POWERTECH®
10.5 L & 12.5 L Diesel Engines

Base Engine

TECHNICAL MANUAL
POWERTECH 10.5 L & 12.5 L Diesel Engines—Base Engine

CTM100 06APR04 (ENGLISH)

For complete service information also see:

John Deere Power Systems

LITHO IN U.S.A.

Forward

This manual is written for an experienced technician. Essential tools required in performing certain service work are identified in this manual and are recommended for use.

This manual (CTM100) covers only the base engine. It is one of three volumes on 10.5 L and 12.5 L engines. The following two companion manuals cover electronic fuel system repair, operation and diagnostics:

- CTM115—Delphi/Lucas Electronic Fuel Systems With Delphi/Lucas EUIs
- CTM188—Level 6 Electronic Fuel Systems With Delphi/Lucas EUIs

CTM115 and CTM188 will cover fuel system repair, formerly included in CTM100, Groups 35 and 36.

Other manuals will be added in the future to provide added information on new electronic fuel systems.

A complete set of all three manuals covering the 10.5 L and 12.5 L engines can be procured by ordering CTM650 Binder Set.

Live with safety: Read the safety messages in the introduction of this manual and the cautions presented throughout the text of the manual.

⚠ This is the safety-alert symbol. When you see this symbol on the machine or in this manual, be alert to the potential for personal injury.

Use this component technical manual in conjunction with the machine technical manual. An application listing in Section 01, Group 001 identifies product-model/component type-model relationship.

Information is organized in sections and groups for the various components requiring service instruction. At the end of this manual are summary listings of all applicable essential tools, service equipment and tools, other materials needed to do the job, service parts kits, specifications, wear tolerances, and torque values.

Before beginning repair on an engine, clean the engine and mount on a repair stand. (See Section 2, Group 010.)

This manual contains SI Metric units of measure followed immediately by the U.S. customary units of measure. Most hardware on these engines is metric.

Some components of this engine may be serviced without removing the engine from the machine. Refer to the specific machine technical manual for information on this and for engine removal and installation procedures.

Read each block of material completely before performing service to check for differences in procedures or specifications. Follow only the procedures that apply to the engine model number you are working on. If only one procedure is given, that procedure applies to all the engines in the manual.

CALIFORNIA PROPOSITION 65 WARNING
Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects and other reproductive harm.

RG,RG34710,1 –19–11OCT00–1/1

John Deere Dealers

The changes listed below make your CTM obsolete. Repair, operation and diagnostics on 10.5 L and 12.5 L diesel engines is now covered in three manuals. Fuel system repair has been removed from CTM100 and incorporated into its two companion manuals. **Discard CTM100 dated 20MAR01 and replace with the following new manuals.**

- CTM100—10.5 L and 12.5 L Diesel Engines—Base Engine
- CTM115—10.5 L and 12.5 L Diesel Engines—Delphi/Lucas Electronic Fuel Systems With Delphi/Lucas EUIs
- CTM188—10.5 L and 12.5 L Diesel Engines—Level 6 Electronic Fuel Systems With Delphi/Lucas EUIs

Also, copy these pages listing changes and route through your Service Department.

SECTION 01, GROUP 000 (Safety)

- Updated safety information.

SECTION 01, GROUP 001 (Engine Identification and Applications)

- Updated engine model designation chart.
- Updated engine application charts.

SECTION 01, GROUP 002 (Fuels, Lubricants and Coolants)

- Revised diesel/bio-diesel fuel guidelines and specifications.
- Revised diesel engine oil guidelines.
- Revised oilscan and coolscan guidelines.
- Revised diesel engine coolant guidelines.

SECTION 02, GROUP 010 (Engine Rebuild)

- Added new engine front lift strap.
- Revised engine disassembly sequence.
- Revised engine assembly sequence.

SECTION 02, GROUP 020 (Cylinder Head and Valves)

- Revised procedure for adjusting valves and injector preload.
- Revised procedure for repair of crankcase ventilation assembly.
- Revised valve guide specifications.
- Revised procedure for installation of rocker arm assembly.

SECTION 02, GROUP 030 (Cylinder Block, Liners, Pistons and Rods)

- Revised procedure for connecting rod inspection.

SECTION 02, GROUP 040 (Crankshaft, Main Bearings and Flywheel)

- Revised procedure for installing timing gear cover.
- Revised procedure for checking flywheel housing face runout.

SECTION 02, GROUP 050 (Camshaft and Timing Gear Train)

- Revised procedure for adjusting front timing gear backlash.

