering the cylinder head cannot be dryed thoroughly and will damage the valve guides and valve stems. Refer to Cylinder head - Rebuild - Disassembly (02-02)



Use the Part No. 3376082 Cylinder Head Water Test Fixture.

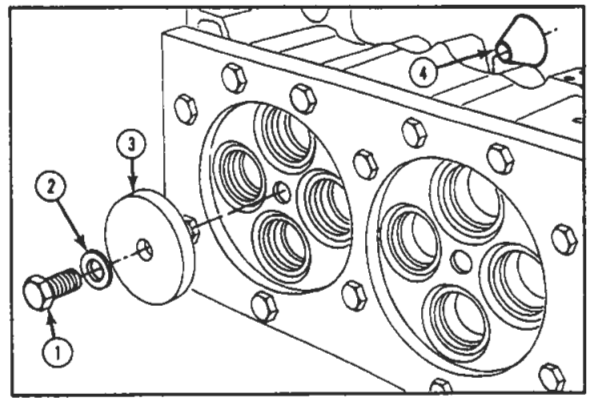
Install the Part No. 3376084 Gasket (1) and the Part No. 3376658 Test Plate (2).

Install the cylinder head capscrews and nuts.

Torque Value: 45 N•m [35 ft-lb]

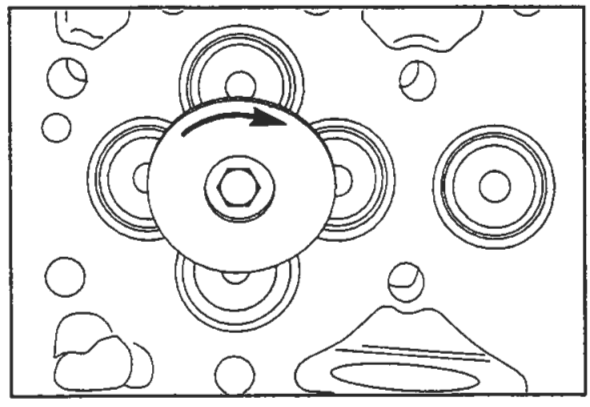
Use six of the Part No. ST-1179 Injector Sleeve Holding Tools.

Install the capscrew (1), flat washer (2), Part No. ST-179-4 Anvil (3), and Part No. ST-1179-2 Mandrel (4) in each injector bore as shown.



Tighten the injector sleeve holding tool capscrews.

Torque Value: Step one - 5 N•m [45 in-lb]
Step two - 10 N•m [90 in-lb]
Step three - 15 N•m [130 in-lb]

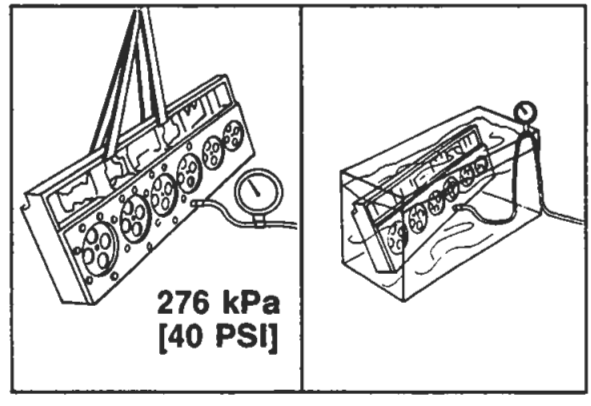


Connect a regulated air supply hose to test fixture plate.

Air Pressure: 276 kPa [40 psi]

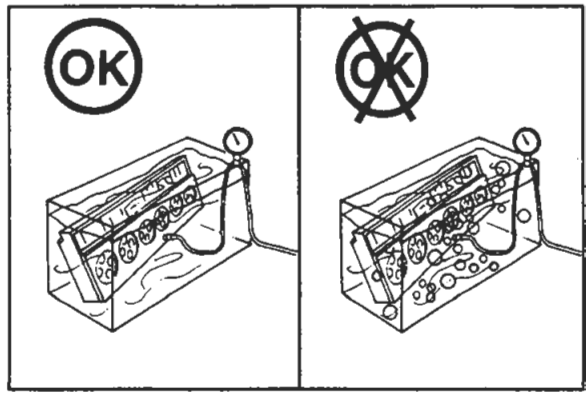
Completely submerge the cylinder head in a tank of warm water.

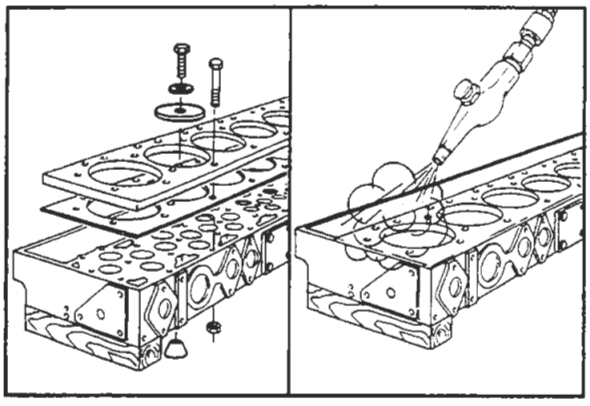
Temperature: 60°C [140°F]



Visually inspect the cylinder head for air leakage.

If air is leaking into the water the cylinder head **must** be replaced or rebuilt. Refer to Cylinder Head - Rebuild (02-02)

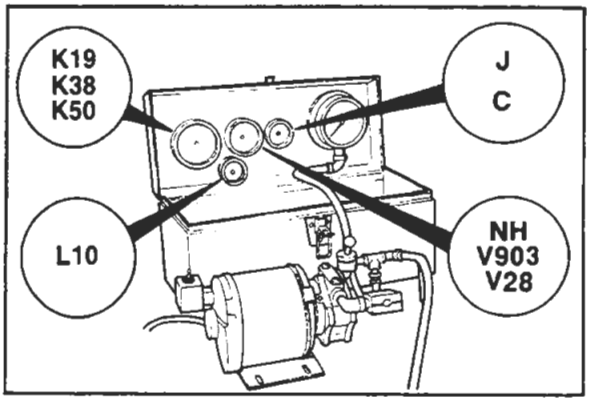




Remove the test equipment.

Use compressed air to dry the cylinder head.

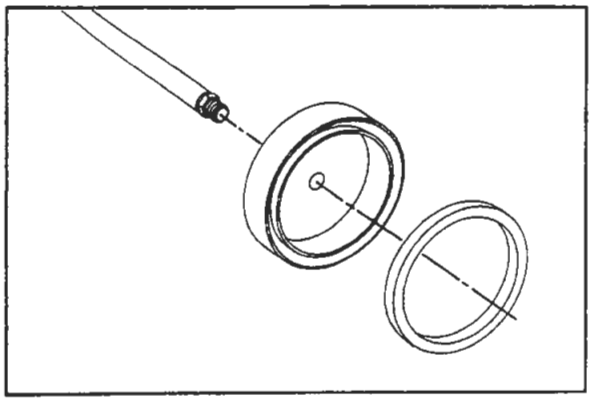
Assemble the cylinder head. Refer to Cylinder Head - Rebuild - Assembly (02-02).



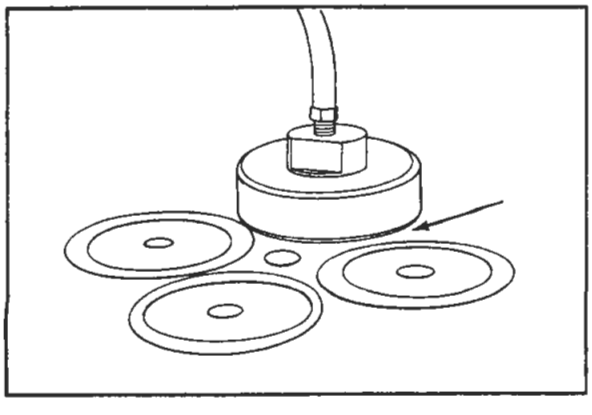
Cylinder Head - Vacuum Test Valve Seating (02-10)

Use the Part No. ST-1257 Valve Vacuum Tester to inspect the seal between the valve and the valve seat.

Note: The valve vacuum tester can be used to test all Cummins engine models. The Part No's. ST-1257-35 Seal Ring and 3376100 Vacuum Cup are used on the L10 cylinder heads.



Install the seal ring and vacuum cup to the vacuum line (hose).



Note: The valves and valve seats **must** be clean and dry when vacuum testing.

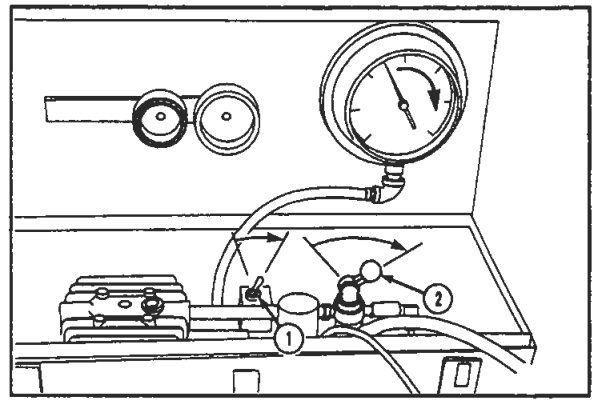
Cover the valve with the cup and seal.

Note: The seal **must** make a tight contact on the cylinder head around the valve.

Move the toggle switch (1) to the "ON" position.

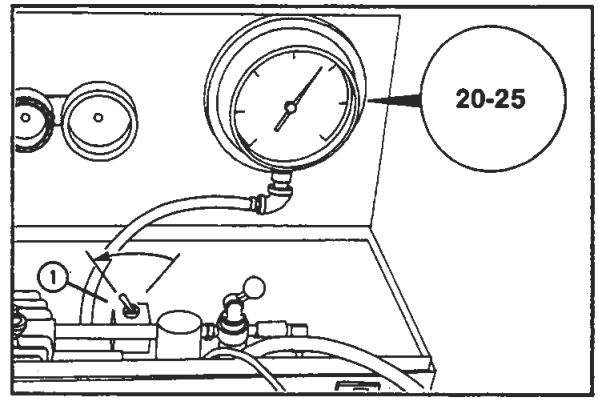
Turn the vacuum control valve (2) to the "OPEN" position.

Note: The vacuum control valve is in the "OPEN" position if the vacuum gauge needle moves clockwise.



Operate the vacuum pump until the gauge indicates the specified vacuum.

Valve to Valve Seat Vacuum		
mm-Hg.		in.Hg.
508	MIN	20
685	MAX	25

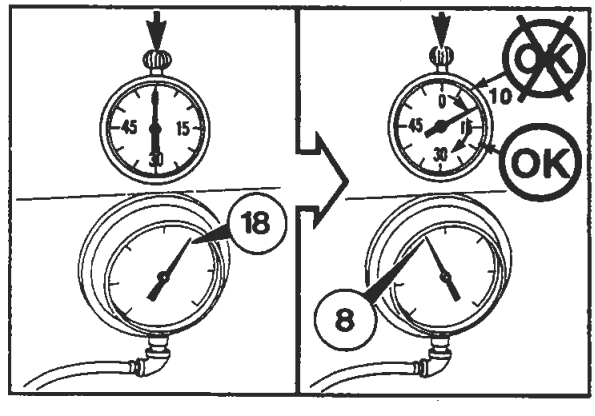


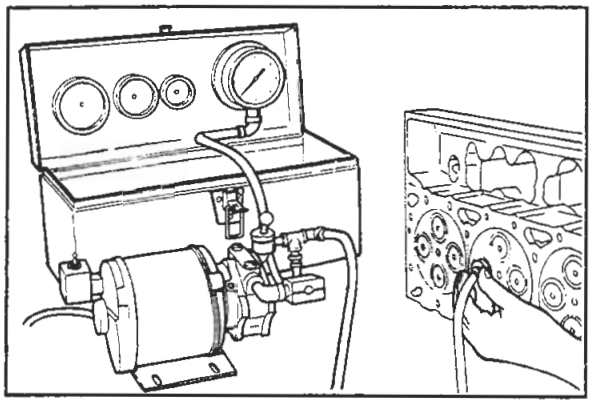
Turn the toggle switch (1) to the "OFF" position.

Use a stopwatch and start timing when the needle on the gauge indicates 457mm-Hg [18 in.Hg].

Stop timing when the needle on the gauge indicates 203mm Hg [8 in.Hg].

The elapsed time for the needle to move between the specified gauge readings **must** be 10 seconds or more.

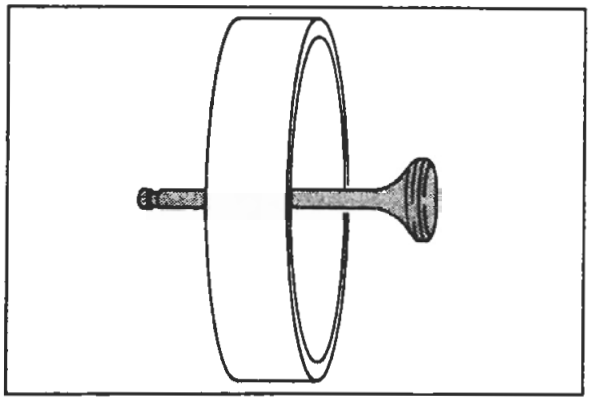




If the elapsed time is **less** than 10 seconds perform the following checks:

- Repeat the test to be sure the equipment is operating properly.
- Use a mallet to hit the valve stem lightly to make sure the valve is seated. Repeat the test.
- Apply a thin layer of grease on the outside diameters of the insert and the valve head. Repeat the test. The grease pattern will show the point of leakage.

Note: A break in the grease seal pattern will indicate leakage between the valves and valve seat or the valve seat insert and the cylinder head. Refer to Cylinder Head - Rebuild (02-02).

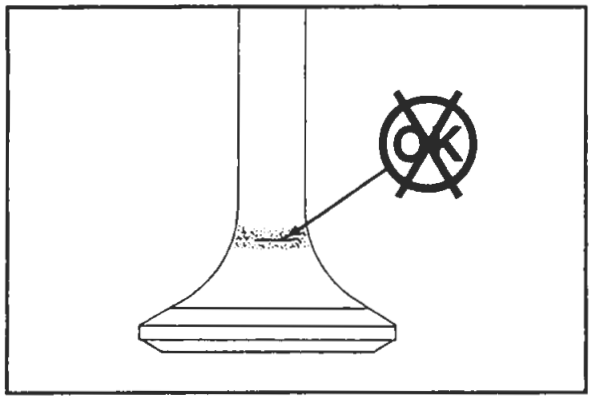


Cylinder Head - Valves - Magnetic Crack Inspection (02-11)

Use the magnetic particle residual method to inspect the valves for cracks.

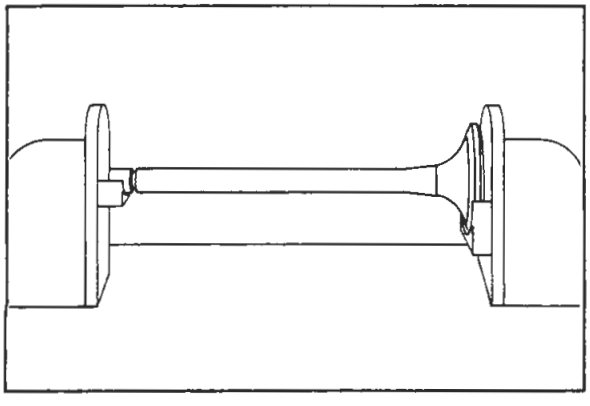
Note: The exhaust valves contain two types of metal and **must** be inspected by the coil shot method. There will be a magnetic leakage apparent at the point where the two metals are welded together. The leakage will appear as a wide pattern of magnetic particles.

Magnetize the valves in a coil of 100 to 200 amperes.



Inspect the valves with residual magnaglo.

Note: A broad fuzzy pattern will appear at the welded joint on the exhaust valves. If there is a distinct line in the pattern, the valve **must** be replaced.



Note: The intake valves contain only one type of metal and **must** be magnetized and inspected in two directions. Use the magnetic coil method and inspect with residual magnaglo the same as exhaust valves.

Magnetize the intake valves again with a headshot at 500 to 700 amperes.

Inspect the valves again with residual magnaglo.

Acceptance Criteria (Exhaust and Intake Valves)

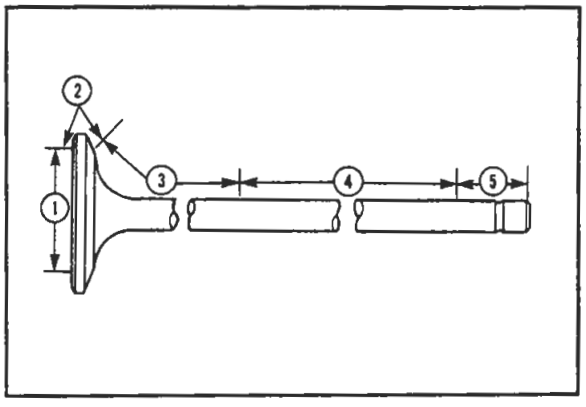
Area (1), **no** indication longer than 12.70mm [0.500 inch].

NOTE: There **must** be no more than five indications or no indications closer together than 3.18mm [0.125 inch].

Areas (2, 3, 4 and 5) **must not** have any magnetic indications or visible indications.

NOTE: "Visible" means an indication of a crack can be seen through a three power magnifying glass after the magnetic particle suspension is removed.

Remove all magnetism and clean the acceptable valves.

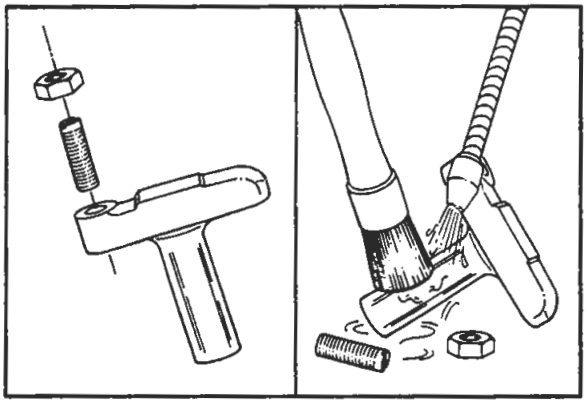


Valve Crosshead - Clean and Inspect for Reuse (02-12)

Disassembly

Remove the adjusting screw and lock nut.

Use solvent to clean the parts. Dry with compressed air.



Inspection

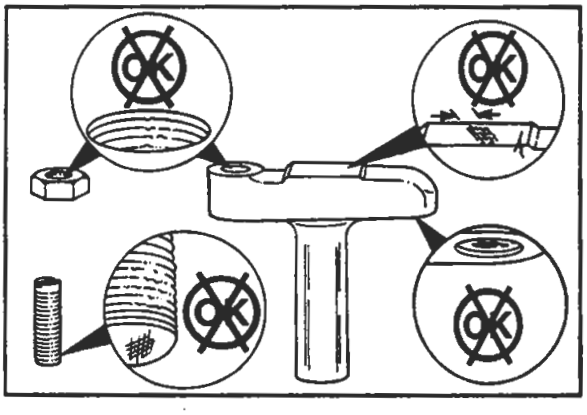
Visually inspect the rocker lever contact pad for wear, cracks or damage.

NOTE: Wear in the pad contact area **must** not exceed 7mm [1/4 inch] in width.

Visually inspect the valve stem contact area for damage.

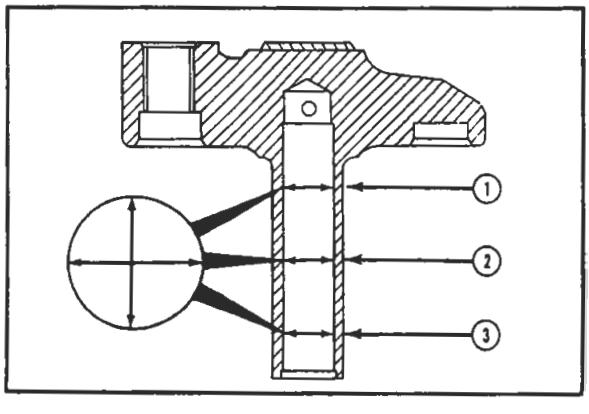
Visually inspect the nut, adjusting screw and crosshead for damaged or distorted threads.

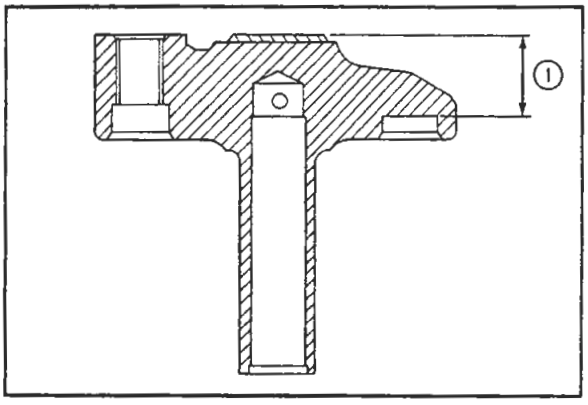
Visually inspect the contact area of the adjusting screw for excessive wear.



Measure the inside diameter of the crosshead stem bore in locations (1, 2 and 3).

Stem Bore I.D.		
mm		In.
11.037	MIN	0.4345
11.175	MAX	0.4400

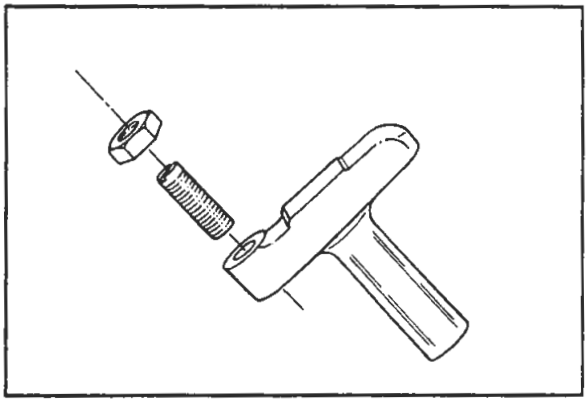




Measure the valve stem pocket depth from the valve stem pocket to the rocker pad face (1).

Stem Pocket to Pad Face		
mm		in.
10.55	MIN	0.415
11.05	MAX	0.435

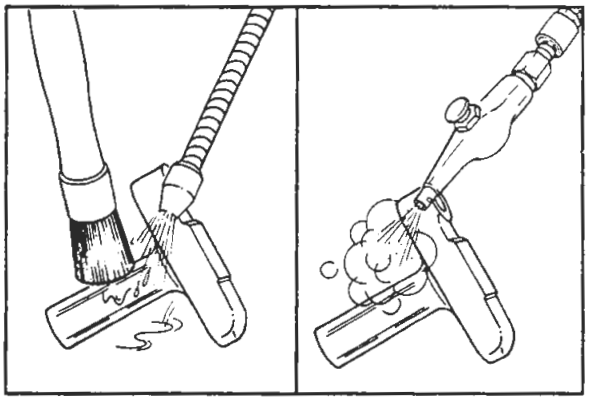
Note: If damaged parts are found or the stem bore or pocket depth are **not** within the limits specified the parts **must** be replaced. If cracks are suspected, refer to Valve Crosshead - Magnetic Crack Inspection (02-13).



Assembly

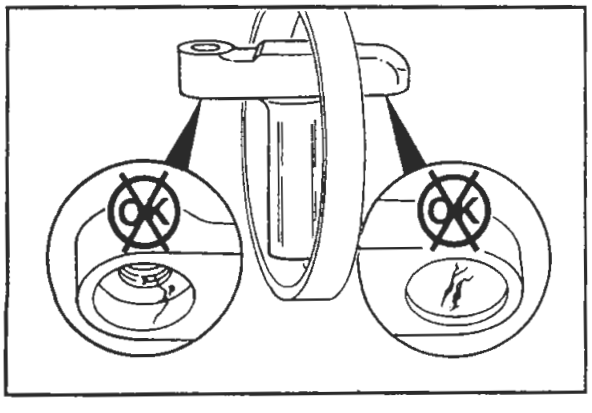
Install the adjusting screw and locknut.

Note: The adjusting screw **must** turn freely in the crosshead. Do **not** tighten the locknut until the crosshead has been installed and adjusted.



Valve Crosshead - Magnetic Crack Inspection (02-13)

Use solvent to clean the crossheads. Dry with compressed air.

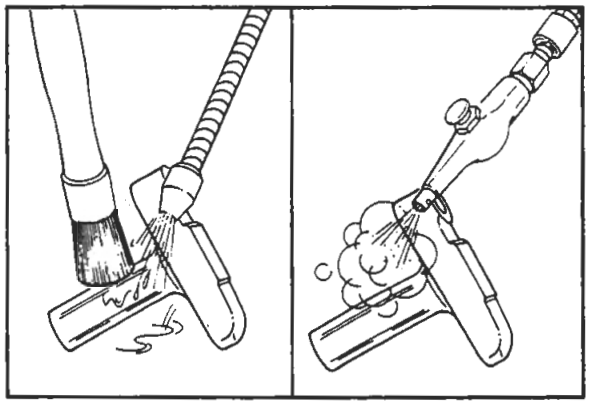


Magnetize the crosshead and inspect it with residual magnaglo.

Note: Cracks will be indicated by a bright line. The primary location for cracks will be the adjusting screw bore and the valve stem pocket area. If cracks are found, the crosshead **must** be replaced.

Remove all magnetism.

Use solvent to clean the crossheads. Dry with compressed air.

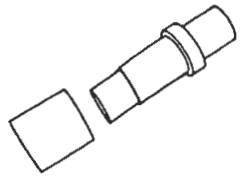
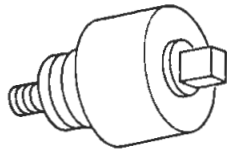


Rocker Levers - Group 03

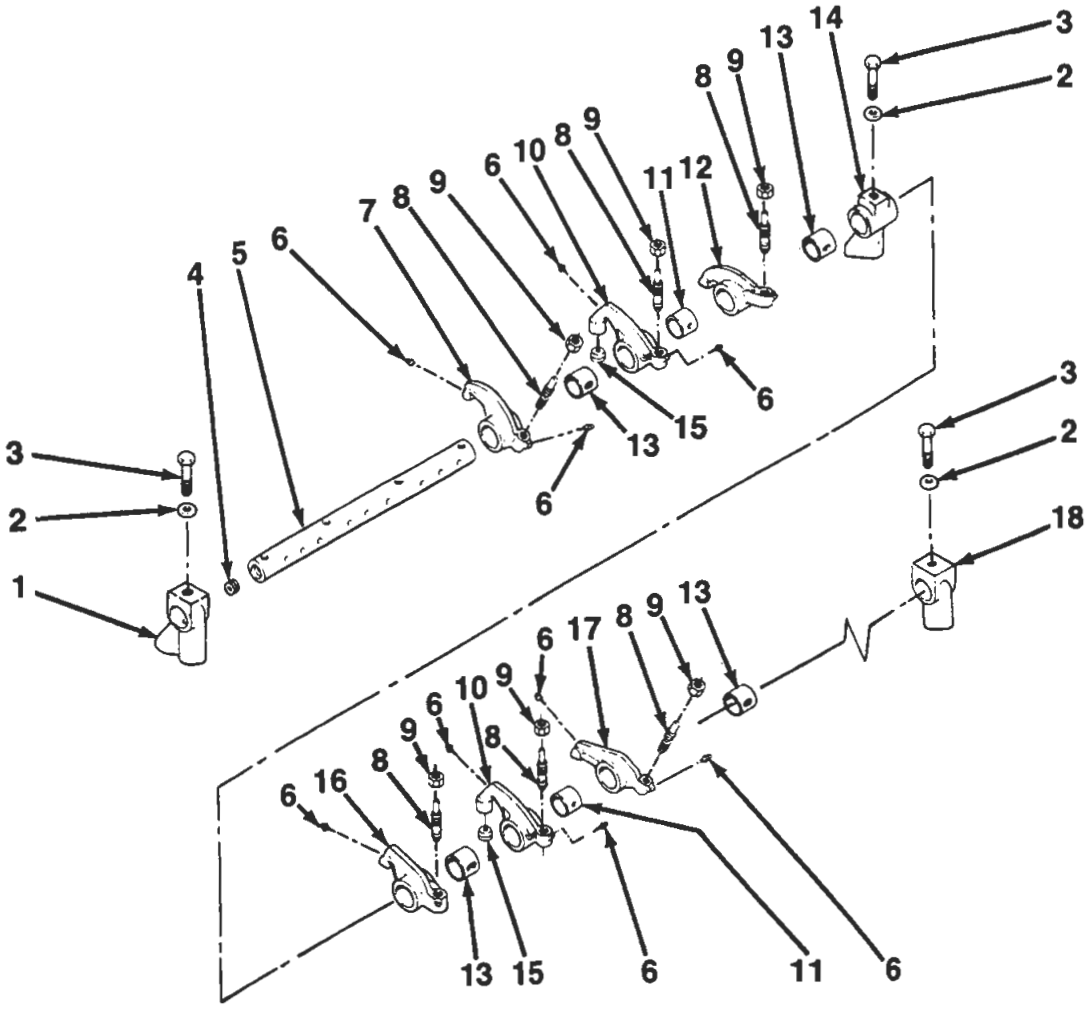
Contents

Rocker Levers - Service Tools

The following special tools are recommended to perform the procedures in Group 03. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

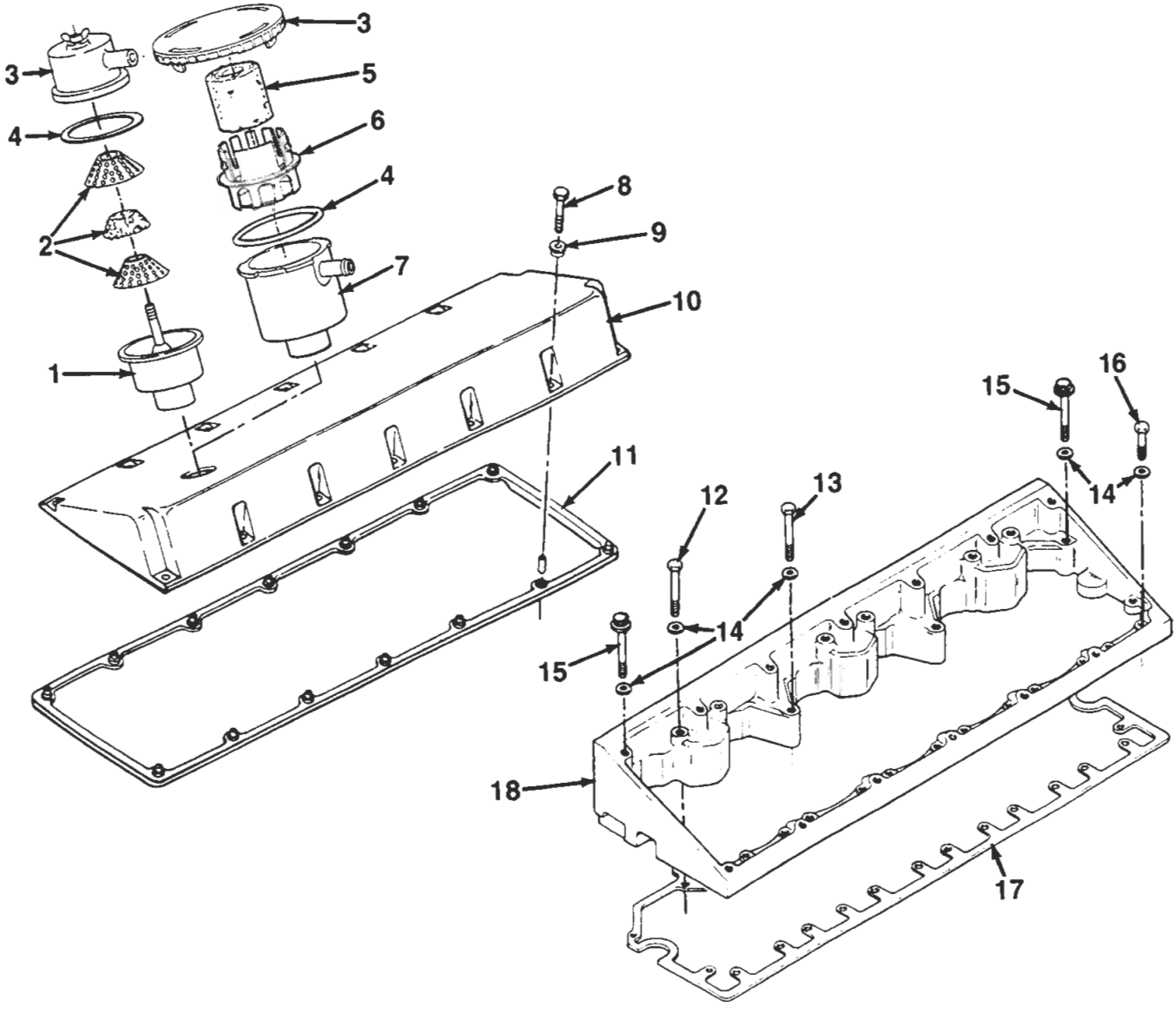
Tool No.	Tool Description	Tool Illustration
ST-1284	**Rocker Lever Bushing Mandrel** Install and remove the rocker lever bushings in the rocker levers.	
3822300	**Chassis Punch** Install the Compuchek® cycle event probe in the rocker lever cover.	

Rocker Levers - Exploded View



Ref. No.	Description	Qty.	Ref. No.	Description	Qty.
1	Support, Rocker Lever	2	10	Rocker Lever, Injector	6
2	Washer, Plain	8	11	Bushing, Injector Rocker Lever	6
3	Capscrew	8	12	Rocker Lever, Intake	3
4	Plug, Drive	4	13	Bushing, Rocker Lever	12
5	Shaft, Rocker Lever	2	14	Support, Rocker Lever	4
6	Rivet	33	15	Socket, Tappet	6
7	Rocker Levers, Exhaust	3	16	Rocker Lever, Intake	3
8	Screw, Slotted Set	18	17	Rocker Lever, Exhaust	3
9	Nut, Adjusting	18	18	Support, Rocker Lever	2

Rocker Lever Housing and Rocker Housing Cover - Exploded View



Ref. No.	Description	Qty.
1	Breather, Crankcase (Earlier Production Style)	1
2	Element, Crankcase Breather	1
3	Cover, Crankcase Breather	1
4	O-ring	1
5	Screen	1
6	Element, Crankcase Breather	1
7	Housing, Crankcase Breather (Present Production Style)	1
8	Capscrew	14
9	Isolator, Noise	14

Ref. No.	Description	Qty.
10	Cover, Rocker Housing	1
11	Gasket, Rocker Cover	1
12	Capscrew	6
13	Capscrew	2
14	Washer, Plain	24
15	Capscrew	2
16	Capscrew	14
17	Gasket, Rocker Lever Housing	1
18	Housing, Rocker Lever	1

Rocker Levers - General Information

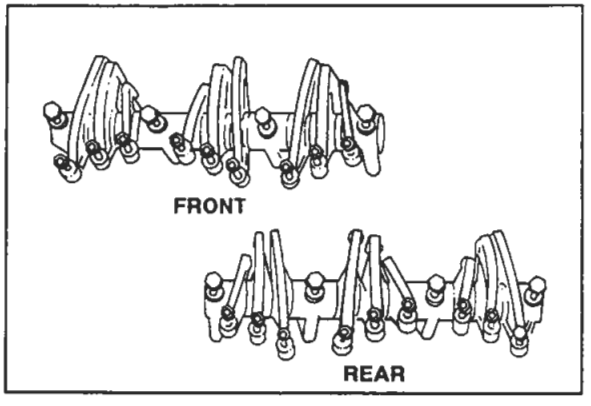
The rocker lever group consists of the rocker lever assembly, rocker lever housing, rocker housing cover, and the crankcase breather. The rocker levers contain replaceable bushings. Both the intake and exhaust rocker levers contain blind rivets to plug the oil drilling holes in the levers. The rocker lever pad on the intake and exhaust rocker levers is precision ground and **must not** be repaired.

Note: The present production style crankcase breather **cannot** be removed from the plastic rocker housing cover without damaging the cover.

Rocker Lever Assembly - Clean and Inspect for Reuse (03-01)

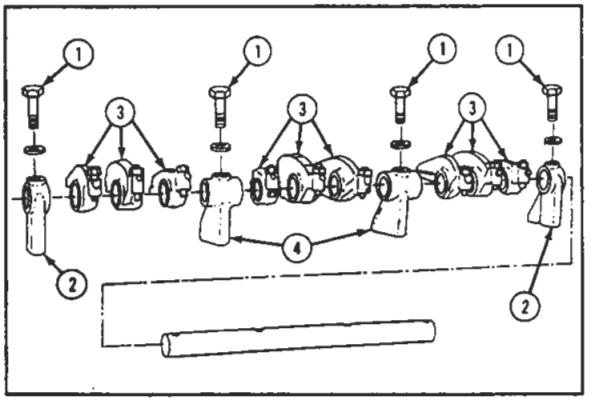
Disassembly

Note: Label the rocker lever shaft assemblies "front" and "rear" when they are removed from the engine. Label the rocker levers and supports with their relative position to each other as they are removed from the shafts. The rocker lever assemblies **must** be installed in the same position they were removed from.

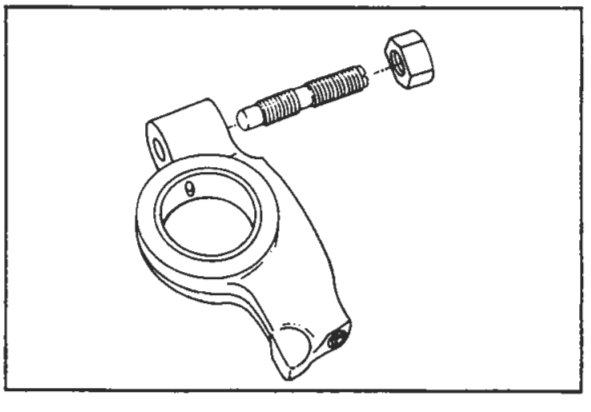


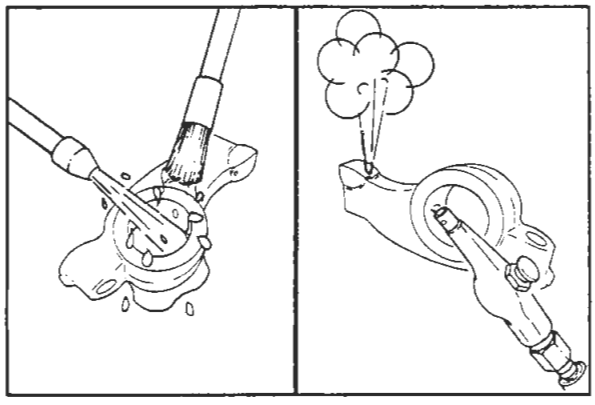
Remove the rocker shaft capscrews (1) and end supports (2).

Remove the rocker levers (3) and center supports (4) from both shaft assemblies.



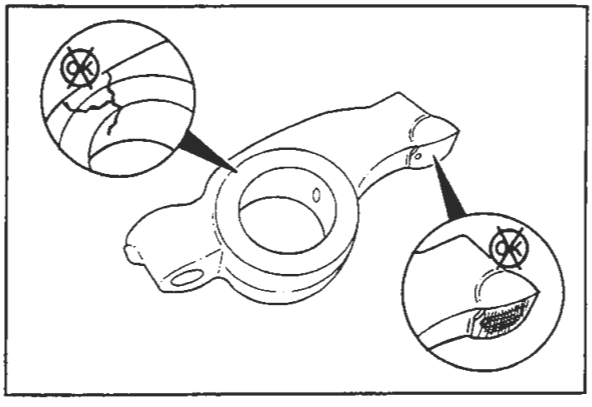
Remove the locknut and adjusting screw from each rocker lever.





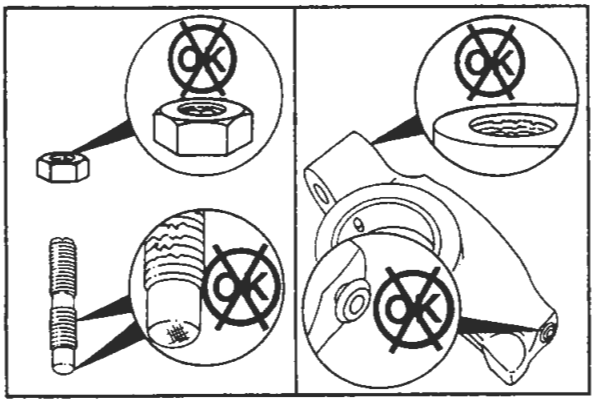
Use solvent to clean the parts. Dry with compressed air.

Use compressed air to make sure the oil passages are not blocked.



Inspection

Visually inspect the rocker levers for cracks, excessive pitting or unusual wear.

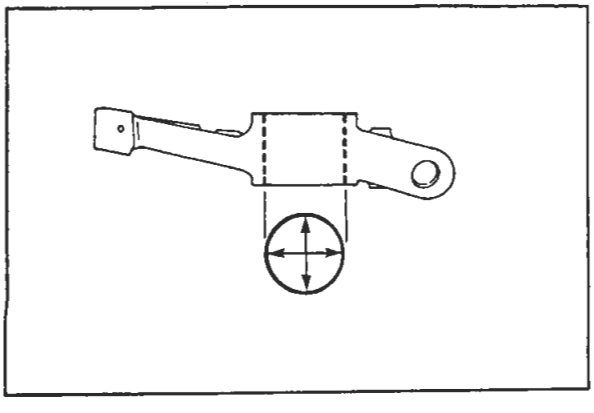


Visually inspect the adjusting screws and locknuts for damaged threads.

Visually inspect the adjusting screw threads in the rocker levers for damaged threads.

Visually inspect the rocker levers for loose rivets.

Visually inspect the adjusting screws for wear on the ball end.



Measure the inside diameter of the rocker lever bushing bore.

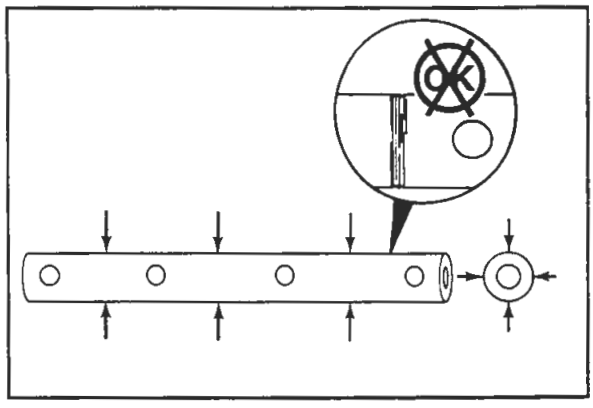
Rocker Lever Bushing Bore I.D.		
mm		in
34.887	MIN	1.3735
34.990	MAX	1.3776

Visually inspect the rocker lever shafts for pitting, scoring or other damage.

Measure the outside diameter of the rocker lever shafts.

Rocker Lever Shaft O.D.

mm		in
34.820	MIN	1.3709
34.863	MAX	1.3726

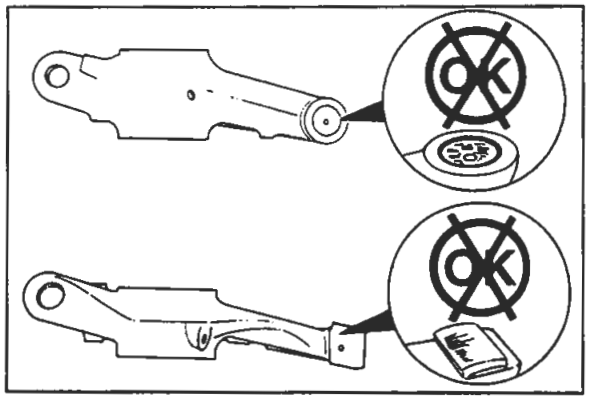


Note: If worn or damaged parts are found or the rocker lever bushings or shafts are **not** within the specifications given, the rocker lever assemblies **must** be rebuilt. Refer to Rocker Lever Assembly - Rebuild (03-02).

Visually inspect the sockets in the injector rocker levers for wear or damage.

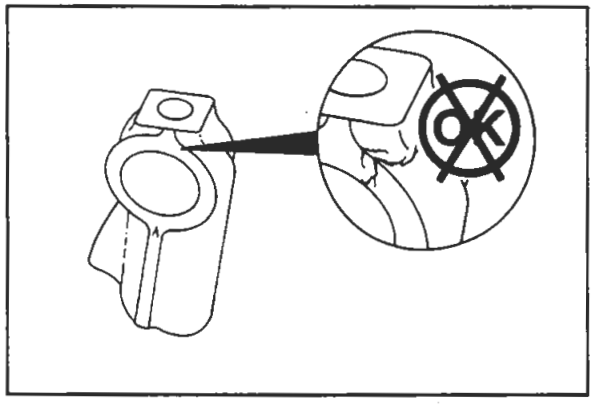
Visually inspect the valve rocker lever pads for wear, cracks or other damage.

Note: If wear, cracks or other damage is found, the rocker lever **must** be replaced.



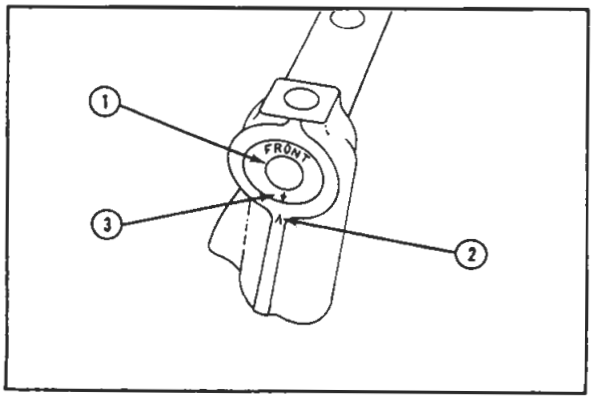
Visually inspect the rocker lever shaft supports for cracks or damage.

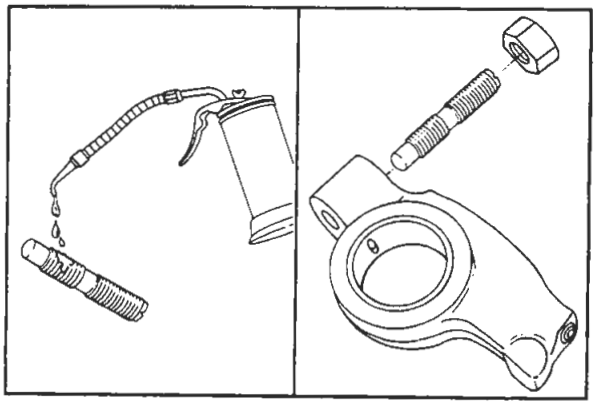
Note: If cracks or damage is found, the rocker lever shaft support **must** be replaced.



Assembly

Note: The rocker lever shafts are labeled "front" and "rear" on the ends of the shafts (1). The shaft end supports have arrows (2) on them to align with arrows (3) stamped on the ends of both rocker lever shafts. The arrows on the shafts and the shaft end supports **must** be aligned to align the oil passages. The shaft end supports are **not** interchangeable.

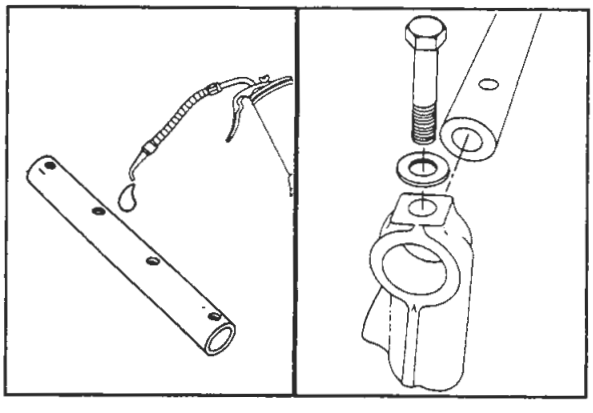




Use clean 15W-40 oil to lubricate the threads of the adjusting screws.

Install the adjusting screws into the rocker levers.

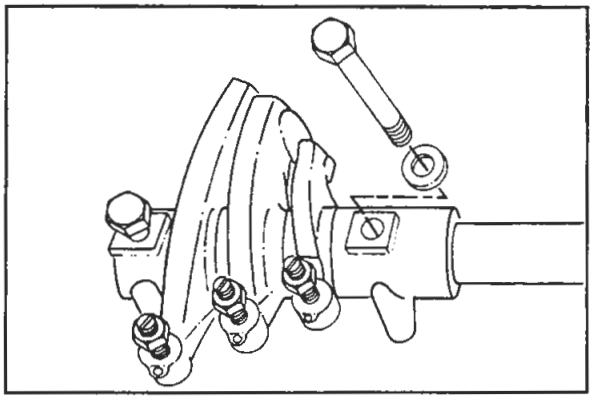
Install the locknuts on the adjusting screws.



Use clean 15W-40 oil to lubricate both rocker lever shafts.

Install the correct end support on each shaft.

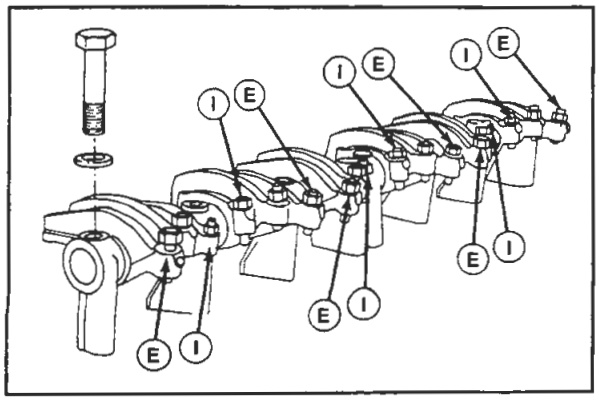
Install the washers and the support mounting capscrews through the end supports.



Install the rocker levers in the correct sequence as shown, on the front rocker lever shaft.

Install one of the two shaft center supports on the shaft.

Install the washer and the center support capscrew.



Install the remaining levers and the supports with the intake (I) and the exhaust (E) valve rocker levers in the correct position as shown.

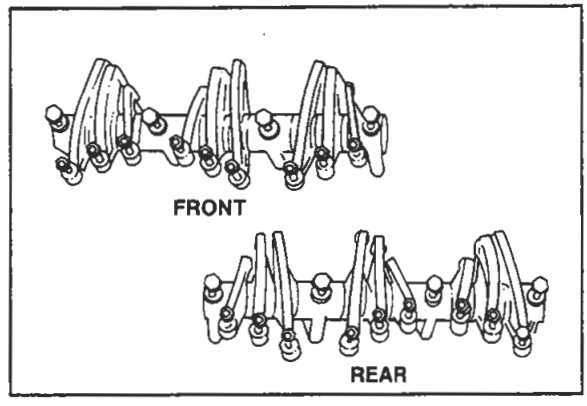
Install the washers and the support mounting capscrews.

Use the same procedure to install the rocker levers and supports on the rear shaft.

Rocker Lever Assembly - Rebuild (03-02)

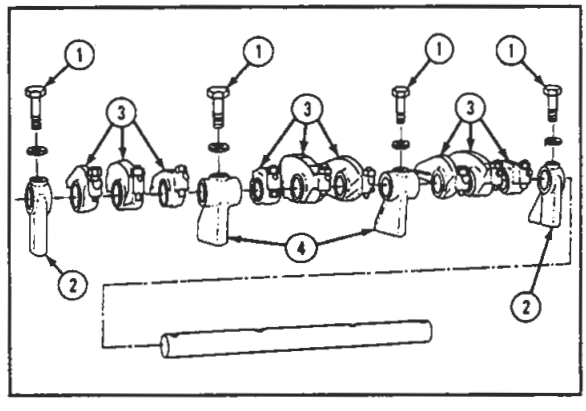
Disassembly

Note: Label the rocker lever shaft assemblies "front" and "rear" when they are removed from the engine. Label the rocker levers and supports with their relative position to each other as they are removed from the shafts. The rocker lever assemblies **must** be installed in the same position they were removed from.

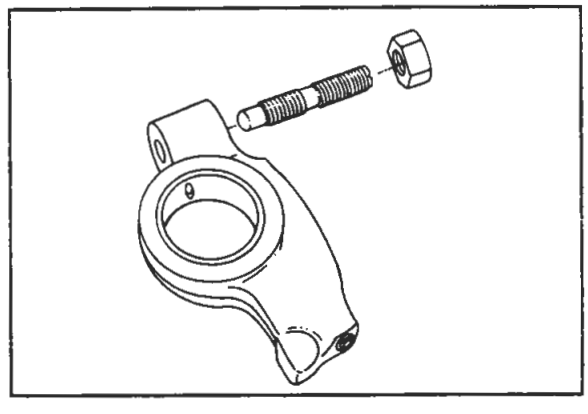


Remove the rocker lever shaft capscrews (1) and end supports (2).

Remove the rocker levers (3) and center supports (4) from both shaft assemblies.



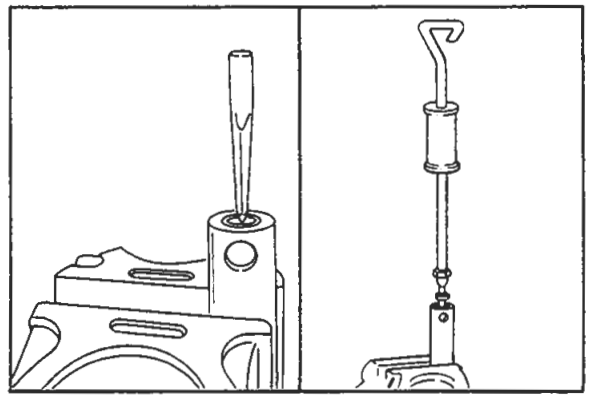
Remove the locknut and adjusting screw from each rocker lever.

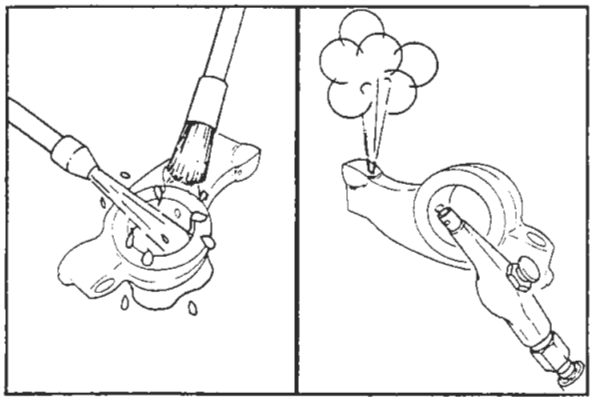


Install the rocker lever shafts in a vise with brass jaws.

Center punch the plugs in the ends of the shafts.

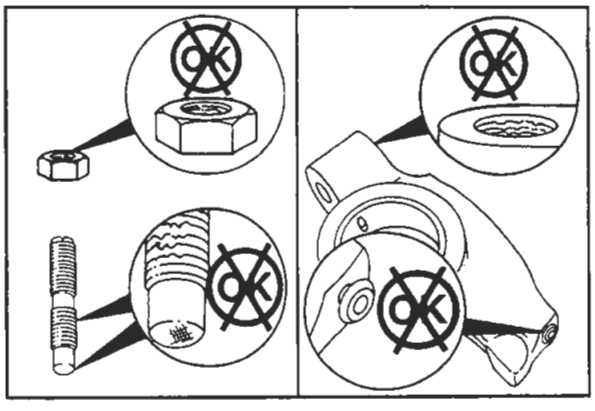
Drill a 1/8 inch hole in the plugs and use a standard dent puller to remove the plugs from the shafts.





Use solvent to clean the parts. Dry with compressed air.

Use compressed air to make sure the oil passages are **not** blocked.



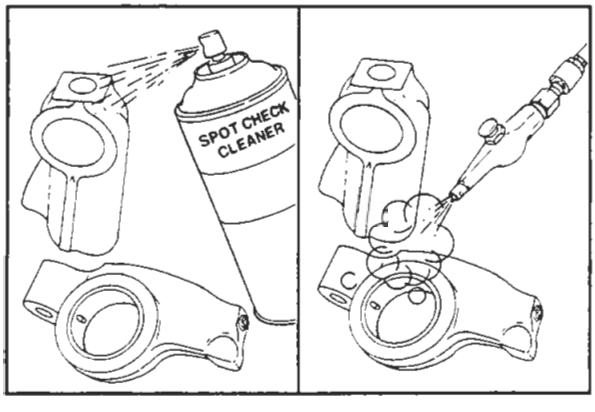
Inspection

Visually inspect the adjusting screws and locknuts for damaged threads.

Visually inspect the adjusting screw threads in the rocker levers for damaged threads.

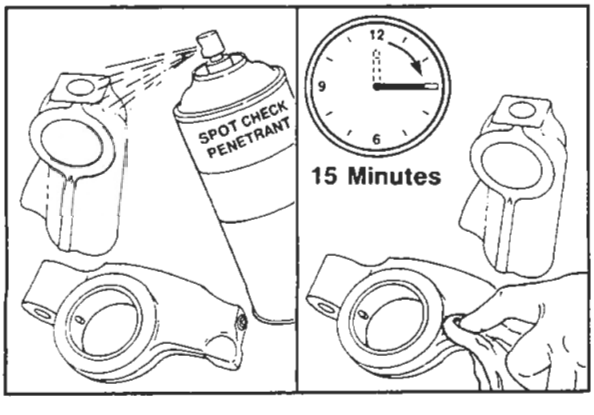
Visually inspect the rocker levers for loose rivets.

Visually inspect the adjusting screws for wear on the ball end.



Use the Part No. 3375432 Crack Detection Kit to inspect the rocker levers and rocker lever shaft supports for cracks.

Use the Part No. 3375433 Crack Detection Cleaner to clean the rocker levers and shaft supports. Dry with compressed air.



Use the Part No. 3375435 Crack Detection Penetrant to spray the rocker levers and shaft supports.

Note: Do **not** dry with compressed air.

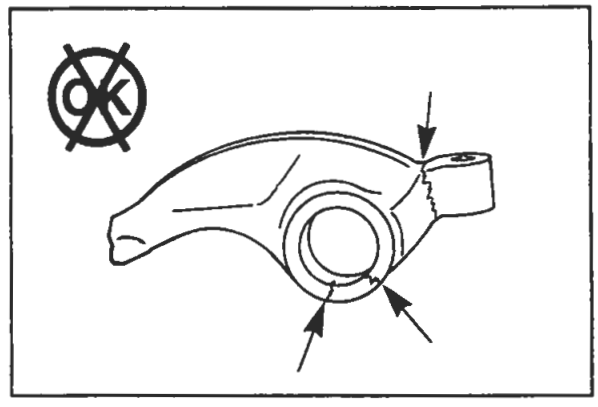
Allow the penetrant to dry for 15 minutes.

Remove the excess penetrant with a dry cloth.

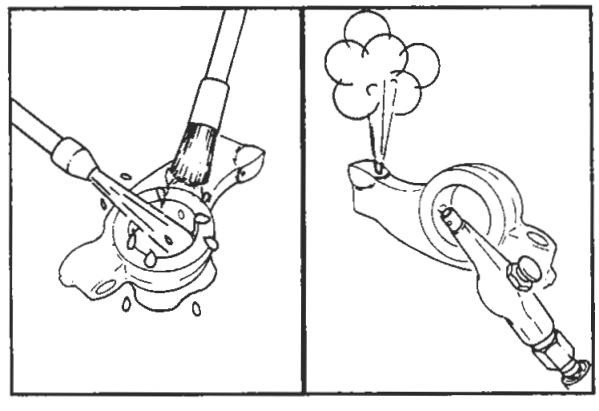
Use the Part No. 3375434 Crack Detection Developer to spray the rocker levers and shaft supports.

Visually inspect the levers and supports. Cracks will appear as a solid bright line.

Note: A crack in the casting will appear as a solid bright line. Cavitation in the casting will appear as a small round mark. If cracks or cavitation are found, the part **must** be replaced.



Use solvent to clean the serviceable levers and supports. Dry with compressed air.

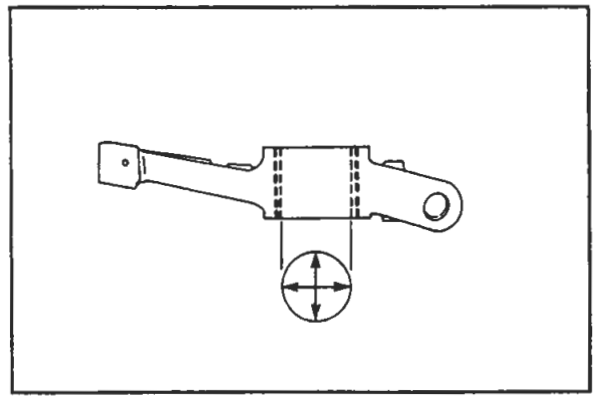


Measure the inside diameter of the rocker lever bushing bore.

Rocker Lever Bushing Bore I.D.

mm		in
34.887	MIN	1.3735
34.990	MAX	1.3776

Note: If the bushing is worn larger than the maximum specification it **must** be replaced. Refer to Rocker Lever Bushing - Replace (03-03).



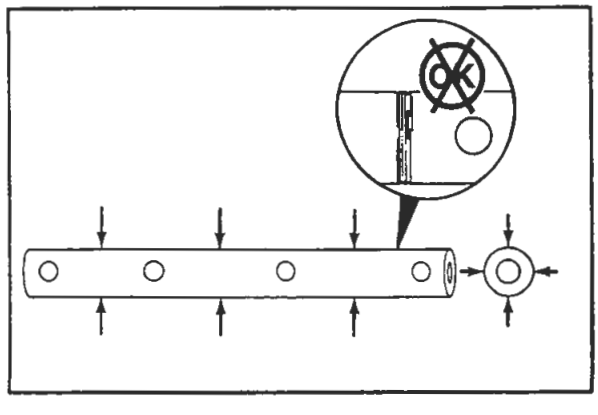
Visually inspect the rocker lever shafts for pitting, scoring or other damage.

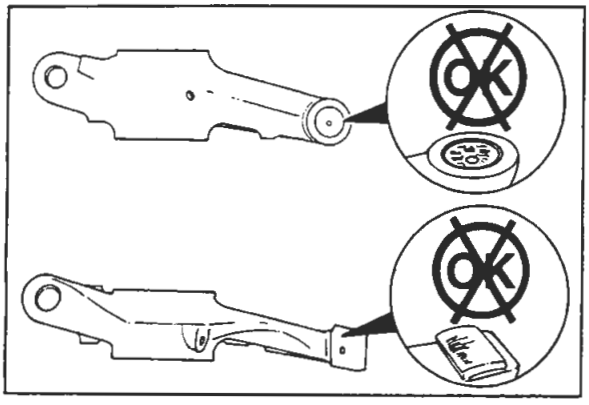
Measure the outside diameter of the rocker lever shafts.

Rocker Lever Shaft O.D.

mm		in
34.820	MIN	1.3709
34.863	MAX	1.3726

Note: If the shaft is damaged or worn smaller than the minimum specification, it **must** be replaced.

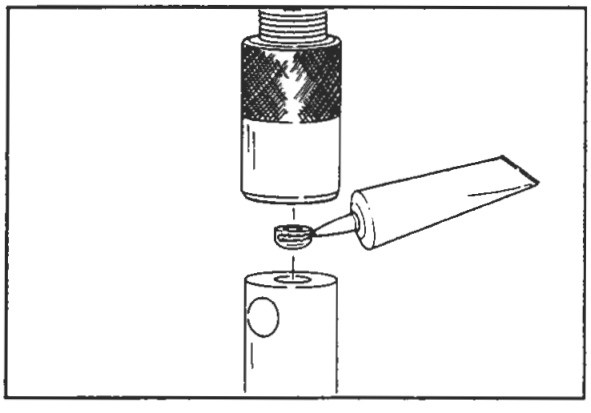




Visually inspect the sockets in the injector rocker levers for wear or damage.

Visually inspect the valve rocker lever pads for wear, cracks or other damage.

Note: If wear, cracks or other damage is found the rocker lever(s) **must** be replaced.

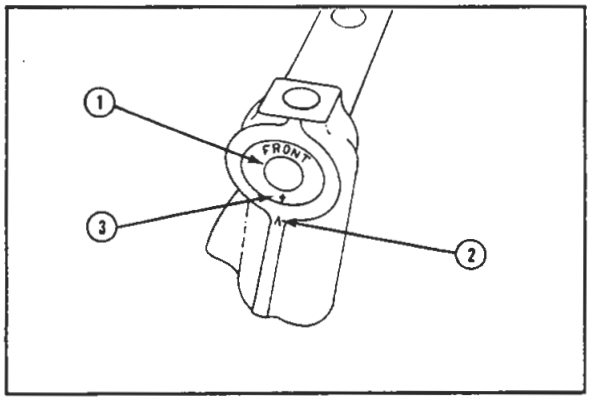


Assembly

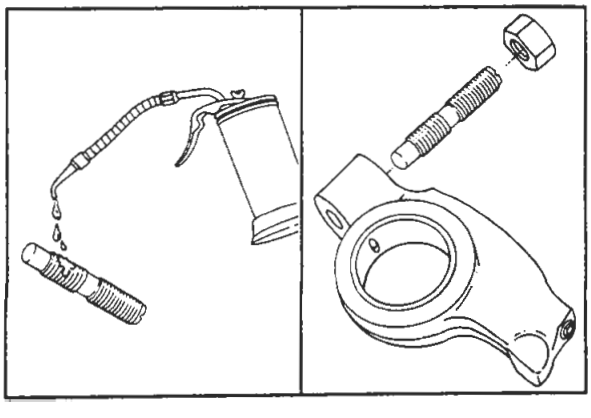
Apply a coat of Part No. 3375068 Cup Plug Sealant to the outside diameter of the drive plugs.

Install the shaft in an arbor press.

Push the plug into the shaft until it is level with the end of the shaft.



Note: The rocker lever shafts are labeled "front" and "rear" on the ends of the shafts (1). The shaft end supports have arrows (2) on them to align with arrows (3) stamped on the ends of **both** rocker lever shafts. The arrows on the shafts and the shaft supports **must** be aligned to align the oil passages. The shaft end supports are **not** interchangeable.



Use clean 15W-40 oil to lubricate the threads of the adjusting screws.

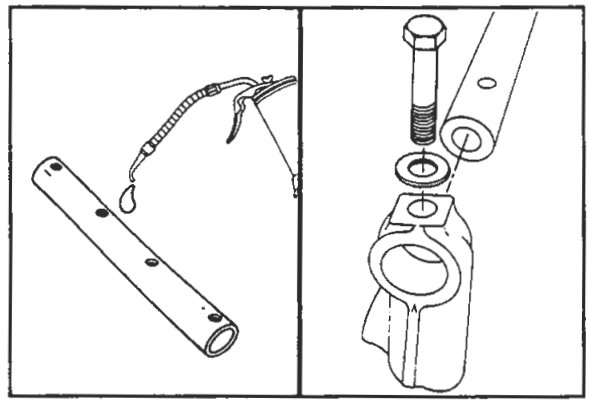
Install the adjusting screws into the rocker levers.

Install the locknuts on the adjusting screws.

Use clean 15W-40 oil to lubricate both rocker lever shafts.

Install the correct end support on each shaft.

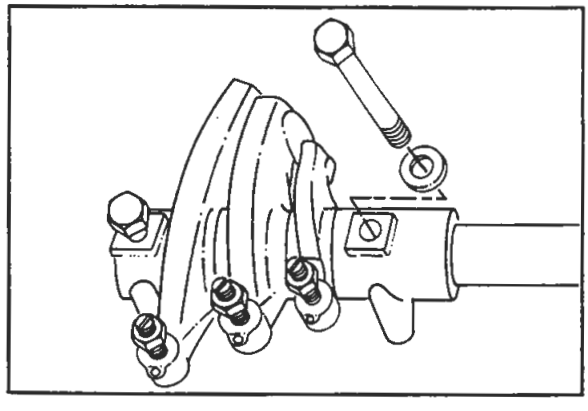
Install the washers and support mounting capscrews through the end supports.



Install the rocker levers in the correct sequence as shown, on the front rocker lever shaft.

Install one of the two shaft center supports on the shaft.

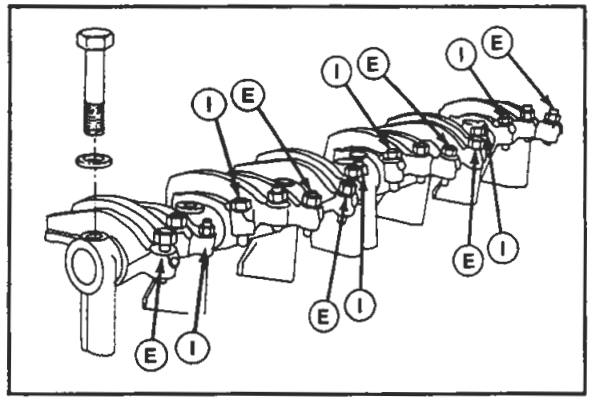
Install the washer and center support capscrew.



Install the remaining levers and supports with the intake (I) and the exhaust (E) valve rocker levers in the correct position as shown.

Install the washers and support mounting capscrews.

Use the same procedure to install the rocker levers and supports on the rear shaft.

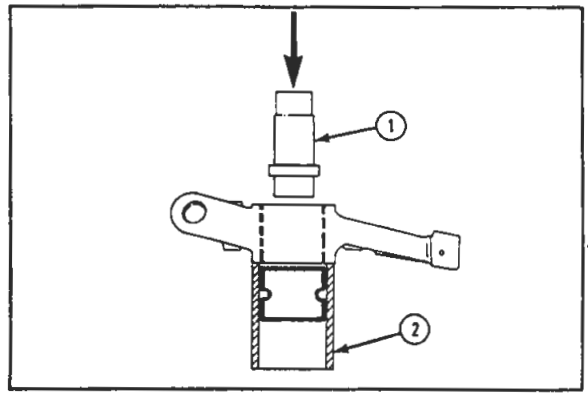


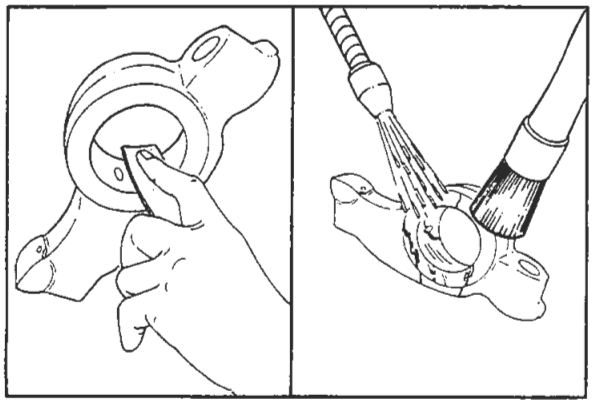
Rocker Lever Bushing - Replace (03-03)

Disassembly

Install the rocker lever in an arbor press.

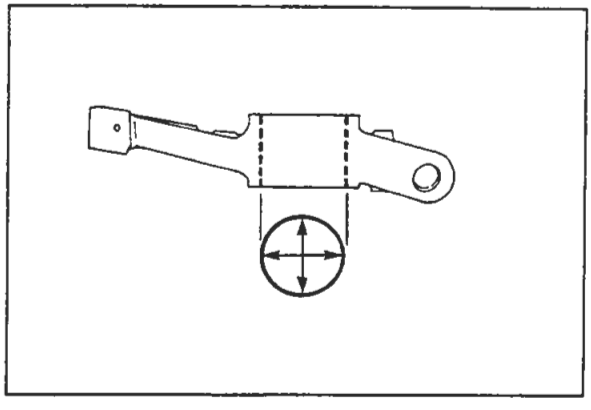
Use the Part No. ST1284 Rocker Lever Bushing Mandrel (1) and a support (2) to push the bushing out of the rocker lever.





Use a 240 grit, or finer, emery cloth to remove any rough edges or burrs from the bore of the rocker lever.

Use solvent to clean the rocker levers. Dry with compressed air.



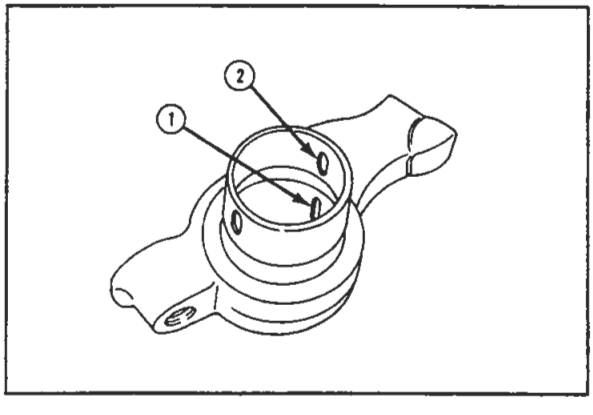
Inspection

Note: If cracks in the rocker lever are suspected, refer to Rocker Lever - Magnetic Crack Inspection (03-04)

Measure the inside diameter of the rocker lever bore.

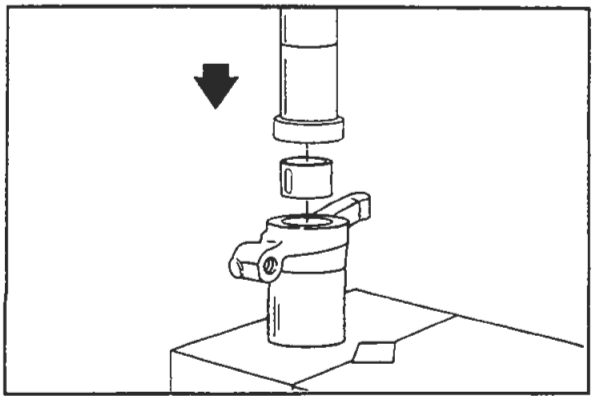
Rocker Lever Bore I.D.		
mm		in
36.474	MIN	1.4359
36.500	MAX	1.4370

Note: If the rocker lever bore is worn larger than the maximum specification the rocker lever(s) **must** be replaced.



Assembly

Note: The oil hole in the rocker lever bore (1) and the oil hole in the bushing (2) **must** be aligned correctly to supply oil to the rocker lever and rocker lever shaft.



Install the rocker lever in an arbor press.

Use the Part No. ST1284 Rocker Lever Bushing Mandrel and a support to push the bushing into the rocker lever.

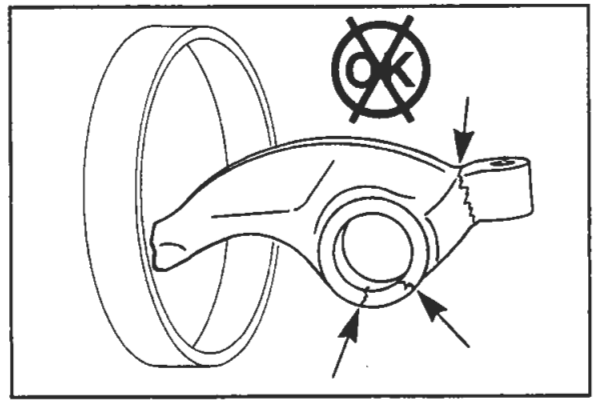
Rocker Lever - Magnetic Crack Inspection (03-04)

Use coil magnetization with residual magnaglow to magnetize the rocker levers.

Magnetize the rocker levers in a coil of 300 to 500 amperes.

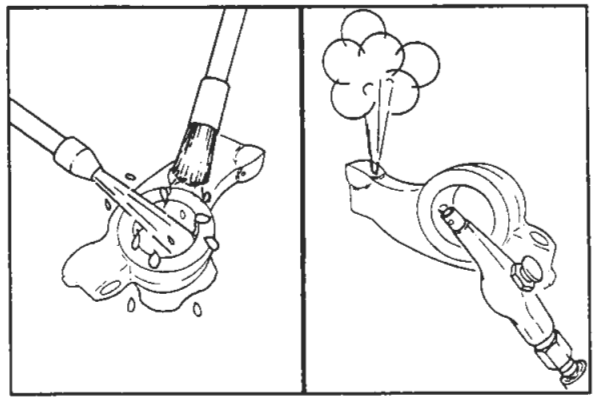
Visually inspect the levers for cracks.

Note: Cracks will appear as a solid bright line. Discard cracked levers.



Use a demagnetizer to remove the magnetism.

Use solvent to clean the rocker levers. Dry with compressed air.

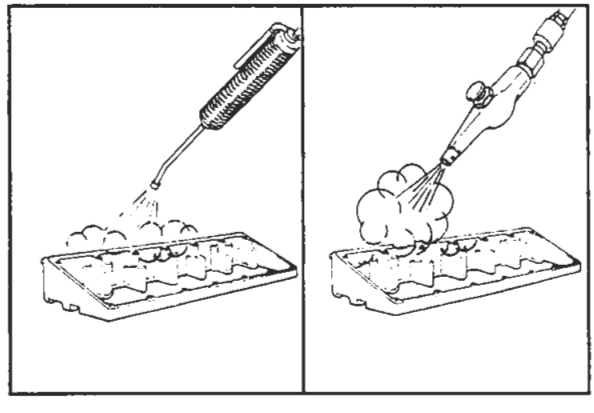


Rocker Lever Housing - Clean and Inspect for Reuse (03-05)

Remove all gasket material from the gasket sealing surfaces.

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use solvent or steam to clean the intake manifold ports and the rocker lever housing. Dry with compressed air.

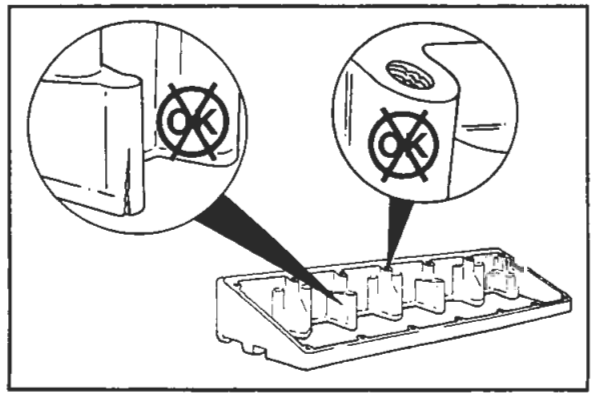


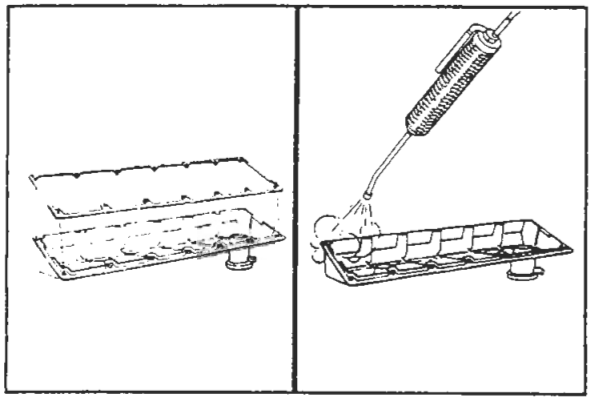
Inspection

Visually inspect the intake manifold ports and rocker lever housing for cracks or damage.

Visually inspect the threaded holes for damaged threads.

Note: If cracks or damage is found, the housing **must** be replaced. Use thread inserts to repair damaged threads.



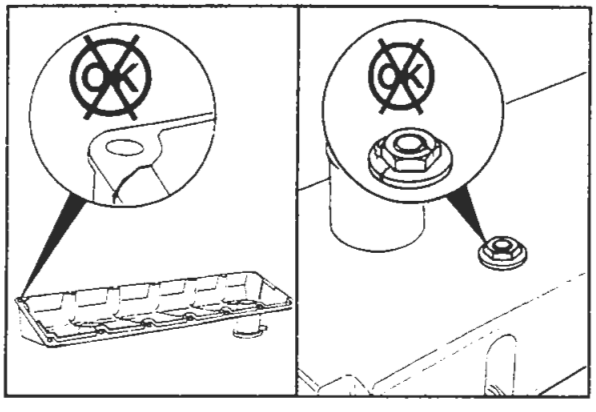


Rocker Lever Cover - Clean and Inspect for Reuse (03-06)

Remove all gasket material from the gasket sealing surface.

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use solvent or steam to clean the rocker lever cover. Dry with compressed air.



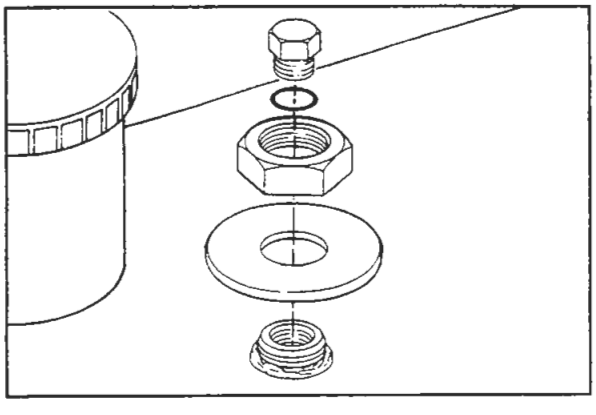
Inspection

Visually inspect the cover for cracks or damage

Present Production Style Rocker Lever Covers

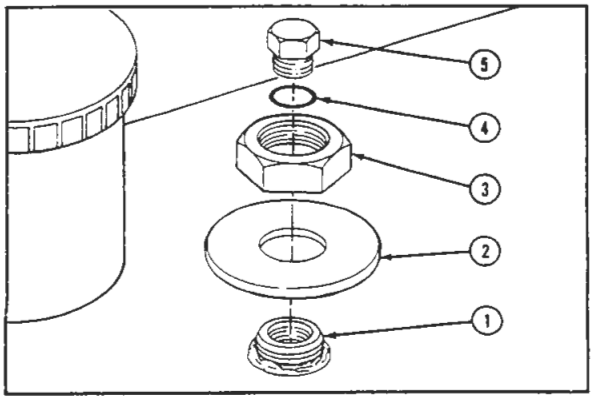
Visually inspect the Compuchek® adapter to make sure the nut and washer are not damaged or loose in the cover.

Note: If cracks or damage is found, the cover **must** be replaced. Repair or replace the Compuchek® adapter if it is loose or damaged.



Rocker Lever Cover - Install Compuchek® Adapter (03-07)

Note: Present production engines are equipped at the factory with fittings and adapters necessary to be compatible with Compuchek®. Earlier production engines were **not** equipped with the fittings and adapters. Complete the following steps to install the rocker lever cover adapter, if it has **not** been installed.



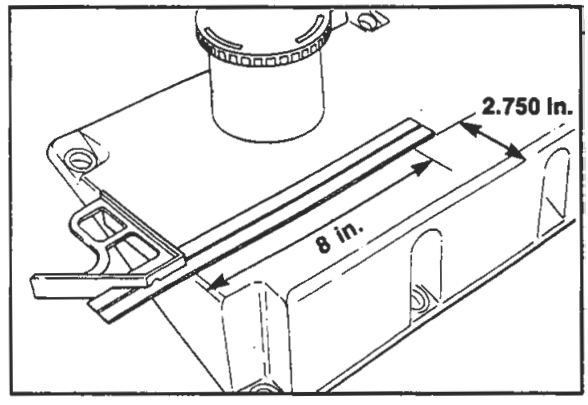
This adapter is the cycle event probe, used to monitor the motion of the number '2' cylinder intake rocker lever. The adapter consists of the following parts:

1. Adapter
2. Flat Washer
3. Nut
4. O-ring
5. Plug

Note: The o-ring (4) and plug (5) are used to seal the adapter when **not** in use.

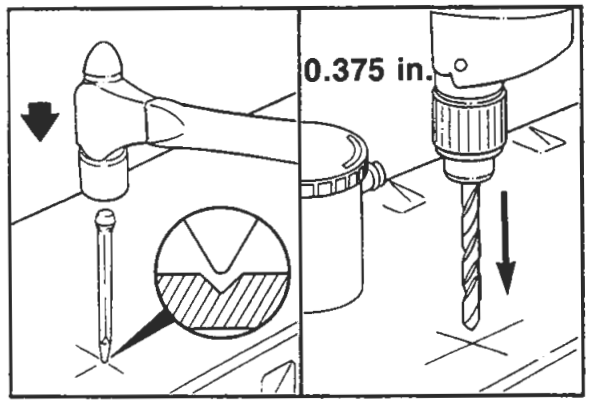
Installation

Use a combination square to locate a position in the cover 203.2 mm [8 inch] from the front, and 69.85 mm [2.750 inch] from the left side of the cover as shown.



Use a center punch to mark the location of the hole.

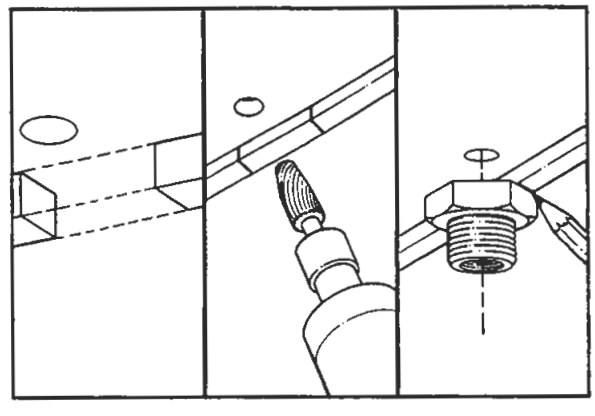
Drill a 9.53 mm [0.375 inch] pilot hole in the cover.



Note: The adapter **must** set flat against the underside of the rocker lever cover.

Put the adapter against the rib on the underside of the cover, and mark the position of the flats of the adapter on the rib.

Use a Part No. 3822501 Grinding Burr to remove the rib area marked for the adapter.

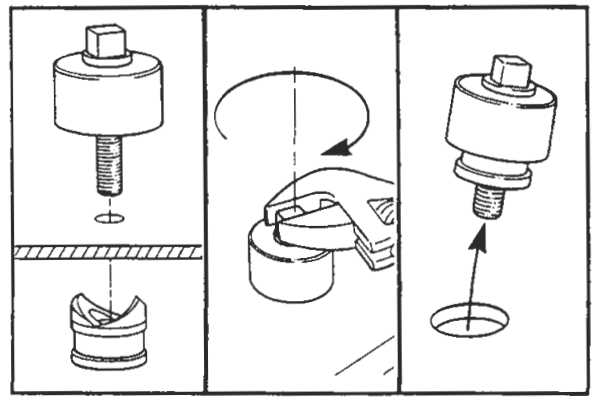


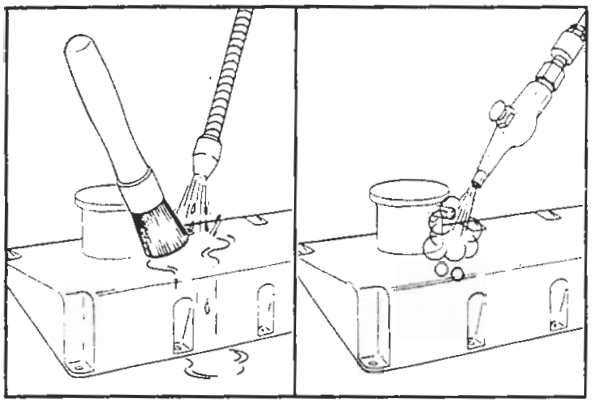
Note: Do not use a drill to cut the hole in the cover. A drill will leave excessive fibers that will interfere with the adapter.

Use clean 15W-40 oil to lubricate the Part No. 3822300 Chassis Punch.

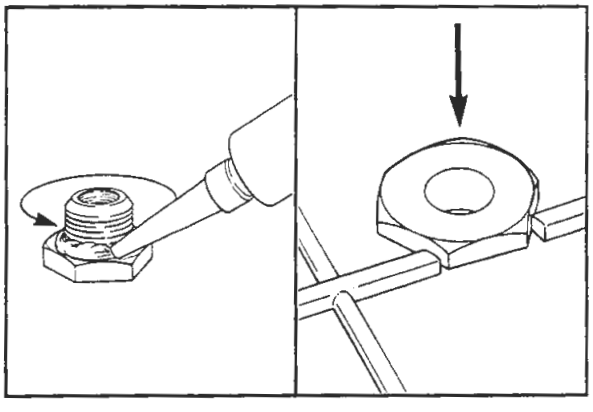
Install the chassis punch into the drilled pilot hole.

Tighten the chassis punch slowly to cut a 39 mm [1.5 inch] hole in the cover.



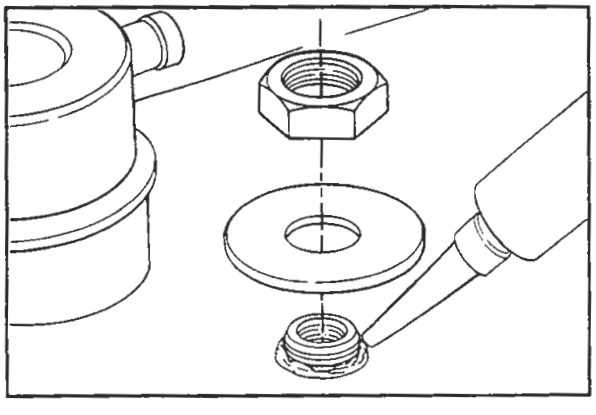


Use solvent to clean the cover. Dry with compressed air.



Use Drilock® 201 to seal the threads of the adapter 8 to 14 mm [0.31 to 0.55 inch] from the threaded end.

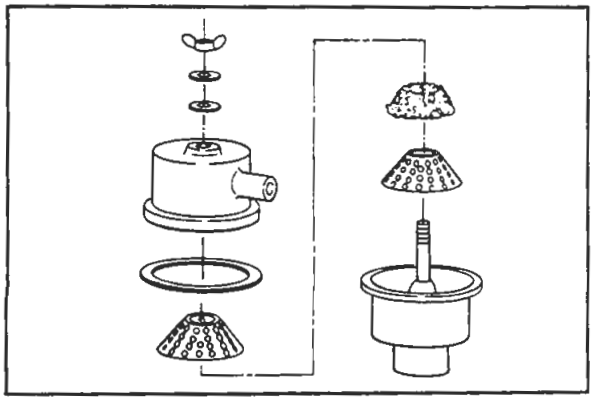
Install the adapter into the cover from the underside with the flats of the adapter in the removed rib area as shown.



Use Permabond® Adhesive 612 and Permabond® Activator 610 to seal the adapter threads above the surface of the cover.

Install the flat washer and nut on the adapter.

Torque Value: 14 N•m [120 in-lb]



Crankcase Breather - Replace (03-08)

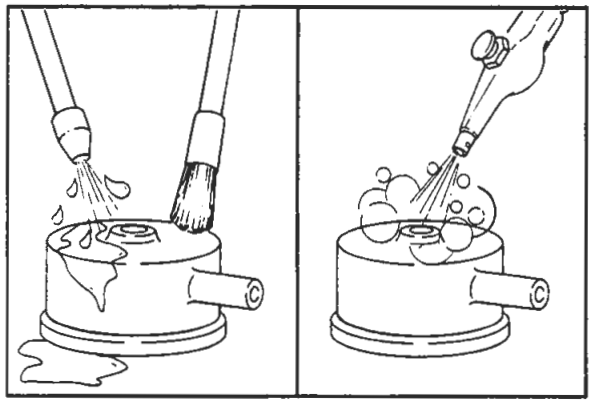
Earlier Production Style Crankcase Breather

Note: Do **not** remove the crankcase breather from the rocker lever cover if the breather is not damaged.

Disassembly

Disassemble the breather as shown.

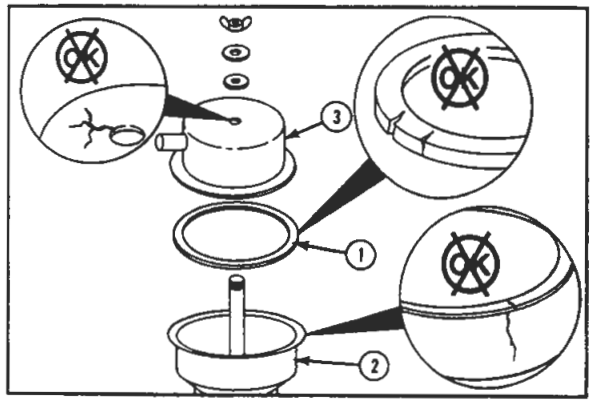
Use solvent to clean the breather parts. Dry with compressed air.



Inspection

Visually inspect the rubber gasket (1), body (2) and cover (3) for cracks or damage.

NOTE: If damage to the rubber gasket (1) or the cover (3) is found the parts **must** be replaced. If damage to the body (2) is found the breather **must** be replaced. Refer to Service Replacement Crankcase Breather following.

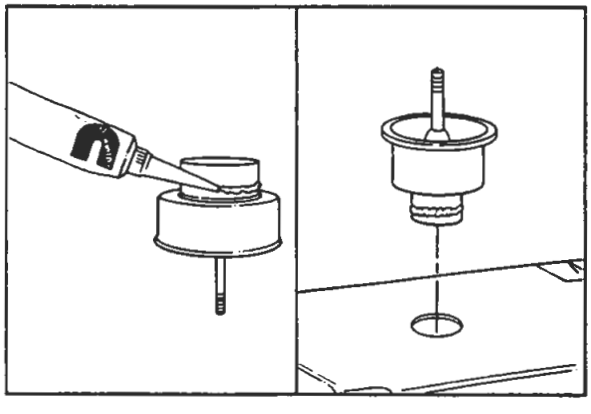


Assembly

Support the rocker lever cover in an arbor press.

Use Loctite® 732 to seal the outside diameter of the breather body.

Use a mandrel to push the breather body into the cover.



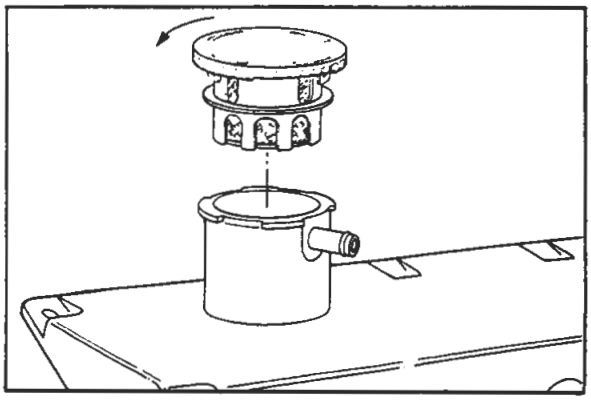
Revised Style Crankcase Breather

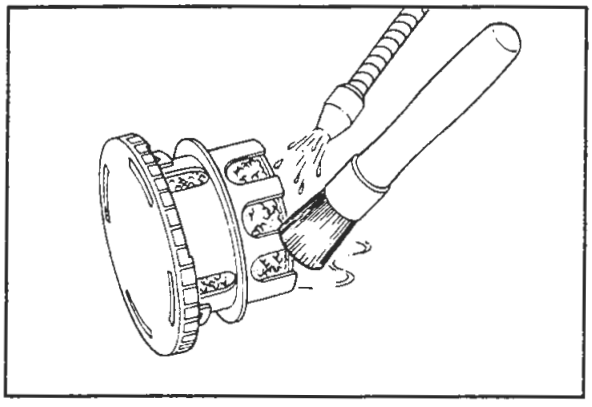
Caution: The revised style "factory installed" crankcase breather housing cannot be removed from the plastic rocker lever cover without damaging the cover.

Disassembly

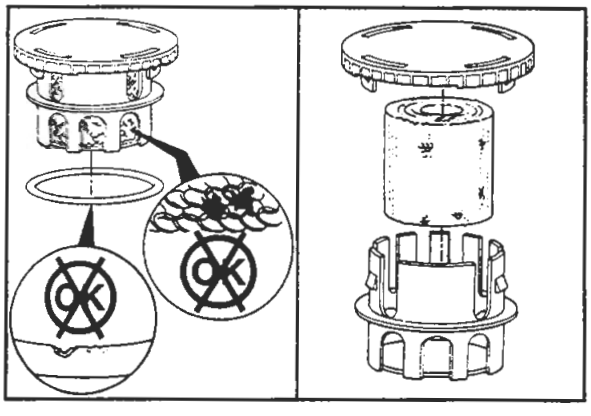
Remove the cover from the breather housing.

NOTE: Twist the cover approximately one-eighth (1/8) of a turn counterclockwise and lift the cover.





Use solvent to remove the excess oil residue and sludge from the screen.

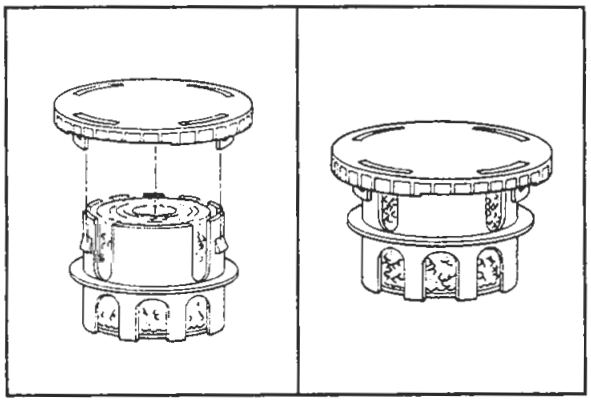


Inspection

Visually inspect the screen for deterioration.

Visually inspect the cover o-ring.

Note: If the screen has deteriorated, pull gently back on the three locking tabs to remove the element and screen from the cover. Discard the screen. Discard the o-ring if damage is found.



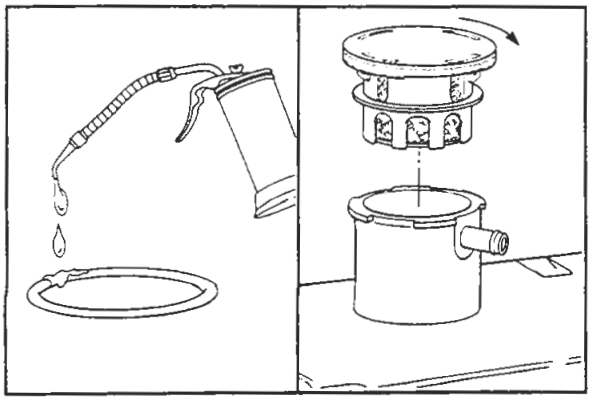
Assembly

Install the new screen and element to the cover as follows:

1. Align the three cover lock tabs with the locking ramps on the element legs.

Note: Make sure all three lock tabs and locking ramps are aligned.

2. Press the parts together.



Use clean 15W-40 oil to lubricate the cover o-ring.

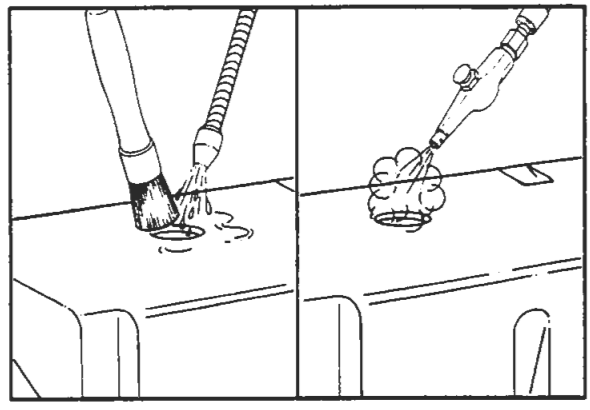
Install the cover on the breather housing.

Note: Twist the cover approximately one-eighth (1/8) of a turn clockwise to lock it in place on the housing.

Service Replacement Crankcase Breather

The revised style crankcase breather can be installed as a service replacement breather on all engine applications where space will permit.

NOTE: Before installing the service replacement crankcase breather, the breather bore in the rocker lever cover **must** be thoroughly cleaned with solvent and dryed with compressed air.

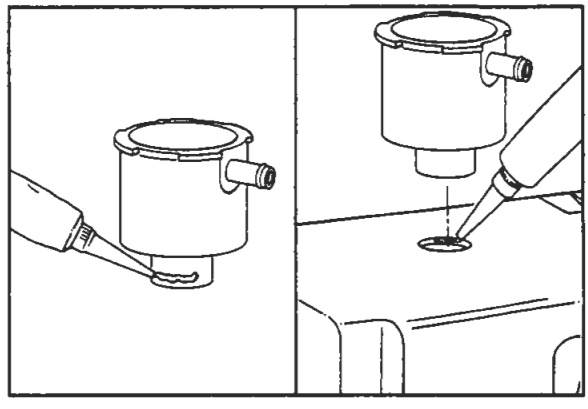


Installation

Remove the cover from the breather housing.

Apply a heavy coat of Part No. 3377132 Sealant to the outside of the tube at the bottom of the breather housing and to the inside of the breather bore in the rocker lever cover.

Apply a 6 to 10 mm [1/4 to 3/8 inch] bead of the Sealant to the bottom surface of the breather housing.



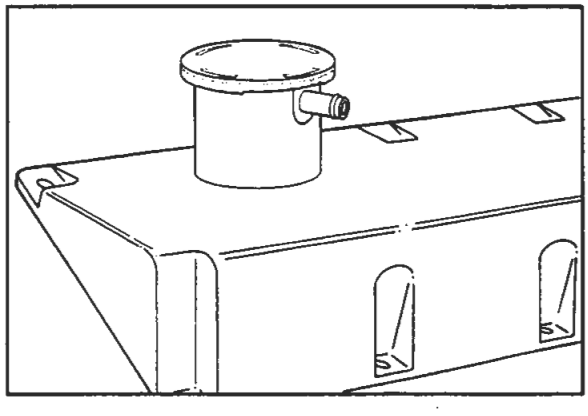
Align the breather outlet tube to the desired position relative to the rocker lever cover.

Install the breather housing into the bore of the cover.

NOTE: Make sure the bottom of the breather housing is firmly seated against the cover.

Wipe the excess sealant from the base of the breather housing.

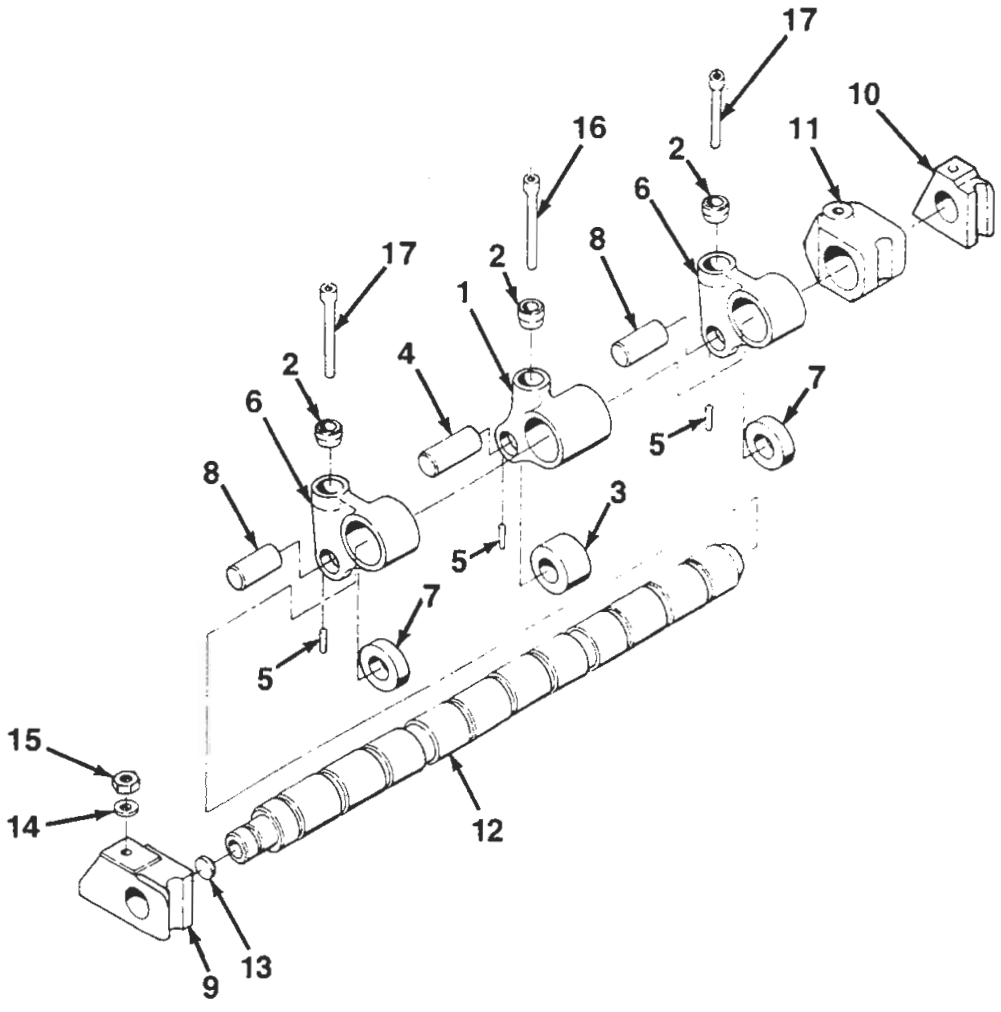
NOTE: Follow the sealant manufacturer's guidelines for the required curing time before installing the cover on the breather housing.



Cam Follower Assembly - Group 04

Contents

Cam Follower Assembly - Exploded View



Ref. No.	Description	Qty.
1	Lever, Injector Cam Follower	6
2	Socket, Tappet	18
3	Roller, Injector Cam Follower	6
4	Pin, Injector Cam Follower	6
5	Pin, Roll	18
6	Lever, Valve Cam Follower	12
7	Roller, Valve Cam Follower	12
8	Pin, Valve Cam Follower	12
9	Support, Cam Follower Shaft	1

Ref. No.	Description	Qty.
10	Support, Cam Follower Shaft	1
11	Support, Cam Follower Shaft	5
12	Shaft, Cam Follower	2
13	Plug, Drive	4
14	Washer, Plain	7
15	Nut	7
16	Rod, Injector Push	6
17	Rod, Valve Push	12

Cam Follower Assembly - General Information

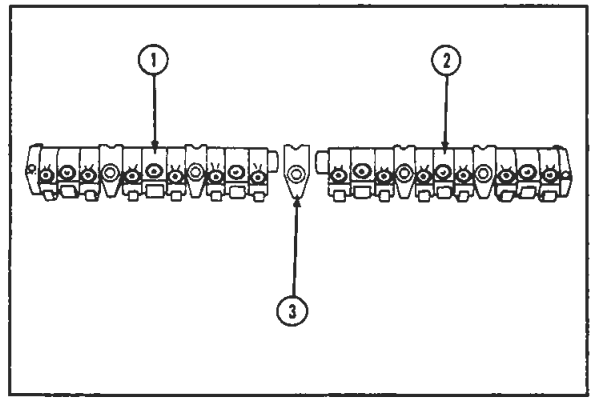
The cam follower group consists of the injector and valve cam followers, cam follower shafts and supports and the valve and injector push rods.

Two styles of cam follower rollers have been used on the L10 engines. The earlier production style cam followers use a flat roller design. The present production style rollers have a crowned or curved design. The present design crowned rollers can be identified by a groove machined in one side of the roller. Crowned and flat cam follower rollers **can** be intermixed within an engine. The injection timing and valve and injector settings are **not** changed with the crowned rollers.

NOTE: Label or tag all of the cam follower parts, with the engine cylinder number and their relative position to the other parts as they are removed from the engine. Many of the cam follower parts are interchangeable; however, due to established wear patterns, they **must** be installed in the same position they were removed from.

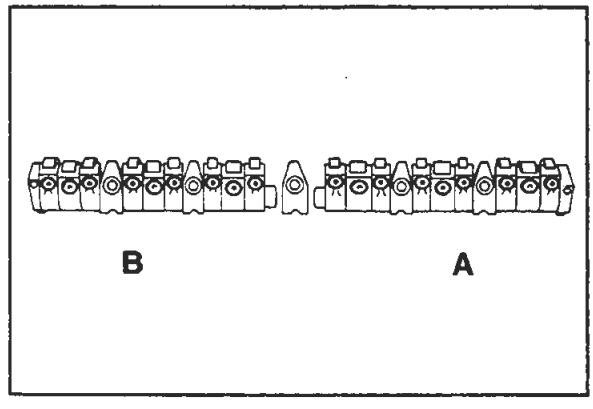
Cam Follower Assembly - Clean and Inspect for Reuse (04-01)

Note: The cam follower assembly consists of two shaft assemblies (1) and (2) installed on the engine with a common center support (3).



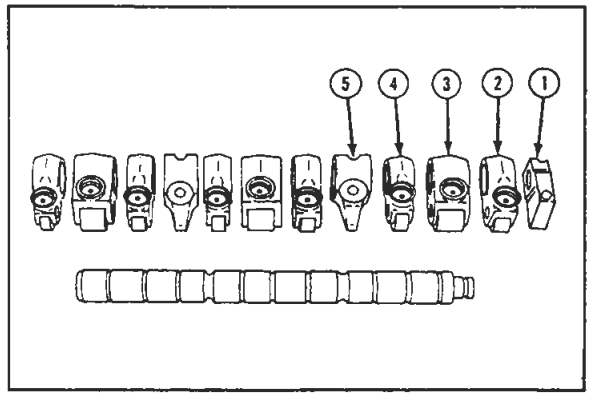
Disassembly

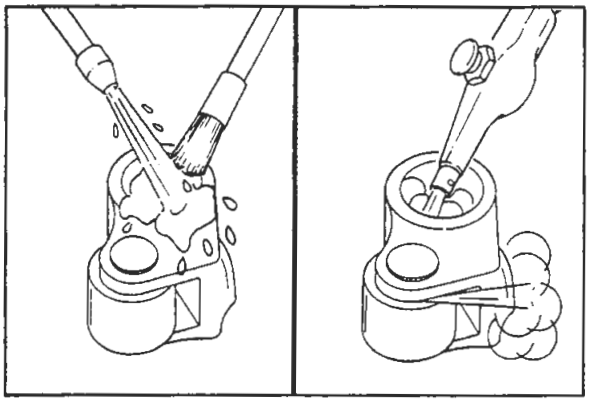
Note: The cam follower levers have established wear patterns and **must** be installed in the same position they were removed from. Mark the end supports and all of the cam followers to identify their position, front (A) and rear (B), when they are removed. The end supports are **not** interchangeable.