SECTION 02, GROUP 060 (Lubrication System)

- Added torque specifications for remote filter lines.
- Revised procedure for installation of oil pump.
- Revised specifications for oil pan cap screw torque.

SECTION 02, GROUP 070 (Cooling System)

- Revised procedure for replacement of fan drive bearings.
- Revised procedure for replacement of belt tensioners.
- Revised procedures for removal and installation of thermostats.

SECTION 02, GROUP 080 (Air Intake and Exhaust System)

- Added new information for extending turbocharger life.

OUO1004,0000BBC –19–11OCT00–1/2

SECTION 02—GROUP 090 and 091(Fuel System)

NOTE: Repair procedures for fuel systems has been moved to the following manuals:

- CTM115—Delphi/Lucas Electronic Fuel Systems With Delphi/Lucas EUIs, Section 02, Group 090
- CTM188—Level 6 Electronic Fuel Systems With Delphi/Lucas EUIs, Section 02, Group 090 (Dual Rail System) and Group 091 (Single Rail System)

Later Tier II 12.5 L engines with dual- or single-rail fuel systems are covered in CTM188.

SECTION 02—GROUP 100 (Starting and Charging Systems)

- Updated torque specifications for alternator mounting hardware.

SECTION 02—GROUP 110 (Electrical Engine Control)

NOTE: Repair procedures for electrical engine control components has been moved to section 02, group 110 of the following manuals:

- CTM115—Delphi/Lucas Electronic Fuel Systems With Delphi/Lucas EUIs
- CTM188—Level 6 Electronic Fuel Systems With Delphi/Lucas EUIs

SECTION 03—GROUP 120 (Base Engine Operation)

- Base engine theory of operation is covered in this section/group.

NOTE: Fuel system theory of operation has been moved to Section 03, Group 130 of the following manuals:

- *CTM115—Delphi/Lucas Electronic Fuel Systems With Delphi/Lucas EUIs*
- *CTM188—Level 6 Electronic Fuel Systems With Delphi/Lucas EUIs*

SECTION 04—GROUP 150 (Observable Diagnostics and Tests)

- Base engine observable tests and diagnostics are covered in this section/group.

NOTE: Fuel system testing and diagnostics has been moved to Section 04, Group 150 in two other technical manuals: CTM115—Delphi/Lucas Electronic Fuel Systems With Delphi/Lucas EUIs and CTM188—Level 6 Electronic Fuel Systems With Delphi/Lucas EUIs.

SECTION 5 (Tools and Other Materials)

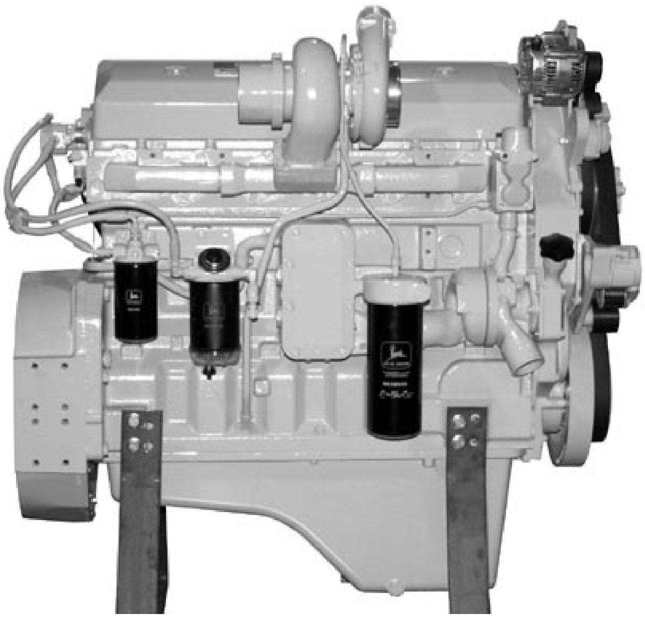
- All essential tools, service tools, dealer fabricated tools and other materials listed throughout this manual are consolidated in this section for ease of reference.