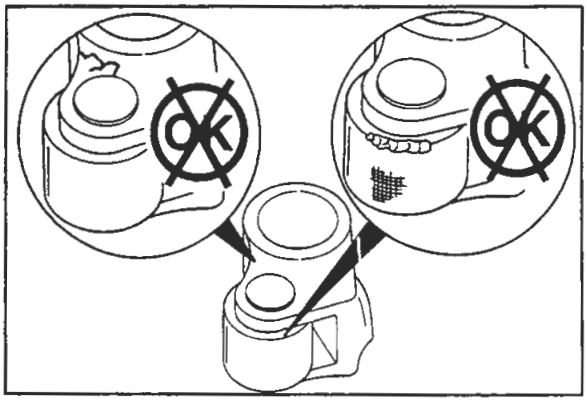
Remove the end supports (1) from the shafts.

Remove the valve cam followers (2), the injector cam followers (3), the valve cam followers (4), and the shaft supports (5).



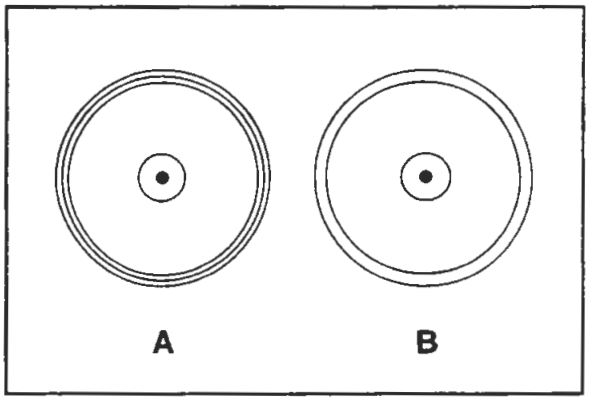


Clean the cam follower parts with solvent. Dry with compressed air.

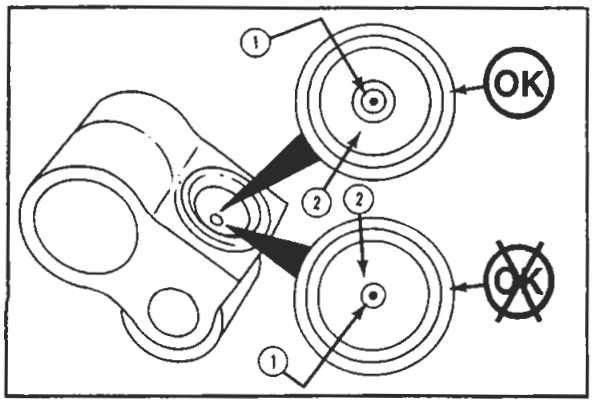


Inspection

Visually inspect the cam followers for cracks, scoring or other damage.



NOTE: Two styles of sockets have been used in the L10 cam followers. Style socket (A) can be identified by a machining mark on the top ledge of the socket. The earlier production style socket (B) does **not** have any identification mark.



Visually inspect the sockets for excessive wear.

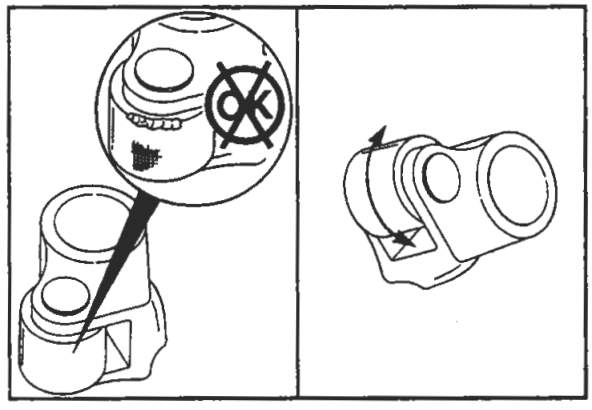
NOTE: If the seating pattern extends down into the oil drain hole chamfer (1) or pitting or scratches in the seating pattern (2) can be seen or felt, the socket(s) **must** be replaced. Refer to Cam Follower Socket - Replace (Roller Removed) (04-05).

NOTE: If a socket is replaced, the mating push rod **must** also be replaced.

Visually inspect the cam follower rollers for flat spots, scuff marks or other damage.

Turn the rollers by hand to make sure they rotate freely.

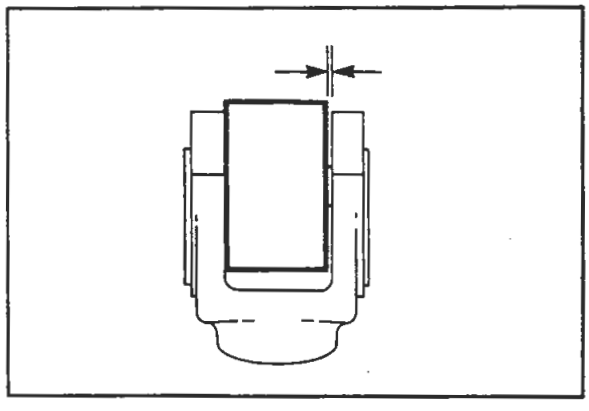
Note: If the cam follower rollers are damaged or do **not** rotate freely, the rollers **must** be replaced. Refer to Cam Follower Lever - Replace Roller (04-03).



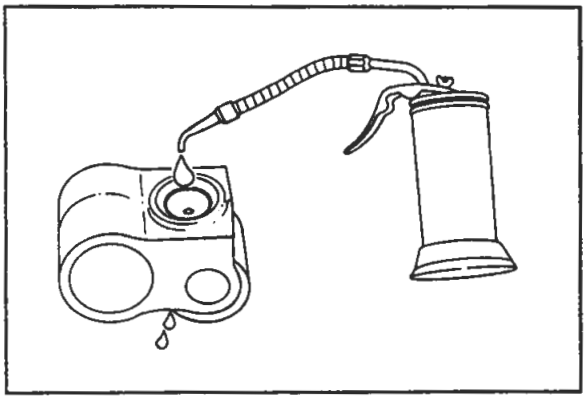
Measure the cam follower roller side clearance.

Roller Side Clearance		
mm		in
0.20	MIN	0.008
0.66	MAX	0.026

Note: If the roller side clearance is **not** within these specificatins, the roller **must** be replaced. Refer to Cam Follower Lever - Replace Roller (04-03).

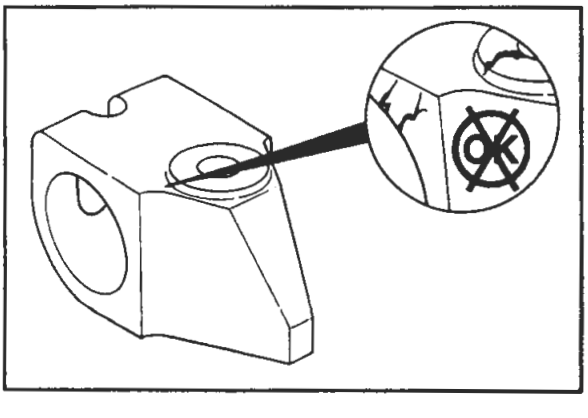


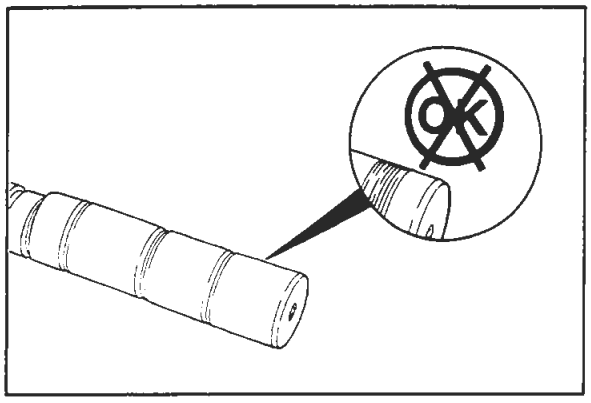
Use clean 15W-40 oil to check the oil flow through the cam followers.



Visually inspect the cam follower shaft supports for cracks or damage.

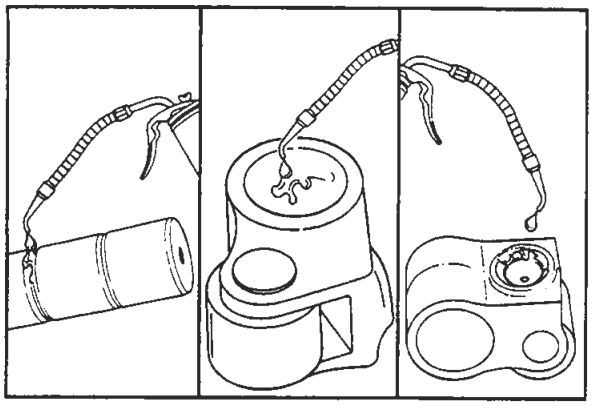
Note: If cracks or damage is found, the shaft supports **must** be replaced.





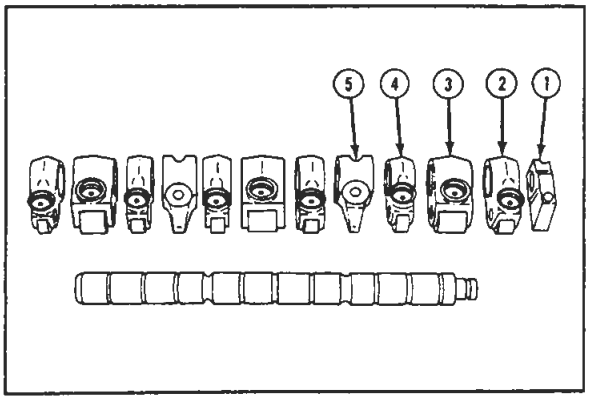
Visually inspect the cam follower shafts for scoring or damage.

Note: If scoring or damage is found, the cam follower shaft(s) **must** be replaced.



Assembly

Use clean 15W-40 oil to lubricate the cam follower shafts and the injector and valve cam followers.

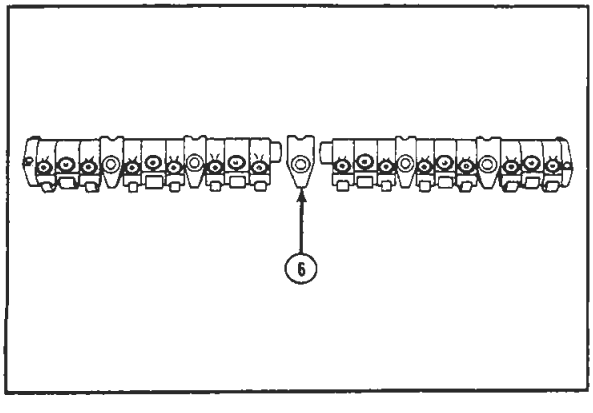


Note: The cam follower levers, supports and shafts have established wear patterns and **must** be installed in the same position from which they were removed. The shaft end supports are **not** interchangeable.

Install the end support (1) on the shaft.

Install the valve cam follower (2), the injector cam follower (3), the valve cam follower (4), and the shaft support (5) on the shaft.

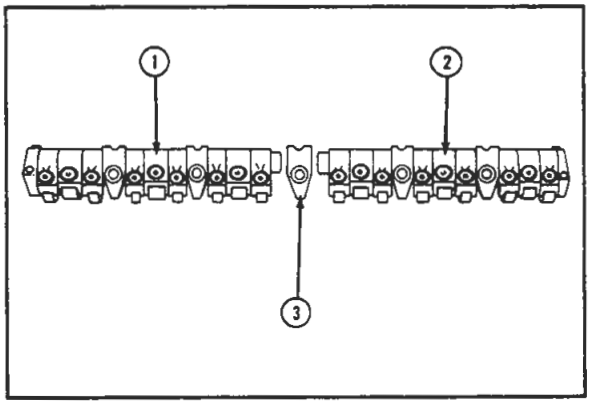
Install the remaining cam followers and supports in the same sequence.



Install the two cam follower shaft assemblies in the common center support (6).

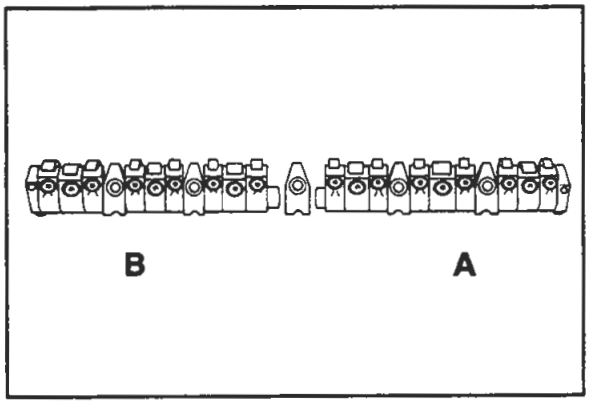
Cam Follower Assembly - Rebuild (04-02)

Note: The cam follower assembly consists of two shaft assemblies, (1) and (2), installed on the engine with a common center support (3).



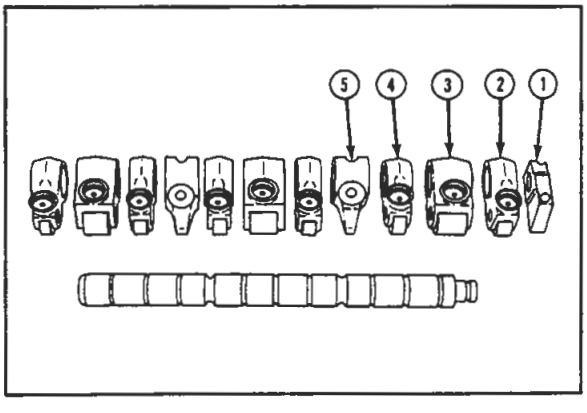
Disassembly

Note: The cam follower levers have established wear patterns and **must** be installed in the same position they were removed from. Mark the end supports and all of the cam followers to identify their position, front (A) and rear (B), when they are removed. The end supports are **not** interchangeable.



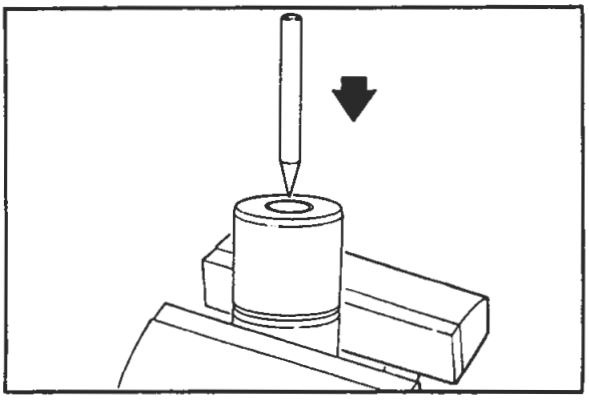
Remove the end supports (1) from the shafts.

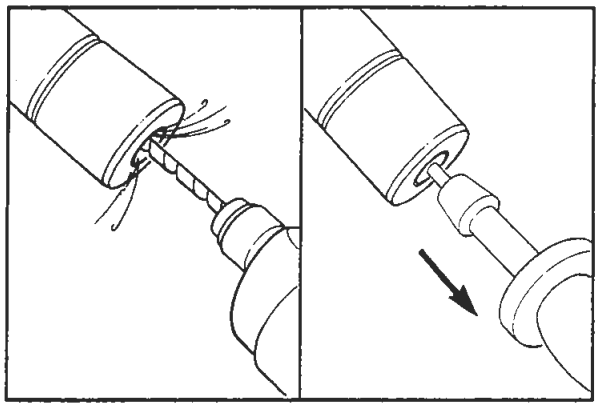
Remove the valve cam followers (2), injector cam followers (3), valve cam followers (4), and shaft supports (5).



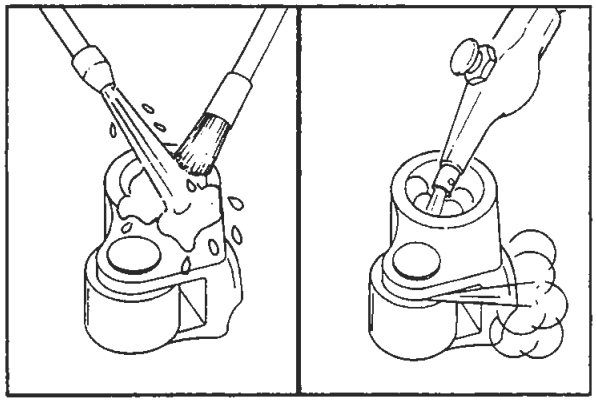
Install the cam follower shafts in a vise with brass jaws.

Center punch the plugs in the ends of the shafts.

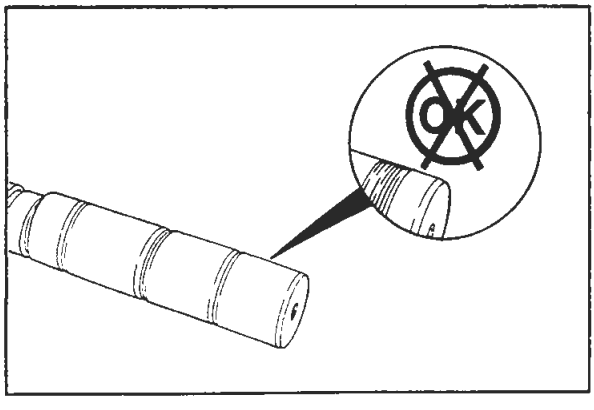




Drill a 1/8 inch hole in the plugs and use a standard dent puller to remove the plugs from the shafts.

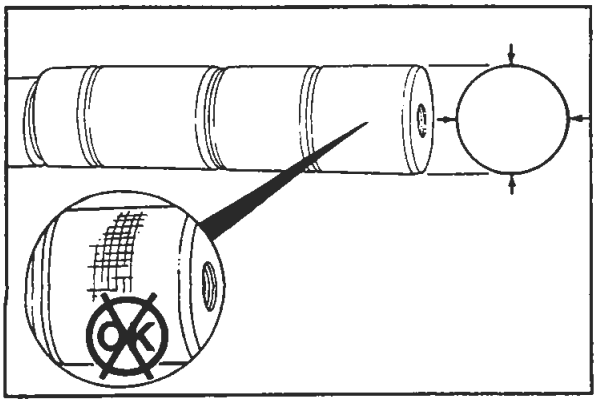


Clean the cam follower parts with solvent. Dry with compressed air.



Inspection

Visually inspect the cam follower shafts for scoring or damage.

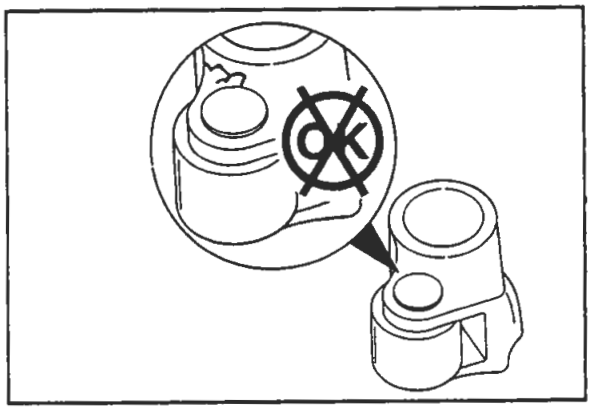


Measure the outside diameter of the cam follower shaft journals.

Shaft Journals O.D.		
mm		in.
33.980	MIN	1.3378
34.009	MAX	1.3389

Note: If scoring or damage is found or the shafts are **not** within the specifications, the shaft(s) **must** be replaced.

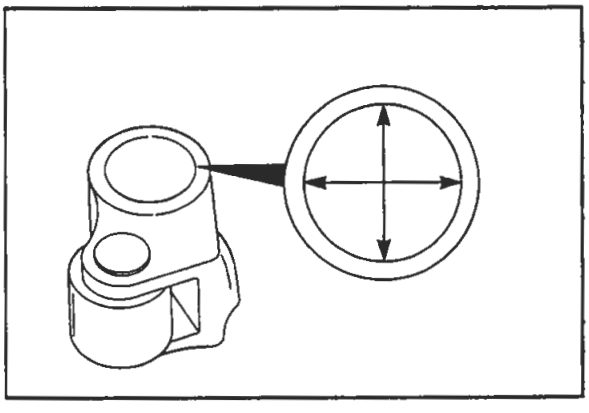
Visually inspect the cam follower levers for cracks or damage.



Measure the inside diameter of the shaft bore in the cam follower levers.

Shaft Bore I.D.		
mm		in
34.086	MIN	1.3420
34.115	MAX	1.3431

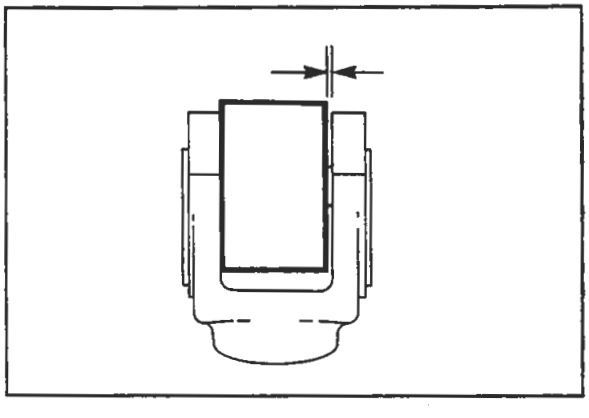
Note: If the cam follower lever is damaged or the shaft bore is **not** within the maximum specification, the lever(s) **must** be replaced.



Measure the cam follower roller side clearance.

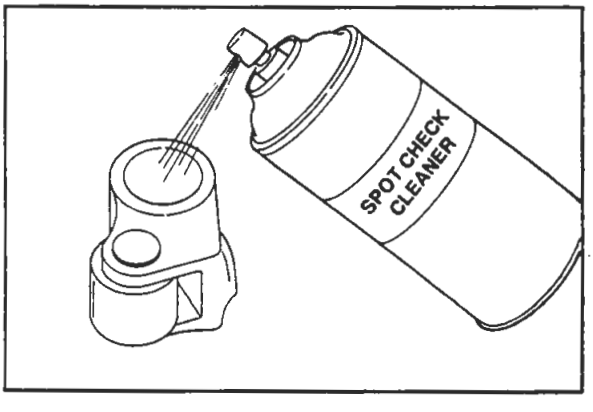
Roller Side Clearance		
mm		in
0.20	MIN	0.008
0.66	MAX	0.026

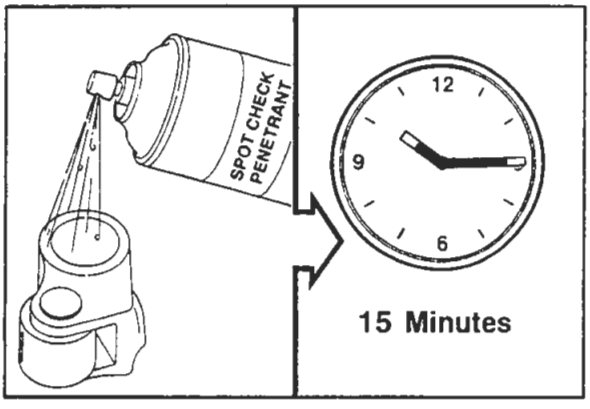
Note: If the roller side clearance is **not** within the specifications, the roller **must** be replaced. Refer to Cam Follower Lever - Replace Roller (04-03).



Use the Part No. 3375432 Crack Detection Kit to inspect the cam follower levers and supports for cracks.

Use the Part No. 3375433 Crack Detection Cleaner to clean the levers and supports. Dry with compressed air.



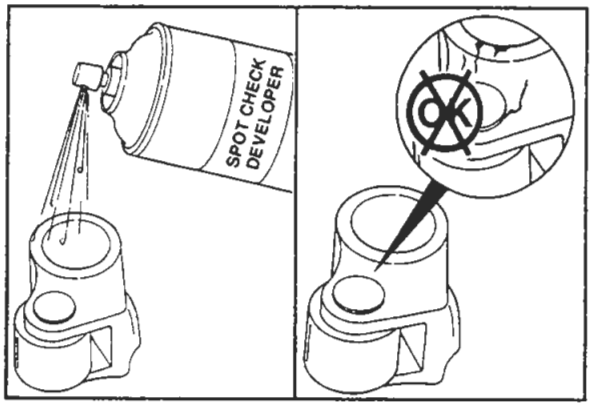


Use the Part No. 3375435 Crack Detection Penetrant to spray the levers and supports.

Note: Do **not** dry the penetrant with compressed air.

Allow the penetrant to dry for 15 minutes.

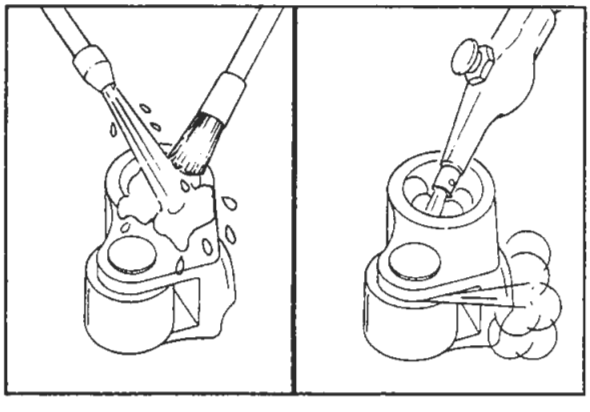
Remove the excess penetrant with a dry cloth.



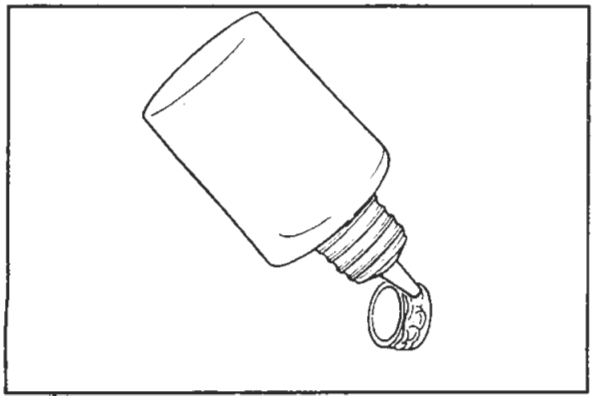
Use the Part No. 3375434 Crack Detection Developer to spray the levers and supports.

Visually inspect the levers and supports. Cracks will appear as a solid bright line.

Note: A crack in the casting will also appear as a solid bright line. Cavitation in the casting will appear as a small round mark. If cracks or cavitation are found the part **must** be replaced.



Use solvent to clean the acceptable levers and supports. Dry with compressed air.



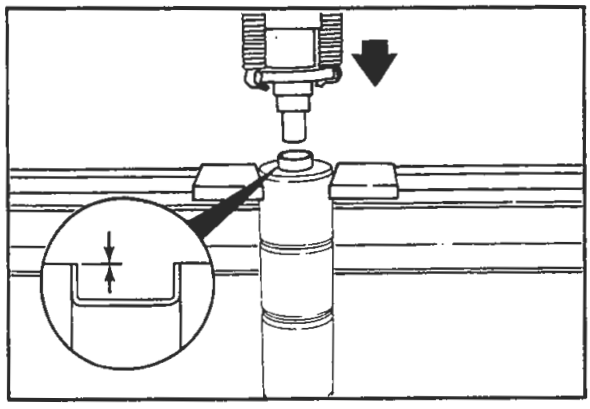
Assembly

Apply a coat of Part No. 3375068 Cup Plug Sealant to the outside diameter of the shaft plugs.

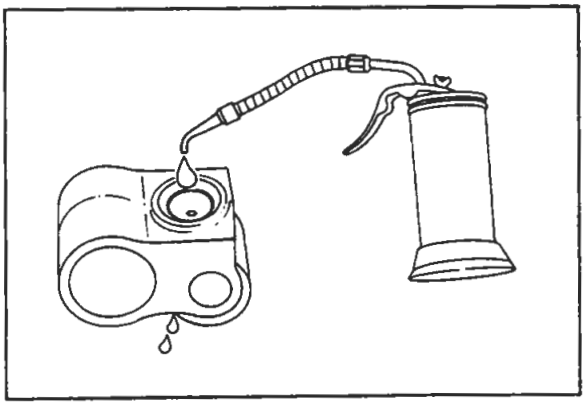
Install the shaft in an arbor press.

Note: Make sure the end of the shaft is supported.

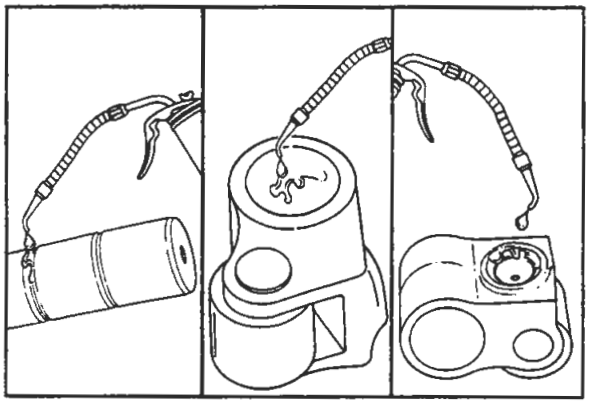
Push the plug into the shaft until it is level with the end of the shaft.



Use clean 15W-40 oil to check the oil flow through the cam followers.



Use clean 15W-40 oil to lubricate the cam follower shafts and the injector and valve cam followers.

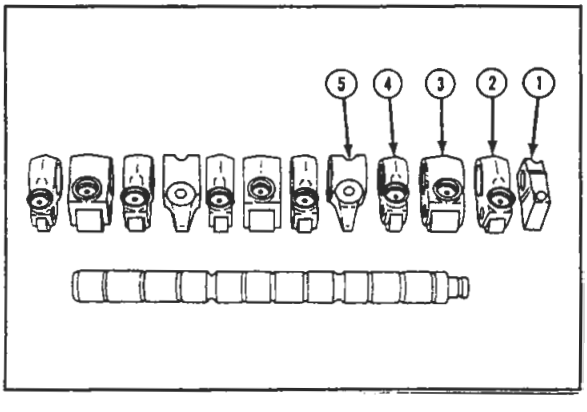


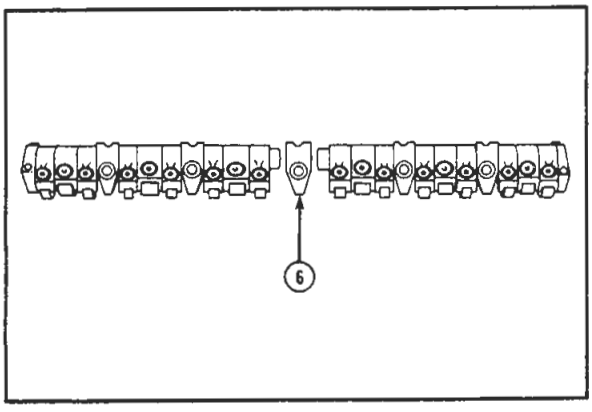
Note: The cam follower levers, supports, and shafts have established wear patterns and **must** be installed in the same position from which they were removed. The shaft end supports are **not** interchangeable.

Install the end support (1) on the shaft.

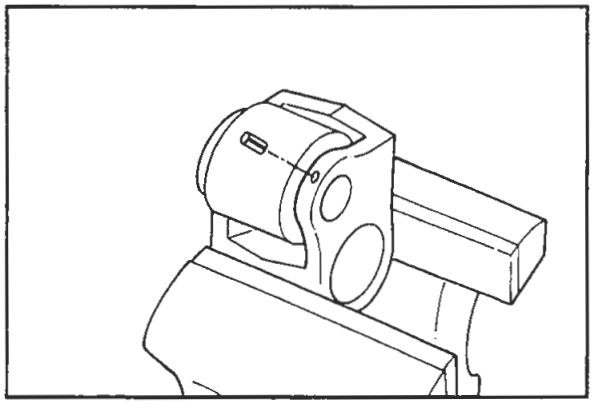
Install the valve cam follower (2), injector cam follower (3), valve cam follower (4), and shaft support (5) on the shaft.

Install the remaining cam followers and supports in the same sequence.





Install the two cam follower shaft assemblies into the common center support (6).

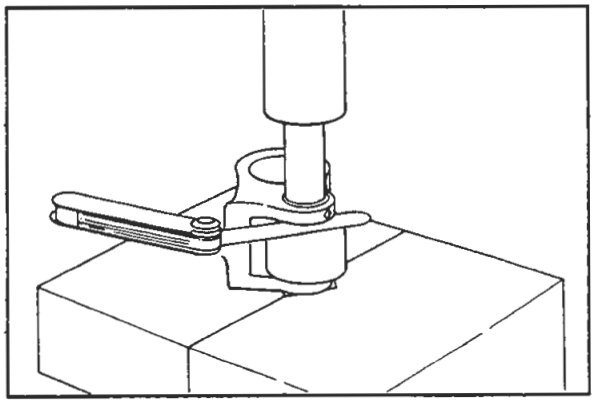


Cam Follower Lever - Replace Rollers (04-03)

Disassembly

Install the cam follower lever in a vise with brass jaws.

Use a pair of side cutters to remove the roll pin, if equipped.

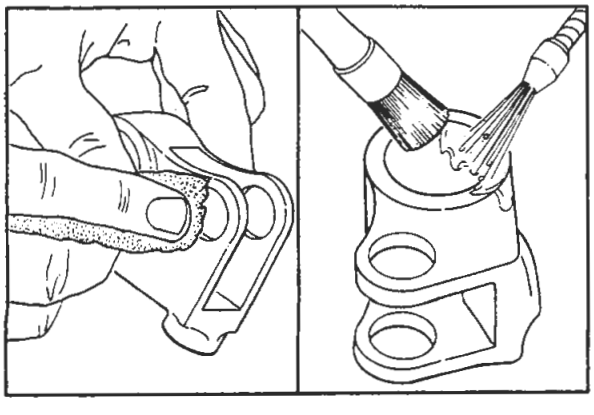


Install the cam follower lever in an arbor press.

Caution: Use the largest feeler gauge that will fit between the roller and the lever to prevent damage when removing the roller pin.

Install a feeler gauge between the roller and the leg of the lever.

Push the roller pin from the cam follower lever. Discard the unacceptable rollers and roller pins.



Use a 240 grit, or finer, emery cloth to remove any burrs from the edges of the pin bore holes.

NOTE: Do **not** burnish the inside diameter of the pin bore holes.

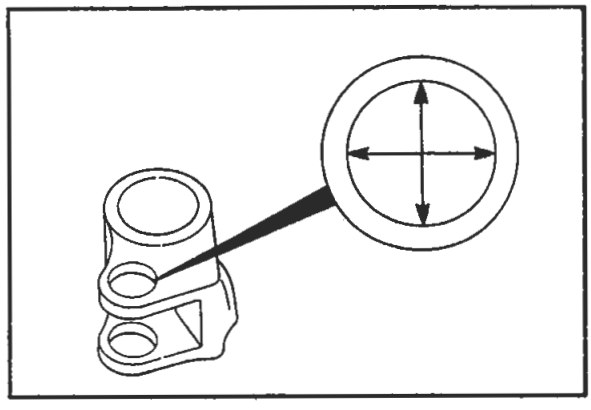
Use solvent to clean the levers. Dry with compressed air.

Inspection

Use the magnetic crack inspection method to inspect the cam follower levers for cracks. Refer to Cam Follower - Magnetic Crack Inspection (Roller Removed) (04-04)

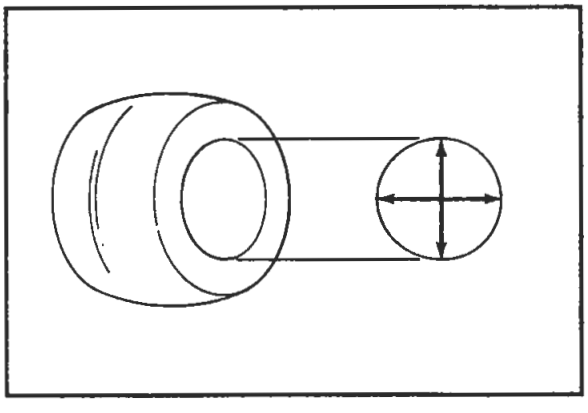
Measure the inside diameter of cam follower lever roller pin bore.

Roller Pin Bore I.D.		
mm		In
19.043	MIN	0.7497
19.055	MAX	0.7502



Measure the inside diameter of the new cam follower lever roller bore.

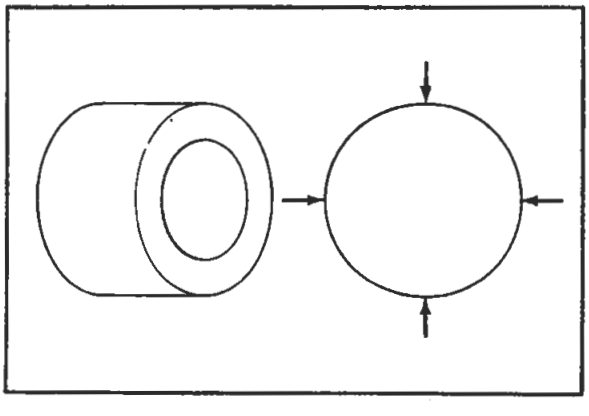
Roller Bore I.D.		
mm		In
19.151	MIN	0.7540
19.177	MAX	0.7550

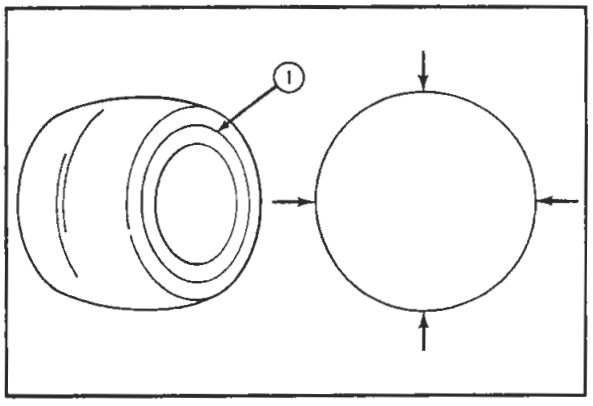


Measure the outside diameter of the new cam follower roller.

NOTE: Flat rollers do **not** have a machining groove on the roller side. If a machining groove exists, the roller is **not** a "flat" style roller.

Flat Roller O.D.		
mm		In
41.249	MIN	1.6240
41.275	MAX	1.6250

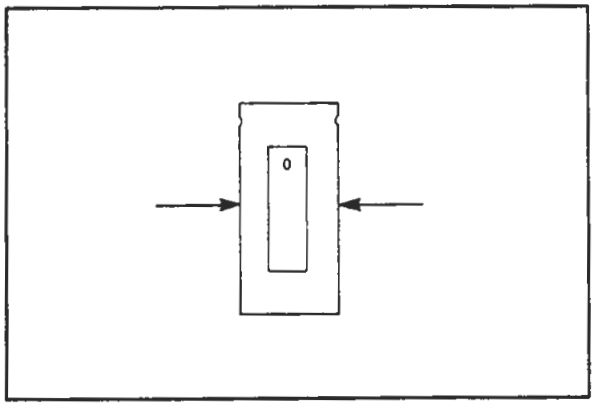




Crowned rollers were introduced on injector followers with ESN 34520781 and on valve followers with ESN 34509367. Crowned rollers appear flat to the naked eye but can be identified by a groove (1) machined on the side of the roller. The identification groove was removed from the cam follower rollers on 9/12/88.

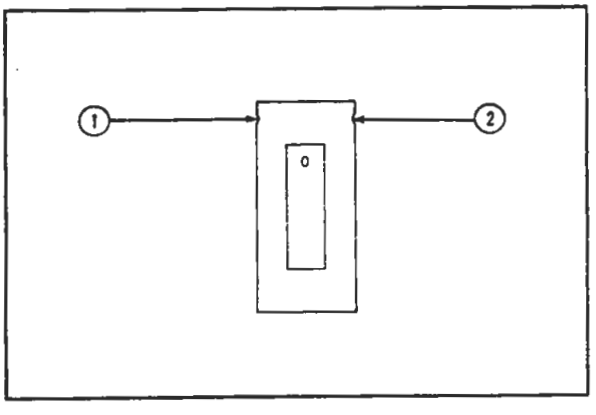
NOTE: The crowned roller **must** be measured in the middle of the roller outside diameter.

Crowned Roller O.D.		
mm		in
41.237	MIN	1.6235
41.287	MAX	1.6255



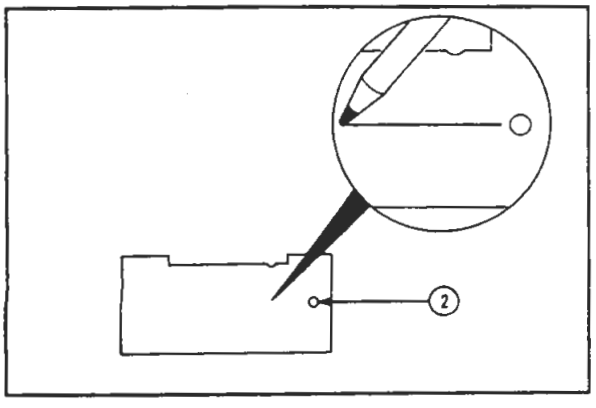
Measure the outside diameter of the new roller pin.

Roller Pin O.D.		
mm		in
19.065	MIN	0.7506
19.073	MAX	0.7509



Assembly

NOTE: The roller pin **must** be installed correctly to be sure the cam follower roller and roller pin are supplied with oil. Inspect the new roller pin as shown to determine the oil feed passage (1) and the alignment hole (2) locations. The oil feed passage is approximately three times as deep as the alignment hole.

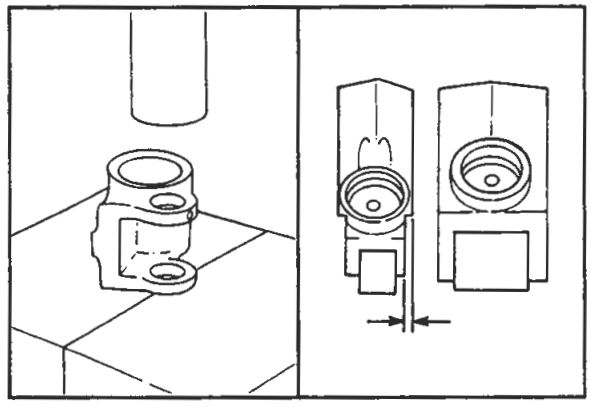


Use a grease pencil or similar marker to draw a line on the side of the roller pin that is parallel to the alignment hole (2).

NOTE: The line will help align the roller pin correctly in the cam follower lever.

Install the cam follower lever in an arbor press with the leg with the alignment hole towards the top.

NOTE: Because of the offset on the valve cam follower levers, it is necessary to install a 1.6 mm [1/16 inch] shim under the lever. This will prevent leg deflection and keep the lever perpendicular to the roller pin.

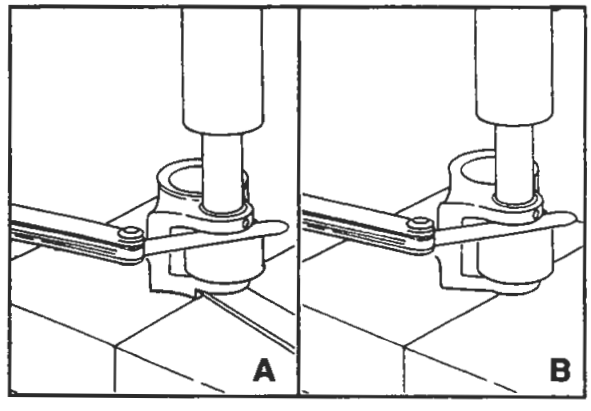


Install the roller in the cam follower lever.

Caution: Use the largest feeler gauge that will fit between the roller and the lever to prevent leg deflection when installing the roller pin. This will reduce shaving of the bronze roller pin and prevent leg breakage.

Install a feeler gauge between the roller and the leg of the lever.

- Valve cam follower lever (A)
- Injector cam follower lever (B)

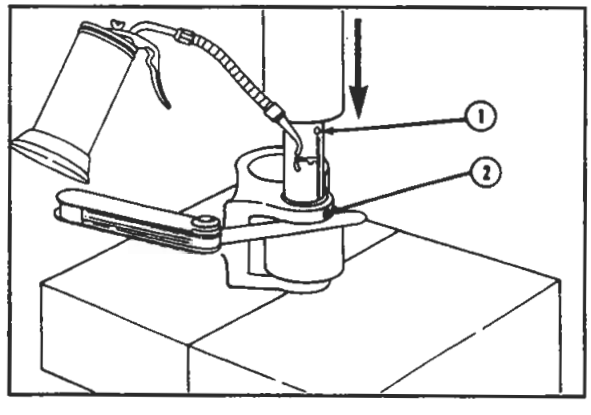


NOTE: Freezing the roller pin will simplify it's installation.

Use clean 15W-40 oil to lubricate the roller pin.

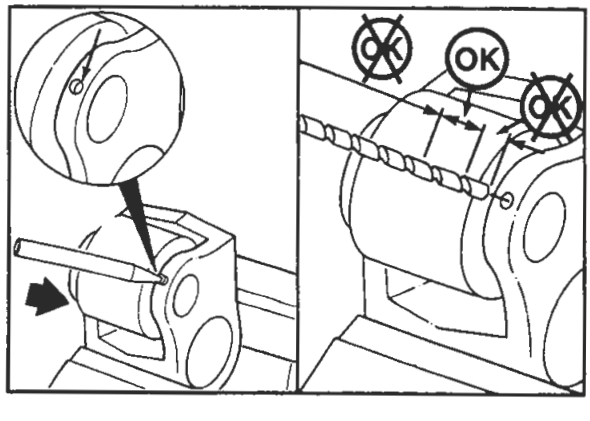
Install the roller pin. Make sure the pin alignment hole (1) is correctly aligned with the alignment hole (2) in the lever before pushing the roller pin into the cam follower lever.

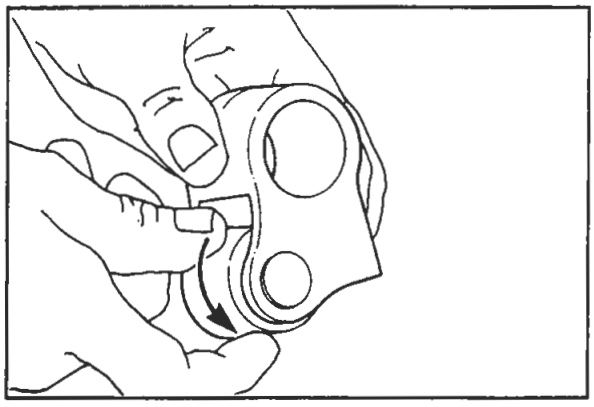
Install a new roll pin into the cam follower lever. The roll pin, when installed, should protrude approximately 1.6 mm [1/16 inch].



NOTE: If the roll pin will **not** go in or goes in until it is flush with the cam follower lever the roller pin has been installed incorrectly.

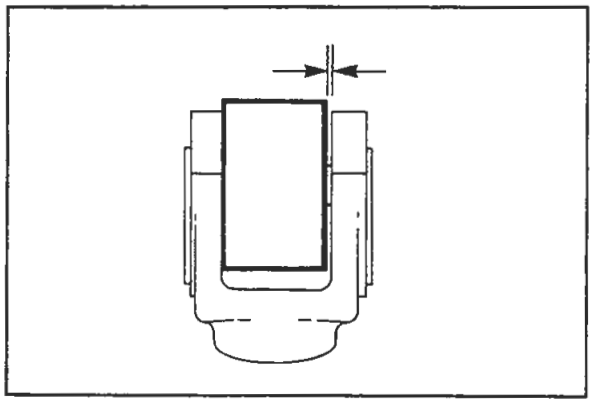
NOTE: Cam followers that do **not** have roll pins can be checked for correct roller pin installation by using a 5/64-inch drill bit. If the drill bit enters 10.2 mm [0.40 inch] the roller pin **is** installed correctly. If the drill bit enters only 5.1 mm [0.20 inch] or goes in 18.0 mm [0.70 inch] the roller pin is installed incorrectly. Roller pins that are **not** installed correctly **must** be removed and new roller pins installed.





Final Inspection

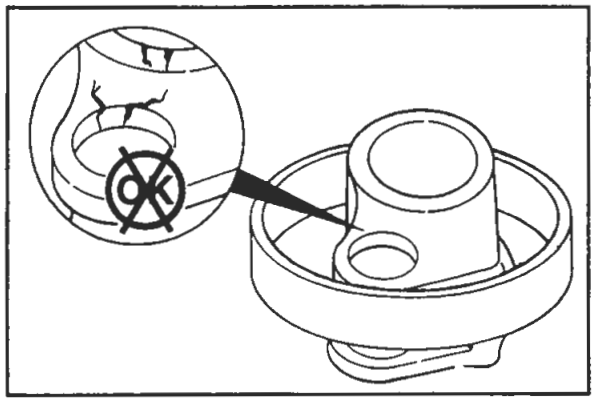
Turn the roller by hand to make sure it rotates freely.



Measure the cam follower roller side clearance.

Roller Side Clearance		
mm		in
0.20	MIN	0.008
0.66	MAX	0.026

Note: If the roller does **not** rotate freely or the side clearance does **not** meet the specifications, the cam follower lever **must** be rebuilt again.



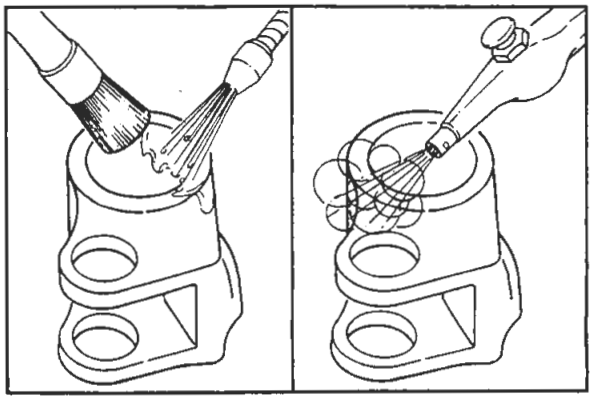
Cam Follower Lever - Magnetic Crack Inspection (Roller Removed) (04-04)

Use coil magnetization with residual magnaglow to magnitize the cam follower levers.

Amperage
300 Ampere Turns min.
500 Ampere Turns max.

Visually inspect the levers for cracks.

Note: Cracks will appear as a solid bright line. Discard cracked levers.



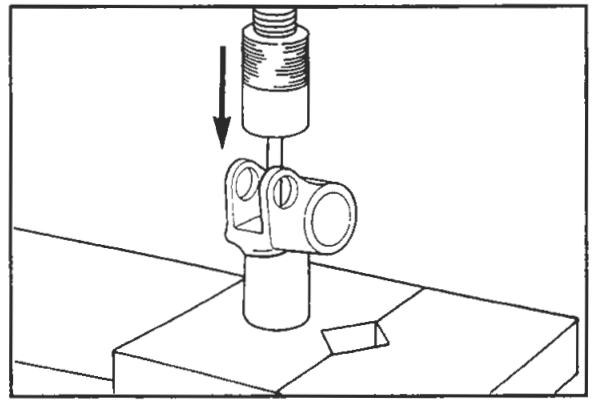
Use a demagnetizer to remove the magnetism.

Use solvent to clean the cam follower levers. Dry with compressed air.

Cam Follower Lever Socket - Replace (Roller Removed) (04-05)

Disassembly

Install the cam follower lever in an arbor press, as shown.

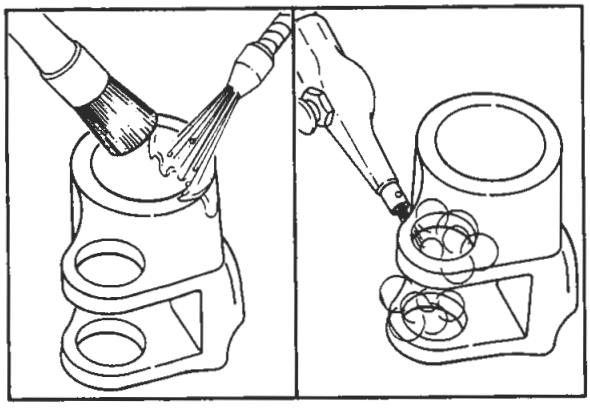


Push the socket from the lever.

Note: If a socket is replaced, the mating push rod **must** also be replaced.

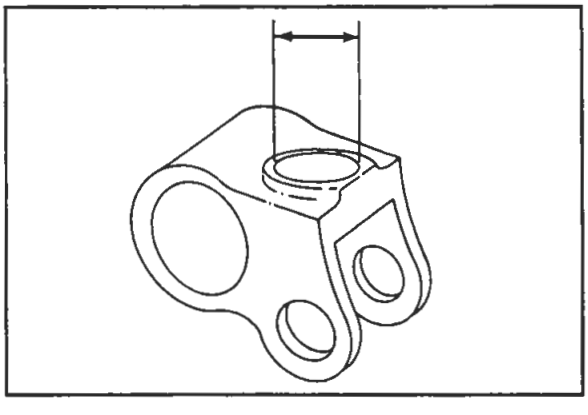
Use solvent to clean the cam follower lever. Dry with compressed air.

Use compressed air to blow any debris from the oil passages.



Inspection

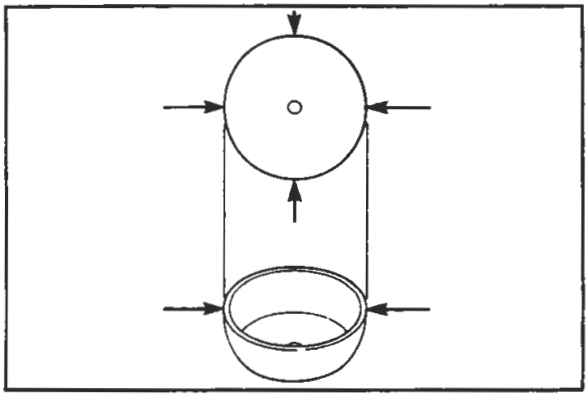
Measure the inside diameter of the cam follower lever socket bore.



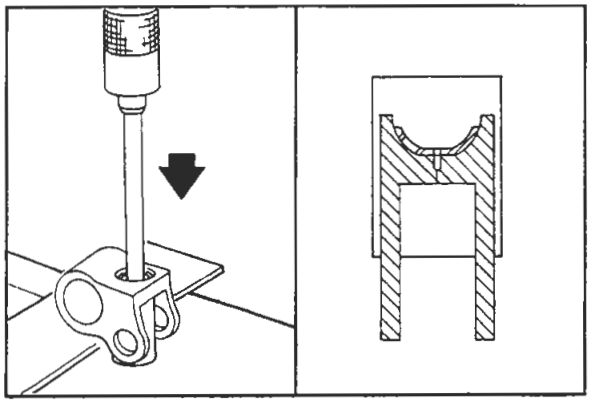
Socket Bore I.D.		
mm		in
19.024	MIN	0.7490
19.050	MAX	0.7500

Note: If the cam follower lever socket bore does **not** meet the specifications. The lever **must** be replaced.

Measure the outside diameter of the new cam follower lever socket.



Socket O.D.		
mm		in
19.062	MIN	0.7505
19.088	MAX	0.7515

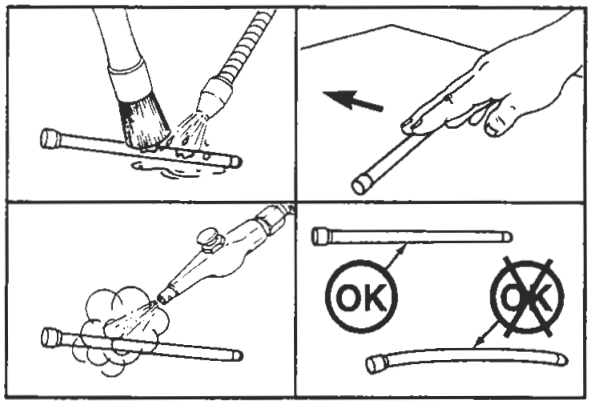


Assembly

Install the cam follower lever in an arbor press, as shown.

Use a used push rod to push the new socket into the lever.

Visually inspect the bottom side of the socket through the oil passage hole in the lever. The socket **must** be completely seated.

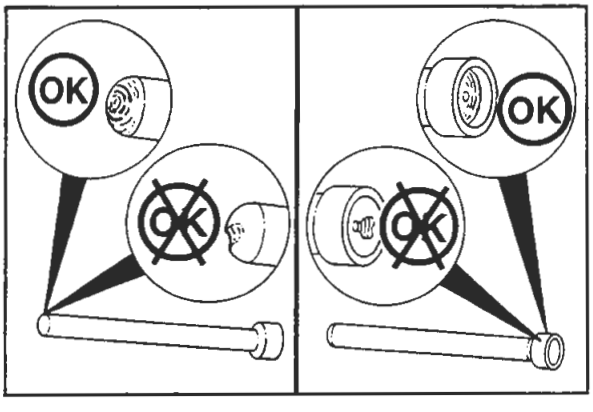


Push Rod - Clean and Inspect for Reuse (04-06)

Inspection

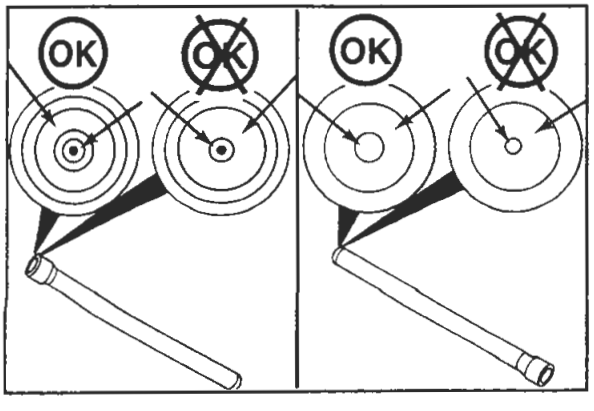
Use solvent to clean the push rods. Dry with compressed air.

Visually inspect the straightness of the push rod by rolling it on a level surface.



Visually inspect the ball and socket ends of the push rod for pitting, uneven wear, or scratches.

Note: If a push rod is replaced, the mating cam follower **must** also be replaced.



Visually inspect the seating pattern in the push rod socket for excessive wear.

Visually inspect the push rod ball end for excessive wear.

Note: If the push rods are not straight or pitting or scratches in the seating pattern can be seen or felt, the push rods **must** be replaced.

Fuel System - Group 05

Contents

Fuel Pump

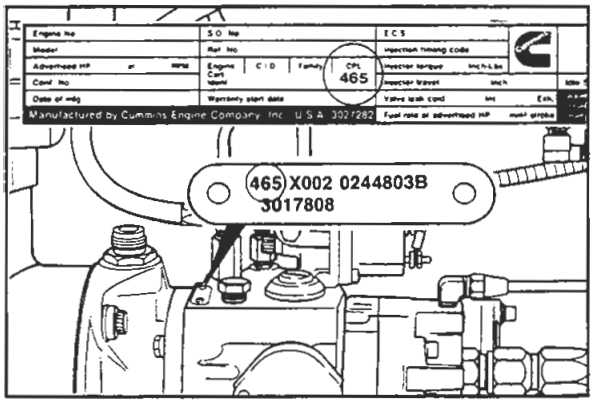
Fuel Pump - General Information

NOTE: Warranty repairs are **not** to be made to the fuel pump unless the work is performed in a shop meeting all requirements established by Cummins Engine Company, Inc. to accurately calibrate, test and repair the fuel systems on Cummins engines.

The fuel pump is calibrated for a specified performance and will vary between engine application and model. The performance of the engine is defined by the Control Parts List (CPL) and the fuel pump code.

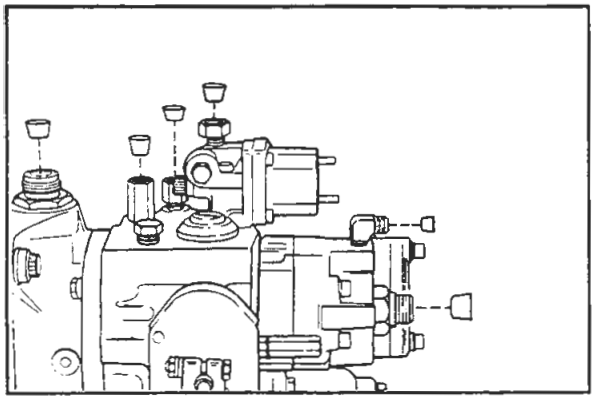
The fuel pump calibration **must** be within the published specifications. Fuel pump calibration is certified by several emission agencies. Tampering with the fuel pump can be a violation of the law. Tampering with the fuel pump can also void the engine warranty and lower the performance of the engine.

Two different design fuel pump support brackets are used on the L10 engine. Both the present production and earlier production support brackets **can** be mounted on the current production cylinder block. The present production support bracket **cannot** be mounted on the earlier production cylinder block.

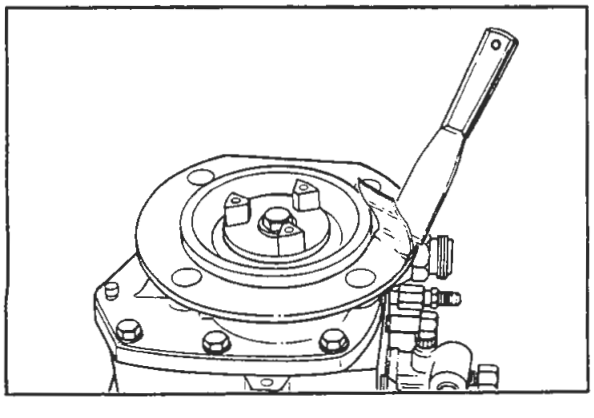


Fuel Pump - Clean and Inspect for Reuse (05-01)

When removing the fuel pump from the engine, check to make sure the same Control Parts List (CPL) number is on both the fuel pump dataplate and the engine dataplate.



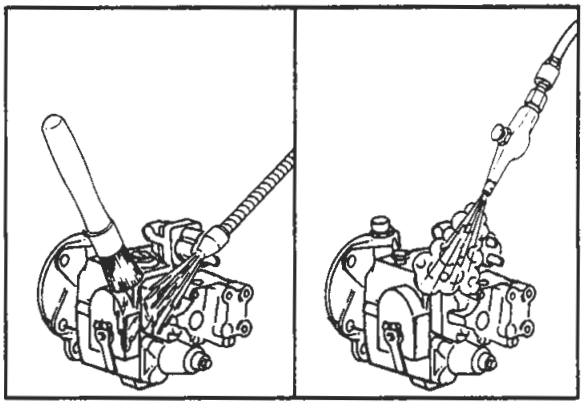
Install plastic cup plugs or tape on all openings of the fuel pump to prevent dirt or cleaning solvent from entering the pump.



Remove the gasket material from the front cover gasket sealing surface.

Caution: Use a cleaning solvent approved for cleaning aluminum to prevent damage to the fuel pump.

Use a brush and solvent to clean the fuel pump exterior. Dry with compressed air.

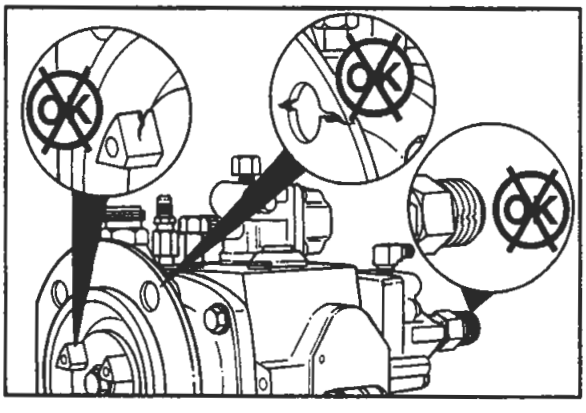


Inspection

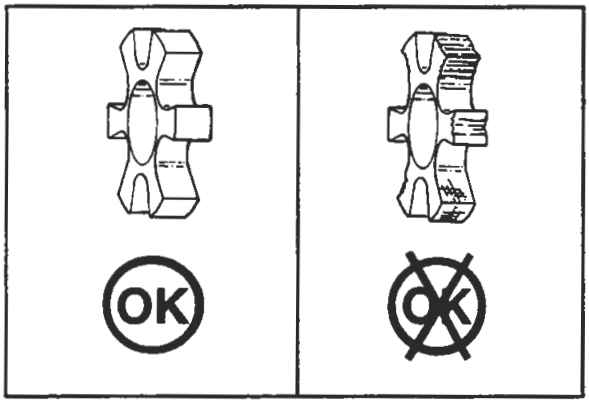
Visually inspect the fuel pump body and front cover for cracks or other damage.

Visually inspect the fuel pump assembly for damaged capscrews and damaged or loose fuel fittings.

Visually inspect the drive coupling lugs for excessive wear or damage.

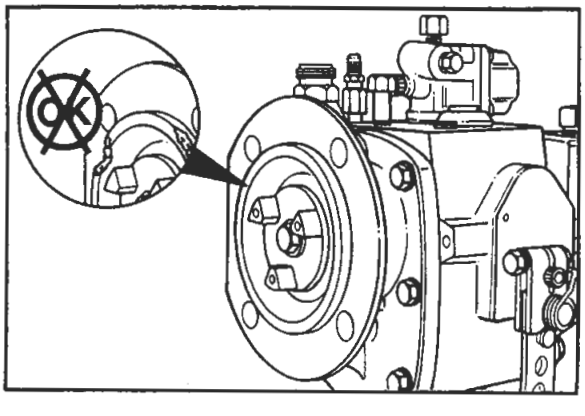


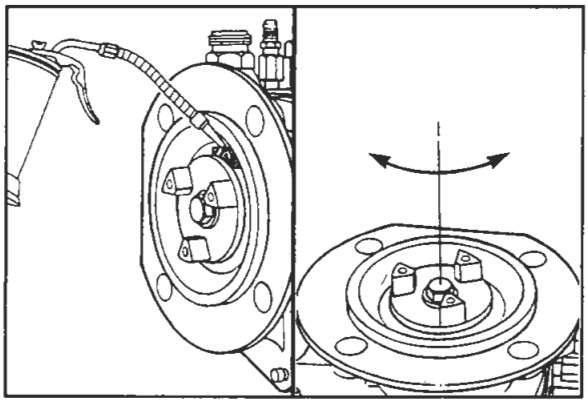
Visually inspect the drive coupling spider for cracks or other damage.



Visually inspect the front cover pilot to be sure the pilot is continuous without cracks or gaps.

Note: The L10 fuel pumps **must** use the continuous pilot front cover.

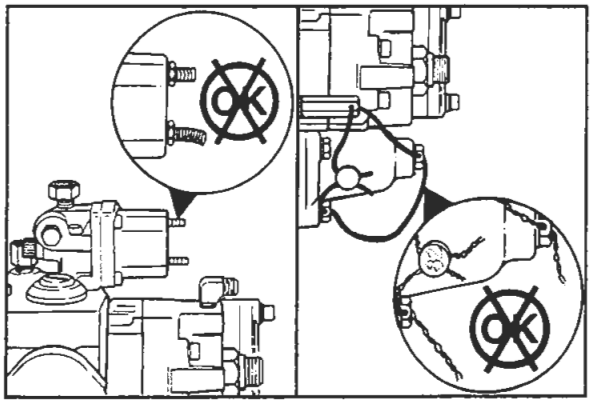




Use clean 15W-40 oil to lubricate the tachometer drive gear.

Turn the fuel pump shaft by hand. the shaft **must** rotate freely.

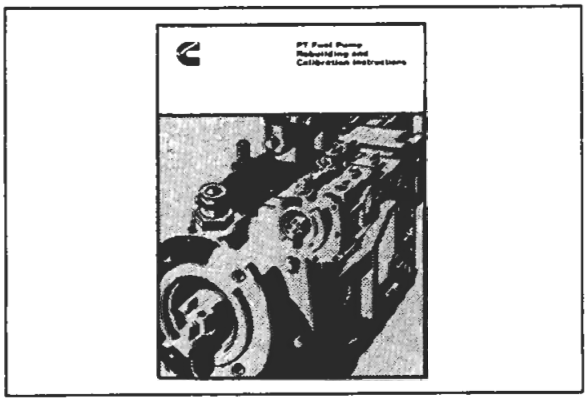
Note: If the shaft does **not** rotate freely, the pump **must** be disassembled for further inspection. Refer to Fuel Pump - Rebuild (05-02).



Visually inspect the fuel pump shutoff valve for loose or damaged electrical terminals.

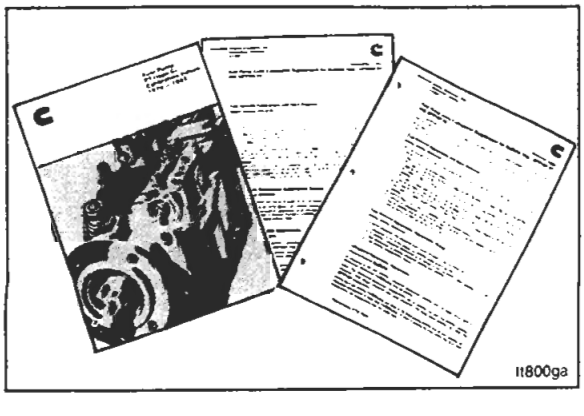
Visually inspect the fuel pump tamper seals.

Note: If the tamper seals have been broken or are missing, the fuel pump **must** be calibrated to insure the calibration accuracy. Refer to Fuel Pump - Calibrate (05-03).



Fuel Pump - Rebuild (05-02)

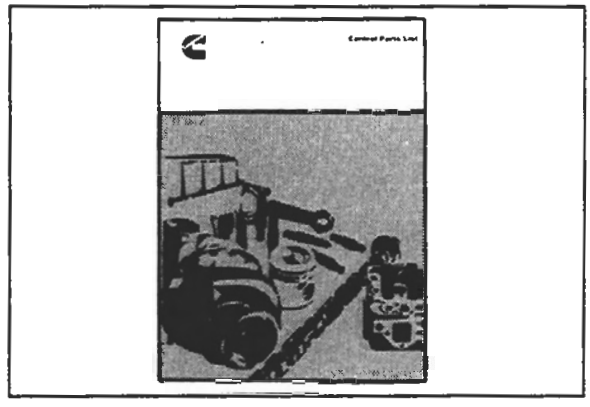
The disassembly, inspection, repair, assembly and calibration procedures for the fuel pump are covered in PT Fuel Pump Rebuilding and Calibration Instructions, Bulletin No. 3379084.



Fuel Pump - Calibrate (05-03)

The fuel pump calibration instructions are covered in the fuel pump rebuild manual. Calibration specifications for the fuel pump are provided in Fuel Pump, PT (type G) Calibration Values 1981-1986, Bulletin No. 3379352, and in monthly supplements available through the Fuel System Publications Subscription Service, Bulletin No. 3379209.

The Control Parts List (CPL) Manual, Bulletin No. 3379133, is a listing of basic engine parts and timing specifications which are necessary to produce a given engine performance. By using the CPL number stamped on the engine dataplate and this manual, parts within the engine can be identified. These parts then determine whether a fuel pump calibration is correct for that engine.



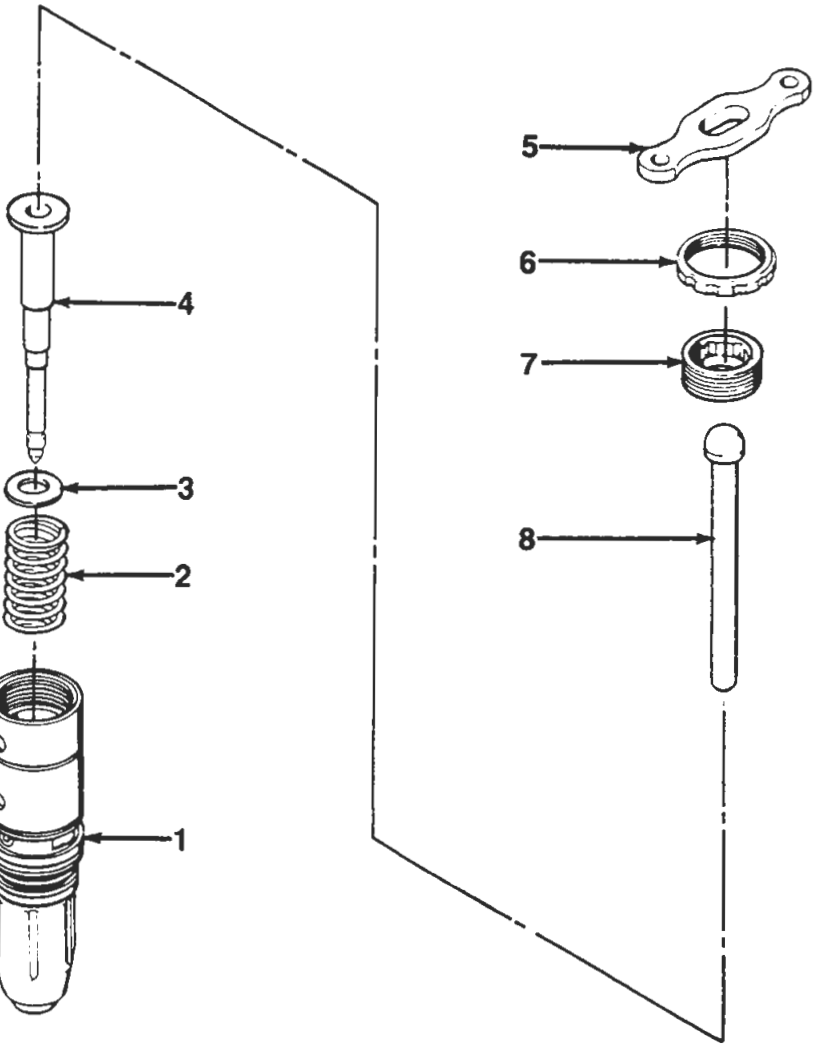
PT Fuel Pump Rebuilding and Calibration Instructions, Bulletin No. 3379352, contains an index of CPL numbers versus fuel pump codes and engine ratings. The index is used to:

1. Determine the correct fuel pump code for an engine based on the engine dataplate CPL number and the advertised horsepower and RPM.
2. Determine alternate fuel pump codes and engine ratings available for a specific engine dataplate CPL number.

Injectors and Fuel Lines - Group 06

Contents

Injector - PT (type D) Top Stop - Exploded View



Ref. No.	Description	Qty.	Ref. No.	Description	Qty.
1	Part Number Location	-	5	Clamp, Hold Down	6
2	Spring, Injector	6	6	Locknut	6
3	*Retainer, Spring	6	7	Nut, Stop	6
4	Plunger, Coupling	6	8	Link, Injector Plunger	6

*Notch indicates hardened spring retainer, to be used in Top Stop injectors.

Injectors - PT (type D) Top Stop - General Information

Note: Warranty repairs are **not** to be made to the injectors unless the work is performed in a shop meeting all requirements established by Cummins Engine Company, Inc. to accurately calibrate, test and repair the fuel systems on Cummins engines.

The injectors used on the L10 engine are the PT (type D) Top Stop style injectors. The earlier production style Top Stop injectors did **not** have the stop nut adjusted to limit the plunger travel. The present production style Top Stop injectors **do** have the stop nut adjusted to limit the plunger travel. The injector adjusting procedure is different for these injectors when setting the overhead. The injectors that do **not** have the stop nut adjusted to limit the plunger travel, use the dial indicator method. The injectors that **do** have the stop nut adjusted to limit the plunger travel, use the torque wrench method to preload the top stop injector.

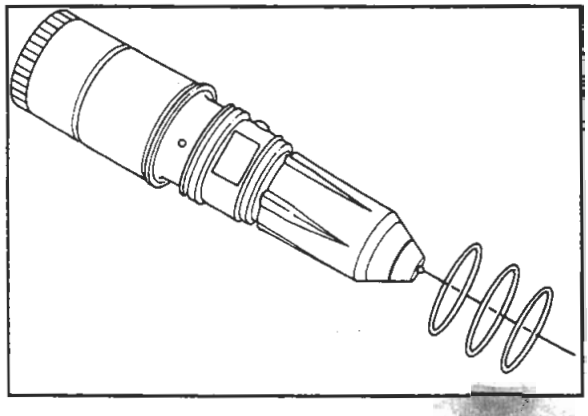
Note: The injector plunger coupling and barrel are machined to a very precise tolerance and are available as a matched assembly only. Do **not** mix the plunger and barrel assemblies. Always replace the plunger and barrel as a matched assembly if the injector is rebuilt.

When removing the injectors from the engine, compare the injector assembly number with the appropriate Control Parts List injector assembly number listed in the CPL manual. If the numbers do **not** match, either replace the injector or rebuild it to match the assemblies required.

Injectors - Clean the Exterior and Inspect for Reuse (06-01)

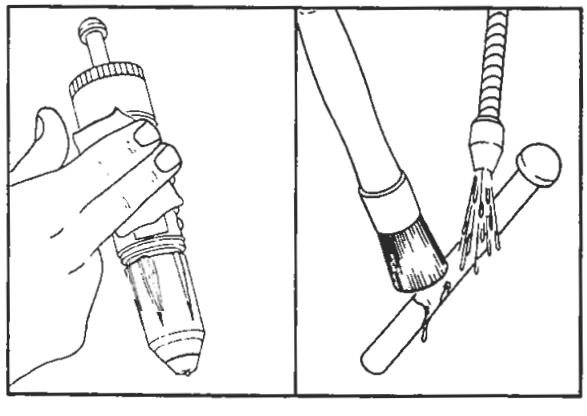
Caution: Do not remove the injector plungers or allow the plungers to fall out of the injector body. Injector plungers and barrels have a very precise fit and are damaged easily.

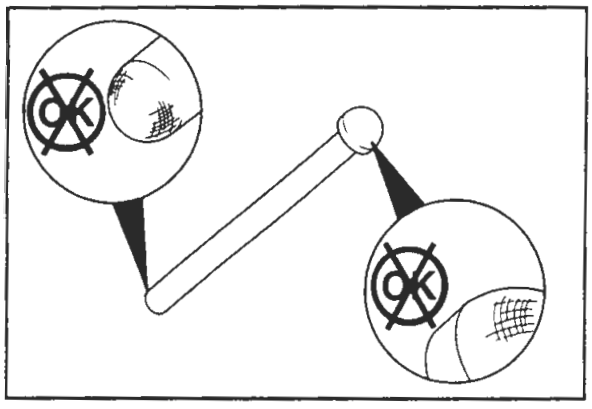
Remove and discard the three injector o-rings.



Use a clean, lint free cloth to clean the exterior of the injectors.

Use solvent to clean the injector plunger links.

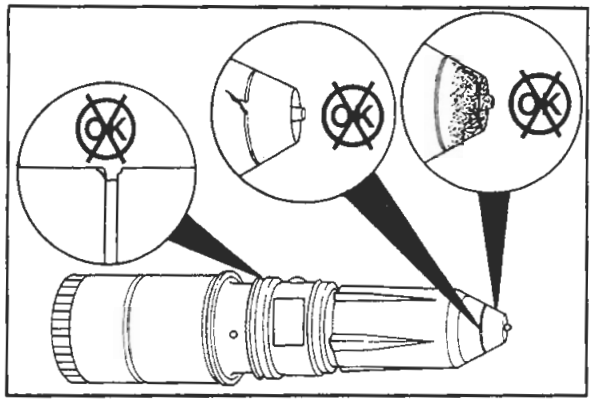




Inspection

Visually inspect the injector plunger links for damage, excessive wear and pitting or scoring on the ball ends.

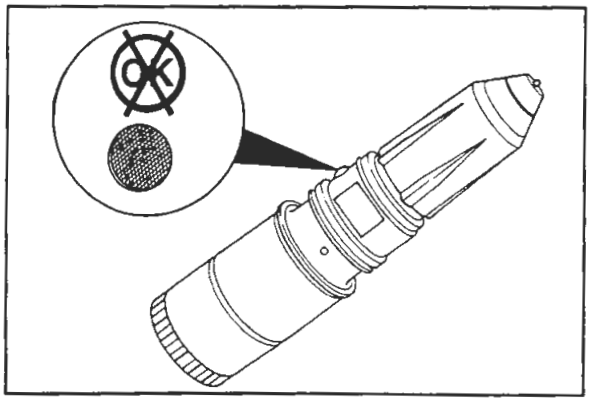
Note: If the plunger link is damaged, or the pitting or scoring can be seen or felt, the plunger links **must** be replaced.



Visually inspect the injector for carbon deposits on the injector cup and cup retainer.

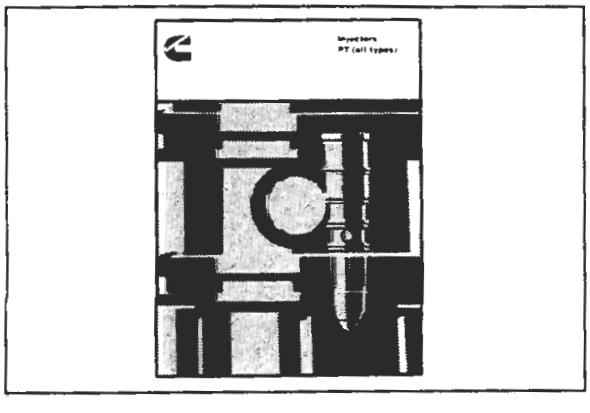
Visually inspect the o-ring grooves for damage.

Visually inspect the injector body and cup retainer for cracks or other damage.



Visually inspect the orifice screen for damage, contamination or metal particles.

Note: If damaged or contaminated parts are found, the injectors **must** be replaced or rebuilt. Refer to Injector Rebuild and Calibration information (06-02 and 06-03).

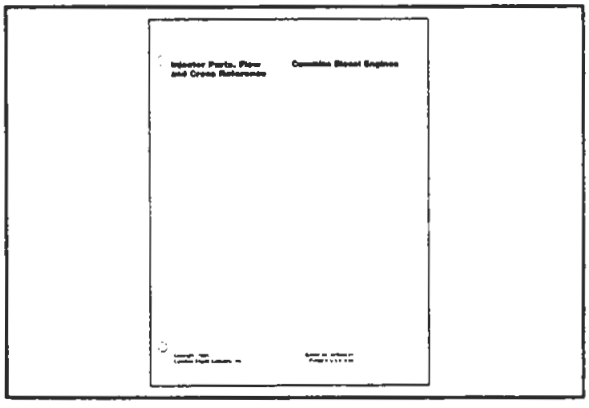


Injectors - Rebuild (06-02)

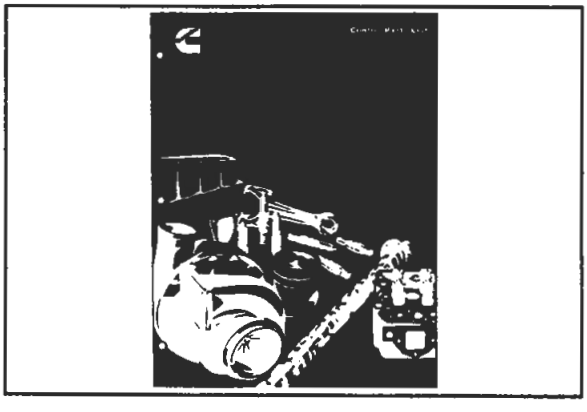
The disassembly, inspection, repair and calibration procedure for the injectors are covered in Cummins PT Injectors (all types), Bulletin No. 3379071.

Injectors - Calibrate (06-03)

The injector calibration specifications and parts information are provided in Injector Parts, Flow and Cross Reference, Bulletin No. 3379664.

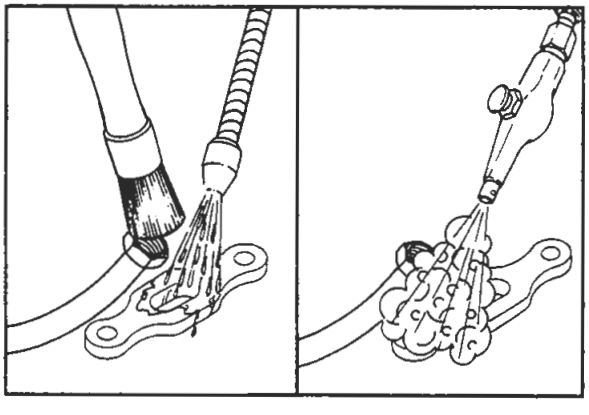


The CPL (Control Parts List) Manual, Bulletin No. 3379133 is a listing of basic engine parts and timing specifications which are necessary to produce a given engine performance. The CPL number stamped on the engine dataplate is used to identify parts within the engine, including the injectors.



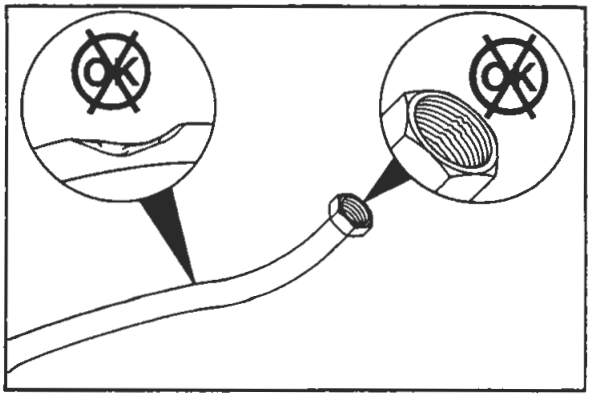
Fuel Tubes, Fittings and Mounting Parts - Clean and Inspect for Reuse (06-04)

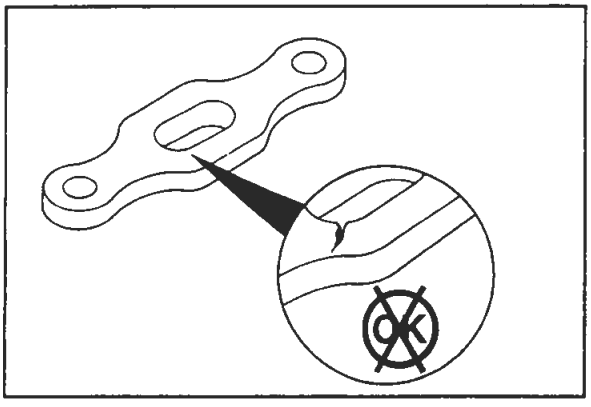
Use solvent to clean the fuel tubes, fittings and parts. Dry with compressed air.



Inspection

Visually inspect the fuel tubes for cracks or locations where the tubing is crushed. Do **not** attempt to repair fuel tubing.





Visually inspect the injector hold down clamps for cracks or other damage.

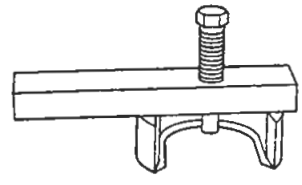
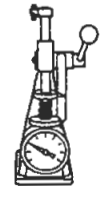
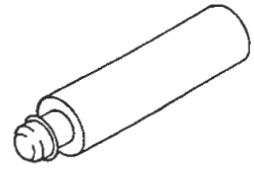
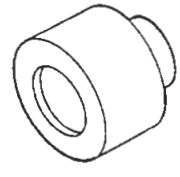
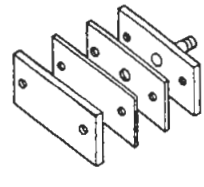
Note: If cracked or damaged parts are found the parts **must** be replaced.

Lubricating Oil System - Group 07

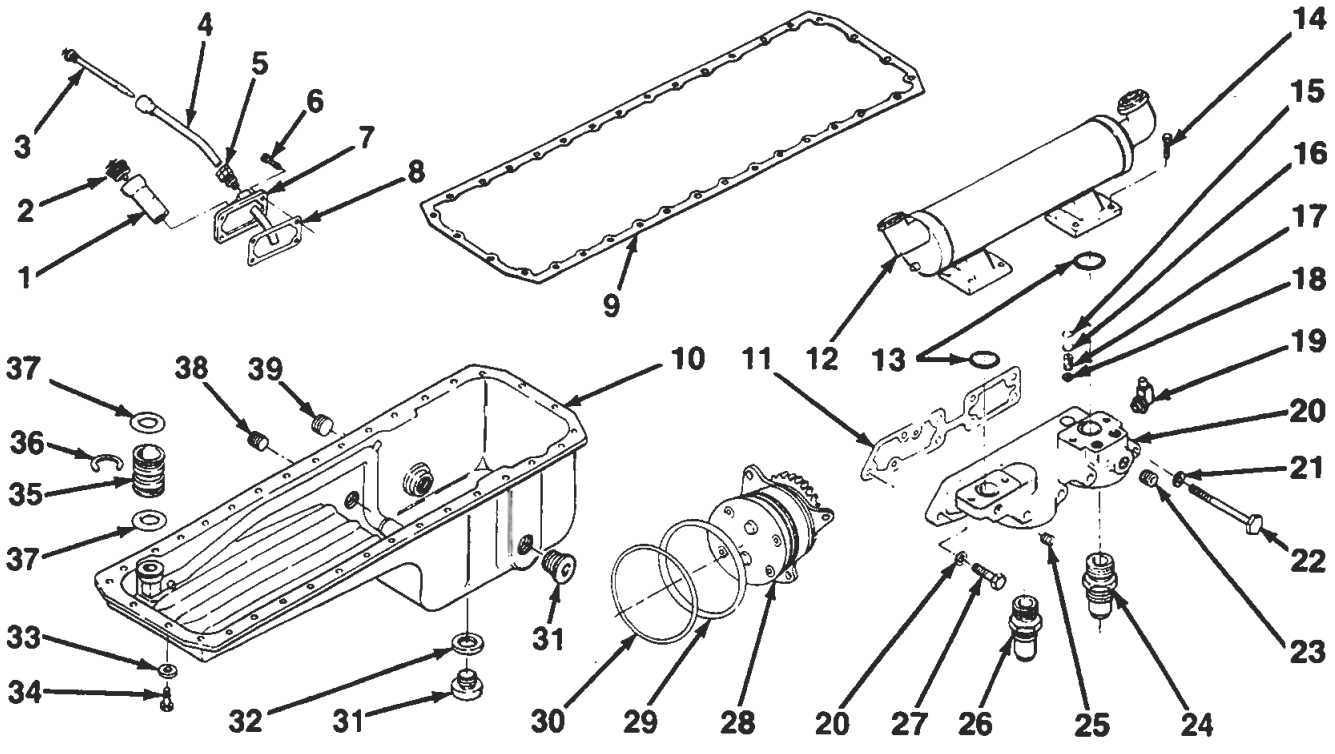
Contents

Lubricating Oil System - Service Tools

The following special tools are recommended to perform the procedures in Group 07. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

Tool No.	Tool Description	Tool Illustration
3375082	**Lubricating Oil Pump Gear Puller** Remove the lubricating oil pump main drive gear.	
3375182	**Valve Spring Tester** Measure the tension of the oil filter head by-pass valve spring.	
3376795	**Expansion Plug Driver Handle** Use with the Part No. 3376816 Expansion Plug Driver.	
3376816	**Expansion Plug Driver** Install the bypass valve regulator assembly expansion plug.	
3376861	**Lubricating Oil Cooler Pressure Test Kit** Pressure test the lubricating oil cooler element. Test Kit consists of: 3376889 Test Plate, 3376890 Test Plates (2), and 3376866 Test Gasket	

Lubricating Oil System - Exploded View



Ref. No.	Description	Qty.
1	Tube, Oil Filler	1
2	Cap, Oil Filler	1
3	Dipstick	1
4	Tube, Oil Gauge	1
5	Connector, Tube	1
6	Capscrew	4
7	Cover, Handhole	1
8	Gasket, Handhole Cover	3
9	Gasket, Oil Pan	1
10	Pan, Oil	1
11	Gasket, Filter Head	1
12	Cooler, Lubricating Oil	1
13	O-ring	2
14	Capscrew	4
15	Ring, Snap	1
16	Plug, Expansion	1
17	Spring, Compression	1
18	Disc, Bypass	1
19	Turbocharger Supply Fitting	1
20	Head, Lubricating Oil Filter	1

Ref. No.	Description	Qty.
21	Washer, Plain	9
22	Capscrew	4
23	Plug	1
24	Adapter, Filter Head	1
25	Plug	1
26	Adapter, Filter Head	1
27	Capscrew	5
28	Pump, Lubricating Oil	1
29	O-ring	1
30	O-ring	1
31	Plug, Oil Pan	2
32	Washer, Plain	1
33	Washer, Spring	34
34	Capscrew	34
35	Tube, Oil Transfer	1
36	Ring, Retaining	1
37	O-ring, Seal	2
38	Plug, Pipe	1
39	Plug, Pipe	1

Lubricating Oil System - General Information

The lubricating oil system group consists of the oil pan, the oil pan transfer tube, the oil dipstick and tube, the oil filter head, the oil cooler and the lubricating oil pump.

Service replacement oil dipsticks do **not** have the high and low oil level marks indicated on the dipstick. The dipstick **must** be calibrated after the engine is installed in the chassis.

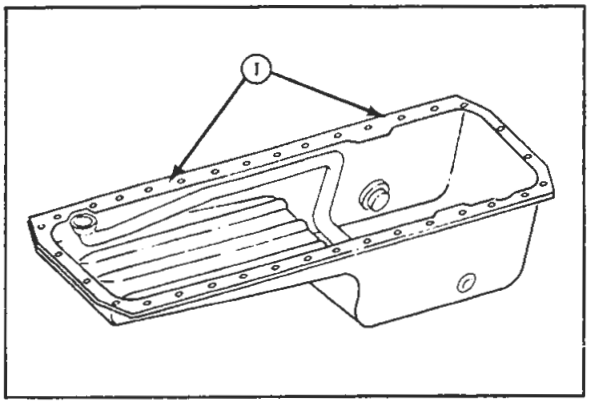
Instructions for pressure testing the lubricating oil cooler element are included in this manual. The oil cooler does **not** have a replaceable element and **cannot** be rebuilt in the field.

Two types of lubricating oil pumps have been used on the L10 engine. The earlier production style pumps have bushings in the body and cover plate and use a gasket between the cover and body. The present production style pumps do **not** use bushings in the body or cover plate and have no gasket.

Caution: The lubricating oil pump bushings cannot be replaced because of the precise and sophisticated drilling and reaming required. Attempting to rebuild the oil pump can cause oil pump failure and future engine damage.

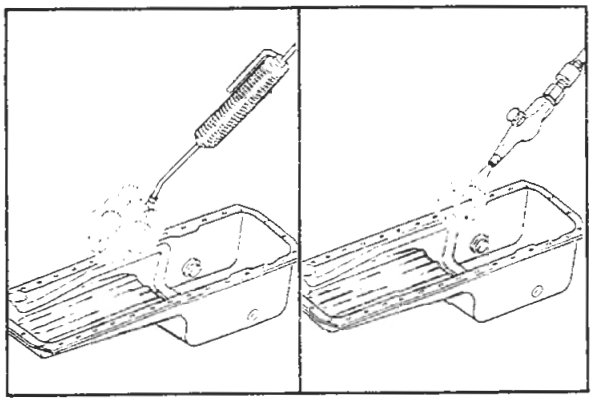
The L10 engine uses capscrews in both metric and U.S. Customary dimensions. In some cases, the capscrews are almost identical in dimensions and appearance. Be sure to install the capscrews in the same location they were removed from.

The pipe plugs and hose clamps installed in the lubricating system are U.S. Customary dimensions.



Lubricating Oil Pan - Clean and Inspect for Reuse (07-01)

Remove all gasket material from the oil pan gasket sealing surface (1).

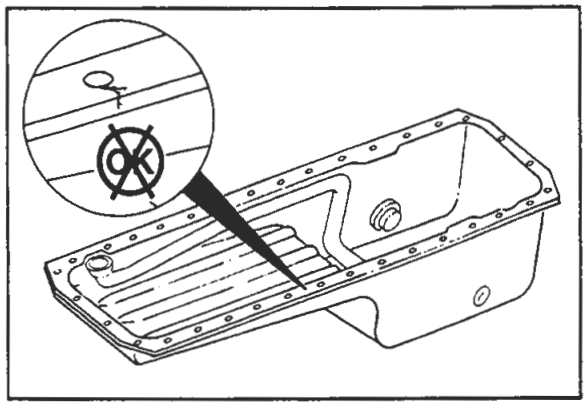


Warning: When using a steam cleaner, wear protective clothing and safety classes or a face shield. Hot steam will cause serious personal injury.

Use steam to clean the oil pan. Dry with compressed air.

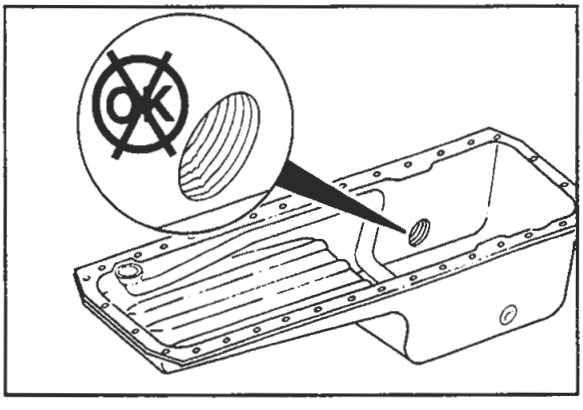
Inspection

Visually inspect the oil pan for cracks or damage.



Visually inspect the threaded holes for damage. Damaged threads may be chased with the following taps.

Oil Pan Threaded Holes	
Thread Location	**Tap Size**
Temperature Gauge	3/8 in. NPTF
Oil Sump Heater	1-18 NS-3B
Oil Drain	1 in. NPTF

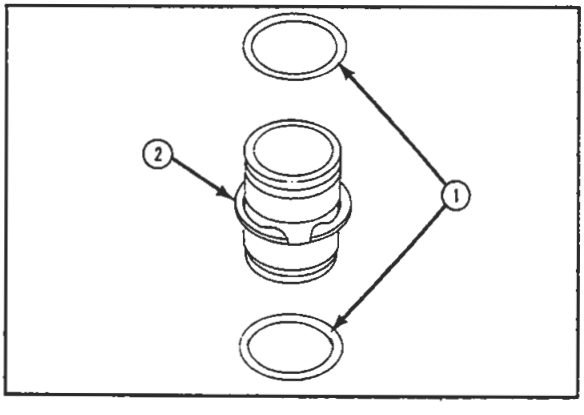


Note: If the oil pan is cracked or damaged or if the threaded holes cannot be repaired with the taps listed above, the oil pan **must** be replaced.

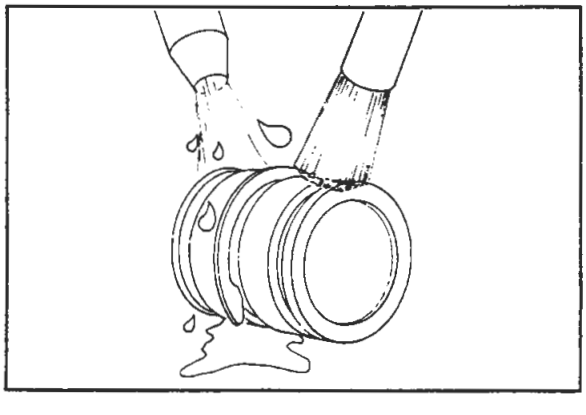
Lubricating Oil Pan Transfer Tube - Clean and Inspect for Reuse (07-02)

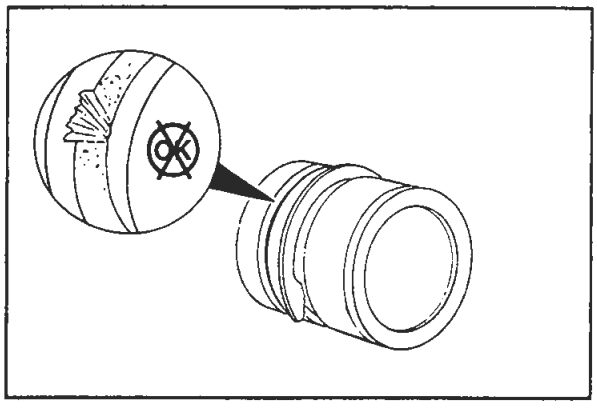
Remove the o-rings (1) from the oil transfer tube.

Note: The snap ring (2) is used to locate the oil transfer tube correctly between the oil pan and the cylinder block during assembly.



Use solvent to clean the oil transfer tube. Dry with compressed air.



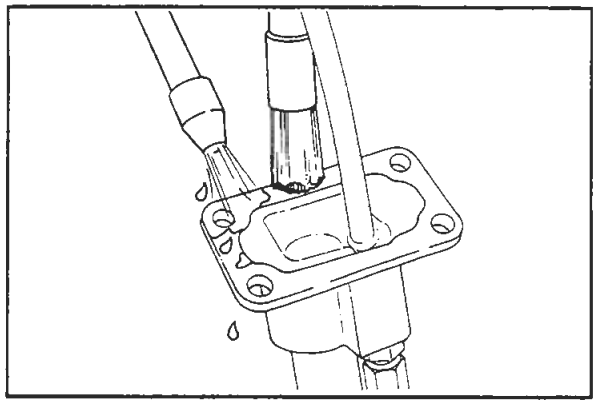


Inspection

Visually inspect the oil transfer tube for cracks or damage.

Visually inspect the o-ring grooves for cavitation or damage.

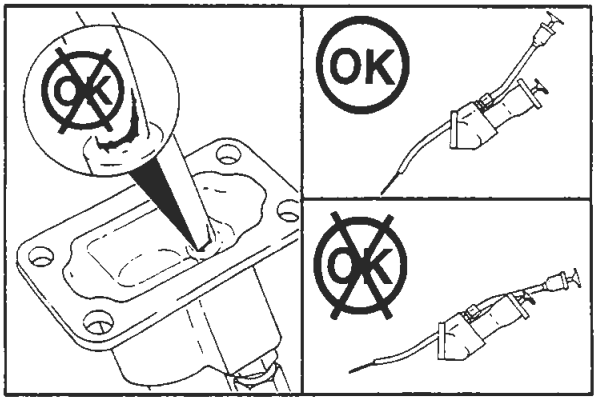
Note: If cracks, damage or cavitation are found, the oil transfer tube **must** be replaced.



Lubricating Oil Dipstick and Dipstick Tube - Clean and Inspect for Reuse (07-03)

Remove all gasket material from the gasket sealing surface.

Use solvent to clean the dipstick and filler tube assembly. Dry with compressed air.

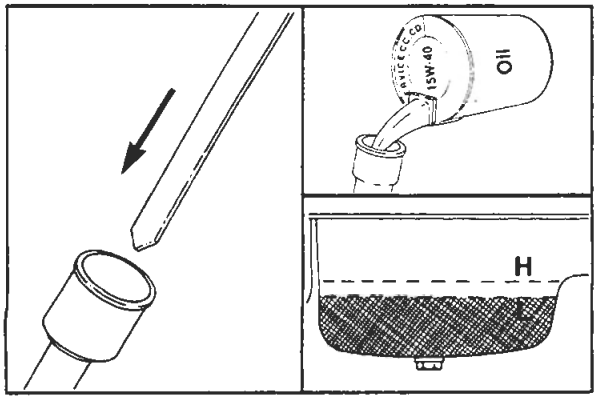


Inspection

Visually inspect the oil gauge tube, filler tube and hand hole cover for cracks or damage.

Visually inspect the oil gauge tube angle.

Note: If cracks or damage is found or the oil gauge tube does **not** angle downward into the oil pan, the damaged parts or oil gauge tube **must** be replaced.



Lubricating Oil Dipstick - Calibrate (07-04)

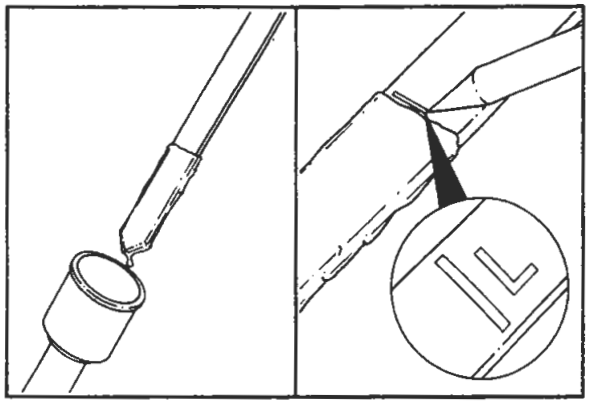
Install the dipstick in the oil gauge tube.

Use clean 15W-40 oil to fill the oil pan to the specified "Low" oil pan capacity level.

Oil Pan Capacity		
Litres		U.S. Gallons
Automotive		
18.9	Low	5.0
26.5	High	7.0
Industrial		
22.7	Low	6.0
26.5	High	7.0

Remove the dipstick and scribe a line across the dipstick. Mark the low oil level with an "L".

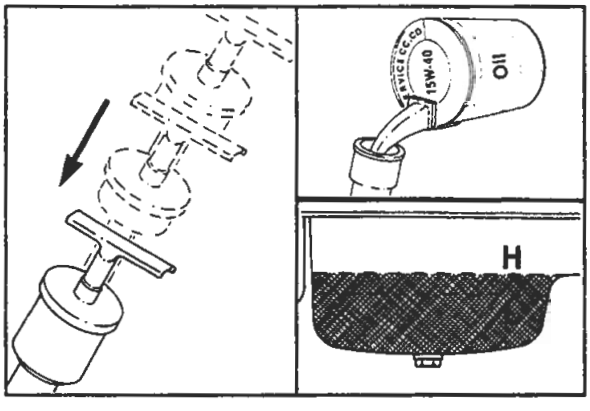
Note: Cut the new dipstick off approximately 38 mm [1.5 inch] below the "Low" oil level mark.



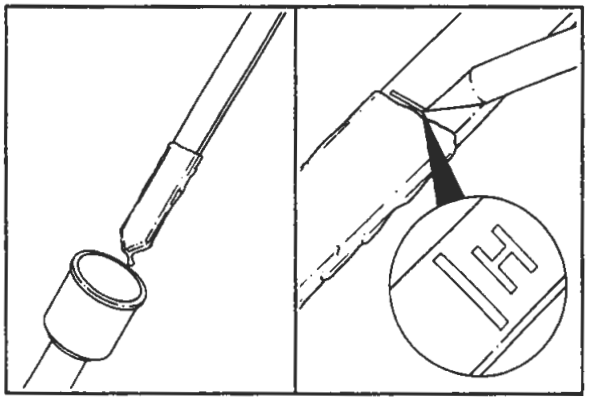
Install the dipstick in the oil gauge tube.

Use clean 15W-40 oil to fill the oil pan to the specified "High" oil pan capacity level.

Refer to the preceding oil pan capacity table for the oil required.



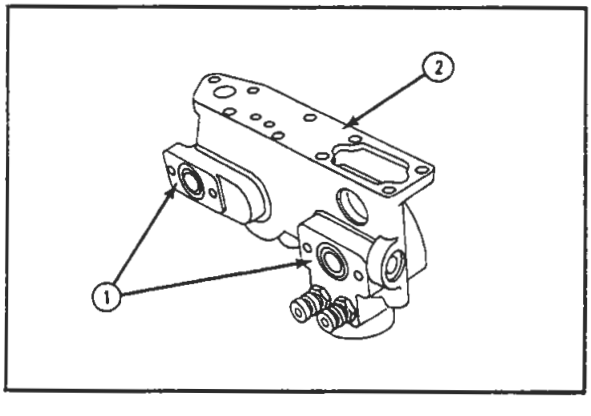
Remove the dipstick and scribe a line across the dipstick. Mark the "High" oil level with an "H".

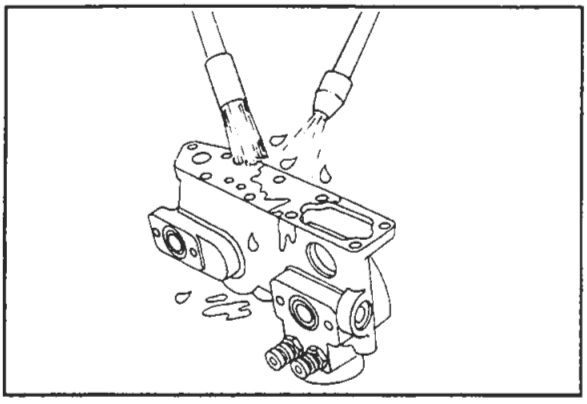


Lubricating Oil Filter Head - Clean and Inspect for Reuse (07-05)

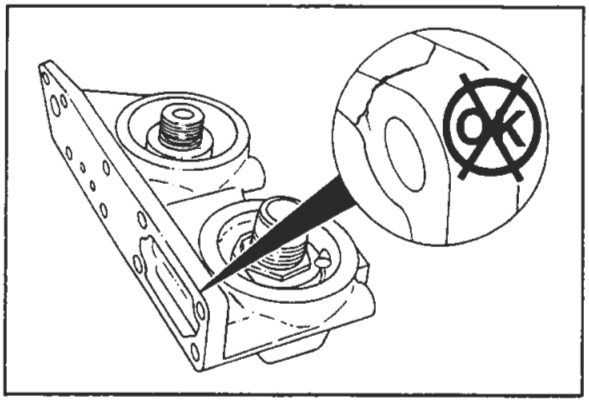
Remove the o-rings from surfaces (1).

Remove the filter head mounting gasket material from surface (2).





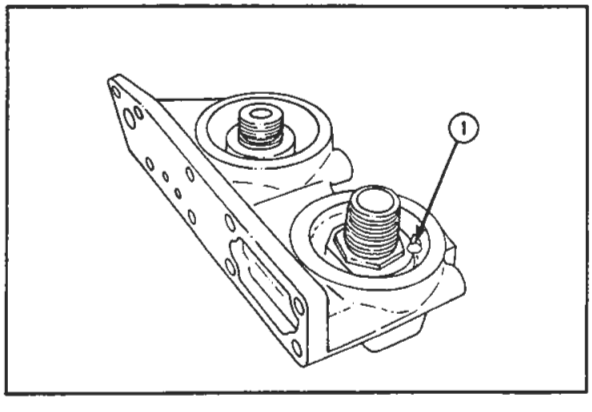
Use solvent to clean the exterior of the filter head. Dry with compressed air.



Inspection

Visually inspect the filter head for cracks or other damage.

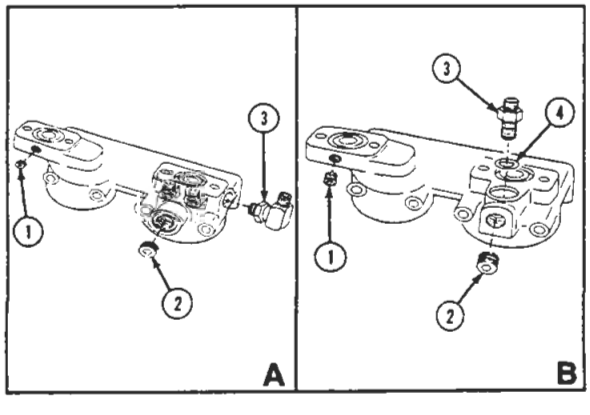
NOTE: If cracks or damage is found, the filter head **must** be replaced.



Use a flat punch to apply pressure to the bypass valve disc (1).

The bypass valve disc **must** move freely when pressure is applied.

NOTE: If the bypass valve does not move freely, refer to Lubricating Oil Filter Head - Rebuild (07-06) to replace the bypass valve.



Lubricating Oil Filter Head - Rebuild (07-06)

Disassembly

Remove the plugs (1 and 2). Remove and discard the o-rings, if used. Remove the turbocharger oil supply fitting (3). Remove and discard the oil supply fitting o-ring (4).

NOTE: The turbocharger oil supply hose fitting at the front of the filter head, can be above the bypass valve in Style (B) as shown or in the plug hole (2).

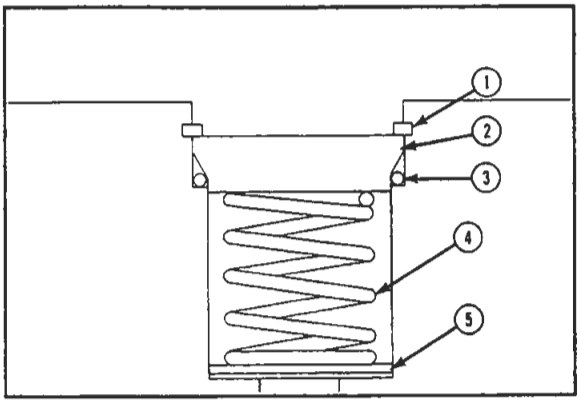
- Style (A)
- Style (B)

If the turbocharger oil supply fitting was installed above the bypass valve:

Remove the snap ring (1), the insert (2) and the insert o-ring (3). Discard the o-ring.

Note: The insert (2) is pressed into the filter head and will require a slide hammer for removal.

Remove the bypass valve spring (4) and disc (5).

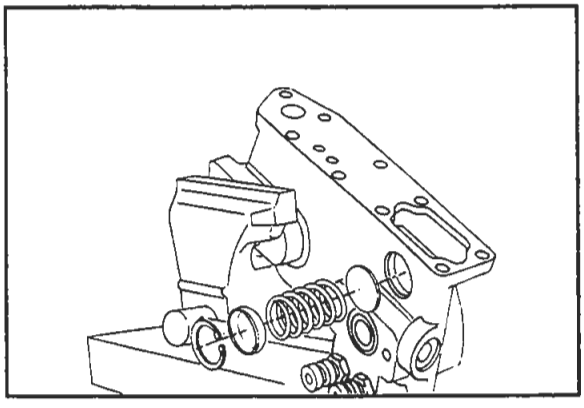


If the turbocharger oil supply fitting was installed in the plug hole:

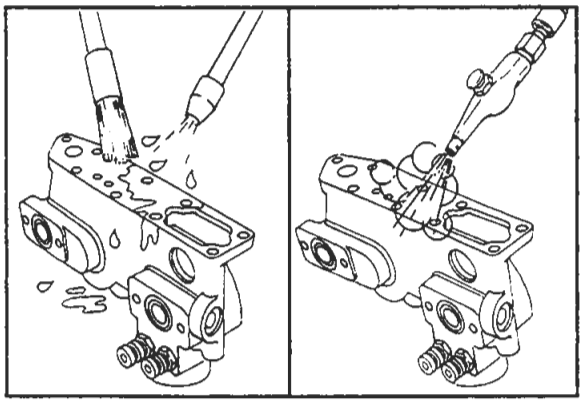
Remove the snap ring.

Drill a 1/8 inch hole in the expansion plug and remove the plug with a dent puller.

Remove the bypass valve spring and disc.



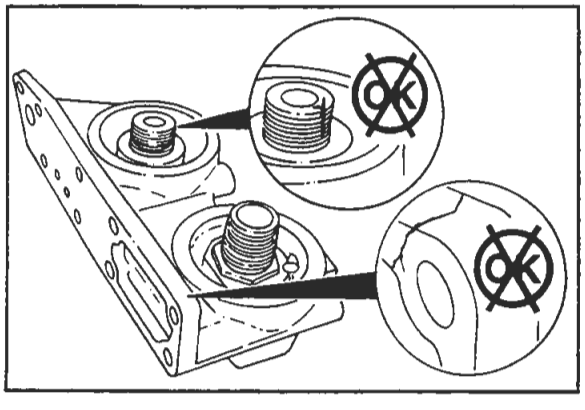
Use solvent to clean the filter head parts. Dry with compressed air.

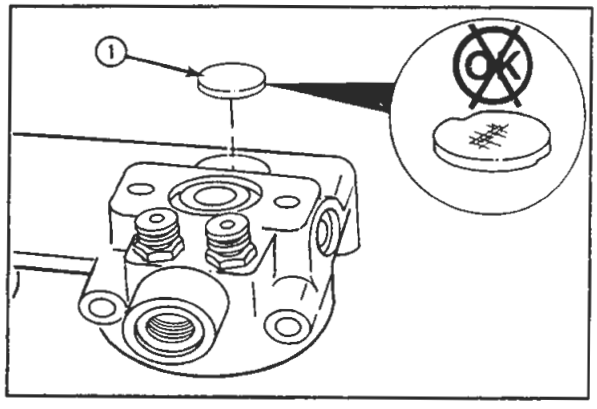


Inspection

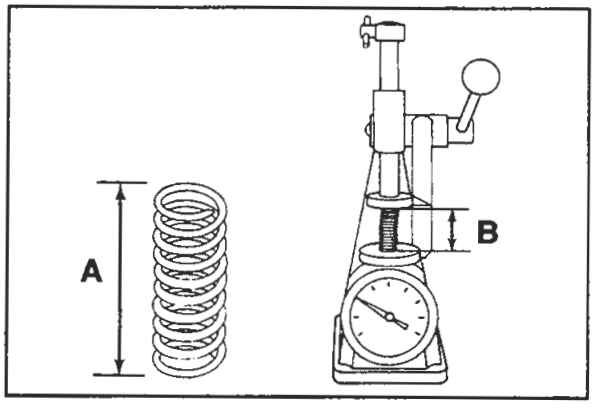
Visually inspect the filter head for cracks or other damage.

Visually inspect the oil filter adapters for damaged or distorted threads.





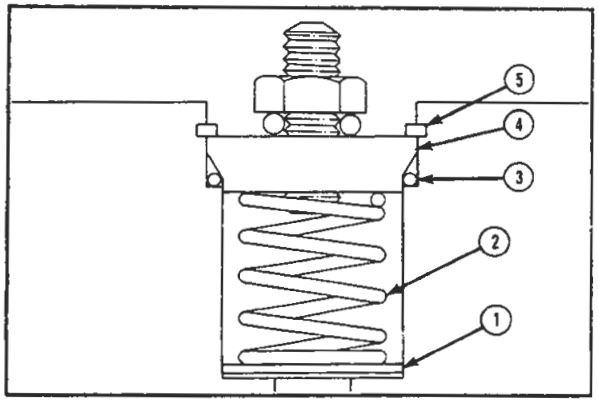
Visually inspect the layer of rubber on the bypass valve disc (1) for tears, distortion or damage.



Use the Part No. 3375182 Valve Spring Tester to inspect the operating condition of the bypass valve spring.

Spring Specifications		
Free Length (A)		
mm		**in.**
38.6	MIN	1.52
42.7	MAX	1.68
Load at 20.3 mm [0.80 in] (B)		
N		**lbf**
44.9	MIN	10.1
54.7	MAX	12.3

Note: If damaged parts are found or the bypass spring is not within the specifications given, the parts **must** be replaced.



Assembly

If the turbocharger oil supply fitting is installed above the bypass valve:

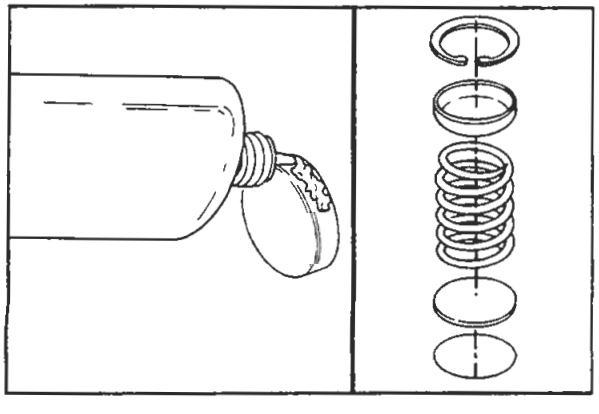
Install the bypass valve disc (1) and spring (2).

Use clean 15W-40 to lubricate the o-rings.

Install the new o-ring (3) and press the insert (4) into the filter head. Install the snap ring (5).

Install the turbocharger supply fitting and o-ring.

Torque Value: 25 N•m [20 ft-lb]



If the turbocharger oil supply fitting is installed in the pipe plug hole:

Install the bypass valve disc and spring into the filter head.

Apply a coating of Part No. 3375068 Cup Plug Sealant to the outside diameter of the expansion plug.

Use the Part No. 3376816 Expansion Plug Driver to push the expansion plug into the filter head.

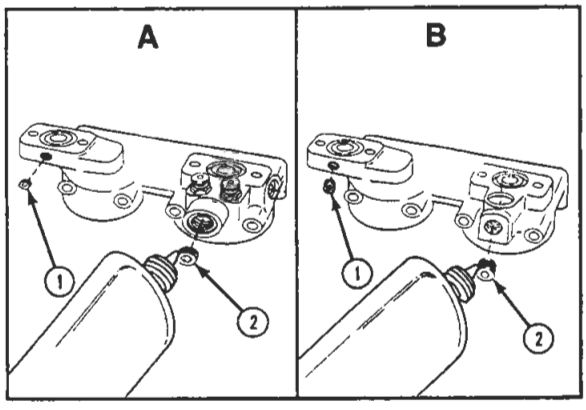
Install the snap ring.

Apply a coating of Part No. 3375066 Pipe Sealant to the threads of the plugs (1 and 2) or turbocharger supply fitting (2).

Install the pipe plug (1) and the pipe plug or turbocharger supply filling (2).

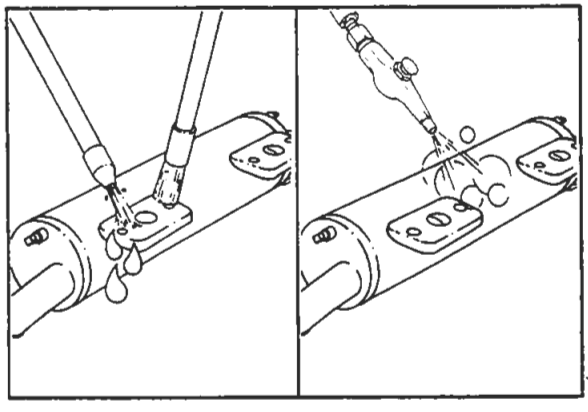
Torque Value: 25 N•m [20 ft-lb]

- Present Production Style (A)
- Earlier Production Style (B)



Lubricating Oil Cooler - Clean and Inspect for Reuse (07-07)

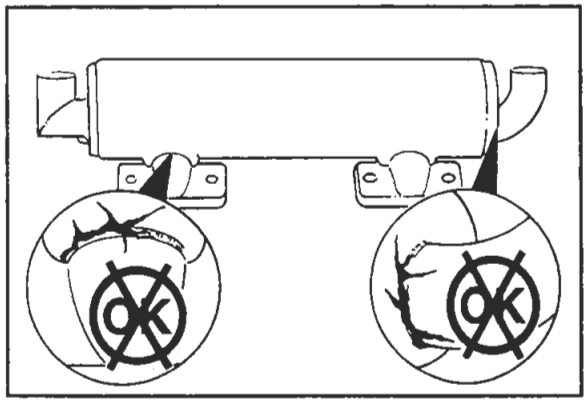
Use solvent to clean the outside of the oil cooler assembly. Dry with compressed air.



Inspection

Visually inspect the oil cooler for cracks or damage.

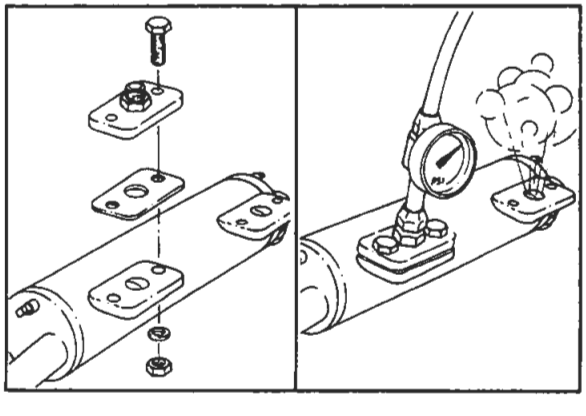
Note: If cracks or damage are found, the oil cooler **must** be replaced.

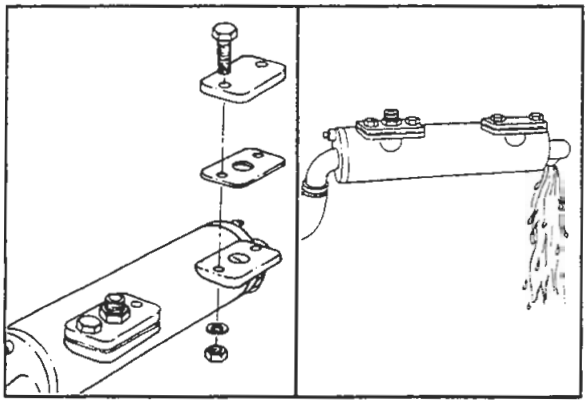


Use the Part No. 3376861 Lubricating Oil Cooler Pressure Test Kit to seal the oil passage.

Install one of the pressure test plates on one of the oil passage openings.

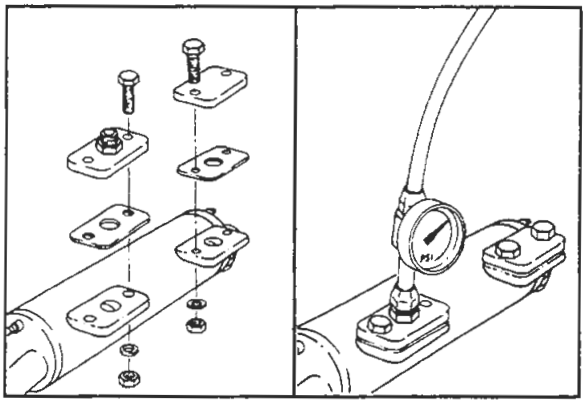
Use air pressure to blow the moisture from inside the oil passages.





Use a cooling system cleaner attached to the coolant outlet side of the housing to flush the coolant passages.

Note: If the oil or coolant passages are contaminated by foriegn material, the oil cooler **must** be replaced.



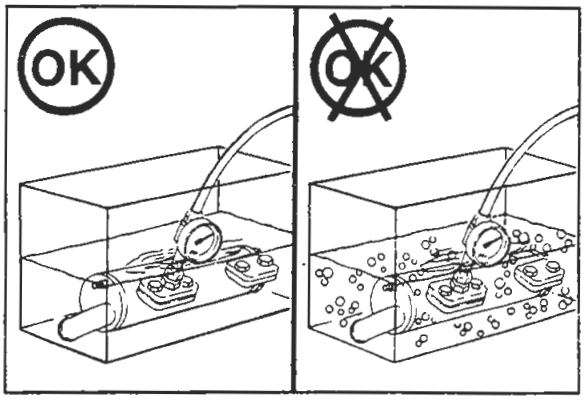
Pressure Test the Oil Cooler Element

Use the Part No. 3376861 Lubricating Oil Cooler Pressure Test Kit to pressure test the oil cooler element.

Install the two gaskets and test plates to the oil passage openings.

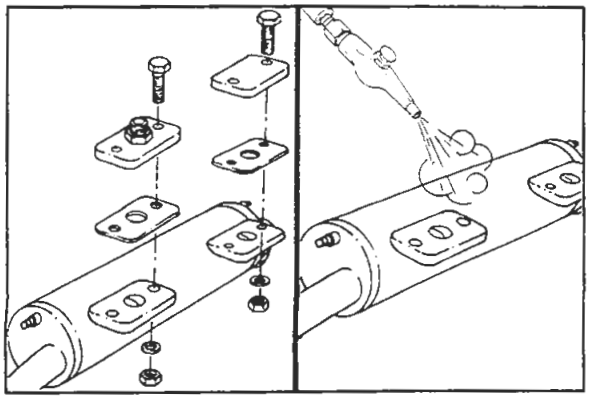
Install a regulated air pressure line to the Part No. 3376869 Test Plate.

Air Pressure: 414 kPa [60 psi]



Install the oil cooler in a tank of water.

Note: If leaks are found in the oil cooler element, the oil cooler **must** be replaced.



Remove the oil cooler from the tank of water.

Remove the pressure test equipment.

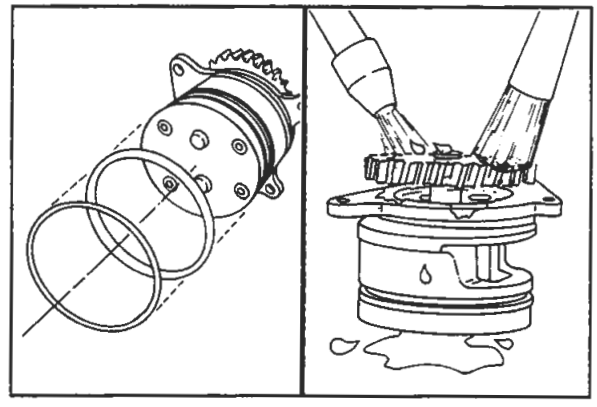
Use compressed air to dry the oil cooler.

Note: Cover all of the openings with tape to prevent dirt from entering the element when the oil cooler is not in use.

Lubricating Oil Pump - Clean and Inspect for Reuse (07-08)

Remove the two sealing o-rings. Discard the o-rings.

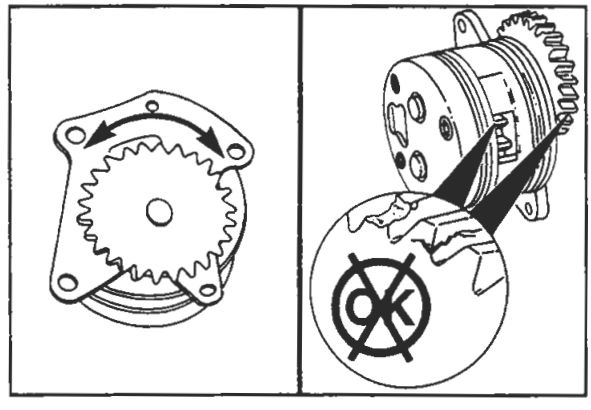
Use solvent to clean the oil pump. Dry with compressed air.



Inspection (Visual)

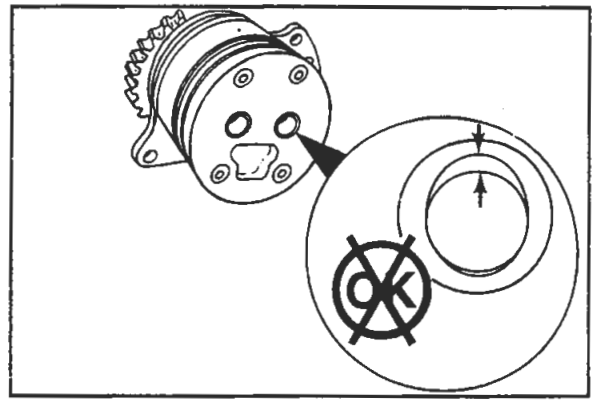
Turn the main drive gear by hand to inspect the external gears for freedom of rotation.

Visually inspect the gears for cracked or broken teeth.



Visually inspect the rear cover plate bushings or shaft bores for excessive wear or discoloration due to overheating or shaft seizure.

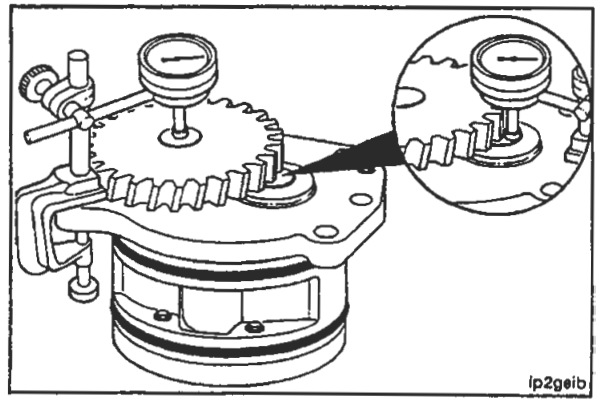
NOTE: The present production style oil pumps do **not** use bushings in the cover plate or pump body.

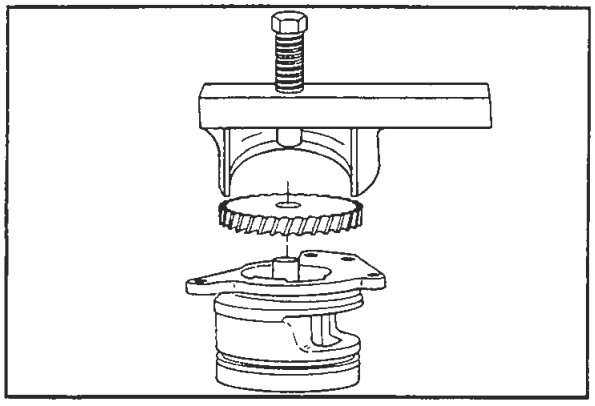


Measure the end clearance of both shafts.

Shaft End Clearance		
mm		in.
0.064	MIN	0.0025
0.270	MAX	0.0106

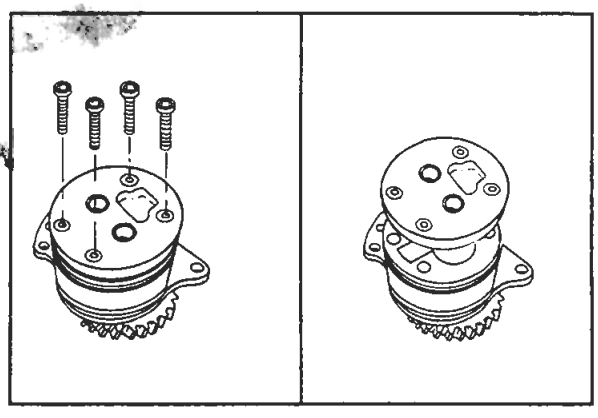
NOTE: If the main drive gear does **not** turn freely by hand, cracked or broken gear teeth are found or the shaft end clearance is not within the specifications given, the oil pump **must** be disassembled for further inspection.





Disassembly

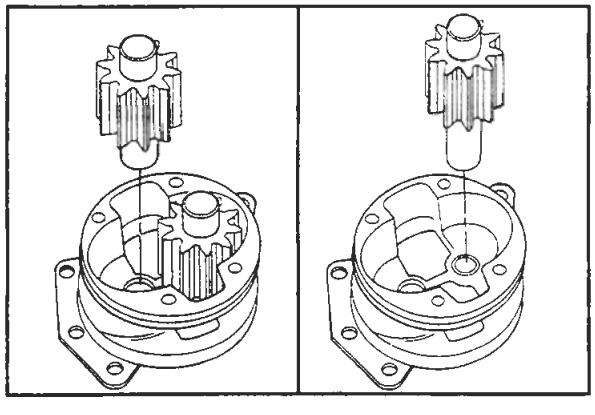
Use the Part No. 3375082 Lubricating Oil Pump Gear Puller to remove the main drive gear.



Remove the rear cover plate capscrews.

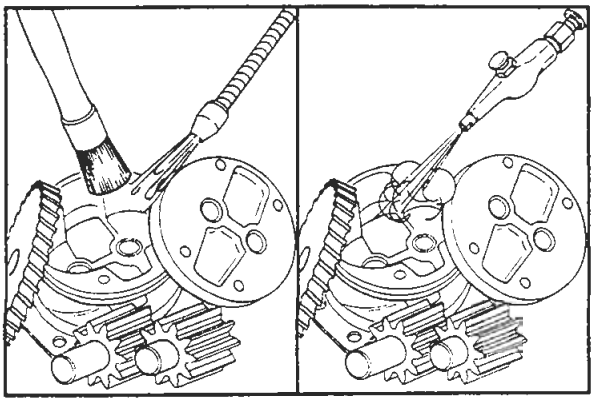
Remove the rear cover plate and gasket, if used.

Note: The present production style oil pumps do **not** use a gasket between the cover plate and oil pump body.



Remove the driven gear and shaft from the pump body.

Remove the drive gear and shaft from the pump body.

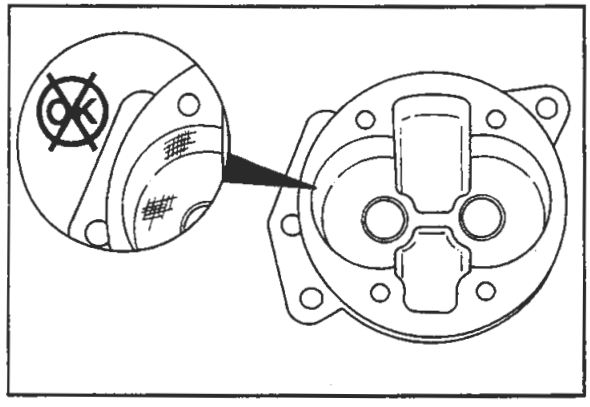


Remove all of the gasket material from the cover plate and pump body, if gaskets were used.

Use solvent to clean the oil pump parts. Dry with compressed air.

Inspection

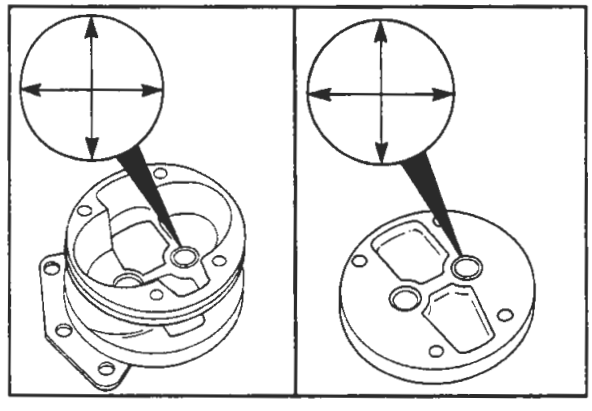
Visually inspect the gear pockets in the pump body for excessive wear or scoring.



NOTE: If excessive wear or scoring is found, the oil pump must be replaced.

Caution: Do not attempt to replace the bushings or drill and ream the oil pump body and cover plate. Oil pump failure and future engine damage can result.

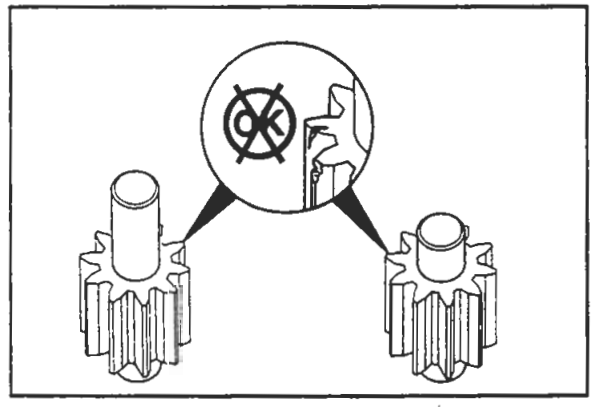
Measure the inside diameter of the bushings or shaft bores in the oil pump body and cover plate.



Bushing and Shaft Bore I.D.		
mm		in.
15.081	MIN	0.5937
15.130	MAX	0.5957

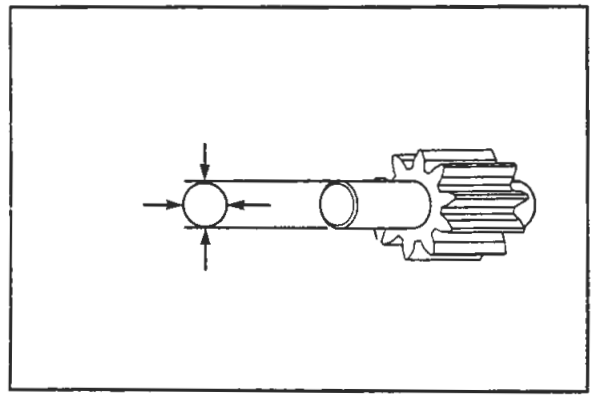
NOTE: The present production style oil pumps do **not** have bushings in the pump body or cover plate. The inside diameter dimensions are the same for both the bushings and shaft bores.

Visually inspect the internal oil pump gears for cracked or broken teeth and excessive wear.



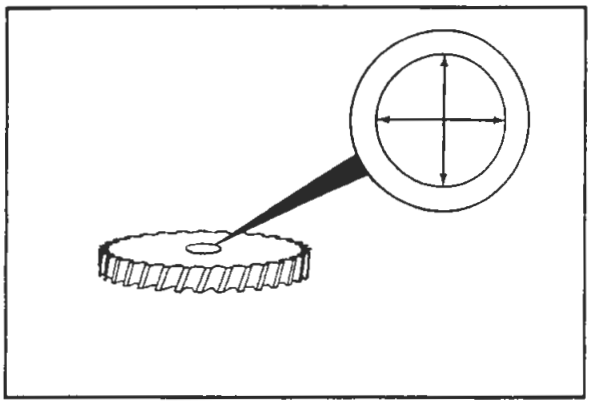
NOTE: If cracked or broken teeth or excessive wear is found, the gear(s) **must** be replaced.

Measure the outside diameter of the oil pump gear shafts.



Gear Shafts O.D.		
mm		in.
15.025	MIN	0.5915
15.037	MAX	0.5920

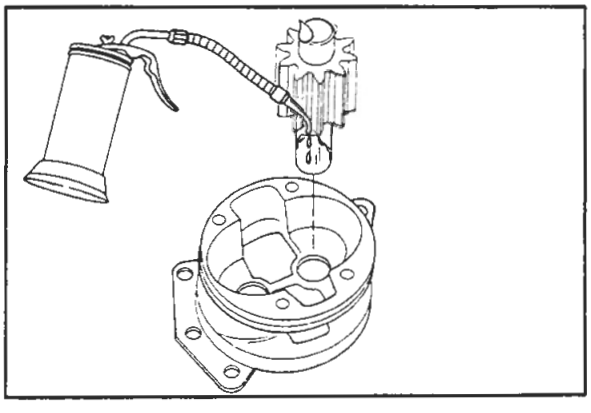
NOTE: If the gear shafts are worn beyond the minimum limit specified, the shaft(s) **must** be replaced.



Measure the inside diameter of the drive gear bore.

Drive Gear Bore I.D.		
mm		**in.**
14.95	MIN	0.589
14.98	MAX	0.590

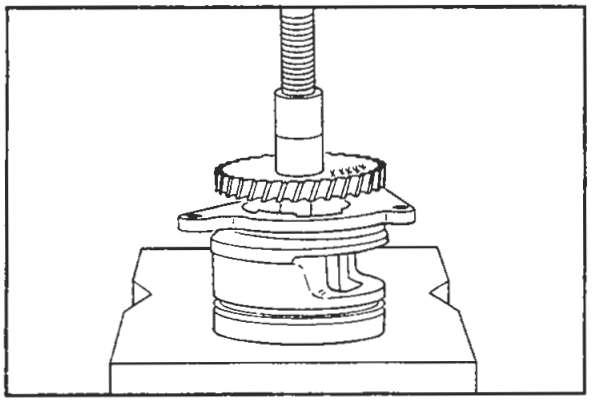
Note: If the drive gear bore is worn beyond the maximum limit, the drive gear **must** be replaced.



Assembly

Use clean 15W-40 oil to lubricate the internal drive gear and shaft.

Install the drive gear and shaft in the oil pump body.

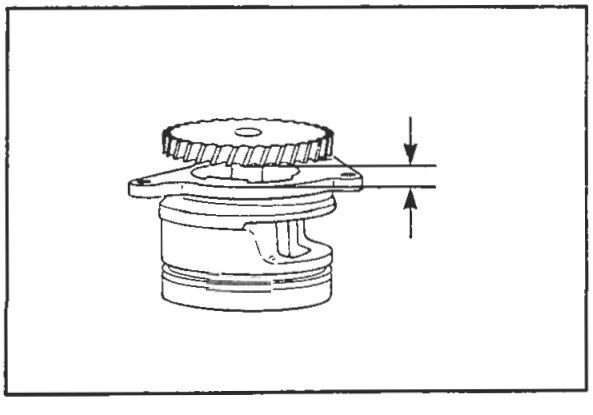


Install the oil pump body in an arbor press with front of the body facing up.

Note: Make sure the end of the drive shaft is supported.

Install the drive gear on the shaft with the part number facing up.

Note: Push the gear on the shaft far enough to leave the specified clearance between the gear and pump body.

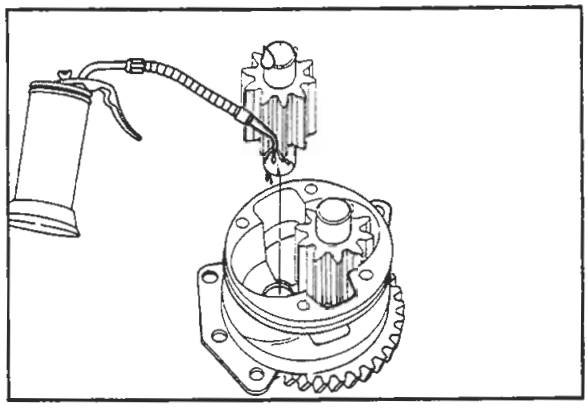


Measure the drive gear to pump body clearance.

Gear to Body Clearance		
mm		**in.**
9.50	MIN	0.37
12.00	MAX	0.47

Use clean 15W-40 oil to lubricate the driven gear and shaft.

Install the driven gear and shaft into the oil pump body.

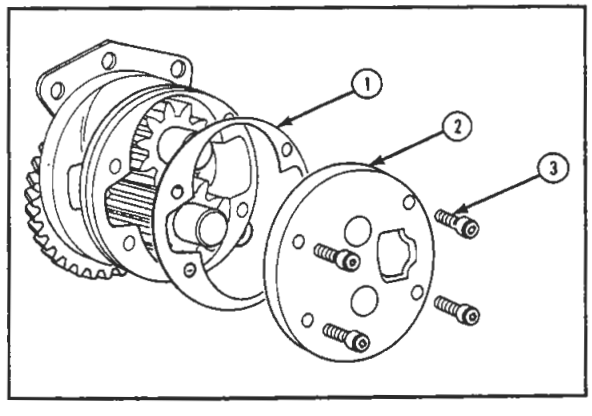


Install the new gasket (1), if used, rear cover plate (2) and the four hex head capscrews (3).

Note: Do **not** install a gasket if the pump body does **not** have bushings. If the pump body has bushings a gasket is required.

Alternately tighten the four hex head capscrews.

Torque Value: 20 N•m [18 ft-lb]

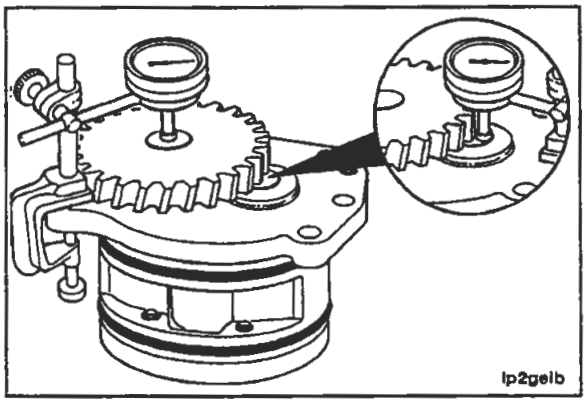


Final Inspection

Turn the drive gear by hand, to check the shafts and gears for freedom of rotation.

Measure the drive shaft end clearance in two locations 90 degrees apart.

Shaft End Clearance		
mm		In.
0.064	MIN	0.0025
0.270	MAX	0.0106



Note: If the end clearance does **not** meet the specifications, the pump **must** be disassembled, inspected and assembled again.

Lubricating Oil Pump - Rebuild (07-09)

Caution: The lubricating oil pump bushings cannot be replaced and the body cannot be drilled and reamed due to the highly precise and sophisticated drilling and reaming required. Attempting to rebuild the oil pump can cause oil pump failure and future engine damage.

Cooling System - Group 08

Contents

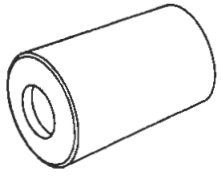
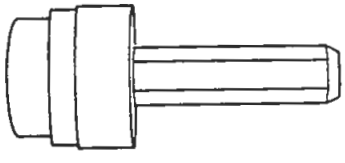
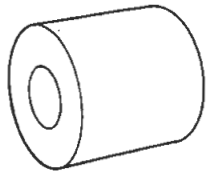
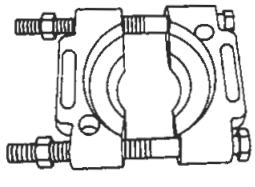
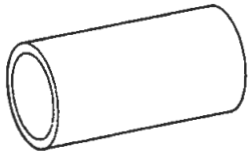
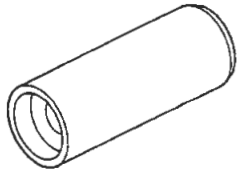
Contents (Continued)

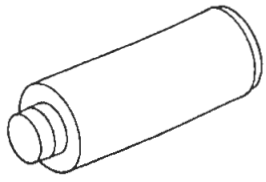
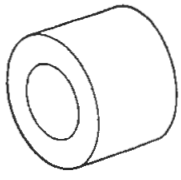
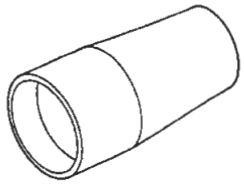
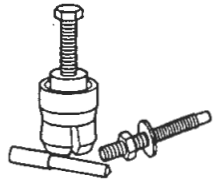
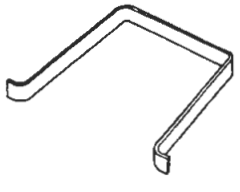
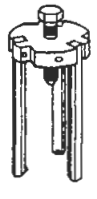
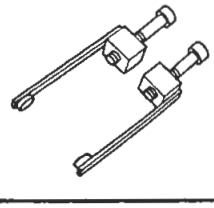
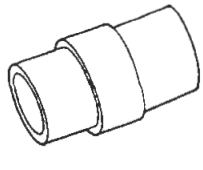
Page

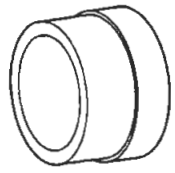
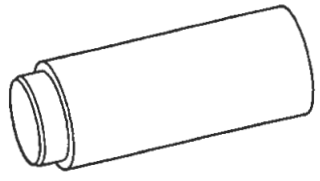
Cooling System Components

Cooling System - Service Tools

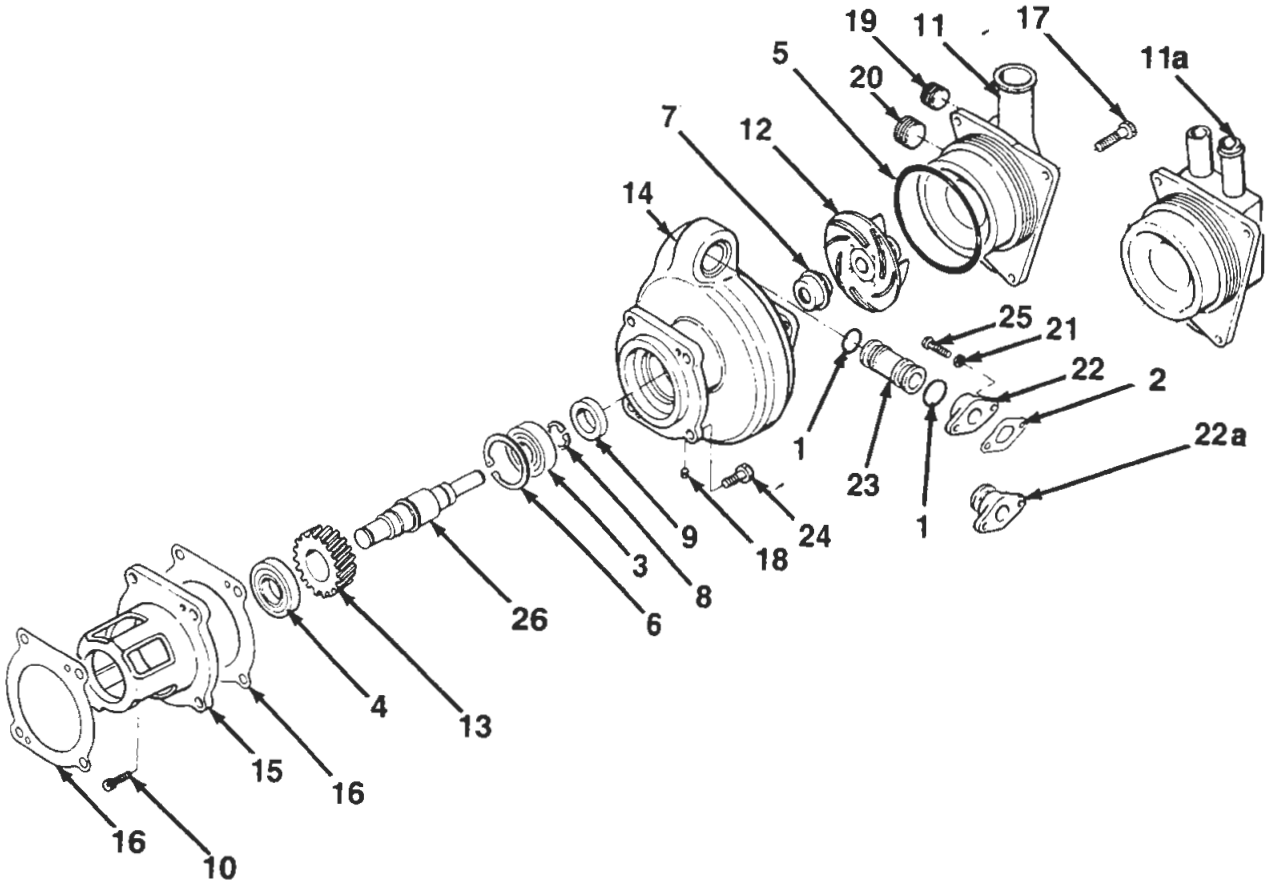
The following special tools are recommended to perform the procedures in Group 08. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

Tool No.	Tool Description	Tool Illustration
ST-658	**Water Pump Bearing Mandrel** Install the water pump bearing on the shaft.	
ST-1225	**Thermostat Seal Mandrel** Install the thermostat seal in the thermostat housing.	
3375318	**Water Pump Bearing Mandrel** Install the water pump bearing on the shaft.	
3375326	**Water Pump Bearing Separator** Remove the water pump bearings from the shaft.	
3375696	**Bearing Driver** Install the bearing races in the fan idler pulley.	
3376091	**Water Pump Seal Driver** Install the water pump seal in the water pump body.	

Tool No.	Tool Description	Tool Illustration
3376139	**Water Pump Oil Seal Driver** Install the water pump oil seal in the water pump body.	
3376384	**Water Pump Gear Mandrel** Install the water pump shaft into the water pump gear.	
3376387	**Water Pump Oil Seal Expander** Install the water pump shaft assembly into the water pump body.	
3376542	**Water Pump Impeller Puller Kit** Remove or install the water pump impeller. The kit consists of: 3376543 Spacer Pin, 3376544 Puller Sleeve, 3376545 Compression Sleeve, 3376546 Pressure Screw, 3376547 Pusher Screw, 3376548 Friction Puller, 3376549 Puller Halves (two required) and 3822296 Spacer Pin.	
3377070	**Fan Clutch Piston Puller** Remove the clutch piston from the gear driven fan hub. *(Included in Part No. 3377088 Gear Driven Fan Hub Tool Kit.)	
3377071	**Seal Housing Puller** Remove the seal housing from the gear driven fan hub. *(Included in Part No. 3377088 Gear Driven Fan Hub Tool Kit.)	
3377072	**Spring Pack Compressor** Remove and install the gear driven fan hub clutch shaft. *(Included in Part No. 3377088 Gear Driven Fan Hub Tool Kit.)	
3377073	**Small Bearing Mandrel** Remove and install the small taper roller bearing in the gear driven fan hub. Install the seal housing in the fan clutch housing. *(Included in Part No. 3377088 Gear Driven Fan Hub Tool Kit.)	

Tool No.	Tool Description	Tool Illustration
3377074	**Large Bearing Mandrel** Remove and install the large taper roller bearing in the gear driven fan hub. *(Included in Part No. 3377088 Gear Driven Fan Hub Tool Kit.)	
3377075	**Needle Bearing Mandrel** Install the needle roller bearing in the front shaft of the gear driven fan hub. *(Included in Part No. 3377088 Gear Driven Fan Hub Tool Kit.)	
3377076	**Snap Ring Pliers** Remove and install the bearing retainer ring from the gear driven fan hub shaft. *(Included in Part No. 3377088 Gear Driven Fan Hub Tool Kit.)	
3377088	**Gear Driven Fan Hub Tool Kit** *Refer to the above tool list for the tool description of the tools included in the kit.	

Water Pump Assembly - Exploded View



Ref. No.	Description	Qty.
1	O-ring*	2
2	Gasket, Connection*	1
3	Bearing, Ball	1
4	Bearing, Ball	1
5	O-ring	1
6	Ring, Retaining	1
7	Seal, Water Pump	1
8	Ring, Retaining	1
9	Seal, Oil	1
10	Screw, Socket Head	2
11	Cover, Water Pump	1
11a	Cover, Water Pump (Optimized Aftercooling)	1
12	Impeller, Water Pump	1
13	Gear, Water Pump	1

Ref. No.	Description	Qty.
14	Body, Water Pump	1
15	Support, Bearing	1
16	Gasket, Bearing Support*	2
17	Capscrew	3
18	Plug, Pipe	1
19	Plug, Pipe	1
20	Plug, Pipe	1
21	Washer, Plain*	2
22	Connection, Water Transfer*	1
22a	Connection, Water Transfer (Optimized Aftercooling)*	1
23	Tube, Water Transfer*	1
24	Capscrew*	4
25	Capscrew*	2
26	Shaft, Water Pump	1

* Mounting Parts

Water Pump Assembly - General Information

The L10 engine water pump is a centrifugal type pump with a phenolic impeller. The water pump is gear driven from an idler gear in the front gear train. The water pump contains an oil seal and a unitized water seal. The water pump bearings, gear and shaft receive lubrication from engine oil in the front gear train.

The L10 engine uses both metric and U.S. Customary capscrews. In some cases, capscrews in metric and U.S. Customary threads are almost identical in appearance. Be sure to install the capscrews in the same location they were removed from.

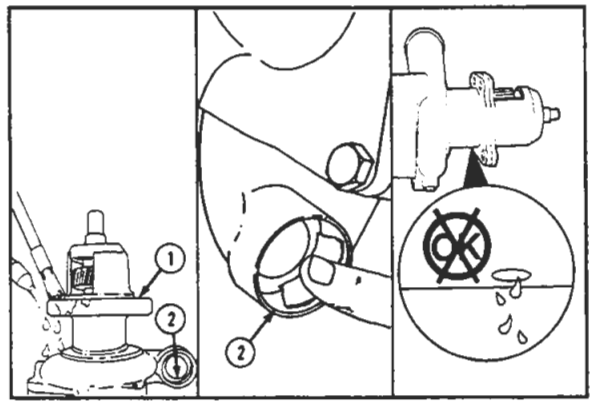
Pipe plugs used in the cooling system are U.S. Customary dimensions.

Water Pump - Clean and Inspect for Reuse (08-01)

Remove all the gasket material from surface (1).

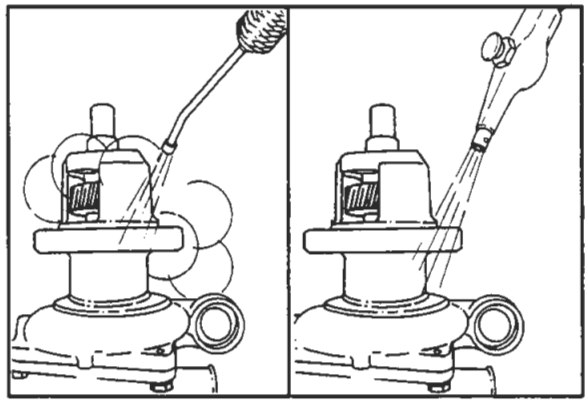
Use 240 grit aluminum oxide paper to clean surface (2).

Visually inspect the water pump weep hole for indication of leakage.



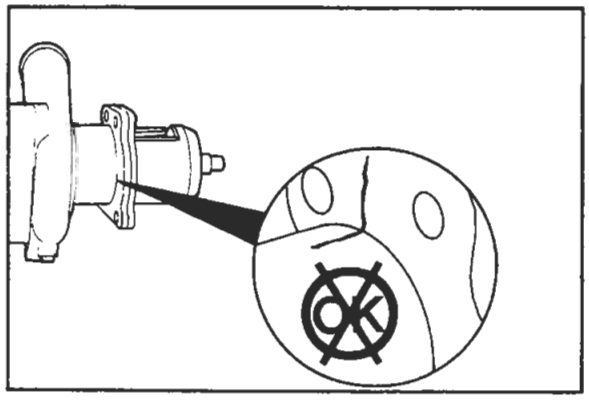
Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

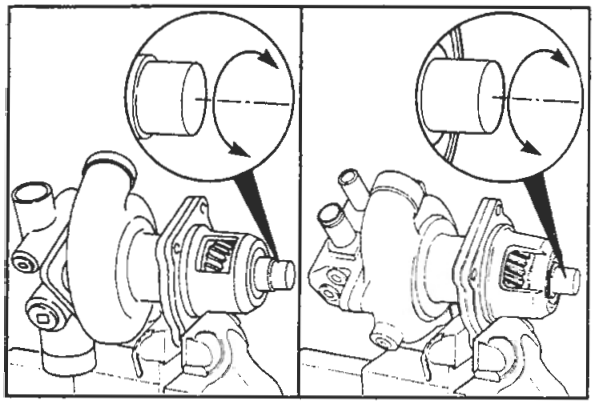
Use solvent or steam to clean the water pump exterior. Dry with compressed air.



Inspection

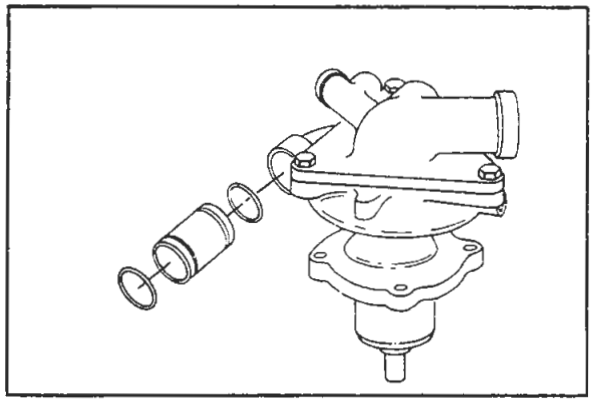
Visually inspect the water pump body for cracks or damage.





Turn the water pump shaft by hand to inspect the bearings and impeller for freedom of rotation.

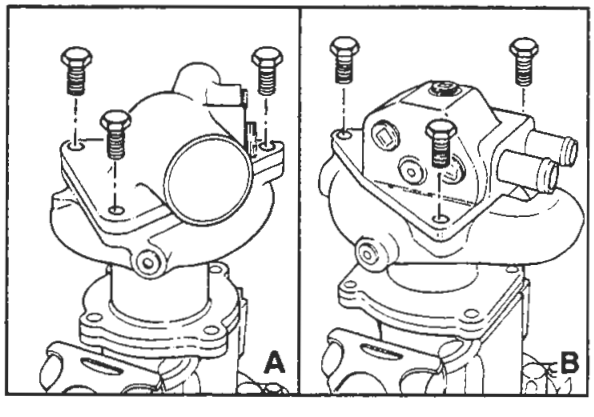
Note: If damaged parts are found or the shaft does **not** rotate freely in the water pump body, the water pump **must** be rebuilt or replaced. Refer to Water Pump - Rebuild (08-02).



Water Pump - Rebuild (08-02)

Disassembly

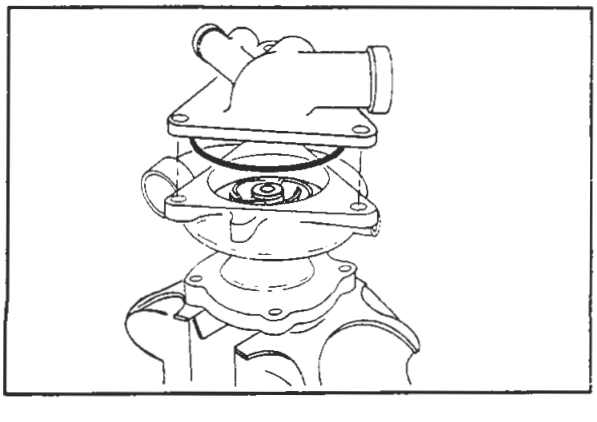
Remove the water transfer tube. Remove the o-rings from the tube. Discard the o-rings.



Install the water pump in a vise with brass jaws with the inlet cover facing up.

Remove the three capscrews.

- Conventional Aftercooling (A)
- Optimized Aftercooling (B)

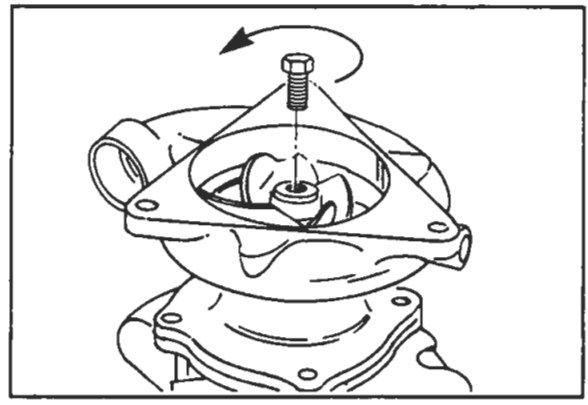


Use a mallet to loosen the cover. Remove the inlet cover from the water pump body.

Remove the o-ring from the cover. Discard the o-ring.

Remove the impeller clamping capscrew.

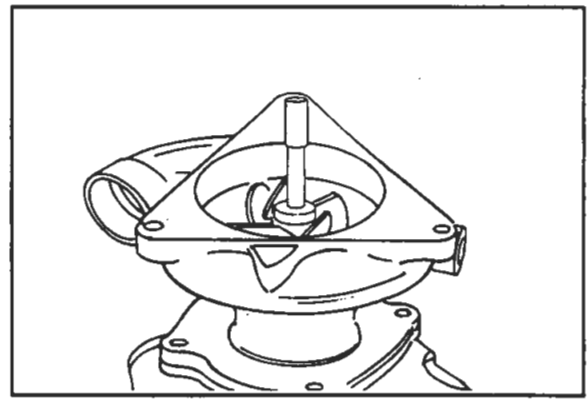
Note: Present production style water pump shafts do **not** use the impeller clamping capscrew.



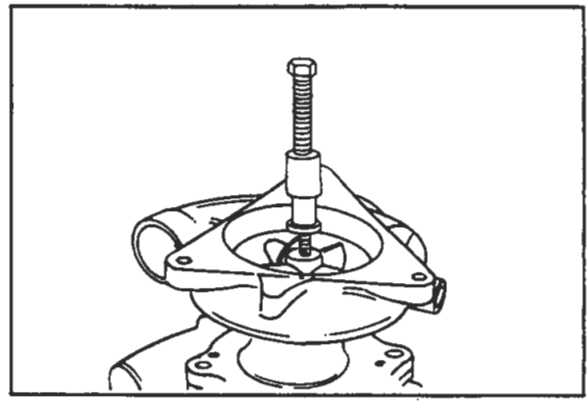
Use the Part No. 3376542 Water Pump Impeller Puller Kit to remove the impeller.

Install the spacer pin into the bore of the water pump impeller.

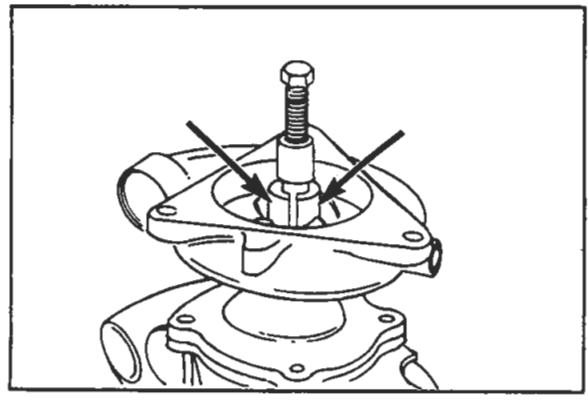
Note: Use the Part No. 3376543 Spacer Pin if the shaft has internal threads. Use the Part No. 3382296 Spacer Pin if the shaft does **not** have internal threads.

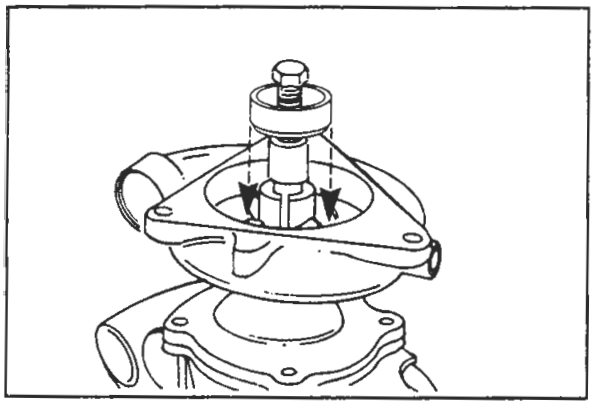


Install the Part No. 3376544 Puller Sleeve and the Part No. 3376546 Pressure Screw over the spacer pin.

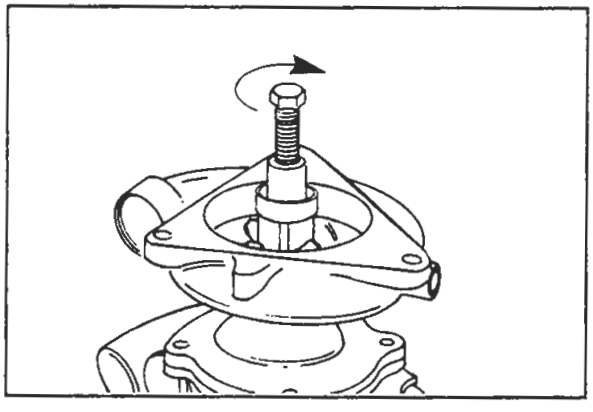


Install the Part No. 3376549 Puller Halves on the threaded sleeve assembly.

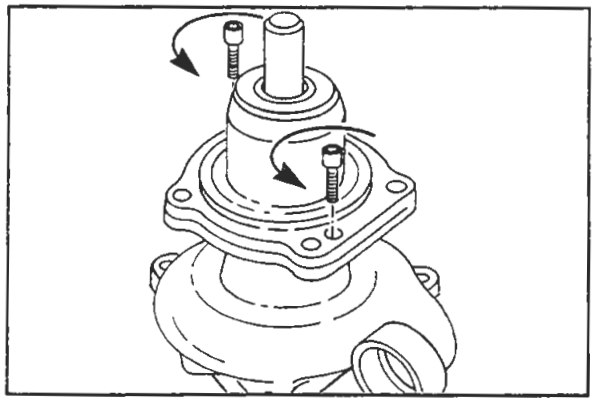




Install the Part No. 3376545 Compression Sleeve over the two puller halves.

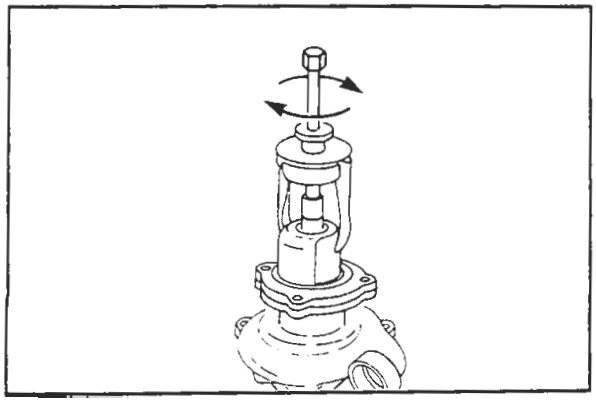


Turn the pressure screw clockwise to remove the impeller.



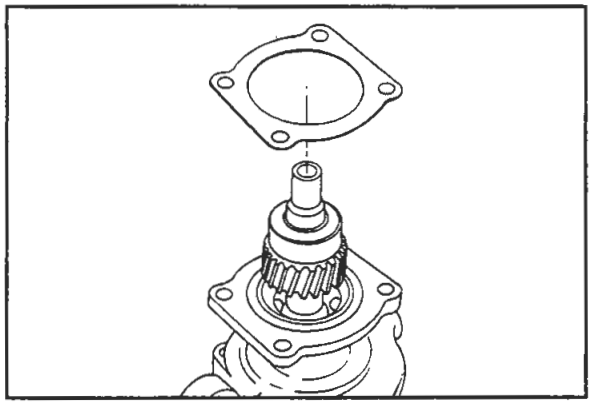
Use an allen wrench to remove the two front bearing support capscrews.

NOTE: Some water pumps require a 5 mm allen wrench and some water pumps require a 4 mm allen wrench.



Use the two jaw puller from the Part No. 3375779 Puller Kit to remove the front bearing support.

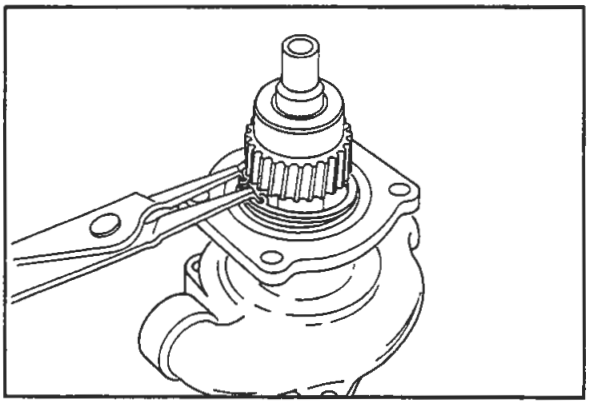
Remove and discard the gasket.



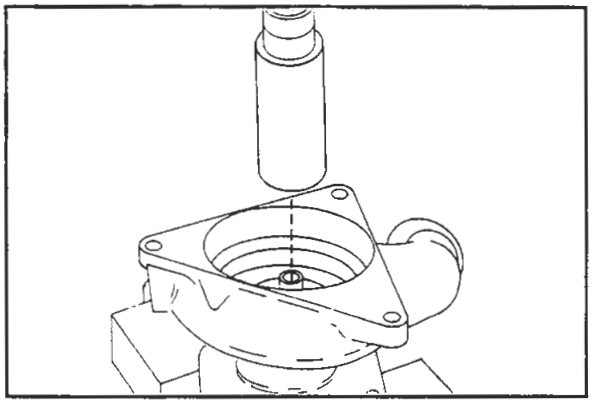
Caution: Do not attempt to remove the retainer ring from the shaft assembly until the rear bearing is removed. The retainer ring will be bent or broken if it is removed before the rear bearing is removed from the shaft.

Use a pair of long nose angle snap ring pliers to remove the rear bearing retainer ring from the water pump body.

Note: Do **not** pull the retainer ring over the gear. Leave the retainer ring loose on the shaft until the bearing is removed.

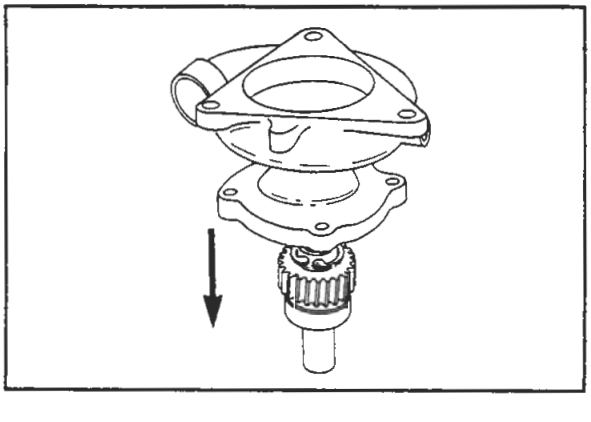


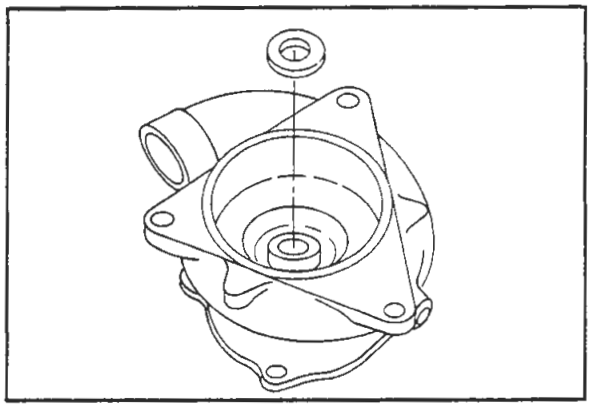
Install the water pump in an arbor press with the front bearing support mating face down.



Caution: Do not allow the shaft assembly to fall when pushed from the water pump body. Damage to the shaft or personal injury can occur.

Push the shaft assembly from the water pump body.

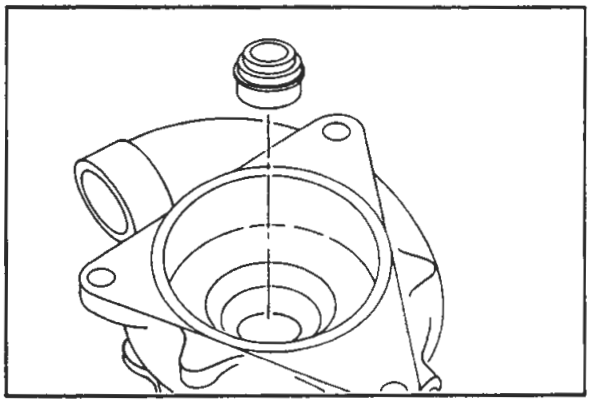




Install the water pump body on a bench with the front bearing support mating face down.

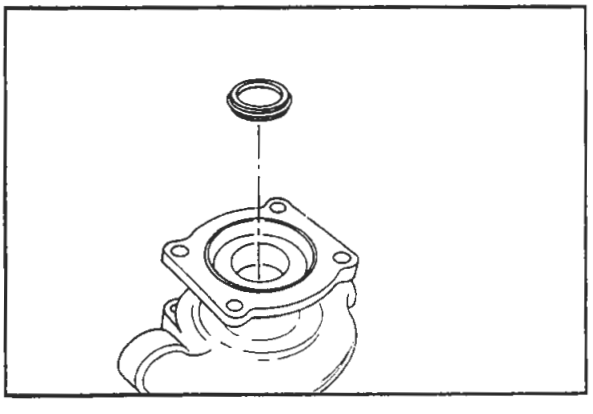
Remove the water seal seat if the water pump is equipped with a two piece water seal and seat assembly.

Note: Present production style and service replacement water seals and seats are installed and removed as a unitized assembly.



Caution: Do not damage the water seal bore when removing the water seal to prevent water pump failure in the future.

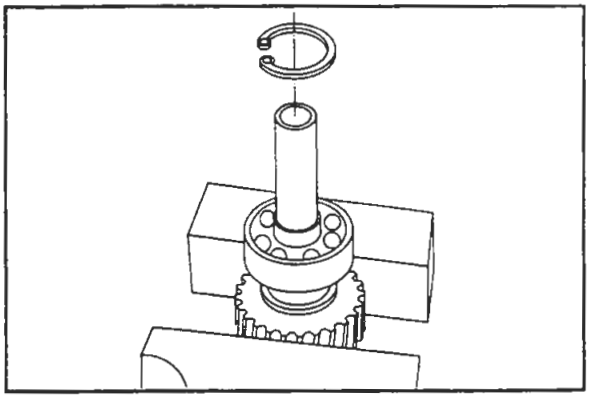
Turn the water pump body over and use a punch and hammer to remove the water seal.



Install the water pump body on a bench with the front bearing support mating face up.

Caution: Do not damage the oil seal bore when removing the oil seal to prevent water pump failure in the future.

Turn the water pump over and use a punch and hammer to remove the oil seal.



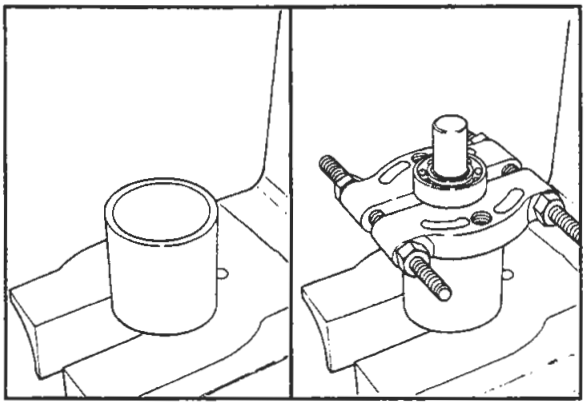
Install the water pump shaft assembly in a vise with brass jaws.

Use a pair of long nose angle snap ring pliers to remove the rear bearing retainer ring from the shaft.

Install a section of pipe (3-1/2 inch O.D. x 3 inch I.D. x 3-1/2 inch L.) in an arbor press to support the bearing separator.

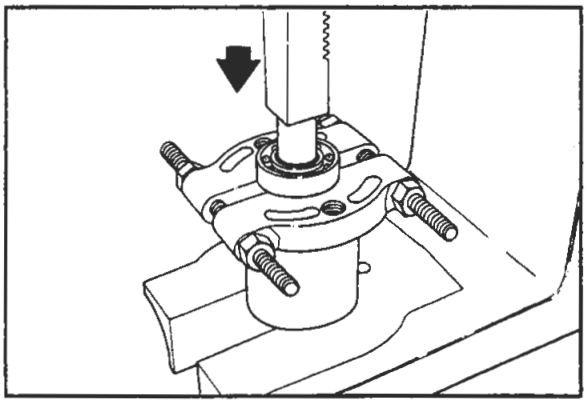
Caution: The bearing separator halves must be under the inner race of the bearing to prevent personal injury or bearing damage when the shaft is pushed from the bearing.

Install the shaft assembly in the arbor press with the rear bearing inner race supported by Part No. 3375326 Bearing Separator.

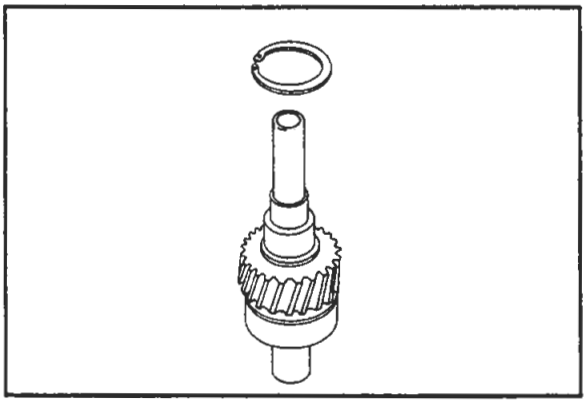


Caution: Do not allow the shaft to fall when pushed from the rear bearing. Damage to the shaft or personal injury can occur.

Push the shaft from rear bearing.



Remove the rear bearing to water pump body retainer ring from the shaft.

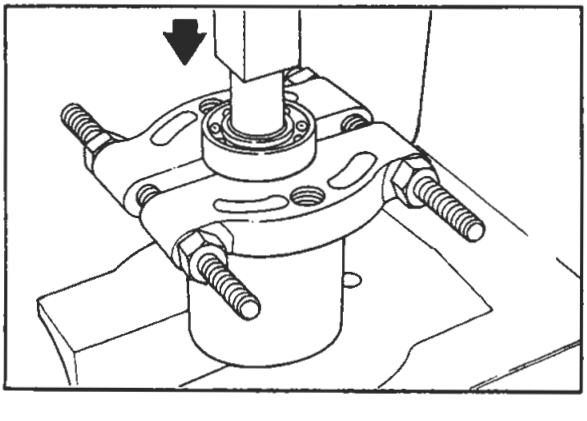


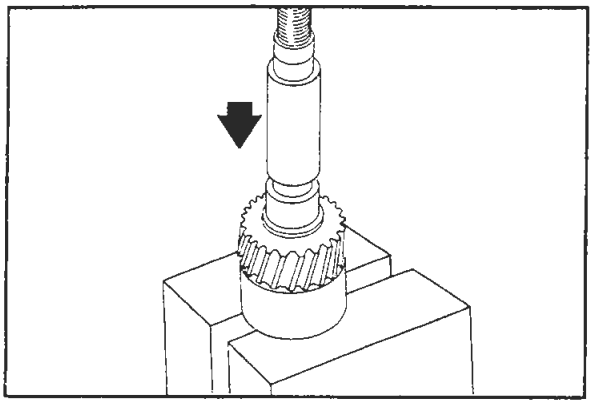
Caution: The bearing separator halves must be under the inner race of the bearing to prevent personal injury or bearing damage when the shaft is pushed from the bearing.

Install the shaft assembly in the section of pipe and arbor press with the front bearing inner race supported by Part No. 3375326 Bearing Separator.

Caution: Do not allow the shaft to fall when pushed from the front bearing. Damage to the shaft or personal injury can occur.

Push the shaft from the front bearing.



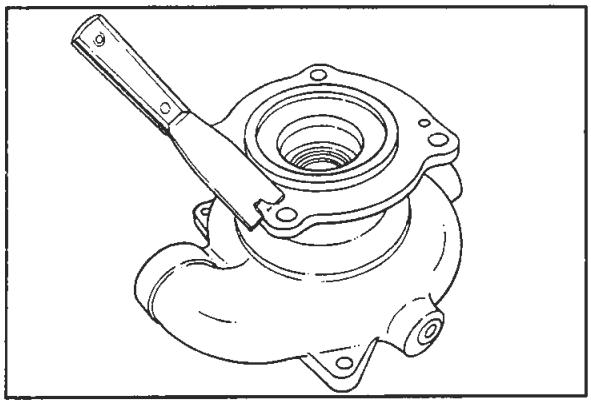


Install the shaft and gear in an arbor press.

Note: The shoulder of the shaft with which the gear is in contact **must** be below the gear.

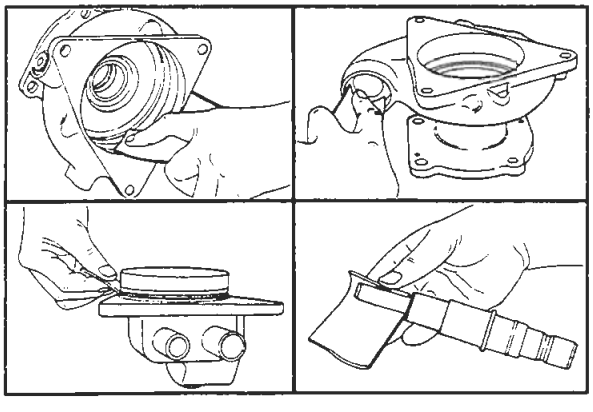
Caution: Do not allow the shaft to fall when pushed from the gear. Damage to the shaft or personal injury can occur.

Push the shaft from the gear.



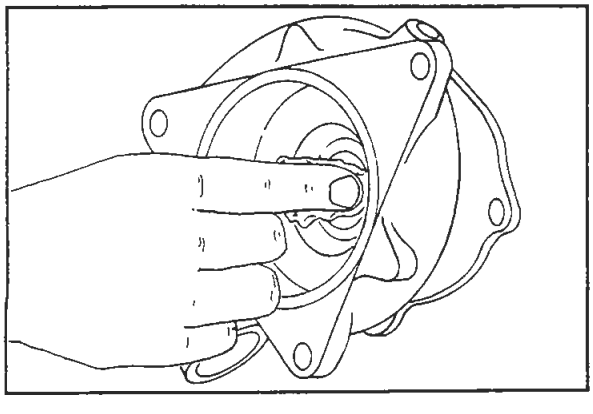
Cleaning

Use a scraper to remove all of the gasket material from the gasket sealing surfaces.



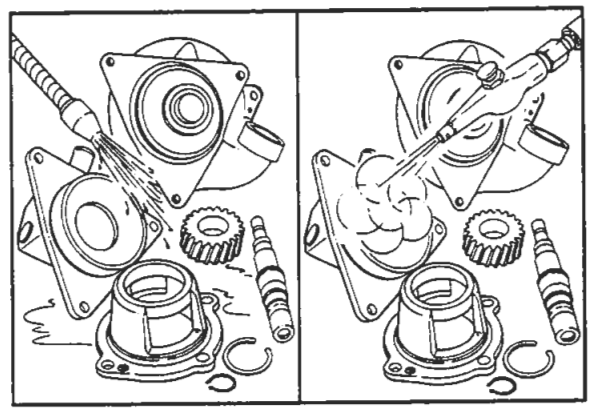
Use 240 grit aluminum oxide paper to clean the o-ring bores and grooves in the water pump body and cover.

Use 240 grit aluminum oxide paper to clean the water pump shaft.



Use 240 grit aluminum oxide paper to clean the bearing bores in the water pump body.

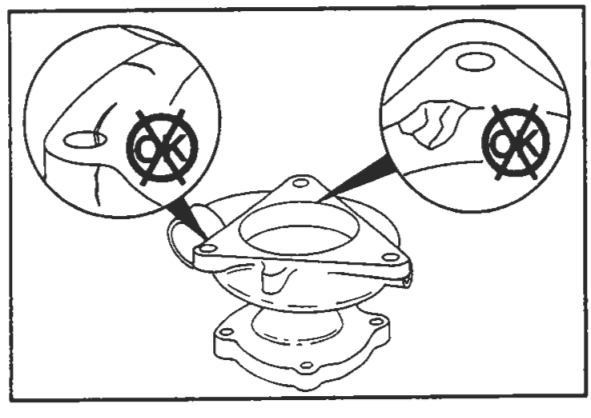
Use solvent to clean the water pump parts. Dry with compressed air.



Inspection

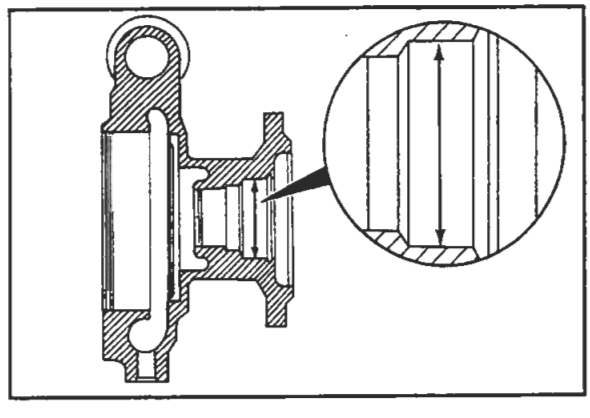
Note: If the part being inspected does **not** meet the specifications given, if it is damaged or no alternative is given, the part **must** be replaced.

Visually inspect the water pump body for cracks, porosity or excessive corrosion.



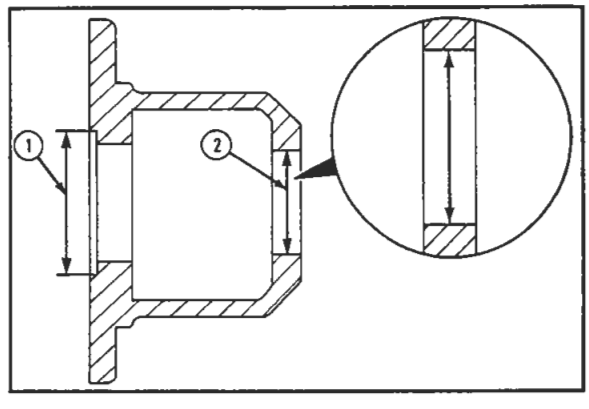
Measure the water pump body bearing bore inside diameter.

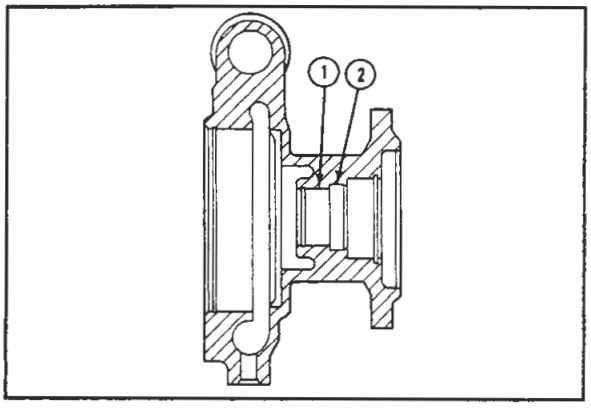
Water Pump Body Bearing Bore I.D.		
mm		In
51.996	MIN	2.0471
52.011	MAX	2.0477



Measure the bearing support bearing bore inside diameter.

Bearing Support Bearing Bore I.D.			
Point	mm		In
1	93.00	MIN	3.661
	93.05	MAX	3.663
2	61.996	MIN	2.4408
	62.011	MAX	2.4414

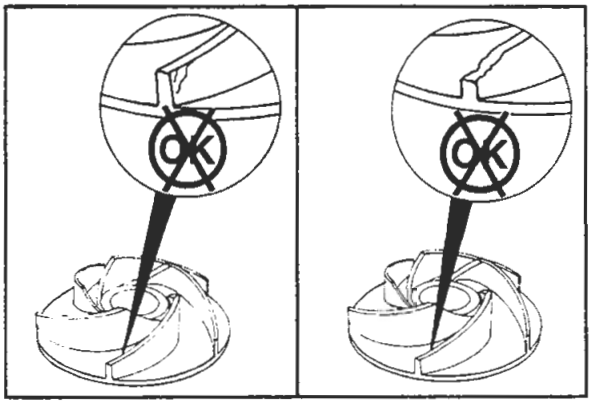




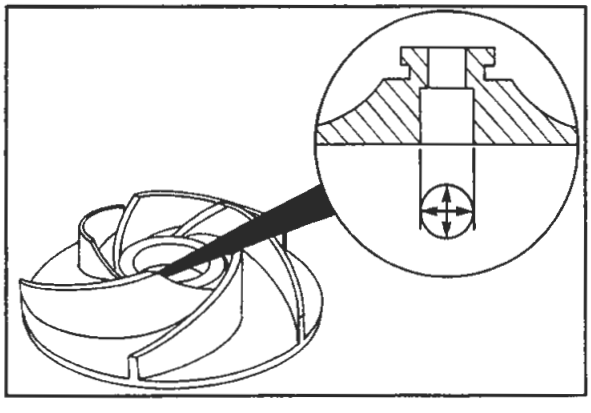
Measure the water seal bore inside diameter (1).

Measure the oil seal bore inside diameter (2).

Seal Bore I.D.			
Point	**mm**		**in.**
1	36.450	MIN	1.4350
	36.475	MAX	1.4360
2	40.975	MIN	1.6132
	41.025	MAX	1.6152

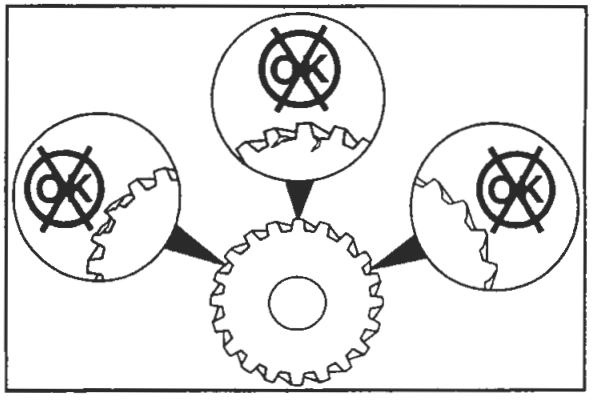


Visually inspect the water pump impeller for cracks or damage.



Measure the water pump impeller bore inside diameter.

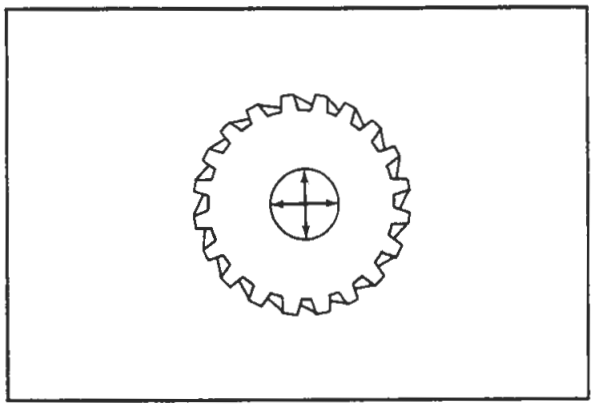
Impeller Bore I.D.		
mm		**In**
15.339	MIN	0.6039
15.365	MAX	0.6049



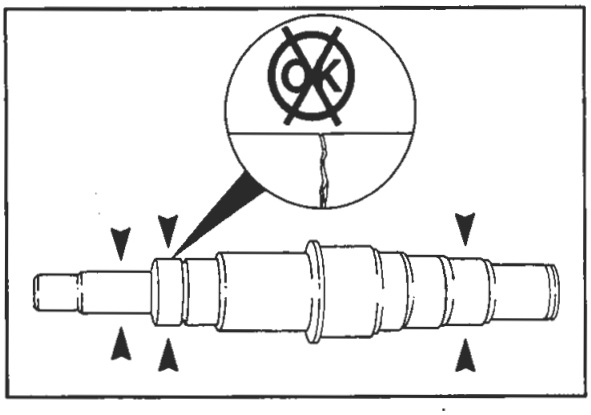
Visually inspect the water pump drive gear for broken teeth, cracks or excessive or uneven tooth wear.

Measure the water pump drive gear bore inside diameter.

Drive Gear Bore I.D.		
mm		**in.**
33.900	MIN	1.335
33.925	MAX	1.336

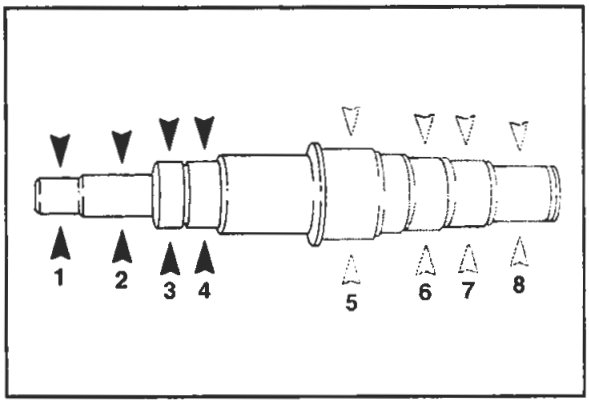


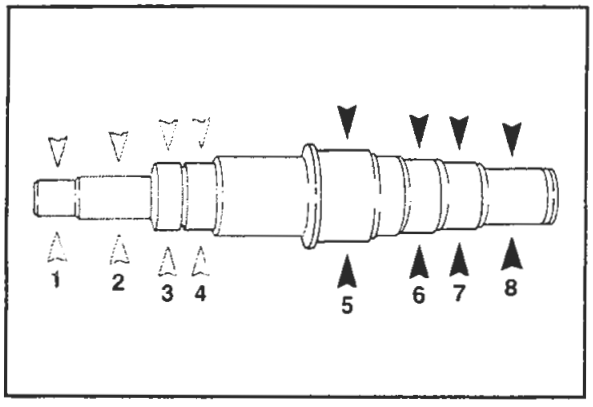
Inspect the seal surfaces of the water pump shaft for large grooves, nicks or damage.



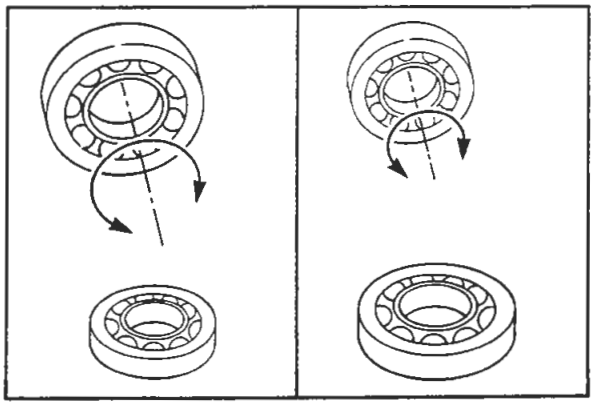
Measure the water pump shaft journal outside diameters.

Shaft Journals O.D.			
Point	**mm**		**in.**
1	15.389	MIN	0.6059
	15.402	MAX	0.6064
2	15.897	MIN	0.6259
	15.910	MAX	0.6264
3	24.999	MIN	0.9842
	25.009	MAX	0.9846
4	24.999	MIN	0.9842
	25.009	MAX	0.9846

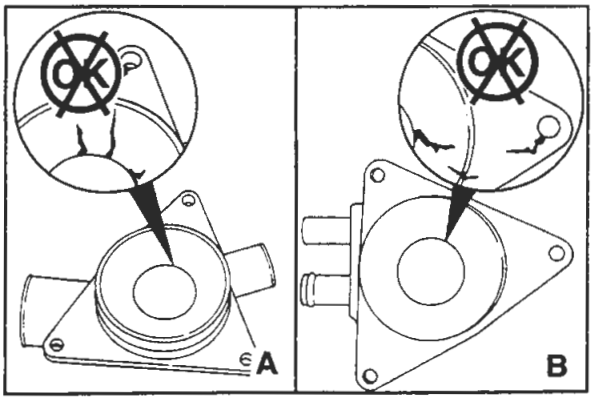




Shaft Journals O.D. (Cont'd.)			
Point	**mm**		**in.**
5	33.951	MIN	1.3366
	33.976	MAX	1.3376
6	29.998	MIN	1.1810
	30.008	MAX	1.1814
7	27.975	MIN	1.1014
	28.025	MAX	1.1033
8	22.175	MIN	0.8730
Earlier Production Style Shaft	22.200	MAX	0.8740
8	27.887	MIN	1.0979
Present Production Style Shaft	27.900	MAX	1.0984



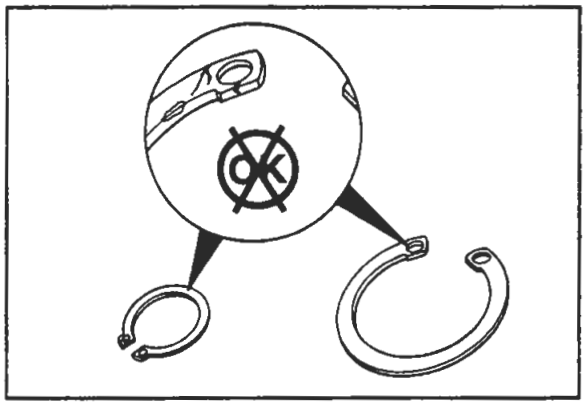
Turn the water pump bearings by hand to inspect for freedom of rotation.



Visually inspect the water inlet cover for cracks or excessive corrosion.

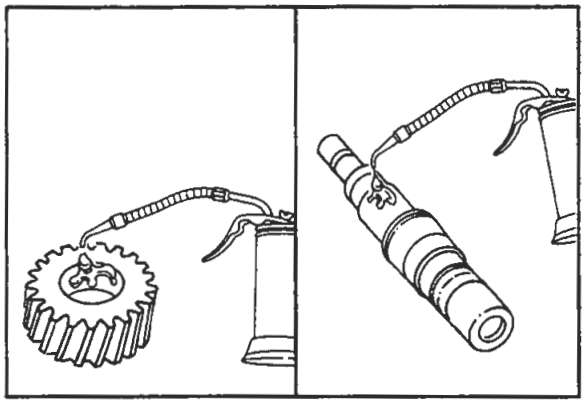
- Conventional Aftercooling (A)
- Optimized Aftercooling (B)

Visually inspect the bearing retainer rings for nicks or cracks.

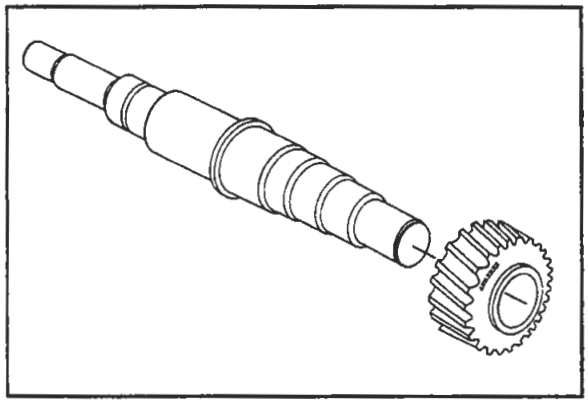


Assembly

Use clean 15W-40 oil to lubricate the drive gear bore and the shaft.



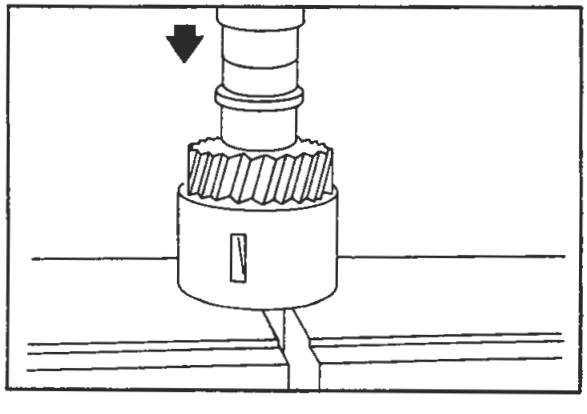
Caution: The numbered side of the drive gear must be installed toward the large diameter end of the shaft to prevent damage to the gear when the water pump is installed on the engine.

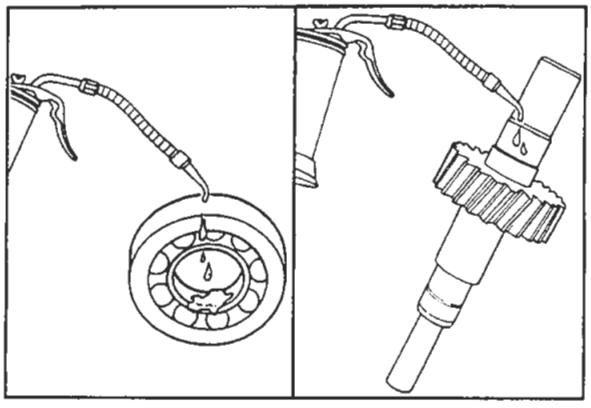


Install the shaft and gear in an arbor press.

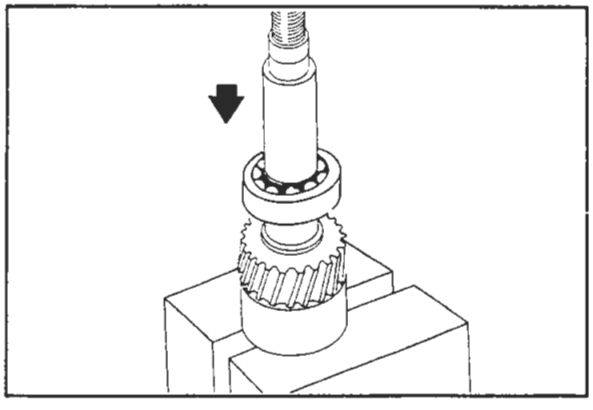
Use the Part No. 3376384 Water Pump Gear Mandrel to push the shaft into the gear.

Note: Push the shaft into the gear until the shoulder on the shaft is firmly seated against the gear.





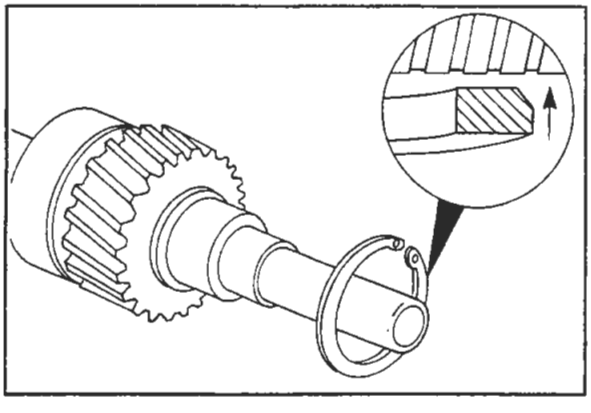
Use clean 15W-40 oil to lubricate the front bearing and the shaft front bearing journal.



Install the shaft assembly in an arbor press. Use the Part No. 3376384 Water Pump Gear Mandrel to support the gear and shaft.

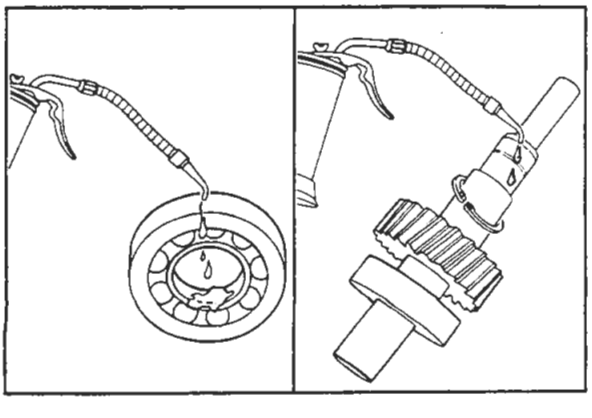
Caution: Push against the inner race of the bearing to prevent personal injury or bearing damage.

Use the Part No. 3375318 Water Pump Bearing Mandrel to push the front bearing on the shaft until the bearing touches the shoulder on the shaft.



Caution: The beveled side of the retainer ring must be installed toward the drive gear to prevent future water pump damage.

Install the rear bearing to water pump body retainer ring on the shaft.

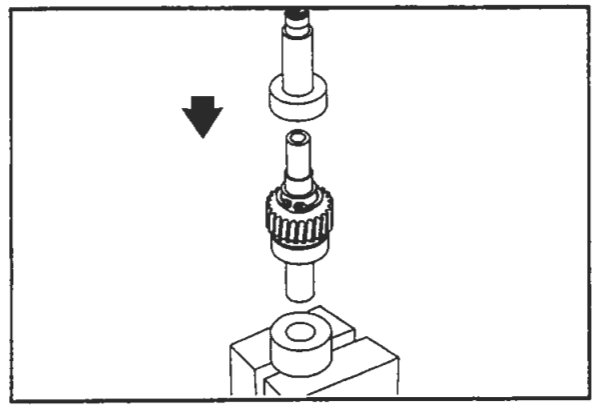


Use clean 15W-40 oil to lubricate the rear bearing and shaft rear bearing journal.

Install the shaft assembly in an arbor press. Use the Part No. 3375318 Water Pump Bearing Mandrel to support the shaft assembly.

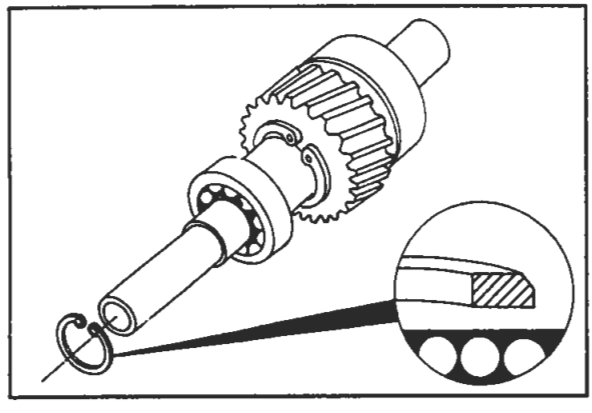
Caution: Push against the inner race of the bearing to prevent personal injury or bearing damage.

Use the Part No. ST-658 Water Pump Bearing Mandrel to push the rear bearing on the shaft until the bearing touches the shoulder on the shaft.



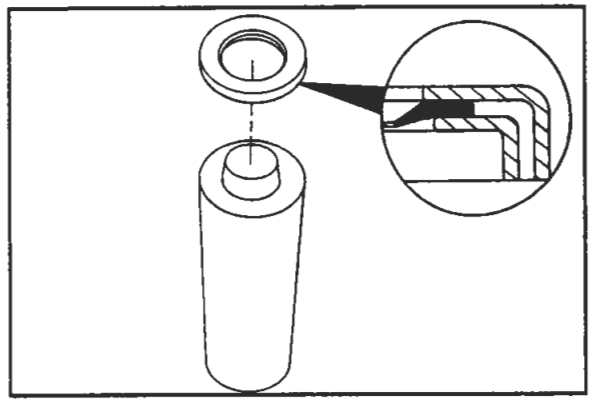
Caution: The flat side of the retainer ring must be installed toward the rear bearing to prevent future water pump damage.

Use a pair of snap ring pliers to install the rear bearing retainer ring into the groove on the shaft.



Caution: The sealing lip of the oil seal must be installed toward the seal driver to prevent future water pump damage.

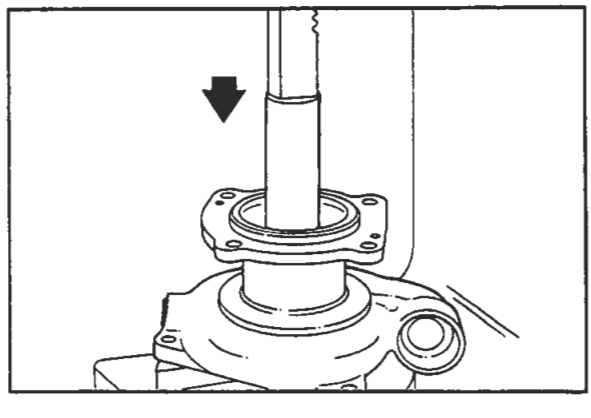
Install the oil seal on the Part No. 3376139 Water Pump Oil Seal Driver.

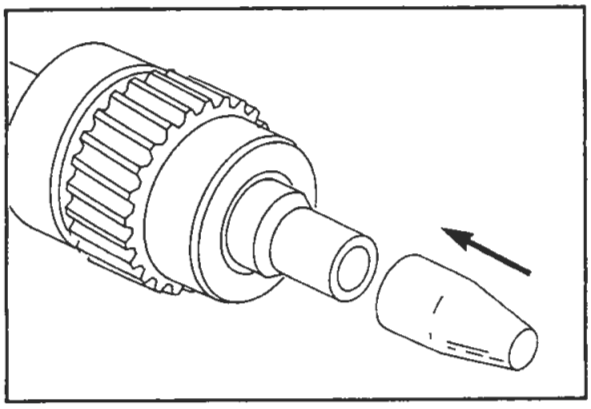


Install the water pump body in an arbor press with the oil seal bore facing up.

Install the oil seal and oil seal driver into the oil seal bore.

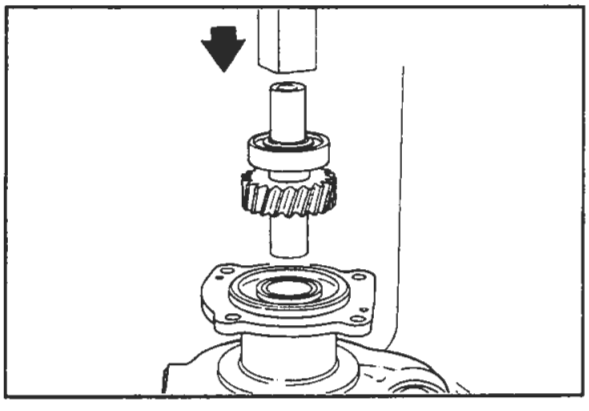
Push the oil seal into the oil seal bore until the seal driver touches the water pump body.





Caution: Do not lubricate the oil seal. The oil seal must be installed with the lip of seal and the shaft clean and dry to provide a proper sealing surface and prevent future water pump and engine damage.

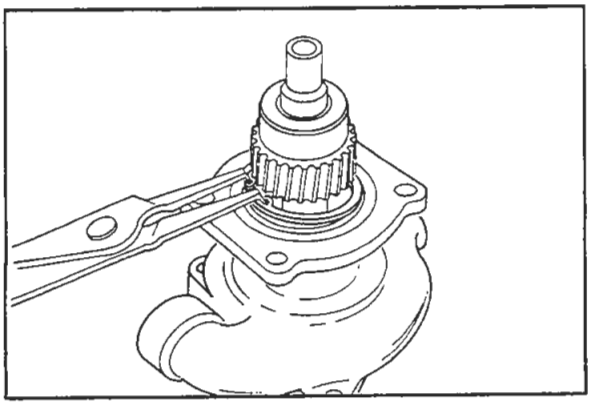
Install the Part No. 3376387 Water Pump Oil Seal Expander on the impeller end of the shaft.



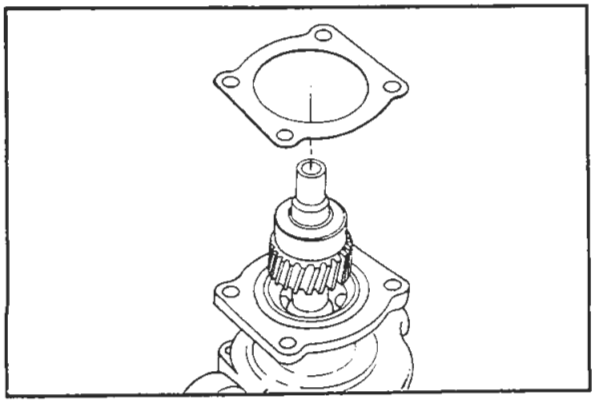
Install the water pump body in an arbor press with the front bearing support mating surface facing up.

Push the shaft assembly and oil seal expander into the water pump body. Remove the oil seal expander.

Note: The shaft assembly **must** be pushed into the body far enough to install the rear bearing retainer ring into the groove of the body.



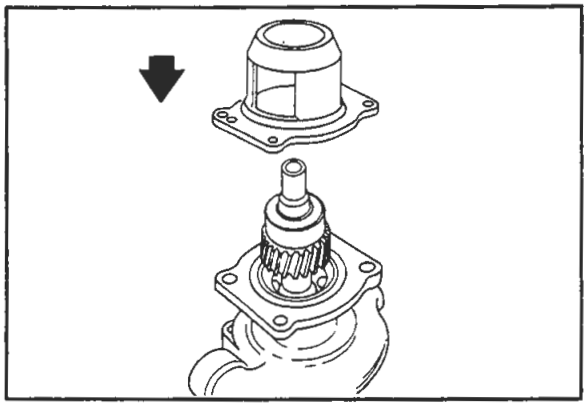
Use a pair of long nose angle snap ring pliers to install the rear bearing retainer ring into the groove of the water pump body.



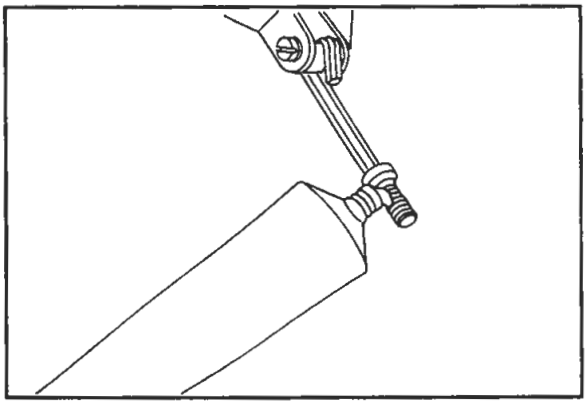
Install a new bearing support gasket on the water pump body.

Install the front bearing support on the water pump body. Align all of the capscrew holes.

Use a plastic hammer to install the front bearing support on the water pump body.



Use Part No. 3801048 Sealant to coat the threads of the two allen head front bearing support capscrews.

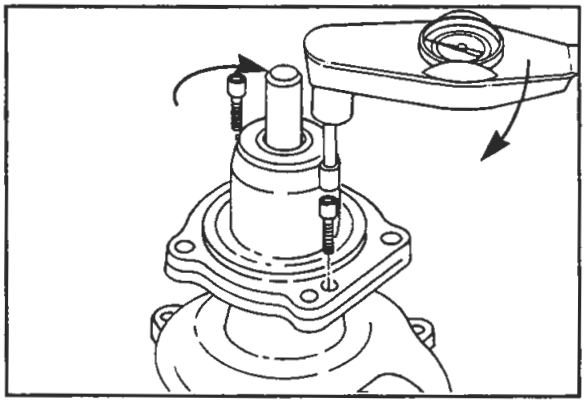


Install the two capscrews in the bearing support.