SECTION 6 (Specifications)

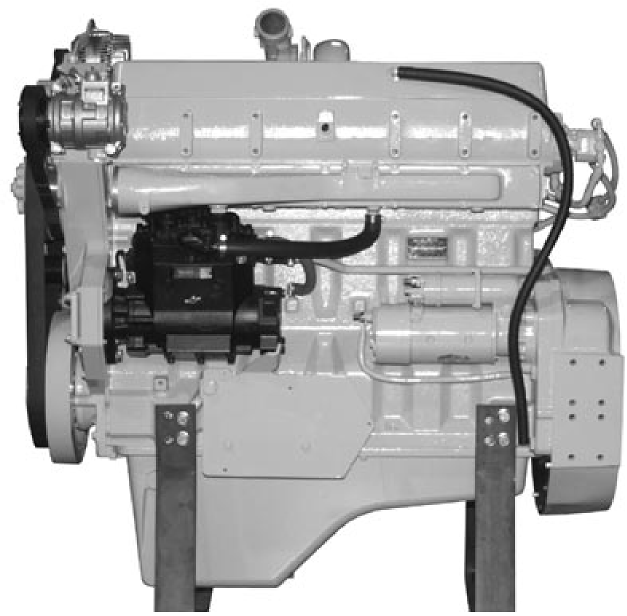
- All repair, test and diagnostic specifications listed throughout this manual are consolidated in this section for ease of reference.
- Updated dynamometer test specifications.
- Updated intake manifold pressure specifications.

OUO1004,0000BBC –19–11OCT00–2/2

POWERTECH® 6105HF and 6125HF Engines


RG9030 —UN—21MAY98

Right Side View (Early Engine)


RG9031 —UN—21MAY98

Left Side View (Early Engine)


RG9032 —UN—21MAY98

3/4 Right Front View (Early Engine)


RG9033 —UN—21MAY98

3/4 Left Front View (Early Engine)

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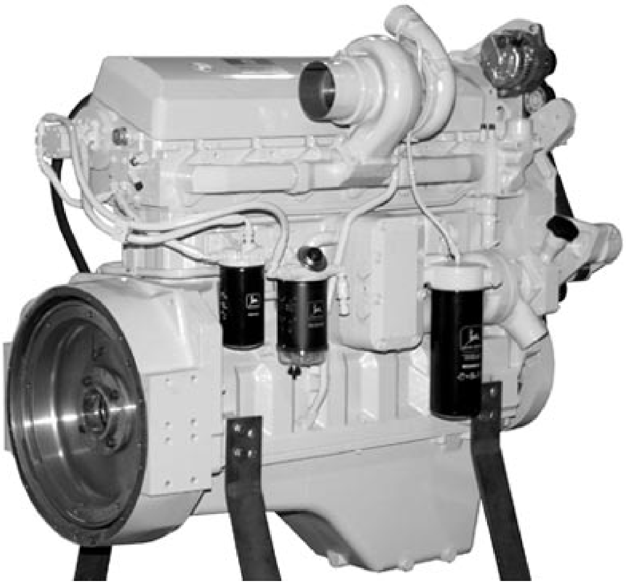
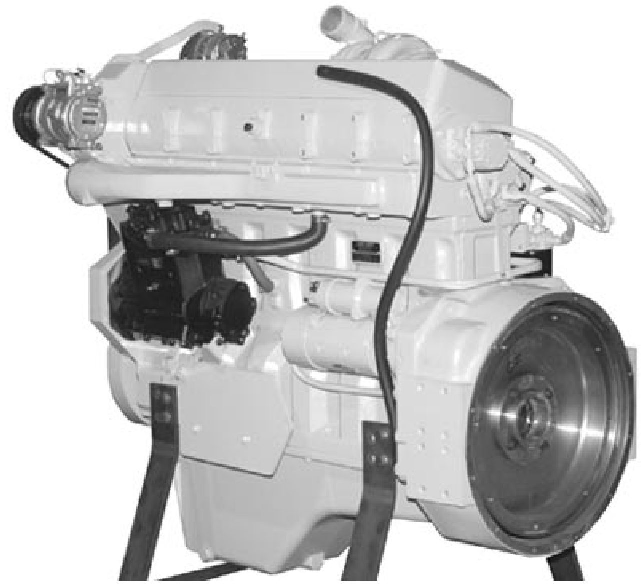
RG,RG34710,3 –19–06NOV00–1/1

POWERTECH® 6105HF and 6125HF Engines—Continued



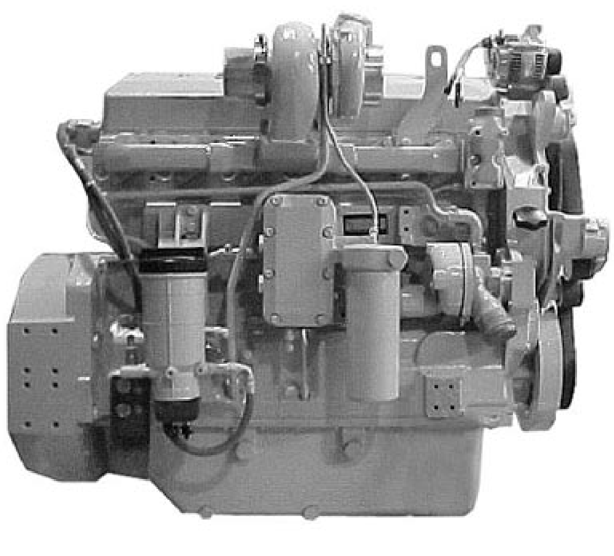
RG11174 –UN–20NOV00

3/4 Right Rear View (Early Engine)



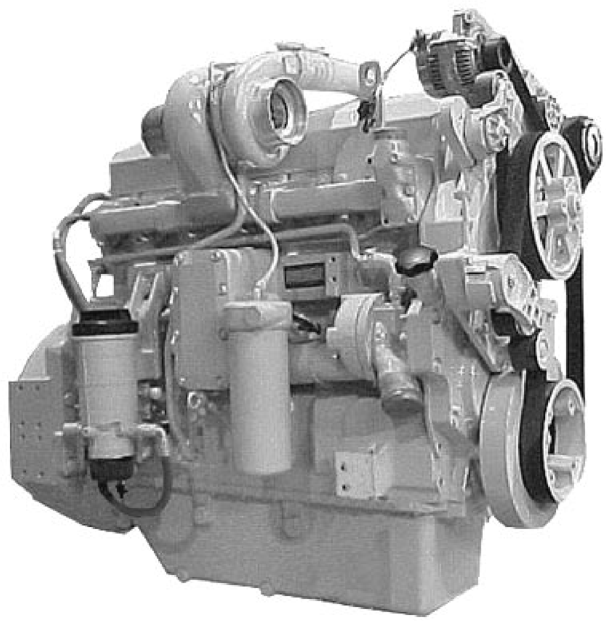
RG11175 –UN–20NOV00

3/4 Left Rear View (Early Engine)



RG11171A –UN–03NOV00

Right Side View Later Engine S.N. (30000—)



RG11172A –UN–04DEC00

3/4 Right Front View Later Engine S.N. (30000—)

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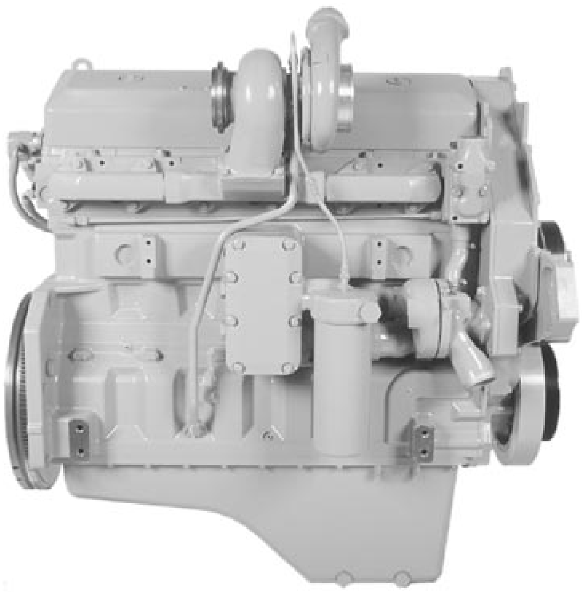
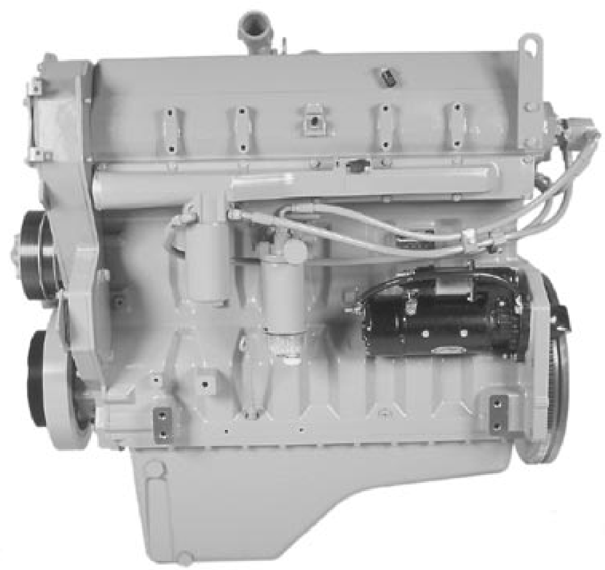
POWERTECH® 6105HRW and 6125HRW Engines