Use the Part No. 3375044 Torque Wrench with a hex drive socket to tighten the capscrews.

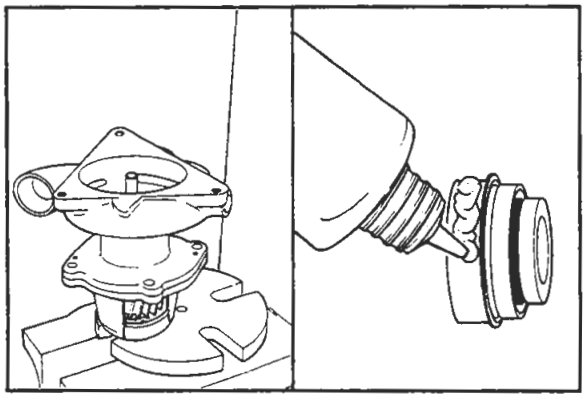
NOTE: Some water pumps require a 5 mm allen wrench and some water pumps require a 4 mm allen wrench.

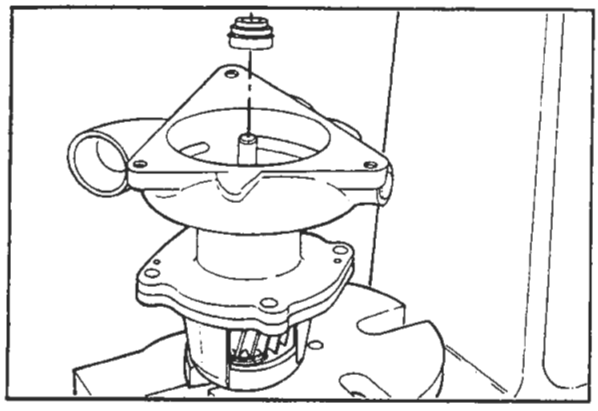
Torque Value: 15 N•m [135 in-lb]



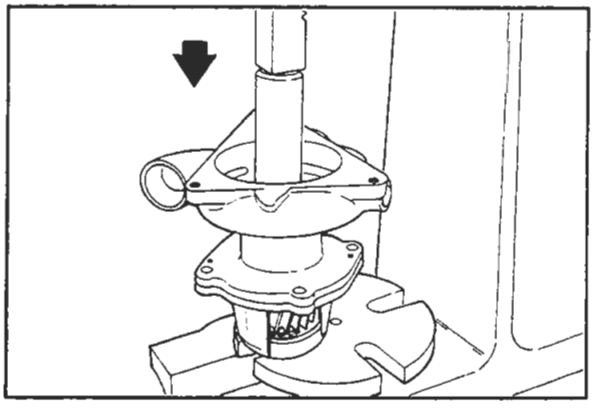
Install the water pump assembly in an arbor press. Support the pump assembly on the drive side of the body with the impeller end of the water pump shaft facing up.

Apply a coat of Part No. 3375066 Pipe Sealant to the outside diameter of the new water seal.



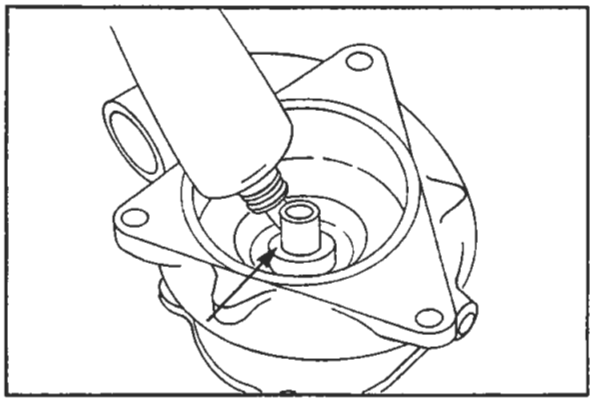


Install the water seal over the shaft.

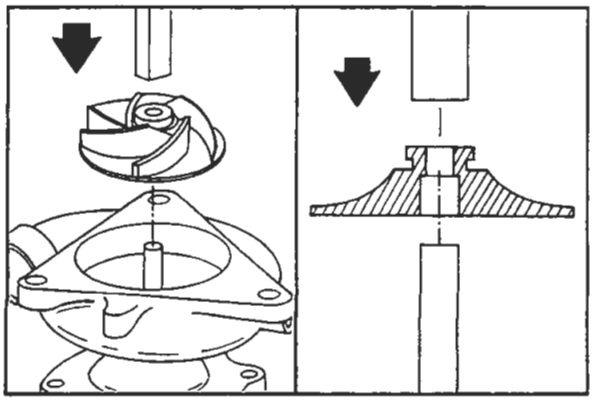


Use the Part No. 3376091 Water Pump Seal Driver to push the seal into the water pump body.

Note: The use of any tool other than Part No. 3376091 **may** result in seal damage.



Apply one drop of Loctite 290®, or equivalent, to the joint between the water pump shaft and the water pump seal.



Install the water pump body in an arbor press with the impeller end of the shaft facing up. Support the bottom end of the shaft.

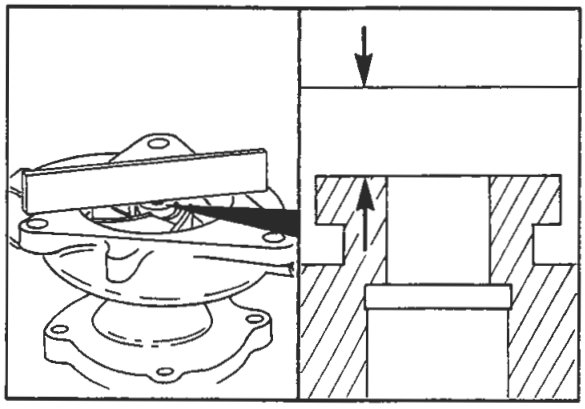
Push the impeller on the shaft until the step inside the impeller bore touches the shaft.

Note: A capscrew in the threaded hole is not required and can be deleted. The impeller to shaft press fit will hold the impeller in place.

Install a straight edge on the cover mounting surface of the water pump body. Measure the distance from the impeller hub to the water pump body surface.

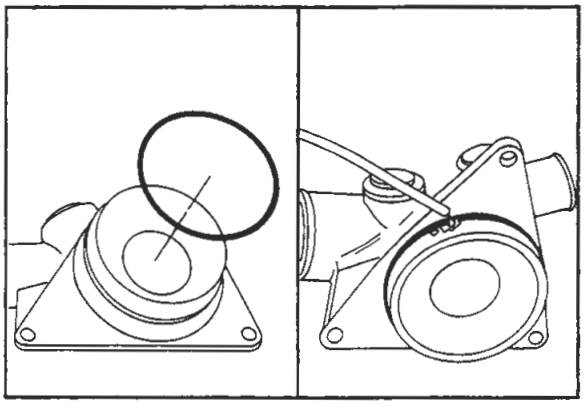
Impeller Hub to Body Surface		
mm		in.
13.52	MIN	0.532
13.72	MAX	0.540

Note: If the distance from the impeller hub to the body surface is greater than the maximum specification, use the Part No. 3376542 Water Pump impeller puller kit to move the impeller to the proper distance.

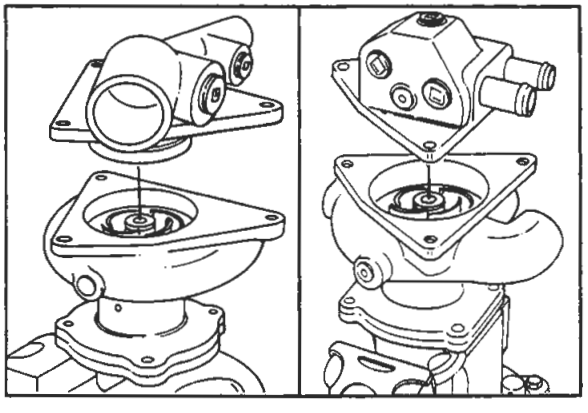


Install the new o-ring on the water inlet cover.

Use clean vegetable oil to lubricate the o-ring.

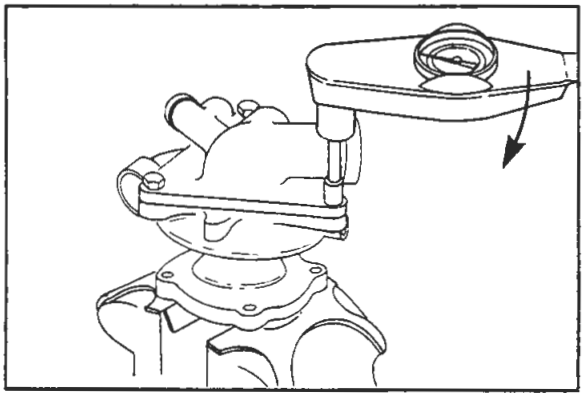


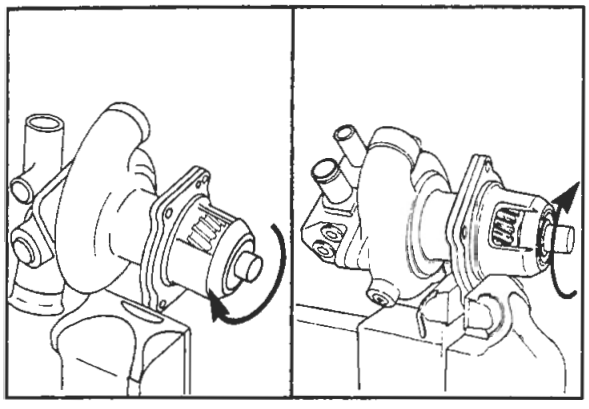
Install the water inlet cover on the water pump body.



Install three (M10-1.50 x 25) capscrews in the water pump body.

Torque Value: 45 N•m [35 ft-lb]



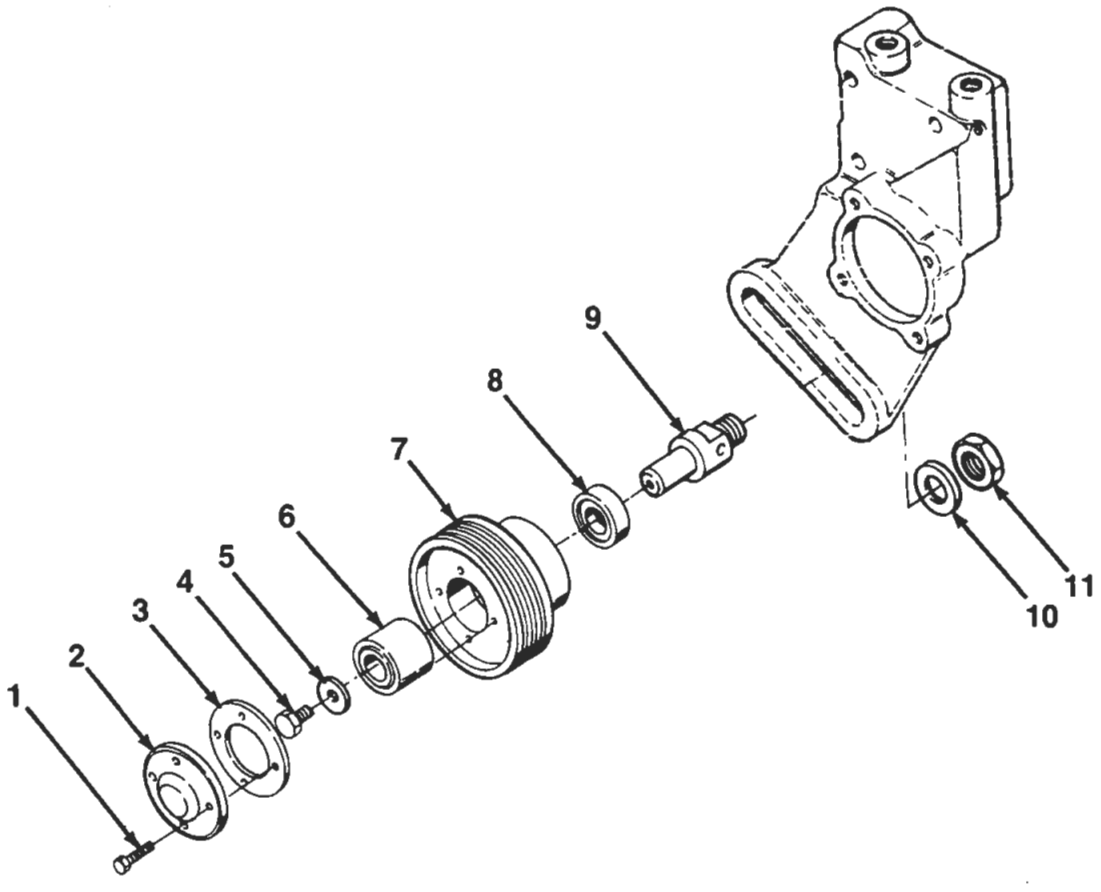


Final Inspection

Turn the water pump shaft by hand to inspect the bearings and impeller for freedom of rotation.

Note: If the water pump shaft does **not** rotate freely in the water pump body, the water pump **must** be disassembled, inspected and assembled again.

Fan Hub (Belt Driven)* and Fan Idler Pulley - Exploded View



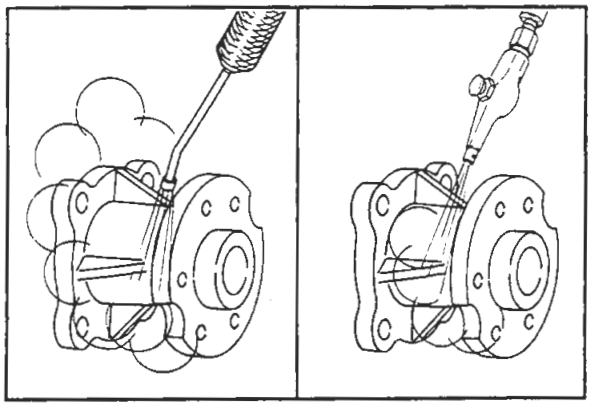
Ref. No.	Description	Qty.
1	Capscrew	4
2	Plate, Cover	1
3	Gasket, Cover Plate	1
4	Capscrew	1
5	Washer, Plain	1
6	Bearing, Roller	1

Ref. No.	Description	Qty.
7	Pulley, Idler	1
8	Seal, Oil	1
9	Shaft, Idler	1
10	Washer, Plain	1
11	Nut	1

Fan Hub (Belt Driven) and Fan Idler Pulley - General Information

The fan belt tension is adjusted by an adjusting screw and idler pulley in the fan hub support.

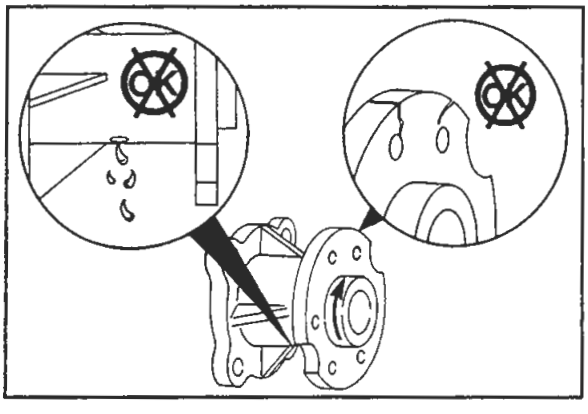
The fan idler pulley contains two antifriction tapered roller type bearings. The idler pulley end clearance is set properly by two bearing race spacers. **Always** replace the complete bearing set if any one piece requires replacement.



Fan Hub (Belt Driven) - Clean and Inspect for Reuse (08-03)

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use solvent or steam to clean the fan hub exterior. Dry with compressed air.

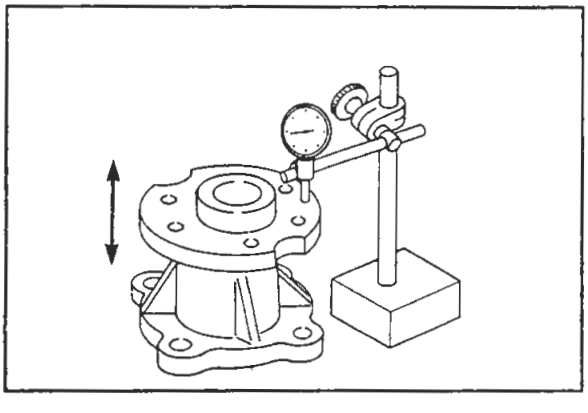


Inspection

Visually inspect the fan hub for indication of oil seal leakage.

Visually inspect the fan hub for cracks or damage.

Turn the fan hub shaft by hand to inspect the fan hub for freedom of rotation.



Measure the fan hub shaft end clearance.

Shaft End Clearance		
mm		In.
0.08	MIN	0.003
0.41	MAX	0.016

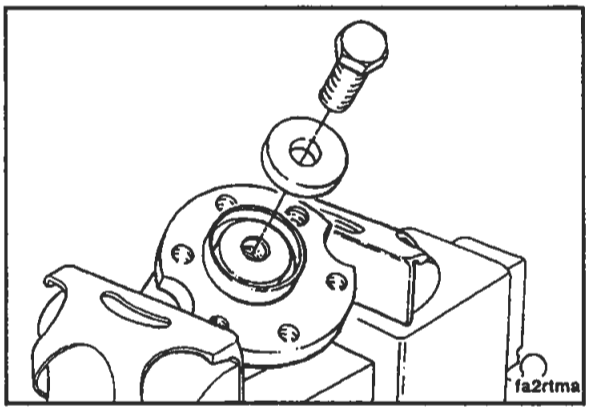
NOTE: If damaged parts are found, the shaft does **not** rotate freely or the shaft end clearance is **not** within the specifications, the fan hub **must** be replaced.

Fan Hub (Belt Driven) - Rebuild (8-04)

Disassembly

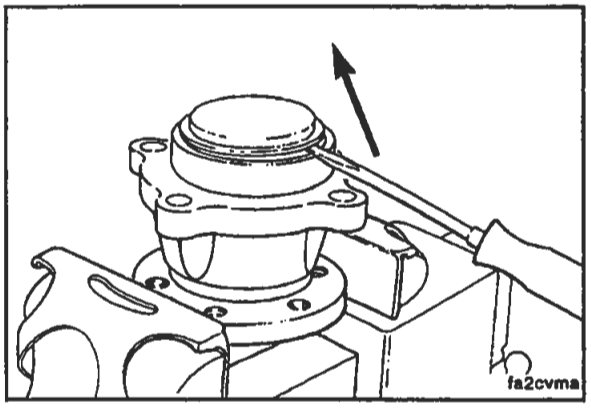
Install the flange in a vise with brass jaws, and with the fan mounting surface face up.

Remove the retaining capscrew and washer.



Loosen the vise and turn the fan hub assembly over so the back side of the assembly is facing up.

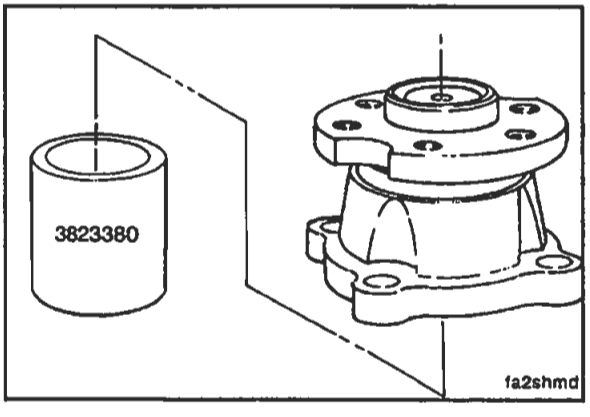
Insert a screwdriver blade under the cover flange and pry the cover out of the fan hub. Save the cover for reuse.



Caution: The shaft will be damaged if the rear bearing inner race is not supported when removing the shaft.

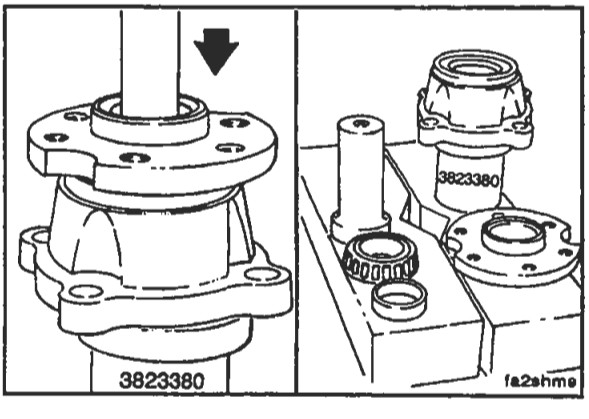
Use disassembly pot, Part No. 3823380, to support the bearing inner race.

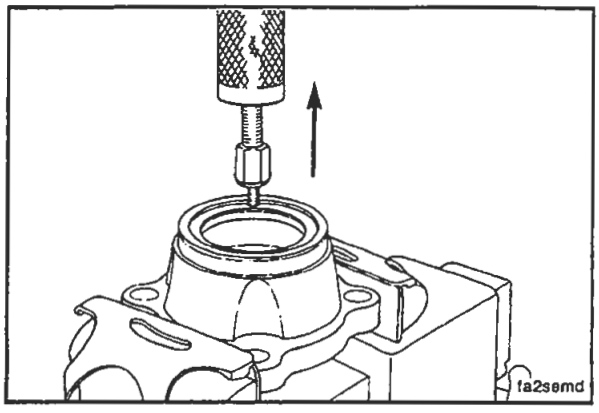
Place the support on an arbor press with the fan hub assembly on top of the support. The fan mounting surface **must** be facing up.



Press the shaft through the flange.

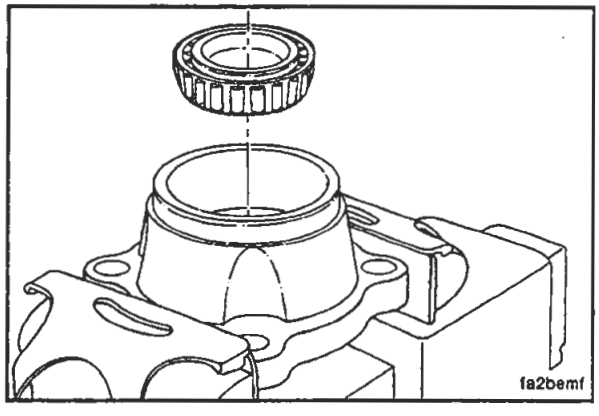
Remove the flange, shaft, small bearing spacer and rear bearing.



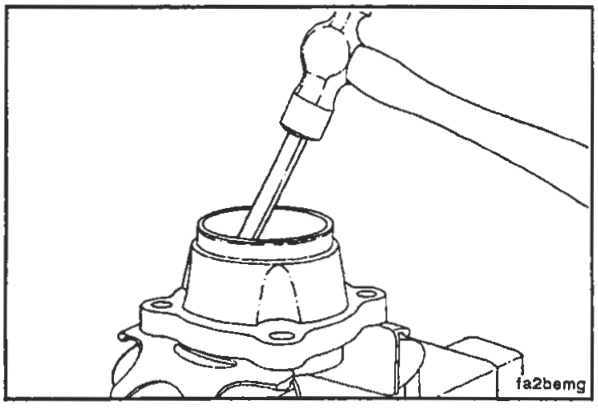


Place the hub in a vise with brass jaws and the outer side up.

Use a seal puller, or equivalent, to remove the front grease seal. Discard the seal.

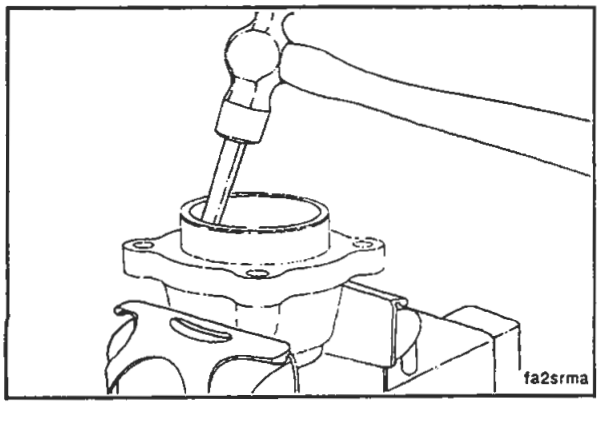


Remove the front bearing.



Use a punch and hammer to remove the rear bearing outer race.

NOTE: Use care **not** to damage the inside bore of the hub as the bearing race is removed.



Turn the hub over in the vise so the back side is facing up.

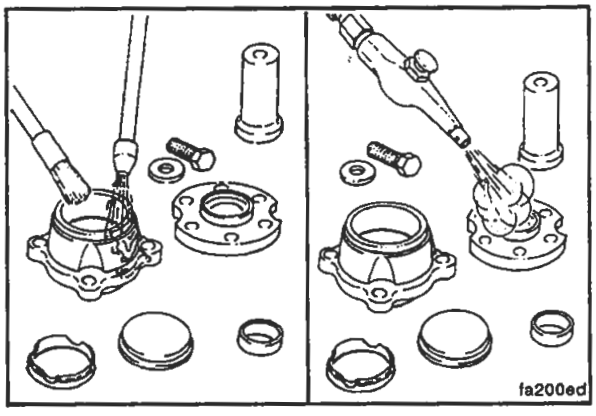
Use a hammer and punch to remove the front bearing outer race and large bearing spacer.

NOTE: Use care **not** to damage the inside bore of the hub when removing the race.

NOTE: Inspect the bearing retaining ring. If the ring is **not** damaged, it does **not** need to be removed.

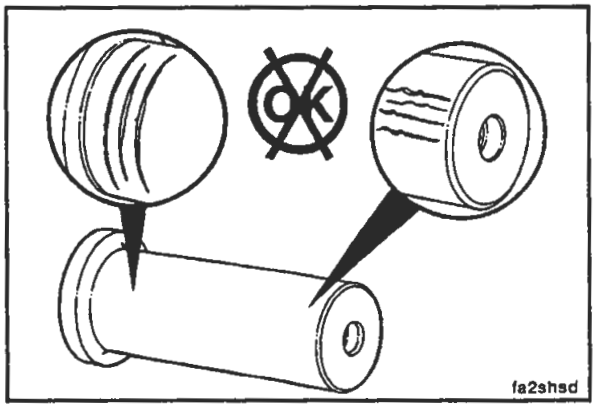
Cleaning

Use solvent to clean the fan hub assembly parts. Dry with compressed air.



Inspection

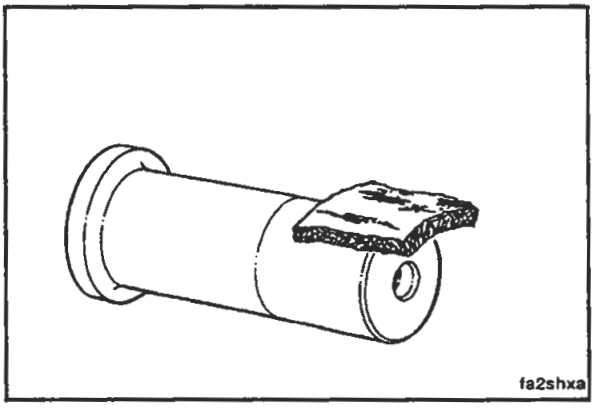
Visually check the shaft for grooves, scoring, cracks or any other types of damage.



Use Scotch-Brite® 7448, Part No. 3823258, or equivalent, to remove any minor flaws from the shaft.

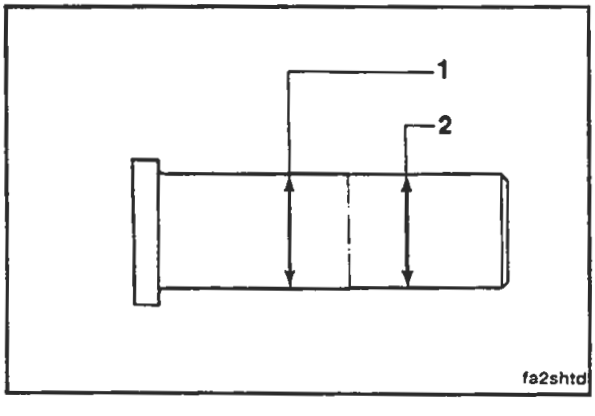
NOTE: When removing flaws with Scotch-Brite® or other material, the shaft O.D. specifications **must** be maintained, or the shaft **must** be replaced.

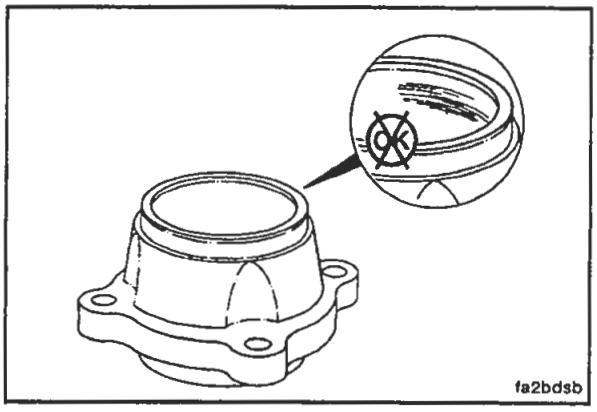
Use solvent to clean the shaft. Dry with compressed air.



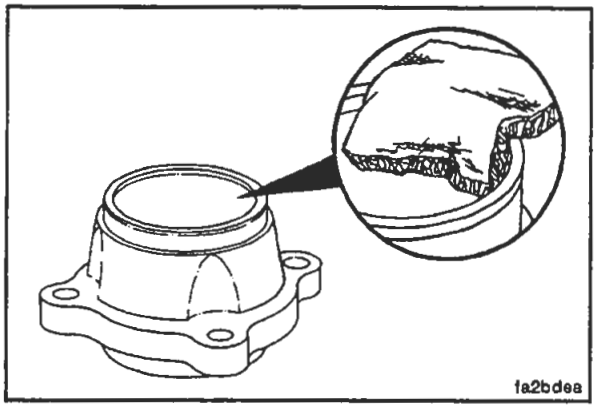
Measure the outside diameter of the shaft at points (1) and (2).

Point	Fan Hub Shaft O.D. mm		In
1	34.590	MIN	1.3760
	34.963	MAX	1.3765
2	34.912	MIN	1.3745
	34.925	MAX	1.3750





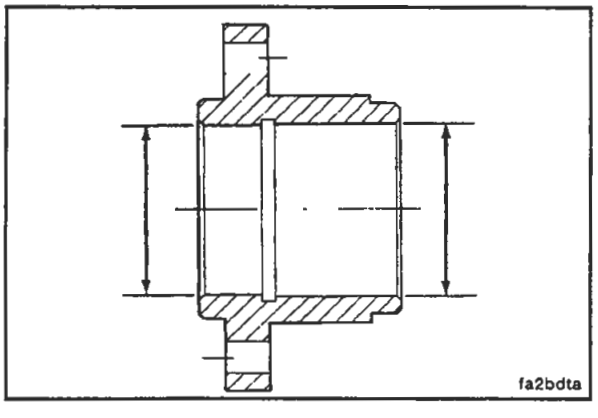
Visually check the hub bore for scoring, nicks, scratches or any other type of damage.



Use Scotch-Brite® 7448, Part No. 3823258 or equivalent, to remove any minor damage from the hub bore.

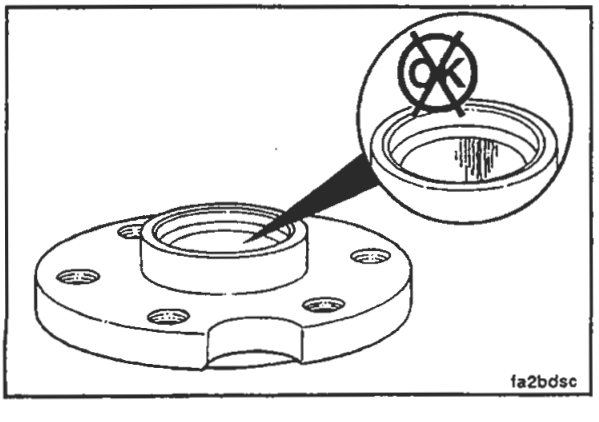
NOTE: When removing nicks or scratches from the hub, the inside diameter **must** be maintained, or the hub **must** be replaced.

Use solvent to clean the hub and dry with compressed air.



Measure the inside diameter of the hub bearing bores.

Hub Bearing Bore I.D.		
mm		In
65.038	MIN	2.5605
65.076	MAX	2.5620

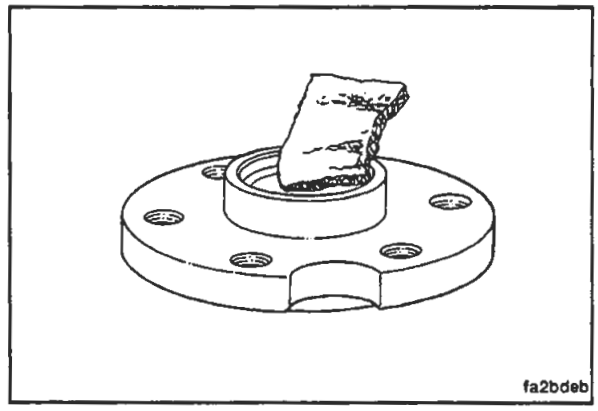


Visually check the flange bore for grooves, scratches or any type of damage.

Use Scotch-Brite® 7448, Part No. 3823258 or equivalent to remove any minor damage from the flange bore.

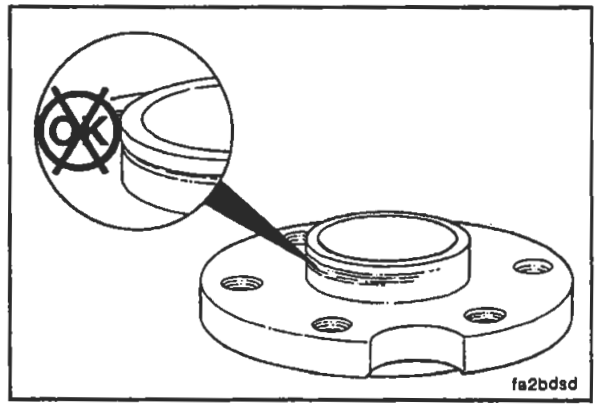
NOTE: When removing nicks or scratches from the flange, the inside diameter **must** be maintained, or the flange **must** be replaced.

Use solvent to clean the flange and dry with compressed air.



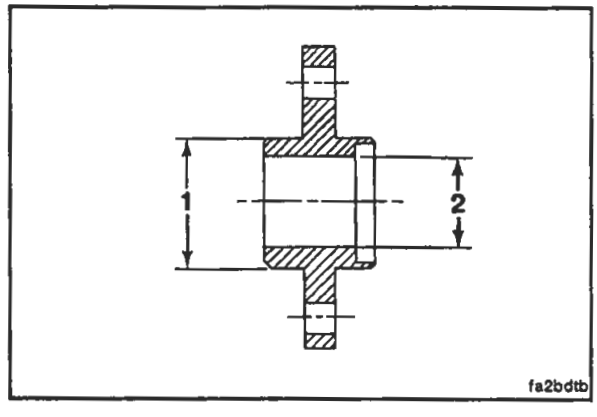
Visually check the grease seal contact area on the flange.

The grease seal contact area **must not** be grooved more than 0.25 mm [0.010 inch] deep on the flange. If the groove is deeper than specified, the flange **must** be replaced.



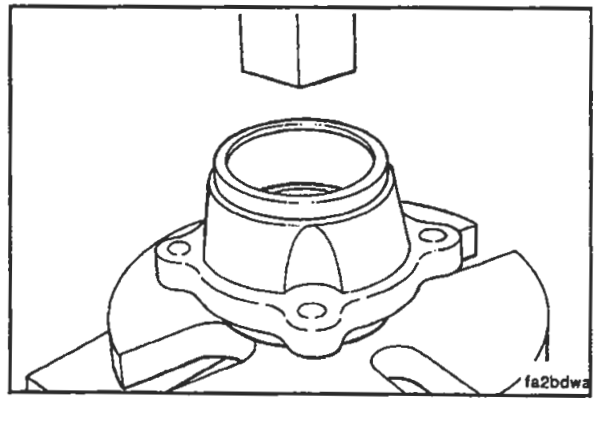
Measure the outside diameter (1) and inside diamter (2) of the flange.

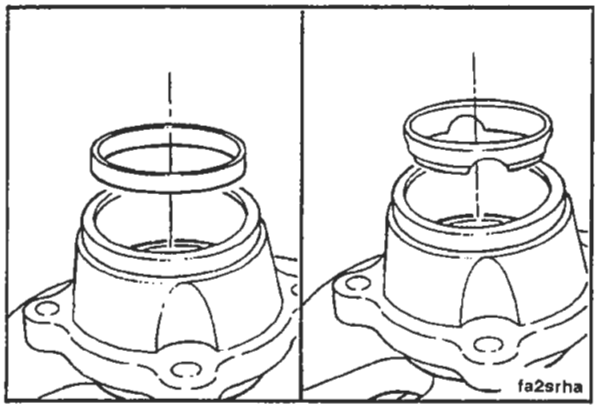
Point	Flange O.D. and I.D. mm		In
1	48.975	MIN	1.9281
	49.000	MAX	1.9291
2	34.849	MIN	1.3720
	34.875	MAX	1.3730



Assembly

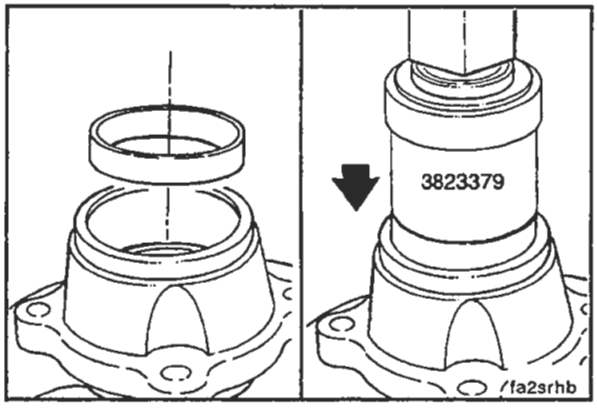
Position the hub in an arbor press with the front of the hub facing up.



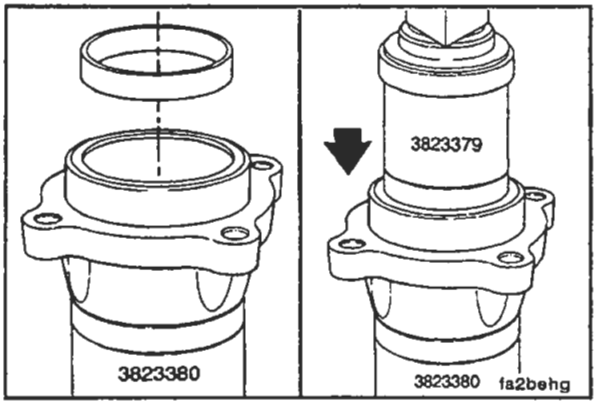


Install the large bearing spacer into the front of the hub.

NOTE: If a spacer without slots is used, either end of the spacer can be installed against the retaining ring. If a slotted spacer is used, install the slotted end of the spacer against the retaining ring.

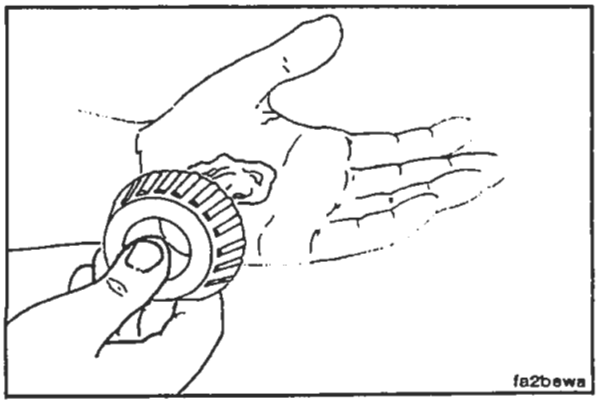


With the large diameter of the bearing race facing up, use the small end of bearing driver, Part No. 3823379, to press a new front bearing race into the hub until it touches the bearing spacer.



Turn the assembly over and support the front bearing race with disassembly pot, Part No. 3823380.

With the large inside diameter of the bearing race facing up, use bearing driver, Part No. 3823379, to press a new rear bearing race into the hub until it touches the bearing spacer.

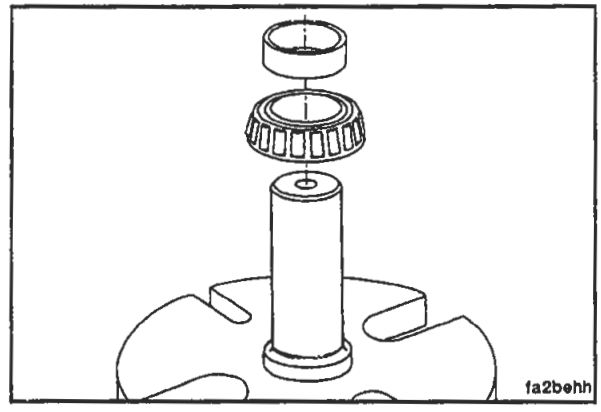


Use Chevron SRI grease, or equivalent, to pack both bearings.

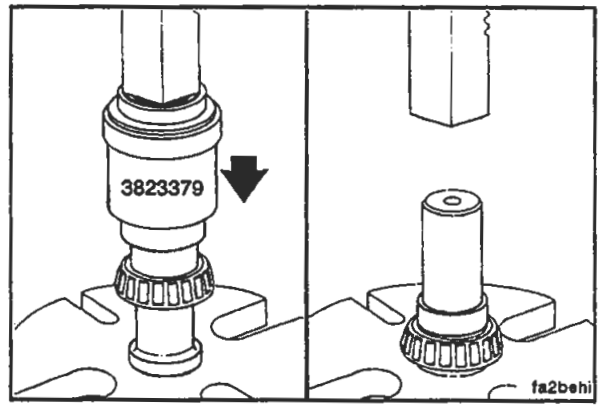
Place the shaft on the arbor press table with the small end pointed up.

Install the rear bearing on the shaft with the small diameter of the bearing on top.

Install the small bearing spacer on top of the bearing.

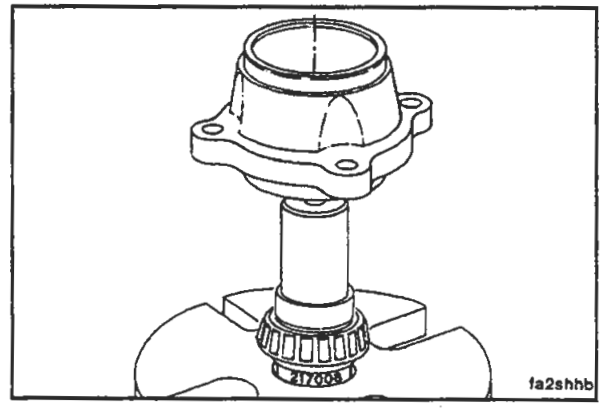


Use the small end of the bearing driver, Part No. 3823379, to press the spacer and bearing onto the shaft until it touches the shaft shoulder.

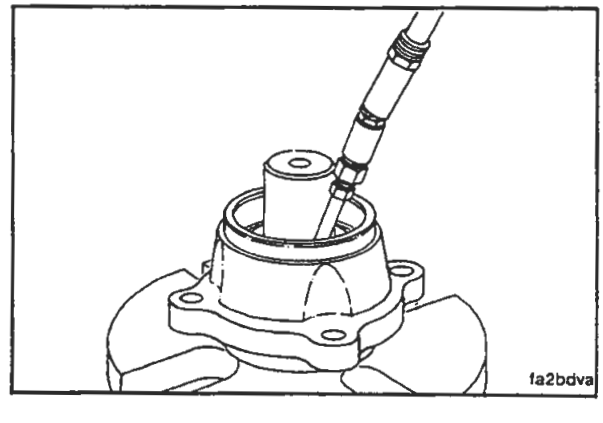


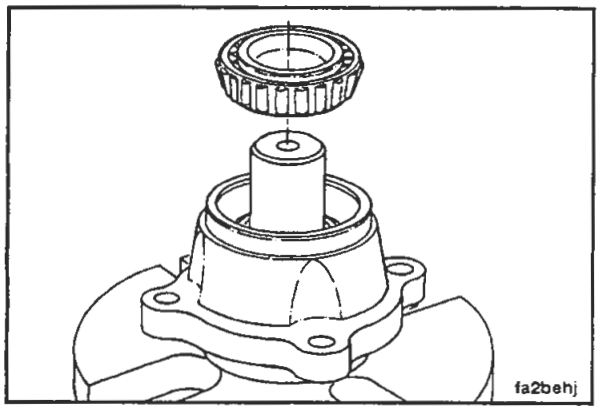
If the shaft is shorter than 95.2 mm [3.75 inch], support the shaft with spacer, Part No. 217008 or equivalent.

With the tapered (fan mounting) end of the fan hub facing up, place the hub over the shaft and bearing assembly.

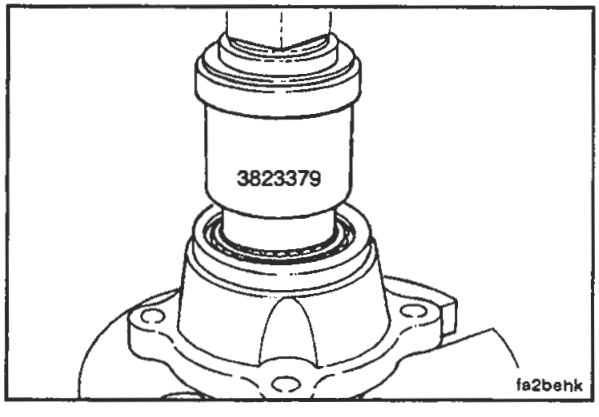


Use Chevron SRI grease, or equivalent, to fill the hub to the top of the bearing spacer.

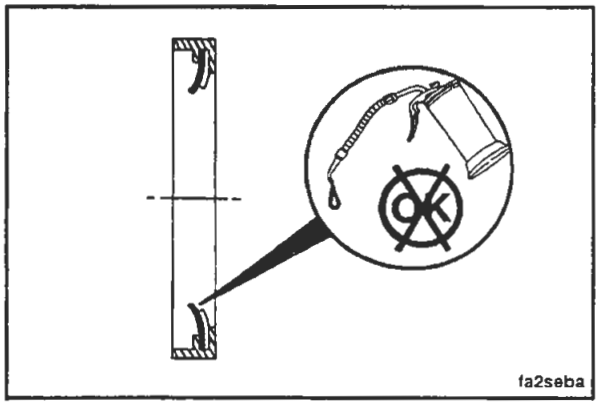




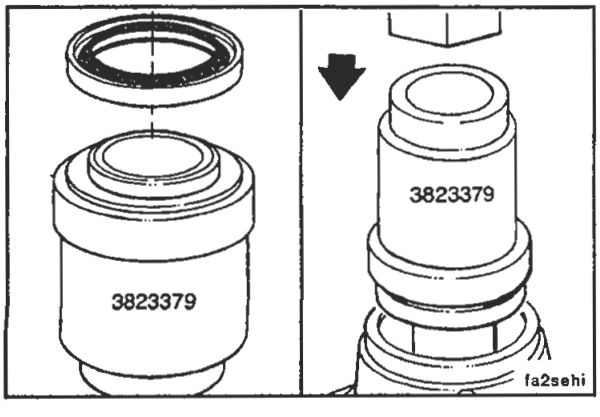
With the small end of the bearing facing down, install the front bearing on the shaft.



Use the small end of bearing driver, Part No. 3823379, to press the front bearing onto the shaft until the inner race of the bearing touches the bearing spacer.



Caution: Do not lubricate the grease seal. The seal must be installed with the lip of the seal clean and dry to provide a proper sealing surface and prevent hub damage. Make sure the seal installation tool and flange are clean and dry when the fan hub is assembled.



The sealing lip of the grease seal **must** be installed away from the seal driver.

Place the seal on the large end of bearing driver, Part No. 3823379, with the open side of the seal facing away from the driver.

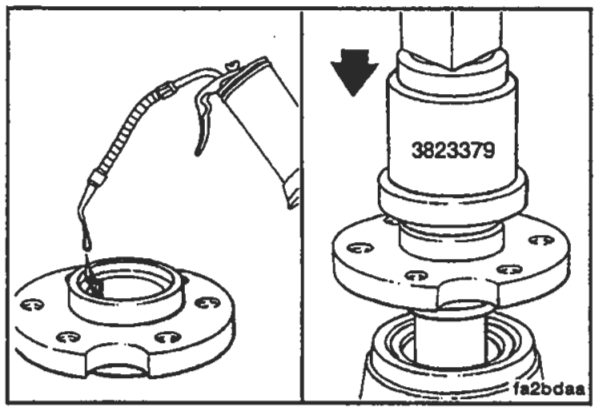
Press the seal into the hub until the driver touches the hub.

If the shaft is shorter than 95.2 mm [3.75 inch], support the shaft with spacer, Part No. 217008 or equivalent.

Place the hub on an arbor press with the tapered (fan mounting) end facing up.

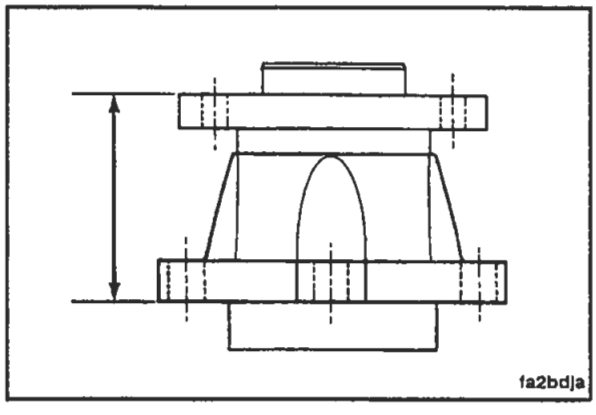
Apply a thin film of oil into the bore of the fan hub flange.

Use the large end of bearing driver, Part No. 3823379, to press the flange onto the shaft until it touches the front bearing.



Measure the distance between the fan hub mounting faces.

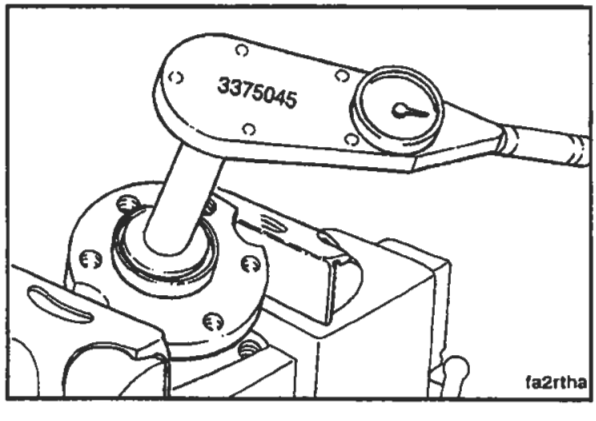
Face to Face Distance		
mm		In
73.4	MIN	2.890
74.0	MAX	2.913



Install the fan hub in a vise with the fan mounting flange facing up.

Install the flat washer and the (M10-1.50 x 25) capscrew.

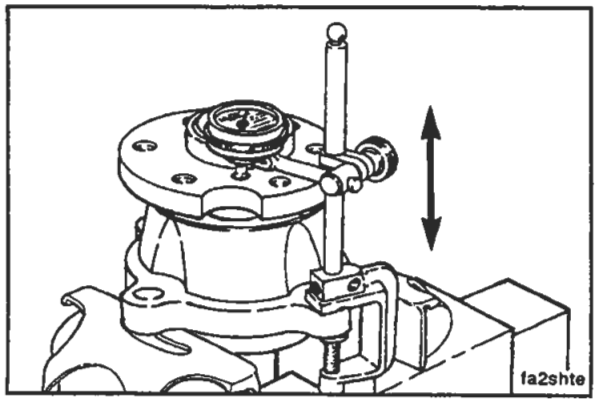
Torque Value: 61 N•m [45 ft-lb]

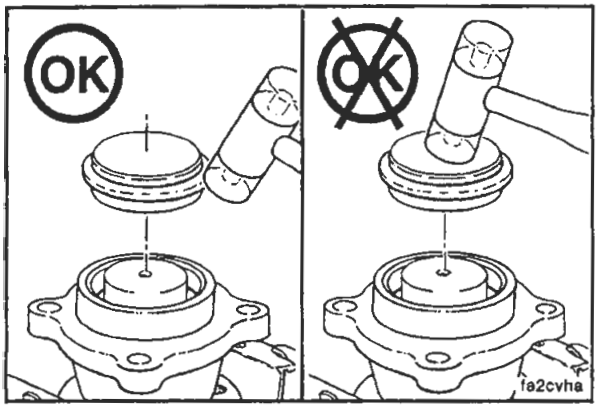


Install the fan hub in a vise so the shaft end clearance can be measured.

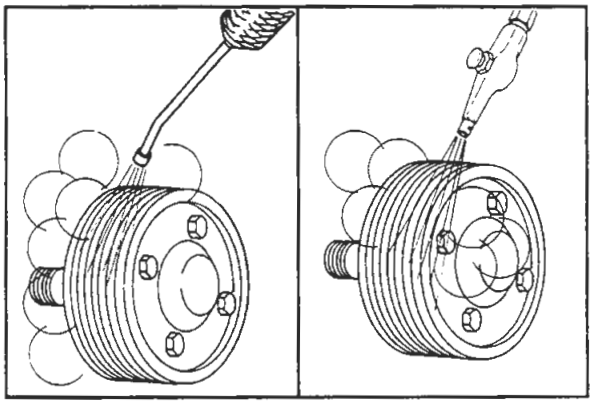
Shaft End Clearance		
mm		In
0.076	MIN	0.0030
0.406	MAX	0.0160

If the shaft end clearance is **not** within the specifications, disassemble and inspect for incorrect assembly.





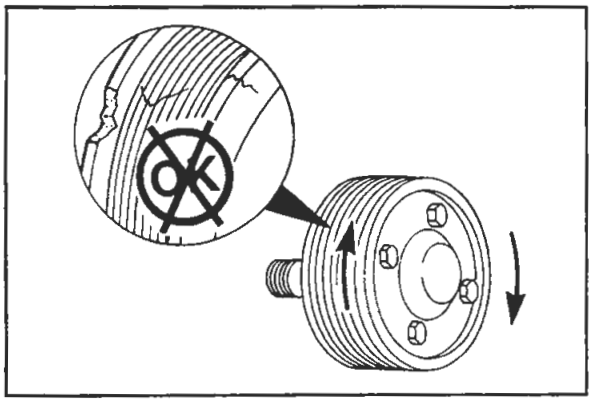
Use a leather hammer to install the cover. Do **not** hit in the center of the cover.



Fan Idler Pulley - Clean and Inspect for Reuse (08-05)

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

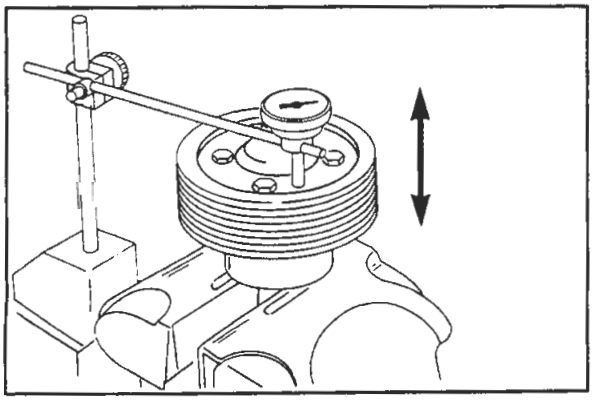
Use solvent or steam to clean the fan idler pulley exterior. Dry with compressed air.



Inspection

Visually inspect the idler assembly for cracked, chipped or broken pulley grooves.

Turn the idler pulley by hand to inspect the shaft for freedom of rotation.



Measure the idler pulley end clearance.

Pulley End Clearance		
mm		in.
0.05	MIN	0.002
0.25	MAX	0.010

NOTE: If damaged parts are found, the pulley does **not** rotate freely or the pulley end clearance is **not** within the specifications, the idler pulley **must** be replaced or rebuilt. Refer to Fan Idler Pulley - Rebuild (08-06).

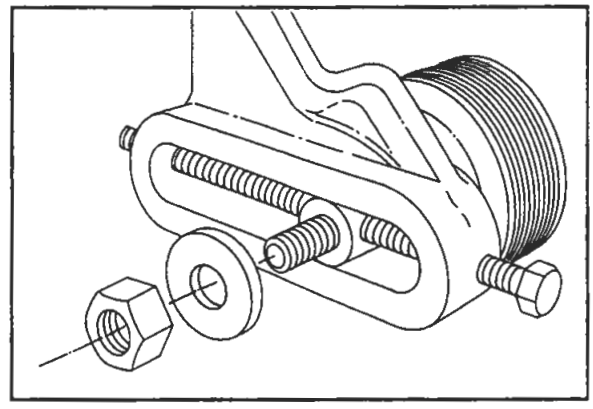
Fan Idler Pulley - Rebuild (08-06)

Disassembly

Install the fan hub support in a vise with brass jaws.

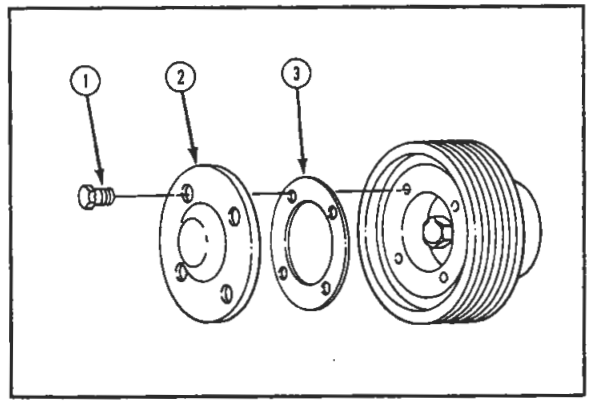
Remove the idler pulley from the fan hub support.

NOTE: Earlier production style idler pulleys use a capscrew and washer. Present production style idler pulleys use a nut and washer.



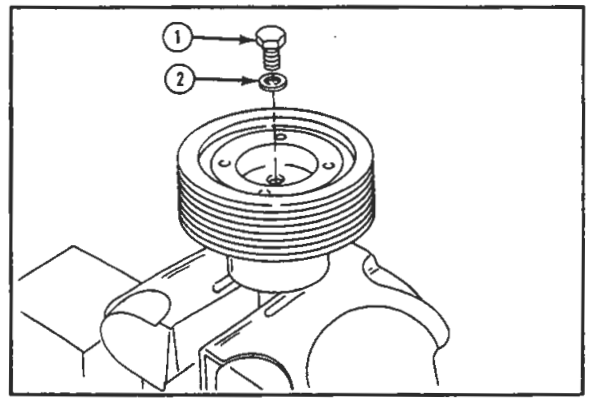
Remove the four capscrews (1), cover plate (2) and gasket (3) from the idler pulley.

Discard the gasket.

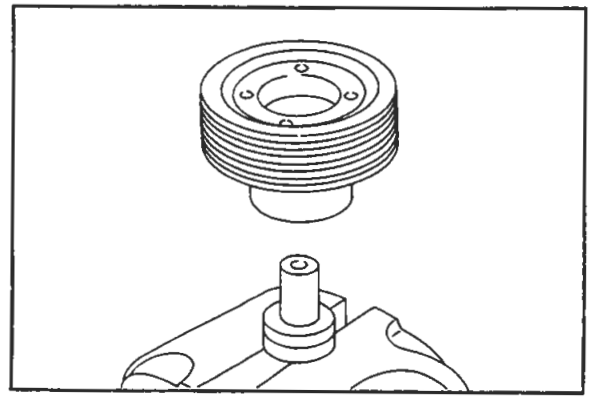


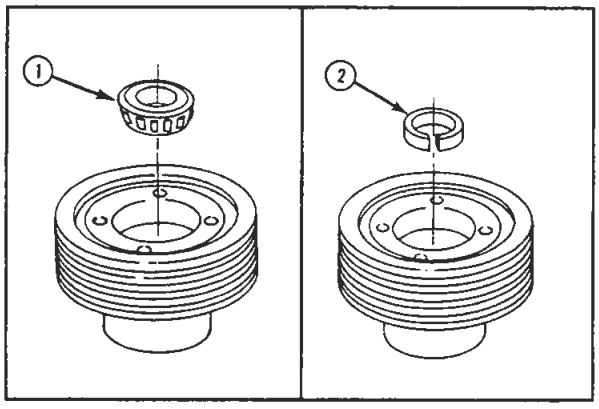
Install the pulley shaft in a vise with brass jaws.

Remove the capscrew (1) and washer (2) from the pulley shaft.



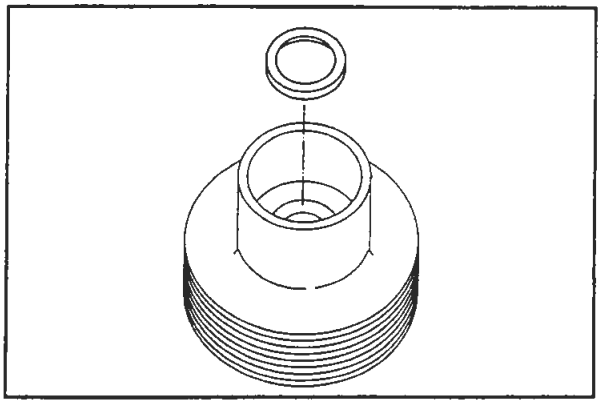
Remove the idler pulley from the shaft.





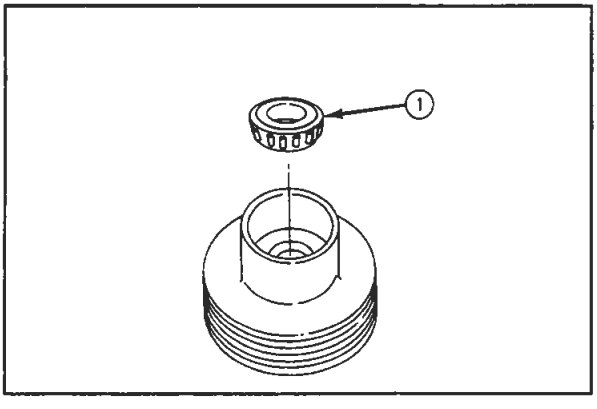
Remove the front bearing (1) from the idler pulley.

Remove the bearing spacer (2) from the idler pulley.

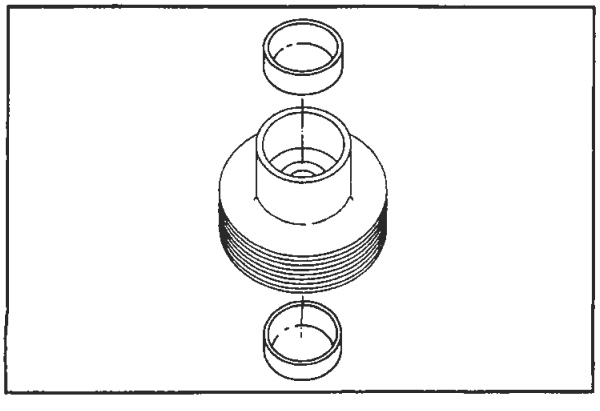


Caution: Do not damage the pulley bore when removing the rear grease seal. The idler pulley can fail.

Use a "flat tip" screwdriver or pry bar to remove the rear grease seal.



Remove the rear bearing (1) from the idler pulley.



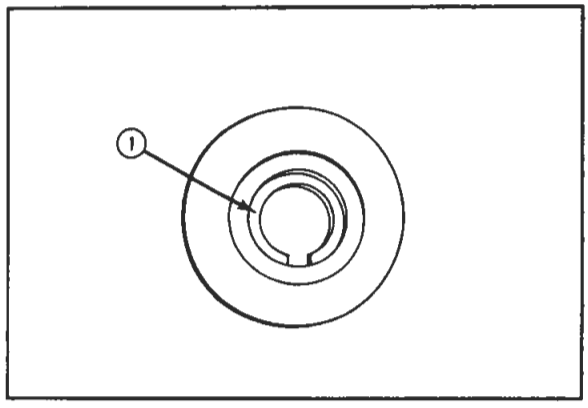
NOTE: The bearing races do not need to be removed during the inspection and rebuild procedure if they are not damaged. See Inspection following, if damage is found:

Install the idler pulley mounting flange in a vise with brass jaws.

Caution: Do not damage the pulley bore when removing the bearing races. The idler pulley can fail.

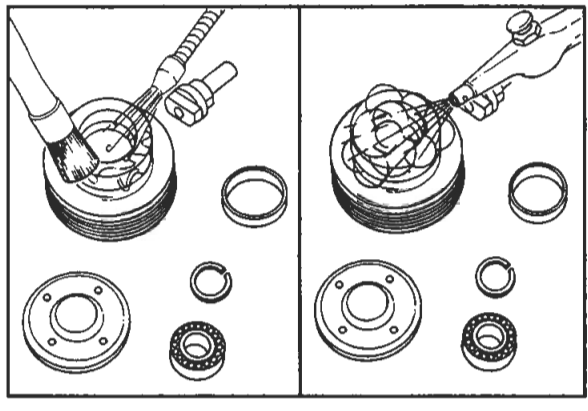
Use a punch and hammer to remove the front and rear bearing races.

NOTE: If the bearing race spacer (1) is **not** worn or damaged, it does **not** need to be removed during the inspection and rebuild procedure.



Cleaning

Use solvent to clean the idler pulley parts. Dry with compressed air.

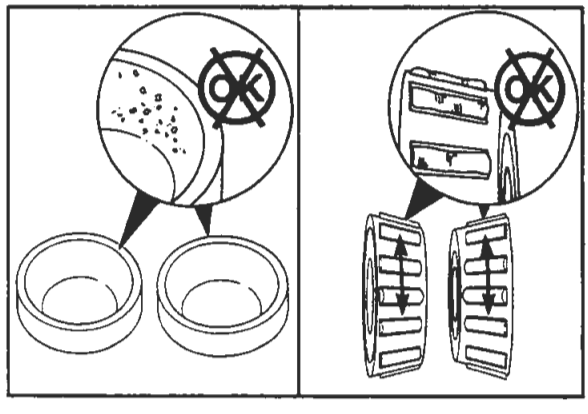


Inspection

Caution: The new idler pulley roller bearing set consists of two bearings, two races, an inner spacer and an outer spacer. To prevent future idler pulley failure, the bearings must be replaced as a complete set and not individual parts. Bearings and races that are to be used again must also be kept in sets.

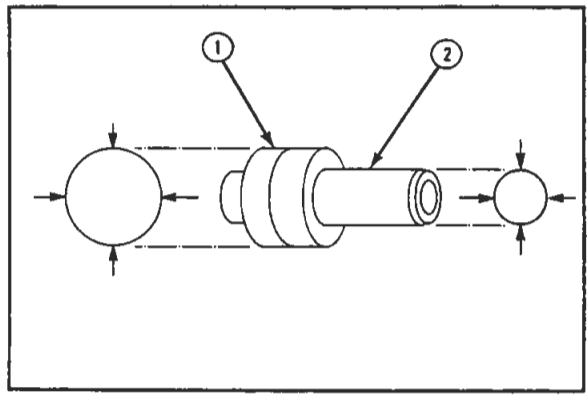
Visually inspect the bearing races for pitting or scoring.

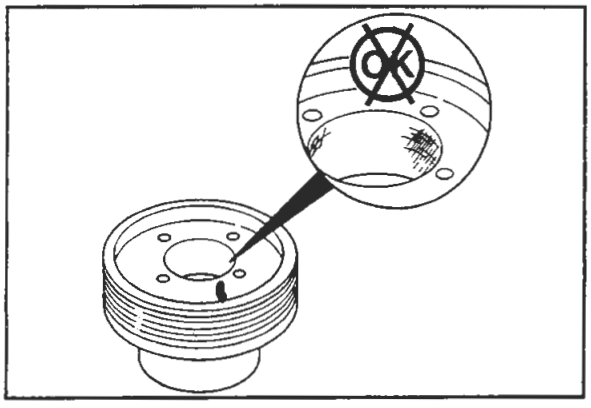
Visually inspect the bearings for freedom of movement or damage.



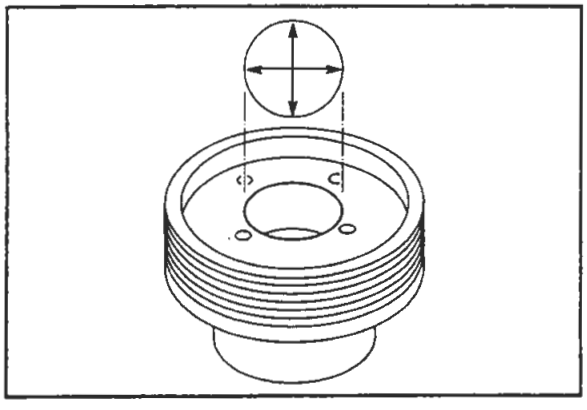
Measure the outside diameter of the seal (1) and bearing (2) surfaces of the idler pulley shaft.

Point	Shaft O.D. mm		Shaft O.D. In.
1	32.975	MIN	1.2982
	33.000	MAX	1.2992
2	19.037	MIN	0.7495
	19.050	MAX	0.7500



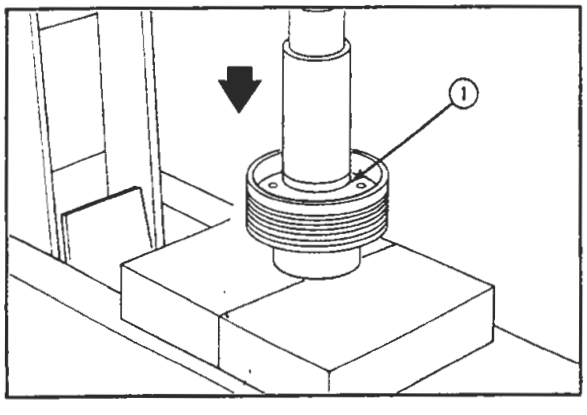


Visually inspect the idler pulley bore for scoring, nicks or scratches.



Measure the inside diameter of the idler pulley bearing bores.

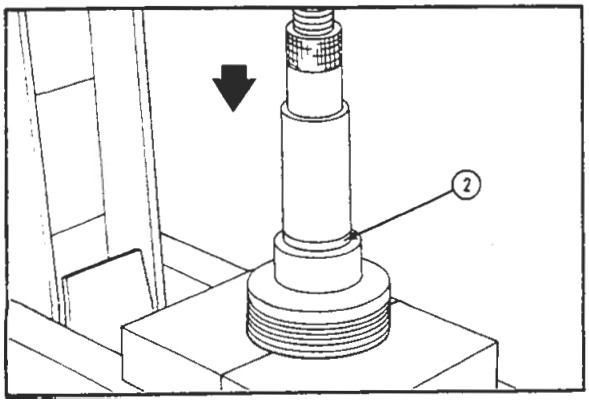
Front and Rear Bearing Bores I.D.		
mm		in.
45.199	MIN	1.7795
45.224	MAX	1.7805



Assembly

Install the idler pulley in an arbor press with the mounting flange facing down.

Use the Part No. 3375696 Bearing Driver to push the front bearing race (1) into the pulley until it touches the spacer ring.

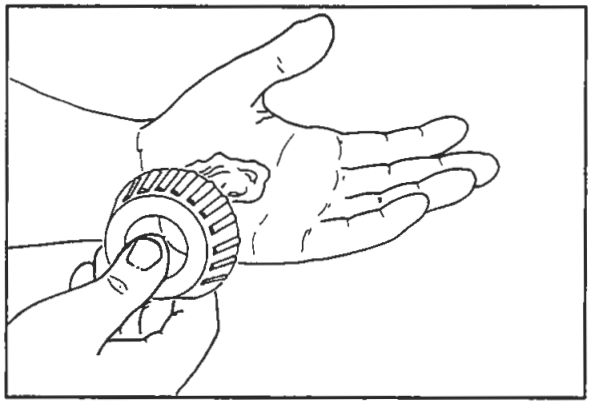


Turn the pulley over with the mounting flange facing up in the arbor press.

Use the Part No. 3375696 Bearing Driver to push the rear bearing race (2) into the pulley until it touches the spacer ring.

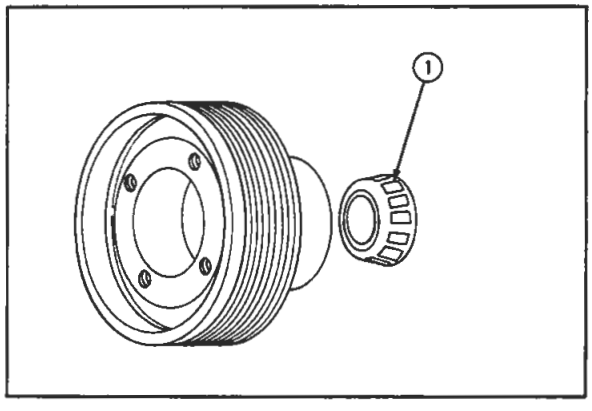
Use clean Aeroshell®5 Grease, or equivalent to lubricate the front and rear bearings.

NOTE: Fill the space between the two bearings with grease when assembling the idler pulley.



Install the rear bearing (1) into the mounting flange end of the pulley.

NOTE: The rear bearing **must** be seated in the rear bearing race.

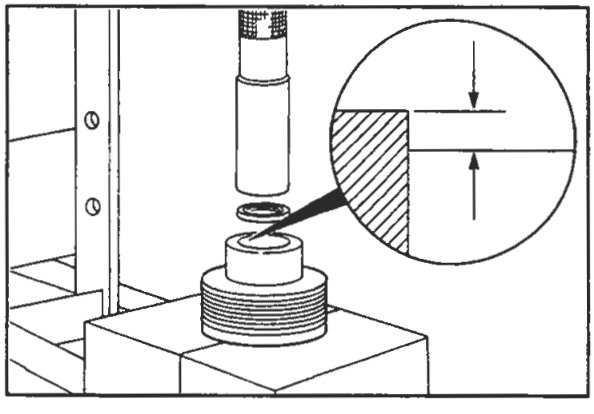


Install the idler pulley in an arbor press with the mounting flange facing up.

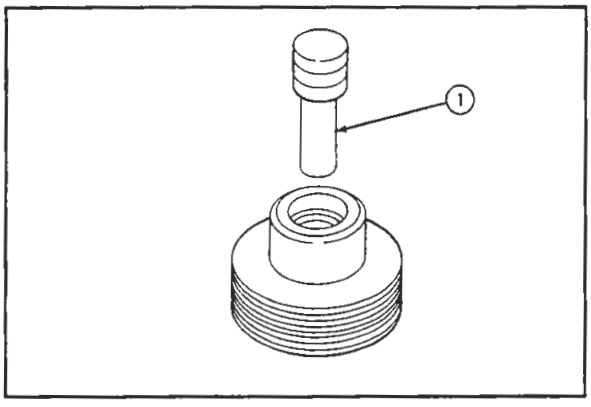
Caution: Do not lubricate the seal. The oil seal must be installed with the lip of the seal clean and dry to provide a proper oil sealing surface and prevent future idler pulley damage.

Install the seal into the pulley bore with the lip of the seal facing down.

Use the Part No. 3375696 Bearing Driver to push the oil seal into the pulley bore to the specified depth from the mounting flange surface.

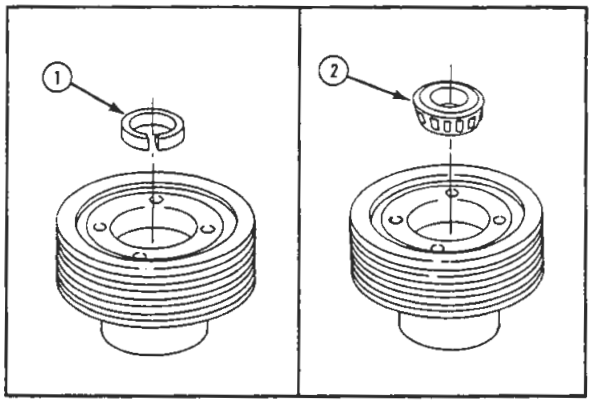


Oil Seal Installed Depth		
mm		In.
0.00	MIN	0.000
0.25	MAX	0.010



Caution: Do not allow the dust lip on the seal to roll under when installing the idler pulley shaft. The dust seal must be correctly installed to prevent contamination and future idler pulley failure.

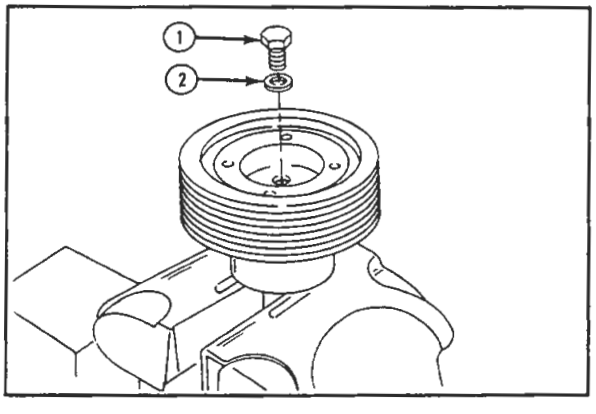
Install the idler pulley shaft (1) into the bore of the pulley with the large end of the shaft seated in the mounting flange.



Install the front bearing spacer (1) into the idler pulley bore.

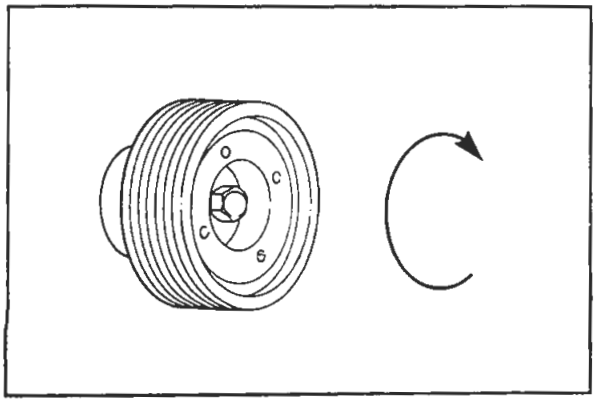
Install the front bearing (2) into the idler pulley bore.

NOTE: The front bearing must be seated in the front bearing race.



Install the capscrew (1) and washer (2) into the idler pulley shaft.

Torque Value: 45 N•m [35 ft-lb]

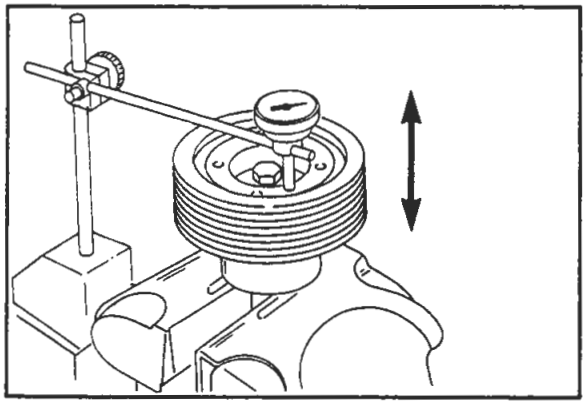


Final Inspection

Turn the idler pulley by hand to inspect the shaft for freedom of rotation.

NOTE: If the idler pulley does **not** rotate freely, disassemble and inspect for incorrect assembly.

Measure the idler pulley end clearance.



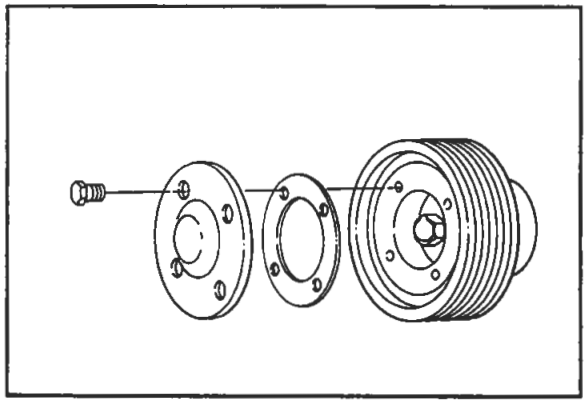
Pulley End Clearance		
mm		In.
0.05	MIN	0.002
0.25	MAX	0.010

NOTE: If the idler pulley end clearance is **not** within the specifications, disassemble and inspect for incorrect assembly.

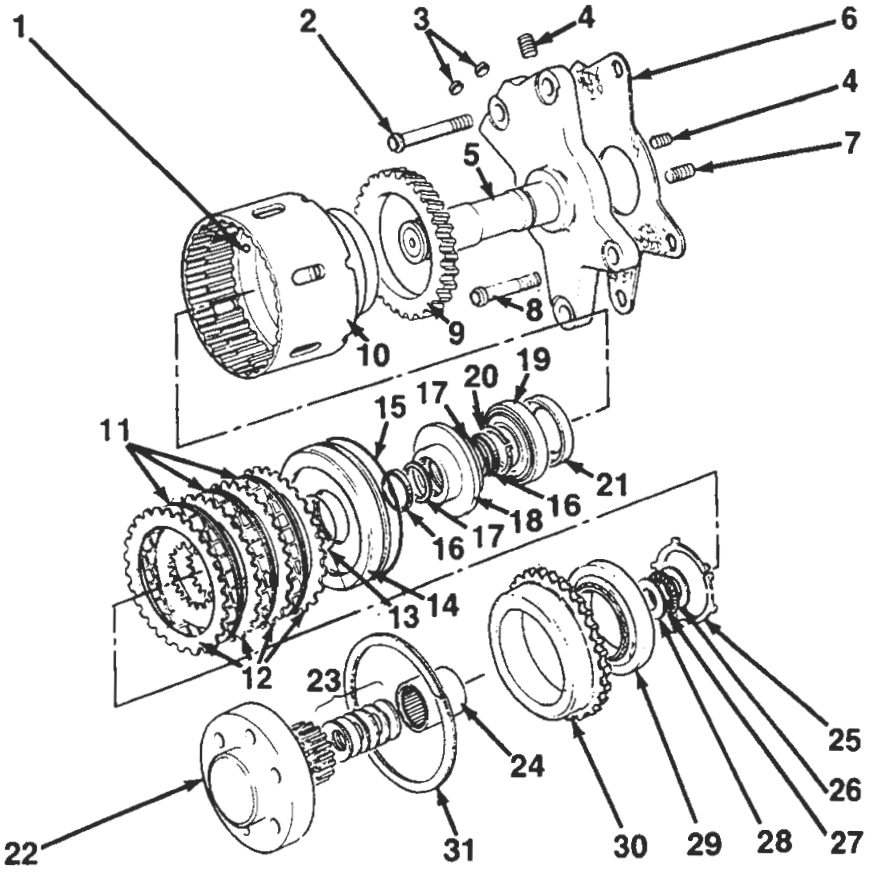
Install a new gasket and the cover plate.

Install the four mounting capscrews.

Torque Value: 10 N•m [90 in-lb]



Fan Hub, Holset (Gear Driven) - Exploded View



Ref No.	Description	Qty.
1	Ball	1
2	Capscrew	3
3	Plug, Expansion	2
4	Screw, Hex Socket	2
5	Spindle	1
6	Gasket	1
7	Screw, Hex Socket	1
8	Capscrew	1
9	Gear	1
10	Housing	1
11	Plate, Clutch Friction	3
12	Plate, Clutch Driving	4
13	Seal, O-ring	1
14	Piston	1
15	Seal, O-ring	1
16	Seal, Rectangular Ring	2

Ref No.	Description	Qty.
17	Spring, Rectangular Ring Seal	2
18	Housing, Seal	1
19	Bearing, Roller	1
20	Ring, Retaining	1
21	Plate, Oil Baffle	1
22	Shaft	1
23	Washer, Spring	6
24	Bearing, Needle	1
25	Ring, Retaining	1
26	Washer, Thrust	1
27	Bearing, Thrust	1
28	Washer, Thrust	1
29	Bearing, Roller	1
30	Cover	1
31	Ring, Retaining	1

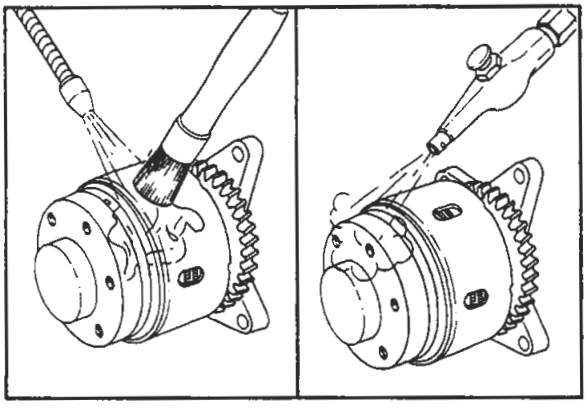
Fan Hub, Holset (Gear Driven) - General Information

The gear driven fan hub is a hydraulic clutch type fan hub. Oil flow from the engine main rifle drilling lubricates the fan hub bearings and activates the hydraulic clutch. A thermal sensing unit in the thermostat housing controls the oil flow required to operate the fan clutch.

Fan Hub, Holset (Gear Driven) - Clean and Inspect for Reuse (08-07)

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use solvent or steam to clean the fan hub exterior. Dry with compressed air.

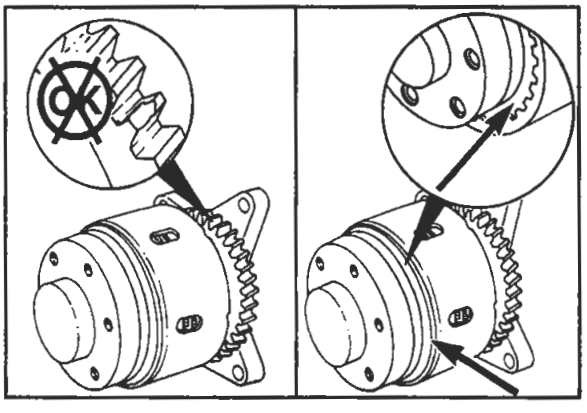


Inspection

Visually inspect the drive gear for cracked or broken teeth.

Visually inspect the position of the retainer ring in the fan hub.

NOTE: The retainer ring **must** be positioned firmly against the fan clutch cover as shown.

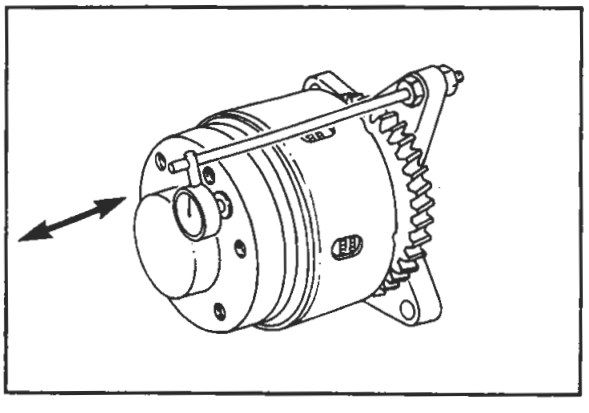


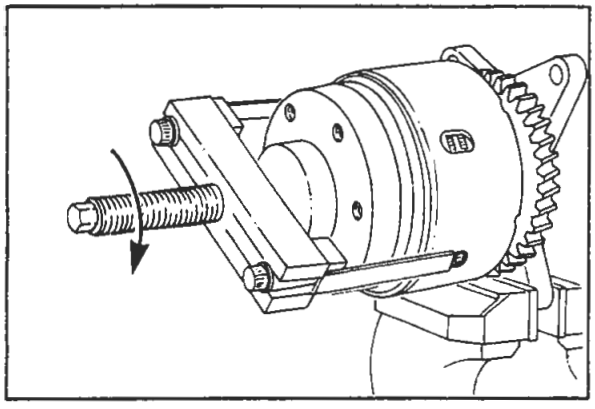
Install a dial indicator in one of the capscrew holes on the mounting flange.

Measure the end clearance from the front face of the fan hub.

NOTE: The fan hub **must not** have any measurable end clearance.

NOTE: If damaged parts are found, the retainer ring is **not** seated against the fan clutch cover or there is **any** end clearance, the fan hub **must be** replaced or rebuilt. Refer to Fan Hub, Holset (Gear Driven) - Rebuild (08-08).





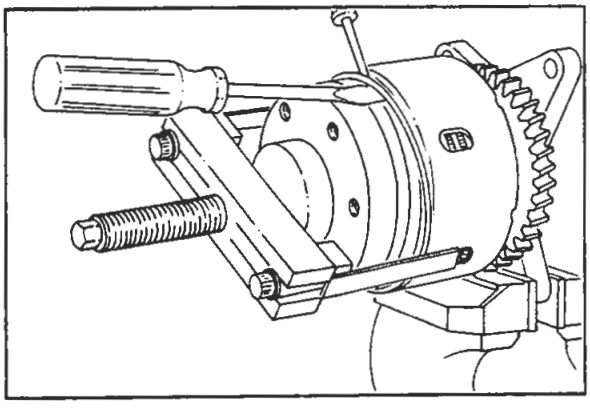
Fan Hub, Holset (Gear Driven) - Rebuild (08-08)

Disassembly

Install the fan clutch assembly spindle plate in a vise with brass jaws.

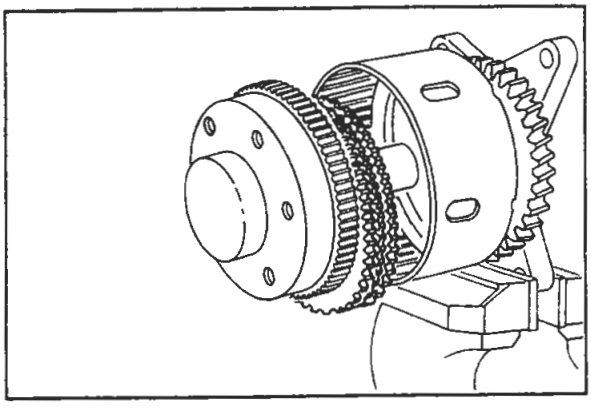
Use the Part No. 3377072 Spring Pack Compressor and the Part No. ST-647 Puller to compress the clutch shaft.

NOTE: Compress the clutch shaft far enough to relieve the pressure from the retainer ring.



Use two small screw drivers to remove the retainer ring.

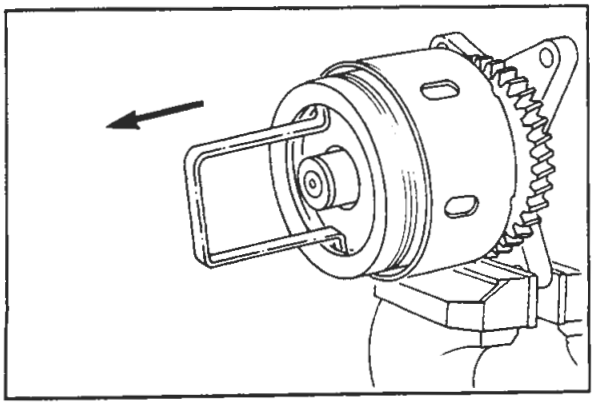
Remove the puller and spring pack compressor.



Remove the fan clutch shaft and cover, including the clutch plates.

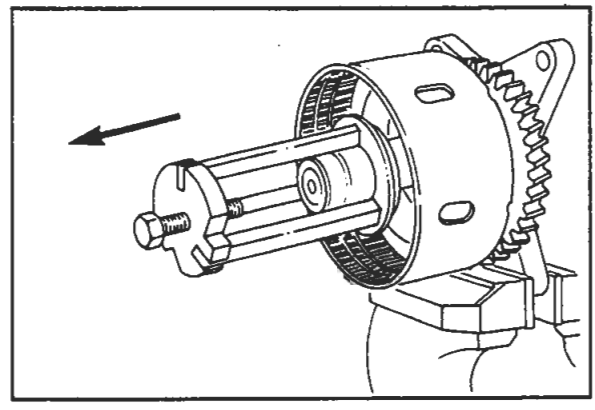
Remove the clutch plates from the shaft.

NOTE: Do **not** allow the spring washers to fall from the clutch shaft.

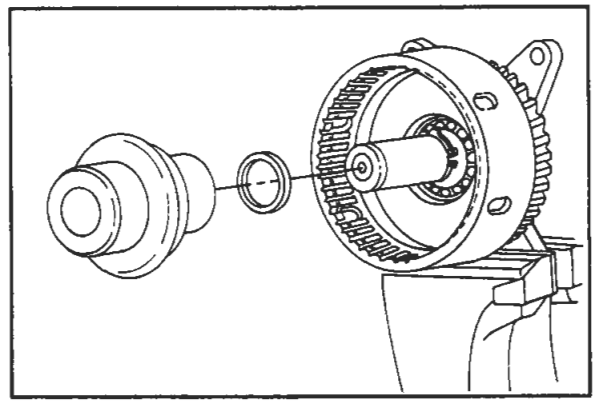


Use the Part No. 3377070 Fan Clutch Piston Puller under the piston flange lip to remove the fan clutch piston.

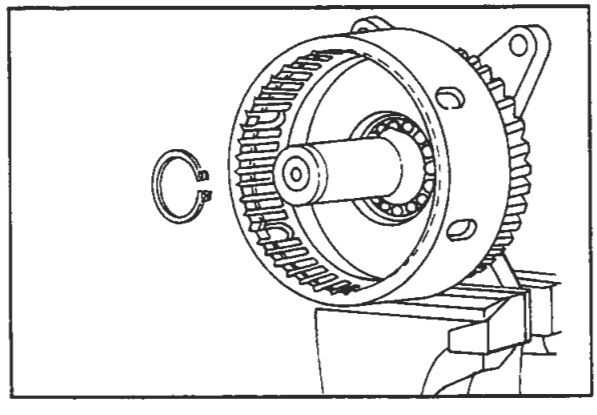
Use the Part No. 3377071 Seal Housing Puller to remove the seal housing.



Remove and discard the rectangular ring seal and the rectangular seal ring spring.



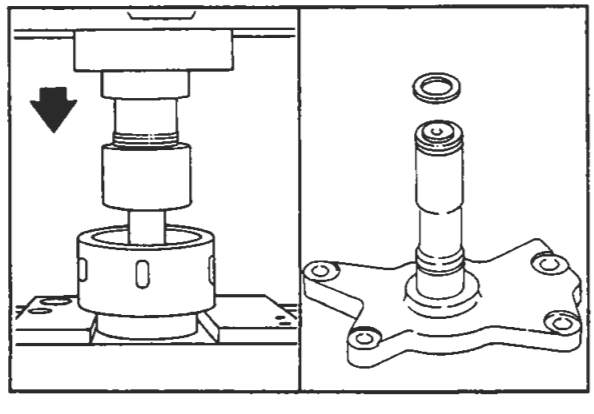
Use snap ring pliers to remove the roller bearing retainer ring.

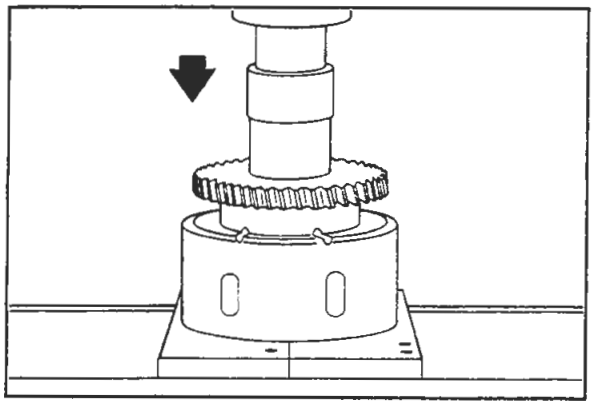


Install the fan clutch housing in an arbor press.

Push the spindle out of the housing.

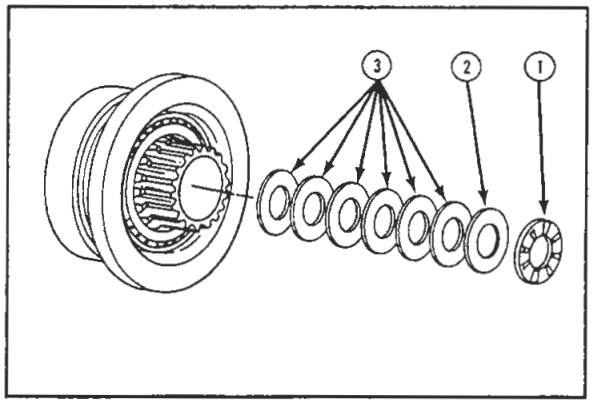
Remove the thrust washer from the spindle. Discard the thrust washer.





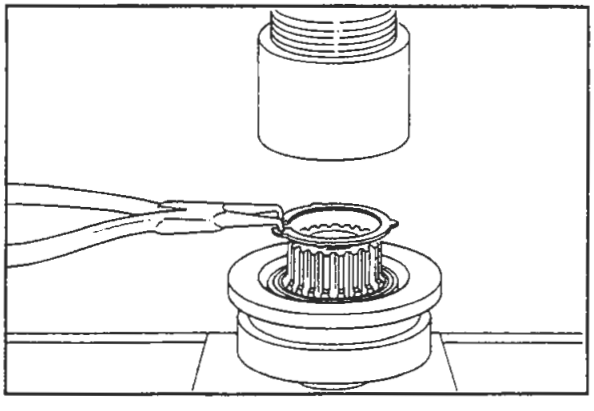
Remove the roller bearing from the bearing race.

Use the Part No. 3377073 Small Bearing Mandrel to push the bearing race and oil baffle plate from the housing.

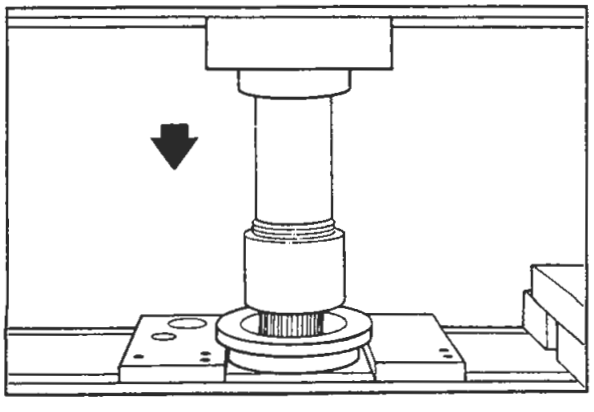


Remove the thrust bearing (1), thrust washer (2) and spring washers (3).

Discard the bearings and washers.

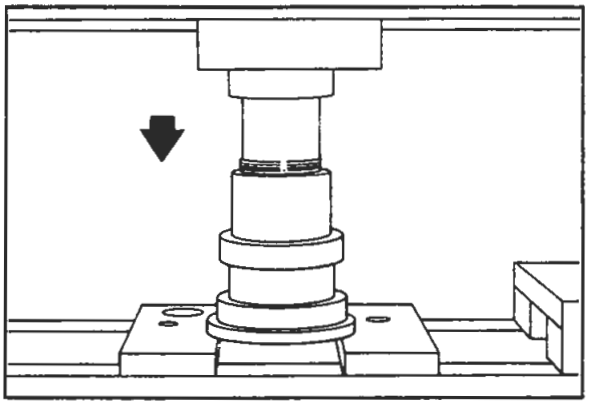


Use the Part No. 3377076 Snap Ring Pliers to remove the bearing to shaft retainer ring.



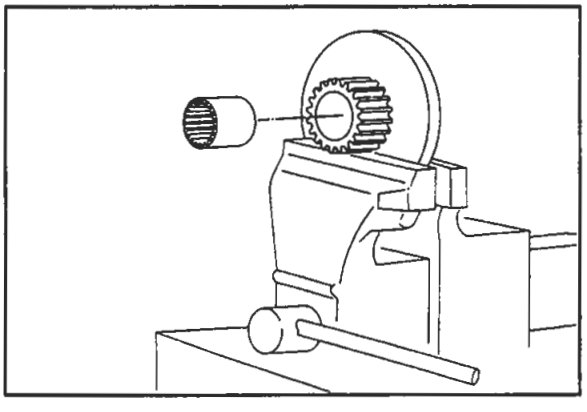
Push the shaft from the cover.

Use the Part No. 3377074 Large Bearing Mandrel to push the bearing race from the cover.



Install the clutch shaft assembly in a vise with brass jaws.

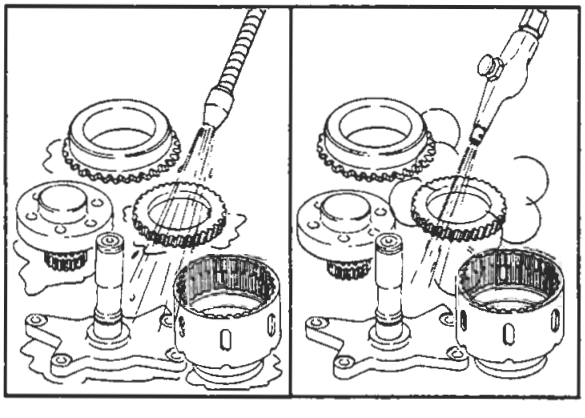
Use the Part No. 3375784 Light Duty Puller Kit and inside puller jaws to remove the needle bearing from the shaft.



Cleaning

Remove all gasket material.

Clean the fan hub parts with solvent. Dry with compressed air.

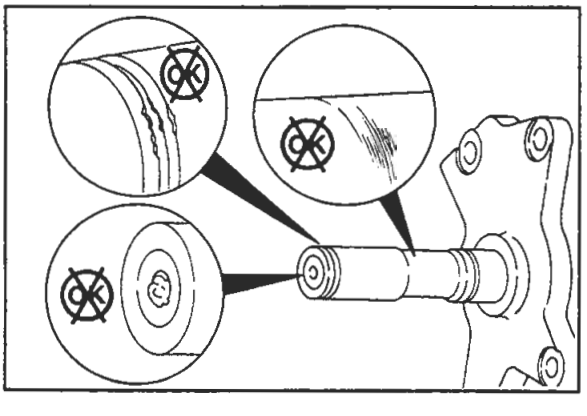


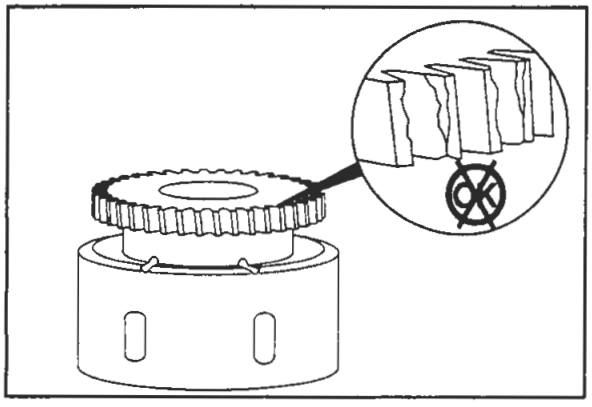
Inspection

Visually inspect the fan clutch spindle oil passages to make sure they are clear.

Visually inspect the retaining ring groove for wear or damage.

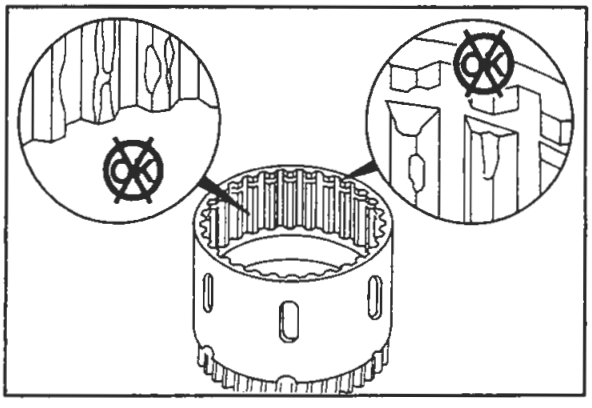
Visually inspect the spindle shaft for excessive wear caused by the seals or roller bearings.





Visually inspect drive gear for burrs and worn or damaged teeth.

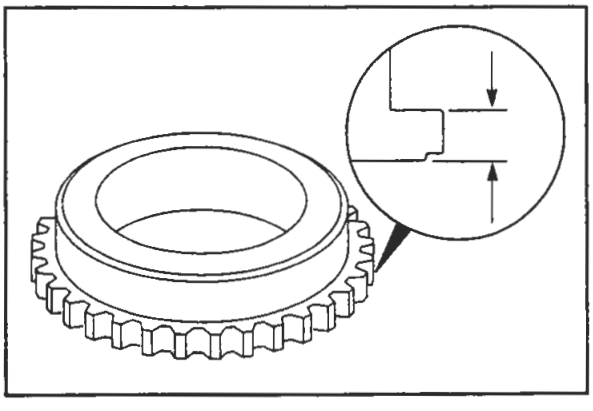
NOTE: If no damage is found **do not** remove the drive gear from the clutch housing.



Visually inspect the fan clutch housing internal splines for excessive wear, cracks or other damage.

NOTE: Earlier production fan clutch housings have one-half (1/2) splines at the outer edge of the housing.

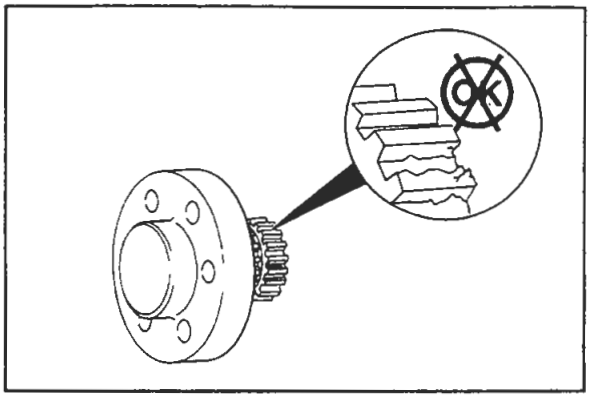
Visually inspect the retaining ring groove and o-ring sealing surface for excessive wear or damage.



Measure the fan clutch cover flange width.

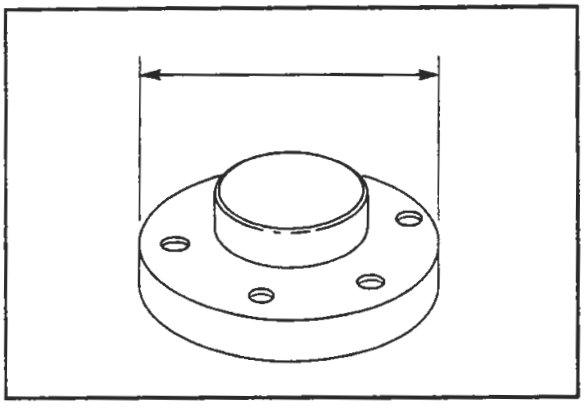
Cover Flange Width		
mm		In.
8.45	MIN	0.331
8.60	MAX	0.339

NOTE: Measure the flange width 4.0 to 10 mm [0.16 to 0.40 inch] from the outer diameter of the spline.



Visually inspect the fan clutch shaft spline for excessive wear, cracks or other damage.

Measure the fan clutch shaft cover seal diameter.

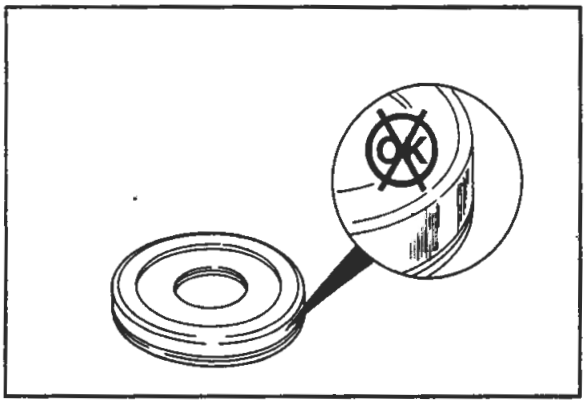


Cover Seal Diameter		
mm		in.
109.98	MIN	4.330
110.03	MAX	4.332

Visually inspect the oil supply holes for obstructions.

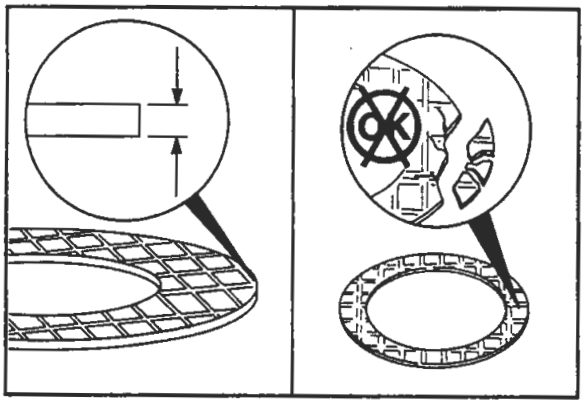
Visually inspect the fan clutch piston for scoring.

Measure the depth of scoring found.



Piston Scoring Depth		
mm		in.
0.00	MIN	0.000
0.38	MAX	0.015

Measure the thickness of the clutch plate friction material.

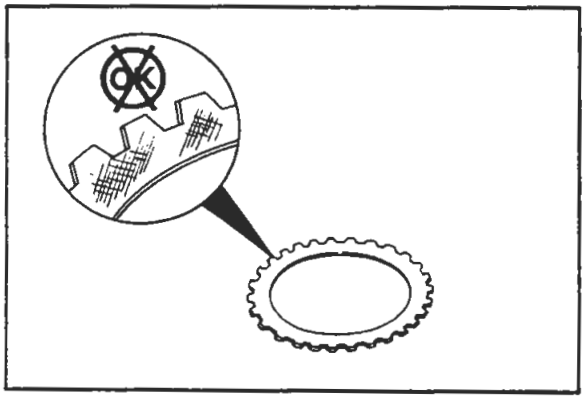


Friction Material Thickness		
mm		in.
2.90	MIN	0.114

NOTE: The friction material must **not** crumble when scraped lightly.