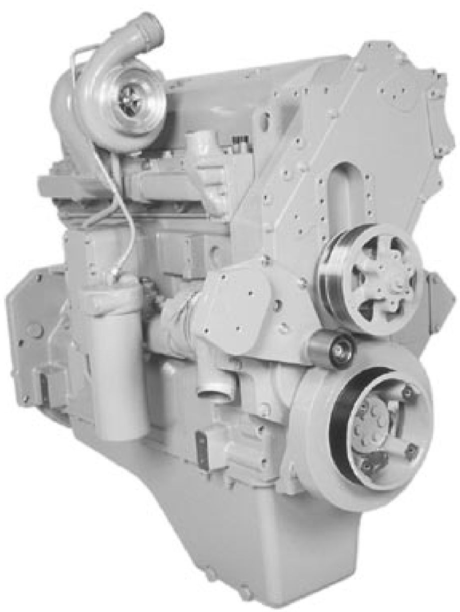
RG8222 –UN–21MAY98

Right Side View



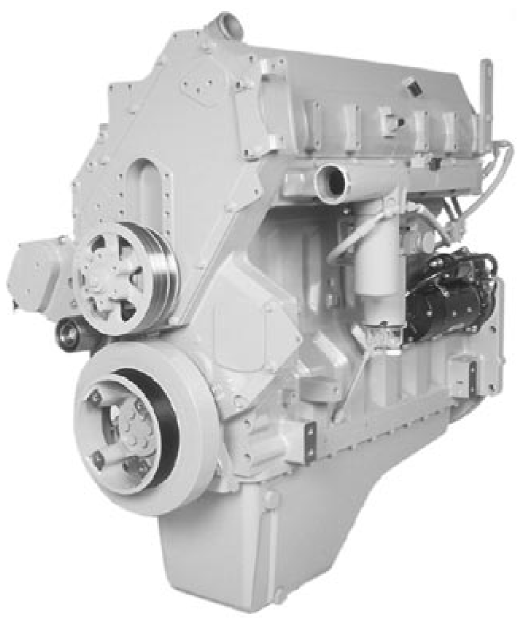
RG8221 –UN–21MAY98

Left Side View



RG8223 –UN–21MAY98

3/4 Right Front View



RG8224 –UN–21MAY98

3/4 Left Front View

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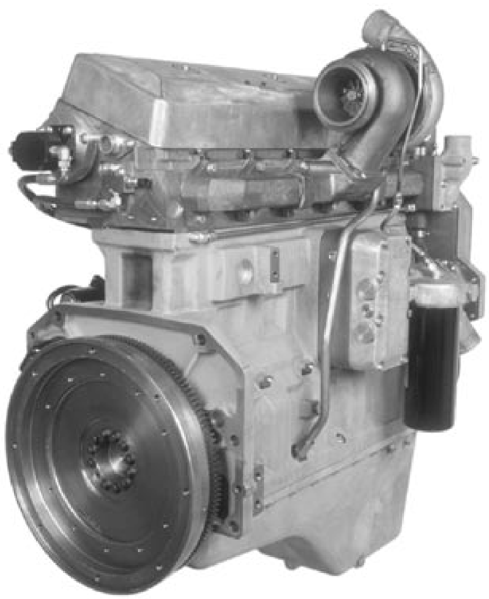
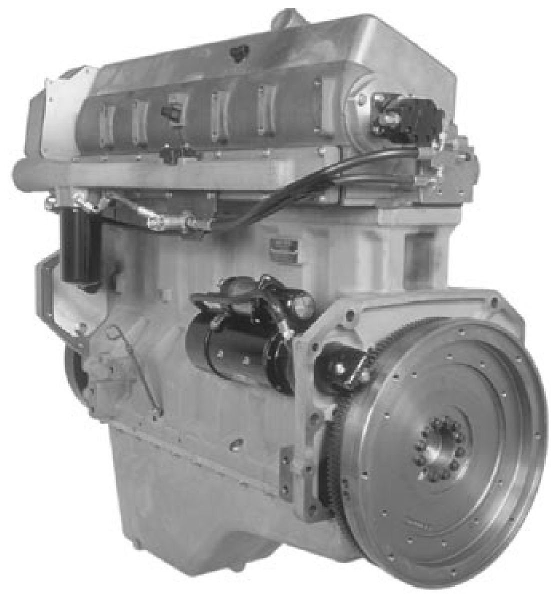
POWERTECH® 6105HRW and 6125HRW Engines—Continued



3/4 Right Rear View



3/4 Left Rear View

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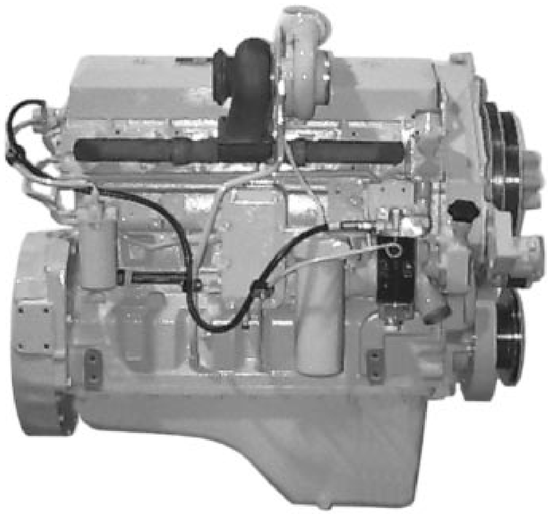
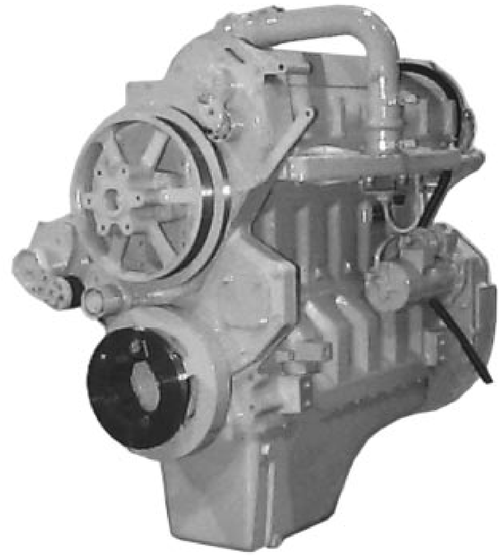
POWERTECH® 6105ADW Engine



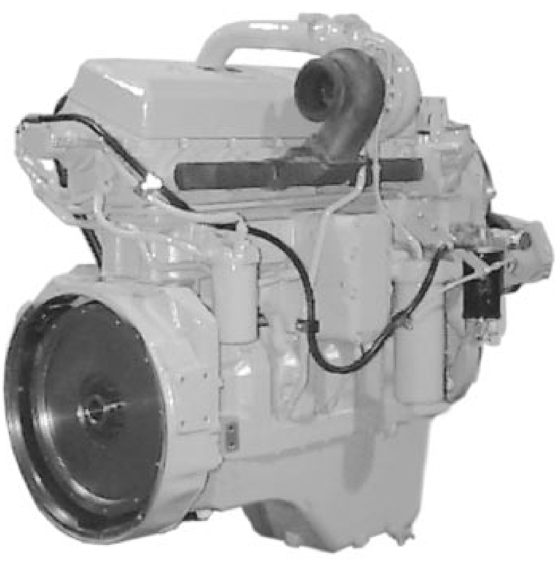
RG8454 –UN–21MAY98

Right Side View (Early Engine)



RG8448 –UN–21MAY98

3/4 Left Front View (Early Engine)



RG8453 –UN–21MAY98

3/4 Right Rear View (Early Engine)

RG8451 –UN–21MAY98

3/4 Left Rear View (Early Engine)