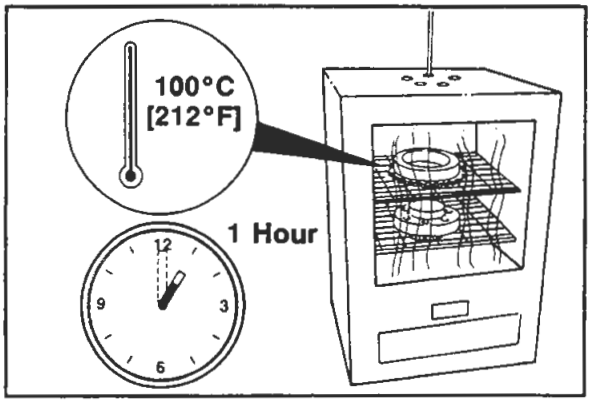
Visually inspect the clutch driving plates for scoring.

Measure the depth of scoring found.



Drive Plate Scoring		
mm		in.
0.00	MIN	0.000
1.48	MAX	0.058

Discard damaged parts.

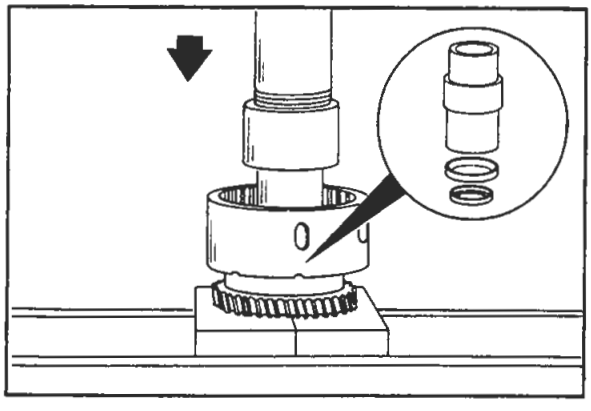


Assembly

Warning: When heating parts in an oven, wear protective clothing to prevent personal injury from the extreme heat.

Put the fan clutch housing, cover and shaft in an oven for one hour.

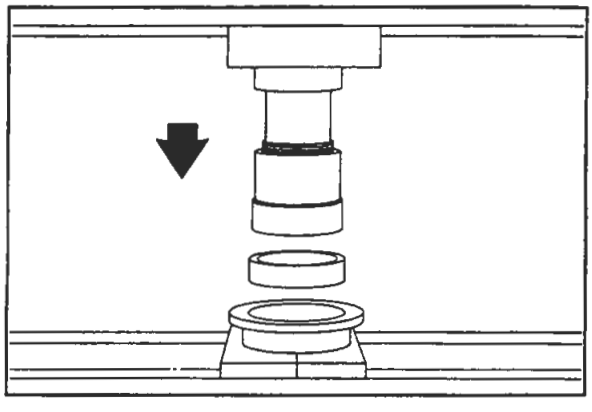
Temperature: 100°C [212°F]



Remove the fan clutch housing from the oven and install the housing in an arbor press.

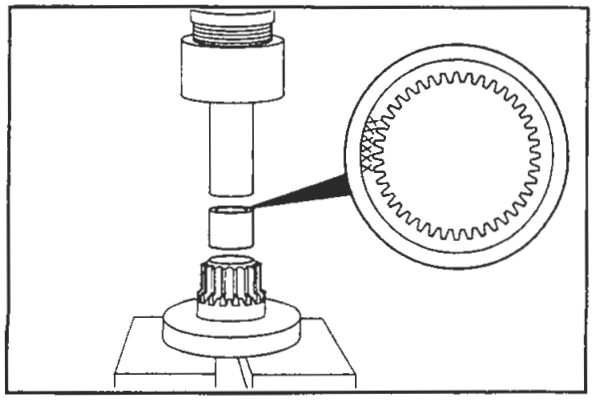
Use the Part No. 3377073 Small Bearing Mandrel to push the oil baffle plate and bearing race into the housing.

NOTE: The oil baffle plate **must** be seated against the bearing race.



Remove the fan clutch cover from the oven and install the cover in an arbor press.

Use the Part No. 3377074 Large Bearing Mandrel to push the bearing race into the cover.



Remove the fan clutch shaft from the oven and install the shaft in an arbor press.

NOTE: Install the needle bearing with the part number facing out.

Use clean 15W-40 oil to lubricate the needle bearing.

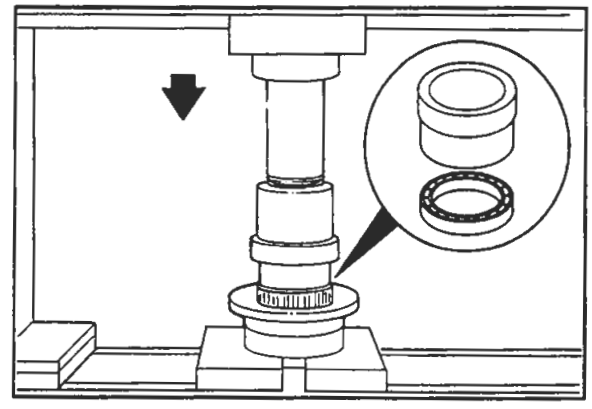
Use the Part No. 3377075 Needle Bearing Mandrel to push the needle bearing into the shaft.

Install the fan clutch cover over the shaft.

Caution: Push against the inner race of the bearing to prevent personal injury or damage to the bearing.

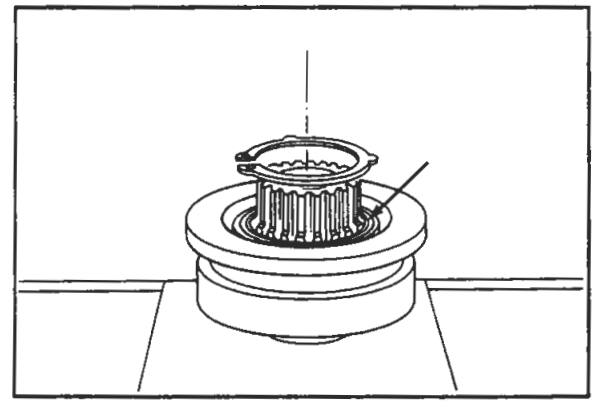
Use clean 15W-40 oil to lubricate the bearing.

Use the Part No. 3377074 Large Bearing Mandrel to push the bearing on the shaft until it touches the bearing race.



Use the 3377076 Snap Ring Pliers to install the retainer ring on the shaft.

NOTE: The retainer ring **must be** seated against the bearing.



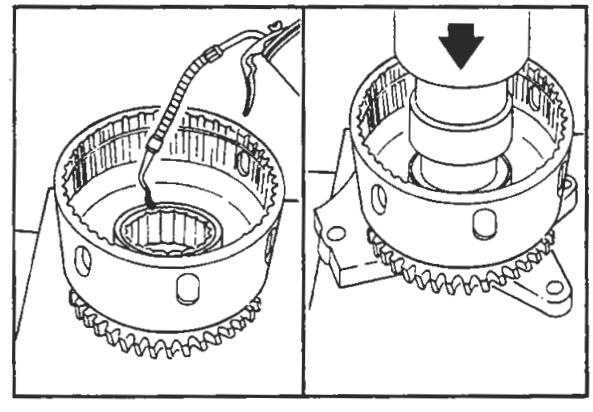
Use clean 15W-40 oil to lubricate the bearing.

Install the fan clutch housing over the spindle.

Install the clutch spindle in an arbor press.

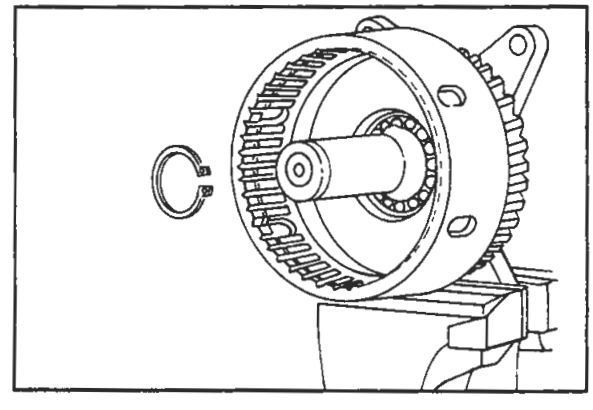
Caution: Push against the inner race of the bearing to prevent personal injury or damage to the bearing.

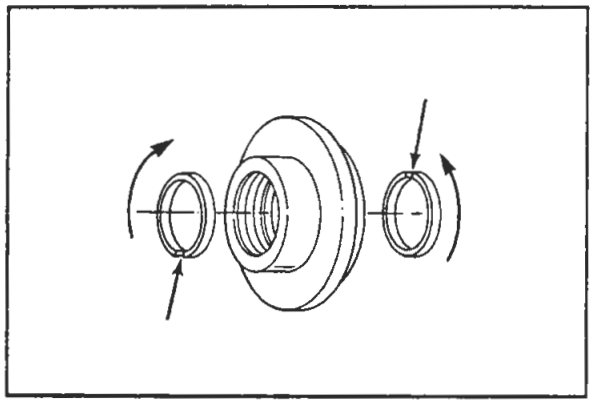
Use the Part No. 3377073 Small Bearing Mandrel to push the roller bearing on the spindle.



Use snap ring pliers to install the retainer ring.

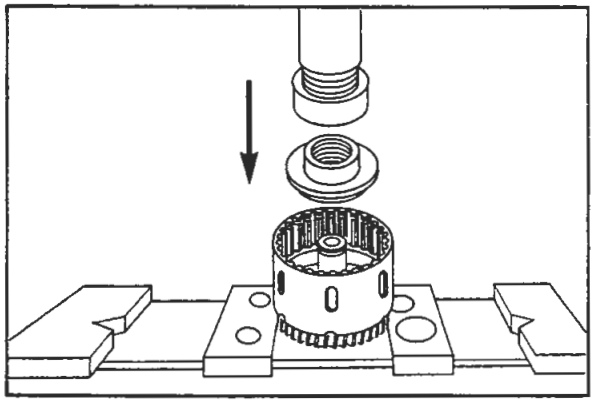
NOTE: The retainer ring **must be** seated against the bearing.





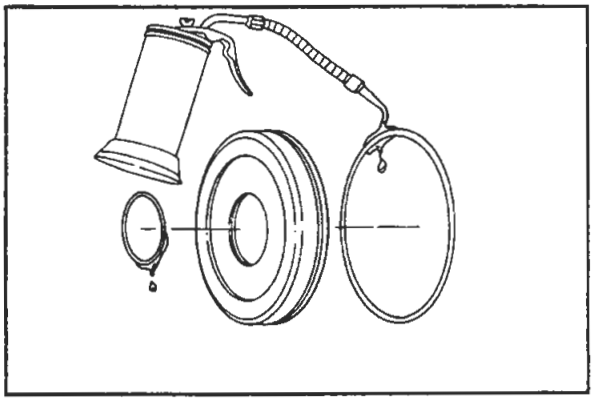
Install the new rectangular ring seal and the new ring seal spring into the seal housing with the ring gaps 180 degrees apart.

NOTE: After installing the ring seal spring, the seal should be rotated into the housing, with the gaps between the seal and the spring loader at 180 degrees apart. The ring seal and spring **must** be in constant contact with the fan clutch shaft.



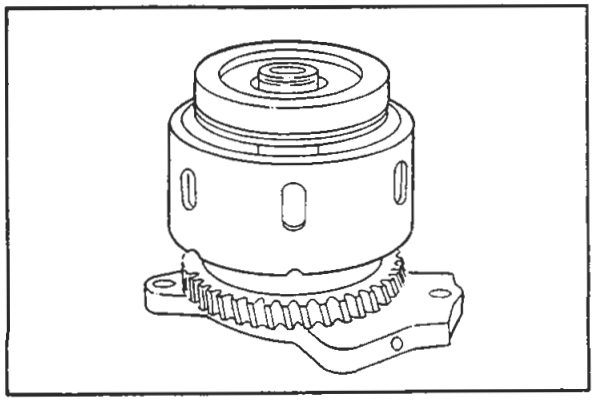
Caution: Do not damage the seals during assembly to prevent future fan hub failure.

Push the seal housing on the spindle shaft into the clutch housing.



Use clean 15W-40 oil to lubricate the new fan clutch piston o-rings.

Install the o-rings on the piston.

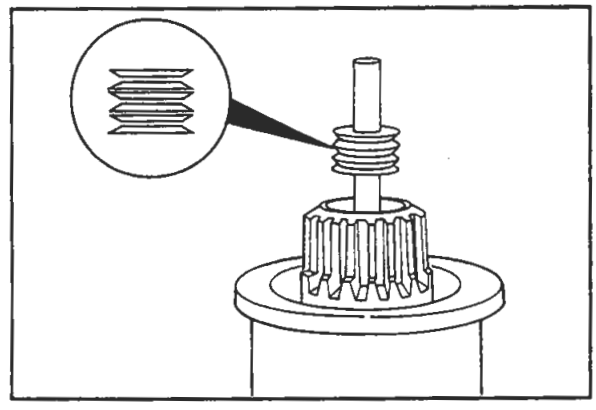


Install the fan clutch piston into the fan clutch housing.

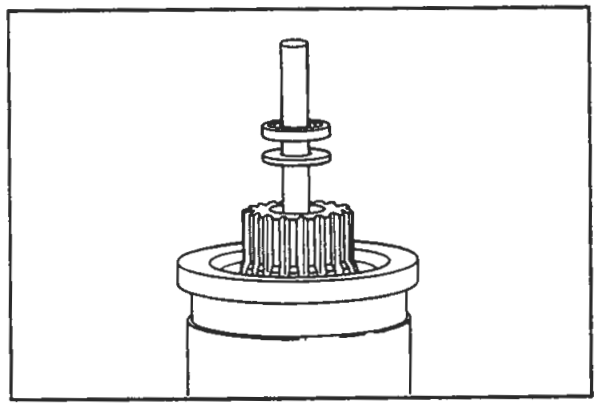
NOTE: The puller holes in the piston **must** face out toward the front of the fan clutch.

Install the spring washers onto the clutch shaft.

NOTE: Make sure the spring washers are installed as shown.



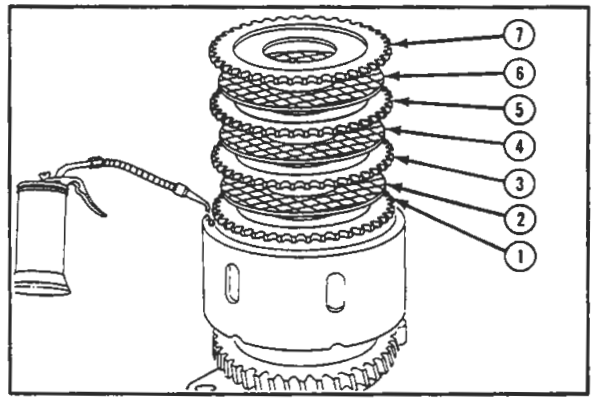
Install the thrust washer and bearing on the spring washers.



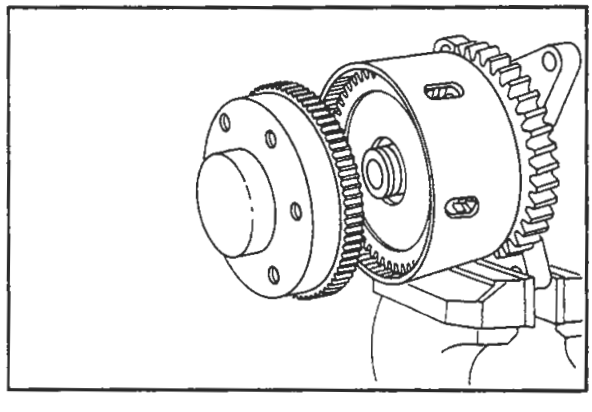
NOTE: The clutch pack consists of four clutch drive plates and three friction plates. Assemble as follows: 1) Drive Plate, 2) Friction Plate, 3) Drive Plate, 4) Friction Plate, 5) Drive Plate, 6) Friction Plate and 7) Drive Plate.

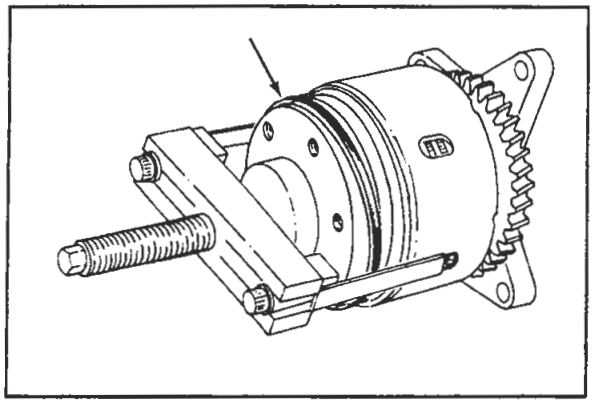
Use clean 10W-40 oil to lubricate the clutch plates.

Install the clutch pack into the splines of the clutch housing.



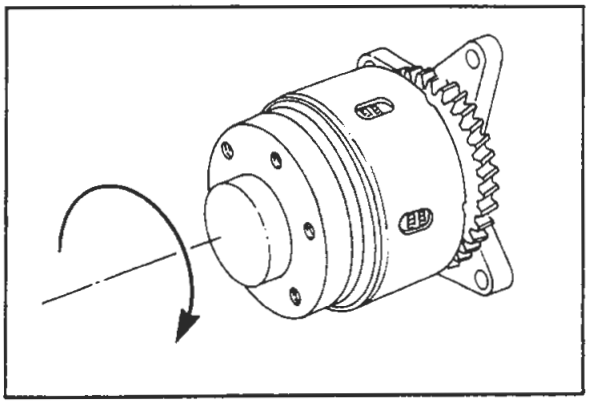
Install the shaft assembly into the fan clutch housing.





Use the Part No. 3377072 Spring Pack Compressor and the Part No. ST-647 Puller to compress the clutch shaft.

Install the retainer ring.



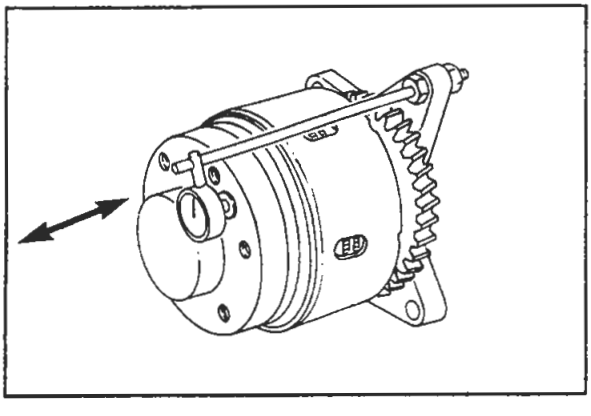
Final Inspection

Turn the fan hub by hand to inspect it for freedom of rotation.

NOTE: The fan Hub should turn freely.

Torque: Less than 1 N•m [10 in-lb] if the plates were assembled dry.

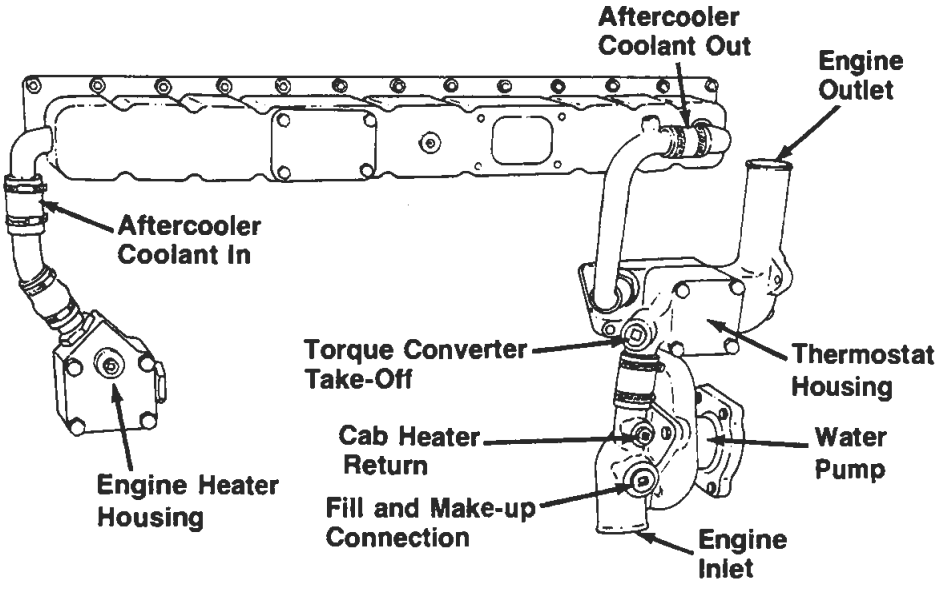
Less than 3 N•m [25 in-lb] if the plates are covered in oil.



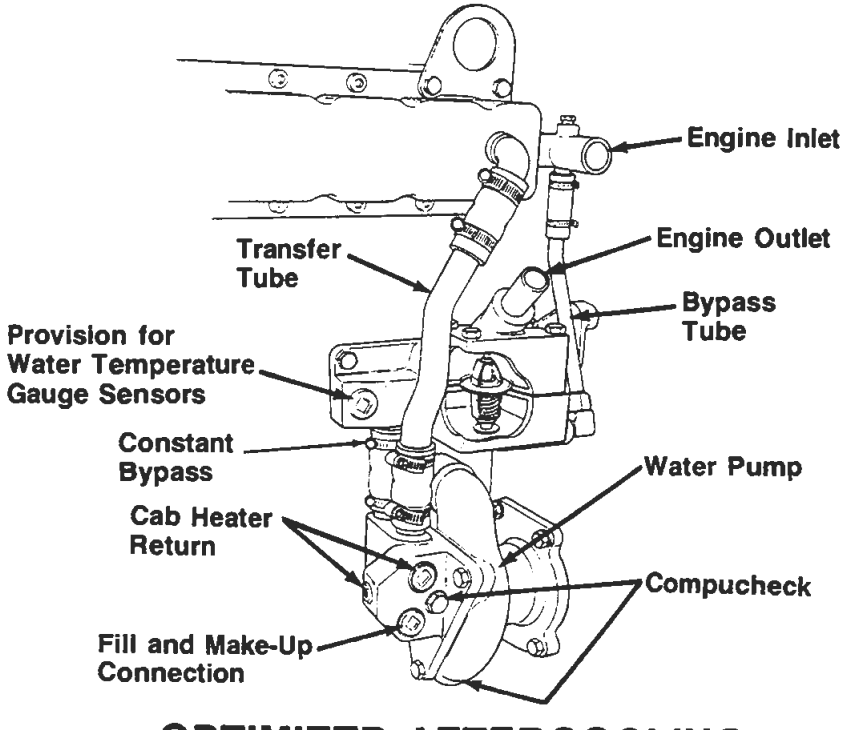
Measure the fan hub end clearance.

NOTE: If the fan hub has **any** measureable end clearance it **must** be disassembled, inspected and assembled again.

Cooling System Components



CONVENTIONAL AFTERCOOLING

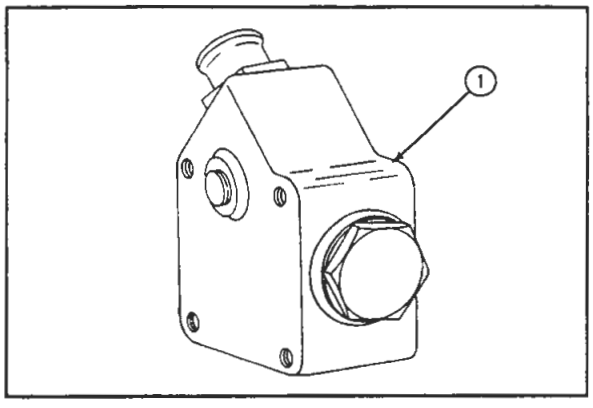


OPTIMIZED AFTERCOOLING

Comparison of Cooling System Components

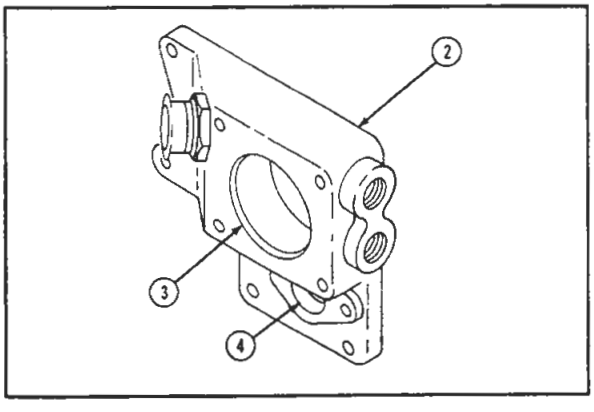
Cooling System Components - General Information

There is a significant difference in the routing of the coolant flow between conventional aftercooled and optimized aftercooled engines. A new thermostat and thermostat housing were designed locating the thermostat in a vertical position as compared to the horizontal position of the conventional thermostat housing. The engine heater housing does **not** supply coolant to the optimized aftercooler and has a threaded plug installed in the outlet connection.



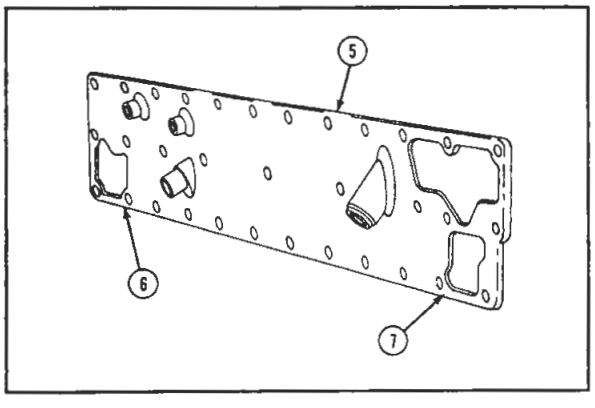
Heater Housing, Thermostat Support and Water Header Cover - Clean and Inspect (08-09)

Remove the gasket material from the engine heater housing surface (1).



Remove the gasket material from the thermostat support surfaces (2, 3 and 4).

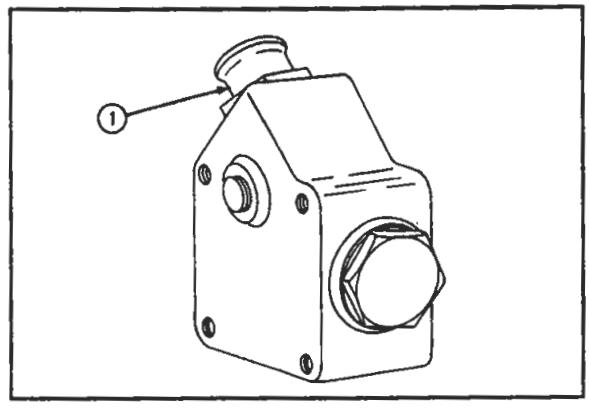
NOTE: The thermostat support is used on the conventional aftercooling engines **only**.



Remove the gasket material from the water header cover surfaces (5, 6 and 7).

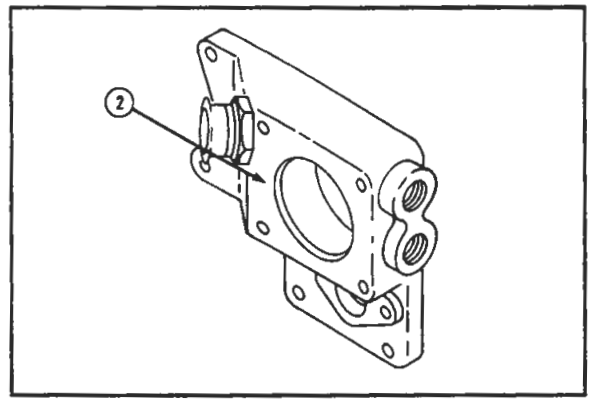
Use a wire brush to remove the rust and corrosion from the engine heater housing surface.

NOTE: The optimized aftercooling engine heater housing has a threaded plug in the water outlet connection (1).

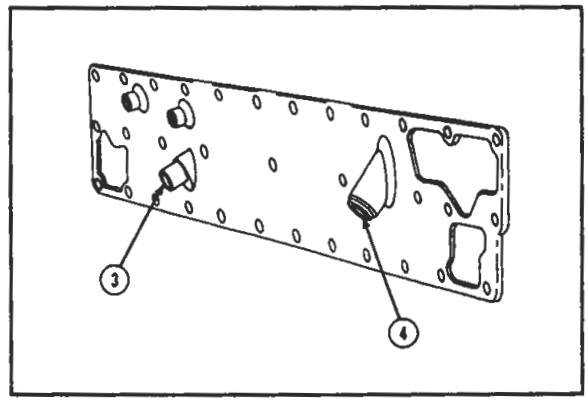


Use a wire brush to remove the rust and corrosion from the thermostat support surface (2).

NOTE: The thermostat support is used on the conventional aftercooling engines **only**.

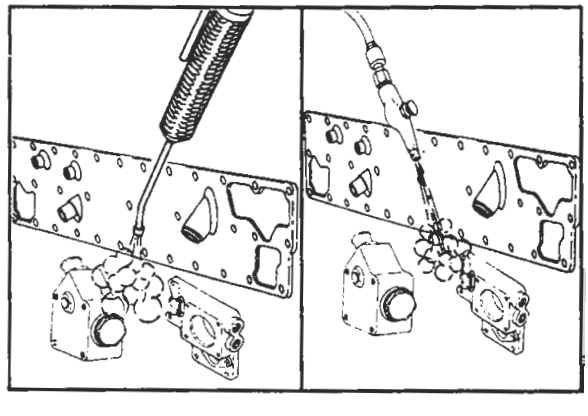


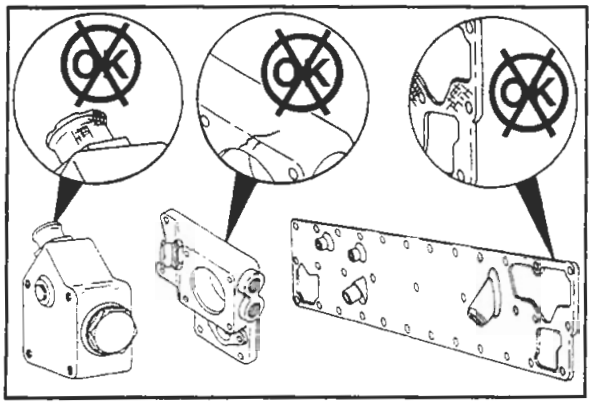
Use a wire brush to remove the rust and corrosion from the water header cover surfaces (3 and 4).



Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use steam to clean the parts. Dry with compressed air.

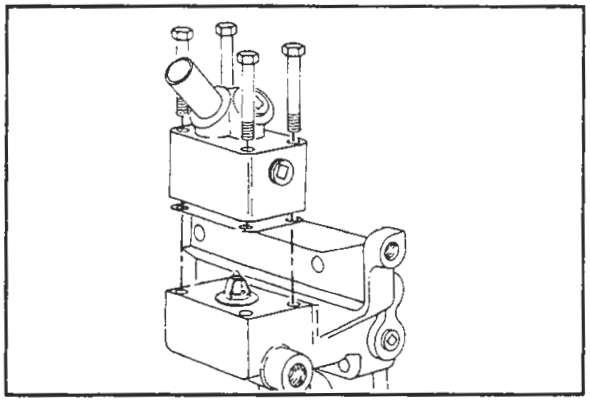




Inspection

Visually inspect the parts for cracks, damage or excessive corrosion.

NOTE: If damaged parts or excessive corrosion is found the part **must be** replaced.

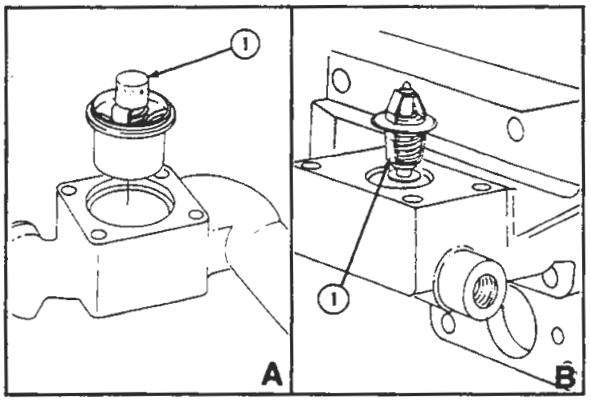


Thermostat Housing Assembly - Rebuild (08-10)

Disassembly

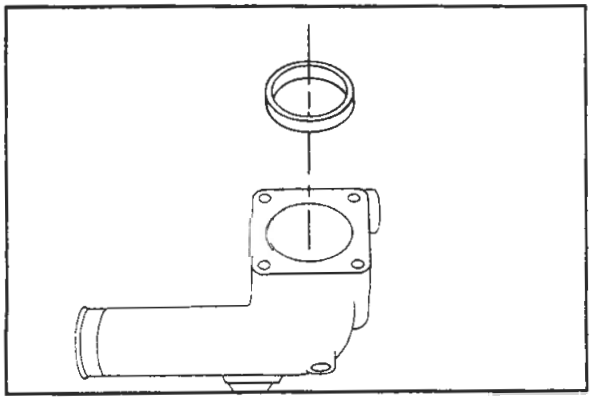
Remove the four capscrews from the optimized aftercooling thermostat housing cover.

Remove the thermostat housing cover and gasket. Discard the gasket.



Remove the thermostat (1).

- Conventional Aftercooling (A)
- Optimized Aftercooling (B)



Caution: Do not damage the thermostat housing when removing the thermostat water seal to prevent future engine damage.

Use a punch and hammer to remove the thermostat water seal.

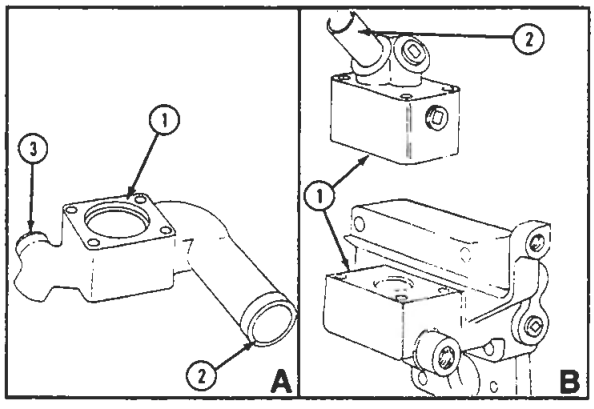
NOTE: The optimized aftercooling thermostat housing does **not** use a water seal.

Cleaning

Use a gasket scraper to remove all gasket material from surfaces (1).

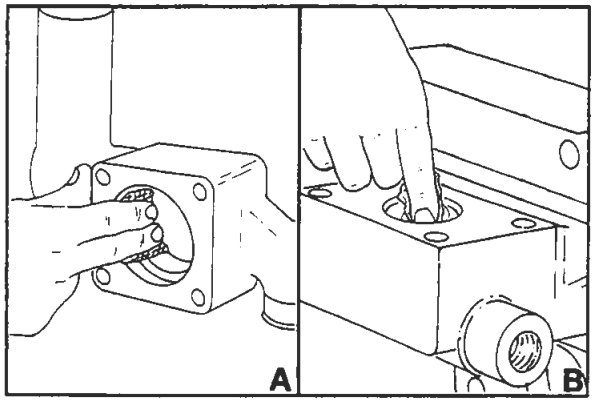
Use a wire brush to clean the hose sealing surfaces (2 and 3).

- Conventional Aftercooling (A)
- Optimized Aftercooling (B)



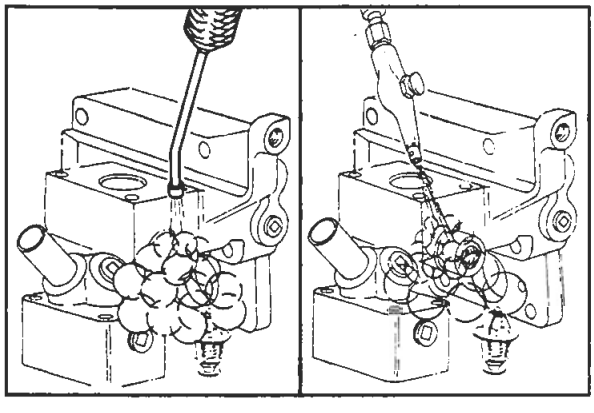
Use 240 grit aluminum oxide paper to remove the corrosion from the thermostat housing bore.

- Conventional Aftercooling (A)
- Optimized Aftercooling (B)



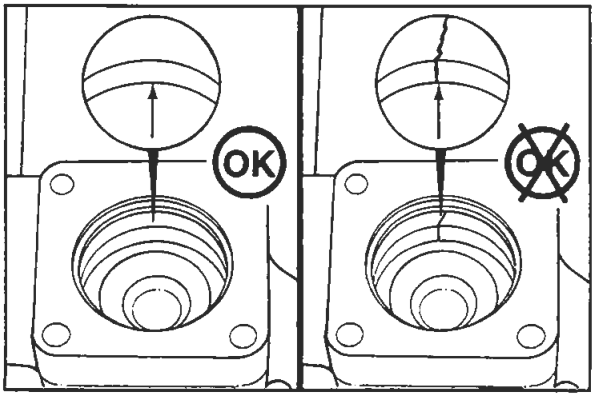
Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

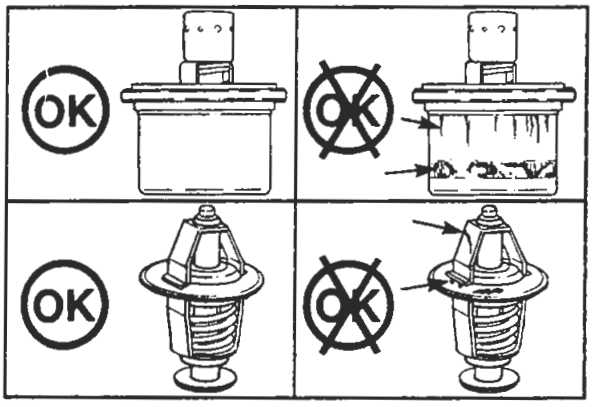
Use steam to clean the parts. Dry with compressed air.



Inspection

Visually inspect the parts for excessive corrosion, cracks or damage.

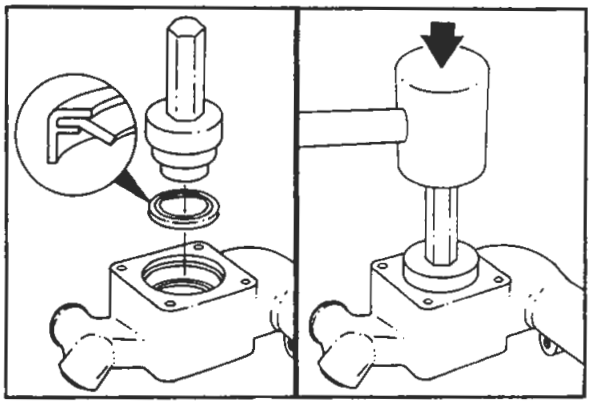




Visually inspect the thermostat for cracks or other damage.

NOTE: If excessive corrosion, cracks or other damage is found the part must be replaced.

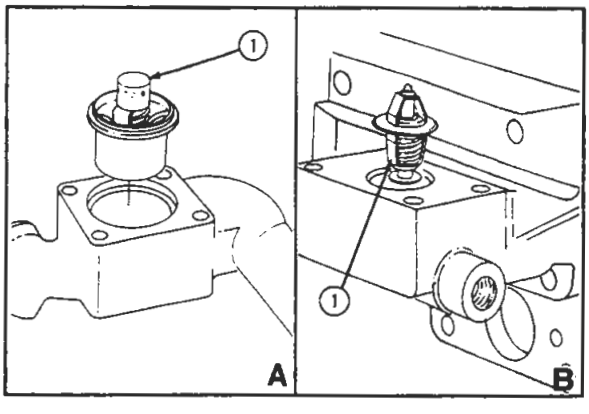
Refer to Thermostat - Check Operating Temperature (08-11).



Assembly

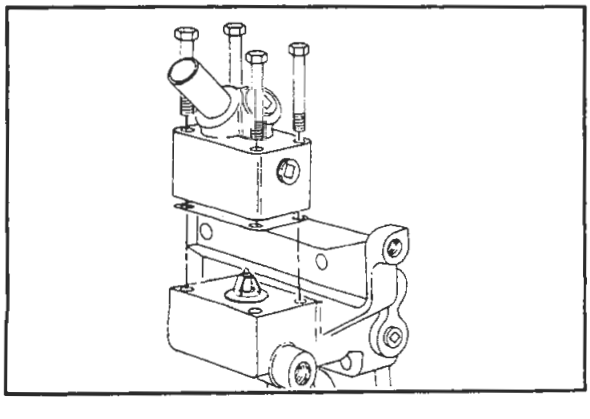
NOTE: When installing the conventional aftercooling thermostat water seal, the flat side of the seal **must be** facing the thermostat seal mandrel.

Use the Part No. ST-1225 Thermostat Seal Mandrel and a mallet to install the new seal.



Install the thermostat (1) into the thermostat housing.

- Conventional Aftercooling (A)
- Optimized Aftercooling (B)

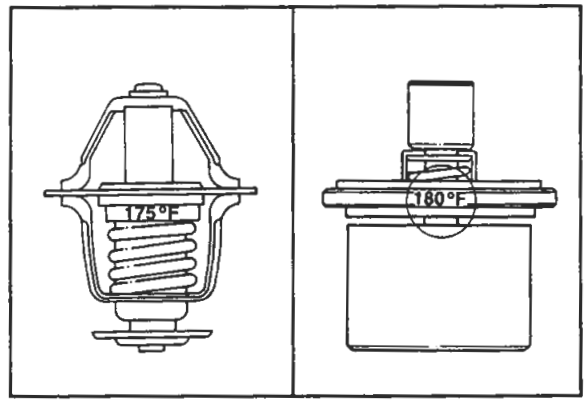


Install a new gasket, the thermostat housing cover and four capscrews onto the optimized aftercooling thermostat housing.

Torque Value: 45 N•m [35 ft-lbs]

Thermostat - Inspect Operating Temperature (08-11)

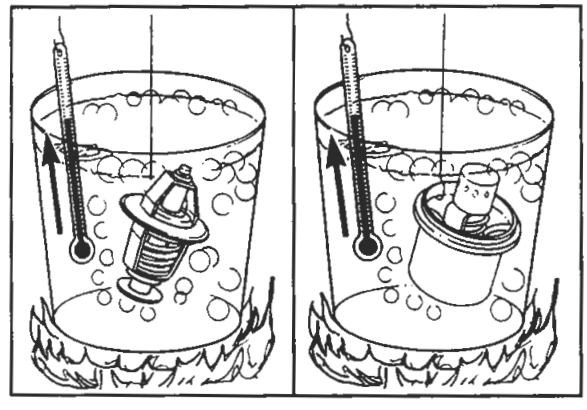
Check the temperature marked on the thermostat to see when the thermostat is designed to open. Record the nominal opening temperature.



Suspend the thermostat and a thermometer in a container of water.

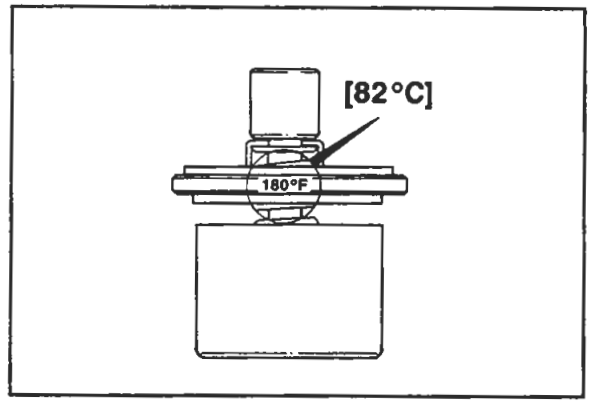
NOTE: Do not allow the thermostat or thermometer to touch the side of the container.

Heat the water. Check the temperature when the thermostat starts to open.



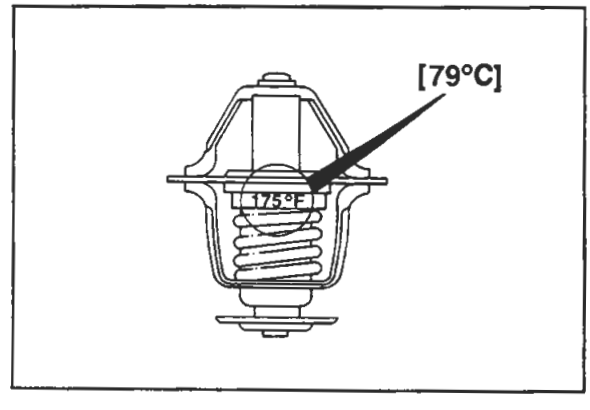
The conventional aftercooling thermostat **must** operate within the following specifications.

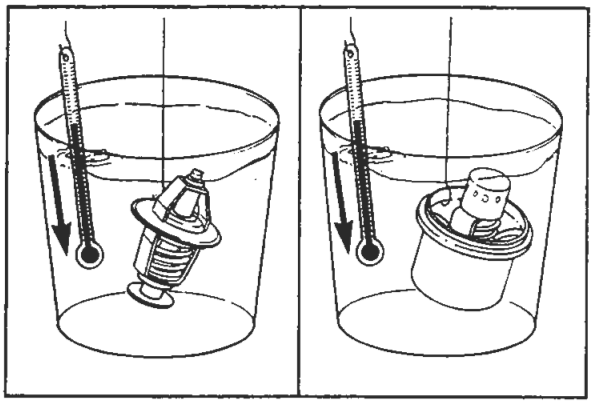
Initial Opening Temperature		
Degree °C		Degree °F
80°C	MIN	177°F
83°C	MAX	182°F
Fully Open Temperature		
94°C	MAX	202°F
Maximum Open Distance		
mm		In.
9.52	MAX	0.375



The optimized aftercooling thermostat **must** operate within the following specifications.

Initial Opening Temperature		
Degree °C		Degree °F
78°C	MIN	173°F
80°C	MAX	177°F
Fully Open Temperature		
91°C	MAX	197°F
Maximum Open Distance		
mm		In.
2.54	MAX	0.100

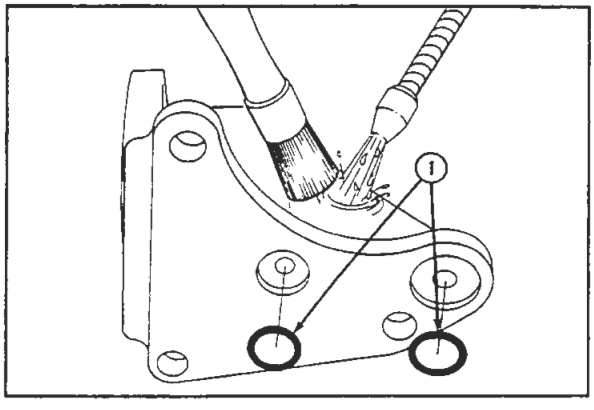




Remove the container from the heat.

The thermostat **must** begin to close as the temperature drops below the nominal temperature marked on the thermostat.

NOTE: If the thermostat fails to open at the specified temperature or does **not** completely close after the water temperature has dropped below the nominal operating temperature, the thermostat **must be** replaced.

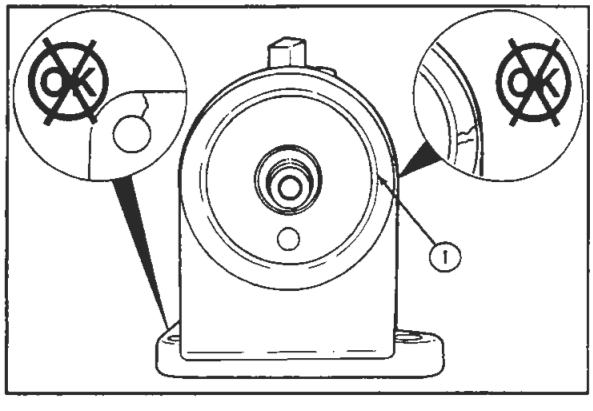


Water Filter Head Assembly - Clean and Inspect for Reuse (08-12)

Remove the o-ring seals (1) from the mounting flange.

Discard the o-ring seals.

Use solvent to clean the filter head assembly. Dry with compressed air.

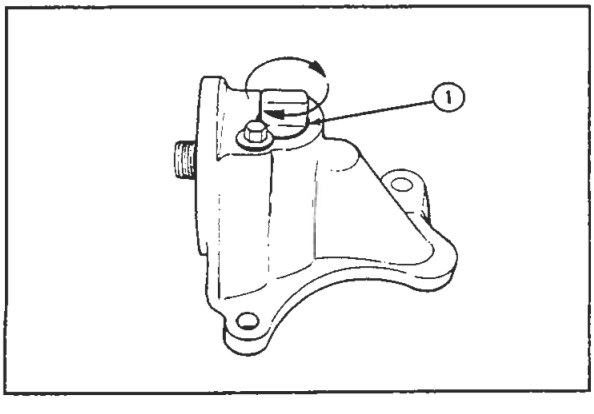


Inspection

Visually inspect the filter head assembly for cracks or damage.

Visually inspect the water filter element sealing surface (1) for cracks or damage.

NOTE: If cracks or damage are found the filter head assembly **must be** replaced.



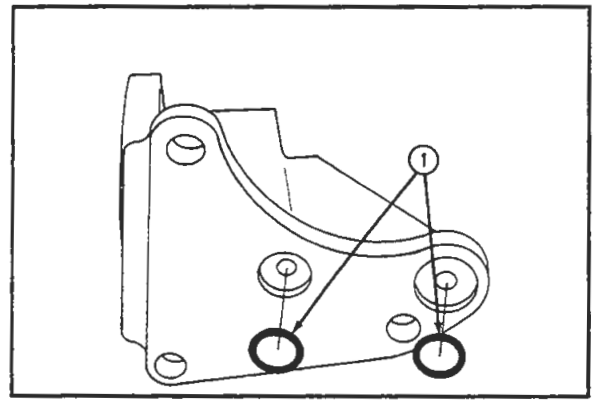
Turn the shutoff valve shaft (1) from the "OPEN" to the "CLOSED" position and back to the "OPEN" position again to inspect for freedom of movement.

NOTE: If the shut-off valve shaft does **not** turn freely by hand, the filter head assembly **must be** rebuilt. Refer to Water Filter Head Assembly Rebuild (08-13).

Water Filter Head Assembly - Rebuild (08-13)

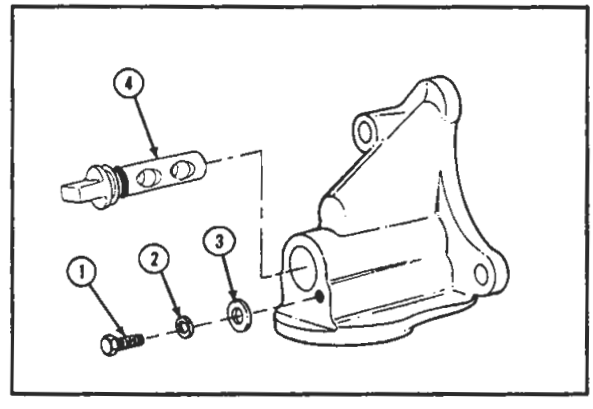
Disassembly

Remove the o-ring seals (1) from the mounting flange. Discard the o-rings.

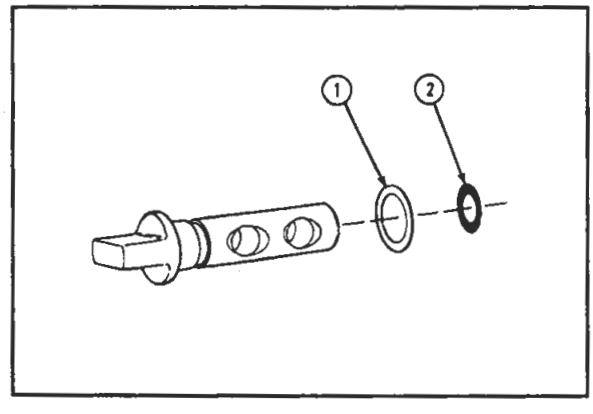


Remove the capscrew (1), and the washers (2 and 3) from the filter head.

Use a pair of pliers to remove the shutoff valve shaft (4) from the filter head.

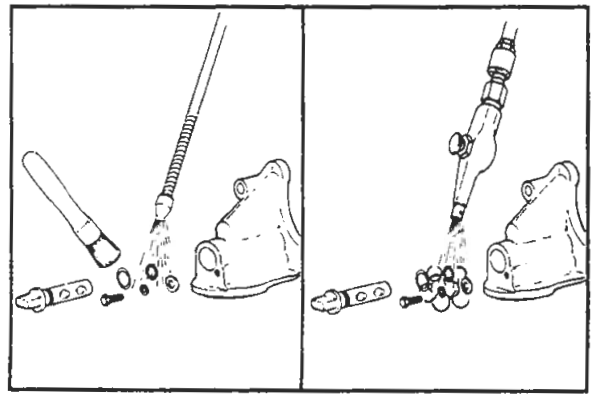


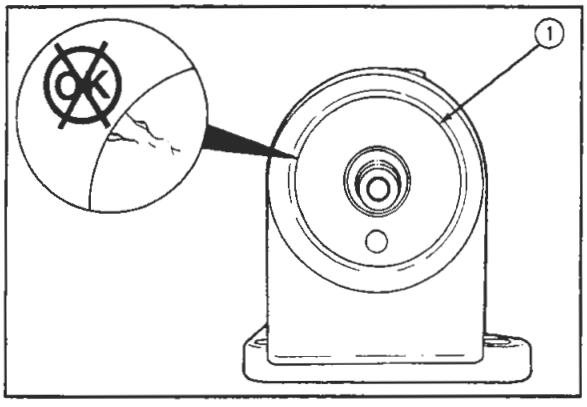
Remove the o-ring (1) end spring washer (2) from the shutoff valve shaft.



Cleaning

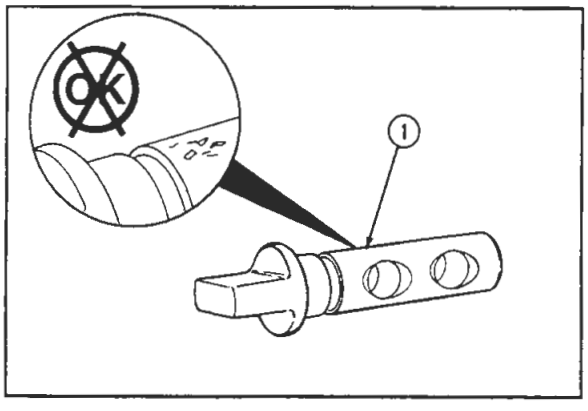
Use solvent to clean the parts. Dry with compressed air.





Inspection

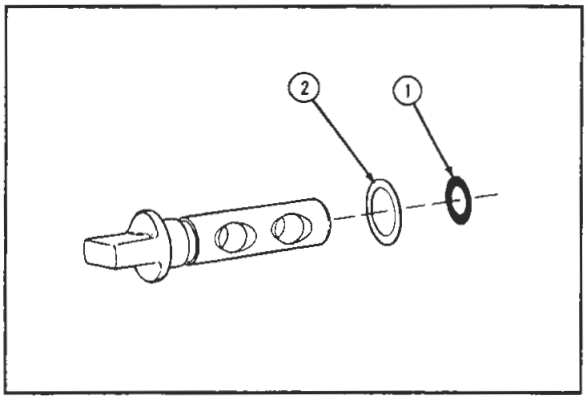
Visually inspect the filter head and water filter element sealing surface (1) for cracks or damage.



Visually inspect the water passages in the shutoff valve shaft (1).

Visually inspect the shaft for corrosion or pitting. Use 240 grit aluminum oxide paper to remove the corrosion.

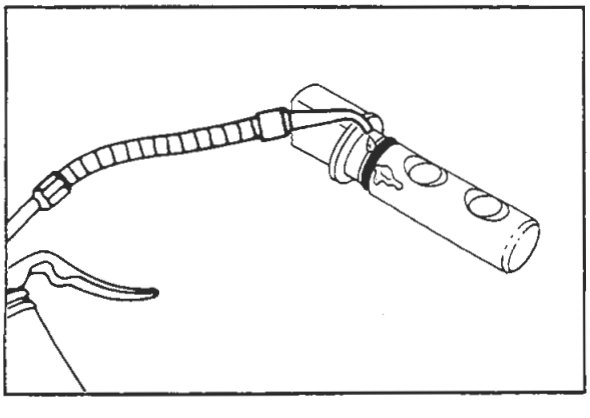
NOTE: If the parts are cracked or damaged, the filter head assembly **must be** replaced.



Assembly

Install the spring washer (1) on the shutoff valve shaft.

Install a new o-ring (2) in the groove of the shaft.



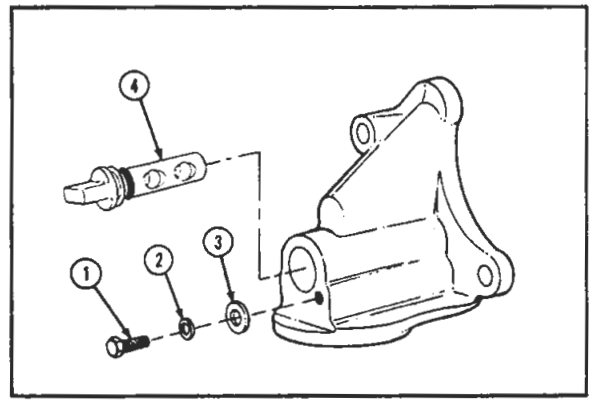
Use clean 15W-40 oil to lubricate the shaft and o-ring.

Install the shutoff valve shaft (4) in the filter head.

Install the hardened flat washer (3), lockwasher (2) and clamping capscrew (1) in the filter head.

NOTE: Make sure the flat washer (3) is a hardened steel washer.

Torque Value: 10 N•m [60 in-lb]

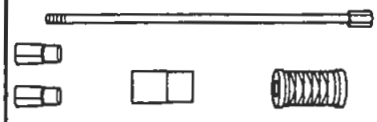
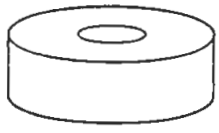
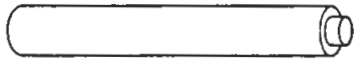


Drive Units - Group 09

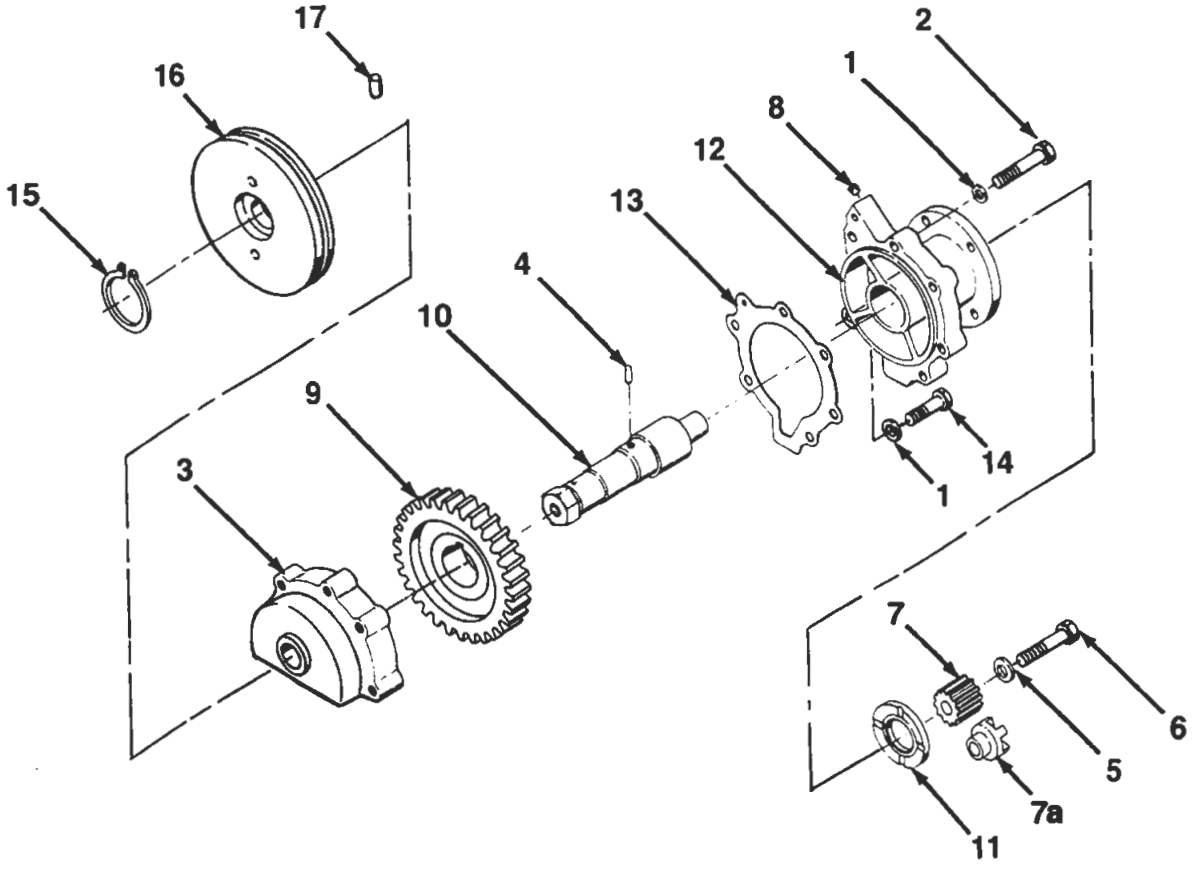
Contents

Drive Units - Service Tools

The following special tools are recommended to perform the procedures in Group 09. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

Tool No.	Tool Description	Tool Illustration
ST-1134	**Dowel Pin Extractor** Remove the dowel pins from the drive shaft.	
3376663	**Coupling Puller** Remove the splined coupling gear from the compressor drive.	
3376820	**Hydraulic Drive Gear Driver** Install the hydraulic pump drive gear on the drive shaft.	
3376821	**Hydraulic Drive Support Bearing Driver** Remove and install the hydraulic drive support bearings.	
3822372	**Expansion Plug Driver** Install the expansion plug to the proper depth in the drive support.	

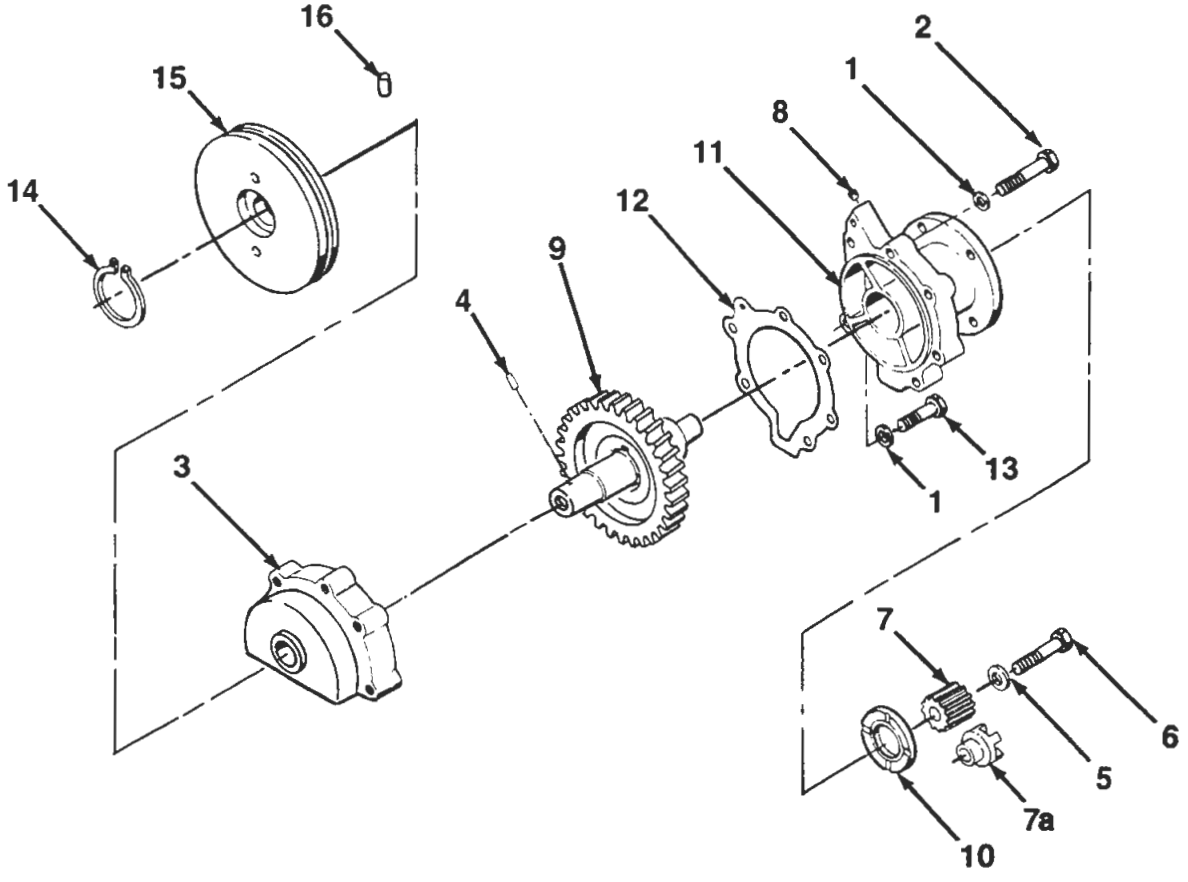
Fuel Pump and Compressor Drive - Exploded View



Hexed Accessory Drive Shaft Style Drive

Ref. No.	Description	Qty.
1.	Washer, Plain	6
2.	Capscrew	5
3.	Support Accessory Drive	1
4.	Groove, Pin	1
5.	Washer, Plain	1
6.	Capscrew	1
7.	Gear, Splined Coupling	1
7a.	Coupling, Hub	1
8.	Plug, Expansion	1
9.	Gear, Fuel Pump and Compressor Drive	1
10.	Shaft, Accessory Drive	1
11.	Bearing, Thrust	1
12.	Support, Accessory Drive	1
13.	Gasket, Accessory Drive Support	1
14.	Capscrew	1
15.	Ring, Retaining	1
16.	Pulley, Accessory Drive	1
17.	Dowel, Pin	1

Fuel Pump and Compressor Drive - Exploded View



Non-Hexed Accessory Drive Shaft Style Drive

Ref. No.	Description	Qty.
1.	Washer, Plain	6
2.	Capscrew	5
3.	Support Accessory Drive	1
4.	Groove, Pin	1
5.	Washer, Plain	1
6.	Capscrew	1
7.	Gear, Splined Coupling	1
7a.	Coupling, Hub	1
8.	Plug, Expansion	1

Ref. No.	Description	Qty.
9.	Gear and Shaft Assembly	1
10.	Bearing, Thrust	1
11.	Support, Accessory Drive	1
12.	Gasket, Accessory Drive Support	1
13.	Capscrew	1
14.	Ring, Retaining	1
15.	Pulley, Accessory Drive	1
16.	Dowel, Pin	1

Drive Units - General Information

Fuel Pump and Compressor Drive

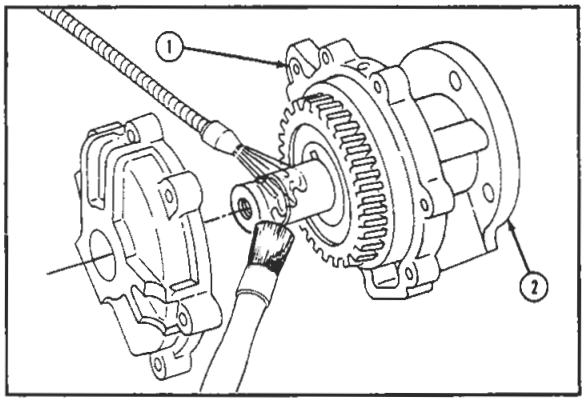
The fuel pump and compressor drive housings are available in two designs, **with** and **without** hardware for mounting an air compressor. The fuel pump drive assembly has hardware for a hub or spider type coupling. The compressor drive assembly has hardware for a **splined sleeve** type coupling. The rebuild procedures are the same for both designs.

The L10 Engine uses both metric and U.S. Customary capscrews. In some cases, capscrews in metric and U.S. Customary threads are almost identical in appearance. Be sure to install the capscrews in the same location they were removed from.

Fuel Pump and Compressor Drive - Clean and Inspect for Reuse (09-01)

Remove all gasket material from surfaces (1 and 2).

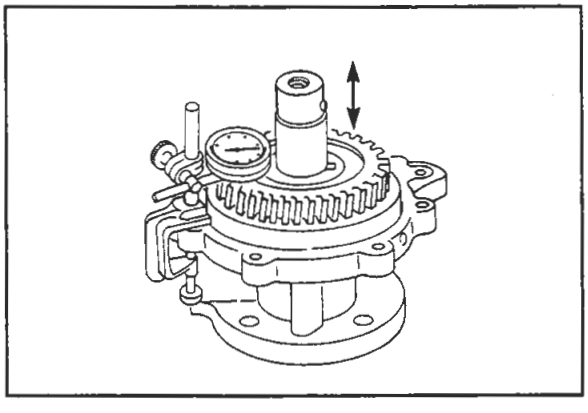
Clean the exterior of the drive with solvent, dry with compressed air.



Inspection

Measure the driveshaft end clearance.

Drive Shaft End Clearance		
mm		in.
0.10	MIN	0.004
0.30	MAX	0.012



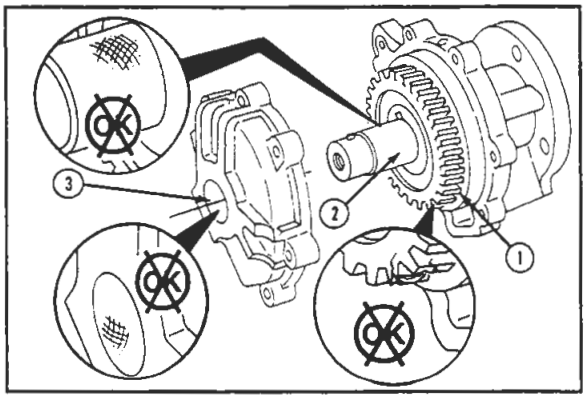
Note: If the shaft end clearance **does not** meet these specifications, rebuild or replace the drive unit. Refer to Fuel Pump and Compressor Drive - Rebuild (09-02).

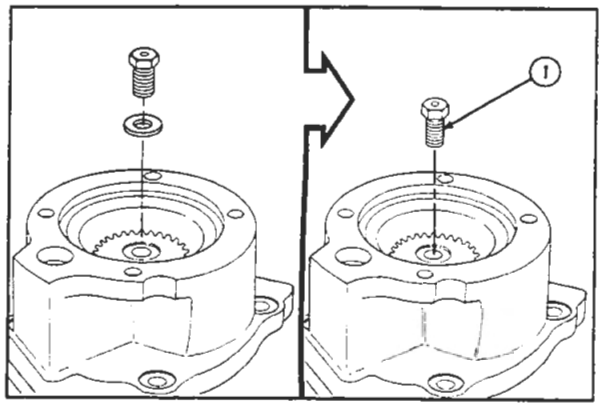
Visually inspect both housings for cracks or damaged mounting holes.

Visually inspect the drive gear (1) for damaged teeth.

Visually inspect the shaft (2) for scratches, scoring or other damage.

Visually inspect the support bore (3) for scratches, scoring or other damage.



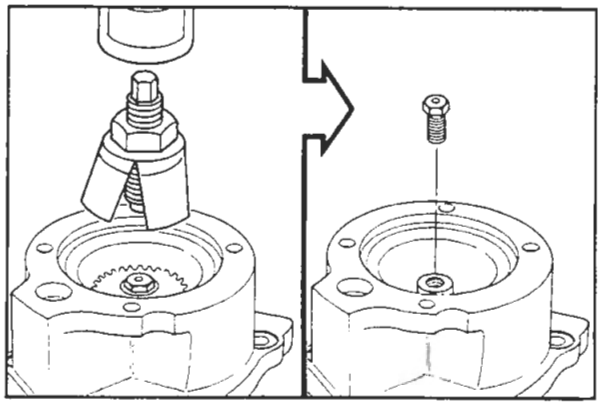


Fuel Pump and Compressor Drive - Rebuild (09-02)

Disassembly

Remove the capscrew and washer.

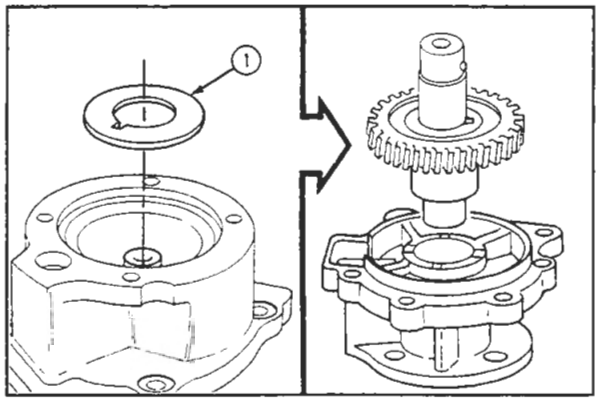
Caution: Install the retainer capscrew (1), without the washer to prevent damage to the shaft while the gear is being removed.



Use the Part No. 3376663 Coupling Puller to remove the splined coupling.

Use a three jaw puller to remove the hub type coupling.

Remove the capscrew.

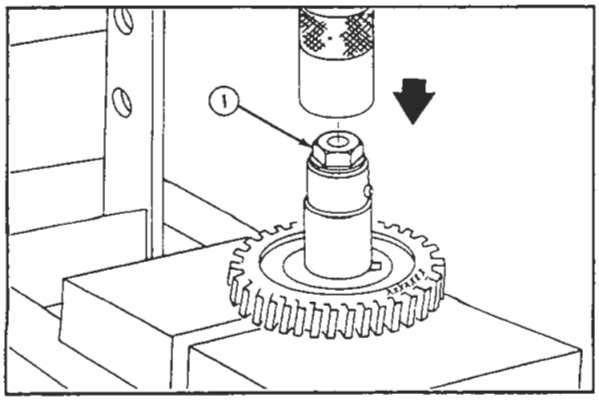


Remove the thrust bearing (1).

Remove the shaft and gear assembly.

Clean the parts with solvent, dry with compressed air.

Visually inspect the parts for damage.



Hexed Accessory Drive Shaft and Gear

NOTE: The earlier production style shaft has a hex machined on the end of the shaft, used to rotate the crankshaft.

Install the shaft and gear assembly in an arbor press with the part number side of the gear facing up.

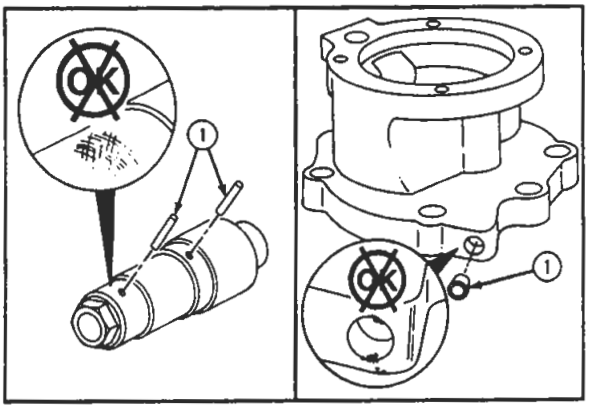
Caution: Do not let the shaft fall when removing it from the drive gear. Damage to the shaft or personal injury can occur.

Push the shaft from the gear.

Use the Part No. ST-1134 Dowel Pin Extractor to remove the dowel pin(s) (1) from the drive shaft.

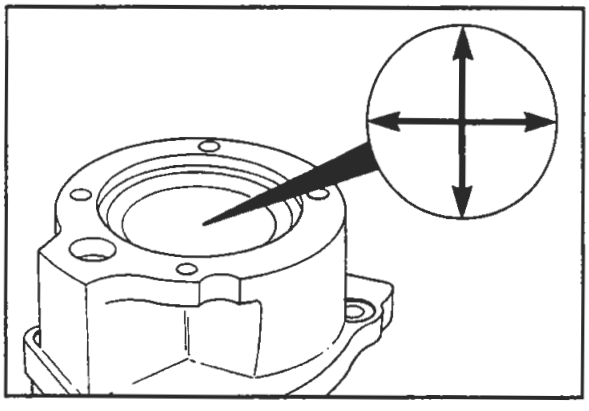
Remove the expansion plug (1) from the drive housing.

Visually inspect the parts for damage.



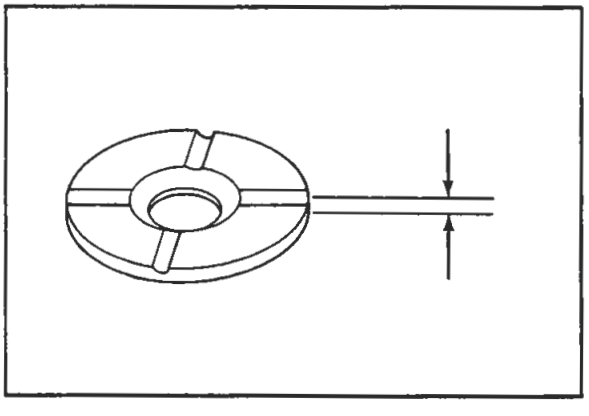
Inspection

Measure the inside diameter of the bearing bore in the drive housing.



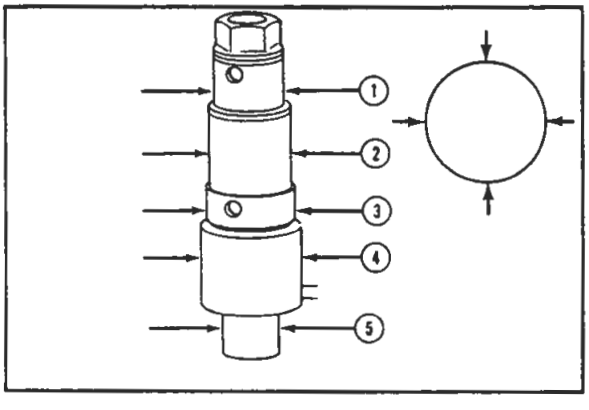
Bearing Bore I.D.		
mm		in.
47.676	MIN	1.8770
47.775	MAX	1.8809

Measure the thrust bearing thickness.



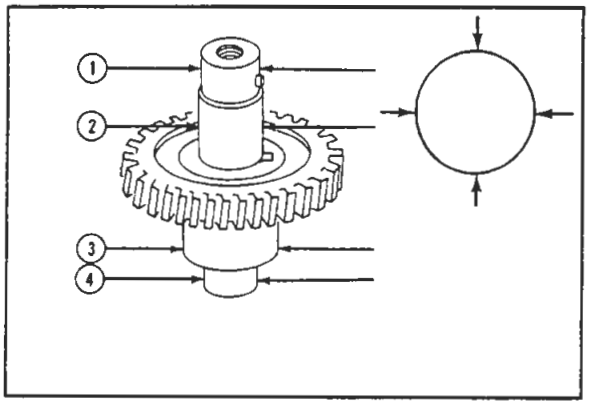
Thrust Bearing Thickness		
mm		in.
6.084	MIN	0.2395
6.312	MAX	0.2485

Measure the drive shaft outside diameter.



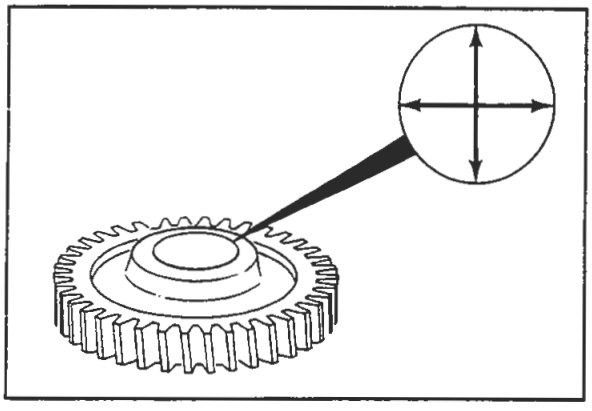
Hexed Accessory Drive Shaft

Drive Shaft Journal O.D.			
Point	mm		in.
(1)	32.988	MIN	1.2987
	33.000	MAX	1.2992
(2)	37.960	MIN	1.4945
	38.000	MAX	1.4960
(3)	40.042	MIN	1.5765
	40.067	MAX	1.5774
(4)	47.520	MIN	1.8709
	47.570	MAX	1.8728
(5)	25.476	MIN	1.0030
	25.489	MAX	1.0035



Non-Hexed Accessory Drive Shaft

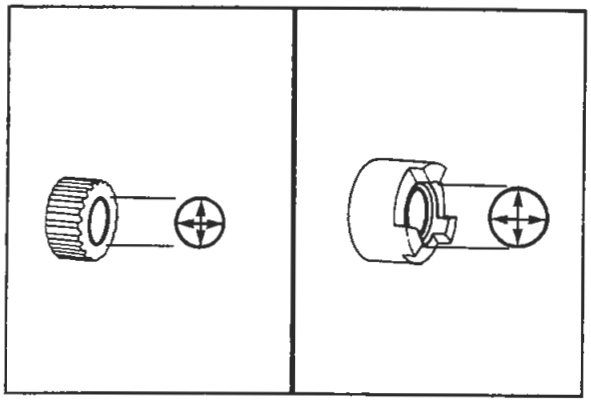
Drive Shaft Journal O.D.			
Point	mm		In.
(1)	34.984	MIN	1.3773
	35.000	MAX	1.3779
(2)	44.975	MIN	1.7706
	45.000	MAX	1.7716
(3)	47.554	MIN	1.8722
	47.570	MAX	1.8728
(4)	25.476	MIN	1.0030
	25.489	MAX	1.0035



Measure the inside diameter of the drive gear.

Hexed Accessory Drive Shaft Style

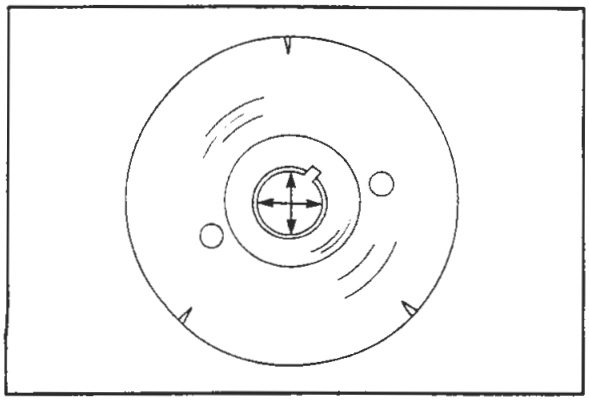
Drive Gear Bore I.D.		
mm		In.
39.967	MIN	1.5735
39.992	MAX	1.5745



Measure the inside diameter of the splined coupling gear or hub coupling.

Splined Coupling I.D.		
mm		In
25.400	MIN	1.0000
25.425	MAX	1.0010

Hub Coupling I.D.		
mm		In
25.425	MIN	1.0010
25.438	MAX	1.0015



Measure the inside diameter of the drive pulley bore.

Hexed Accessory Drive Shaft

Drive Pulley Bore I.D.		
mm		In.
32.925	MIN	1.2963
32.950	MAX	1.2972

Non-Hexed Accessory Drive Shaft

34.941	MIN	1.3756
34.965	MAX	1.3765

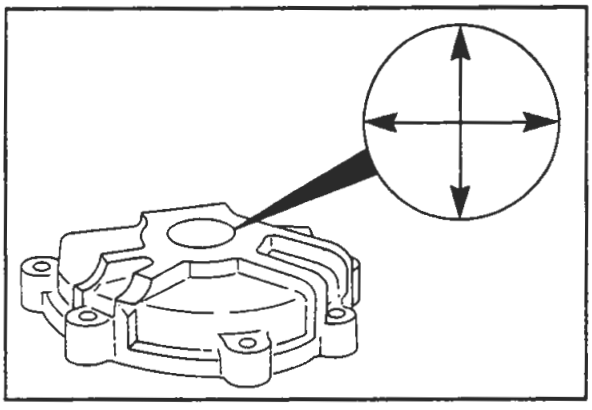
Measure the inside diameter of the bore in the front support housing.

Hexed Accessory Drive Shaft

Front Support Housing Bore I.D.		
mm		In.
38.350	MIN	1.5098
38.425	MAX	1.5128

Non-Hexed Accessory Drive Shaft

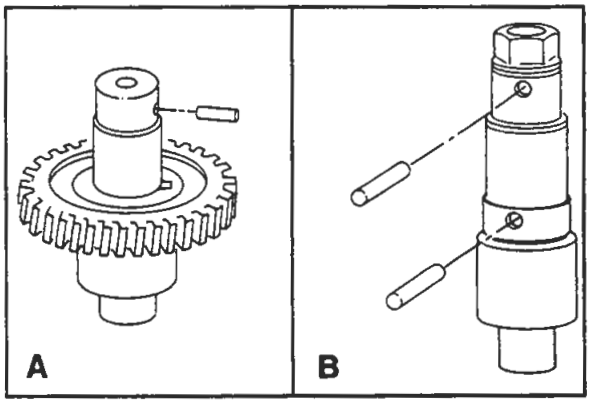
45.100	MIN	1.7755
45.175	MAX	1.7785



Assembly

Use a lead hammer to install the dowel pin(s) in the shaft.

- Present Production Style (A).
- Earlier Production Style (B).



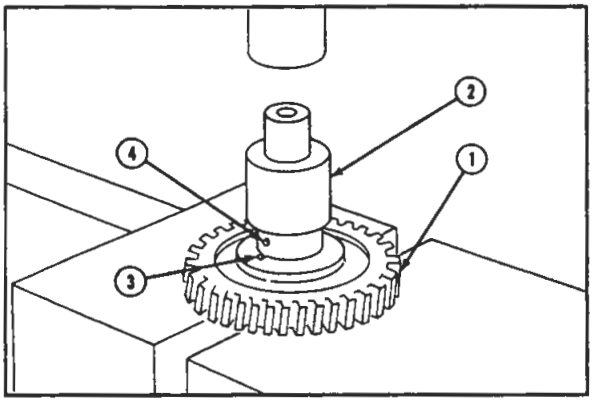
Hexed Accessory Drive Shaft and Gear

Install the drive gear (1) in an arbor press. Support the gear as shown.

NOTE: Make sure the part number side of the gear faces down.

Install the hex end of the shaft (2) through the gear bore. Align slot (3) in the gear with dowel pin (4) in the shaft.

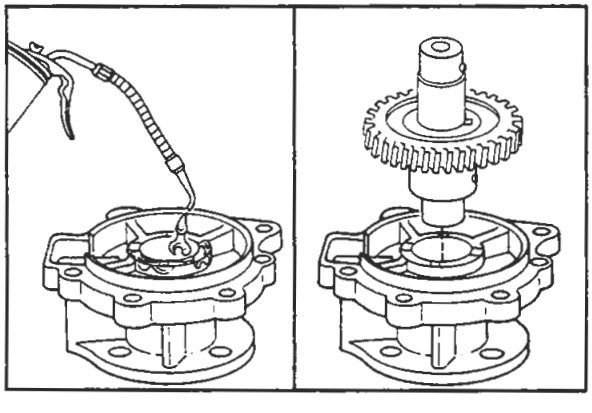
Push the shaft into the gear until the bearing journal shoulder of the shaft contacts the gear.

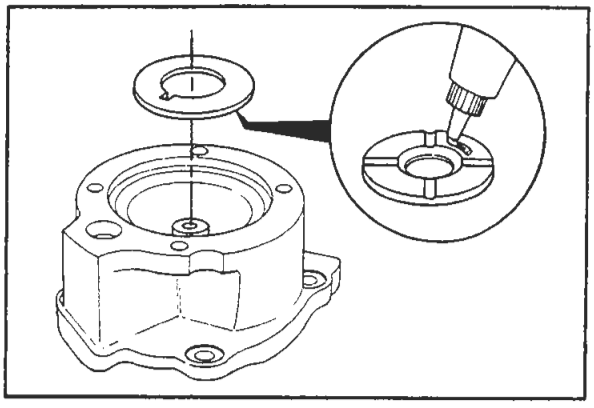


Use clean 15W-40 oil to lubricate the shaft bore and thrust bearing surface of the housing.

Install the shaft and gear assembly into the housing.

NOTE: Both present production and earlier production shaft and gear assemblies are installed in the same manner.

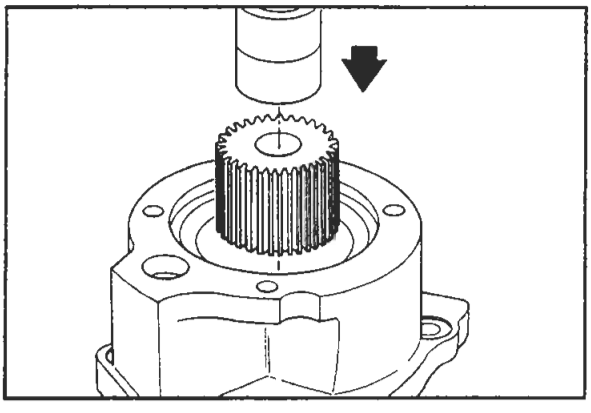




Use Lubriplate® No. 105, or equivalent to lubricate the grooved surface of the thrust bearing.

Install the thrust bearing over the shaft.

Caution: The grooved surface of the thrust bearing must be facing the thrust surface of the housing to provide proper lubrication and prevent damage to the drive assembly.



Install the Spline Coupling Gear

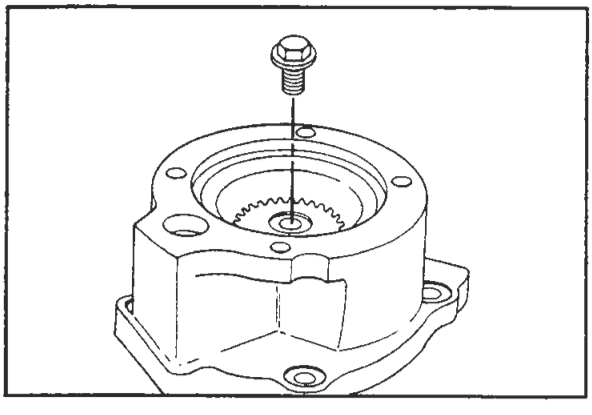
Use clean 15W-40 oil to lubricate the bore of the splined coupling gear.

Install the drive assembly in an arbor press with the drive gear facing down.

Note: Make sure the end of the drive shaft is supported.

Install the flange end of the gear toward the shaft.

Push the gear onto the shaft.

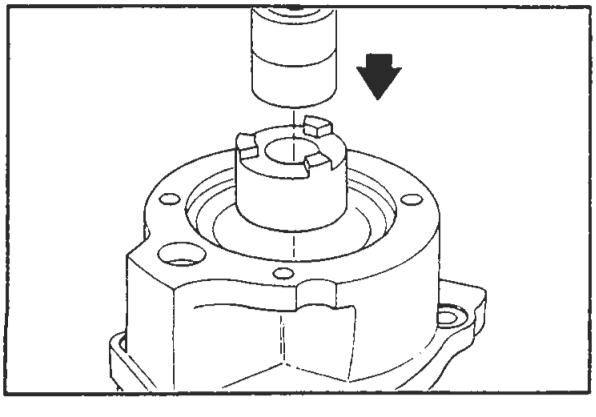


Install the splined coupling gear retainer washer and capscrew.

Caution: The retainer capscrew must have an oil drilling if an air compressor is to be used. The oil drilling will lubricate and prevent damage to the coupling.

Tighten the capscrew.

Torque Value: 45 N•m [35 ft-lb]



Install the Hub Coupling

Use clean 15W-40 oil to lubricate the bore of the coupling.

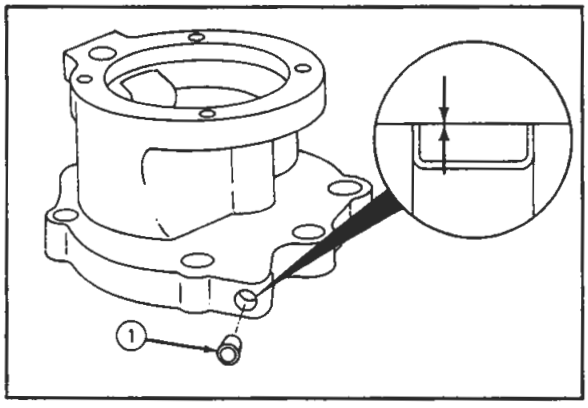
Install the drive assembly in an arbor press with the drive gear facing down.

Note: Make sure the end of the drive shaft is supported.

Push the coupling onto the shaft.

Install the washer and capscrew.

Use Part No. 3375068 Cup Plug Sealant to coat the expansion plug outside diameter.
Use the Part No.3376048 Expansion Plug Driver to install the expansion plug.
Note: The expansion plug (1) **must** be flush with the edge of the housing.

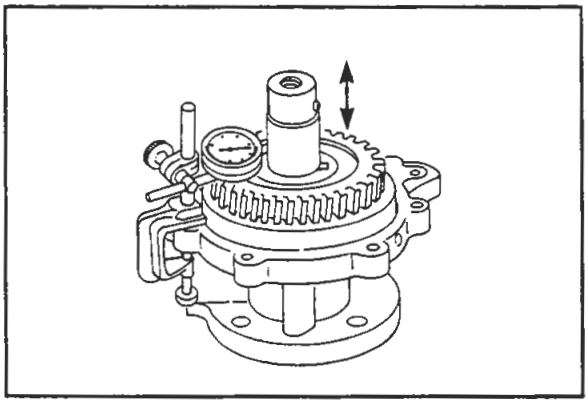


Rotate the drive shaft to check for correct assembly.

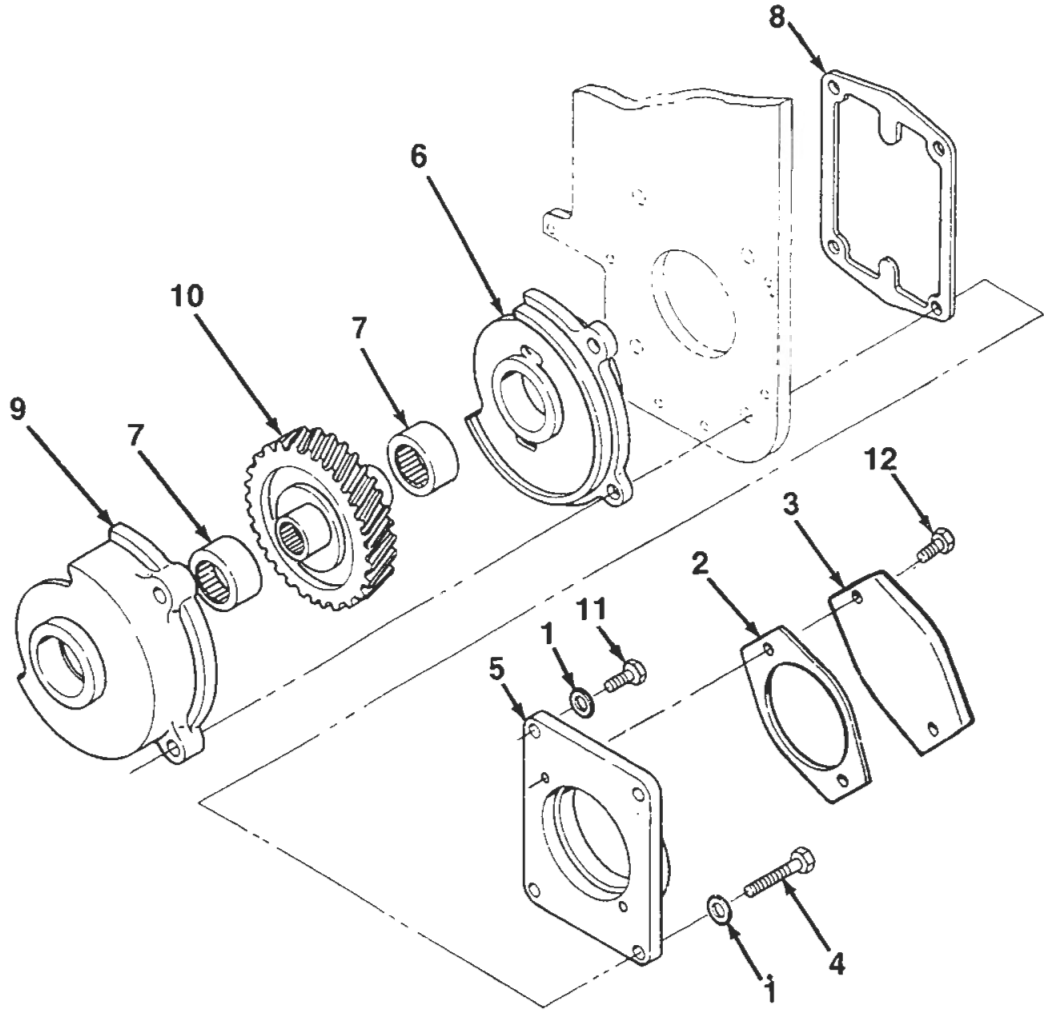
Measure the drive shaft end clearance.

Drive Shaft End Clearance		
mm		in.
0.10	MIN	0.004
0.30	MAX	0.012

Note: If the drive shaft end clearance does **not** meet these specifications, disassemble the drive and inspect the gear and thrust bearing positions. If the drive gear and thrust bearing are within specifications, the fuel pump and compression drive housing **must** be replaced.



Hydraulic Pump Drive - Exploded View



Ref. No.	Description	Qty.
1.	Washer, Plain	4
2.	Gasket, Cover Plate	1
3.	Plate, Cover	1
4.	Capscrew	3
5.	Adapter, Hydraulic Pump	1
6.	Support, Hydraulic Pump	1

Ref. No.	Description	Qty.
7.	Bearing	2
8.	Gasket, Hydraulic Pump	1
9.	Support, Hydraulic Pump	1
10.	Gear, Hydraulic Pump	1
11.	Capscrew	1
12.	Capscrew	2

Drive Units - General Information

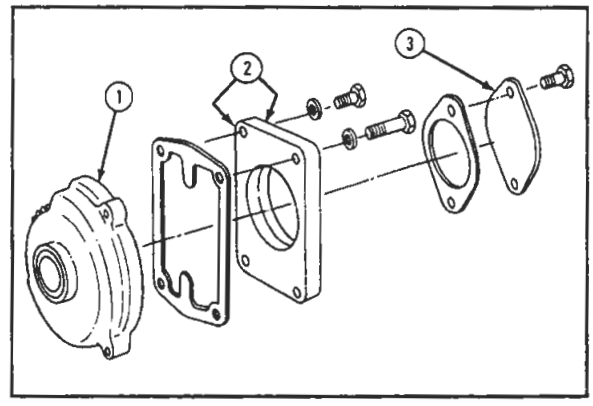
Hydraulic Pump Drive

The hydraulic pump is gear driven from an idler gear in the front gear train. The drive gear and shaft are contained in the front and rear supports by two roller type bearings. The bearings, gear and shaft receive lubrication from engine oil in the front gear train.

Hydraulic Pump Drive - Clean and Inspect for Reuse (09-03)

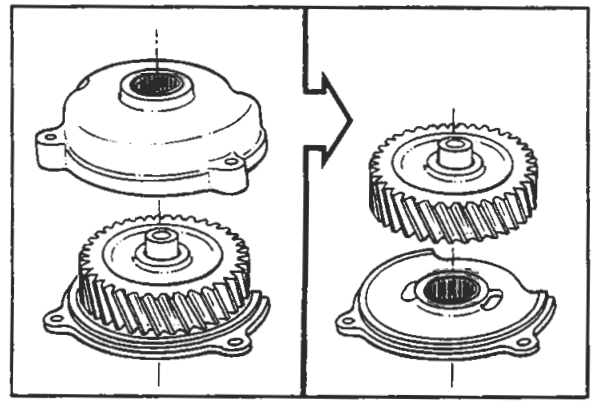
Disassembly

Remove all gasket material from surfaces (1, 2 and 3). Discard the gaskets.



Remove the front support from the assembly.

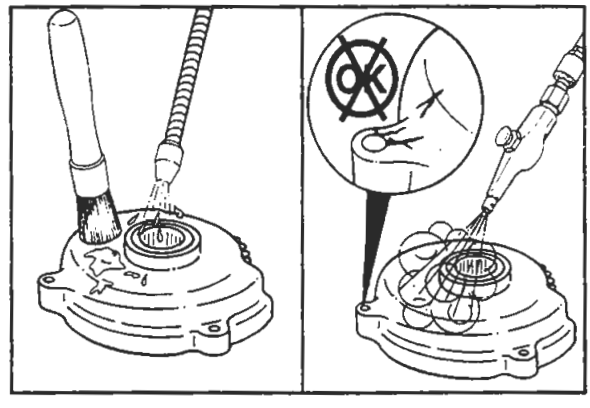
Remove the shaft and gear assembly from the rear support.

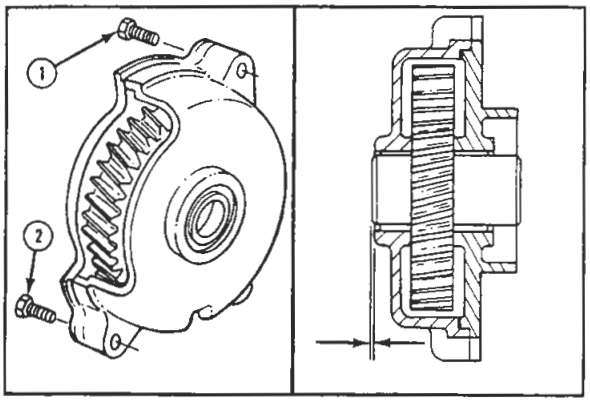


Clean the parts with solvent, dry with compressed air.

Visually inspect the parts for damage.

Note: Do not remove the gear from the shaft. If the parts are damaged refer to Hydraulic Pump Drive - Rebuild (09-04).





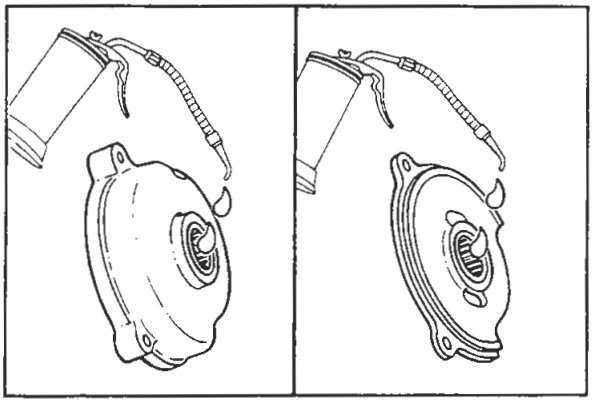
Inspection

Note: Use two (M10-1.50x20) capscrews (1 and 2) to hold the front and rear supports together while measuring the end clearance.

Measure the drive shaft end clearance.

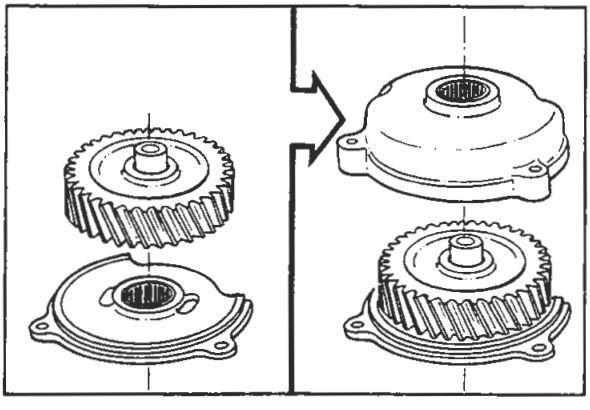
Drive Shaft End Clearance		
mm		in.
0.127	MIN	0.0050
0.318	MAX	0.0125

Note: If the shaft end clearance does **not** meet the specifications, inspect the front and rear support thrust surfaces for wear. Refer to Hydraulic Pump Drive - Rebuild (09-04).



Assembly

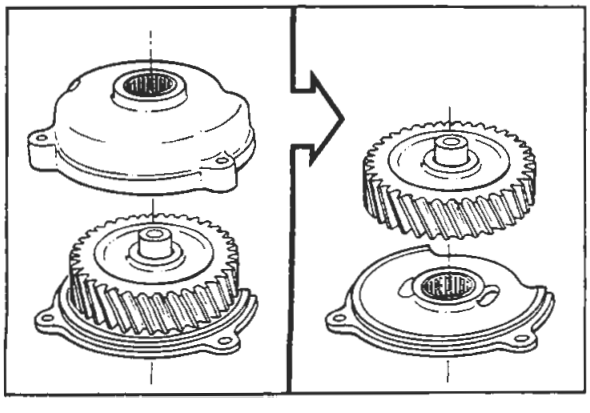
Use clean 15W-40 oil to lubricate the bearings in the front and rear supports.



Install the shaft and gear assembly into the rear support.

Install the front support over the shaft and gear assembly.

Note: The shaft drive gear **must** turn freely in the support bearings.



Hydraulic Pump Drive - Rebuild (09-04)

Disassembly

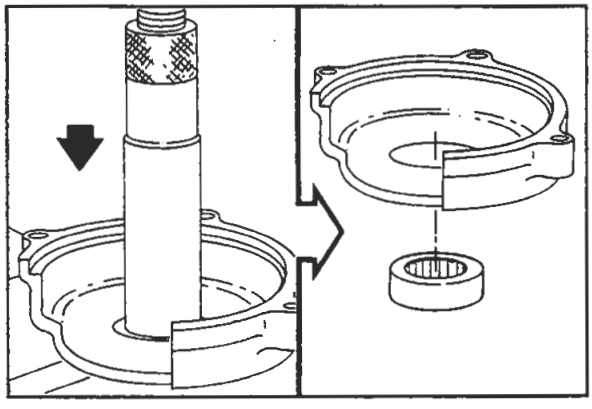
Remove the front support from the assembly.

Remove the shaft and gear assembly from the rear support.

Install the front support in an arbor press with the mounting flange facing up.

Caution: Push against the outer race or numbered side of the bearing to prevent personal injury or damage to the bearing.

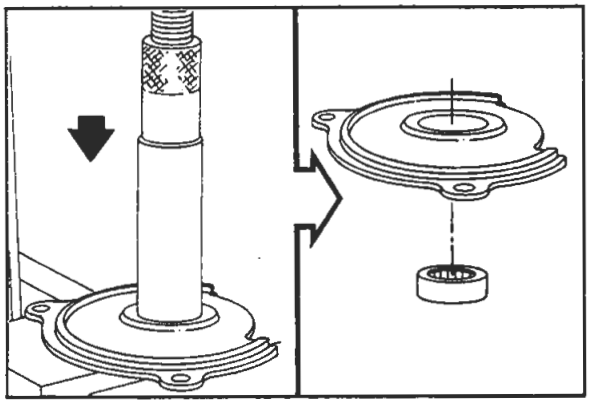
Use the Part No. 3376821 Hydraulic Drive Support Bearing Driver to push the bearing from the support.



Install the rear support in an arbor press with the mounting flange facing up.

Caution: Push against the outer bearing race or numbered side of the bearing to prevent personal injury or damage to the bearing.

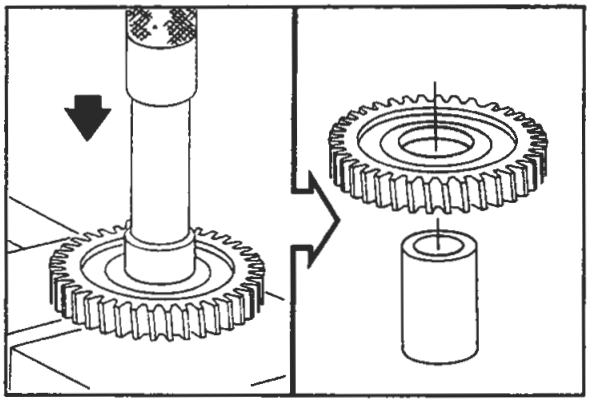
Use the Part No. 3376821 Hydraulic Bearing Support Driver to push the bearing from the support.



Install the shaft and gear assembly in an arbor press with the part number side of the gear facing down.

Caution: Do not allow the shaft to fall when removing it from the gear. Personal injury or damage to the shaft can result.

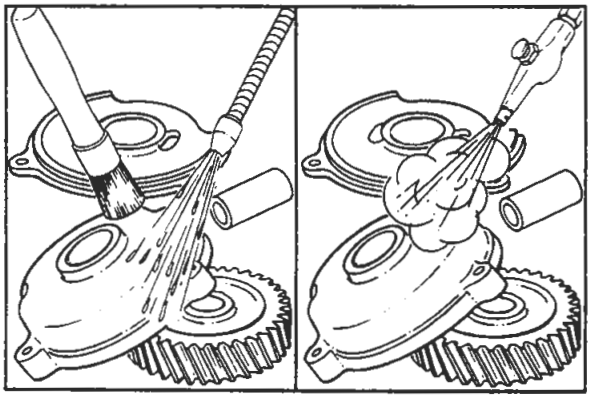
Push the shaft toward the chamfered side of the gear.

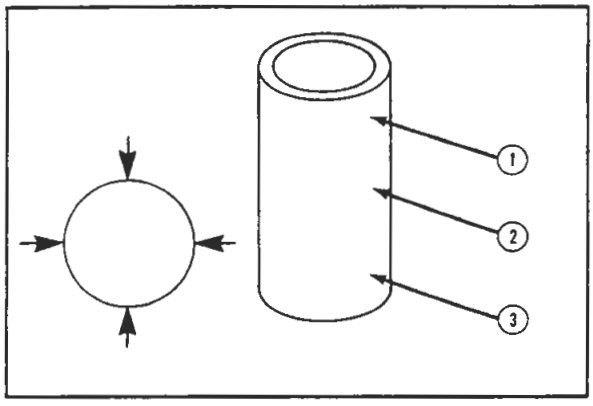


Clean the parts with solvent, dry with compressed air.

Visually inspect the parts for damage.

Replace damaged parts.



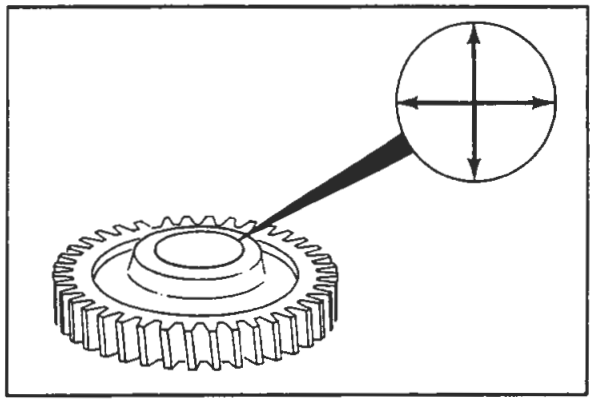


Inspection

Note: If the part being inspected **does not** meet the specifications given, or if no alternative is given, the part **must** be replaced.

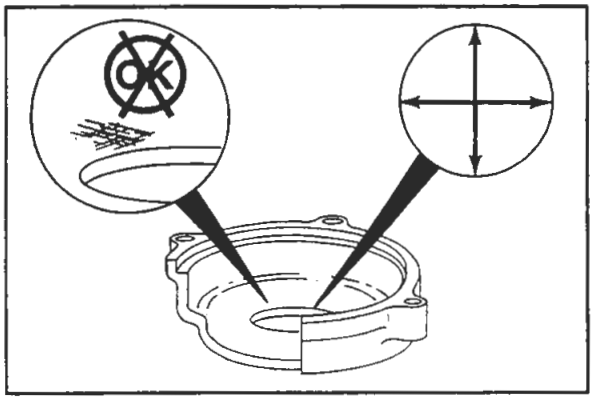
Measure the drive shaft outside diameter in two positions 90 degrees apart at points (1, 2 and 3).

Drive Shaft O.D.		
mm		**in.**
34.984	MIN	1.3773
35.000	MAX	1.3780



Measure the inside diameter of drive gear bore.

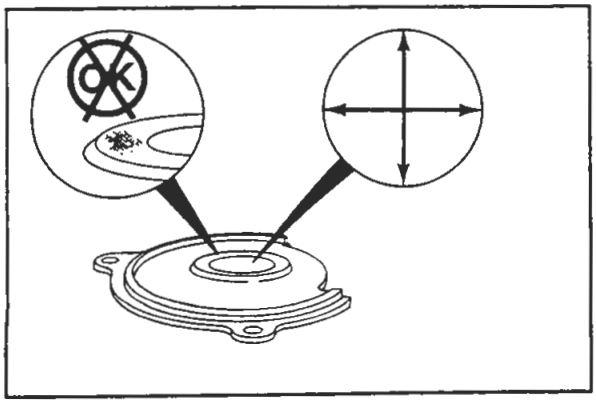
Drive Gear Bore I.D.		
mm		**in.**
34.925	MIN	1.3750
34.950	MAX	1.3760



Visually inspect the front support thrust surface for scoring, excessive wear or other damage.

Measure the inside diameter of the front support bore.

Front Support Bore I.D.		
mm		in.
41.967	MIN	1.6522
41.992	MAX	1.6532



Visually inspect the rear support thrust surface for scoring, excessive wear or other damage.

Measure the inside diameter of the rear support bore.

Rear Support Bore I.D.		
mm		**in.**
41.967	MIN	1.6522
41.992	MAX	1.6532

Note: If scoring, excessive wear or damage is found or the bore inside diameter is **not** within the specifications given, the front and rear supports **must be** replaced.

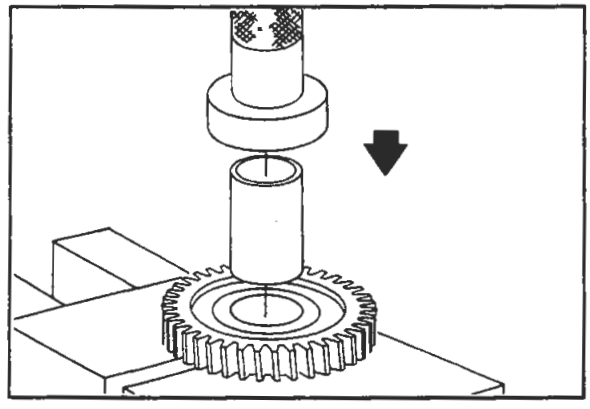
Assembly

Install the drive gear in an arbor press with the part number side of the gear facing down.

Install the shaft into the gear.

Note: The splined end of the shaft **must be** toward the **non**-part number side of the gear.

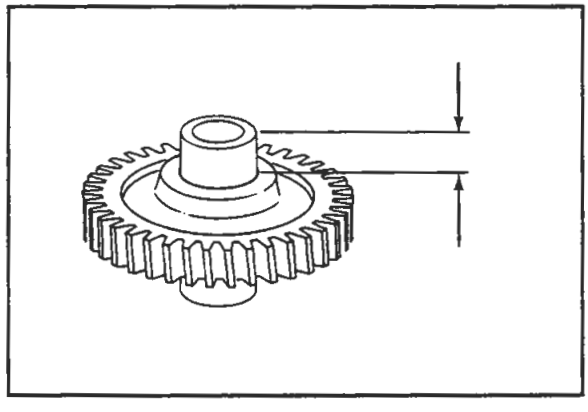
Use the Part No. 3376820 Hydraulic Drive Gear Driver to push the shaft into the gear until the gear driver touches the gear.



Measure the installed height of the shaft.

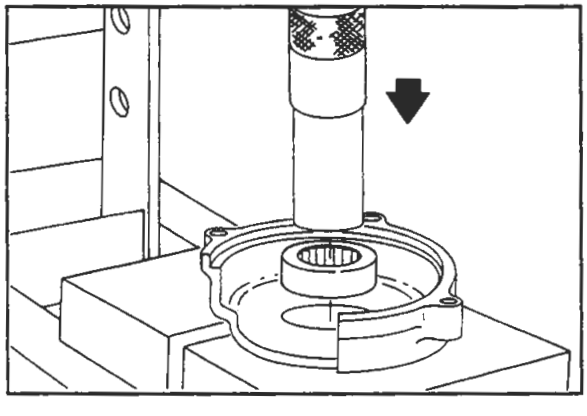
Note: Measure the installed height of the shaft in the drive gear from the front. Make sure the part number side of the gear is facing up. If the shaft **does not** meet the specifications, remove the shaft from the gear and install the shaft to the specified height.

Drive Shaft Installed Height		
mm		in.
18.50	MIN	0.728
19.50	MAX	0.768



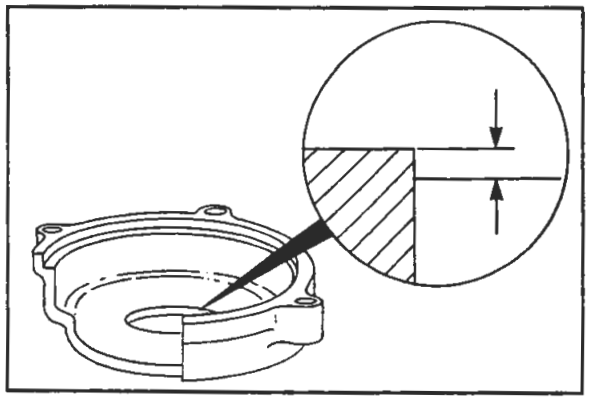
Caution: The numbered side of the bearing must face the drive gear. Push against the outer race or numbered side of the bearing to prevent personal injury or damage to the bearing.

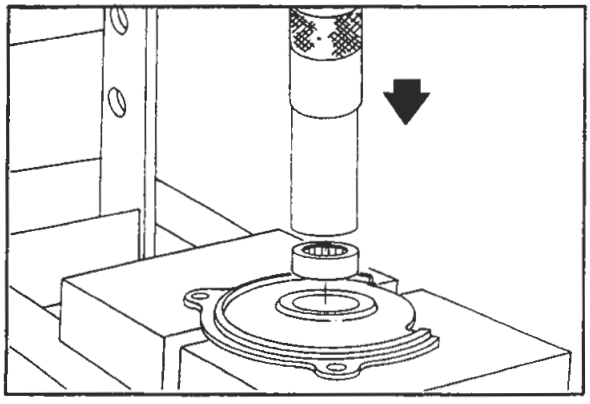
Install the front support in an arbor press with the mounting flange facing up.



Use the Part No. 3376821 Hydraulic Support Bearing Driver to Push the bearing into the support to the specified depth.

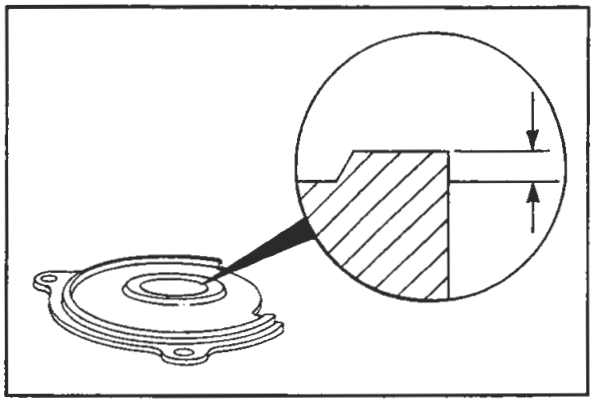
Bearing Depth in Housing Bore		
mm		in.
0.00	MIN	0.000
-0.25	MAX	-0.010





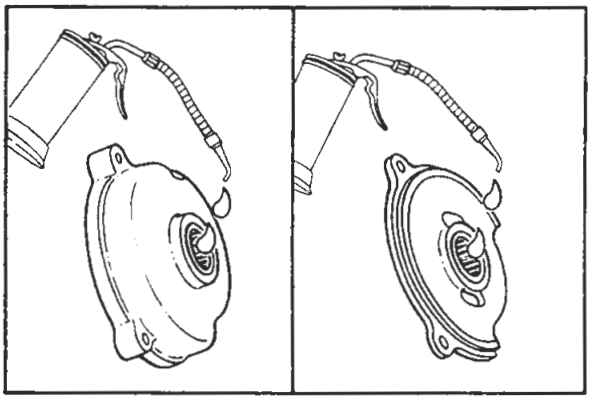
Caution: The numbered side of the bearing must face the drive gear. Push against the outer race or numbered side of the bearing to prevent personal injury or damage to the bearing.

Install the rear support in an arbor press with the mounting flange facing up.

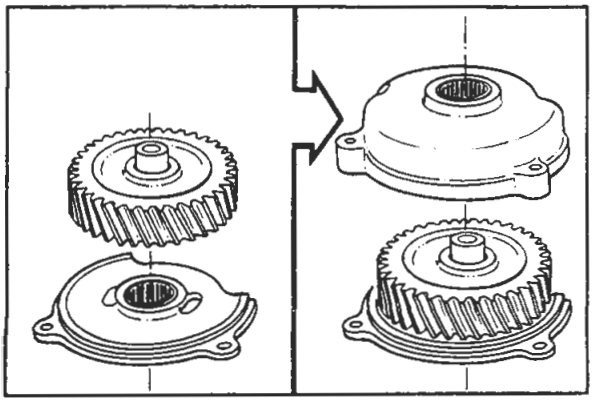


Use the Part No. 3376821 Hydraulic Support Bearing Driver to push the bearing into the support to the specified depth.

Bearing Depth in Housing Bore		
mm		**in.**
0.00	MIN	0.000
-0.25	MAX	-0.010



Use clean 15W-40 oil to lubricate the bearings in the front and rear supports.



Install the shaft and gear assembly into the rear shaft.

Install the front support over the shaft and gear assembly.

Note: The shaft and drive gear **must** turn freely in the support bearings.

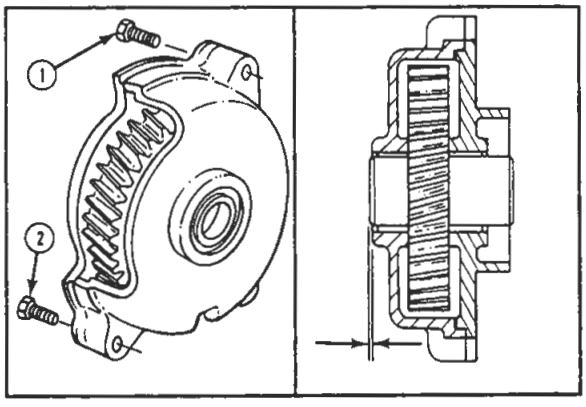
Final Inspection

NOTE: Use two (M10-1.50x20) capscrews (1 and 2) to hold the front and rear supports together while measuring the end clearance.

Measure the drive shaft end clearance.

Drive Shaft End Clearance		
mm		in.
0.127	MIN	0.0050
0.318	MAX	0.0125

NOTE: If the drive shaft end clearance **does not** meet the specifications, the front and rear support thrust surfaces are worn excessively. Replace the front and rear supports.



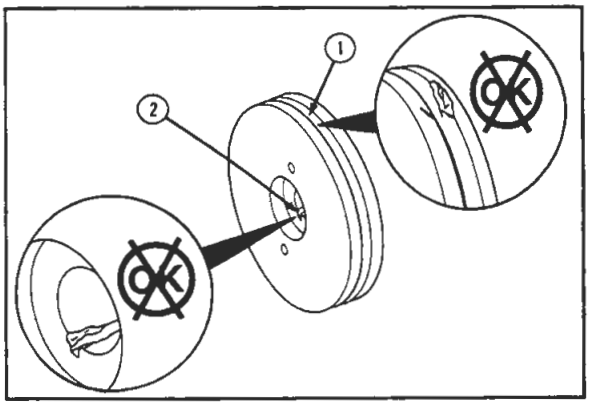
Accessory Drive Pulley - Clean and Inspect for Reuse (09-05)

Clean the accessory drive pulley with solvent, dry with compressed air.

Inspection

Visually inspect the grooves of the pulley (1) for wear or damage.

Visually inspect the pulley bore and keyway (2) for damage.

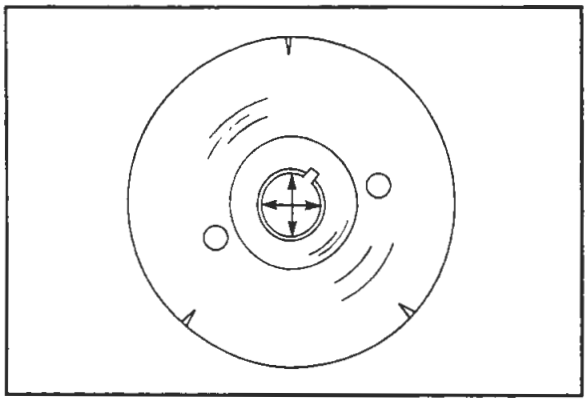


Measure the inside diameter of the drive pulley bore.

Hexed Accessory Drive Shaft Engines		
Drive Pulley Bore I.D.		
mm		in.
32.925	MIN	1.2963
32.950	MAX	1.2972

Non-Hexed Accessory Drive Shaft Engine		
mm		in.
34.941	MIN	1.3756
34.965	MAX	1.3765

NOTE: If the pulley bore **does not** meet the specifications given or wear or damage is found, the pulley **must be** replaced.

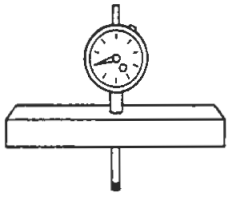


Air Intake System - Group 10

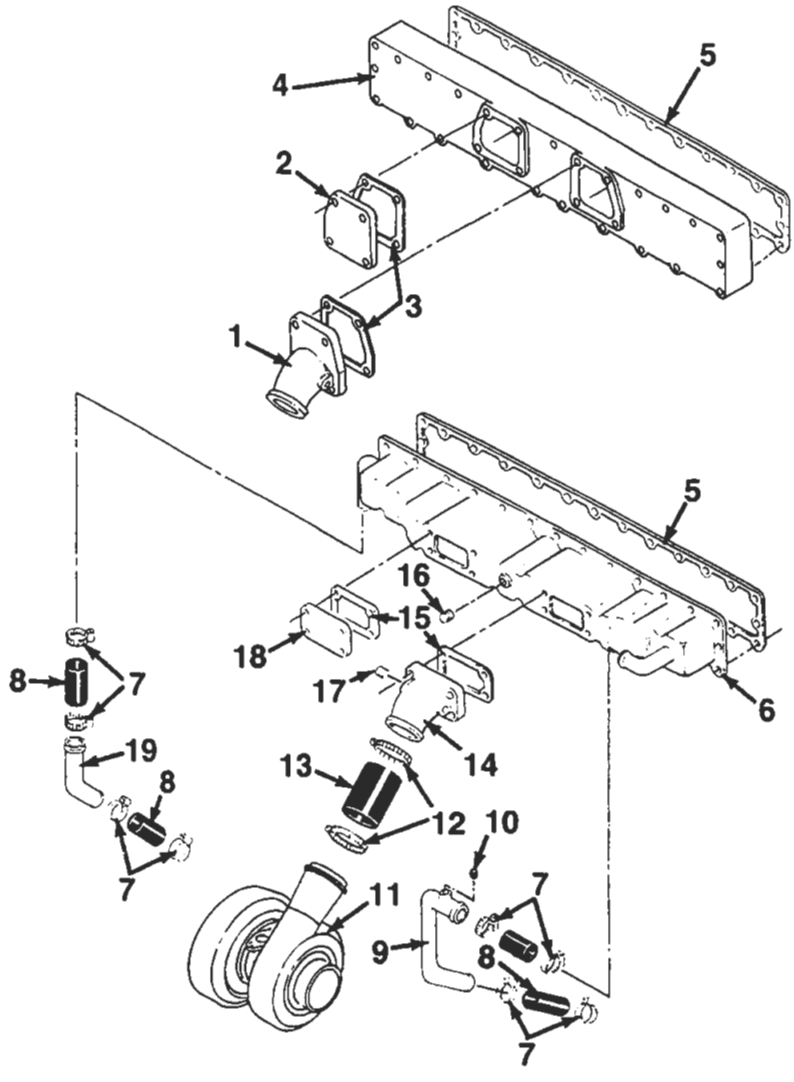
Contents

Air Intake System - Service Tools

The following special tools are recommended to perform the procedures in Group 10. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

Tool No.	Tool Description	Tool Illustration
ST-537	**Dial Depth Gauge** Measure the turbocharger end clearance	

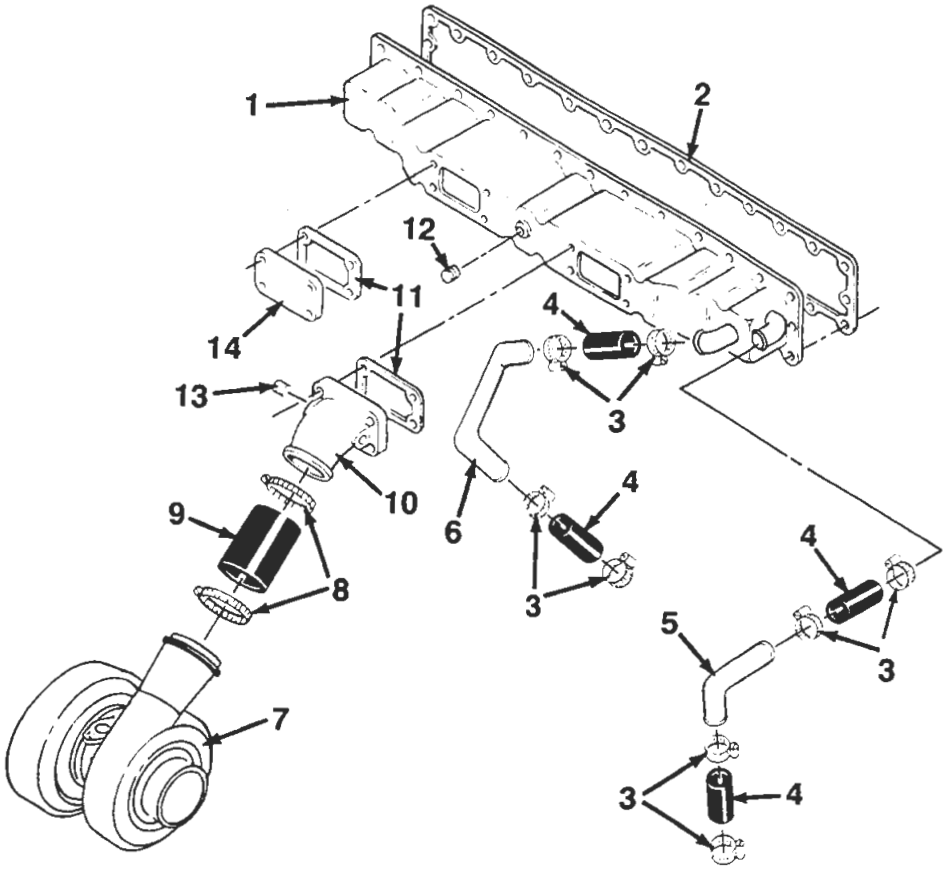
Air Intake System - Exploded View



Intake Manifold and Conventional Aftercooling

Ref. No.	Description	Qty.	Ref. No.	Description	Qty.
1.	Connection, Air Intake	1	11.	Turbocharger	1
2.	Plate, Cover	1	12.	Clamp, Tee Bolt	2
3.	Gasket, Connection	2	13.	Hose, Plain	1
4.	Manifold, Intake	1	14.	Connection, Air Intake	1
5.	Gasket, Intake Manifold	1	15.	Gasket, Connection	2
6.	Aftercooler, Housing	1	16.	Plug, Pipe	1
7.	Clamp, Hose	8	17.	Plug, Pipe	1
8.	Hose, Plain	4	18.	Plate, Cover	1
9.	Tube, Aftercooler	1	19.	Tube, Aftercooler	1
10.	Plug, Pipe	1			

Air Intake System - Exploded View



Optimized Aftercooling

Ref. No.	Description	Qty.	Ref. No.	Description	Qty.
1.	Aftercooler, Housing	1	8.	Clamp, Tee Bolt	2
2.	Gasket, Intake Manifold	1	9.	Hose, Plain	1
3.	Clamp Hose	8	10.	Connection, Air Intake	1
4.	Hose, Plain	4	11.	Gasket, Connection	2
5.	Tube, Aftercooler	1	12.	Plug, Pipe	1
6.	Tube, Aftercooler	1	13.	Plug, Pipe	1
7.	Turbocharger	1	14.	Plate, Cover	1

Air Intake System - General Information

The Air Intake System Group consists of the intake manifold cover, aftercooler assembly, aftercooler water tubes and the turbocharger.

Both the conventional and optimized aftercoolers use engine coolant to cool the air between the turbocharger and combustion chambers during engine operation. The aftercooler also performs as a starting aid by warming the intake air, if the engine is equipped with an engine coolant heater.

The turbocharger is cooled and lubricated with engine oil from the engine lubricating oil system.

The L10 engine uses capscrews in both metric and U.S. Customary dimensions. In some cases, the capscrews are almost identical in dimensions and appearance. Be sure to install capscrews in the same location as they were removed from.

The pipe plugs and hose clamps installed in the intake system are U.S. Customary dimensions.

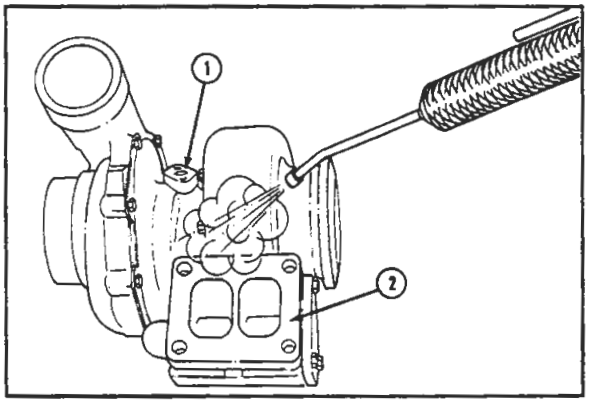
Turbocharger - Clean and Inspect for Reuse (10-01)

Remove all carbon deposits and gasket material from surfaces (1 and 2).

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Caution: Tape or plug all openings to prevent solvent or steam from damaging the oil cavities in the turbocharger.

Use solvent or steam to clean the exterior of the turbocharger. Dry with compressed air.



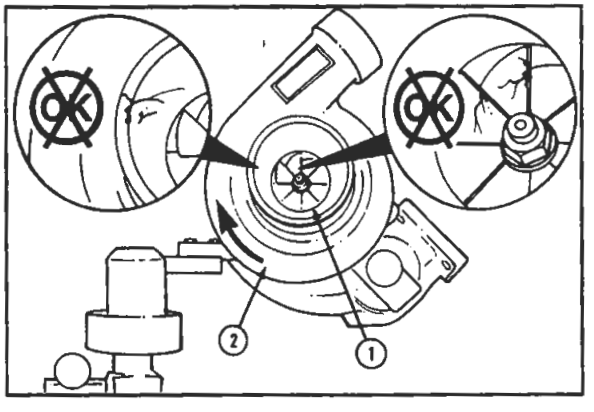
Inspection

Visually inspect the housings for damage.

Visually inspect the turbine wheel and compressor impeller (1) for fretting, cracked or broken vanes.

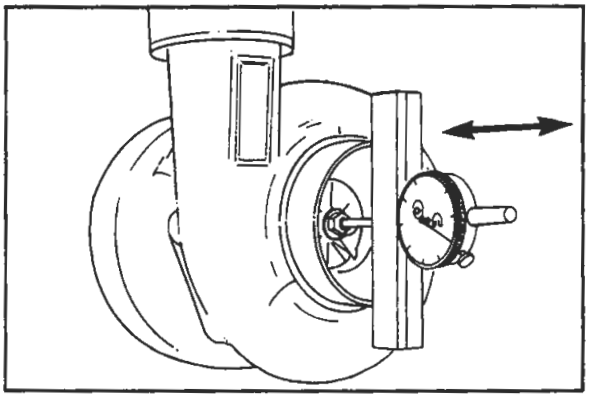
Turn the impeller in the direction shown with arrow (2), to inspect the turbine shaft for freedom of rotation. The shaft **must** rotate freely.

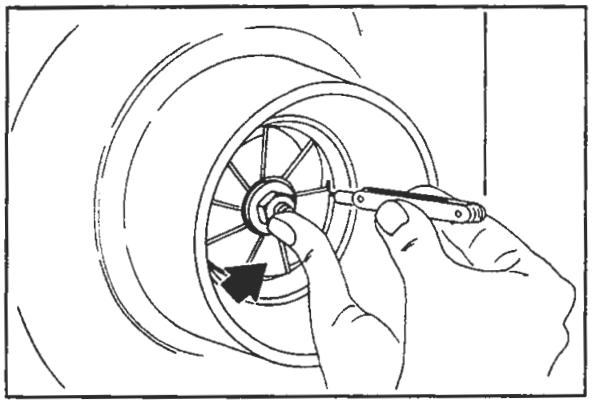
Replace damaged parts.



Measure the turbocharger shaft end clearance with the Part No. ST-537 Dial Depth Gauge.

Shaft End Clearance		
mm		in.
0.003	MIN	0.001
0.007	MAX	0.003

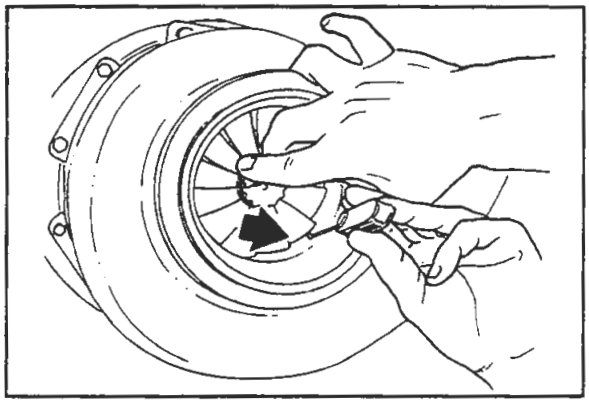




Push the compressor impeller by hand toward the compressor housing.

Install a wire feeler gauge, at the minimum clearance point, between the impeller and the housing to measure the radial clearance.

Compressor Impeller Radial Clearance		
mm		**in.**
0.20	MIN	0.008
0.41	MAX	0.016

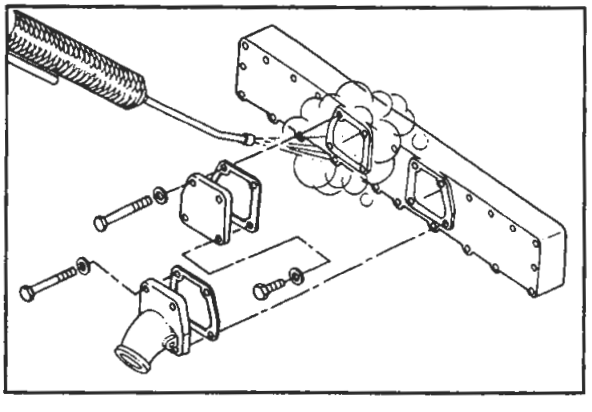


Push the turbine wheel by hand toward the turbine housing.

Install a wire feeler gauge, at the minimum clearance point, between the turbine wheel and the housing to measure the radial clearance.

Turbine Wheel Radial Clearance		
mm		**in.**
0.27	MIN	0.011
0.47	MAX	0.019

Note: If the compressor impeller or turbine wheel to housing radial clearance does **not** meet the above specifications, the turbocharger **must** be rebuilt. Refer to Turbocharger Component Shop Manual, Bulletin No. 3379461, for rebuild instructions.



Intake Manifold Cover - Clean and Inspect for Reuse (10-02)

Remove the air intake connection and cover plate.

Remove all gasket material.

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

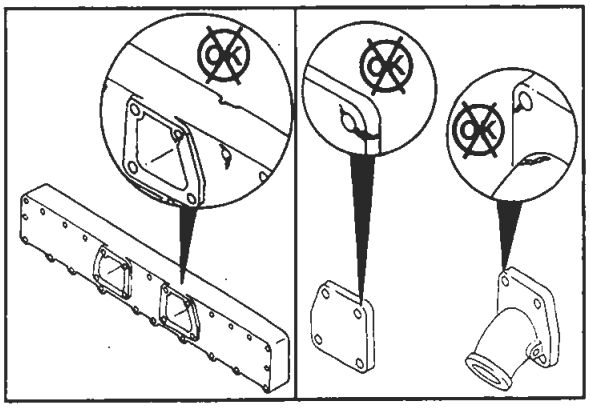
Use solvent or steam to clean the parts. Dry with compressed air.

Inspection

Visually inspect the intake manifold cover for cracks or damage.

Visually inspect the intake connection and cover plate for cracks or damage.

Replace damaged parts.

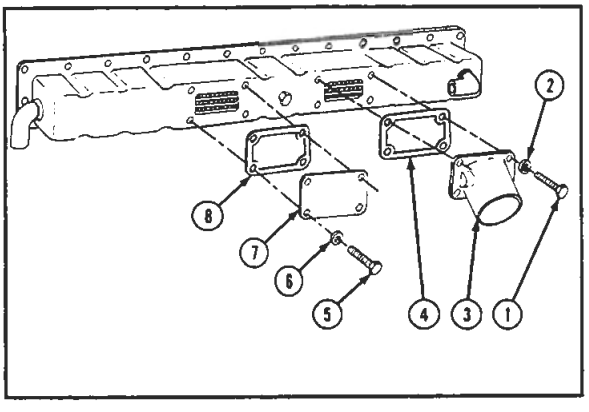


Aftercooler Assembly - Clean and Inspect for Reuse (10-03)

Disassembly

Remove the four capscrews (1) and washers (2) from the inlet housing (3). Remove the inlet housing and gasket (4).

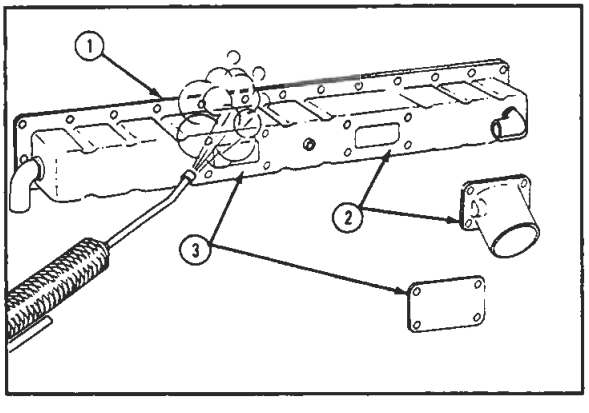
Remove the four capscrews (5) and washers (6) from the cover plate (7). Remove the cover plate and gasket (8).



Remove all gasket material from surfaces (1, 2 and 3).

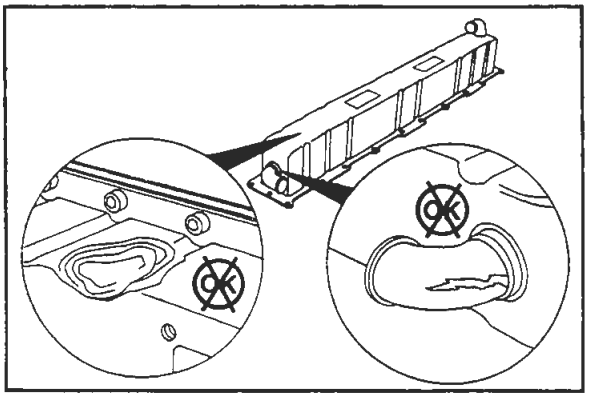
Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

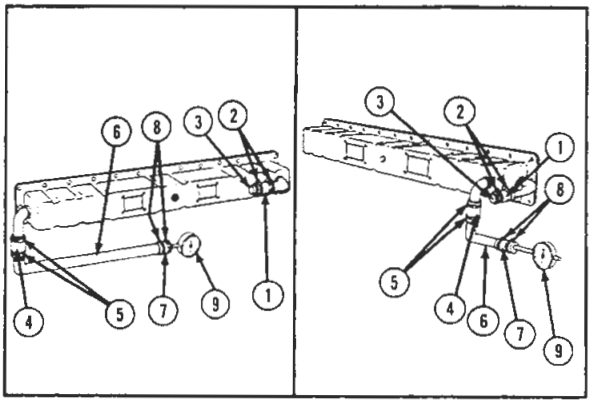
Use solvent or steam to clean the aftercooler assembly. Dry with compressed air.



Inspection

Visually inspect the aftercooler assembly for cracks or damage.



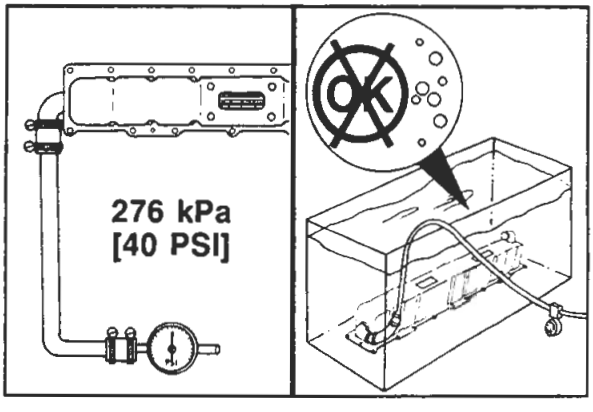


Pressure Test the Aftercooler Core

Install the hose (1), hose clamps (2) and solid pipe plug (3).

Install the hose (4), hose clamps (5) and the tube (6).

Install the hose (7), hose clamps (8) and air pressure gauge (9).

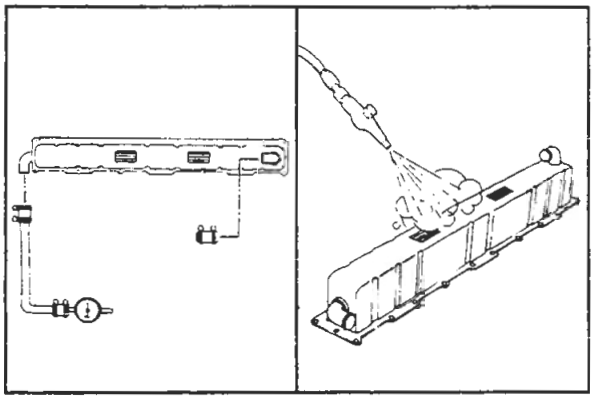


Connect the air pressure gauge to a regulated air supply.

Air Pressure: 276 kPa [40 psi]

Submerge the aftercooler in a tank of water.

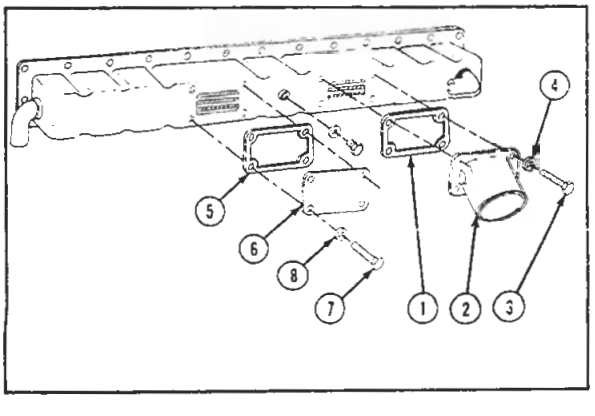
Note: If air bubbles appear, the core is damaged and the aftercooler **must** be replaced.



Remove the aftercooler from the water tank.

Remove the test equipment.

Use compressed air and dry the aftercooler.



Assembly

Use four (M8-1.25x25) capscrews (3) and washers (4) to install the gasket (1) and air inlet connection (2).

Use four (M8-1.25x16) capscrews (7) and washers (8) to install the gasket (5) and air inlet cover plate (6).

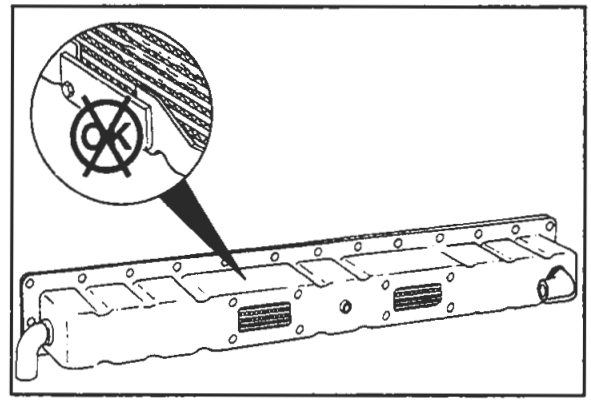
Tighten the eight capscrews.

Torque Value: 25 N•m [18 ft-lb]

Aftercooler Assembly - Rebuild (10-04)

Caution: The present production aftercooler is a unitized assembly and cannot be rebuilt. Any attempt to repair the aftercooler core will reduce the coolant flow and cause future engine damage.

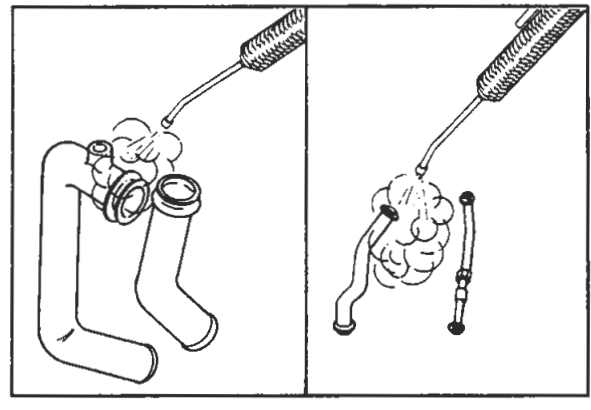
Refer to Aftercooler Assembly - Clean and Check for Reuse (10-03).



Aftercooler Water Tubes - Clean and Inspect for Reuse (10-05)

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use solvent or steam to clean the water inlet and outlet tubes. Clean the water bypass tube.

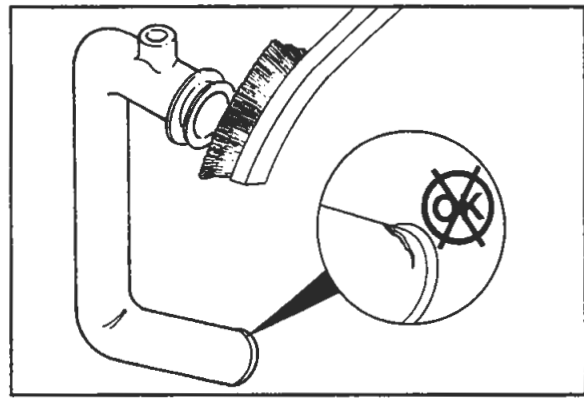


Use a wire brush to clean the hose sealing surfaces.

Inspection

Visually inspect the tubes for cracks or damage.

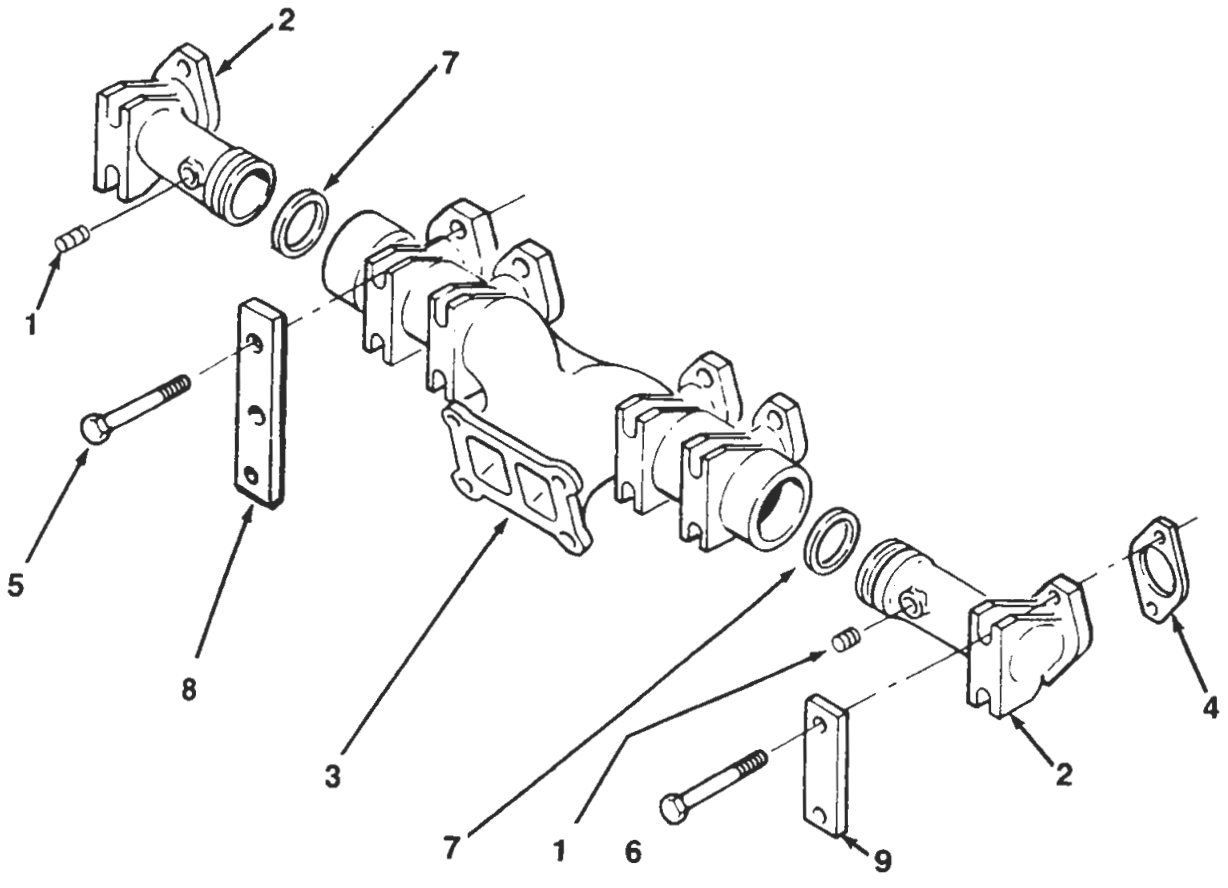
Replace damaged parts.



Exhaust System - Group 11

Contents

Exhaust System - Exploded View



Exhaust Manifold

Ref. No.	Description	Qty.
1.	Plug, Pipe	2
2.	Manifold, Exhaust	2
3.	Manifold, Exhaust	1
4.	Gasket, Exhaust Manifold	6
5.	Capscrew	6
6.	Capscrew	4
7.	Seal, Exhaust Manifold	2
8.	Plate, Clamping	2
9.	Plate, Clamping	4

Exhaust System - General Information

The exhaust manifold group consists of the exhaust manifolds and the turbocharger mounting studs.

Caution: The special self-locking exhaust manifold mounting capscrews can be removed and installed a maximum of two times. After the second time the capscrews must be replaced to prevent damage to the threads of the capscrew hole.

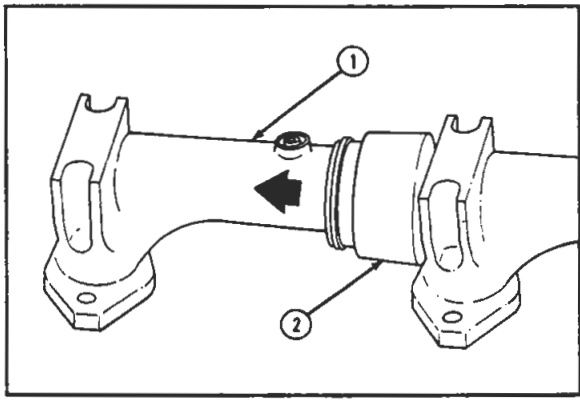
Caution: The exhaust manifold capscrews have self-locking threads. Do not use an air wrench to remove or install these capscrews to prevent distorting the threads in the capscrew holes. Use only the special capscrews to fasten the exhaust manifold assembly to the cylinder head.

The exhaust manifold seals and seal ring expanders used between the exhaust manifold sections **must** be replaced when removed. The seal rings **can** leak if used again.

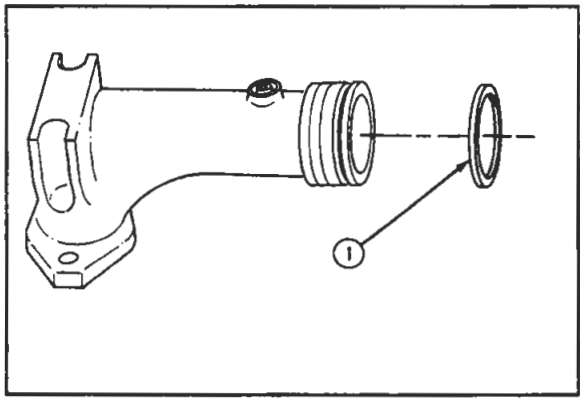
Exhaust Manifold - Clean and Inspect for Reuse (11-01)

Disassembly

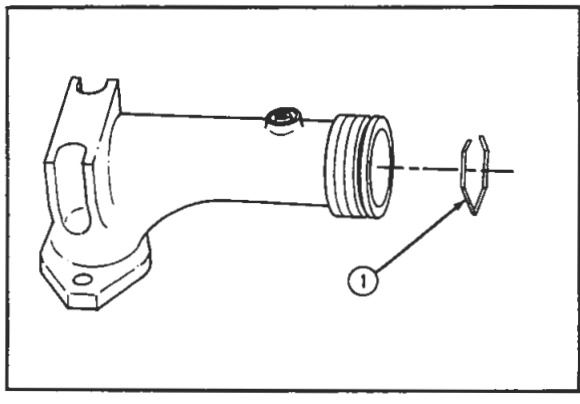
Use a mallet, remove the two end sections (1) from the center section (2).

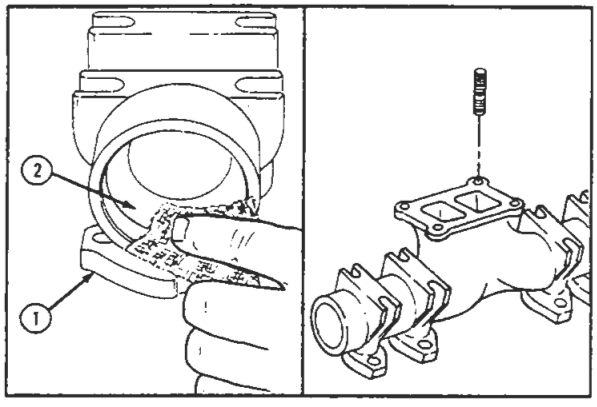


Remove the seal ring (1) from both end sections.



Remove the seal ring expander (1) from both end sections.



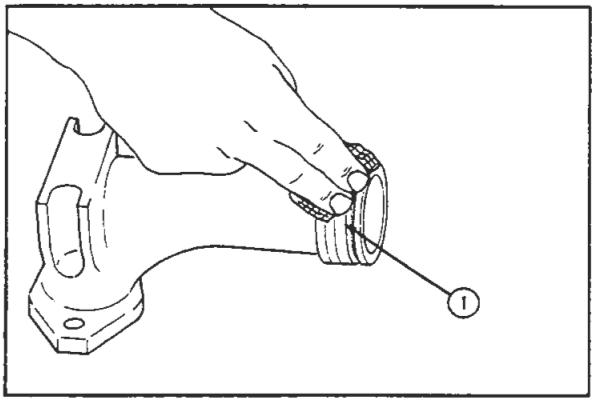


Clean

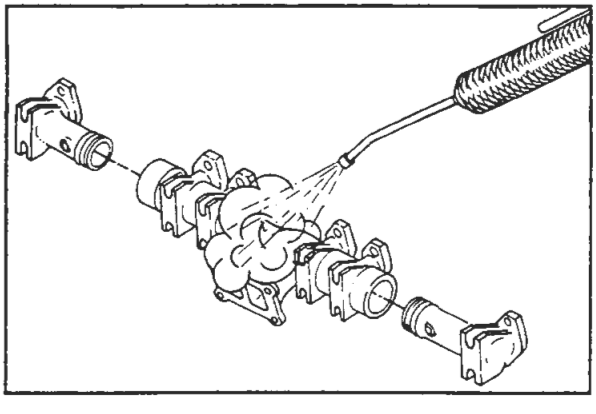
Use a wire brush to remove the carbon from the gasket sealing surfaces (1).

Use emery cloth to remove the carbon from the center section sealing surface bores (2).

Use a standard stud extractor to remove the four turbocharger mounting studs from the center section.

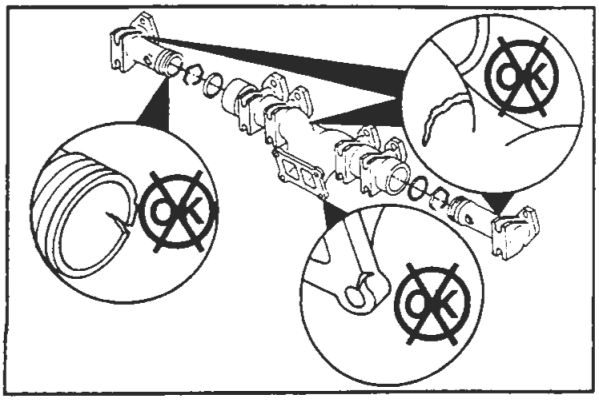


Use emery cloth to remove the carbon from the connection surface (1) of both end sections.



Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use steam to clean the manifold sections. Dry with compressed air.



Inspection

Visually inspect the manifold sections for cracks or damage.

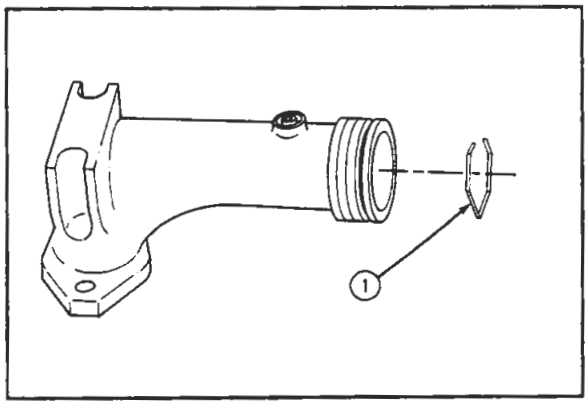
Visually inspect the sealing connection surfaces for damage.

Visually inspect the center section for damaged threads in the turbocharger mounting stud holes.

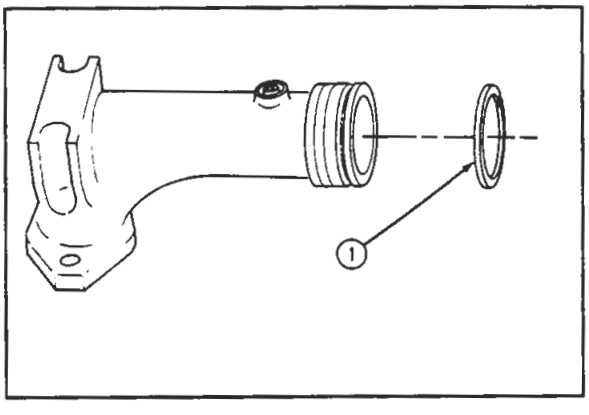
Replace damaged parts.

Assembly

Install a new seal ring expander (1) on both end sections.

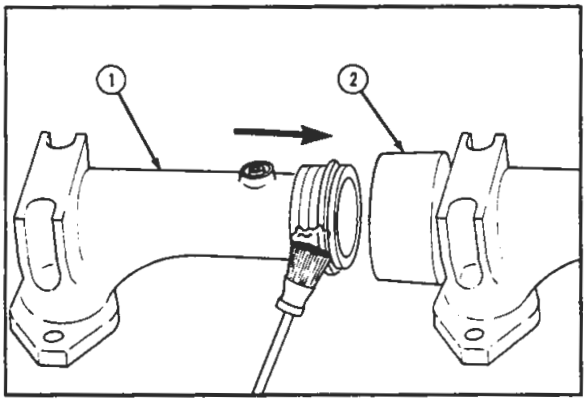


Install a new seal ring (1) on both end sections.



Apply a coat of anti-seize compound to the outside diameter of both end sections in the area that enters the center section.

Install the end sections (1) in the center section (2).



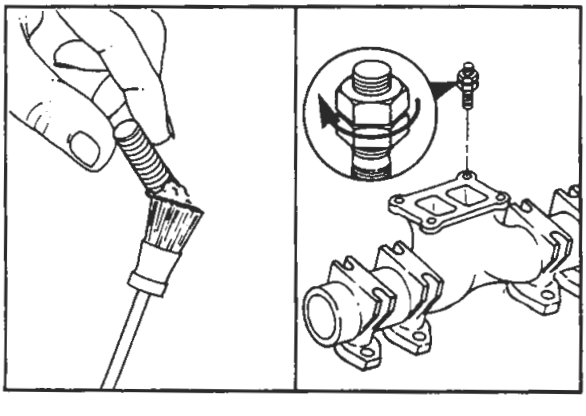
Note: Install the **shorter** threaded end of the turbocharger mounting stud in the exhaust manifold flange.

Apply a coat of anti-seize compound to the threads.

Install the studs in the mounting flange.

Use two mounting nuts locked together to tighten the studs.

Torque Value: 65 N•M [50 ft-lb]



Air Equipment - Group 12

Contents

Air Equipment - General Information

Air Compressor

The air equipment group consists of Cummins single and two cylinder air compressors, compressor check valves and air and coolant piping. It also includes air activated cranking motors.

The air compressor is lubricated by engine lubricating oil which enters the compressor through a drilling in the support. The oil lubricates the connecting rod bearings and the crankshaft. The oil then flows to the air compressor crankcase and returns to the engine through a drain passage located in the support.

The air compressor is cooled by the engine coolant. Only the cylinder head is cooled on the single cylinder air compressor. Both the cylinder head and cylinders are cooled on the two cylinder air compressor.

Service information, specifications, and repair of Cummins air compressors are contained in the following publications:

- Single cylinder air compressor - Air Equipment Rebuild Manual, Bulletin No. 3810242
- Two cylinder air compressor - Air Equipment Rebuild Manual, Bulletin No. 3810257

Instructions for testing and repairing air cranking motors and air compressors not manufactured by Cummins, **can** be obtained from the original equipment manufacturers.

The following list contains the addresses of suppliers of air equipment for use on Cummins engines:

U.S.A.

Bendix H.V.S.G.
901 Cleveland St.
Elyria, OH 44036
Attention: Technical Services Dept.

Engine Starting Systems
Allen and Martinsville Rd.
P.O. Box 1776
Liberty Corner, NJ 07938

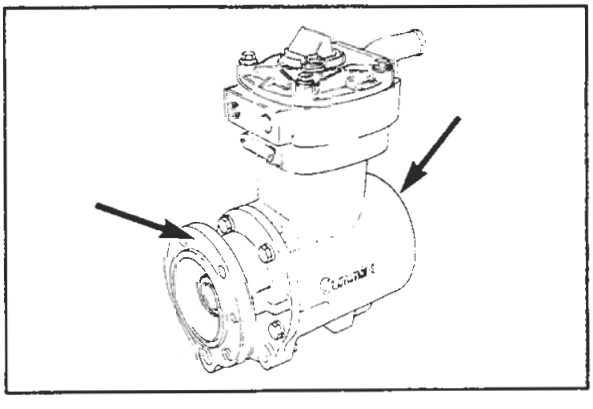
Midland Brake, Inc.
490 South Chestnut St.
Owosso, MI 48867

Canada

Bendix H.V.S.G.
P.O. Box 5712
1005 Wilton Grove Rd.
London Ontario, Canada N6A4S8
Attention: Technical Services Dept.

International

Bendix H.V.S.G. Europe Ltd.
66 Grosvenor St.
London, England W1X90B
Attention: Technical Services Dept.



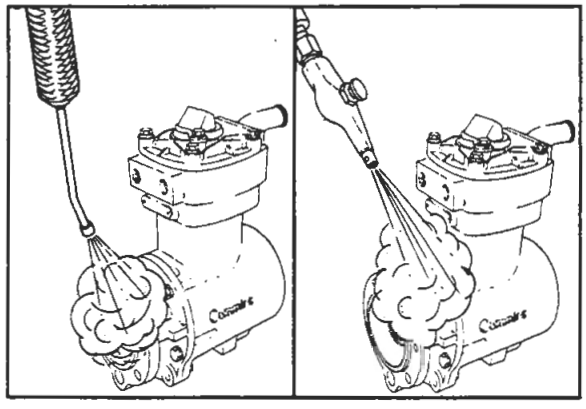
Air Compressor - Clean and Inspect for Reuse (12-01)

Remove all gasket material from the sealing surfaces.

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Caution: Seal all openings with tape to prevent future damage from solvent or steam entering the oil passages in the air compressor.

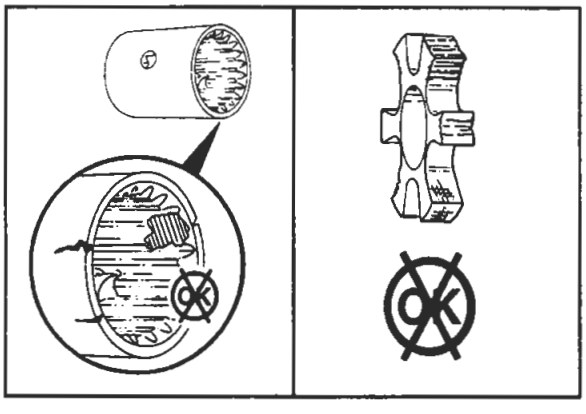
Use solvent or steam to clean the air compressor. Dry with compressed air.



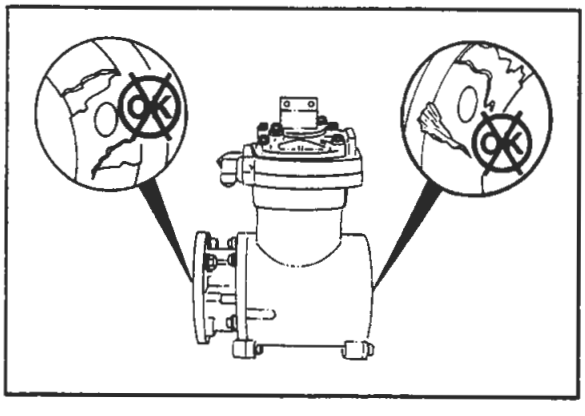
Inspection

Visually inspect the compressor drive splined coupling for cracks or broken splines.

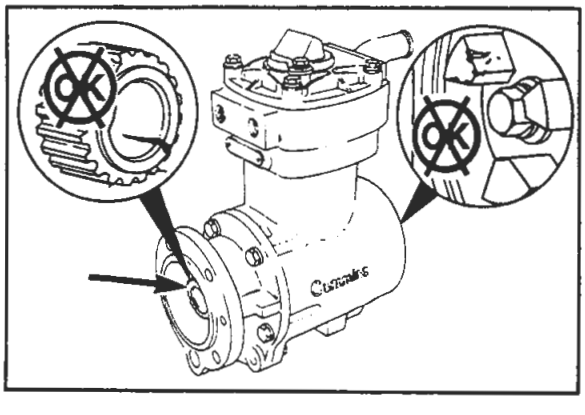
Visually inspect the fuel pump drive hub or spider coupling for wear or damage.

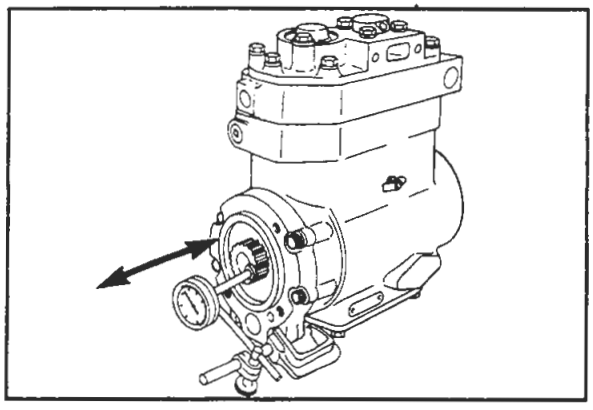


Visually inspect the compressor housing for cracks or damage.



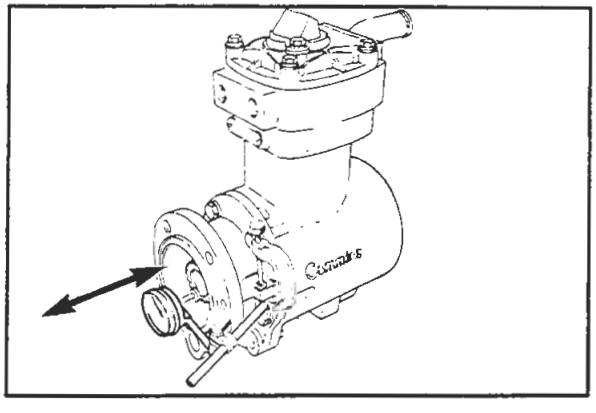
Visually inspect the compressor drive gear and the fuel pump "hub type" drive coupling for wear or damage.





Measure the single cylinder air compressor crankshaft end clearance.

Crankshaft End Clearance		
mm		**in.**
0.05	MIN	0.002
0.15	MAX	0.006



Measure the two cylinder air compressor crankshaft end clearance.

Crankshaft End Clearance		
mm		**in.**
0.05	MIN	0.002
0.19	MAX	0.008

Note: If cracked or damaged parts are found or the end clearance exceeds the limits specified, the air compressor **must be** rebuilt or replaced. Refer to Air Equipment Rebuild Manual, Bulletin No. 3810242, for single cylinder, or Bulletin No. 3810257, for two cylinder air compressor rebuild instructions.

Electrical Equipment - Group 13

Contents

Electrical Equipment - General Information

The electrical equipment used on the L10 engine is **not** manufactured by Cummins Engine Company, Inc. Complete instructions for adjusting, testing, and repairing the electrical equipment **can** be obtained from the equipment manufacturer. The following list contains the suppliers of the electrical equipment used on Cummins engines.

Alternators

Robert Bosch Ltd.
P.O. Box 166
Rhodes Way
Watford
WD2 41B
England
Telephone: 0923-44233

Butec Electrics
Cleveland Road
Leyland
PR5 1XB
England
Telephone: 0744-21663

C.A.V. Electrical Equipment
P.O. Box 36
Warple Way
London
W3 7SS
England
Telephone: 01-743-3111

A.V. Delco Components Group
Civic Offices
Central Milton Keynes
MK9 3EL
England
Telephone: 0908-66001

Delco-Remy
P.O. Box 2439
Anderson, IN 46018
U.S.A.
Telephone: (317) 646-7838

Leece-Neville Corp.
1374 E. 51st St.
Cleveland, OH 44013
U.S.A.
Telephone: (216) 431-0740

*Air Starting Motors

Ingersoll Rand
Chorley New Road
Horwich
Bolton
Lancashire
England
BL6 6JN
Telephone: 0204-65544

Ingersoll-Rand
Engine Starting Systems
651 Part Avenue
King of Prussia, PA 19406
U.S.A.
Telephone: (215) 337-5900

Electric Starting Motors

Butec Electrics
Cleveland Road
Leyland
PR5 1XB
England
Telephone: 0744-21663

C.A.V. Electrical Equipment
P.O. Box 36
Warple Way
London
W3 7SS
England
Telephone: 01-743-3111

A.C. Delco Components Group
Civic Offices
Central Milton Keynes
MK9 3EL
England
Telephone: 0908-66001

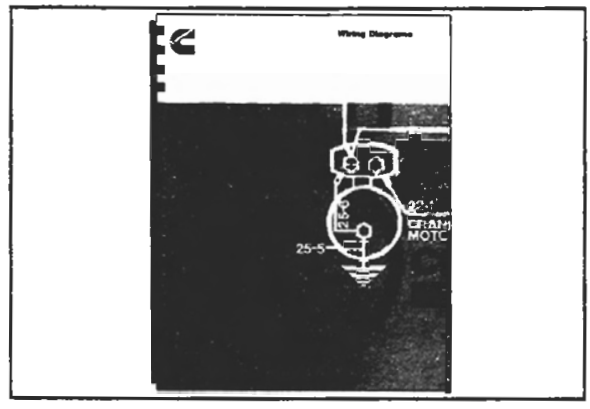
Delco-Remy
P.O. Box 2439
Anderson, IN 46018
U.S.A.
Telephone: (317) 646-7838

Leece-Neville Corp.
1374 E. 51st Street
Cleveland, OH 44013
U.S.A.
Telephone: (216) 431-0740

* Non Electrical Equipment Suppliers

Wiring Diagrams

A complete collection of electrical wiring diagrams, as applied to all Cummins engines, is contained in Wiring Diagrams, Bulletin No. 3379099.



Alternator Bracket - Clean and Inspect for Reuse (13-01)

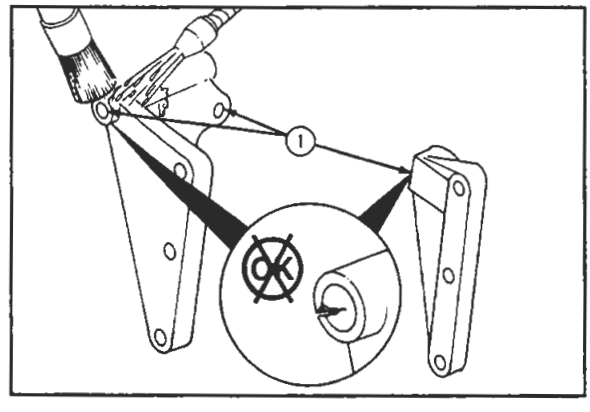
Use solvent to clean the bracket. Dry with compressed air.

Inspection

Visually inspect the bracket area (1) for cracks. Inspect the bracket for other damage.

Discard damaged parts.

Note: The cylinder block mounting surface **must be** clean and free of paint to provide a proper electrical ground for the alternator.



Alternator Adjusting Link - Clean and Inspect for Reuse (13-02)

Use solvent to clean the adjusting link. Dry with compressed air.

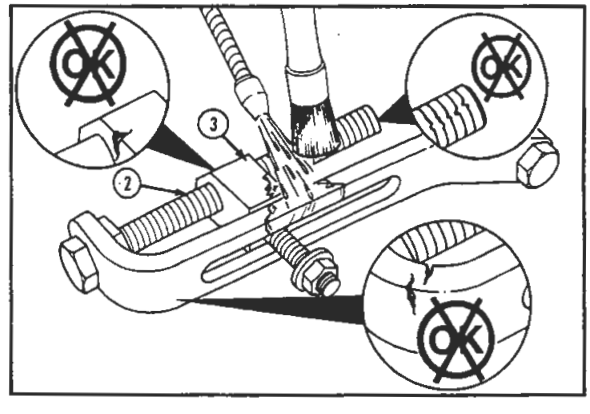
Inspection

Note: Some parts can vary in design.

Visually inspect the adjusting link (1), capscrew (2), and the adjusting retainer (3) for damage.

Note: The capscrew (2) **must** turn freely in the retainer (3).

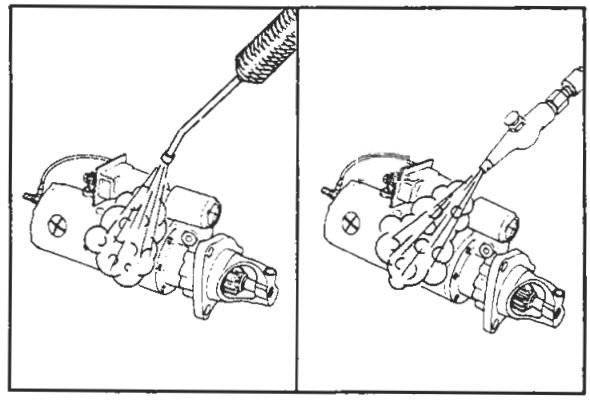
Discard damaged parts.

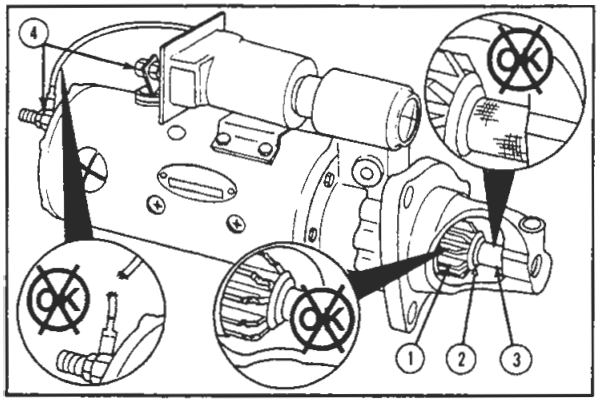


Starting Motor - Clean and Inspect for Reuse (13-03)

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use steam to clean the starting motor. Dry with compressed air.





Inspection

Visually inspect the gear (1) for cracked or broken teeth.

Visually inspect the drive bushing (2) and the gear shaft (3) for excessive wear or damage.

Visually inspect the terminal posts (4) for loose or broken connections.

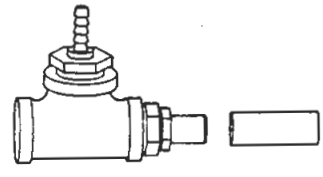
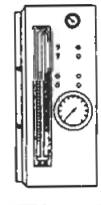
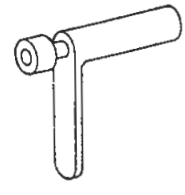
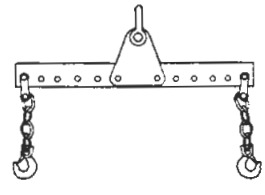
Note: If the starting motor parts are damaged or the posts are loose or damaged, the starting motor **must** be repaired or rebuilt. Refer to the electrical equipment manufacturers specifications to rebuild the starting motor.

Engine Testing - Group 14

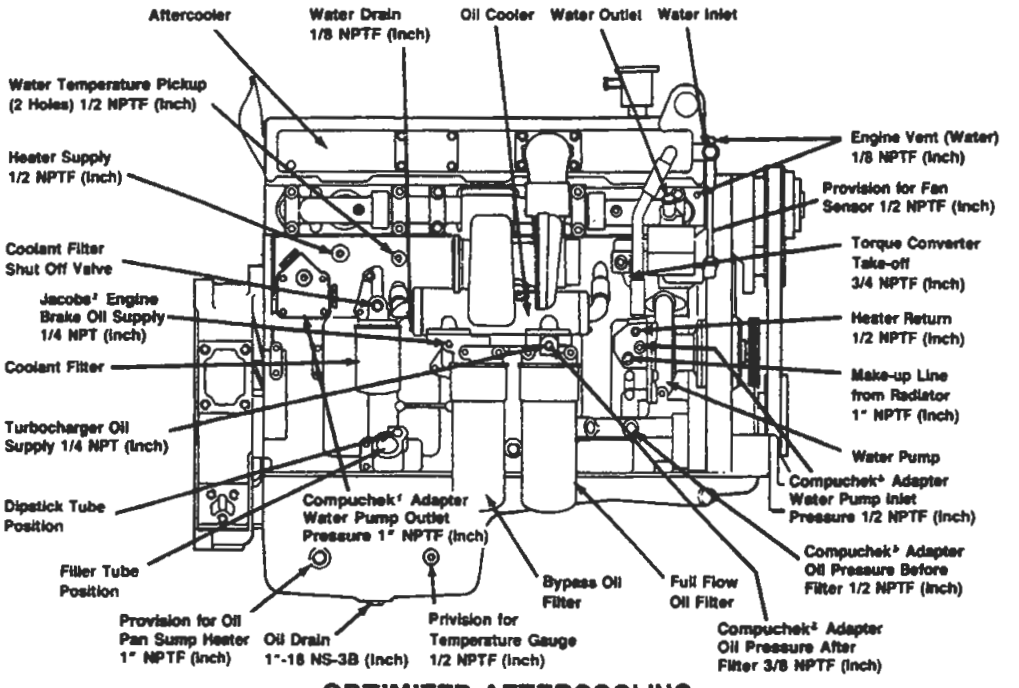
Contents

Engine Testing - Service Tools

The following special tools are recommended to perform the procedures in Group 14. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

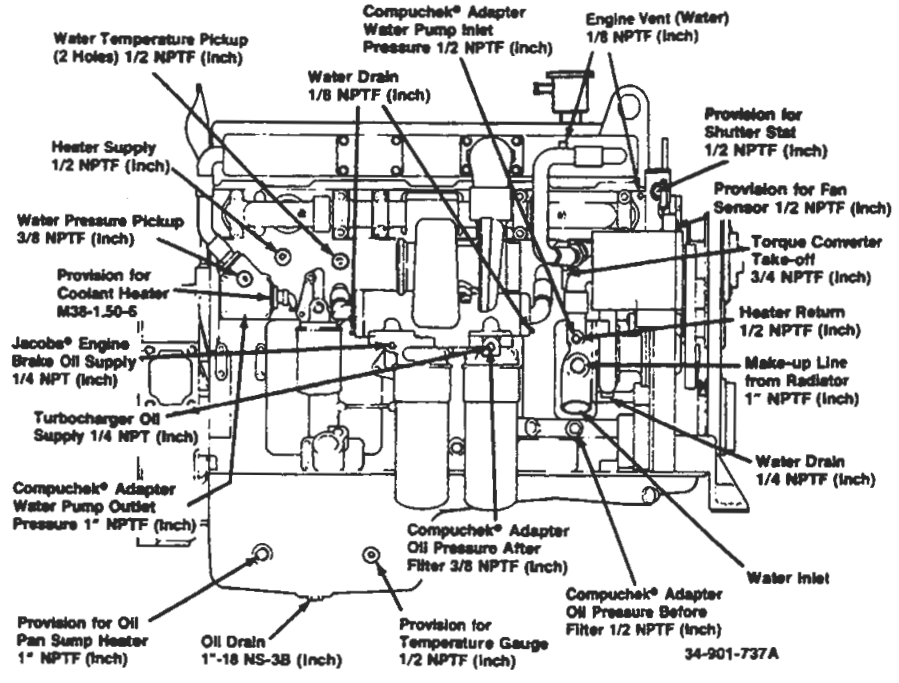
Tool No.	Tool Description	Tool Illustration
ST-434	**Vacuum Gauge** Check the fuel filter and air intake restriction during the engine performance test. The Part No. ST-434-2 Hose Adapter and Part No. ST-424-12 Vacuum Gauge are used to perform the test.	
ST-1135	**Lubricating Oil Sampling Filter** Used with the Part No. 196250 Filter Disk to take a sample of engine oil for testing.	
3375788	**Engine Blowby Tool** Used with a water manometer to measure the engine crankcase pressure.	
3376375	**Fuel Measuring Instrument** Measure the rate of fuel consumption in pounds per hour. Measure the fuel rail pressure and fuel temperature.	
3377247	**AFC No-Air Adjusting Tool** Used to adjust the AFC no-air valve.	
3822512	**Engine Lifting Fixture** Install and remove the engine from the engine test stand.	

Engine Testing - Engine Side Views



OPTIMIZED AFTERCOOLING

ew200gz

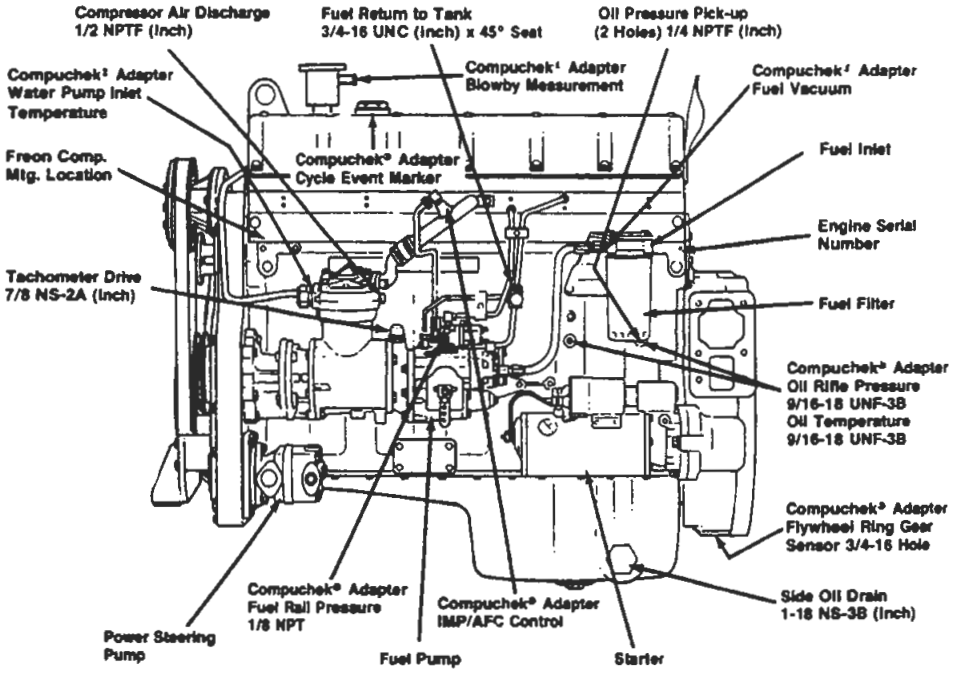


CONVENTIONAL AFTERCOOLING

ew200gy

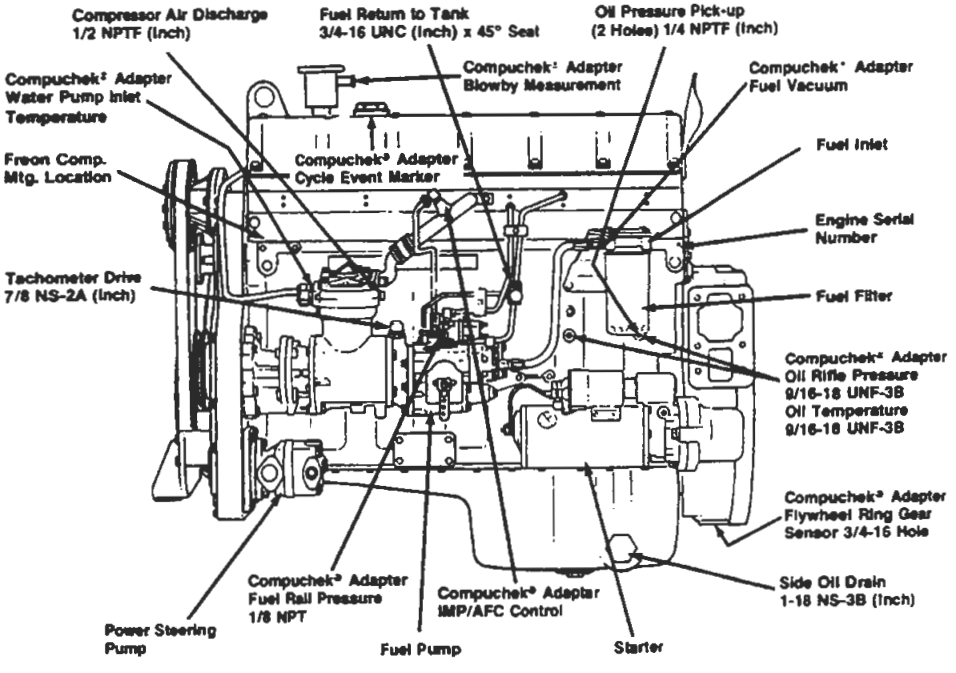
Exhaust Manifold Side

Engine Testing - Engine Side Views



OPTIMIZED AFTERCOOLING

ew200gw



CONVENTIONAL AFTERCOOLING

ew200gx

Fuel Pump Side

Engine Testing - General Information

The engine test is a combination of an engine run-in and a performance check. The engine run-in procedure provides an operating period that allows the engine parts to achieve a final finish and fit. The performance check provides an opportunity to perform final adjustments needed to optimize the engine performance.

An engine test can be performed using **either** an engine dynamometer **or** a chassis dynamometer. If a dynamometer is **not** available, an engine test **must** be performed in a manner that simulates a dynamometer test.

Check the dynamometer before beginning the test. The dynamometer **must** have the capability to test the performance of the engine when the engine is operating at the maximum RPM and horsepower range (full power).

The engine crankcase pressure, often referred to as engine blowby, is an important factor that indicates when the piston rings and the valves are securely positioned to put the engine into a service application. Rapid changes of blowby, or values that exceed specifications more than 50 percent indicate that something is wrong. The engine test **must** be discontinued until the cause has been determined and corrected.

General Specifications

Engine Speed (RPM) at standard rating 2100

Note: Refer to the engine dataplate for optional engine speed rating.

Displacement ..... 10.0 liters [611 C.I.D.]

Bore and Stroke ..... 125 mm [4.921 in.] x 136 mm [5.354 in.]

Firing Order 1-5-3-6-2-4

General Engine Test Specifications

Intake Restriction (Maximum) ..... 635 mm H_2O [25.0 in. H_2O]

Exhaust Back Pressure (Maximum) ..... 75 mm Hg [3.0 in. Hg]

Blowby (at rated engine speed and load) (Maximum) ..... 305 mm H_2O [12.0 in. H_2O]

Oil Pressure

- Low Idle (Minimum Allowable) ..... 69 kPa [10.0 psi]
- At 1300 RPM or Torque Peak (Minimum Allowable) ..... 207 kPa [30.0 psi]

Fuel Filter Restriction (Maximum) ..... 200 mm Hg [8.0 in. Hg]

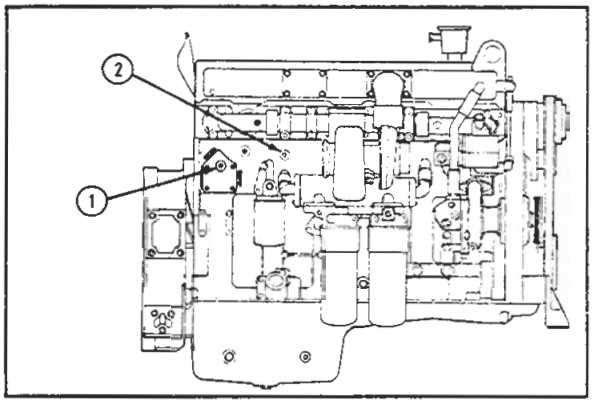
Fuel Return Restriction (Maximum) ..... 64 mm Hg [2.5 in. Hg]

Note: Due to variations in ratings of different engine models, refer to the specific "Engine Data Sheet" for the engine model being tested. Refer to the engine dataplate for the engine model, horsepower and RPM.

Engine Dynamometer Test - Install the Engine (14-01)

Note: Be sure the dynamometer capacity is sufficient to permit testing at 100 percent of the engine rated horsepower. If the capacity is **not** enough, the testing procedure **must** be modified to the restrictions of the dynamometer.

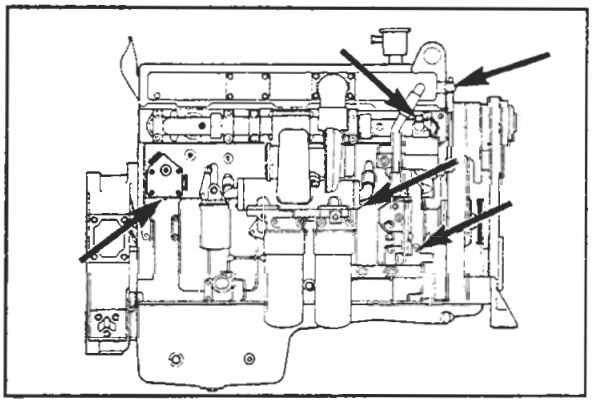
Use the Part No. 3822512 Engine Lifting Fixture to install the engine to the test stand. Align and connect the dynamometer. Refer to the manufacturer's instructions for aligning and testing the engine.



Note: Some engines are equipped with fittings used for Compuchek® testing sensors, refer to Engine Side Views pages 14-3 and 14-4. The sensor probes used for Compuchek® and dynamometer testing are **not** compatable. If the same location is used, remove the Compuchek® fitting and install adapters for the dynamometer sensor.

Install the coolant pressure sensor (1).

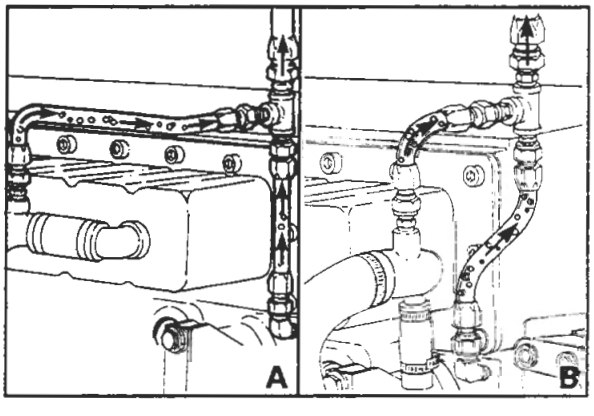
Install the coolant temperature sensor (2).



Connect the coolant supply to the water inlet connection.

Connect the coolant return to the water outlet connection.

Install the drain plugs and close all of the water drain cocks.

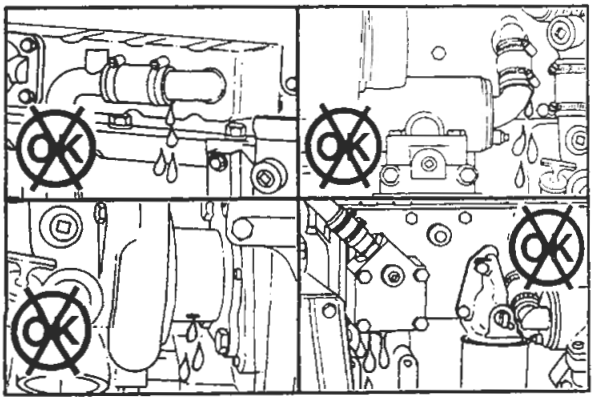


Open the cooling system vent.

Note: Make sure that the vent lines are connected to the aftercooler outlet and cylinder head.

Fill the system with coolant until it flows from the vent. Close the vent and finish filling the system.

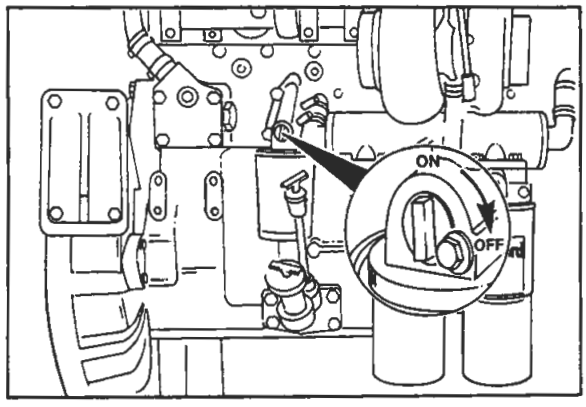
- Conventional Aftercooling (A)
- Optomized Aftercooling (B)



Visually inspect the engine for coolant leaks.

Repair all leaks found.

Turn the water shutoff valve to the "OFF" position during engine run-in.

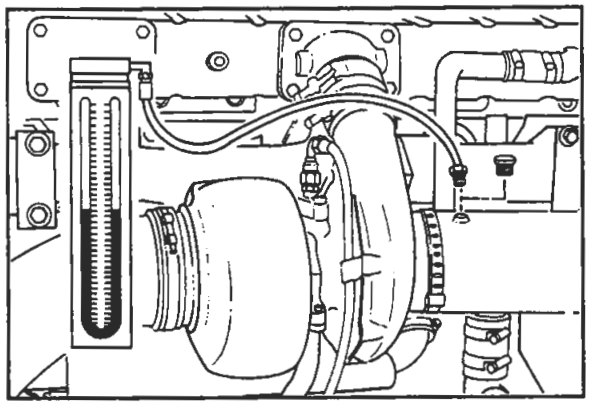


Install a water manometer to the air inlet pipe of the turbocharger.

Note: The manometer adapter **must** be installed at a 90 degree angle to the air flow in a straight section of pipe, one pipe diameter before the turbocharger.

Note: A vacuum gauge **can** be used to record the intake air restriction.

Minimum Gauge Capacity: 760 mm H_20 [30 inches H_20].

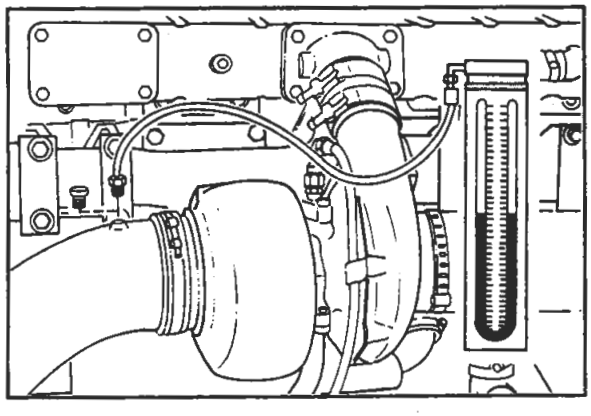


Install a mercury manometer to a straight section of the exhaust piping near the turbocharger outlet.

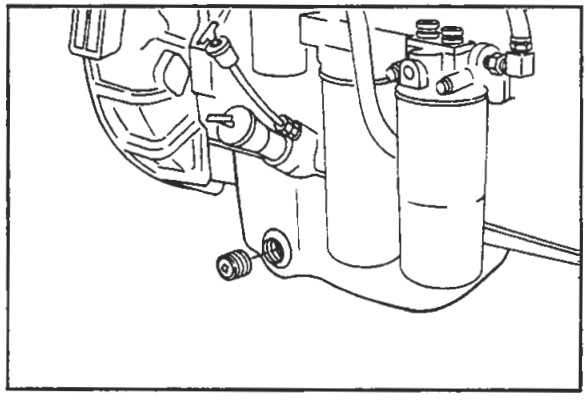
Note: The manometer **must** be scaled to record exhaust back pressure in excess of 75 mm [3.0 inches] of mercury.

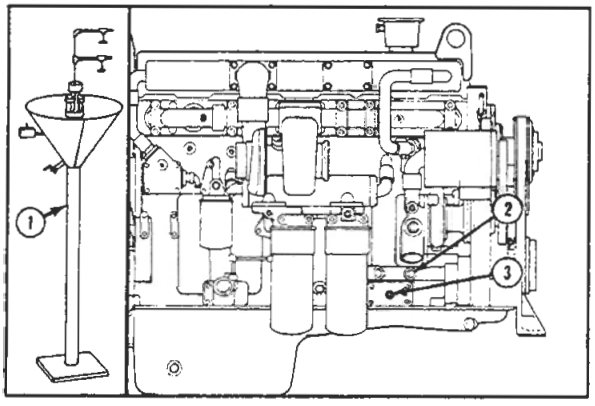
Note: A pressure gauge **can** be used to record the exhaust back pressure.

Minimum Gauge Capacity: 254 mm Hg [10 inches Hg].



Remove the pipe plug on either side of the oil pan and install the lubricating oil temperature sensor.





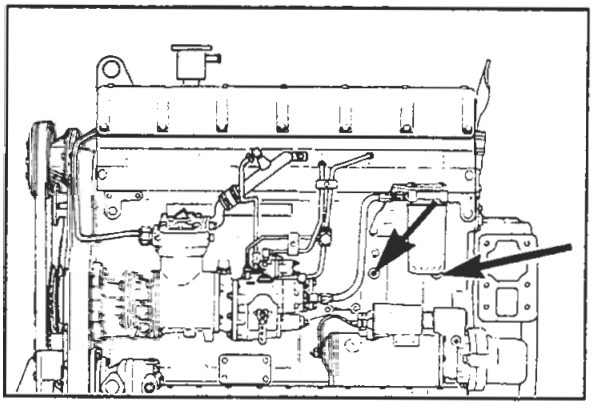
Install the Part No. ST-1135 Lubricating Oil Sampling Filter (1) to monitor oil contamination.

Connect the filter inlet hose to the pipe plug hole (2) in the cylinder block.

Remove the standard hand hole cover plate and install the Part No. 3034818 Hand Hole Cover Plate.

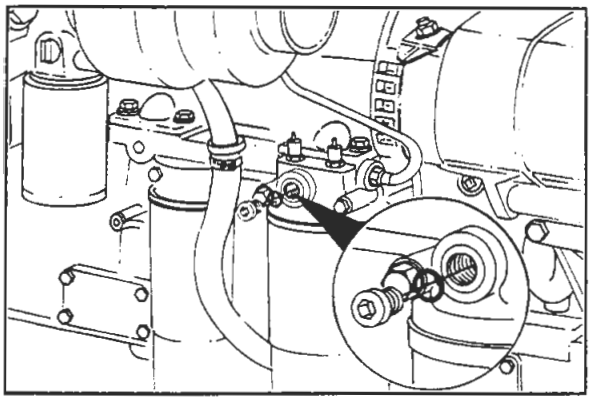
Connect the filter outlet hose to the hand hole cover plate (3).

Refer to the tool manufacturer's instructions to perform the test.



Remove the pipe plug from the main oil rifle drilling in the cylinder block.

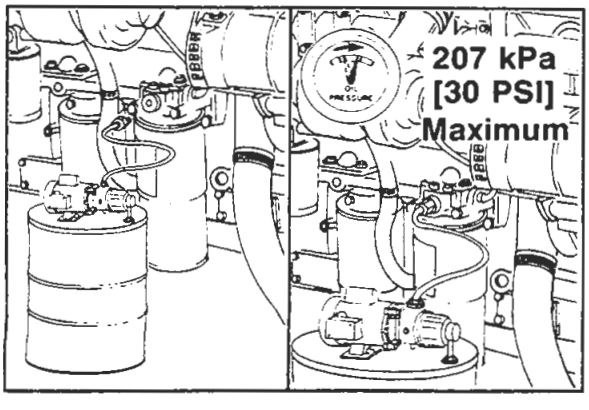
Install the lubricating oil pressure sensor.



Caution: The lubricating oil system must be primed before operating the engine after rebuild to avoid internal component damage. If an external pressure pump is used, do not prime the system from the bypass filter, the filter will be damaged.

Remove the plug from the lubricating oil filter head above the full flow oil filter.

Note: Due to design changes some filter heads are different in appearance; however, a similar location is to be used for priming the lubricating oil system.



Install an oil supply line connected to a source of clean 15W-40 lubricating oil in the oil filter head.

Prime the lubricating system until the oil pressure gauge indicates a positive pressure.

Note: The oil pressure **must not** exceed the maximum of 270 kPa [30 psi].

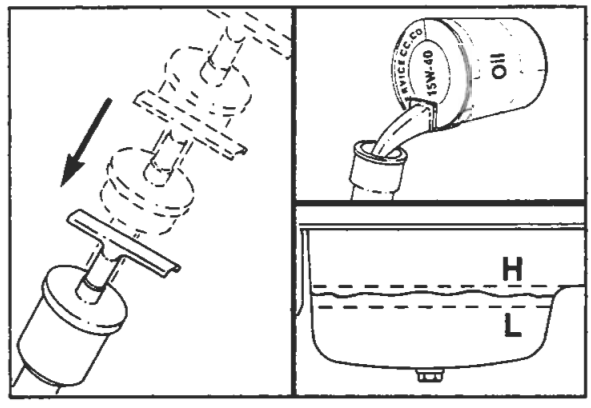
Remove the oil supply and install the plug.

Torque Value: 55 N•m [40 ft-lb]

Wait ten minutes to be sure the lubricating oil has drained into the oil pan. Use the dipstick to measure the oil level.

Note: If a new dipstick is used, it **must be** calibrated. Refer to Lubricating Oil Dipstick - Calibrate (07-04).

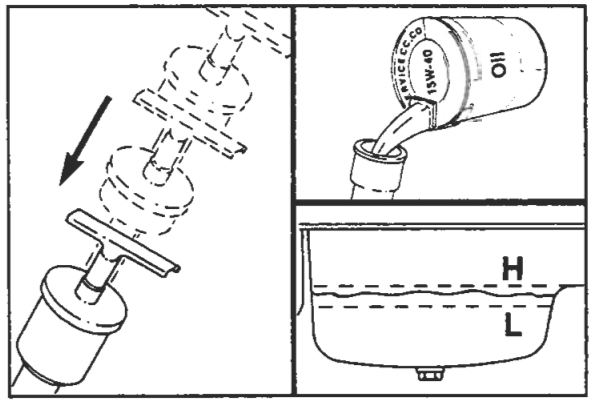
Fill the oil pan to the specified "high" level.



Note: If an external pressure pump is not available, prime the lubricating system as follows:

Use the dipstick to measure the lubricating oil level.

Fill the oil pan to the "high" level mark on the dipstick.

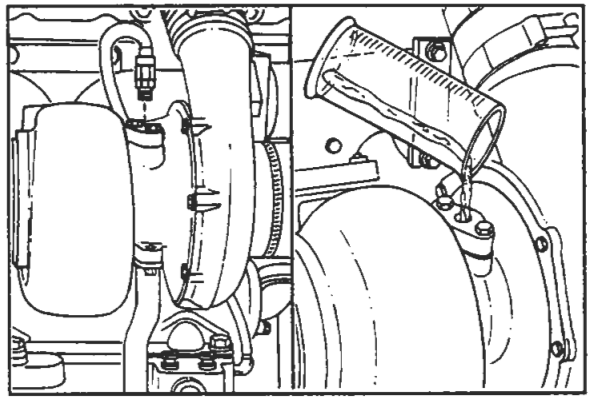


Disconnect the turbocharger lubricating oil supply line.

Pour 50 to 60 cc [2.0 to 3.0 fl oz] of clean 15W-40 oil in the turbocharger oil supply line fitting.

Install the turbocharger oil supply line.

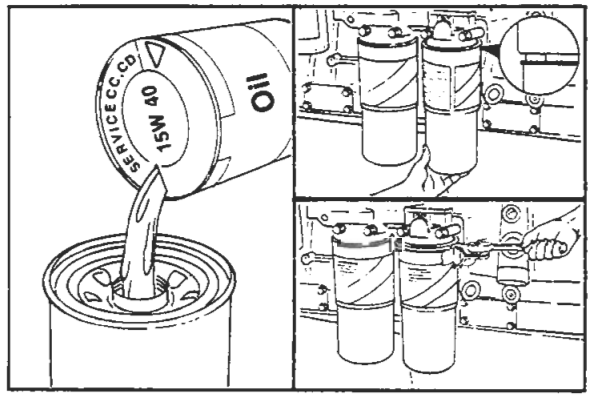
Torque Value: 20 N•m [15 ft-lb]

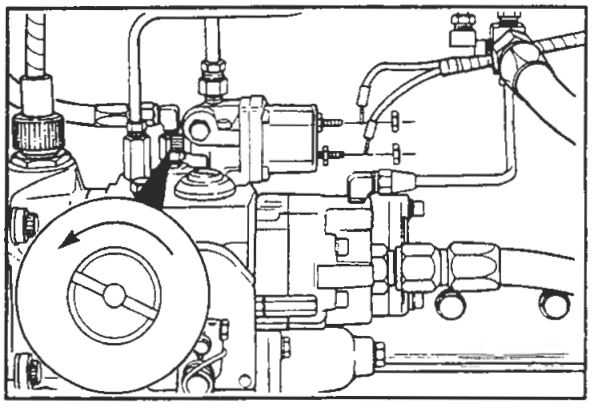


Use clean 15W-40 oil to fill the lubricating oil filters.

Tighten the filters until the gasket contacts the filter head surface.

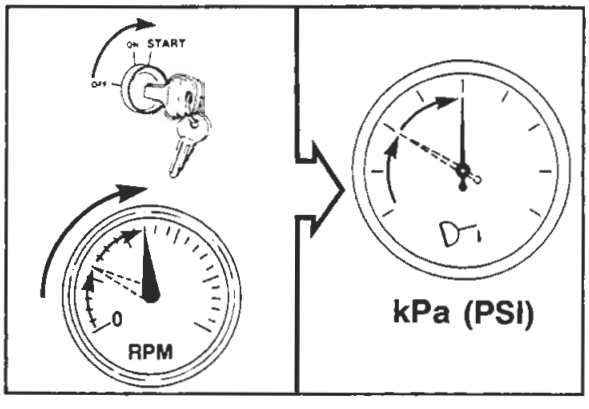
Tighten the filters an additional three-fourths to one (3/4 to 1) turn.





Disconnect the two electrical wires that supply power to the fuel pump solenoid.

Note: The manual override screw **must be** turned **counterclockwise** until it stops.

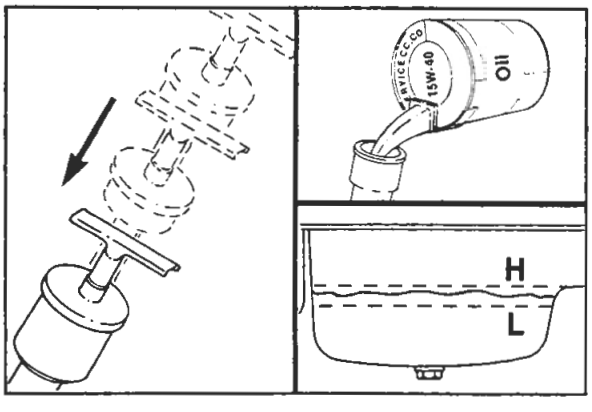


Caution: Do not crank the starting motor for more than 30 seconds. Excessive heat will damage the starting motor.

Crank the engine until the oil pressure gauge indicates a positive pressure.

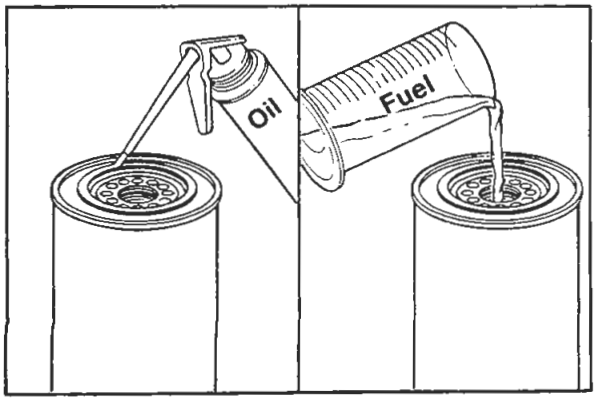
Note: If a positive pressure is **not** indicated within 30 seconds stop cranking the engine and allow two minutes for the starting motor to cool before cranking the engine again.

Note: If a positive oil pressure is still **not** indicated, find and correct the problem before continuing.



Wait ten minutes to be sure the lubricating oil has drained into the oil pan. Use the dipstick to measure the oil level.

Fill the oil pan to the specified "high" level.

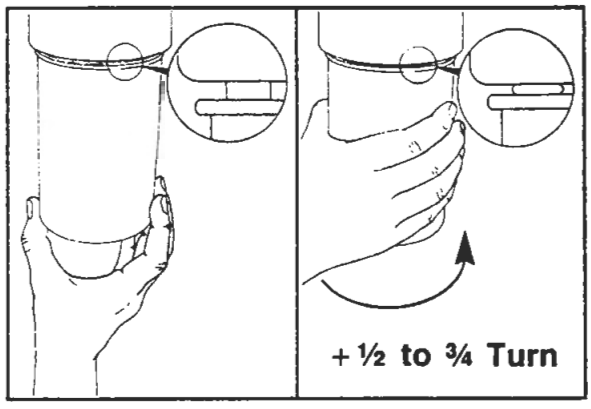


Use clean 15W-40 oil to lubricate the fuel filter gasket.

Fill the filter with clean fuel.

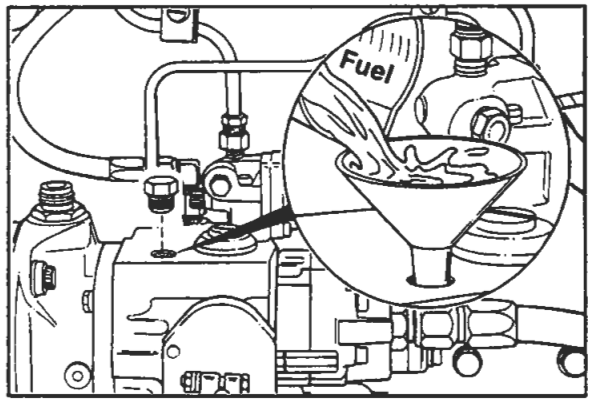
Install the filter on the filter head and tighten the filter until the gasket contacts the filter head surface.

Tighten the filter an additional one-half to three-fourths (1/2 to 3/4) turn.



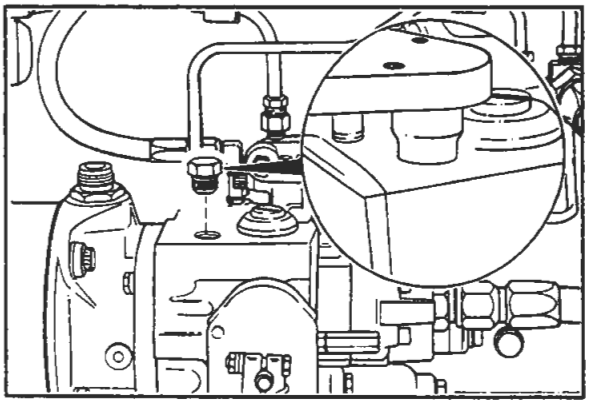
Remove the plug from the top of the fuel pump housing.

Fill the housing with clean fuel.



Install the plug in the fuel pump housing.

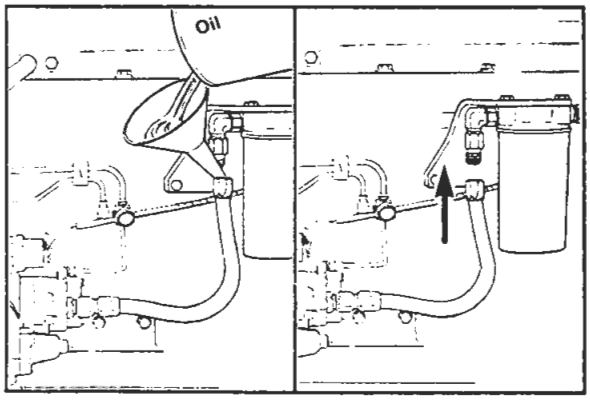
Torque Value: 30 N•m [20 ft-lb]

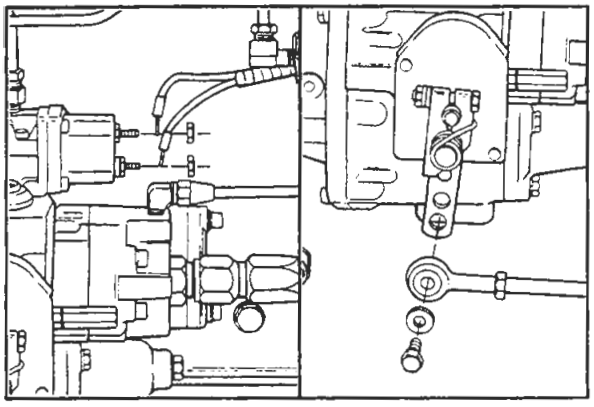


Note: If the priming plug is difficult to remove or the fuel pump is a VS type, use clean 15W-40 oil to fill the gear pump.

Remove the fuel supply hose at the fuel filter or the flow meter and fill the hose with clean 15W-40 oil.

Install the fuel supply hose to the filter head or flow meter.