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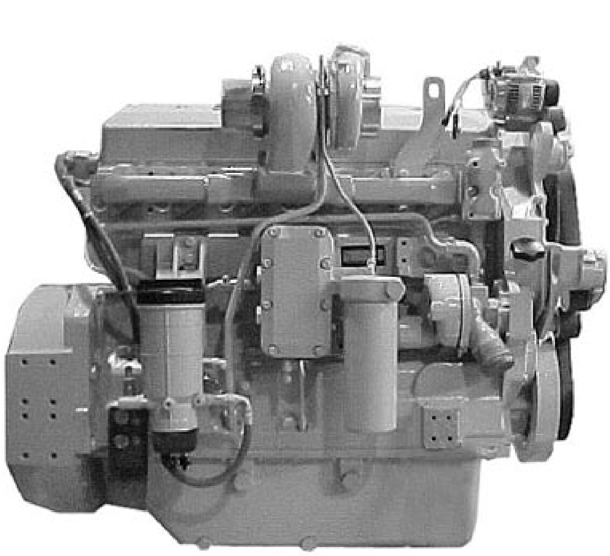
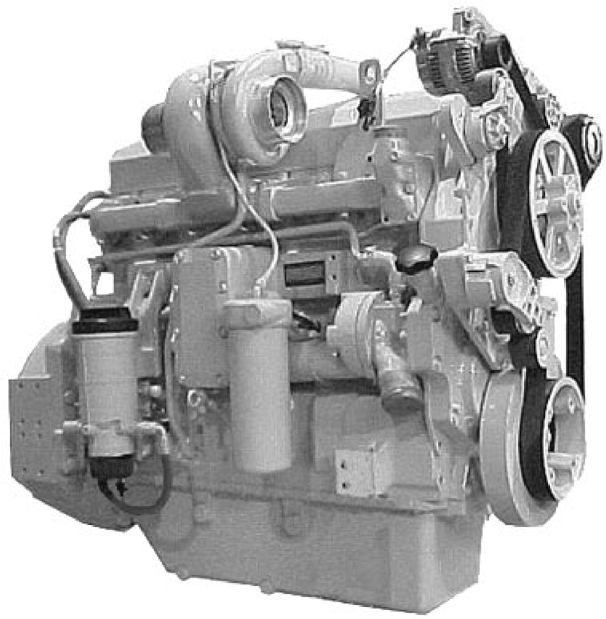
POWERTECH® 6105ADW Engine—Continued



Right Side View Later Engines S.N. (30000—)



Right Front View Later Engines S.N. (30000—)

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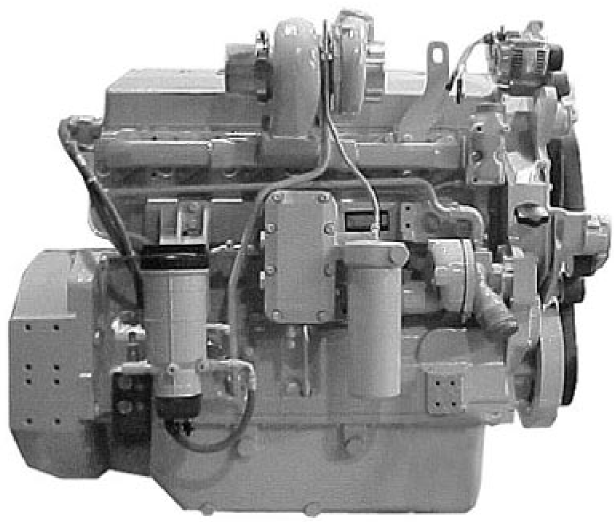
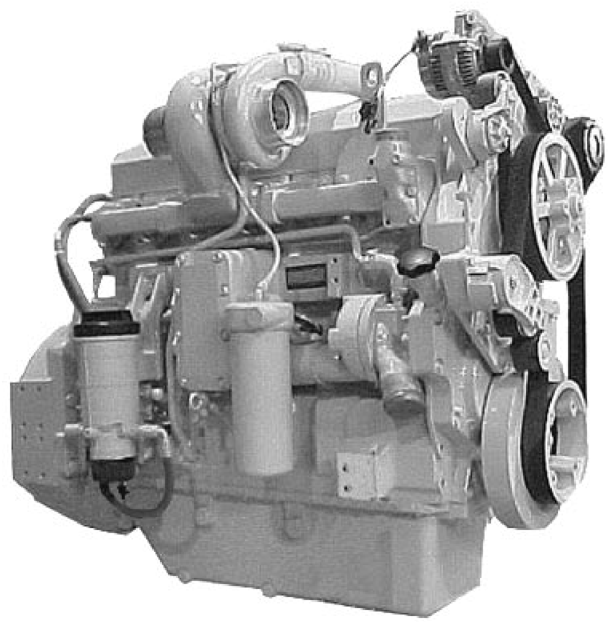
POWERTECH® 6125 Tier II (30000—)



RG11171A –UN–03NOV00

Right Side View (30000—)



RG11172A –UN–04DEC00

Right Front View (30000—)