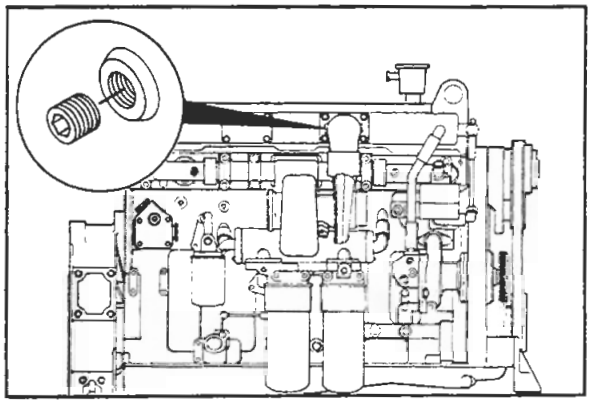


Note: Inspect the voltage rating on the fuel pump solenoid before installing the electrical wiring.

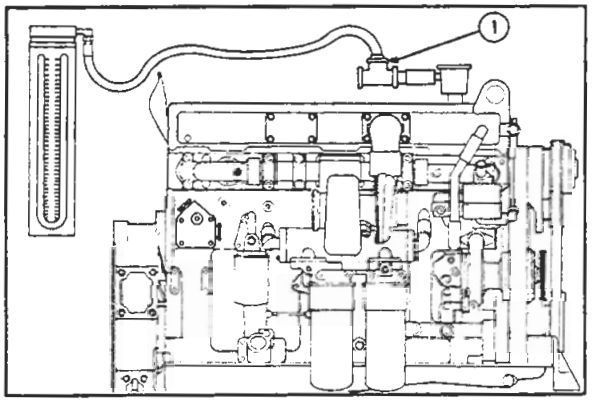
Install the two electrical wires that supply power to the solenoid.

Note: The manual override screw on the solenoid **must be** turned counterclockwise until it stops to allow the solenoid to "open" and "close".

Install the throttle control device to the throttle arm on the fuel pump.



Remove the pipe plug in the aftercooler inlet air connection and install the intake manifold pressure sensor.

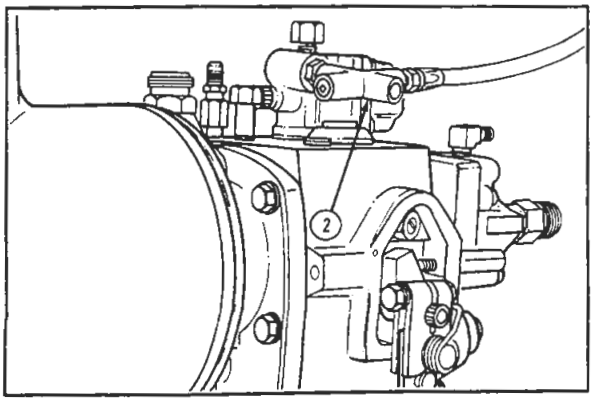


Install the Part No. 3375788 Engine Blowby Tool (1), to the breather on the rocker lever cover.

Install a water manometer to the engine blowby tool.

Note: A pressure gauge **can** be used to record the engine blowby.

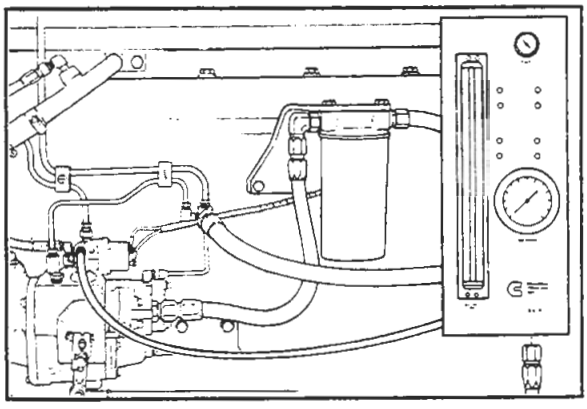
Minimum Gauge Capacity: 1270 mm H_20 [50 inches H_20].



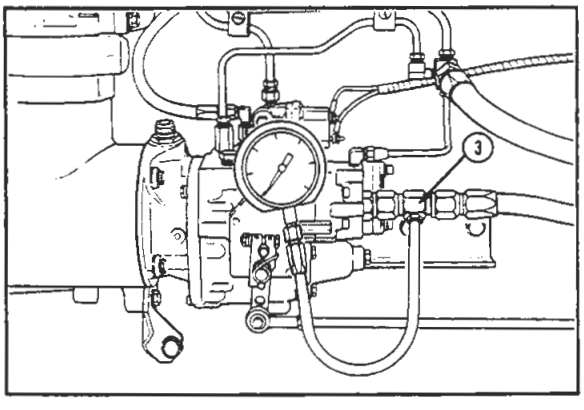
Install the fuel rail pressure sensor (2) to the fuel pump shutoff valve.

The Part No. 3376375 Fuel Measuring Instrument is used during the performance check to measure fuel consumption.

Note: Follow the tool manufacturer's instructions for installing and using the instrument.



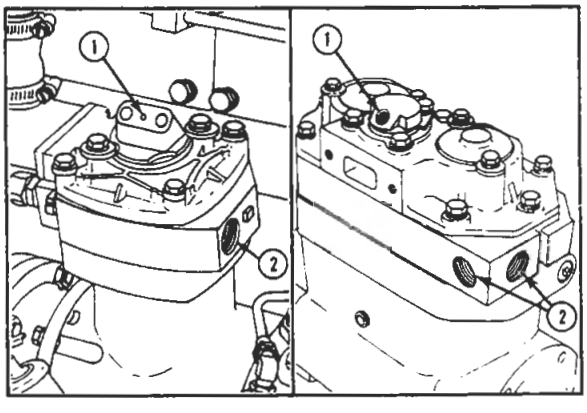
Install the Part No. ST-434 Vacuum Gauge in the gear pump inlet line (3).



Note: All air compressors manufactured by Cummins Engine Company, Inc. **must be** operating during the engine run-in. During the performance check, **all** air compressors **must be** in the unloaded or non-operating mode.

Connect a source of compressed air capable of producing 665 kPa [95 psi] to the air compressor unloader (1). This airline **must** contain a valve between the source and the unloader.

Note: The compressed air load in the accompanying illustration **must** be attached to the air compressor outlet (2).

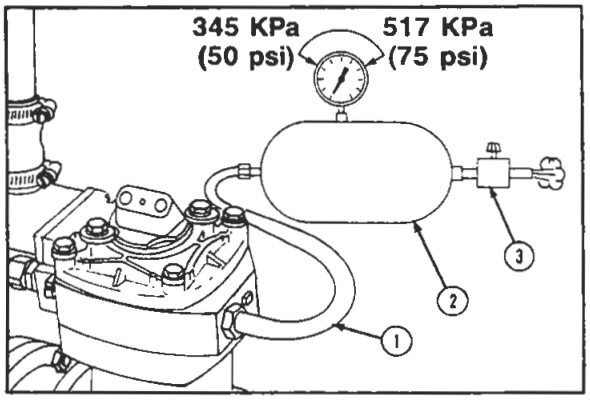


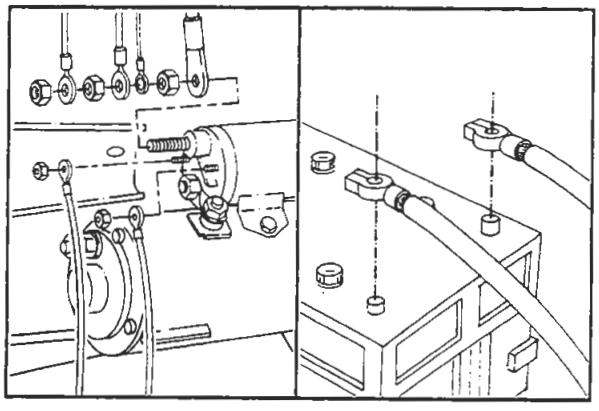
Use an air tank (2). Install an air regulator (3) capable of maintaining 345 to 520 kPa [50 to 75 psi] air pressure at both **minimum** and **maximum** engine RPM.

Install a steel tube or high temperature hose (1).

Hose Temperature (Minimum): 235°C [500°F]

Connect the tube or hose (1) to the air compressor outlet.

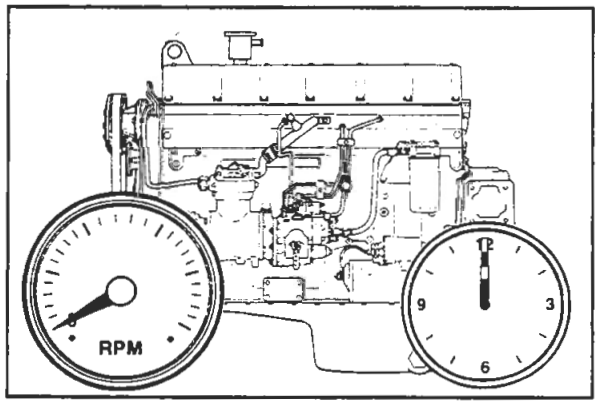




Note: Inspect the voltage rating on the starting motor before installing the electrical wiring.

Install the electrical wiring to the starting motor and batteries, if used.

Note: If another method of starting the engine is used, follow the manufacturer's instructions to make the necessary connections.



Engine Dynamometer Test - Engine Run-In (14-02)

This procedure detects assembly errors and identifies final adjustments that are needed for correct engine performance.

Note: The time specified for engine run-in provides an operating period that allows the engine components to achieve a final finish and fit. However, additional time can be used at each run-in phase, if so desired.

These measurements **must** be recorded during the engine run-in.

- **Engine Speed (RPM)**
- **Torque**
- **Oil Pressure**
- **Coolant Outlet Temperature**
- **Lubricating Oil Temperature**
- **Blow-By (Engine Crankcase) Pressure**

These additional measurements **must** be recorded to evaluate the performance of the engine.

Fuel Pump Outlet Pressure (Rail Pressure)

Intake Manifold Pressure

These measurements are optional if the performance of the engine is within specifications.

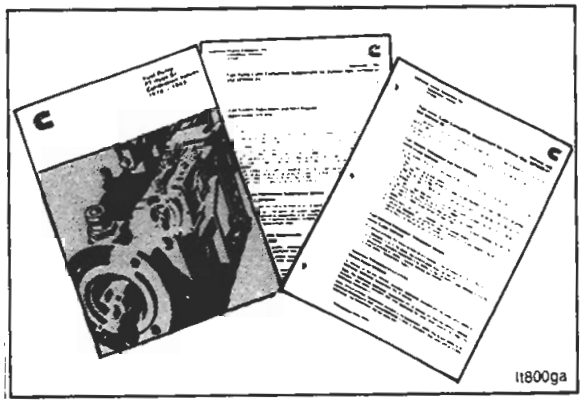
Note: If the performance of the engine is **not** within specifications, the measurements **must** be checked to determine the cause of the problem.

- **Fuel Inlet Restriction**
- **Fuel Temperature**
- **Exhaust Back-Pressure**
- **Inlet Air Restriction**
- **Fuel Drain Line Pressure**
- **Lubricating Oil System Mini-Patch Test**
- **Coolant Pressure**
- **Fuel Flow**

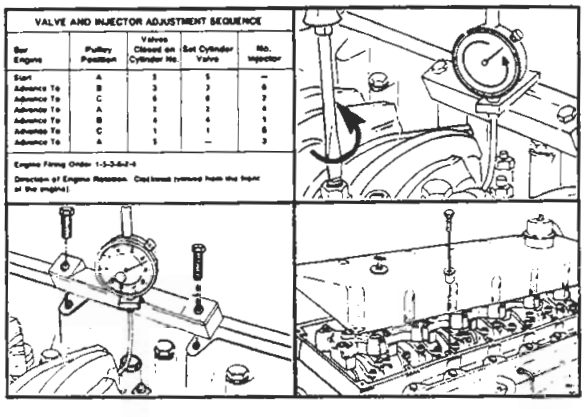
The engine operating specifications can be found in the following publications:

- Fuel Pump PT (type G) Calibration Values, Bulletin No. 3379352
- Engine Data Sheets and Performance Curves
  - Construction, Mining, Logging and Agriculture (CLMA), Bulletin No. 3381194
  - Generator Drive and Genset, Bulletin No. 3381174
  - Automotive, Bulletin No. 3381237

These publications are available form your local Cummins Authorized Repair Location.

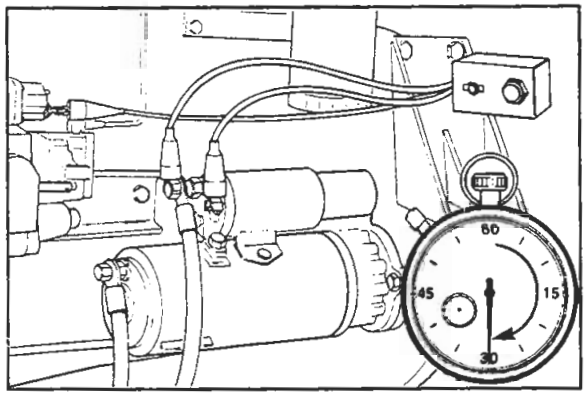


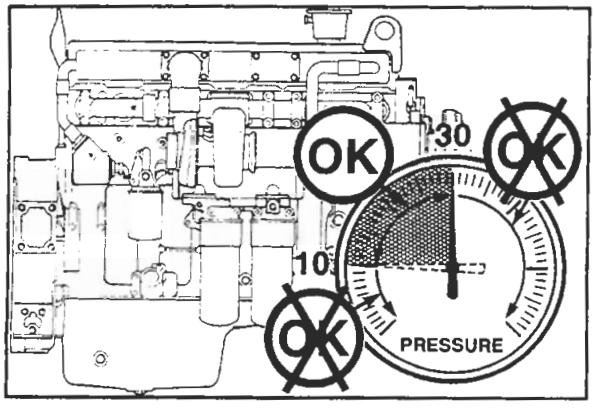
Note: Make sure the injector, valve and crosshead adjustments are correct before starting the engine. Refer to Engine Assembly (00-02).



Caution: Do not crank the engine for more than 30 seconds. Excessive heat will damage the starting motor.

"Start" the engine. If the engine does **not** begin operating after 30 seconds, allow two minutes for the starting motor to cool before cranking the engine again.

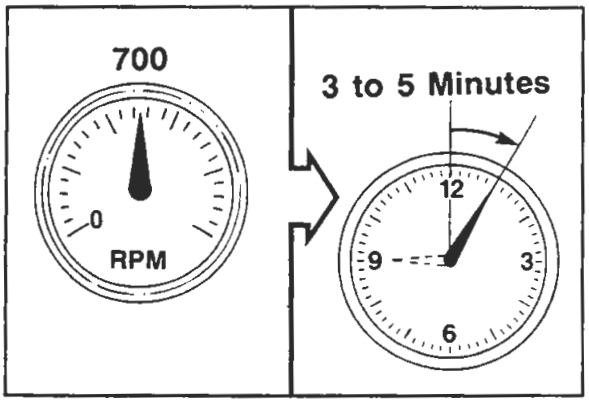




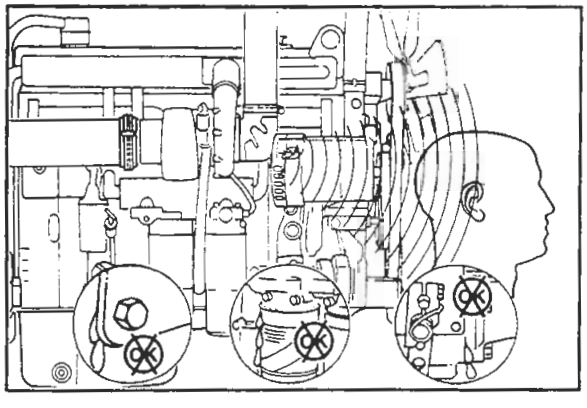
Caution: If the lubricating oil pressure is not within specifications, shut off the engine immediately. Both "low" and "high" oil pressure will cause engine damage.

Lubricating Oil Pressure at Approximately 700 RPM		
kPa		psi
69	MIN	10
207	MAX	30

Note: If the oil pressure is **not** within the specifications, the problem **must be** corrected.

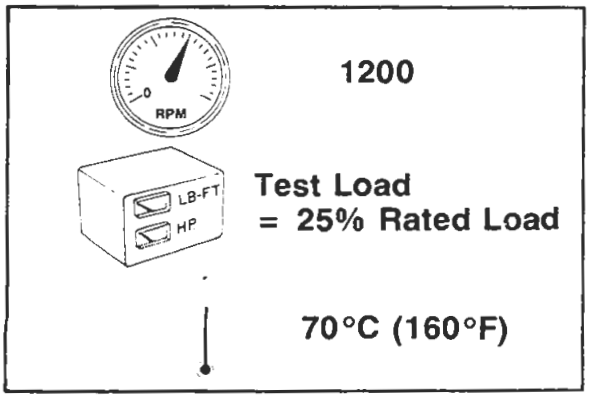


Caution: Operate the engine at approximately 700 RPM for 3 to 5 minutes. Do not operate the engine at "IDLE" speed longer than specified during engine run-in. Excessive carbon formation will cause damage to the engine.



Operate the engine at idle speed (approximately 700 RPM) for 3 to 5 minutes to check for proper operation, unusual noises, and coolant, fuel or lubricating oil leaks.

Note: Leaks or component problems **must** be corrected before the engine run-in is continued.



Adjust the engine speed to 1200 rpm. Adjust the engine test load to 25 percent of the rated load.

Operate the engine at this setting until the coolant temperature indicates 70°C [160°F].

Check all gauges and record the data.

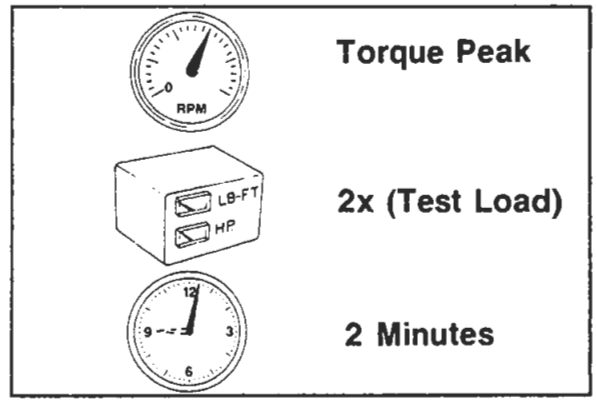
Note: Do not proceed to the next step until a steady blowby reading is obtained. Record the blowby readings at one minute intervals during the engine run-in.

Adjust the engine speed to the torque peak RPM. Adjust the dynamometer load to equal two times the test load (50 percent of rated load).

Operate the engine for two minutes.

Check all gauges and record the data.

Note: Do not proceed to the next step until the blowby becomes stable within specifications. Refer to the engine Test Specifications.

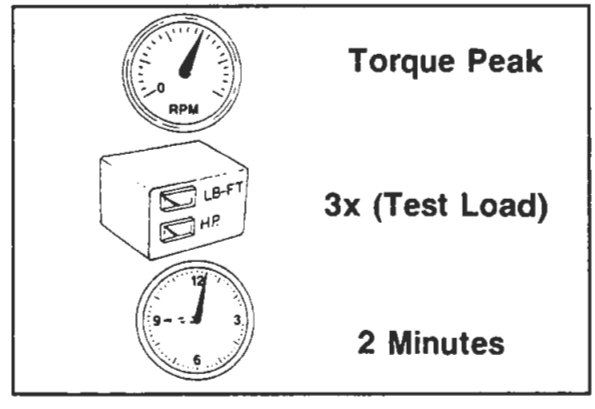


Maintain the engine speed at torque peak RPM. Increase the dynamometer load to equal three times the test load (75 percent of rated load).

Operate the engine for two minutes.

Check all gauges and record the data.

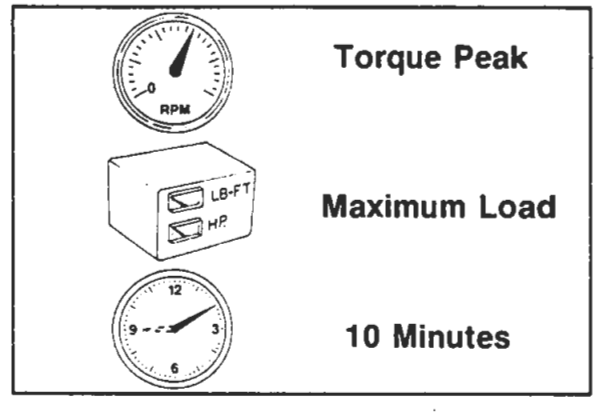
Note: Do not proceed to the next step until the blowby becomes stable within specifications. Refer to the engine Test Specifications.



Move the throttle lever to the "Full Open" position. Increase the dynamometer load until the engine speed is at torque peak RPM.

Operate the engine at this setting for **10 minutes** or until the blowby becomes stable within specifications. Refer to the engine Test Specifications.

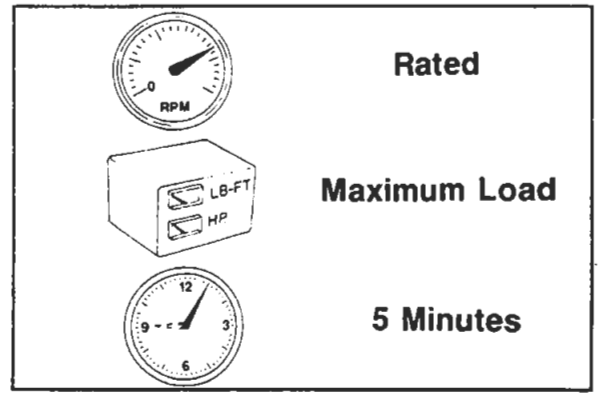
Check all gauges and record the data.

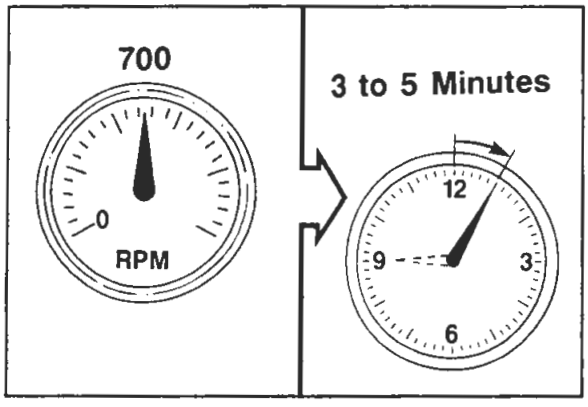


Reduce the dynamometer load until the engine speed increases to the rated RPM.

Operate the engine for five minutes.

Check all gauges and record the data.



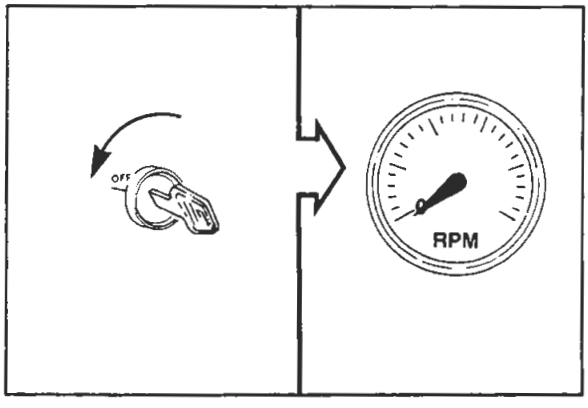


Reduce the dynamometer load completely.

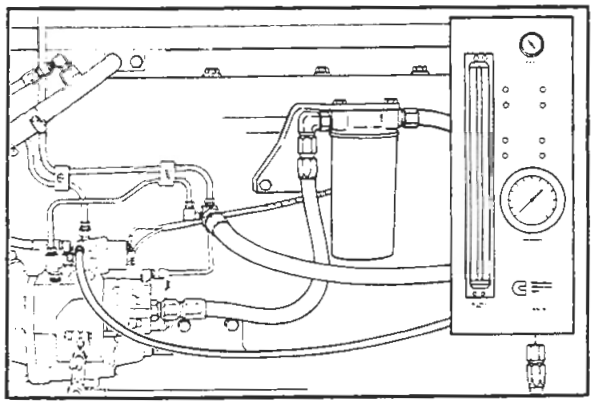
Caution: Do not shut off the engine immediately. The engine must be allowed to cool to prevent damage to the turbocharger and internal components.

Operate the engine at "Idle Speed" for three to five minutes. This will allow the turbocharger and other components to cool.

Note: Do not operate the engine at "Idle Speed" longer than specified.



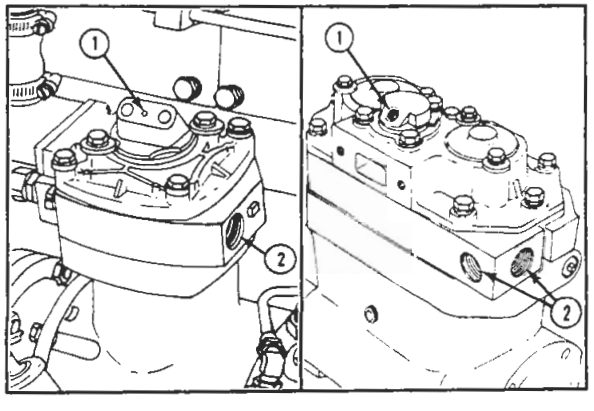
Shut off the engine.



Engine Dynamometer Test - Performance Check (14-03)

Connect the Part No. 3376375 Fuel Measuring Instrument to measure the fuel consumption during the performance check.

Note: Follow the tool manufacturers instructions for installing and using the instrument.



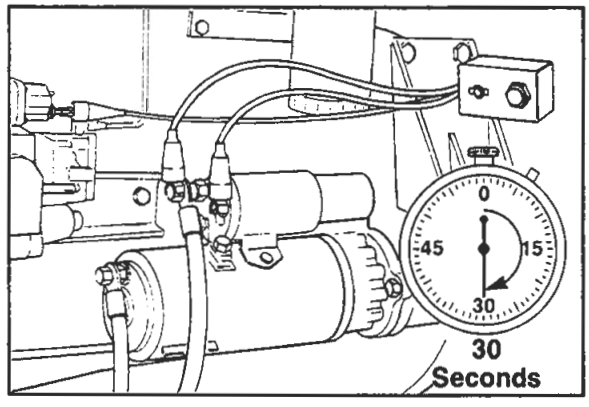
Note: All air compressors **must** be unloaded during the performance check.

Apply regulated air pressure to the air compressor unloader valve (1).

Air Pressure: 665 kPa [95 psi]

Caution: Do not crank the engine for more than 30 seconds. Excessive heat will damage the starting motor.

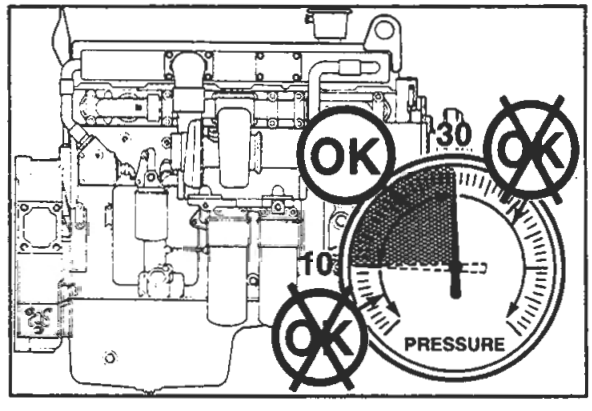
Start the engine. If the engine does **not** begin operating after 30 seconds, allow two minutes for the starting motor to cool before cranking the engine again.



Caution: If the lubricating oil pressure is not within specifications, shut off the engine immediately. Both "low" and "high" oil pressure will cause engine damage.

Lubricating Oil Pressure at Approximately 700 RPM		
kPa		psi
69	MIN	10
207	MAX	30

Note: If the oil pressure is **not** within specifications, the problem **must** be corrected.



Note: Make sure the engine is at operating temperature.

Move the throttle lever to the "Full Open" position.

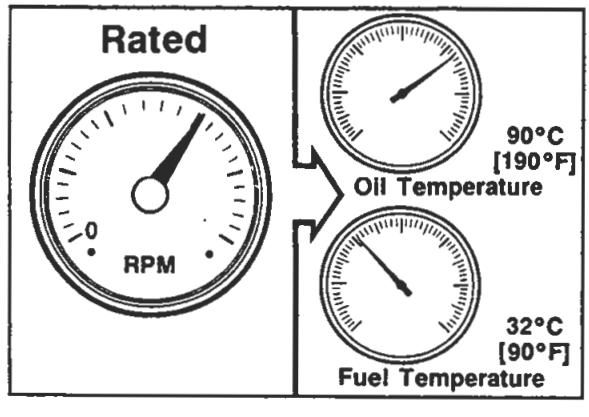
Adjust the dynamometer load until the engine maintains the rated RPM.

Note: The horsepower reading **will not** be accurate if the lubricating oil or fuel temperature is **not** within specifications.

Lubricating Oil Temperature: MIN 90°C [190°F]

Fuel Temperature: MAX 32°C [90°F]

Check all gauges and record the data.

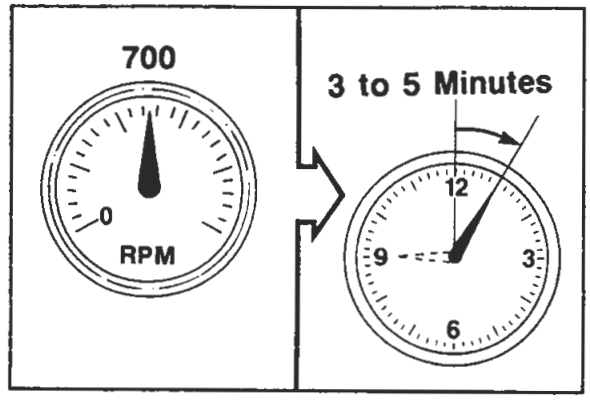


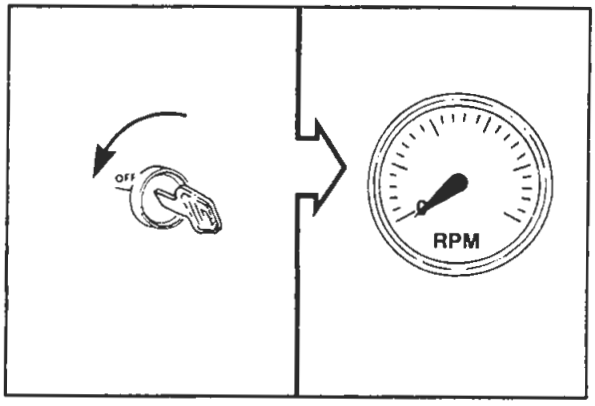
Reduce the dynamometer load completely.

Caution: Do not shut off the engine immediately. The engine must be allowed to cool to prevent damage to the turbocharger and internal components.

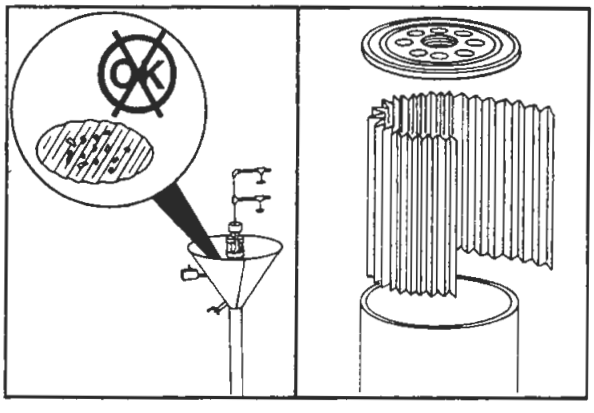
Operate the engine at "Idle Speed" for three to five minutes. This will allow the turbocharger and other components to cool.

Note: Do not operate the engine at "Idle Speed" longer than specified.





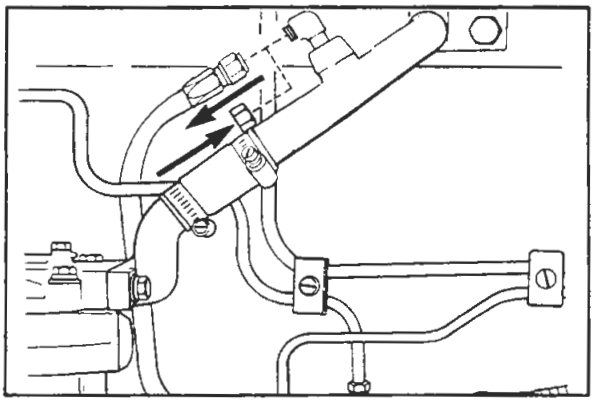
Shut off the engine.



Remove lubricating oil the mini-patch filter.

Visually inspect the filter patch for evidence of metal particles.

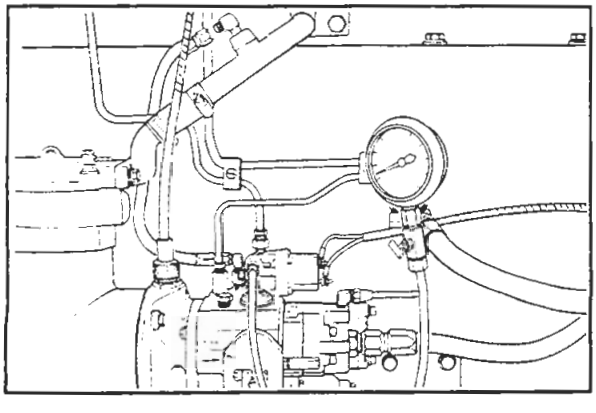
Note: If the filter patch shows evidence of metal particles, remove the full-flow lubricating oil filter and cut it open. Visually inspect the filter element for foreign material. Determine the origin of the foreign material and correct the problem.



Fuel Pump - Adjust the No-Air Setting

Remove the AFC air supply line from the air intake manifold or the air compressor air tube.

Install a plug or a cap in the air manifold hole.



Start the engine. Operate the engine at "High Idle" speed until the coolant temperature indicates 70°C [160°F].

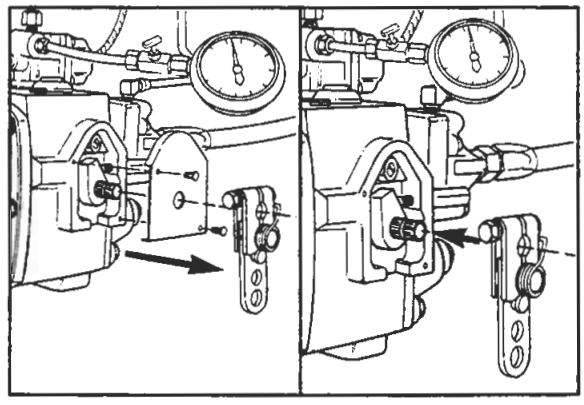
Note: Make sure the engine is at operating temperature.

Move the throttle lever to the "Full Open" position.

Increase the dynamometer load until the engine speed is at the AFC No-Air Setting RPM. Check the AFC no-air fuel (rail) pressure. Refer to the Fuel Pump Calibration Values, Bulletin No. 3379352 for the AFC No-Air Setting RPM and No-Air psi values.

If the no-air pressure **is not** within the specifications, shut off the engine and remove the throttle lever and the throttle lever cover plate from the fuel pump.

Install the throttle lever.



Note: It is illegal to adjust the fuel pump no-air pressure to a value greater than specified in the Fuel Pump Calibration Manual, Bulletin No. 3379352.

1 Pump Code	X002-C
2 Date - Control Parts List	OCT82 0465
3 Test H P @ R P M	285 - 295 @ 2200
4 Engine Fuel P S I	160 - 178
37 A F C P S I - Flow	71 - 262
38 A F C Spring	179826
39 A F C No Air Setting R P M	1600
40 A F C No Air P S I - Flow	58 - 230
41 Certified - Year - By	9999 CONS
42 Certified By	
43 Engine Model	10 LITRE
44 Notes	SEE NOTE (5)

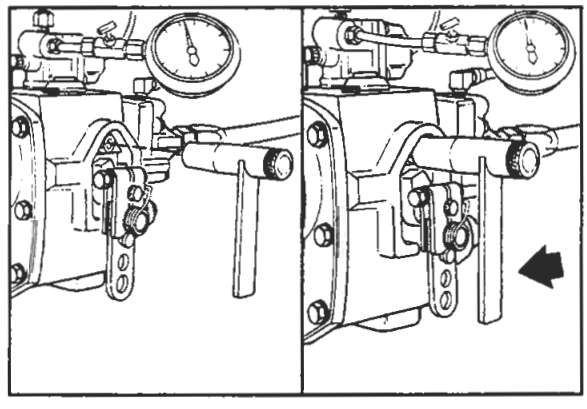
Operate the engine at the AFC no-air setting RPM.

Use the Part No. 3377247 AFC No-Air Adjusting Tool to adjust the AFC no-air valve to the specified pressure.

Note: Turn the knurled knob clockwise to lower the pressure.

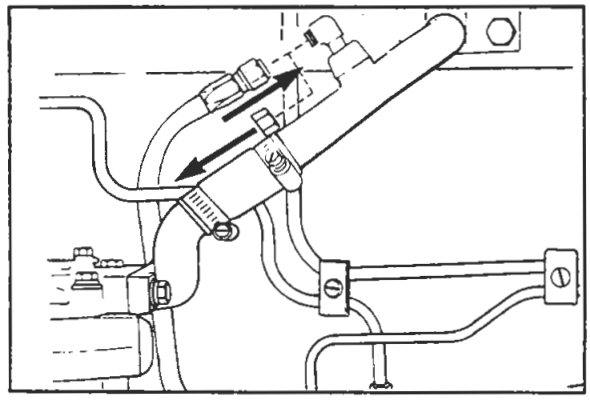
Tighten the locknut on the AFC no-air valve.

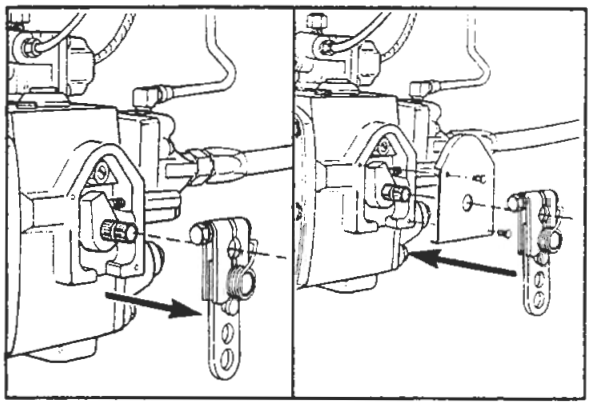
Torque Value: 5 N•m [45 in-lb]



Remove the dynamometer load from the engine and move the throttle lever to "Low Idle" speed.

Remove the plug or cap from the air manifold and connect the AFC air supply line.

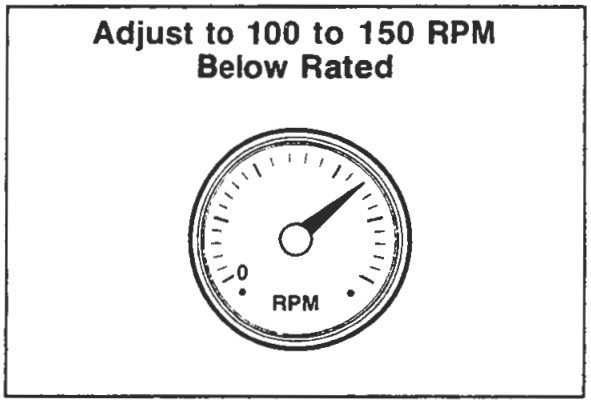




Remove the throttle lever.

Install the throttle shaft cover plate.

Install the throttle lever.

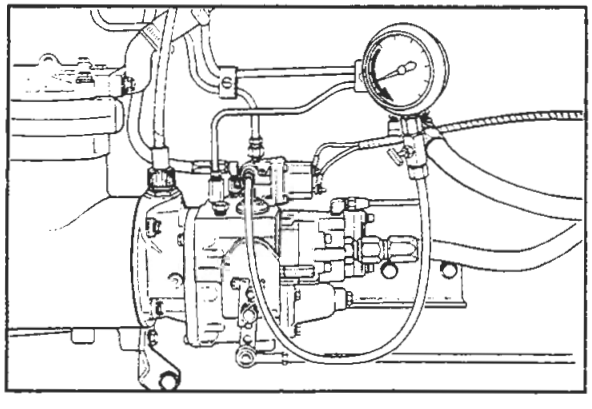


Governor Break - Check

Move the throttle lever to the "Full Open" position.

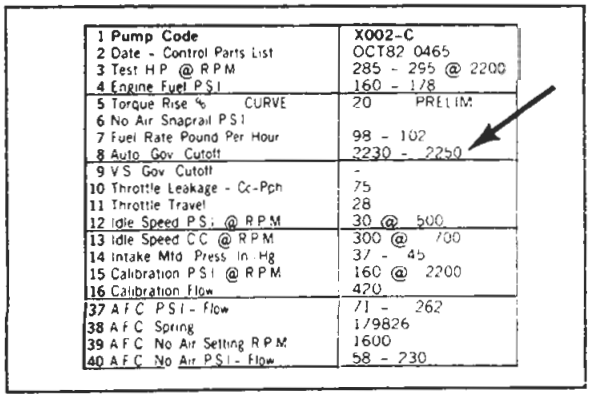
Adjust the dynamometer load until the engine speed is at 100 to 150 rpm below the engine rated speed.

Operate the engine at this setting until the engine stablizes.



Reduce the dynamometer load.

Note: Watch the fuel pressure gauge. The fuel pressure will **increase** with the engine speed until the governor breaks. After the governor breaks the fuel pressure will **decrease**.



1 Pump Code	X002-C
2 Date - Control Parts List	OCT82 0465
3 Test H P @ R P M	285 - 295 @ 2200
4 Engine Fuel P S I	160 - 178
5 Torque Rise % CURVE	20 PRELIM
6 No Air Snaprail P S I	
7 Fuel Rate Pound Per Hour	98 - 102
8 Auto Gov Cutoff	2230 - 2250
9 V S Gov Cutoff	-
10 Throttle Leakage - Cc-Pch	75
11 Throttle Travel	28
12 Idle Speed P S I @ R P M	30 @ 500
13 Idle Speed C C @ R P M	300 @ 700
14 Intake Mfd Press In Hg	37 - 45
15 Calibration P S I @ R P M	160 @ 2200
16 Calibration Flow	420
37 A F C P S I - Flow	71 - 262
38 A F C Spring	179826
39 A F C No Air Setting R P M	1600
40 A F C No Air P S I - Flow	58 - 230

Record the engine RPM (governor break RPM) when the fuel pressure decreases 6.90 to 10.35 kPa [1 to 1 1/2 psi].

Remove the dynamometer load from the engine and move the throttle lever to "Low Idle" speed.

Refer to the Fuel Pump Calibration Manual, Bulletin No. 3379352 for the governor break (cutoff) engine RPM specifications.

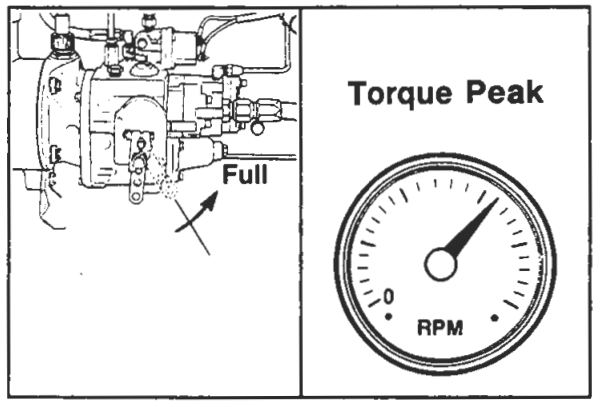
Note: If the governor break RPM is **not** within the specifications given, the fuel pump **must** be adjusted. Refer to the PT (Type G) Fuel Pump Repair Manual, Bulletin No. 3379084.

Torque Peak Check

Move the throttle lever to the "Full Open" position.

Adjust the dynamometer load until the engine reaches torque peak.

Check the engine RPM, the fuel pressure and the fuel flow. Record the data.



Remove the dynamometer load from the engine and move the throttle lever to "Low Idle" speed.

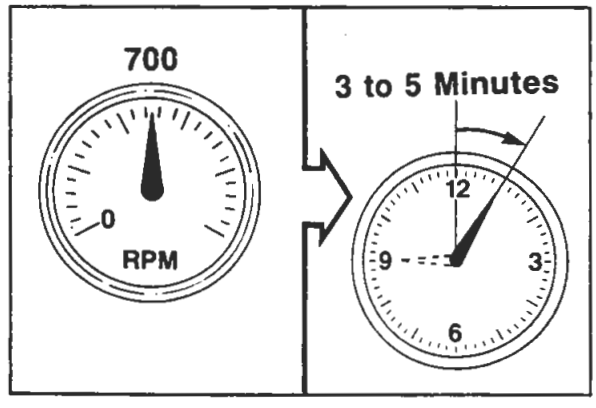
Refer to the Fuel Pump Calibration Manual, Bulletin No. 3379352 for the fuel pressure, engine RPM, and calibration flow specifications. The fuel pump **must** be calibrated if it is **not** within the specifications given.

1	Pump Code	X002-C	X627-B
2	Date - Control Parts List	APR86 0774	APR86 0776
3	Test H.P. @ R.P.M.	265-275 @ 2100	225-231 @ 2100
4	Engine Fuel P.S.I.	145 - 163	128-142
5	Torque Rise % Curve	27 NONE	30 NONE
6	No Air Snapratl P.S.I.		
7	Fuel Rate Pound Per Hour	89 - 93	76 - 80
8	Auto. Gov. Setting	2130 - 2150	2194 - 2214
9	V.S. Gov. Setting	2200 - 2250	2130 - 2150
10	Max. Gov. Check R.P.M.-Psi	2457 15	2457 15
11	Throttle Leakage - Cc-Ppn	110	110
12	Throttle Travel	28	28
13	Idle Speed P.S.I. @ R.P.M.	@	@
14	Idle Speed C.C. @ R.P.M.	300 @ 700	300 @ 910
15	Intake Mfd. Press. In./Hg	35 - 43	32 - 40
16	Calibration P.S.I. @ R.P.M.	155 @ 2100	103 @ 1300
17	Calibration Flow	375	272
18	Check Point (1) P.S.I. @ R.P.M.	120 - 126 @ 1400	131 - 137 @ 2100
19	Check Point Flow	328	316
20	Check Point (2) P.S.I. @ R.P.M.	70 - 82 @ 1000	64 - 76 @ 1000
21	Check Point Flow	248	218
22	Weight Assist Setting - Spring	.750 143855	.750 143855
23	Idle Plunger Code - Part No	25 141631	27 141632
24	Auto. Idle Spring	3018767	3018767

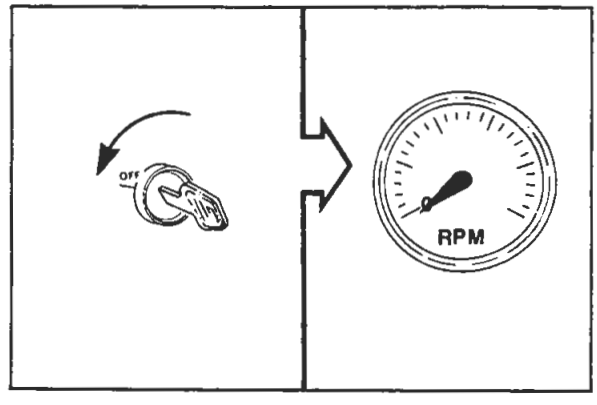
Caution: Do not shut off the engine immediately. The engine must be allowed to cool to prevent damage to the turbocharger and internal components.

Operate the engine at "Idle Speed" for three to five minutes. This will allow the turbocharger and other components to cool.

Note: Do **not** operate the engine at "Idle Speed" longer than specified.



Shut off the engine.

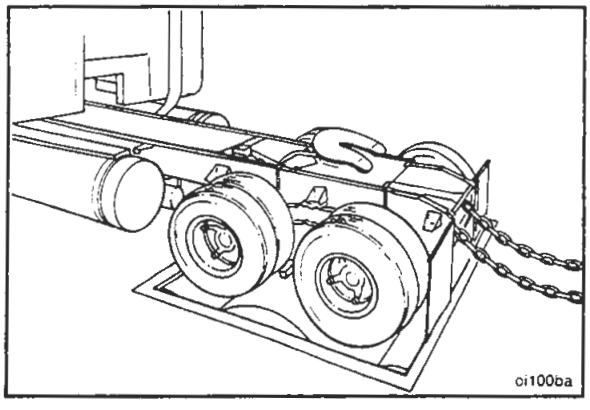


Remove all test instrumentations.

Remove the engine from the dynamometer.

Note: If the engine is to be stored temporarily and does **not** have permanent type anti-freeze, it is necessary to drain all coolant. Refer to Engine Side Views, Pages 14-3 and 14-4 for drain locations.

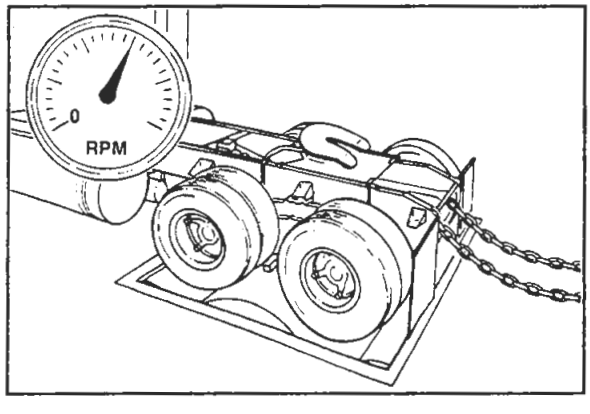
Prepare the engine for Engine Painting (14-06) or Engine Storage (14-07) or (14-08).



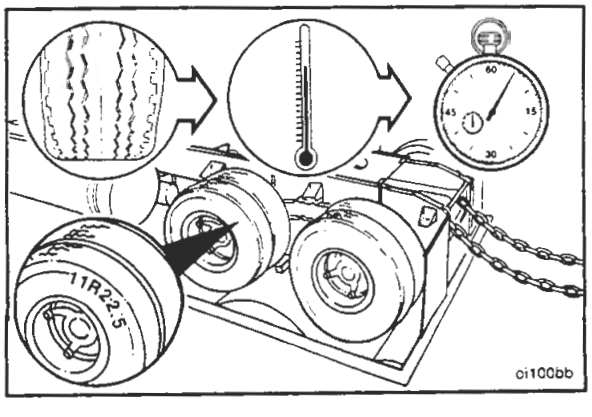
Engine Dynamometer Test-Chassis Dynamometer (14-04)

The performance of an engine installed in "on-highway" vehicles **can** be tested on a chassis dynamometer. Use the schedule described in Engine Dynamometer Test - Engine Run-In (14-02).

Note: Chasis dynamometer torque and horsepower readings will be approximately 80 percent of the published specifications for the engine. This is due to the additional parasitic loads (fan, air compressor, power steering pump, etc.) and drivetrain efficiency.



Use the engine RPM settings shown in the engine run-in instructions. Multiply the load values by 0.8 to determine the load value to use with the chassis dynamometer.

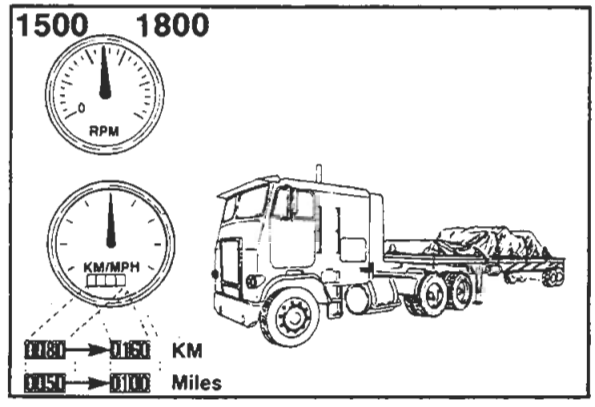


Caution: Low Profile radial tires are more sensitive to heat than bias ply tires. Excessive operating time at full load can damage tires due to overheating. Be sure to check the tire manufacturers recommendations for the maximum allowable chassis dynamometer operating time.

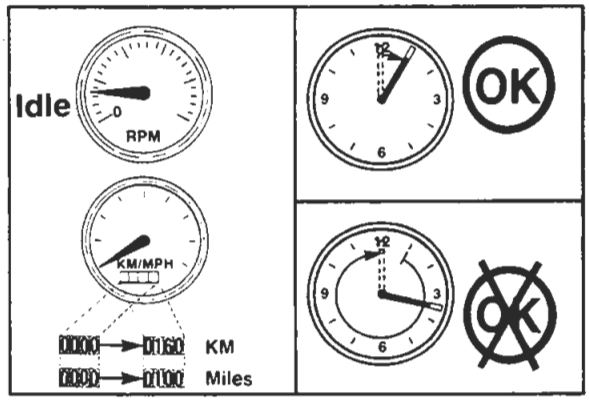
Engine Run-In - Without Dynamometer (14-05)

On-Highway

Operate the engine under load at 1500 to 1800 RPM in high gear as much as possible for the first 80 to 160 kilometers (50 to 100 miles] after rebuild.



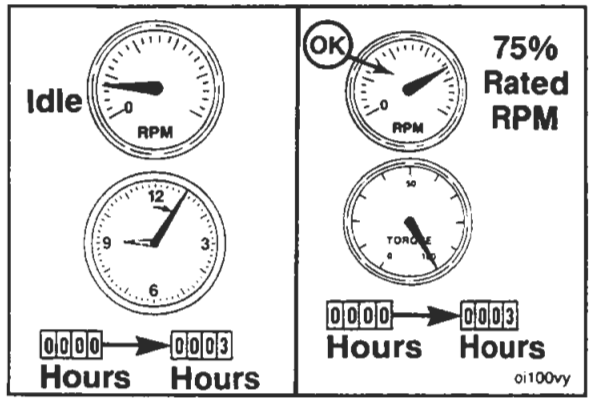
Note: Do not "idle" the engine for more than five minutes at any one time during the first 160 kilometers [100 miles] of operation.



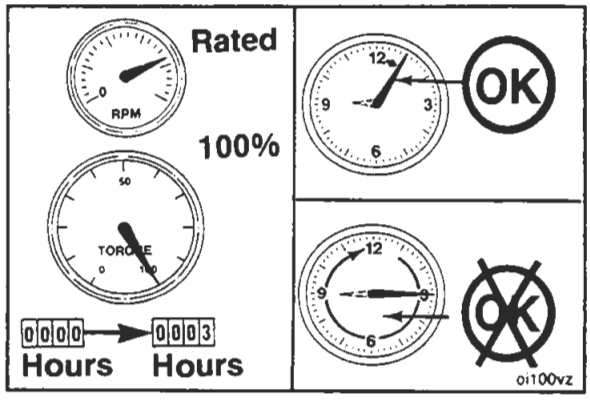
Off-Highway

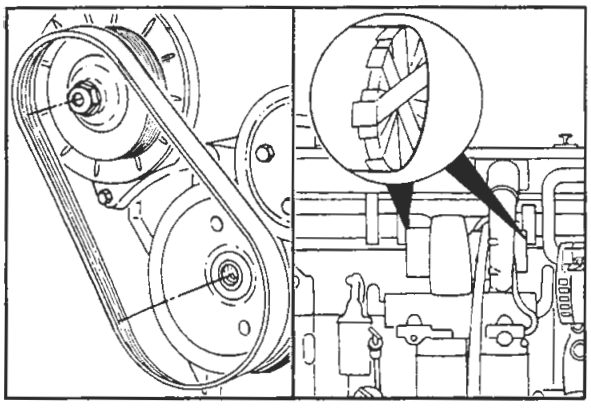
During the first three hours after rebuild:

- **Do not** "idle" the engine for more than five minutes at any one time.
- Operate the engine at 75 percent throttle while loaded.



- **Do not** operate the engine at rated speed (RPM) and full load for more than five minutes at any one time.



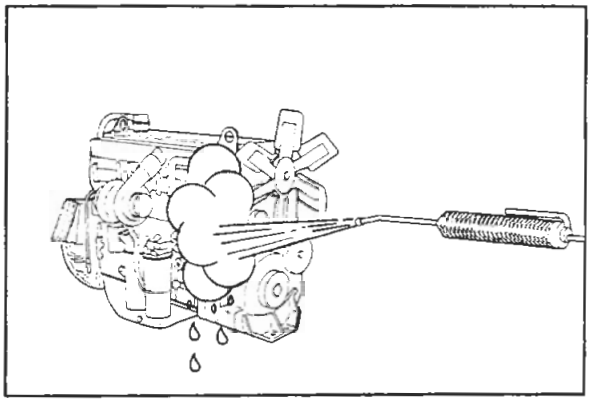


Engine Painting (14-06)

Remove all belts from the engine.

Cover the following:

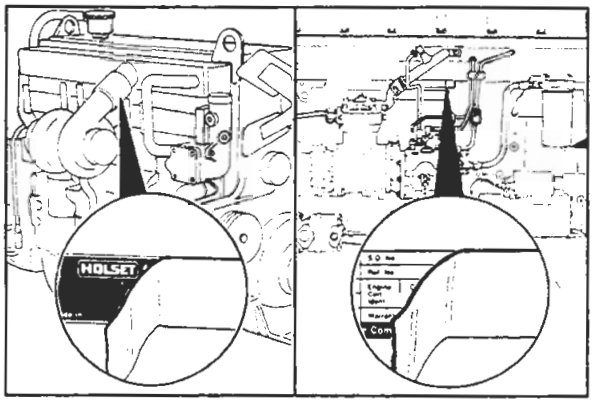
- Exhaust and Intake Openings
- Electrical Components
- Fuel Inlet and Drain Connections
- Any Exposed Fittings, Threads and Electrical Wire Terminals



Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

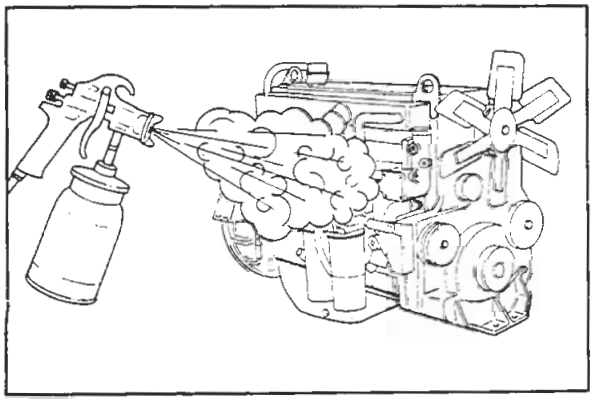
Use steam to clean the engine. Dry with compressed air.

Note: Make sure **all** engine surfaces are clean and dry before painting the engine.



Cover the following:

- All Dataplates
- Valve and Injector Set Marks
- Exhaust Manifold
- Turbocharger Turbine Housing
- Flywheel
- Flywheel Housing Transmission Mounting Surface



Paint the engine.

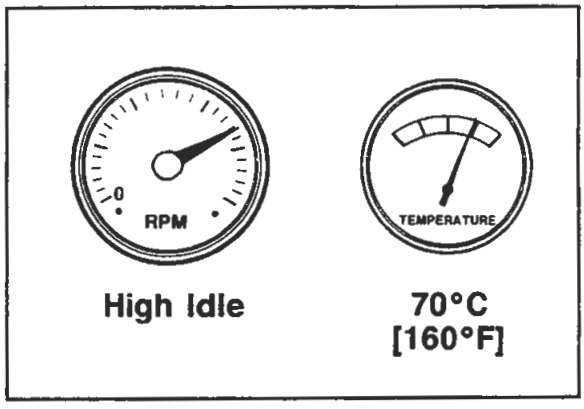
Engine Storage - Short Term (14-07)

Note: This procedure describes the proper method to prepare an engine for short term storage (one to six months).

Operate the engine at "High Idle" speed until the coolant temperature indicator reaches:

Temperature: 70°C [160°F]

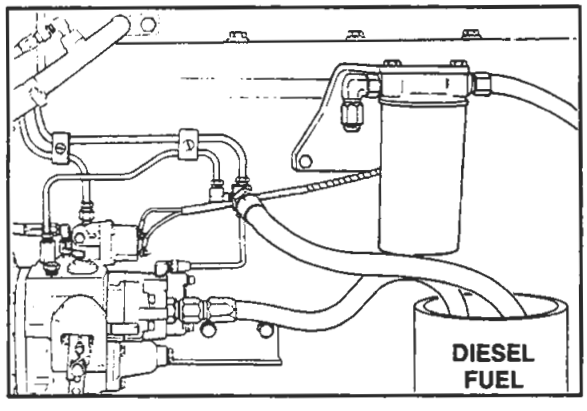
Shut off the engine.



Remove the fuel lines to the engine fuel filter and the injector return line.

Note: Use Daubert Chemical NoxRust No. 518 Preservative Oil, or equivalent. The oil **must** meet Military Specification MIL-L-644 Type P-9.

Fill two containers, one with diesel fuel, the second with preservative oil. Install both fuel lines in the container of diesel fuel.

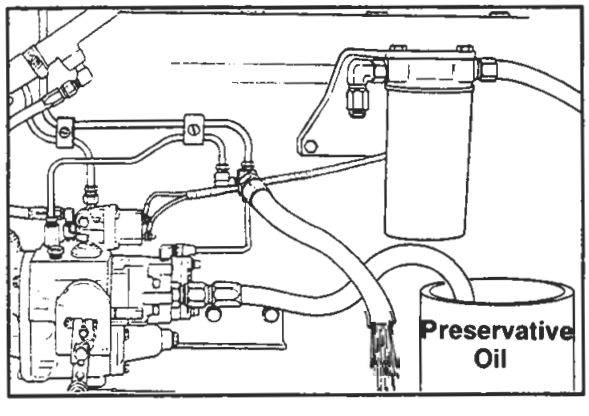


Start the engine.

After the engine is operating smoothly, transfer the fuel supply line to the container of preservative oil. Operate the engine until the preservative oil is coming out of the injector return line.

Shut off the engine.

Install the fuel lines to the fuel filter and the injector return line fitting.

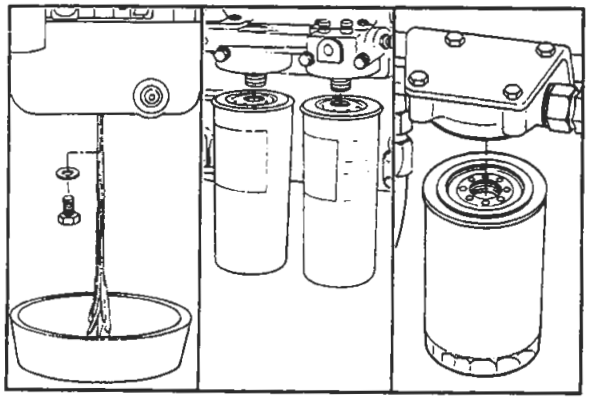


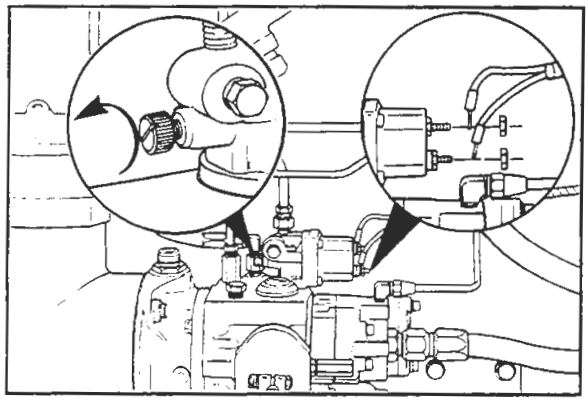
Drain the lubricating oil pan, the oil filters and the fuel filter.

Install the drain plug in the oil pan.

Torque Value: 90 N•m [65 ft-lb]

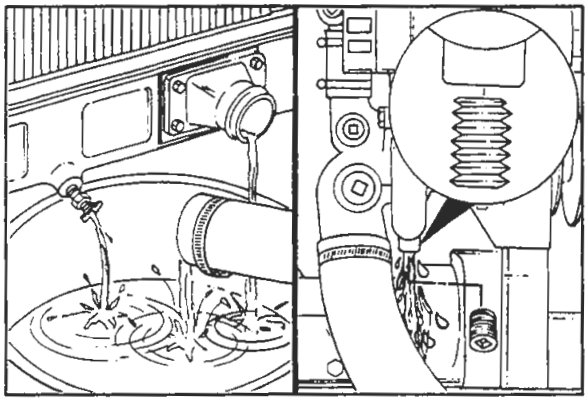
Note: The oil pan **can** remain empty until the engine is ready to use.





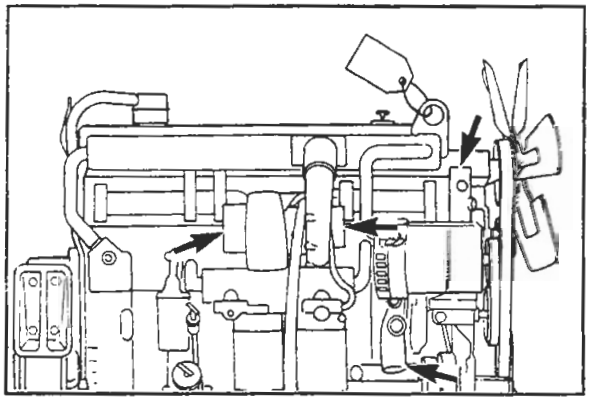
Turn the fuel pump manual shutoff valve **counterclockwise** until it stops.

Remove the electrical wiring from the fuel pump solenoid.



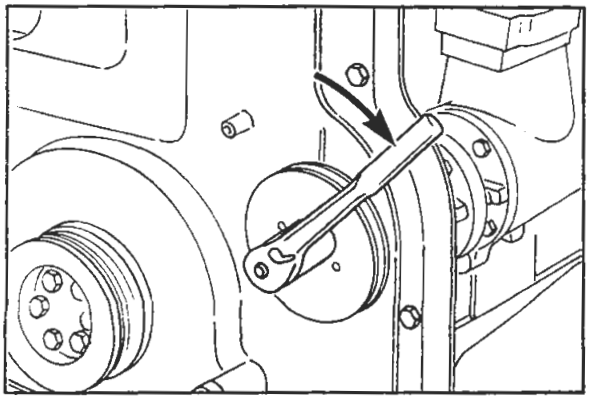
Drain the cooling system.

Note: It is **not** necessary to drain the coolant if it is a permanent type antifreeze with a rust inhibitor. Do **not** drain the coolant if the engine is installed in a vehicle.



Cover **all** openings with tape to prevent dirt and moisture from entering the engine.

Install a warning tag on the engine. The tag **must** indicate that the engine does **not** contain oil and **must** not be operated.



Store the engine in an area that is dry and has a constant temperature.

Use the accessory drive shaft to rotate the crankshaft two to three revolutions every **three** to **four** weeks.

Remove the Engine from Short Term Storage

Remove the tape from the openings. Remove the warning tag.

Replace the oil, water and fuel filters.

Prime the lubricating oil system. Refer to Engine Testing (14-02).

Use clean diesel fuel to flush the preservative oil from the fuel system.

Fill the cooling system (if necessary).

Adjust the injector and valve clearance. Refer to Engine Assembly (00-02).

Adjust the belt tension. Refer to Engine Assembly (00-02).

Engine Storage - Long Term (14-08)

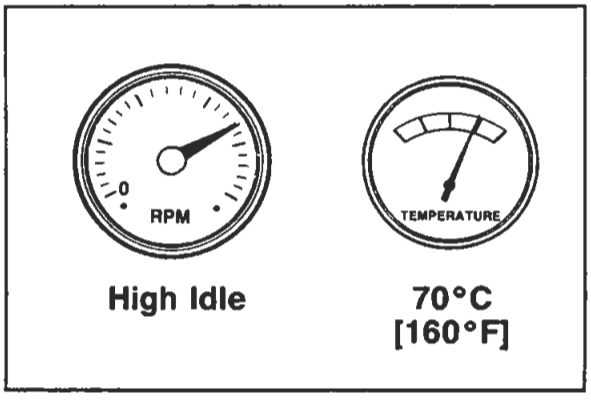
This procedure describes the proper method to prepare an engine for long term storage (six to 24 months).

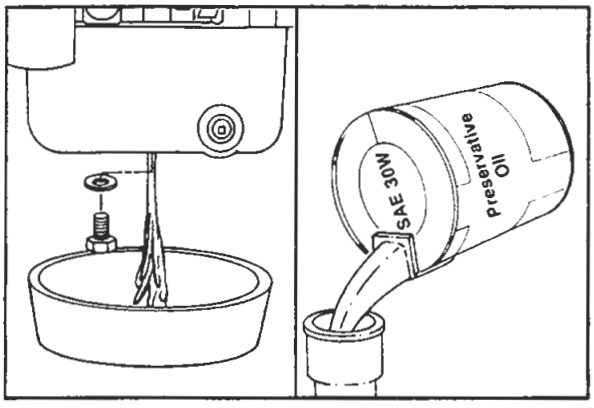
Note: After 24 months in storage, the engine cooling system **must** be flushed with a suitable solvent or a light, hot oil. This procedure **must** then be repeated.

Operate the engine at "High Idle" speed until the coolant temperature indicator reaches:

Temperature: 70°C [160°F]

Shut off the engine.



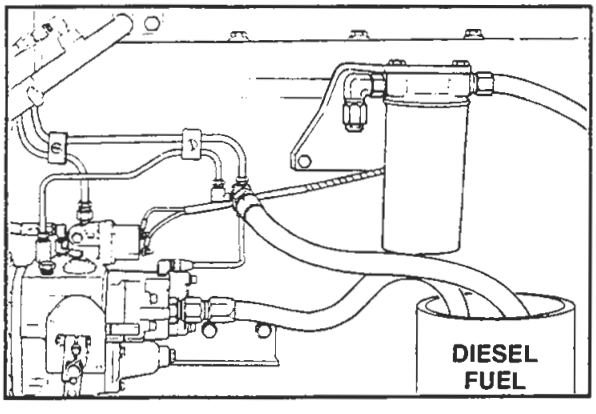


Drain the lubricating oil pan. Install the drain plug.

Torque Value: 90 N•m [65 ft-lb]

Fill the oil pan to the "High" level mark with preservative oil.

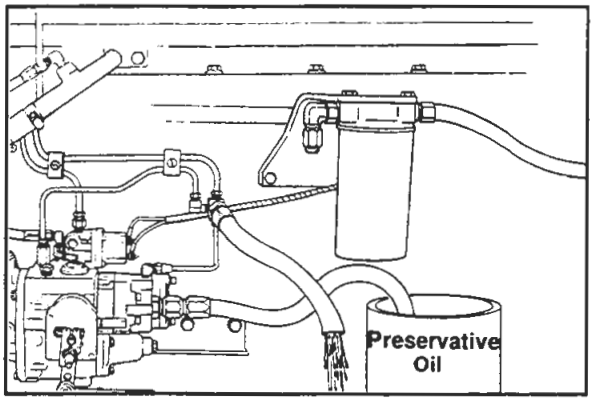
Note: Use Shell 66202, or an equivalent preservative oil. The oil **must** meet Military Specification MIL-L-21260 Type R10 Grade 2 SAE 30.



Remove the fuel lines to the engine fuel filter and the injector return line.

Note: Use Daubert Chemical NoxRust No. 518 Preservative Oil, or equivalent. The oil **must** meet Military Specification MIL-L-644 Type P-9.

Fill two containers, one with diesel fuel, the second with preservative oil. Install both fuel lines in the container of diesel fuel.

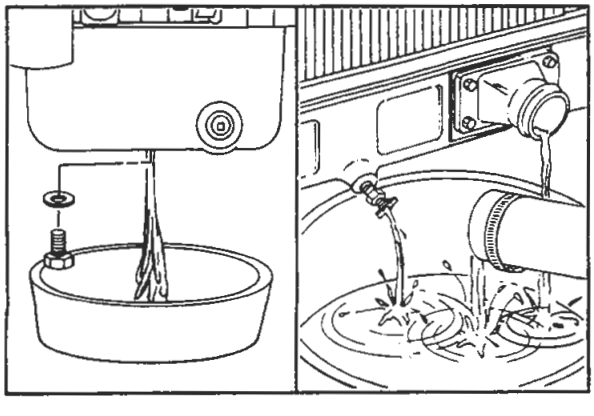


Start the engine.

After the engine is operating smoothly, transfer the fuel supply line to the container of preservative oil. Operate the engine until the preservative oil is coming out of the injector return line.

Shut off the engine.

Install the fuel lines to the fuel filter and the injector return line fitting.



Drain the preservative oil from the lubricating oil pan and the oil filters.

Install the drain plug.

Torque Value: 90 N•m [65 ft-lb]

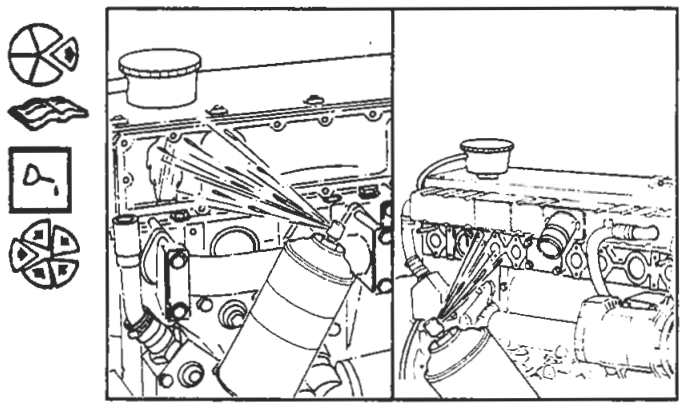
Drain and flush the cooling system.

Note: Use a rust inhibitor that **will mix** with water.

Remove the aftercooler assembly or intake manifold cover. Remove the exhaust manifold. Refer to Engine Disassembly (00-01).

Spray preservative oil into the intake and exhaust ports in the cylinder head and into the aftercooler housing and exhaust manifold.

Install the aftercooler assembly or intake manifold cover. Install the exhaust manifold. Refer to Engine Assembly (00-02).



Remove the rocker housing cover. Refer to Engine Disassembly (00-01).

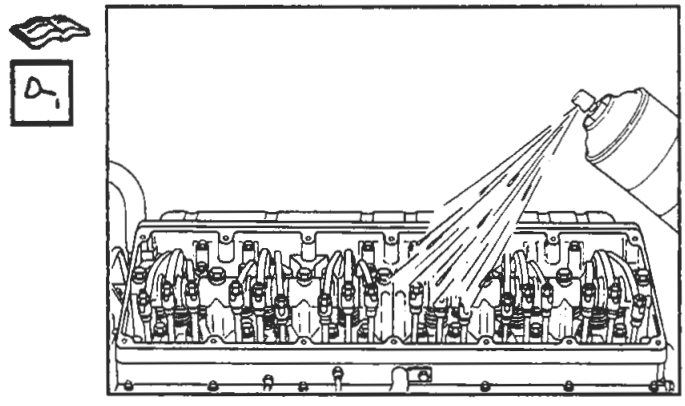
Spray the rocker levers, crossheads, valve springs, valve stems, valve guides, and the push rods with preservative oil.

Install the rocker housing cover. Refer to Engine Assembly (00-02).

Spray preservative oil into the intake port on the air compressor.

Brush or spray preservative compound on all of the exposed surfaces that are not painted.

Note: Use a rust preservative compound that meets Military Specification MIL-C-16137C Type P-2 Grade 1 or 2.

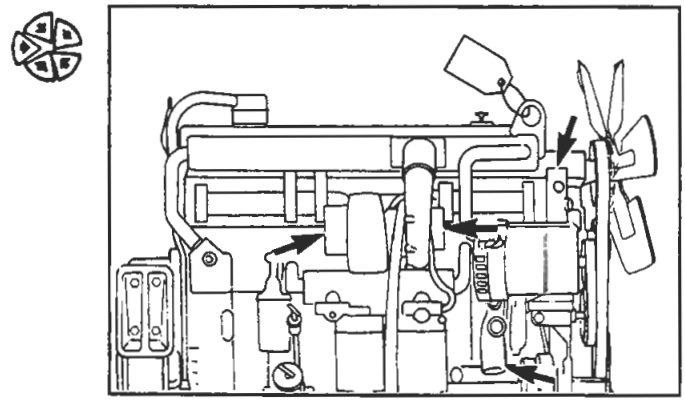


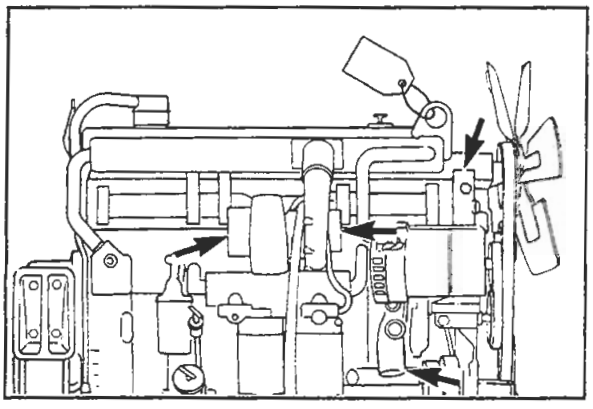
Cover **all** of the openings with heavy paper and tape to prevent dirt and moisture from entering the engine.

Install a warning tag on the engine. The tag **must** indicate:

- The date the engine was treated with preservatives
- Do **not** rotate the crankshaft
- The coolant has been drained
- Do **not** operate the engine.

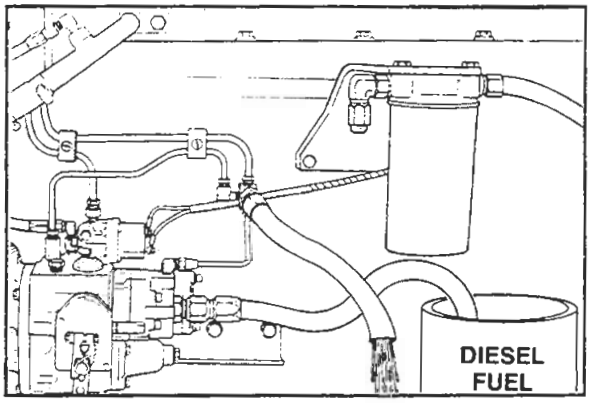
Store the engine in an area that is dry and has a constant temperature.



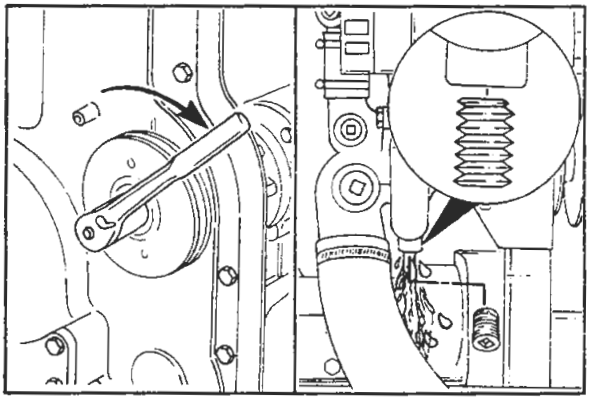


Remove the Engine from Long Term Storage

Remove the heavy paper and tape from the openings. Remove the warning tag.



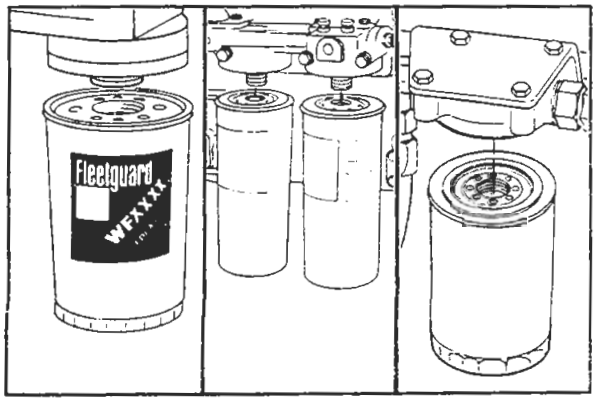
Use clean diesel fuel to flush the preservative oil from the fuel system.



Remove a plug from the main oil rifle drilling. Use a light mineral oil to flush the preservative oil from the engine.

Note: Use the accessory drive shaft to rotate the crankshaft three to four revolutions during the flushing procedure.

Drain and flush the cooling system.



Replace the oil, water and fuel filters.

Fill the cooling system with coolant.

Prime the lubricating oil system. Refer to Engine Testing (14-02).

Adjust the injector and valve clearance.Refer to Engine Assembly (00-02).

Adjust the belt tension. Refer to Engine Assembly (00-02).

Tighten the aftercooler assembly or intake manifold cover capscrews. Tighten the exhaust manifold capscrews. Refer to Engine Assembly (00-02).

Instruments and Controls - Group 15

Contents

Instruments and Controls - General Information

The instruments and control group consists of the gauges, speed switch, safety controls, cold weather operating aids, etc. used on Cummins engines.

Gauges that indicate the coolant temperature, oil pressure, and oil temperature will provide the operator information on the condition of the engine. Overheating and low or high oil pressure indicate a malfunction that requires mechanical correction.

Cold weather operating aids provide cold weather protection and better starting conditions for the engine.

The instruments and controls used on the L10 engine are not manufactured by Cummins Engine Company, Inc. The following list contains the suppliers of the instrumentation used on Cummins engines.

Air Heaters

Fleetguard, Inc.
Rout 8
Cookeville, TN 38501
Telephone: (615) 526-9551

Kim Hotstart Co.
West 917 Broadway
Spokane, WA 99210
Telephone: (509) 534-6171

Coolant Heaters

Fleetguard, Inc.
Route 8
Cookeville, TN 38501
Telephone: (615) 526-9551

Service Products Company, Inc.
635 S. Mapleton Street
Columbus, IN 47201
Telephone: (812) 377-8178

Fuel Warmers

Fleetguard, Inc.
Route 8
Cookeville, TN 38501
Telephone: (615) 526-9551

Service Products Company, Inc.
635 S. Mapleton Street
Columbus, IN 47201
Telephone: (812) 377-8178

Gauges

Grasslin U.K. Ltd.
Vale Rise
Tonbridge
Kent
TN9 1TB
England
Telephone: 0732-359888

Gauges (Cont'd)

Icknield Instruments Ltd.
Jubilee Road
Letchworth
Herts
England
Telephone: 04626-5551

Superb Tool and
Gauge Co.
21 Princip Street
Birmingham
B4 61E
England
Telephone: 021-359-4876

Smiths Industries
50 Oxgate Lane
Cricklewood
London
NW2 7JB
England
Telephone: 01-452-3333

Kabi Elec. and Plastics
Cranborne Road
Potters Bar
Herts
EN6 3JP
England
Telephone: 0707-53444

Datcon Instrument Co.
P.O. Box 128
East Petersburg, PA 17520
Telephone: (717) 569-5713

Rochester Gauge of Texas
11637 Denton Drive
Dallas, TX 75229
Telephone: (214) 241-2161

Instruments and Controls - General Information (Cont'd)

Oil Heaters

Fleetguard, Inc.
Route 8
Cookeville, TN 38501
Telephone: (615) 526-9551

Kim Hotstart Co.
West 917 Broadway
Spokane, WA 99210
Telephone: (509) 534-6171

Service Products Company, Inc.
635 S. Mapleton Street
Columbus, IN 47201
Telephone: (812) 377-8178

Safety Controls

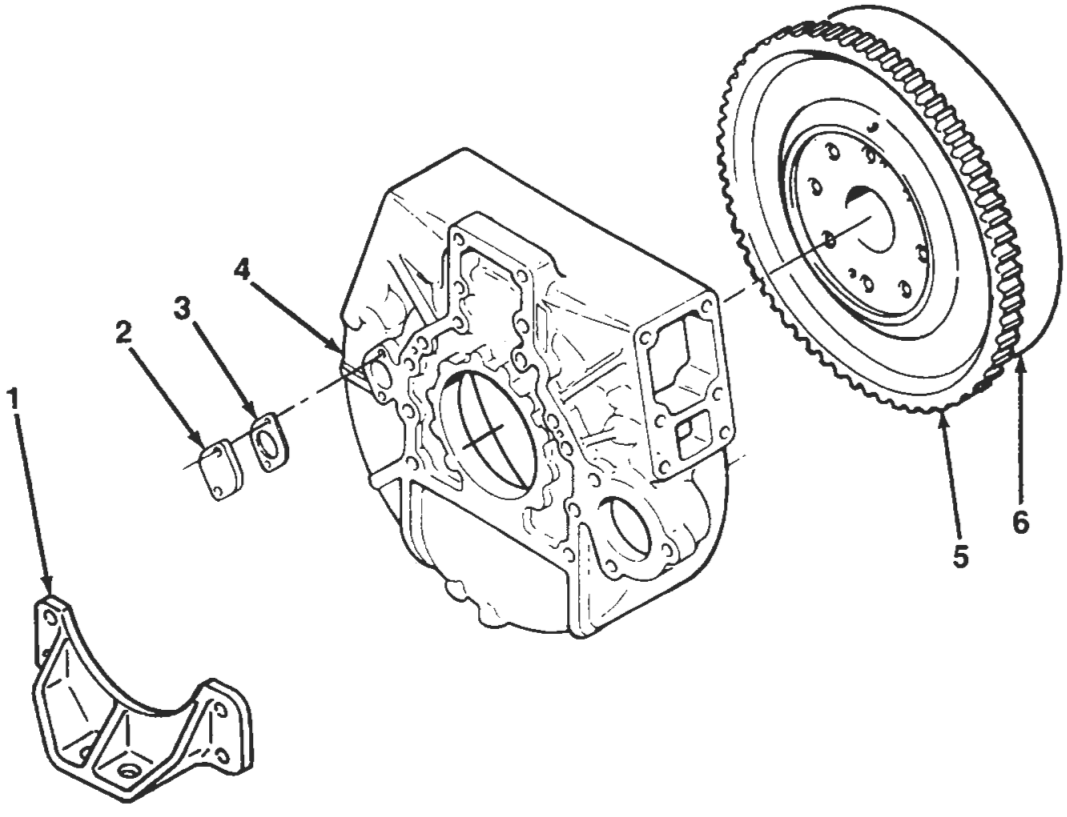
Teddington Ind. Equip.
Windmill Road
Sunburn on Thames
Middlesex
TW16 7HF
England
Telephone: 09327-85500

The Nason Company
10388 Enterprise Drive
Davisburg, MI 48019
Telephone: (313) 625-5381

Mounting Adaptations - Group 16

Contents

Mounting Adaptations - Exploded View



Ref. No.	Description	Qty.	Ref. No.	Description	Qty.
1	Support, Front Engine	1	4	Housing, Flywheel	1
2	Cover, Access Hole	1	5	Gear, Ring	1
3	Gasket, Cover Plate	1	6	Flywheel	1

Mounting Adaptations - General Information

The mounting adaptations group consists of the flywheel housing, flywheel, flywheel ring gear, pilot bearing, and the front engine support.

The flywheel is available **only** as an assembly with the ring gear installed; however, the ring gear is available for service replacement.

Flywheel - Clean and Inspect for Reuse (16-01)

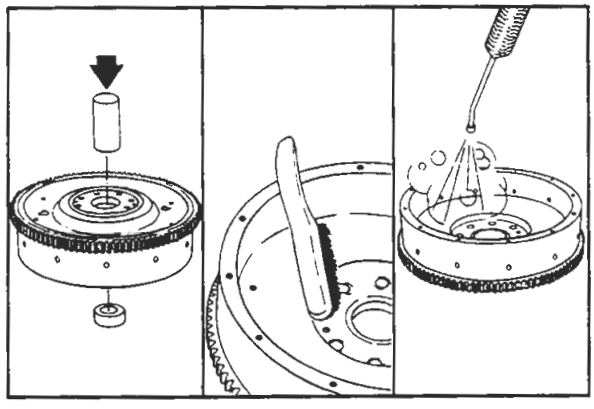
Disassembly

Use a mandrel and hammer to remove the pilot bearing.

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use a wire brush to clean the crankshaft pilot bore.

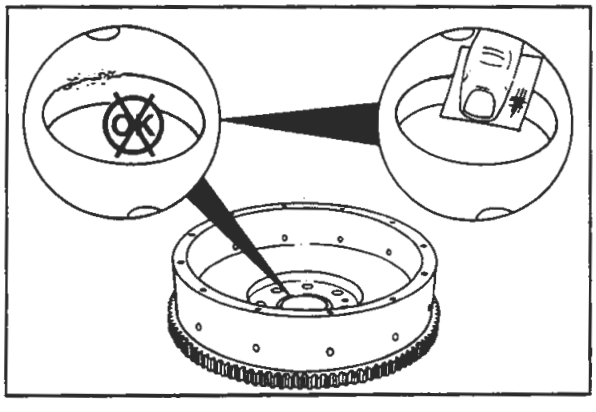
Use solvent or steam to clean the flywheel assembly. Dry with compressed air.



Inspection

Visually inspect the pilot bore for nicks or burrs.

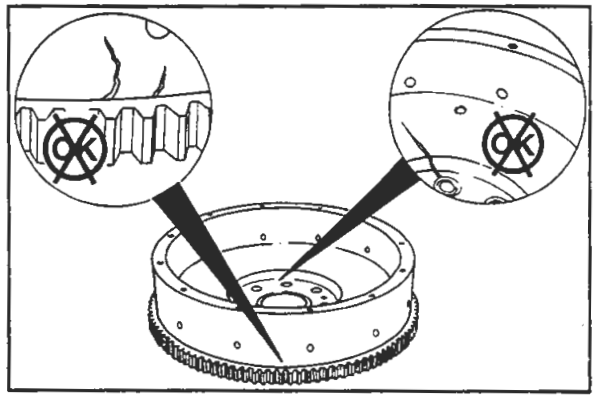
Use 240 grit emery cloth to remove small nicks and burrs.

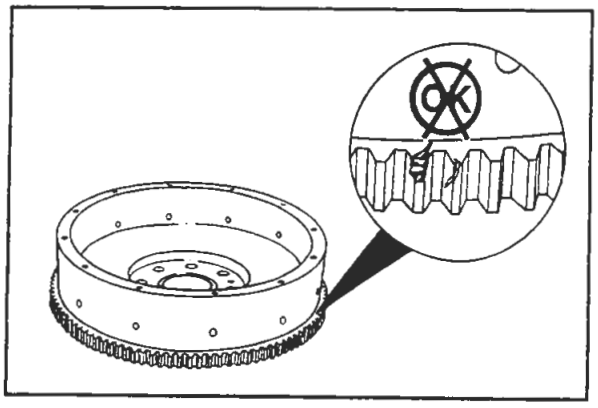


Warning: Do not use a cracked flywheel. A cracked flywheel can break and cause serious personal injury or property damage.

Visually inspect the flywheel and the clutch mounting surface for cracks.

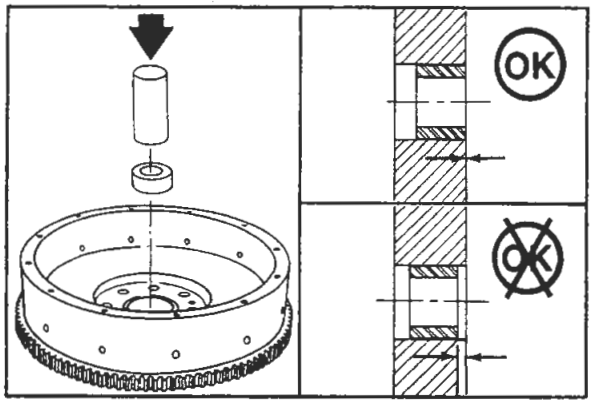
Visually inspect the clutch mounting holes for damaged threads.





Visually inspect the flywheel ring gear for chipped, cracked or broken teeth.

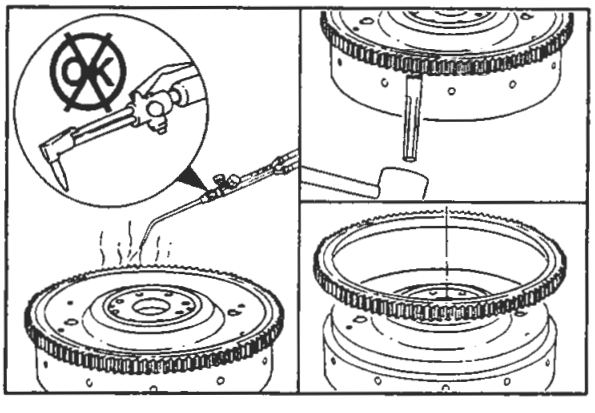
Note: If the ring gear teeth are damaged, the ring gear **must** be replaced. Refer to Flywheel Ring Gear - Replace (16-02).



Assembly

Note: Use a new pilot bearing when installing a new or rebuilt clutch. The pilot bearing **must** be installed flush with the pilot bore surface.

Use a mandrel and hammer to install the pilot bearing.



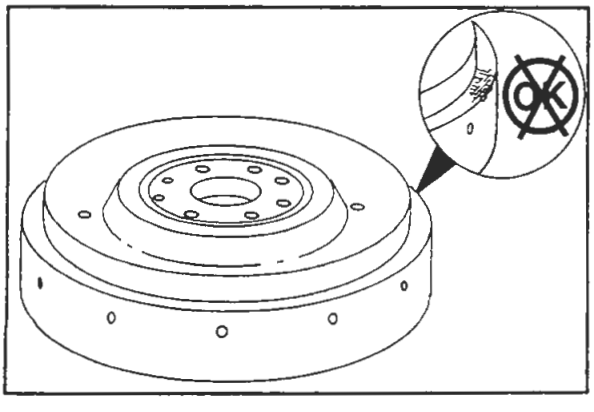
Flywheel Ring Gear - Replace (16-02)

Disassembly

Caution: Do not use a cutting torch to heat the ring gear, the flywheel can be damaged.

Use a heating torch to heat the outside diameter of the ring gear.

Use a blunt chisel and hammer to remove the ring gear from the flywheel.



Inspection

Visually inspect the flywheel outside diameter for damage at the ring gear location.

Use 240 grit emery cloth to remove small nicks and burrs.

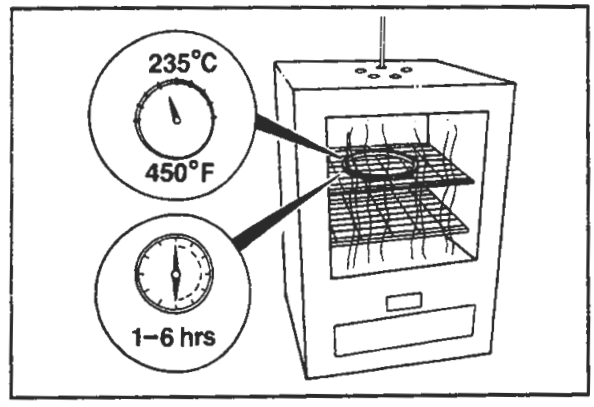
Assembly

Note: Do **not** attempt to install the ring gear without using heat.

Use an oven to heat the new ring gear. Heat the ring gear for a minimum of one hour. Do **not** heat the ring gear for more than six hours.

Temperature: 235°C [450°F]

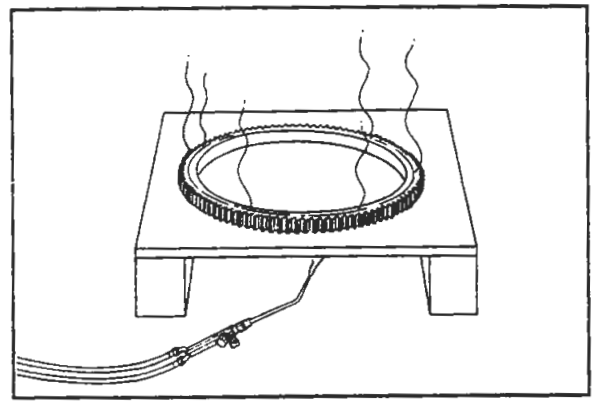
Note: Do **not** exceed the specified time or temperature.



If an oven is not available use a heating torch to heat the gear. Use a Tempilstik® crayon, or equivalent to check the temperature of the gear.

Temperature: 235°C [450°F]

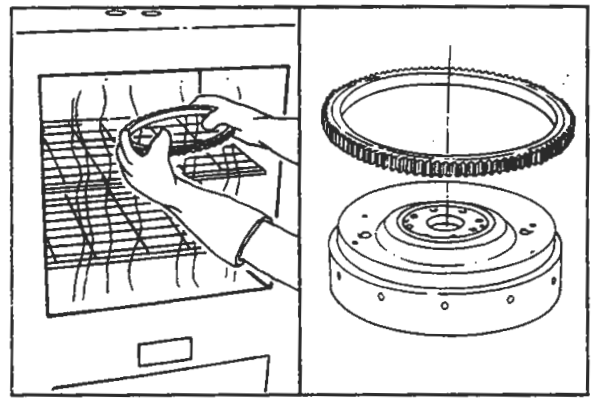
Note: A more even temperature is obtained by placing the ring gear on a metal plate, then heat the bottom side of the plate with the torch. Do **not** exceed the specified temperature.



Caution: Wear protective gloves when handling parts that have been heated to prevent personal injury.

Install the ring gear on the flywheel before it cools.

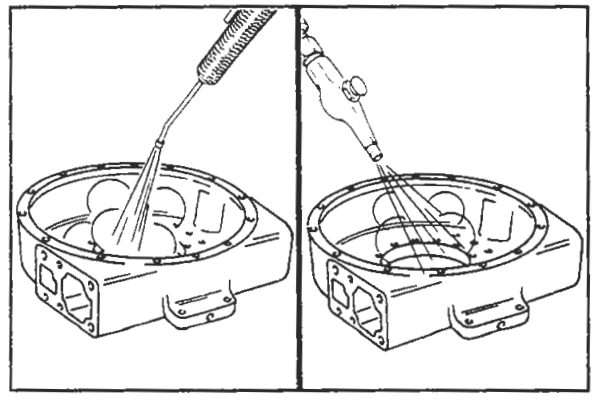
Note: Allow the air to cool the gear. Do **not** use water or oil to reduce the cooling time.

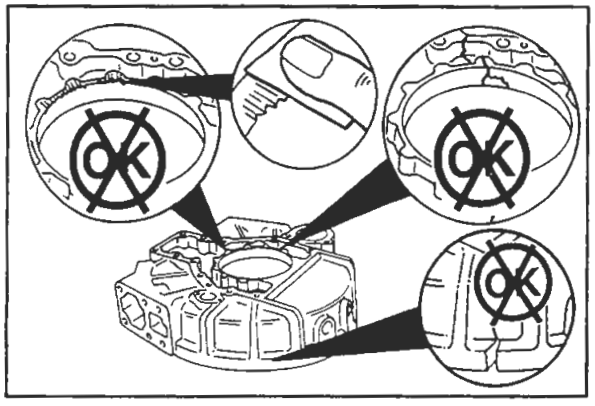


Flywheel Housing - Clean and Inspect for Reuse (16-03)

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use solvent or steam to clean the flywheel housing. Dry with compressed air.

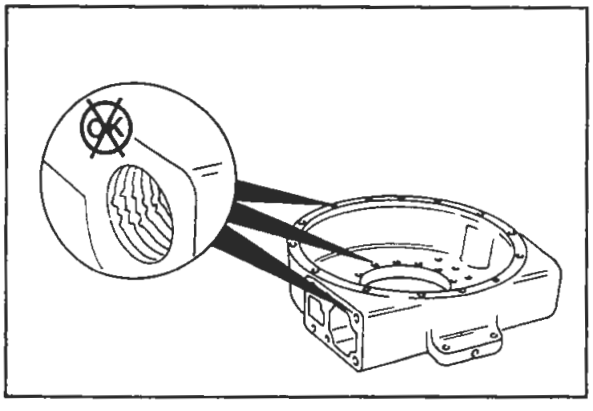




Inspection

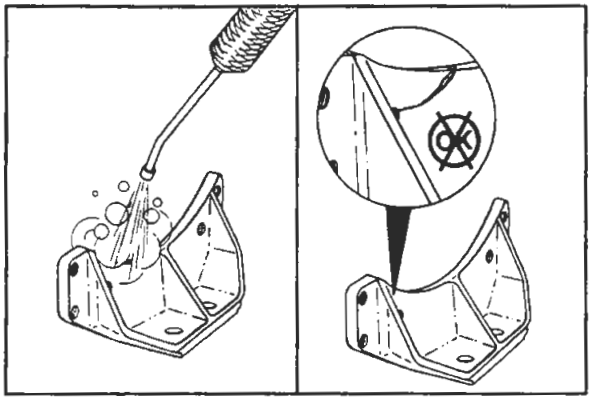
Visually inspect all surfaces of the flywheel housing for nicks, burrs or cracks.

Use 240 grit emery cloth to remove small nicks and burrs.



Visually inspect all threaded capscrew holes for damage.

Note: If cracks are found, the flywheel housing **must** be replaced. Damaged or distorted capscrew threads **can** be repaired with thread inserts.



Front Engine Support - Clean and Inspect for Reuse (16-04)

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use solvent or steam to clean the front engine support. Dry with compressed air.

Inspection

Visually inspect the support for cracks or damage.

Note: If cracks or damage is found, the front engine support **must** be replaced.

Specifications - Group 18

Contents

Specifications — Page

General Engine Specifications

General Engine Data — Metric [U.S. Customary]

Horsepower (Refer to the engine data plate)

Engine speed @ Maximum Output:

- Standard Rating (RPM) 2100
- Formula Rating (RPM) 1900

Bore & Stroke ..... 125 mm [4.921 in.] X 136 mm [5.354 in.]

Displacement ..... 10 litres [611 C.I.D.]

Compression Ratio:

- 49 State (only) 16.3:1
- California (only) 18.0:1

Firing Order 1-5-3-6-2-4

Engine Weight (With Standard Accessories):

- Dry Weight ..... 876 kg [1930 lb.]
- Wet Weight ..... 922 kg [2030 lb.]

Intake System

Maximum Allowable Intake Restriction With Clean Air Filter Element:

- Normal Duty Dry Type Cleaner ..... 25 cm H_20 [10 in. H_20]
- Medium Duty Dry Type Cleaner ..... 30 cm H_20 [12 in. H_20]
- Heavy Duty Dry Type Cleaner ..... 38 cm H_20 [15 in. H_20]

Maximum Allowable Intake Restriction With Dirty Air Filter Element ..... 64 cm H_20 [25 in. H_20]

Lubrication System

Oil Pressure - Low Idle (Minimum Allowable) ..... 70 kPa [10 psi]

- At 1300 RPM or Torque Peak (Minimum Allowable) ..... 208 kPa [30 psi]

Oil Capacity of Standard Engine:

- By-Pass Filter ..... 2.8 litres [0.75 U.S. Gal.]
- Full Flow Filter Capacity ..... 3.5 litres [0.93 U.S. Gal.]
- Oil Pan
  - Automotive (high-low) ..... 26.5 to 19 litres [7 to 5 U.S. Gal.]
  - Construction (high-low) ..... 26.5 to 23 litres [7 to 6 U.S. Gal.]

Total System Capacity Including Bypass Filter .....34 litres [9 U.S. Gal.]

General Engine Specifications (Continued)

Cooling System

Metric [U.S. Customary]

Coolant Capacity (engine only) ..... 11 litres [12 U.S. qt.]

Standard Modulating Thermostat Range:

- Conventional Aftercooling ..... 82 to 93°C [180 to 200°F]
- Optimized Aftercooling ..... 71 to 91°C [175 to 195°F]

Maximum Coolant Cylinder Block Pressure (Pressure Cap Removed)

Closed Thermostat ..... 275 kPa [40 psi]

Maximum Allowable Top Tank Temperature ..... 100°C [212°F]

Minimum Recommended Top Tank Temperature ..... 70°C [158°F]

Minimum Recommended Pressure Cap ..... 50 kPa [7 psi]

Exhaust System

Maximum Allowable Back Pressure Created by Piping & Silencer:

- Hg ..... 75 mm [3 in.]
- H_20 ..... 1016 mm [40 in.]

Exhaust Pipe Size (Normally Acceptable Inside Diameter) ..... 102 mm [4 in.]

Fuel System

Note: For performance and fuel rate values, refer to the engine data sheet or the fuel pump code for the particular model involved.

Maximum Allowable Restriction to Pump:

- With Clean Filter ..... 102 mm Hg [4 in. Hg]
- With Dirty Filter ..... 204 mm Hg [8 in. Hg]

Maximum Allowable Return Line Restriction ..... 63 mm Hg [2.5 in. Hg]

Maximum Allowable Return Line Restriction with Check Valves and/or Overhead Tanks 165 mm Hg [6.5 in. Hg]

Electrical System

Minimum Recommended Battery Capacity

Battery Size	Ambient Temperatures			
	-18°C (0°F)		0°C (32°F)	
	Cold Cranking Amperes	Reserve Capacity * Amperes	Cold Cranking Amperes	Reserve Capacity Amperes
12 Volt	1800	640	1280	480
24 Volt **	900	320	640	240

* The number of plates within a given battery size determine reserve capacity. Reserve capacity determines the length of time sustained cranking can occur.

** CCA ratings are based on two 12 volt batteries in series.

Capscrew Markings and Torque Values

Caution: When replacing capscrews, always use a capscrew of the same measurement and strength as the capscrew being replaced. Using incorrect capscrews can result in engine damage.

Most of the capscrews used on the L10 engine are metric. Some components, such as the air compressor and fuel pump, are installed using U.S. Customary capscrews.

Metric capscrews and nuts are identified by the grade number stamped on the head of the capscrew or on the surface of the nuts. U.S. Customary capscrews are identified by radial lines stamped on the head of the capscrew.

The following examples indicate how capscrews are identified:

Metric (M8-1.25 X 25)		
M8	**1.25**	**25**
Major Thread Diameter in Millimeters	Distance Between Threads in Millimeters	Length in Millimeters

U.S. Customary (5/16 X 18 X 1 1/2)		
5/16	**18**	**1 1/2**
Major Thread Diameter in Inches	Number Threads per Inch	Length in Inches

Notes:

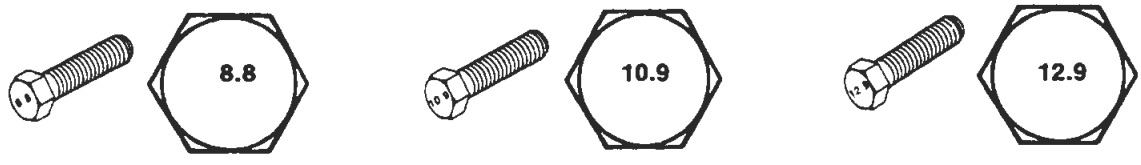
1. **Always** use the torque values listed in the following tables when specific torque values are **not** available.
2. Do **not** use the torque values in place of those specified in other sections of this manual.
3. The torque values in the table are based on the use of lubricated threads.

Capscrew Markings and Torque Values - Metric

Commercial Steel Class

8.8	10.9	12.9

Capscrew Head Markings

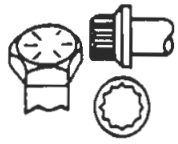


Body Size	Torque				Torque				Torque			
Diam.	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
mm	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
6	9	5	7	4	14	9	11	7	14	9	11	7
7	14	9	11	7	18	14	14	11	23	18	18	14
8	25	18	18	14	32	23	25	18	36	27	28	21
10	40	30	30	25	60	45	45	35	70	50	55	40
12	70	55	55	40	105	75	80	60	125	95	100	75
14	115	85	90	65	160	120	125	95	195	145	150	110
16	180	130	140	100	240	175	190	135	290	210	220	165
18	230	170	180	135	320	240	250	185	400	290	310	230

Capscrew Markings and Torque Values - U.S. Customary

SAE Grade Number	5	8
Capscrew Head Markings		

These are all SAE Grade 5 (3) line



Capscrew Body Size	Capscrew Torque - Grade 5 Capscrew				Capscrew Torque - Grade 8 Capscrew			
	Cast Iron		Aluminum		Cast Iron		Aluminum	
(Inches) - (Thread)	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
1/4 - 20	9	7	8	6	15	11	12	9
- 28	12	9	9	7	18	13	14	10
5/16 - 18	20	15	16	12	30	22	24	18
- 24	23	17	19	14	33	24	25	19
3/8 - 16	40	30	25	20	55	40	40	30
- 24	40	30	35	25	60	45	45	35
7/16 - 14	60	45	45	35	90	65	65	50
- 20	65	50	55	40	95	70	75	55
1/2 - 13	95	70	75	55	130	95	100	75
- 20	100	75	80	60	150	110	120	90
9/16 - 12	135	100	110	80	190	140	150	110
- 18	150	110	115	85	210	155	170	125
5/8 - 11	180	135	150	110	255	190	205	150
- 18	210	155	160	120	290	215	230	170
3/4 - 10	325	240	255	190	460	340	365	270
- 16	365	270	285	210	515	380	410	300
7/8 - 9	490	360	380	280	745	550	600	440
- 14	530	390	420	310	825	610	660	490
1 - 8	720	530	570	420	1100	820	890	660
- 14	800	590	650	480	1200	890	960	710

Refer to the notes on page 18-4.

Pipe Plug Torque Values

Size		Torque		Torque	
Thread	Actual Thread O.D.	In Aluminum Components		In Cast Iron or Steel Components	
in	in	N•m	ft-lb	N•m	ft-lb
1/16	0.32	5	45 in-lb	15	10
1/8	0.41	15	10	20	15
1/4	0.54	20	15	25	20
3/8	0.68	25	20	35	25
1/2	0.85	35	25	55	40
3/4	1.05	45	35	75	55
1	1.32	60	45	95	70
1-1/4	1.66	75	55	115	85
1-1/2	1.90	85	65	135	100

Decimal and Metric Equivalents

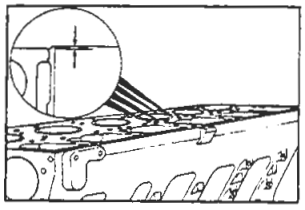
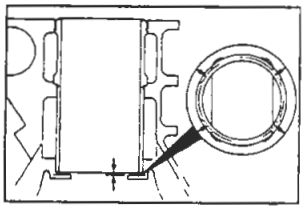
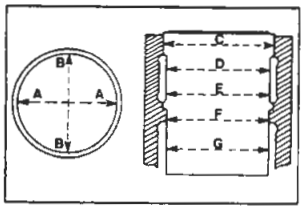
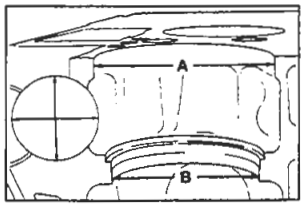
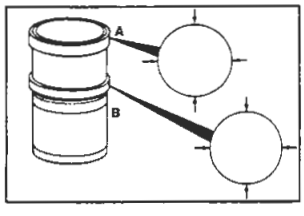
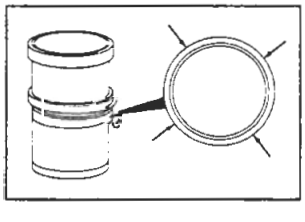
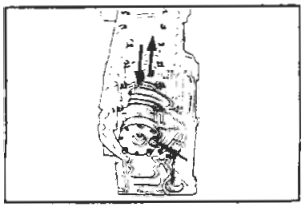
Metric mm	Decimal in.	Fractions	Metric mm	Decimal in.	Fractions
0.39688	0.015625	1/64	13.09687	0.515625	33/64
0.79375	0.03125	1/32	13.49375	0.53125	17/32
1.19062	0.046875	3/64	13.89062	0.546875	35/64
1.58750	0.0625	1/16	14.28750	0.5625	9/16
1.98437	0.078125	5/64	14.68437	0.578125	37/64
2.38125	0.09375	3/32	15.08125	0.59375	19/32
2.77812	0.109375	7/64	15.47812	0.609375	39/64
3.1750	0.125	1/8	15.87500	0.625	5/8
3.57187	0.140625	9/64	16.27187	0.640625	41/64
3.96875	0.15625	5/32	16.66875	0.65625	21/32
4.36562	0.171875	11/64	17.06562	0.671875	43/64
4.76250	0.1875	3/16	17.46250	0.6875	11/16
5.15937	0.203125	13/64	17.85937	0.703125	45/64
5.55625	0.21875	7/32	18.25625	0.71875	23/32
5.95312	0.234375	15/64	18.65312	0.734375	47/64
6.35000	0.250	1/4	19.05000	0.750	3/4
6.74687	0.265625	17/64	19.44687	0.765625	49/64
7.14375	0.28125	9/32	19.84375	0.78125	25/32
7.54062	0.296875	19/64	20.24062	0.796875	51/64
7.93750	0.3125	5/16	20.63750	0.8125	13/16
8.33437	0.328125	21/64	21.03437	0.828125	53/64
8.73125	0.34375	11/32	21.43125	0.84375	27/32
9.12812	0.359375	23/64	21.82812	0.859375	55/64
9.52500	0.375	3/8	22.22500	0.875	7/8
9.92187	0.390625	25/64	22.62187	0.890625	57/64
10.31875	0.40625	13/32	23.01875	0.90625	29/32
10.71562	0.421875	27/64	23.41562	0.921875	59/64
11.11250	0.4375	7/16	23.81250	0.9375	15/16
11.50937	0.453125	29/64	24.20937	0.953125	61/64
11.90625	0.46875	15/32	24.60625	0.96875	31/32
12.30312	0.484375	31/64	25.00312	0.984375	63/64
12.70000	0.500	1/2	25.40000	1.00	1

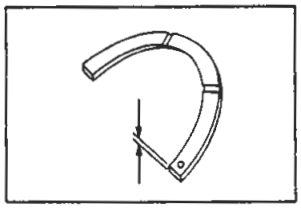
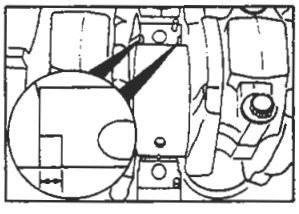
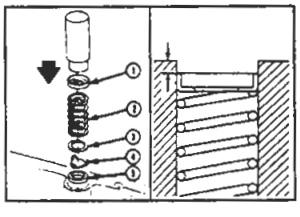
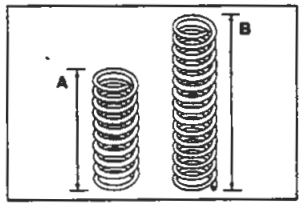
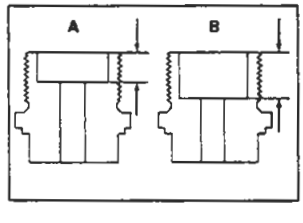
Specifications - General Information

The specifications in this section are organized in the same sequence used in each group of this manual. The minimum and maximum tolerance limit specifications are listed in both metric and U.S. Customary dimensions. The assembly and rebuild specifications and torque values are provided to assure that the parts are correctly assembled, fit properly and are secured with the correct torque value.

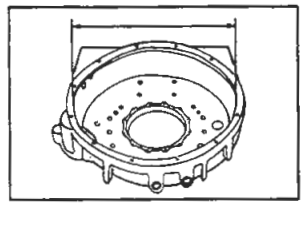
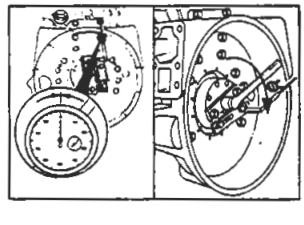
Most of the capscrews used to assemble the L10 engine are metric. Some components, such as the air compressor and the fuel pump, are installed using U.S. Customary capscrews. Capscrew torque values are listed in newton meters and foot pounds, unless otherwise specified. If a torque value is not listed, use the standard torque value for the capscrew. Refer to Capscrew Markings and Torque Values, Page 18-4.

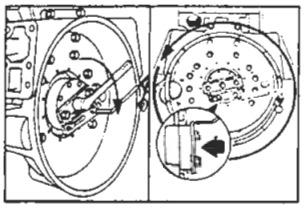
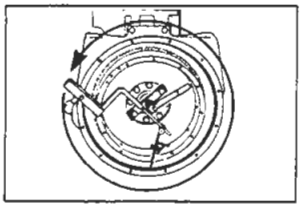
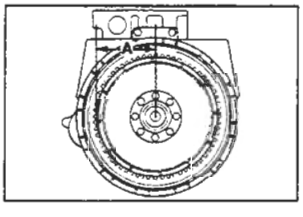
Engine Assembly - Specifications

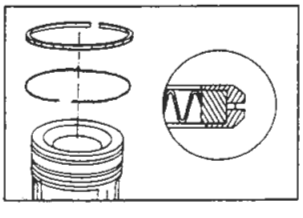
Part or Assembly	Ref. Point	mm		in
 **Cylinder Liner Protrusion**		0.00 0.13	MIN MAX	0.000 0.005
 **Cylinder Liner to Block Clearance**		0.25	MIN	0.010
 **Cylinder Liner Out of Round**		0.10	MAX	0.004
 **Cylinder Block Upper Liner Bore I.D.**	A	145.900 146.027	MIN MAX	5.7441 5.7491
Cylinder Block Liner Seal Seat Bore I.D.	B	138.063 138.113	MIN MAX	5.4355 5.4375
 **Cylinder Liner Top Press Fit O.D.**	A	145.962 146.000	MIN MAX	5.7465 5.7480
Measurement Not Required	B			
 **Cylinder Liner Lower Press Fit O.D.**	C	137.937 138.013	MIN MAX	5.4305 5.4336
 **Crankshaft End Clearance**		0.10 0.55	MIN MAX	0.004 0.022

Part or Assembly	Ref. Point	mm		in	
Crankshaft Thrust Bearing Thickness		4.83 4.89	MIN MAX	0.190 0.192	
Crankshaft Thrust Bearing Surface Width		49.975 50.100	MIN MAX	1.9675 1.9724	
High Oil Pressure Regulator Retainer Plug Installed Depth		8.28	MIN	0.326	
Main Oil Pressure Regulator Spring Free Length					
(Part No. 300449 Spring)	A	58.9	–	2.32	
(Part No. 3010146 Spring)	B	84.1	–	3.31	
Main Oil Pressure Regulator Plug Pocket Depth	A	7.1 8.4	MIN MAX	0.28 0.33	
	B	11.1 13.4	MIN MAX	0.44 0.53	

Note: Use plug "A" with spring "A" and plug "B" with spring "B". Do **not** mix the plugs and springs.

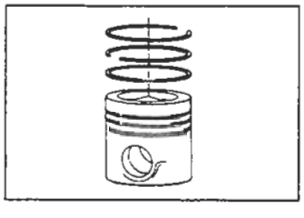
	SAE No.				
Flywheel Housing Bore I.D.	00	787.7	MAX	31.01	
	0	648.0	MAX	25.51	
	1/2	584.4	MAX	23.01	
	1	511.3	MAX	20.13	
	2	447.8	MAX	17.63	
	3	409.7	MAX	16.13	
	SAE No.				
Flywheel Housing Bore Alignment TIR	00	0.31	MAX	0.012	
	0	0.25	MAX	0.010	
	1/2	0.25	MAX	0.010	
	1	0.20	MAX	0.008	
	2	0.20	MAX	0.008	
	3	0.20	MAX	0.008	

	Part or Assembly	Ref. Point	mm		in
	**Flywheel Housing Face Alignment TIR**	SAE No.			
		00	0.31	MAX	0.012
		0	0.25	MAX	0.010
		1/2	0.25	MAX	0.010
		1	0.20	MAX	0.008
		2	0.20	MAX	0.008
		3	0.20	MAX	0.008
	**Flywheel Bore Runout TIR**		0.127	MAX	0.0050
	**Flywheel Face Runout TIR**	Radius (A) mm	in		
		203	8	0.203 MAX	0.008
		254	10	0.254 MAX	0.010
		305	12	0.305 MAX	0.012
		356	14	0.356 MAX	0.014
		406	16	0.406 MAX	0.016



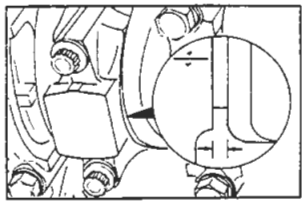
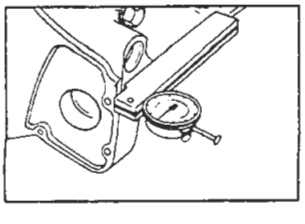
Oil Control Ring End Gap

The two-piece oil ring **must** be installed with the expander gap 180 degrees from the oil ring gap.

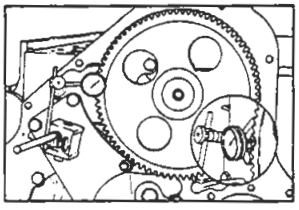


Piston Ring End Gap

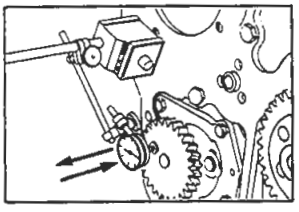
The ring gaps **must** not be aligned with the piston pin bore. Rotate the rings to position the gaps as shown.

	**Connecting Rod Side Clearance**	0.10	MIN	0.004
		0.30	MAX	0.012
	Note: The rod **must** move freely from side-to-side.			
	**Gear Support Plate Protrusion (below the cylinder block oil pan rail)**	0.15	MAX	0.006

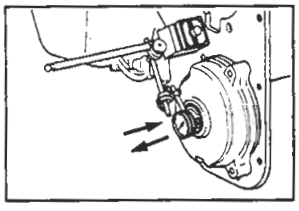
Part or Assembly	Ref. Point	mm		in
Camshaft End Clearance		0.13 0.33	MIN MAX	0.005 0.013



Lubricating Oil Pump Gear End Clearance		0.064 0.270	MIN MAX	0.0025 0.0106

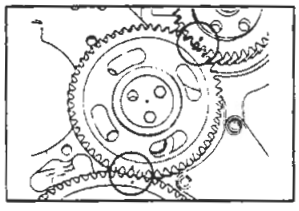


Hydraulic Pump Drive Gear End Clearance		0.076 0.635	MIN MAX	0.003 0.025

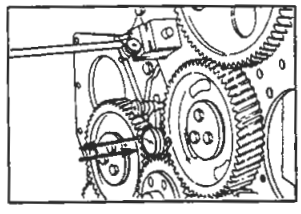


Engine Timing

Note: The timing marks on the camshaft idler gear **must** align with the timing marks on the crankshaft and camshaft gears to make sure the engine timing is set correctly.

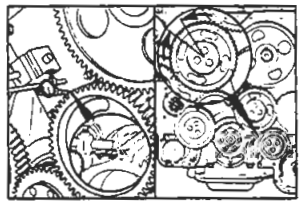


Idler Gear End Clearance		0.30 0.53	MIN MAX	0.012 0.021



Idler Gear Backlash		0.08 0.38	MIN MAX	0.003 0.015

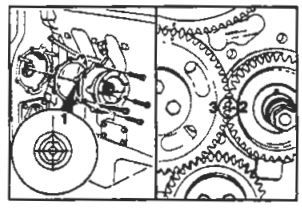
Note: Do **not** allow the mating gears to move while measuring the backlash.

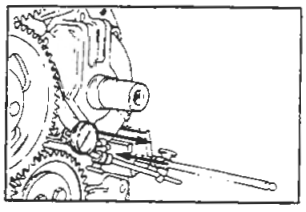
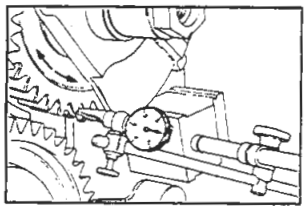
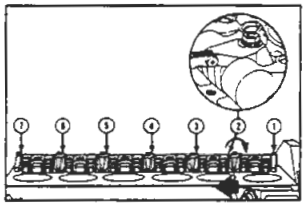


Accessory Drive Assembly Timing

Position the accessory drive shaft dowel pin (1) at the 12:00 o'clock position.

Align the timing mark on the accessory drive gear (2) with the timing mark on the camshaft idler gear (3).



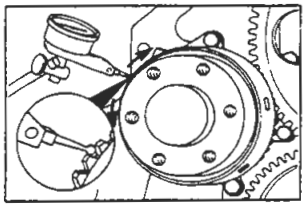
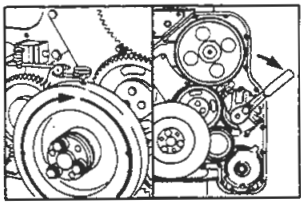
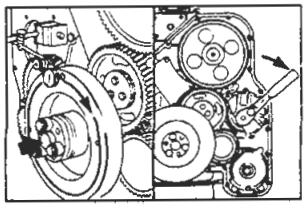
	Part or Assembly	Ref. Point	mm		in
	**Accessory Drive Gear End Clearance**		0.10 0.30	MIN MAX	0.004 0.012
	**Accessory Drive Gear Backlash**		0.08 0.41	MIN MAX	0.003 0.016
	**Cam Follower Side Clearance Between Supports**		0.76	MIN	0.030

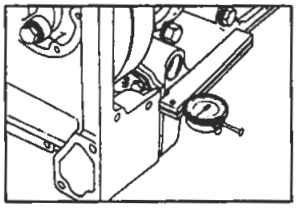
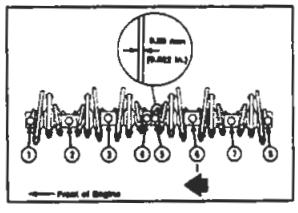
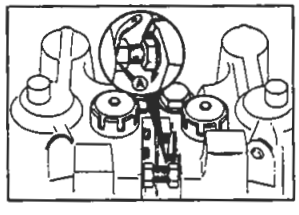
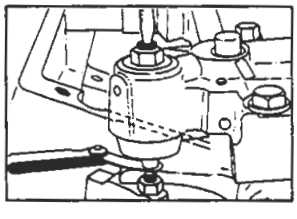
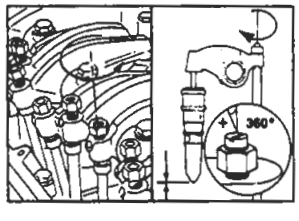
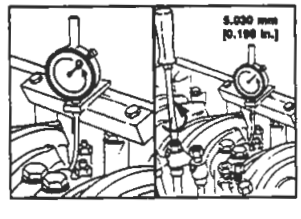
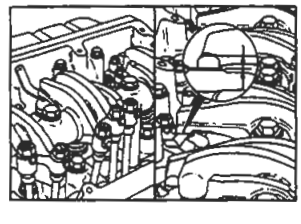
Timing Code	Push Rod Travel @ 5.161 mm [0.2032 in.] BTDC Piston Travel Position
CX	1.98 - 2.08 mm [0.078 - 0.082 inch]
CY	1.85 - 1.96 mm [0.073 - 0.077 inch]
FC	2.11 - 2.21 mm [0.083 - 0.087 inch]
FJ	2.03 - 2.13 mm [0.080 - 0.084 inch]
FN	2.36 - 2.46 mm [0.093 - 0.097 inch]
FO	2.44 - 2.79 mm [0.096 - 0.100 inch]
FS	2.24 - 2.34 mm [0.088 - 0.092 inch]

Injection Timing

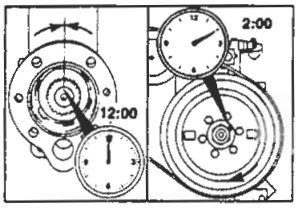
To verify the correct injection timing for a particular engine refer to the engine dataplate.

Refer to Group 00, Engine Assembly, Injection Timing, Page 0-85, for complete instructions.

	**Gear Driven Fan Clutch Gear Backlash**		0.08 0.38	MIN MAX	0.003 0.015
	**Vibration Damper Eccentricity TIR**		6.87	MAX	0.011
	**Vibration Damper Face Alignment ("Wobble") TIR**		6.87	MAX	0.011

Part or Assembly	Ref. Point	mm		In	
Gear Cover Alignment With Oil Pan Mounting Flange		−0.15 +0.15	MIN MAX	−0.006 +0.006	
Rocker Lever Side Clearance		0.55	MIN	0.022	
Jacobs® Brake Oil Connector Screw Clearance	A	0.13 0.38	MIN MAX	0.005 0.015	
Jacobs® Brake Slave Piston Clearance All Non-CARB Engines (49 states) All CARB (California) All 88 L10 (50 states)		 0.46 0.38 0.38	 MIN MIN MIN	 0.018 0.015 0.015	
Top-Stop Injector Adjustment Refer to Engine Assembly Group 00, Top-Stop Injector Adjustment, Page 0-115.					
Non-Top-Stop Injector Adjustment Plunger Travel Refer to Engine Assembly, Group 00, Non-Top-Stop Injector Adjustment, Page 0-116.		5.030	MIN	0.198	
Intake Valve Clearance **Exhaust Valve Clearance**		0.36 0.69	MIN MIN	0.014 0.027	

Part or Assembly	Ref. Point	mm	in

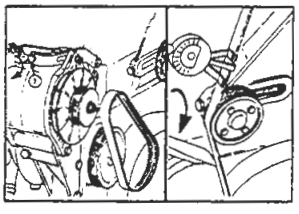


Air Compressor to Accessory Drive Timing

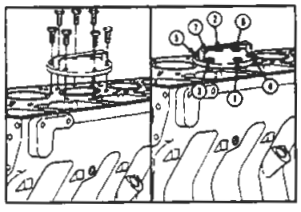
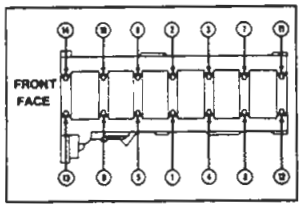
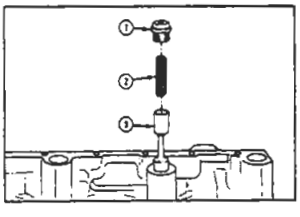
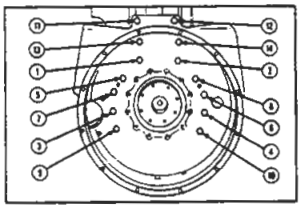
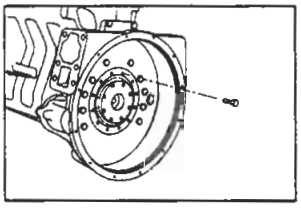
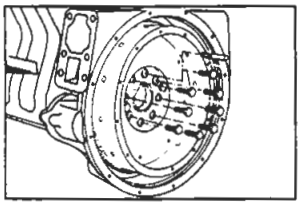
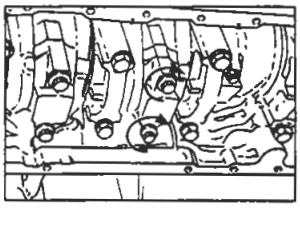
Position the air compressor crankshaft timing mark at the 12:00 o'clock position.

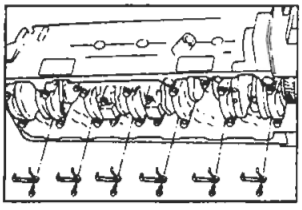
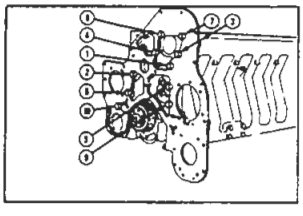
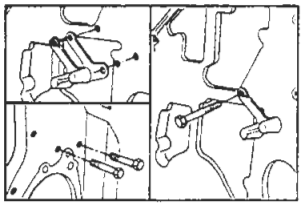
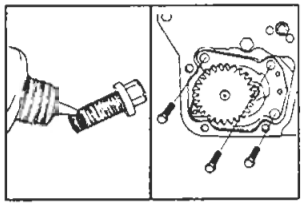
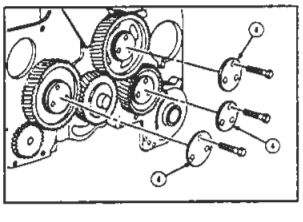
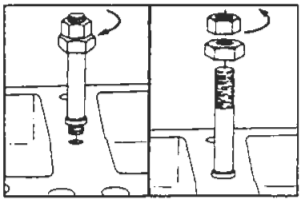
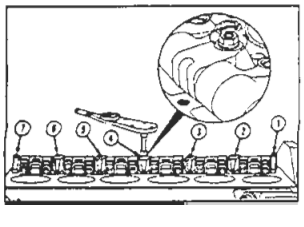
Position the accessory drive shaft dowel pin at the 2:00 o'clock position.

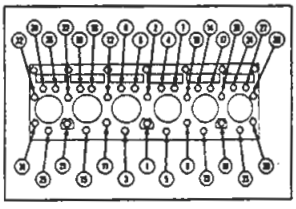
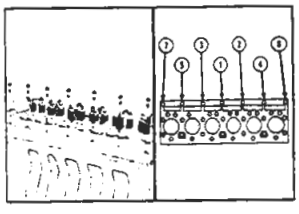
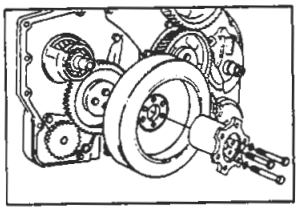
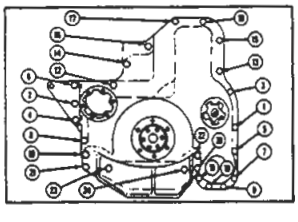
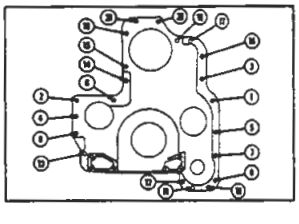
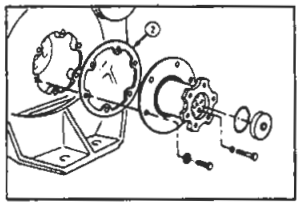
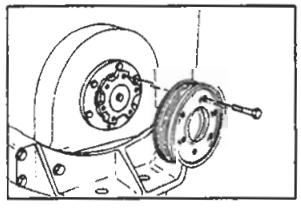
Belt Tension	Ref. Point	Newtons		Pounds
Alternator Belt		445	MIN	100
		490	MAX	110
Fan Belt		890	MIN	200

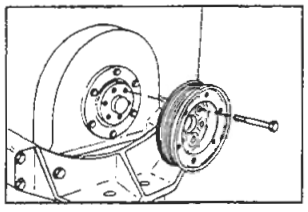
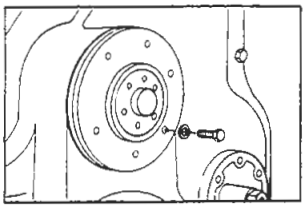
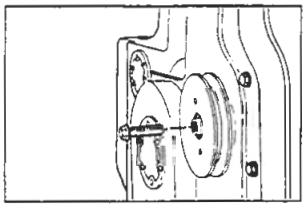
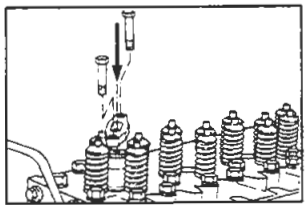
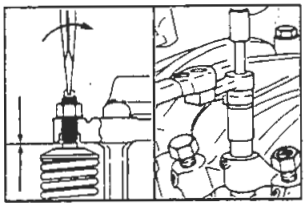
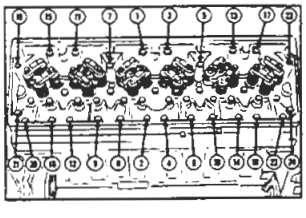
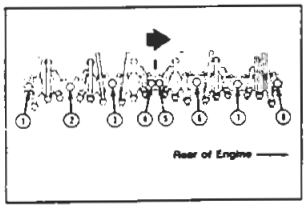


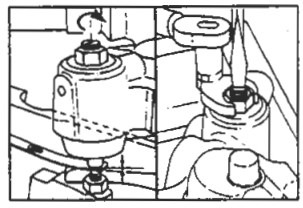
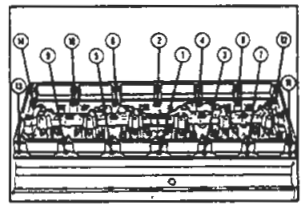
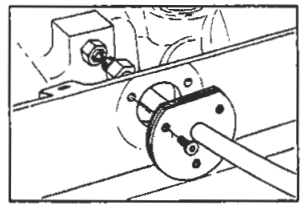
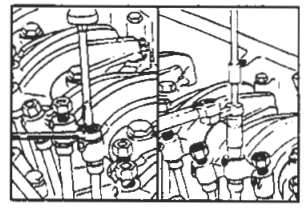
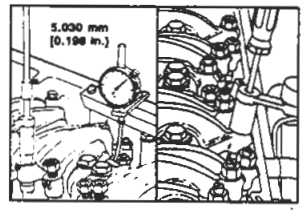
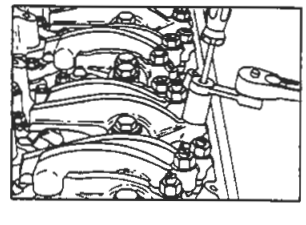
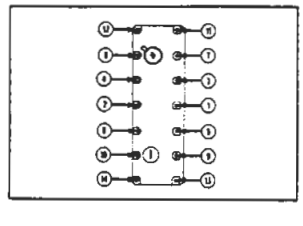
Engine Assembly - Capscrew Torque Values

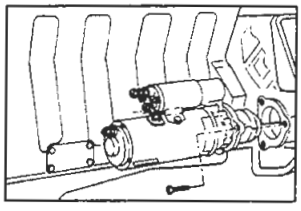
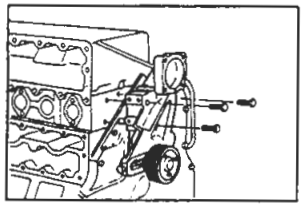
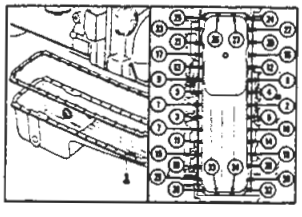
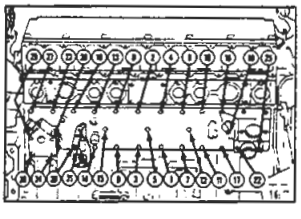
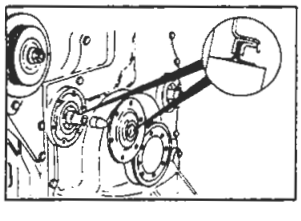
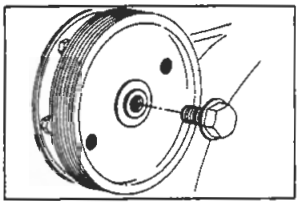
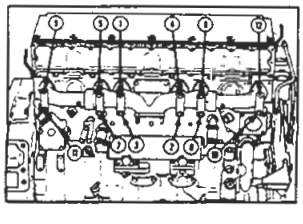
Part or Assembly	Step	Torque Values N•m	Torque Values ft-lb	
Cylinder Liner Clamping Plate **Note:** Tighten the capscrews in the sequence marked on the clamping plate.	1	50	35	
	2	100	70	
	3	140	105	
Main Bearing **Note:** Tighten the capscrews in the sequence shown.	1	70	50	
	2	140	105	
	3	210	155	
	4	Loosen All		
	5	70	50	
	6	140	105	
	7	210	155	
Main Oil Pressure Regulator Retainer Plug (1)		75	55	
Flywheel Housing **Note:** Tighten the capscrews in the sequence shown.	1	65	50	
	2	130	95	
	3	195	145	
Crankshaft Rear Oil Seal **Note:** Tighten in a star pattern.	1	7	60 in-lb	
	2	19	170 in-lb	
Flywheel **Note:** Tighten the capscrews in a star pattern.		185	135	
Connecting Rod	1	70	50	
	2	140	105	
	3	210	155	
	4	Loosen All		
	5	70	50	
	6	140	105	
	7	210	155	

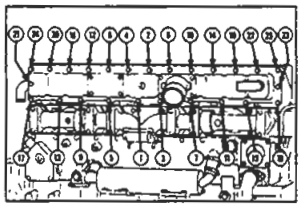
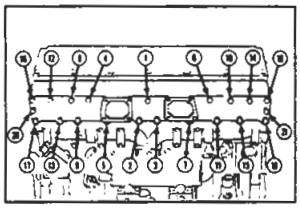
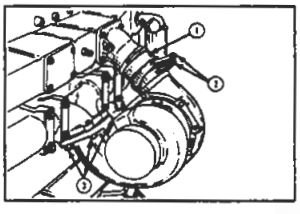
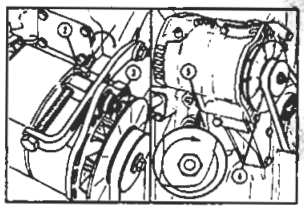
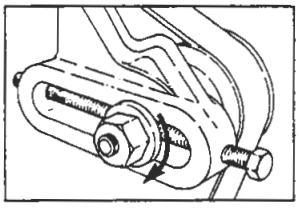
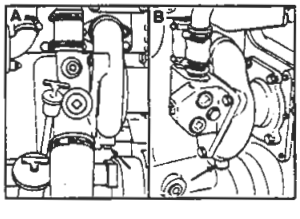
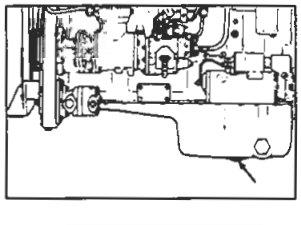
	Part or Assembly	Procedure No.	N•m	ft-lb
	**Piston Cooling Nozzle**		27	18
	**Gear Support Plate:** • Grade 8.8 Capscrews • Grade 10.9 Capscrews **Note:** Tighten the capscrews in a star pattern starting with a capscrew toward the center as shown.		45 65	35 50
	**Accessory Drive Oil Transfer Connection:** • M8-1.50X20 Capscrews • M10-1.50X30 Capscrews		16 45	144 in-lb 35
	**Lubricating Oil Pump** **Note:** Use Loctite 272® or equivalent to coat the threads of the capscrews.		25	20
	**Idler Gear Cover Plate:** • Grade 10.9 Capscrews • Grade 12.9 Capscrews		65 60*	50 45* *plus 60 degrees
	**Cam Follower Support Studs** **Note:** Install the cam follower support studs with two (M10X1.5) nuts tightened together. Remove the nuts after the studs are tightened.		35	25
	**Cam Follower Support Nuts**		45	35

Part or Assembly	Step	Torque Values N•m	ft-lb	
Cylinder Head **Note:** Tighten the cylinder head capscrews in the sequence shown.	1 2 3 4 5 6 7	100 175 235 Loosen All 100 175 235	75 125 175 75 125 175	
Cylinder Head (Fuel Pump Side) Tighten the capscrews in the sequence shown.		45	35	
Vibration Damper and Crankshaft Adapter **Note:** Tighten the capscrews in a star pattern. The present production crankshaft adapter **must** be removed before the gear cover is installed.		150	110	
Gear Cover (Belt and Low Mount Gear Driven Fan) **Note:** Tighten the capscrews in the sequence shown.		45	35	
Gear Cover (High Mount Gear Driven Fan) **Note:** Tighten the capscrews in the sequence shown.		45	35	
Front Crankshaft Oil Seal **Crankshaft Adapter**	1 2	6 15 150	50 in-lb 130 in-lb 110	
Crankshaft Pulley (Present Production Style) **Note:** Tighten the capscrews in a star pattern.		65	50	

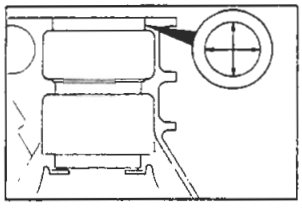
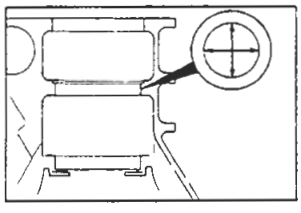
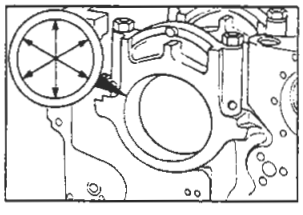
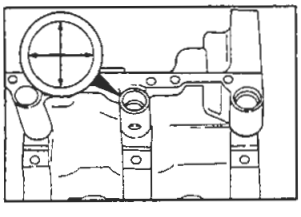
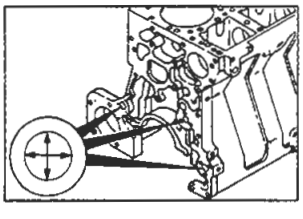
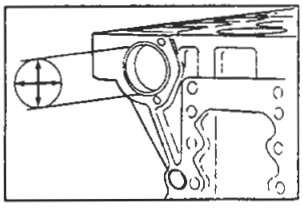
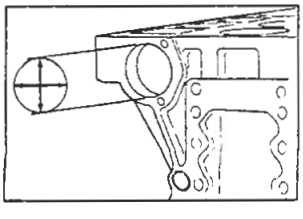
	Part or Assembly	Step	Torque Values N•m	Torque Values ft-lb
	**Crankshaft Pulley (Earlier Production Style)** **Note:** The three capscrews and spacers **must** be removed from the crankshaft adapter. Tighten the six capscrews in a star pattern.		150	110
	**Gear Driven Fan Clutch Oil Seal**	1 2	6 15	50 in-lb 130 in-lb
	Accessory Drive Oil Seal	1 2	6 15	50 in-lb 130 in-lb
	**Accessory Drive Pulley**		540	400
	**Injector Hold-Down Clamp**	1 2 3	5 10 15	45 in-lb 90 in-lb 130 in-lb
	**Crosshead - Adjusting Screw Locknut:** • (Without Torque Wrench Adapter) • (With ST-669 Torque Wrench Adapter)		40 30	30 25
	**Rocker Lever Housing** **Note:** Tighten the capscrews in the sequence shown.		45	35
	**Rocker Lever Assembly**		125	90

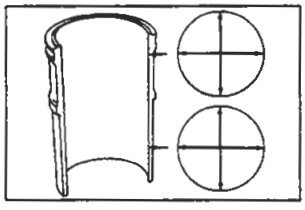
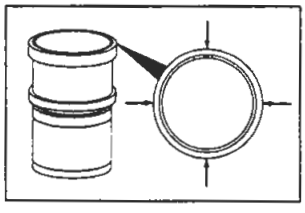
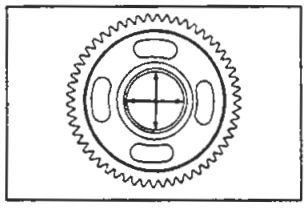
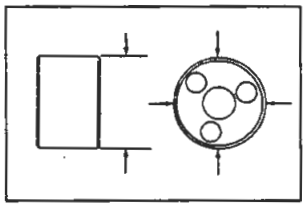
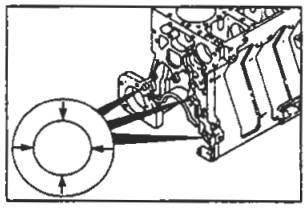
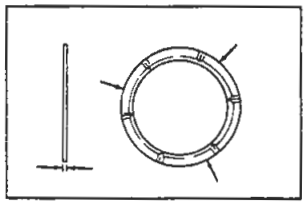
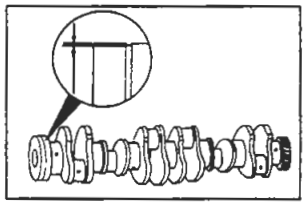
Part or Assembly	Procedure No.	Nem	ft-lb	
Jacobs® Brake Slave Piston				
Adjusting Screw Locknut:				
• (Without Torque Wrench Adapter)		50	40	
• (With ST-669 Torque Wrench Adapter)		45	35	
Jacobs® Brake Housing Spacer		25	18	
Note: Tighten the capscrews in the sequence shown.				
Jacobs® Brake Oil Connector Plate		15	130 in-lb	
Top-Stop Injector Lever Adjusting Screw Locknut:				
• (Without Torque Wrench Adapter)		60	45	
• (With ST-669 Torque Wrench Adapter)		45	35	
Non-Top-Stop Injector Lever Adjusting Screw Locknut:				
• (Without Torque Wrench Adapter)		60	45	
• (With ST-669 Torque Wrench Adapter)		45	35	
Valve Rocker Lever Adjusting Screw Locknut:				
• (Without Torque Wrench Adapter)		60	45	
• (With ST-669 Torque Wrench Adapter)		45	35	
Rocker Lever Cover		15	130 in-lb	
Note: Tighten the capscrews in the sequence shown.				

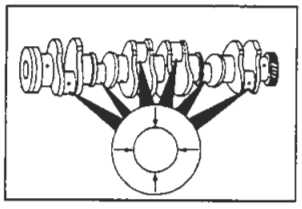
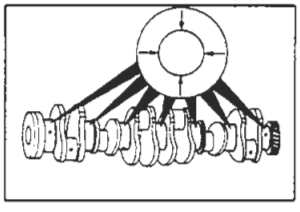
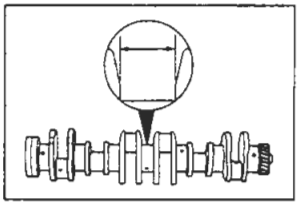
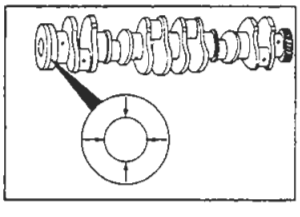
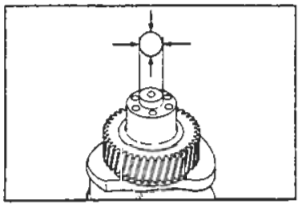
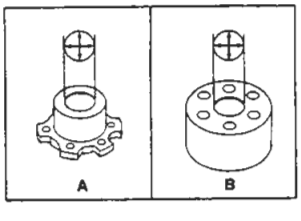
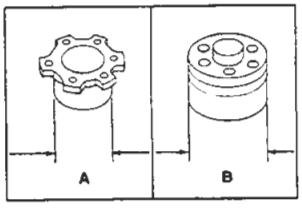
	Part or Assembly	Procedure No.	N•m	ft-lb
	**Starting Motor Mounting**		190	140
	**Fan Hub Support (Belt Driven Fan)**		75	55
	**Lubricating Oil Pan** **Note:** Tighten the capscrews in the sequence shown.		45	35
	**Water Header Plate** **Note:** Tighten the capscrews in the sequence shown.		55	40
	**Alternator Drive/Water Pump Oil Seal** **Note:** Tighten the capscrews in a star pattern.	1 2	7 19	60 in-lb 170 in-lb
	**Alternator Drive Pulley**		115	85
	**Exhaust Manifold** **Note:** Tighten the capscrews in the sequence shown.	1 2	35 65	25 50

Part or Assembly	Procedure No.	Nm	ft-lb	
Aftercooler Housing **Note:** Tighten the capscrews in the sequence shown.		45	35	
Air Manifold Side Cover **Note:** Tighten the capscrews in the sequence shown.		45	35	
Turbocharger - "T-bolt" Clamps (2) Turbocharger - Mounting Nuts (3)		8 60	72 in-lb 45	
Alternator Adjusting Screw Locknuts (2 and 3) **Alternator Mounting Bracket (4) and nut (5)**		80 45	60 35	
Idler Pulley Shaft Locknut		190	140	
Drain Plugs (Coolant) Refer to Engine Diagrams, Pages i-13 and i-14 for the location of the coolant drain plugs.		20	15	
Drain Plug (Lubricating Oil Pan)		95	70	

Cylinder Block - Rebuild Specifications

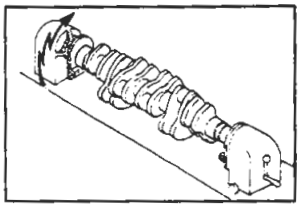
	Part or Assembly	Ref. Point	mm		In
	Cylinder Block Upper Liner Bore I.D.		145.900 146.027	MIN MAX	5.7441 5.7491
	Cylinder Block Liner Seal Seat Bore I.D.		138.063 138.113	MIN MAX	5.4355 5.4375
	Main Bearing Bore I.D.		121.990 122.015	MIN MAX	4.8028 4.8037
	Main Oil Pressure Regulator Valve Bore I.D.		22.226 22.301	MIN MAX	0.8750 0.8780
	Idler Gear Ring Dowel Bore I.D.		19.175 19.215	MIN MAX	0.7549 0.7565
	Camshaft Bushing I.D. (Installed)		72.078 72.142	MIN MAX	2.8377 2.8402
	Note: If one of the bushings exceeds the specifications, all of the bushings **must** be replaced.				
	Cylinder Block Camshaft Bore I.D.		76.987 77.040	MIN MAX	3.0310 3.0331

Part or Assembly	Ref. Point	mm		in	
Cylinder Liner I.D.		125.00 125.14	MIN MAX	4.921 4.927	
Cylinder Liner Top Press Fit O.D.		145.962 146.000	MIN Max	5.7465 5.7480	
Idler Gear Bushing Bore I.D.		60.045 60.100	MIN MAX	2.3640 2.3661	
Idler Gear Shaft O.D.		59.975 59.993	MIN MAX	2.3612 2.3619	
Idler Gear Ring Dowel O.D.		19.217 19.243	MIN MAX	0.7566 0.7576	
Idler Gear Thrust Washer Thickness		2.400 2.470	MIN MAX	0.0945 0.0972	
Crankshaft Rear Oil Seal Wear Groove		0.25	MAX	0.010	

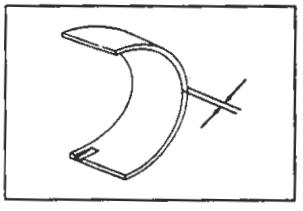
	Part or Assembly	Ref. Point	mm		in
	**Crankshaft Connecting Rod Journal O.D.**		78.950 79.013	MIN MAX	3.1083 3.1107
	**Crankshaft Main Bearing Journal O.D.**		113.990 114.055	MIN MAX	4.4878 4.4903
	**Crankshaft Thrust Face Width**		49.975 50.100	MIN MAX	1.9675 1.9724
	**Crankshaft Rear Oil Seal Flange O.D.**		164.965 165.035	MIN MAX	6.4947 6.4974
	**Crankshaft Damper Pilot O.D.**		32.02 32.05	MIN MAX	1.2606 1.2618
	**Crankshaft Adapter Crankshaft Pilot I.D.** Flanged (A) Non-Flanged (B)		32.05 32.13	MIN MAX	1.2618 1.2650
	**Crankshaft Adapter O.D.** Flanged (A) Non-Flanged (B)		89.975 90.000	MIN MAX	3.5423 3.5433

Part or Assembly	Ref. Point	mm		In

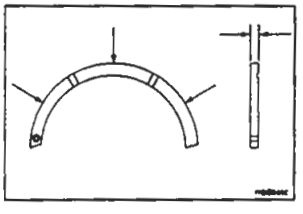
Note: The instructions for performing a magnetic crack inspection and the limits of acceptance for open and subsurface indications are provided in Cylinder Block - Group 01. Refer to Crankshaft - Magnetic Crack Inspection (01-08), Page 1-31.



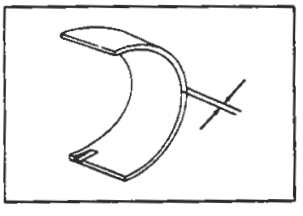
Main Bearing Shell Thickness (Standard)		3.895 3.944	MIN MAX	0.1533 0.1553



Crankshaft Thrust Bearing Thickness		4.75 4.89	MIN MAX	0.1870 0.1925

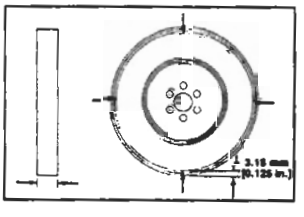


Connecting Rod Bearing Thickness (Standard)		2.430 2.473	MIN MAX	0.0957 0.0974

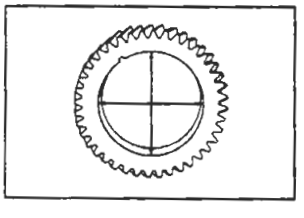


Vibration Damper Thickness

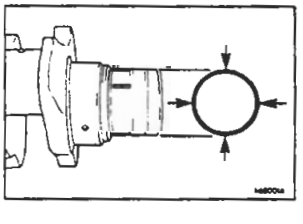
Measure the thickness in four places 90 degrees apart approximately 3.18 mm [0.125 inch] from the outside diameter. The difference between any two of the four measurements must not exceed 0.25 mm [0.010 inch].

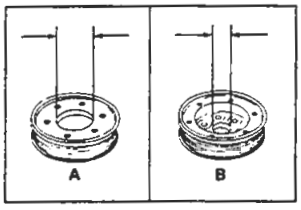
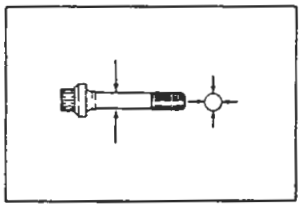
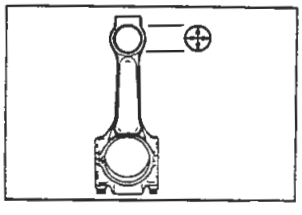
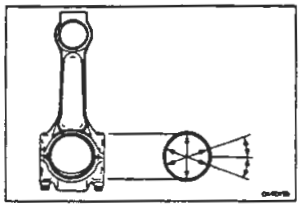
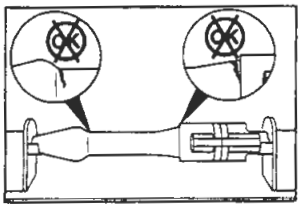
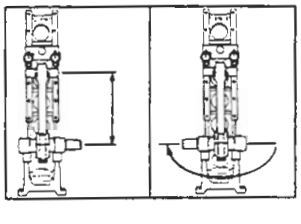
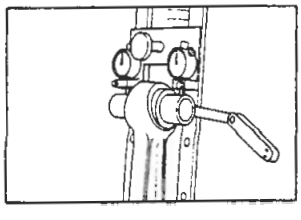


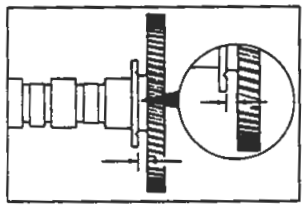
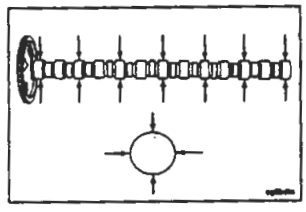
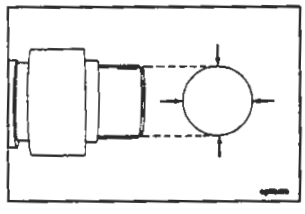
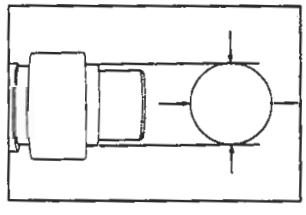
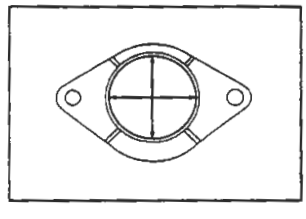
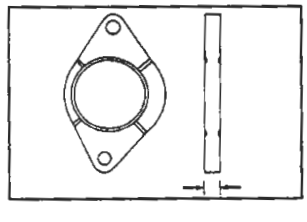
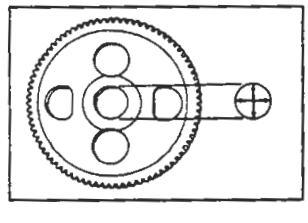
Crankshaft Gear Bore I.D.		85.910 85.935	MIN MAX	3.3823 3.3833



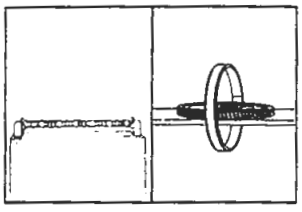
Crankshaft Gear Journal O.D.		85.975 86.000	MIN MAX	3.3848 3.3858



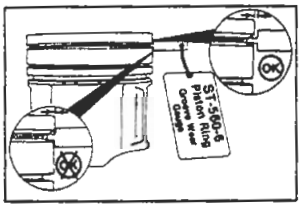
Part or Assembly	Ref. Point	mm		in
				
Crankshaft Pulley Crankshaft Pilot Bore I.D.				
• Flanged Crankshaft Adapter	A	49.25 50.75	MIN MAX	1.939 1.998
• Non-Flanged Crankshaft Adapter	B	32.05 32.13	MIN MAX	1.2618 1.2650
				
Connecting Rod Capscrew O.D.		12.60 12.80	MIN MAX	0.496 0.504
				
Connecting Rod Piston Pin Bushing I.D. (Installed)		54.054 54.100	MIN MAX	2.1281 2.1299
				
Connecting Rod Bearing Bore I.D.		83.987 84.013	MIN MAX	3.3066 3.3076
				
The instructions for performing a magnetic crack inspection of the connecting rod is provided in Group 01. Refer to Connecting Rods - Magnetic Inspection (01-15), Page 1-45.				
				
Connecting Rod - Length		217.975 218.025	MIN MAX	8.5817 8.5836
Connecting Rod - Alignment:				
• (Without Bushing)		0.25	MAX	0.010
• (With Bushing)		0.10	MAX	0.004
				
Connecting Rod - Twist:				
• (Without Bushing)		0.50	MAX	0.020
• (With Bushing)		0.25	MAX	0.010

Part or Assembly	Ref. Point	mm		in	
Camshaft Thrust Plate Clearance		0.13 0.33	MIN MAX	0.005 0.013	
Camshaft Bushing Journal O.D.		71.987 72.013	MIN MAX	2.8341 2.8352	
Camshaft Nose (Gear Mounting Surface) O.D.		46.987 47.013	MIN MAX	1.8499 1.8509	
Camshaft Thrust Bearing Journal O.D.		54.80 55.20	MIN MAX	2.157 2.173	
Camshaft Thrust Plate I.D.		55.60 56.61	MIN MAX	2.189 2.229	
Camshaft Thrust Plate Thickness		8.96 9.04	MIN MAX	0.353 0.356	
Camshaft Gear Bore I.D.		46.912 46.938	MIN MAX	1.8469 1.8480	

Part or Assembly	Ref. Point	mm		in

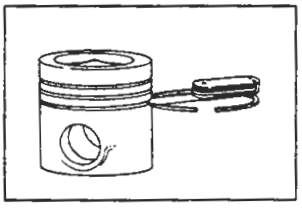


The instructions for performing a magnetic crack inspection of the camshaft and camshaft gear is provided in Group 01. Refer to Camshaft - Magnetic Crack Inspection (01-19), Page 1-54 and Camshaft or Idler Gear - Magnetic Crack Inspection (01-20), Page 1-56.



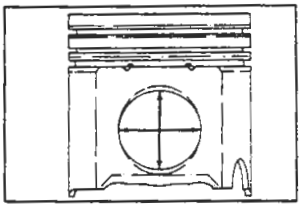
Piston Compression Ring Grooves Width

Use the Part No. ST-560-6 Piston Ring Groove Wear Gauge. The piston **must** be replaced if the widest part of the gauge touches the piston.

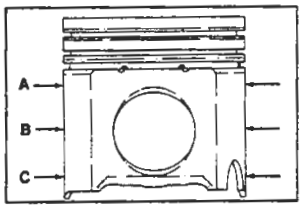


Piston Oil Ring Groove Width

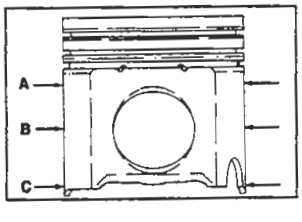
Use a new oil ring and a 0.152 mm [0.006 inch] feeler gauge. If the feeler gauge enters the oil ring groove without resistance the piston must be replaced.



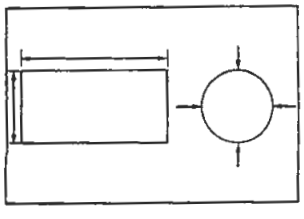
Piston Pin Bore I.D.			
• (Part No. 3037820 Piston)	53.989	MIN	2.1255
	54.030	MAX	2.1272
• (Part No. 3044448 Piston)	54.007	MIN	2.1263
	54.015	MAX	2.1266



Piston Skirt O.D.	124.772	MIN	4.912
• (Part No. 3037820 Piston)	124.789	MAX	4.913
Temperature: 21°C [70°F]			



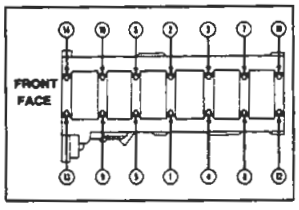
Piston Skirt O.D.	124.824	MIN	4.914
• (Part No. 3044448 Piston)	124.856	MAX	4.916
Temperature: 21°C [70°F]			

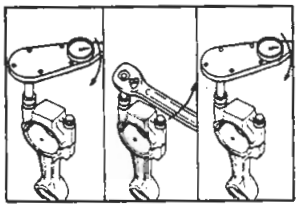


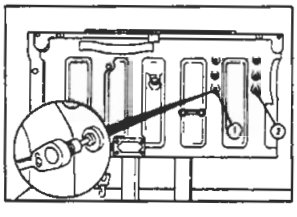
Piston Pin Length	98.150	MIN	3.8600
	98.350	MAX	3.8700
Piston Pin O.D.	53.997	MIN	2.1258
	54.003	MAX	2.1260

Cylinder Block - Torque Values

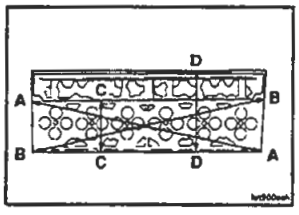
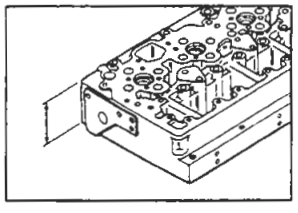
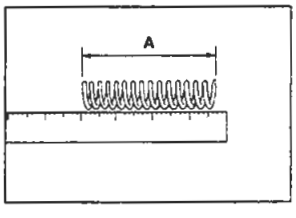
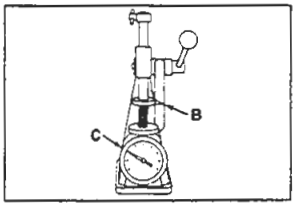
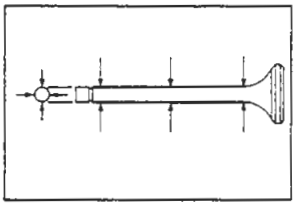
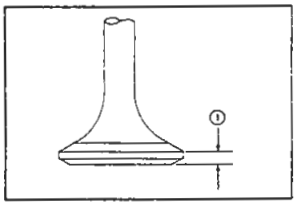
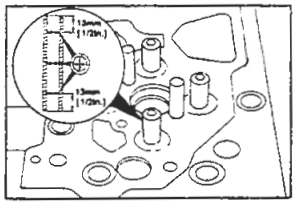
Part or Assembly	Step	Torque Values N•m	Torque Values ft-lb
Main Bearing Capscrews	1	70	50
Note: Tighten the main bearing capscrews in the sequence shown.	2	140	105
	3	210	155
	4	Loosen All	
	5	70	50
	6	140	105
	7	210	155
Connecting Rod Capscrews	1	70	50
	2	140	105
	3	210	155
	4	Loosen All	
	5	70	50
	6	140	105
	7	210	155
Cylinder Block Pipe Plugs		15	11

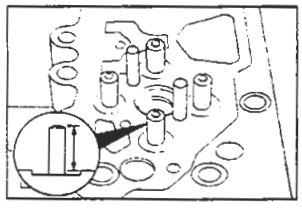
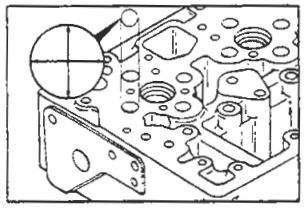
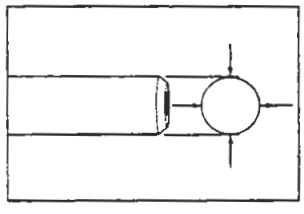
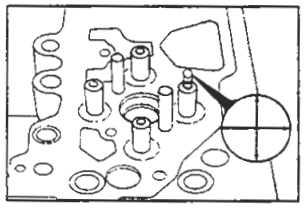
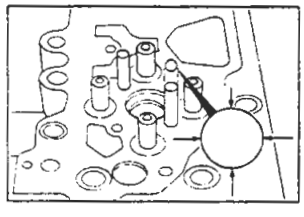
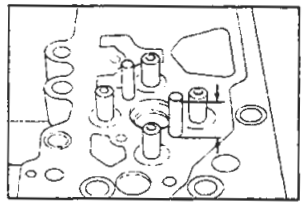
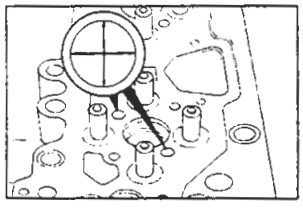


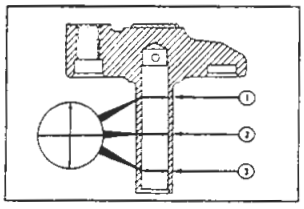
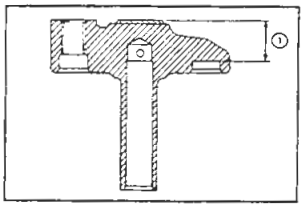
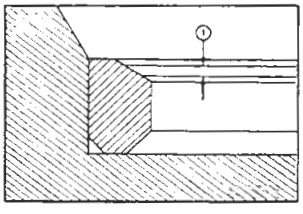
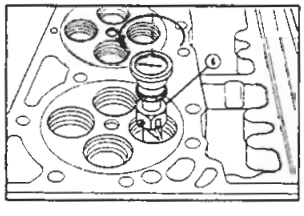
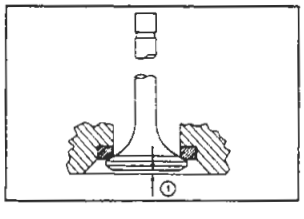
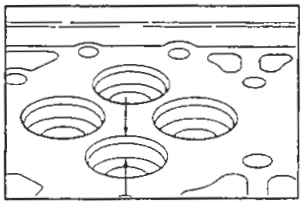
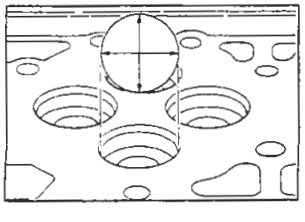




Cylinder Head - Rebuild Specifications

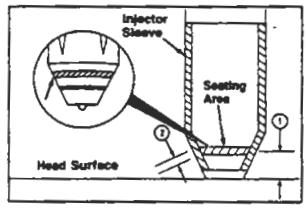
Part or Assembly	Ref. Point	mm		in
				
Cylinder Head Flatness				
AA and BB (Corner to Corner)		0.200	MAX	0.008
CC (Across Combustion Face)		0.076	MAX	0.003
DD (Across Entire Head Surface)		0.127	MAX	0.005
Note: Dimension CC and DD must be checked from font to rear of head.				
				
Cylinder Head Thickness		99.24	MIN	3.907
		100.25	MAX	3.947
				
Valve Spring Free Height:	A			
• Outer		83.72	Nominal	3.296
• Inner		78.71	Nominal	3.099
				
Valve Spring Working Height:	B			
• Outer		52.65	Nominal	2.073
• Inner		45.29	Nominal	1.783
Load for Working Height:	C			
• Outer		977 N	MIN	219 lbf
		1077 N	MAX	242 lbf
• Inner		417 N	MIN	94 lbf
		471 N	MAX	106 lbf
				
Valve Stem O.D.		9.580	MIN	0.3772
		9.633	MAX	0.3793
				
Valve Head Thickness at O.D.	1	3.15	MIN	0.124
		3.62	MAX	0.143
				
Valve Guide (Used) I.D. (Installed)		9.670	MIN	0.3807
		9.730	MAX	0.3831

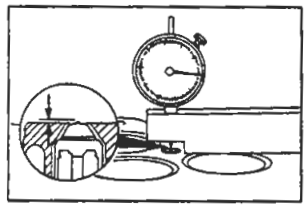
Part or Assembly	Ref. Point	mm		in	
Valve Guide Height (Installed)		36.15 36.65	MIN MAX	1.423 1.443	
Valve Guide Bore I.D.		16.480 16.500	MIN MAX	0.6488 0.6496	
Valve Guide (New) O.D.		16.513 16.526	MIN MAX	0.6501 0.6506	
Valve Guide (New) I.D. (Installed)		9.670 9.695	MIN MAX	0.3807 0.3817	
Crosshead Guide O.D.		10.975 11.011	MIN MAX	0.4321 0.4335	
Crosshead Guide Height (Installed)		47.25 47.75	MIN MAX	1.860 1.880	
Crosshead Guide Bore I.D.		10.947 10.972	MIN MAX	0.4310 0.4320	

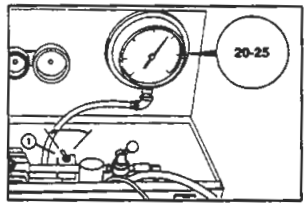
	Part or Assembly	Ref. Point	mm		In
	**Valve Crosshead Stem Bore I.D.**	1 2 3	11.037 11.175	MIN MAX	0.4345 0.4400
	**Valve Crosshead Stem Pocket to Pad Face**	1	10.55 11.05	MIN MAX	0.415 0.435
	**Valve Seat Area Width**	1	1.63 2.69	MIN MAX	0.064 0.106
	**Valve Seat to Valve Guide Concentricity (Per 360 Degrees)**		0.05	MAX	0.002
	**Valve Recess in Cylinder Head** Engines Built Before 1988 Engines Built 1988 and after	1	 0.04 0.46 0.76 1.17	 MIN MAX MIN MAX	 0.002 0.018 0.030 0.046
	**Valve Insert Bore Depth (Standard Insert)** Engines Built Before 1988 Engines Built 1988 and after		 8.71 8.81 9.40 9.50	 MIN MAX MIN MAX	 0.343 0.347 0.370 0.374
	**Valve Insert Bore I.D. (Standard Insert)**		45.920 45.935	MIN MAX	1.8073 1.8085

Note: Refer to Cylinder Head - Install Oversize Valve Seat Inserts (02-05), Page 2-23, for oversize valve insert dimensions.

Part or Assembly	Ref. Point	mm		In
Injector to Injector Sleeve Seat Pattern:				
• Distance from Cylinder Head Surface	1	13.0	Approx.	0.50
• Pattern Width	2	1.52	MIN	0.060
Injector Tip Protrusion:				
• (Used Injector Sleeve)		2.28	MIN	0.090
		2.65	MAX	0.104
• (New Injector Sleeve)		2.28	MIN	0.090
		2.54	MAX	0.100
Valve Seat Leakage (Hg)		508	MIN	20
		685	MAX	25

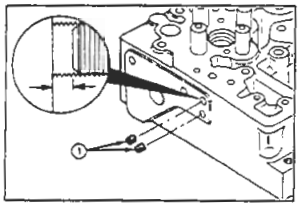
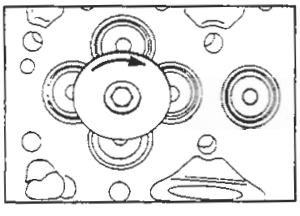
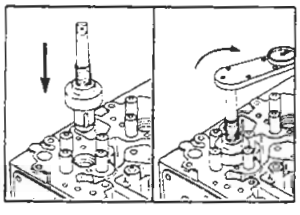
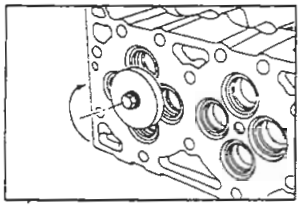
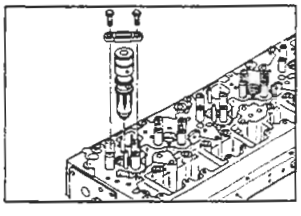
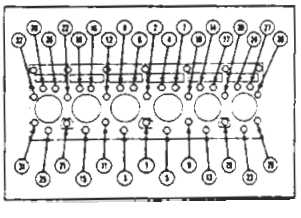


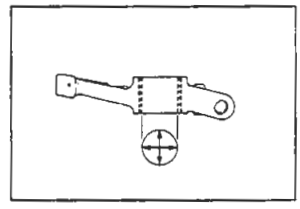
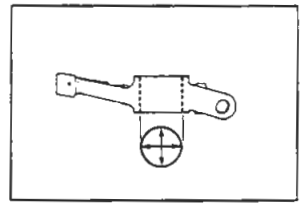
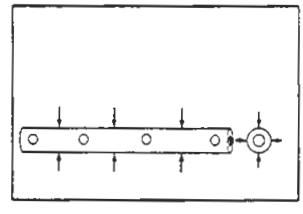
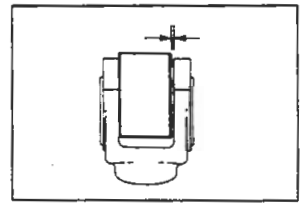
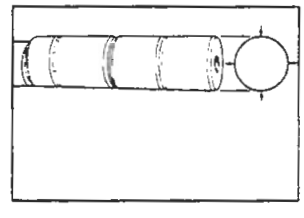
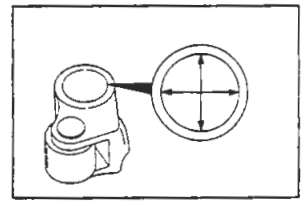
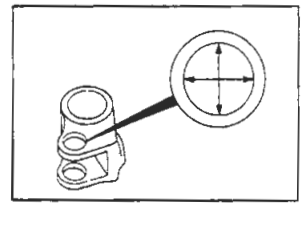


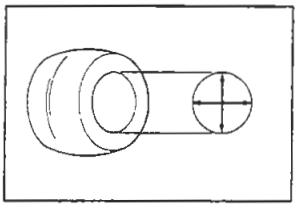
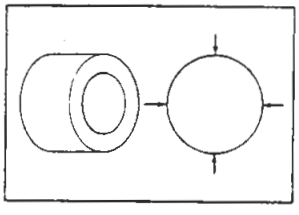
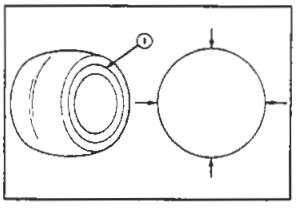
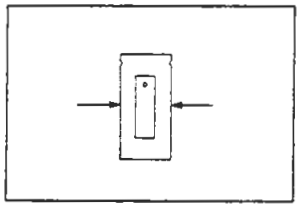
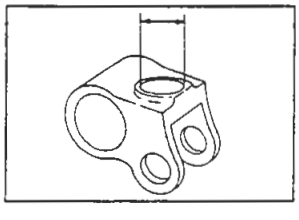
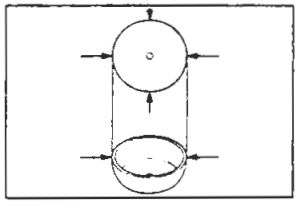


Note: Refer to Cylinder Head - Vacuum Test Valve Seating (02-10), Page 2-32.

Cylinder Head - Torque Values

Part or Assembly	Step	Torque Values N•m	Torque Values ft-lb
 **Cylinder Head Pipe Plugs** **Note:** The pipe plugs (1) located in the front of the cylinder head **must** be installed below the surface of the cylinder head.		10	8
 **Injector Sleeve Holding Tool Capscrew** **Note:** This torque value is for installing new injector sleeves. Refer to Cylinder Head - Replace Injector Sleeves (02-08), Page 2-27.		50	38
 **Injector Sleeve Expander Mandrel**		8.5	75 in-lb
 **Injector Sleeve Holding Tool Capscrew** **Note:** This torque value is for pressure testing the cylinder head. Refer to Cylinder Head-Pressure Test for Reuse (02-09), Page 2-30.	1 2 3	5 10 15	45 in-lb 90 in-lb 130 in-lb
 **Injector Hold-Down Clamp Capscrews**	1 2 3	5 10 15	45 in-lb 90 in-lb 130 in-lb
 **Cylinder Head Capscrew Torque** Refer to Engine Assembly Torque Values, Page 18-17.			

Part or Assembly	Ref. Point	mm		in	
Rocker Lever Assembly - Rebuild Specifications					
Rocker Lever Bushing Bore I.D.		34.887 34.990	MIN MAX	1.3735 1.3776	
Rocker Lever Bore I.D.		36.474 36.500	MIN MAX	1.4359 1.4370	
Rocker Lever Shaft O.D.		34.820 34.863	MIN MAX	1.3709 1.3726	
Cam Follower Assembly - Rebuild Specifications					
Cam Follower Roller Side Clearance		0.20 0.66	MIN MAX	0.008 0.026	
Cam Follower Shaft Journal O.D.		33.980 34.009	MIN MAX	1.3378 1.3389	
Cam Follower Lever Shaft Bore I.D.		34.086 34.115	MIN MAX	1.3420 1.3431	
Cam Follower Lever Roller Pin Bore I.D.		19.043 19.055	MIN MAX	0.7497 0.7502	

	Part or Assembly	Ref. Point	mm		in
	**Cam Follower Lever Roller Bore I.D.**		19.151 19.177	MIN MAX	0.7540 0.7550
	**Cam Follower Roller O.D.** (Earlier Production Style - Flat Roller)		41.249 41.275	MIN MAX	1.6240 1.6250
	**Cam Follower Roller O.D.** (Present Production Style - Crowned Roller) (Machined groove (1) to identify crowned roller)		41.237 41.287	MIN MAX	1.6235 1.6255
	**Cam Follower Roller Pin (New) O.D.**		19.065 19.073	MIN MAX	0.7506 0.7509
	**Cam Follower Lever Socket Bore I.D.**		19.024 19.050	MIN MAX	0.7490 0.7500
	**Cam Follower Lever Socket (New) O.D.**		19.062 19.088	MIN MAX	0.7505 0.7515

Fuel Pump - Rebuild Specifications

The disassembly, inspection, repair, assembly and calibration procedures for the fuel pump are covered in PT Fuel Pump Rebuilding and Calibration Instructions, Bulletin No. 3379084.

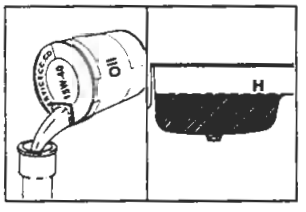
Part or Assembly	Ref. Point	mm		in

Injectors - Rebuild Specifications

The disassembly, inspection, repair and calibration procedure for the injectors are covered in Cummins PT Injectors (all types), Bulletin No. 3379071.

Part or Assembly	Ref. Point	Litres		U.S. Gallons

Lubricating Oil System



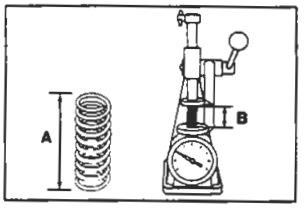
Oil Pan Capacity:

• Automotive		19.0	Low	5.0
		26.5	High	7.0
• Industrial		22.7	Low	6.0
		26.5	High	7.0

Refer to Lubrication System Specifications, page 18-2, for additional specifications.

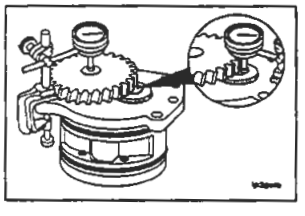
Lubricating Oil Filter Head Bypass Valve Spring:

• Free Length	A	38.6 mm	MIN	1.52 in
		42.7 mm	MAX	1.68 in
• Load at 20.3 mm [0.80 inch]	B	44.9 N	MIN	10.1 lbf
		54.7 N	MAX	12.3 lbf

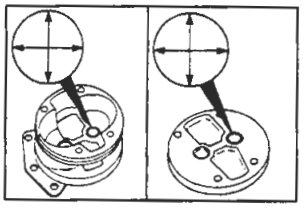


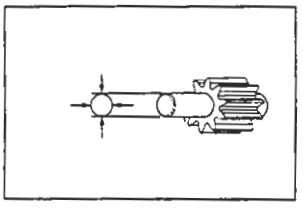
Part or Assembly	Ref. Point	mm		in.

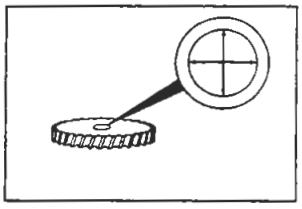
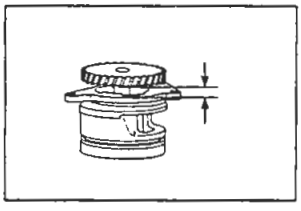
Lubricating Oil Pump - Inspection Specifications



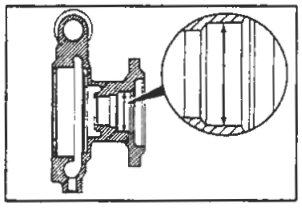
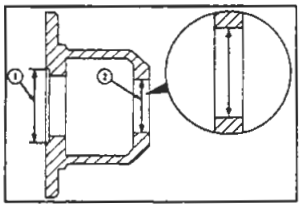
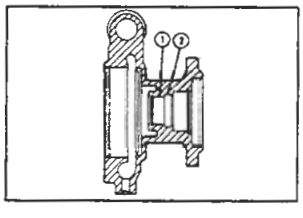
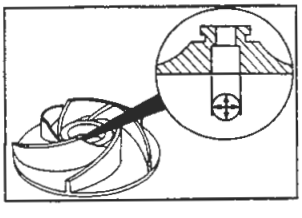
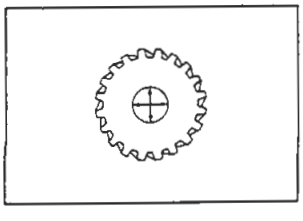
Lubricating Oil Pump Shaft End Clearance		0.064	MIN	0.0025
		0.270	MAX	0.0106
Lubricating Oil Pump Body and Cover Bushing or Shaft Bore I.D.		15.081	MIN	0.5937
		15.130	MAX	0.5957
Lubricating Oil Pump Gear Shaft O.D.		15.025	MIN	0.5915
		15.037	MAX	0.5920



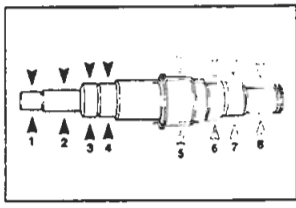


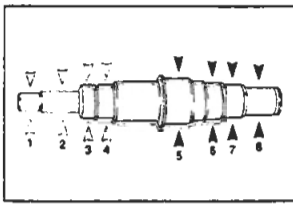
	Part or Assembly	Ref. Point	mm		in
	**Lubricating Oil Pump Drive Gear Bore I.D.**		14.95 14.98	MIN MAX	0.589 0.590
	**Lubricating Oil Pump Gear to Body Clearance**		9.50 12.00	MIN MAX	0.37 0.47

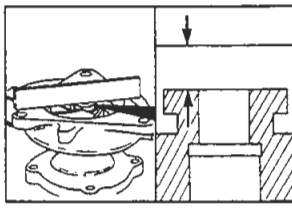
Water Pump Assembly - Rebuild Specifications

	**Water Pump Body Bearing Bore I.D.**	51.996 52.011	MIN MAX	2.0471 2.0477
	**Bearing Support Bearing Bore I.D.:**			
	• Inner Bearing Bore	1	93.00 93.05	MIN MAX	3.661 3.663
	• Outer Bearing Bore	2	61.996 62.011	MIN MAX	2.4408 2.4414
	**Water and Oil Seal Bore I.D.:**			
	• Water Seal Bore	1	36.450 36.475	MIN MAX	1.4350 1.4360
	• Oil Seal Bore	2	40.975 41.025	MIN MAX	1.6132 1.6152
	**Water Pump Impeller Bore I.D.**		15.339 15.365	MIN MAX	0.6039 0.6049
	**Water Pump Drive Gear Bore I.D.**		33.900 33.925	MIN MAX	1.335 1.336

Part or Assembly	Ref. Point	mm		in
Water Pump Shaft Journals O.D.	1	15.389 15.402	MIN MAX	0.6059 0.6064
	2	15.897 15.910	MIN MAX	0.6259 0.6264
	3	24.999 25.009	MIN MAX	0.9842 0.9846
	4	24.999 25.009	MIN MAX	0.9842 0.9846
Water Pump Shaft Journals O.D. (Cont'd.)	5	33.951 33.976	MIN MAX	1.3366 1.3376
	6	29.998 30.008	MIN MAX	1.1810 1.1814
	7	27.975 28.025	MIN MAX	1.1014 1.1033
• Earlier Production Style Shaft	8	22.175 22.200	MIN MAX	0.8730 0.8740
• Present Production Style Shaft	8	27.887 27.900	MIN MAX	1.0979 1.0984
Water Pump Impeller Hub To Body Surface Distance		13.52 13.72	MIN MAX	0.532 0.540

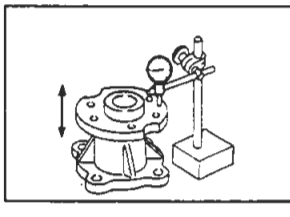






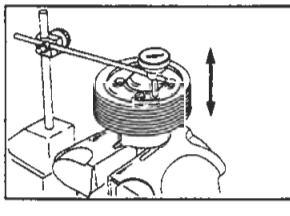
Fan Hub - Inspection Specifications

Fan Hub Shaft End Clearance		0.076 0.406	MIN MAX	0.0030 0.0160

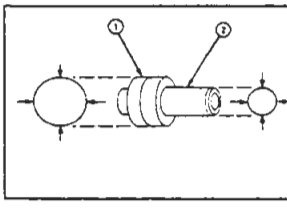


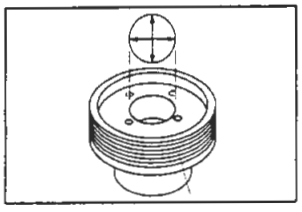
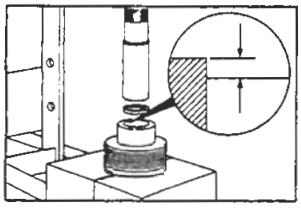
Fan Idler Pulley - Rebuild Specifications

Idler Pulley End Clearance		0.05 0.25	MIN MAX	0.002 0.010

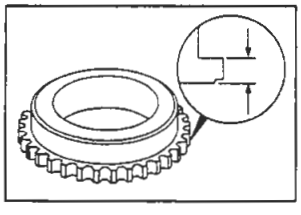
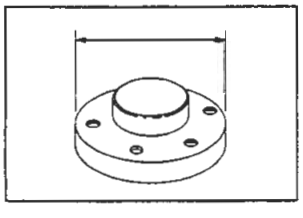
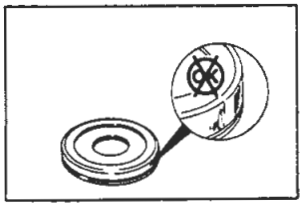
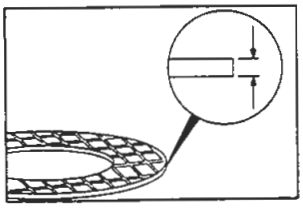
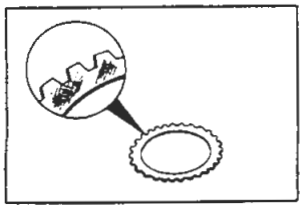


Idler Pulley Shaft O.D.:				
• Oil Seal Surface	1	32.975 33.000	MIN MAX	1.2982 1.2992
• Bearing Surface	2	19.037 19.050	MIN MAX	0.7495 0.7500



Part or Assembly	Ref. Point	mm		in
 **Idler Pulley Bearing Bore I.D.**		45.199 45.224	MIN MAX	1.7795 1.7805
Note: The front and rear bearing bores are the same inside diameter.				
 **Idler Pulley Bore Oil Seal Installed Depth**		0.00 0.25	MIN MAX	0.000 0.010
Note: Measure depth from the mounting flange surface, as shown.				

Fan Hub, Holset (Gear Driven) - Rebuild Specifications

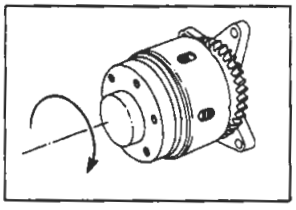
 **Fan Clutch Cover Flange Width**		8.45 8.60	MIN MAX	0.331 0.339
Note: Measure the flange width 4.0 to 10 mm [0.16 to 0.40 inch] from the edge of the flange.				
 **Fan Clutch Cover Seal Diameter**		109.98 110.03	MIN MAX	4.330 4.332
 **Fan Clutch Piston Scoring Depth**		0.00 0.38	MIN MAX	0.000 0.015
 **Clutch Plate Friction Material Thickness**		2.90	MIN	0.114
Note: The friction material must **not** crumble when scraped lightly.				
 **Fan Clutch Drive Plates Scoring Depth**		0.00 1.48	MIN MAX	0.000 0.058

Part or Assembly	Ref. Point	mm	in

Inspection - Turn the fan hub by hand to inspect for freedom of rotation. The fan hub must turn freely.

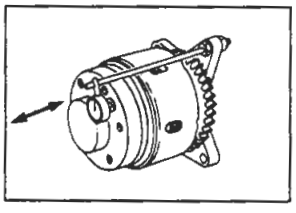
Torque:

- Less than 1 N•m [10 in-lb] if the plates were assembled dry.
- Less than 3 N•m [25 in-lb] if the plates are covered in oil.



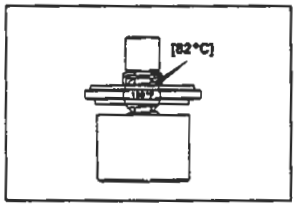
Fan Hub End Clearance

Note: The fan hub must **not** have any measureable end clearance.



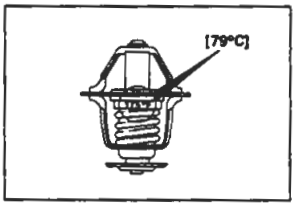
Part or Assembly	Ref. Point	Degree °C		Degree °F

Thermostat - Operating Temperature



Conventional Aftercooling Thermostat:

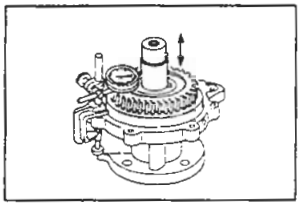
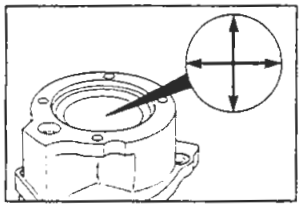
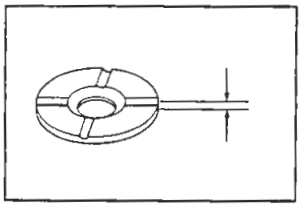
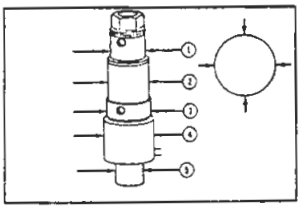
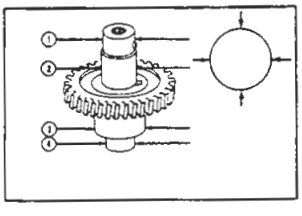
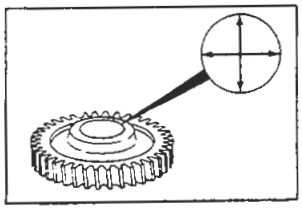
• Initial Opening Temperature	80°C	MIN	177°F
	83°C	MAX	182°F
• Fully Open Temperature	94°C	MAX	202°F
• Maximum Open Distance	9.52 mm	MAX	0.375 in.



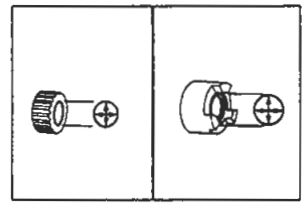
Optimized Aftercooling Thermostat:

• Initial Opening Temperature	78°C	MIN	173°F
	80°C	MAX	177°F
• Fully Open Temperature	91°C	MAX	197°F
• Maximum Open Distance	2.54 mm	MAX	0.100 in.

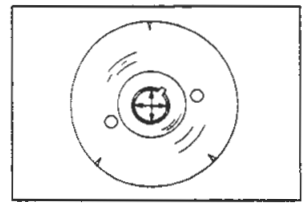
Fuel Pump and Compressor Drive - Rebuild Specifications

Part or Assembly	Ref. Point	mm		in
 **Drive Shaft End Clearance**		0.10 0.30	MIN MAX	0.004 0.012
 **Drive Housing Bearing Bore I.D.**		47.676 47.775	MIN MAX	1.8770 1.8809
 **Thrust Bearing Thickness**		6.084 6.312	MIN MAX	0.2395 0.2485
 **Drive Shaft Journal O.D.** (Hexed Head Accessory Drive Shaft)	1	32.998 33.000	MIN MAX	1.2987 1.2992
	2	37.960 38.000	MIN MAX	1.4945 1.4960
	3	40.042 40.067	MIN MAX	1.5765 1.5774
	4	47.520 47.570	MIN MAX	1.8709 1.8728
	5	25.476 25.489	MIN MAX	1.0030 1.0035
 **Drive Shaft Journal O.D.** (Non-Hexed Accessory Drive Shaft)	1	34.984 35.000	MIN MAX	1.3773 1.3779
	2	44.975 45.000	MIN MAX	1.7706 1.7716
	3	47.554 47.570	MIN MAX	1.8722 1.8728
	4	25.476 25.489	MIN MAX	1.0030 1.0035
 **Drive Gear Bore I.D.**		39.967 39.992	MIN MAX	1.5735 1.5745

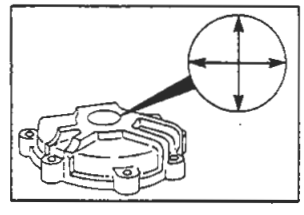
Part or Assembly	Ref. Point	mm		in
Splined Coupling I.D.		25.400	MIN	1.0000
		25.425	MAX	1.0010
Hub Coupling I.D.		25.425	MIN	1.0010
		25.438	MAX	1.0015



Drive Pulley Bore I.D.:				
• Hexed Accessory Drive Shaft		32.925	MIN	1.2963
		32.950	MAX	1.2972
• Non-Hexed Accessory Drive Shaft		34.941	MIN	1.3756
		34.965	MAX	1.3765



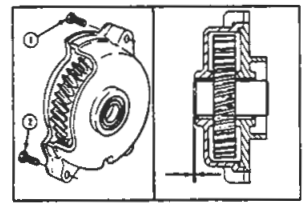
Front Support Housing Bore I.D.:				
• Hexed Accessory Drive Shaft		38.350	MIN	1.5098
		38.425	MAX	1.5128
• Non-Hexed Accessory Drive Shaft		45.100	MIN	1.7755
		45.175	MAX	1.7785



Hydraulic Pump Drive - Rebuild Specifications

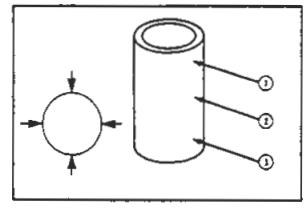
Drive Shaft End Clearance		0.127	MIN	0.0050
		0.318	MAX	0.0125

Note: Use capscrews (1 and 2) to hold the front and rear supports together while measuring the end clearance.

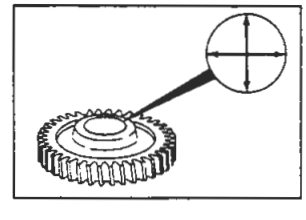


Drive Shaft O.D.		34.984	MIN	1.3773
		35.000	MAX	1.3780

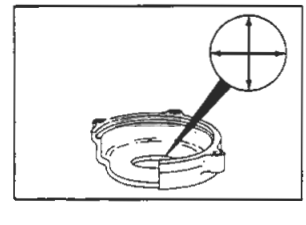
Note: Measure the drive shaft outside diameter in two positions 90 degrees apart at points (1, 2 and 3).

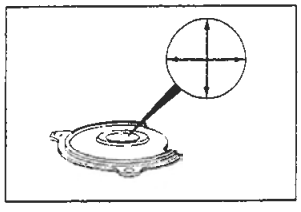
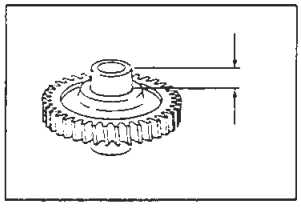
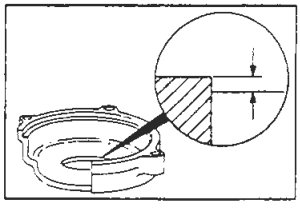
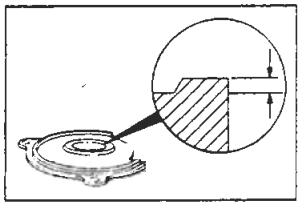


Drive Gear Bore I.D.		34.925	MIN	1.3750
		34.950	MAX	1.3760

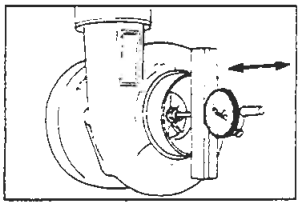
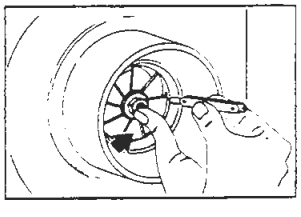
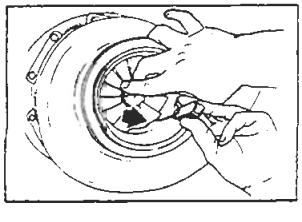


Front Support Bore I.D.		41.967	MIN	1.6522
		41.992	MAX	1.6532



	Part or Assembly	Ref. Point	mm		in
	Rear Support Bore I.D.		41.967 41.992	MIN MAX	1.6522 1.6532
	Drive Shaft Installed Height in the Drive Gear		18.50 19.50	MIN MAX	0.728 0.768
	Front Support Housing Bore Bearing Depth		0.00 –0.25	MIN MAX	0.000 –0.010
	Rear Support Housing Bore Bearing Depth		0.00 –0.25	MIN MAX	0.000 –0.010

Turbocharger - Inspection Specifications

	Turbocharger Shaft End Clearance		0.003 0.007	MIN MAX	0.001 0.003
	Turbocharger Compressor Impeller Radial Clearance		0.20 0.41	MIN MAX	0.008 0.016
	Turbocharger Turbine Wheel Radial Clearance		0.27 0.47	MIN MAX	0.011 0.019

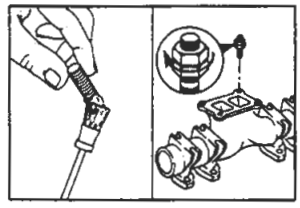
Note: Specifications and instructions for rebuilding the turbocharger are provided in the Turbocharger Component Shop Manual, Bulletin No. 3379461.

Part or Assembly	Ref. Point	mm		In

Exhaust Manifold Flange To Turbocharger Mounting Stud Torque

Torque Value: 65 N•m [50 ft-lb]

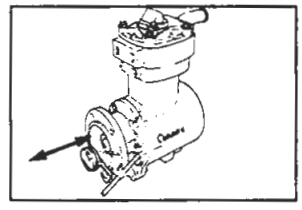
Note: Apply a coat of anti-seize compound to the threads. Use two mounting nuts locked together to tighten the studs.



Air Compressor - Inspection Specifications

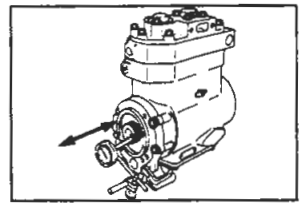
Single Cylinder Air Compressor Crankshaft End Clearance	0.05	MIN	0.002
	0.15	MAX	0.006

Note: Specifications and instructions for rebuilding the single cylinder air compressor are provided in the Air Equipment Rebuild Manual, Bulletin No. 3810242.



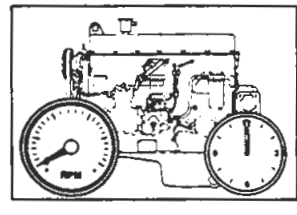
Two Cylinder Air Compressor Crankshaft End Clearance	0.05	MIN	0.002
	0.19	MAX	0.008

Note: Specifications and instructions for rebuilding the two cylinder air compressor are provided in the Air Equipment Rebuild Manual, Bulletin No. 3810257.



Engine Testing - Test Specifications

Note: The specifications and instructions for testing the engine are provided this manual. Refer to Engine Testing - Group 14, Page 14-1.



Vehicle Braking - Rebuild Specifications

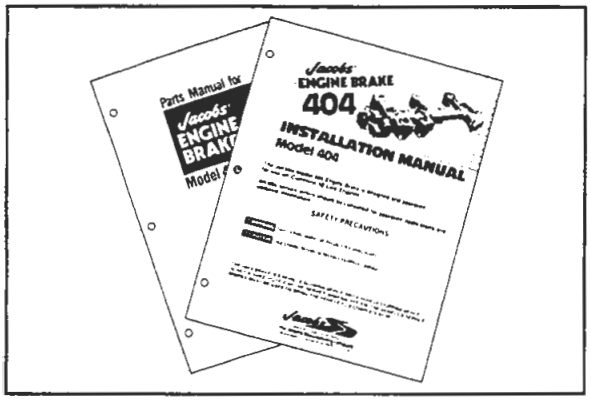
Note: The specifications and instructions for rebuilding the Jacobs® Brake are provided in the Jacobs® Brake Installation Manual. Refer to Vehicle Braking - Group 20, Page 20-1.

Vehicle Braking - Group 20

Contents

Vehicle Braking - General Information

For installation and adjustment of the Jacobs® Engine Brake, Model 404, refer to the installation and parts manuals. The Installation Manual, Form No. 011948, and the Parts Manual, Form No. 3000, can be purchased from a Jacobs® Engine Brake dealer, or refer to the manufacturer at the following address:



The Jacobs® Manufacturing Company
Vehicle Equipment Division
22 East Dudley Town Road
Bloomfield, CT 06002
U.S.A.
Telephone: (203) 243-1441

Section C - Component Manufacturers

Section Contents

Component Manufacturers' Addresses

NOTE: The following list contains addresses and telephone numbers of suppliers of accessories used on Cummins engines. Suppliers may be contacted directly for any specifications **not** covered in this manual.

Air Compressors

Bendix Heavy Vehicles Systems
Div. of Allied Automotive
901 Cleveland Street
Elyria, OH 44036
Telephone: (216) 329-9000

Midland-Grau
Heavy Duty Systems
Heavy Duty Group Headquarters
10930 N. Pomona Avenue
Kansas City, MO 64153
Telephone: (816) 891-2470

Air Cylinders

Bendix Ltd.
Douglas Road
Kingswood
Bristol
England
Telephone: 0272-671881

Catching Engineering
2101 Roberts Drive
Broadview, IL 60153
Telephone: (312) 344-2334

Air Heaters

Fleetguard, Inc.
P.O. Box 6001
Cookeville, TN 38502
Telephone: (615) 526-9551

Kim Hotstart Co.
West 917 Broadway
Spokane, WA 99210
Telephone: (509) 534-6171

Air Starting Motors

Ingersoll Rand
Chorley New Road
Horwich
Bolton
Lancashire
England
BL6 6JN
Telephone: 0204-65544

Ingersoll-Rand Engine
Starting Systems
888 Industrial Drive
Elmhurst, IL 60126
Telephone: (312) 530-3800

StartMaster
Air Starting Systems
A Division of Sycon Corporation
P. O. Box 491
Marion, OH 43302
Telephone: (614) 382-5771

Alternators

Robert Bosch Ltd.
P.O. Box 98
Broadwater Park
North Orbital Road
Denham
Uxbridge
Middlesex UD9 5HG
England
Telephone: 0895-833633

Butec Electrics
Cleveland Road
Leyland
PR5 1XB
England
Telephone: 0744-21663

C.A.V. Electrical Equipment
P.O. Box 36
Warple Way
London
W3 7SS
England
Telephone: 01-743-3111

A.C. Delco Components Group
Civic Offices
Central Milton Keynes
MK9 3EL
England
Telephone: 0908-66001

Delco-Remy
P.O. Box 2439
Anderson, IN 46018
Telephone: (317) 646-7838

Leece-Neville Corp.
1374 E. 51st St.
Cleveland, OH 44013
Telephone: (216) 431-0740

Auxiliary Brakes

The Jacobs Manufacturing Company
Vehicle Equipment Division
22 East Dudley Town Road
Bloomfield, CT 06002
Telephone: (203) 243-1441

Belts

Dayco Rubber U.K.
Sheffield Street
Stockport
Cheshire
SK4 1RV
England
Telephone: 061-432-5163

T.B.A. Ind. Products
P.O. Box 77
Wigan
Lancashire
WN2 4XQ
England
Telephone: 0942-59221

Dayco Corp.
Belt Technical Center
P.O. Box 3258
Springfield, MO 65804
Telephone: (417) 881-7440

Gates Rubber Company
5610 Crawfordsville Road
Suite 2002
Speedway, IN 46224
Telephone: (317) 248-0386

Goodyear Tire and
Rubber Company
49 South Franklin Road
Indianapolis, IN 46219
Telephone: (317) 898-4170

Clutches

Twin Disc International S.A.
Chaussee de Namur
Nivelles
Belguim
Telephone: 067-224941

Twin Disc Clutch Co.
Racine, WI 53403
Telephone: (414) 634-1981

Coolant Heaters

Fleetguard, Inc.
P.O. Box 6001
Cookeville, TN 38502
Telephone: (615) 526-9551

Drive Plates

Detroit Diesel Allison
Division of General Motors
Corporation
P.O. Box 894
Indianapolis, IN 46206
Telephone: (317) 244-1511

Electric Starting Motors

Butec Electrics
Cleveland Road
Leyland
PR5 1XB
England
Telephone: 0744-21663

C.A.V. Electrical Equipment
P.O. Box 36
Warple Way
London
W3 7SS
England
Telephone: 01-743-3111

A.C. Delco Components Group
Civic Offices
Central Milton Keynes
MK9 3EL
England
Telephone: 0908-66001

Delco-Remy
P.O. Box 2439
Anderson, IN 46018
Telephone: (317) 646-7838

Leece-Neville Corp.
1374 E. 51st Street
Cleveland, OH 44013
Telephone: (216) 431-0740

Nippondenso Sales, Inc.
24777 Denso Drive
P.O. Box 5133
Southfield, MI 48086-5133
Telephone: (313) 350-7500

Engine Protection Controls

Teddington Industrial Equipment
Windmill Road
Sunburn on Thames
Middlesex
TW16 7HF
England
Telephone: 09327-85500

The Nason Company
10388 Enterprise Drive
Davisburg, MI 48019
Telephone: (313) 625-5381

Fan Clutches

Holset Engineering Co. Ltd.
P.O. Box 9
Turnbridge
Huddersfield
England
Telephone: 0484-22244

Horton Industries, Inc.
P.O. Box 9455
Minneapolis, MN 55440
Telephone: (612) 378-6410

Rockford Division
Borg-Warner Corporation
1200 Windsor Road
P.O. Box 7007
Rockford, IL 61125-7007
Telephone: (815) 633-7460

Transportation Components Group
Facet Enterprises, Inc.
Elmira, NY 14903
Telephone: (607) 737-8212

Fans

Truflo Ltd.
Westwood Road
Birmingham
B6 7JF
England
Telephone: 021-557-4101

Hayes-Albion
1999 Wildwood Avenue
Jackson, MI 49202
Telephone: (517) 782-9421

Engineering Cooling Systems
201 W. Carmel Drive
Carmel, IN 46032
Telephone: (317) 846-3438

Brookside
McCordsville, IN 46055
Telephone: (317) 873-5093

Aerovent
8777 Purdue Rd.
Indianapolis, IN 46268
Telephone: (317) 872-0030

Kysor
1100 Wright Street
Cadillac, MI 49601
Telephone: (616) 775-4681

Schwitzer
1125 Brookside Avenue
P.O. Box 80-B
Indianapolis, IN 46206
Telephone: (317) 269-3100

Filters

Fleetguard International Corp.
Cavalry Hill Industrial Park
Weedon
Northampton NN7 4TD
England
Telephone: 0327-41313

Fleetguard, Inc.
P.O. Box 6001
Cookeville, TN 38502
Telephone: (615) 526-9551

Flexplates

Corrugated Packing and Sheet Metal
Hamsterley
Newcastle Upon Tyne
Telephone: 0207-560-505

Detroit Diesel Allison
Division of General Motors Corporation
P.O. Box 894
Indianapolis, IN 46206
Telephone: (317) 244-1511

Detroit Diesel Allison
Division of General Motors
36501 Van Born Road
Romulus, MI 48174
Telephone: (313) 595-5711

Midwest Mfg. Co.
30161 Southfield Road
Southfield, MI 48076
Telephone: (313) 642-5355

Fuel Warmers

Fleetguard, Inc.
P.O. Box 6001
Cookeville, TN 38502
Telephone: (615) 526-9551

Gauges

A.I.S.
Dyffon Industrial Estate
Ystrad Mynach
Hengoed
Mid Glamorgan
CF8 7XD
England
Telephone: 0443-812791

Grasslin U.K. Ltd.
Vale Rise
Tonbridge
Kent
TN9 1TB
England
Telephone: 0732-359888

Icknield Instruments Ltd.
Jubilee Road
Letchworth
Herts
England
Telephone: 04626-5551

Superb Tool and Gauge Co.
21 Princip Street
Birmingham
B4 61E
England
Telephone: 021-359-4876

Kabi Electrical and Plastics
Cranborne Road
Potters Bar
Herts
EN6 3JP
England
Telephone: 0707-53444

Datcon Instrument Co.
P.O. Box 128
East Petersburg, PA 17520
Telephone: (717) 569-5713

Rochester Gauge of Texas
11637 Denton Drive
Dallas, TX 75229
Telephone: (214) 241-2161

Governors

Woodward Governors Ltd.
P.O. Box 15
663/664 Ajax Avenue
Slough
Bucks
SL1 4DD
England
Telephone: 0753-26835

Woodward Governor Co.
1000 E. Drake Road
Fort Collins, CO 80522
Telephone: (303) 482-5811

Barber Colman Co.
1300 Rock Street
Rockford, IL 61101
Telephone: (815) 877-0241

United Technologies
Diesel Systems
1000 Jorie Blvd.
Oak Brook, IL 60521
Telephone: (312) 325-2020

Hydraulic and Power Steering Pumps

Hobourn Eaton Ltd.
Priory Road
Strood
Rochester
Kent
ME2 2BD
Telephone: 0634-71773

Honeywell Control Systems Ltd.
Honeywell House
Charles Square
Bracknell
Berks RG12 1EB
Telephone: 0344-424555

Sundstrand Hydratec Ltd.
Cheney Manor Trading Estate
Swindon
Wiltshire
SN2 2PZ
England
Telephone: 0793-30101

Sperry Vickers
1401 Crooks Road
Troy, MI 48084
Telephone: (313) 280-3000

Z.F.
P.O. Box 1340
Grafvonsoden Strasse
5-9 D7070
Schwaebisch Gmuend
West Germany
Telephone: 7070-7171-31510

Oil Heaters

Fleetguard, Inc.
P.O. Box 6001
Cookeville, TN 38502
Telephone: (615) 526-9551

Kim Hotstart Co.
West 917 Broadway
Spokane, WA 99210
Telephone: (509) 534-6171

Torque Converters

Twin Disc International S.A.
Chaussee de Namur
Nivelles
Belgium
Telephone: 067-224941

Twin Disc Clutch Co.
Racine, WI 53403
Telephone: (414) 634-1981

Rockford Division
Borg-Warner Corporation
1200 Windsor Road
P.O. Box 7007
Rockford, IL 61125-7007
Telephone: (815) 633-7460

Modine
1500 DeKoven Avenue
Racine, WI 53401
Telephone: (414) 636-1640

Service Literature

Contents

Service Literature Ordering Location

Region	Ordering Location
United States and Canada	Cummins Distributors or Contact 1-800-DIESELS (1-800-343-7357)
U.K., Europe, Mid-East, Africa, and Eastern European Countries	Cummins Engine Co., Ltd. Royal Oak Way South Daventry Northants, NN11 5NU, England
South and Central America (excluding Brazil and Mexico)	Cummins Americas, Inc. 16085 N.W. 52nd Avenue Hialeah, FL 33104
Brazil and Mexico	Cummins Engine Co., Inc. International Parts Order Dept., MC 40931 Box 3005 Columbus, IN 47202-3005
Far East (excluding Australia and New Zealand)	Cummins Diesel Sales Corp. Literature Center 8 Tanjong Penjuru Jurong Industrial Estate Singapore
Australia and New Zealand	Cummins Diesel Australia Maroondah Highway, P.O.B. 139 Ringwood 3134 Victoria, Australia

Obtain current price information from your local Cummins Distributor or (for U.S.A. and Canada) by calling Cummins Toll Free Number 1-800-DIESELS (1-800-343-7357).

Literature Order Form

Use this form for prompt handling of your literature order.

Item	Bulletin Number	Title of Publication	Quantity	U.S. Price Each	Amount
1				$	$
2					
3					
4					
5					
6					
				Order Total	$

Contact your Cummins distributor for prices and availability.

For problems with literature orders, contact 1-800-DIESELS (1-800-343-7357) (for U.S.A. and Canada).

Prices subject to change without notice.

Please cut on dotted line

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Prices subject to change without notice.

FROM:

Name: _____

Street Address: _____

City: _____ State: _____ Zip Code: _____

Country: _____

SHIP TO: (Name and address where literature is to be shipped)

Name: _____

Street Address: _____

City: _____ State: _____ Zip Code: _____

Country: _____

Please cut on dotted line

Mail the Literature Order Form along with your ship-to address to your nearest Cummins distributor.

FROM:

Name: _____

Street Address: _____

City: _____ State: _____ Zip Code: _____

Country: _____

SHIP TO: (Name and address where literature is to be shipped)

Name: _____

Street Address: _____

City: _____ State: _____ Zip Code: _____

Country: _____

Cummins Customized Parts Catalog

Cummins is pleased to announce the availability of a parts catalog compiled specifically for you. Unlike the generic versions of parts catalogs that support general high volume parts content; Cummins Customized catalogs contains only the new factory parts that were used to build your engine.

The catalog cover, as well as the content, is customized with you in mind. You can use it in your shop, at your worksite, or as a coffee table book in your RV or boat. The cover contains your name, company name, address, and telephone number. Your name and engine model identification even appears on the catalog spine. Everybody will know that Cummins created a catalog specifically for you.

This new catalog was designed to provide you with the exact information you need to order parts for your engine. This will be valuable for customers that do not have easy access to the Cummins Electronic Parts Catalog or the Cummins Parts Microfilm System.

Additional Features of the Customized Catalog include:

- Engine Configuration Data
- Table of Contents
- Separate Option and Parts Indexes
- Service Kits (when applicable)
- ReCon Part Numbers (when applicable)

ORDERING THE CUSTOMIZED PARTS CATALOG

Customers can call Gannett Marketing Services at 1-800-646-5609 and order by credit card. Ask for bulletin 3672139 the Customized Parts Catalog. North American customers can mail in the attached postage pre-paid order card.

ATTENTION: INTERNATIONAL CUSTOMERS (outside U.S.A.) insert the completed Customized Catalog order form in an envelope and mail to the address printed on the order form. Or, use the E-mail address **catalog@gdms.com** to place an order for a Customized Parts Catalog.

Contact GDMS for the current price; Freight will be an additional expense.

This information is required to provide a Customized Parts Catalog:

- Name
- Street Address
- Company Name (optional)
- Telephone no.
- Credit Card No.
- Cummins Engine Serial Number (located on the engine dataplate)

Unfortunately not all Cummins Engines can be supported by this parts catalog. Engines older than 1984 or newer than 3 months may not have the necessary parts information to compile a catalog. We will contact you if this occurs and explain why we are unable to fill your order.

Customized Parts Catalogs are produced specifically for a single customer. This means they are not returnable for a refund. If we make an error and your catalog is not useable, we will correct that error by sending you a new catalog.