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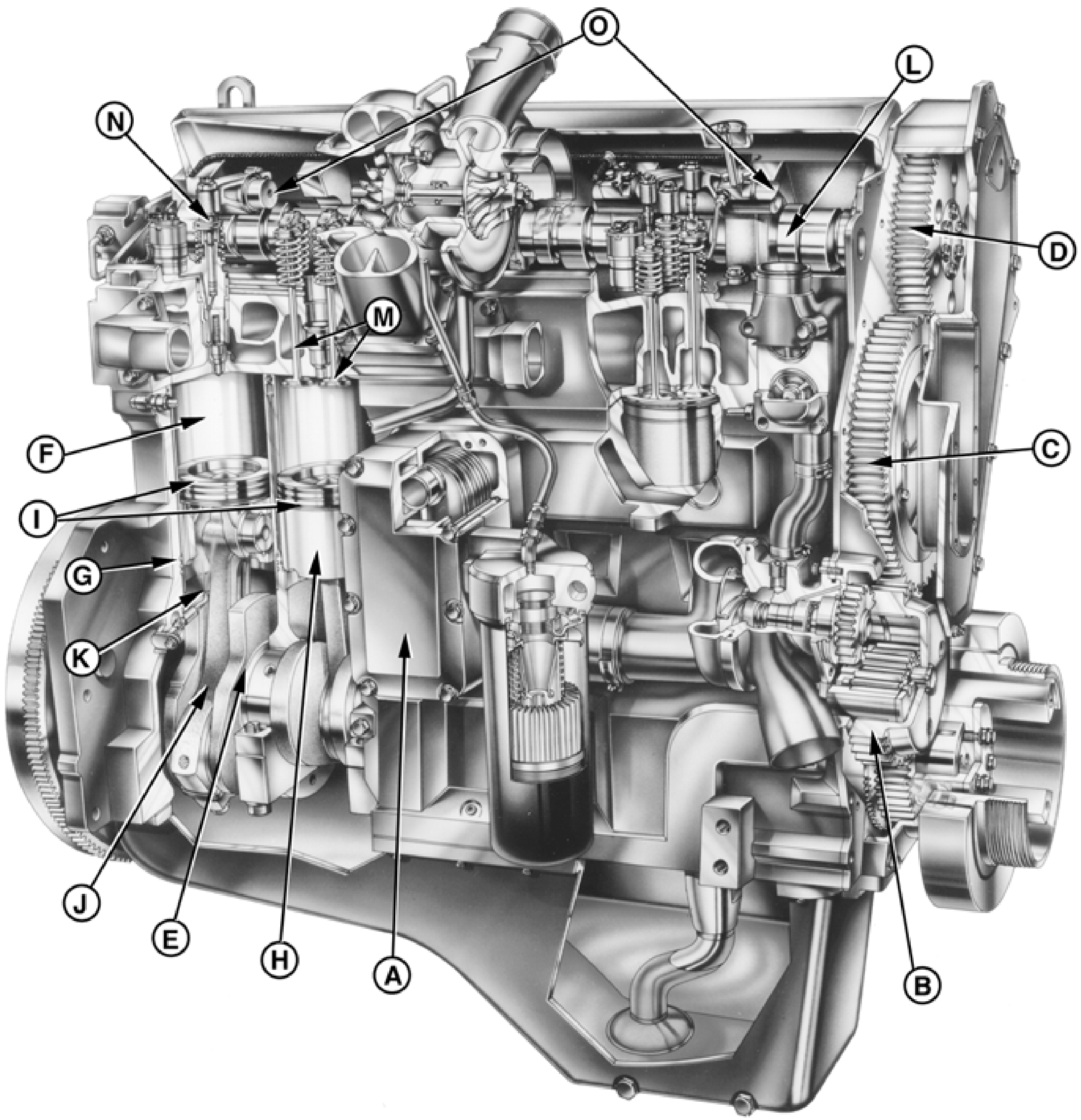
6105 and 6125 Engine Cutaway View



Engine Cutaway View

A—Oil Cooler
B—Oil Pump Drive Gear
C—Idler Gear
D—Camshaft Gear
E—Crankshaft
F—Cylinder Liner
G—Cylinder Liner O-Rings
H—Piston
I—Piston Rings
J—Connecting Rod
K—Oil Spray Jet
L—Camshaft
M—Valves
N—Electronic Unit Injector
O—Two-Piece Rocker Arm Shaft

RG,RG34710,8 –19–30SEP97–1/1

Contents

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Previous Editions
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INDX

Section 01
General Information

Contents

Handle Fluids Safely—Avoid Fires

When you work around fuel, do not smoke or work near heaters or other fire hazards.

Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

Do not store oily rags; they can ignite and burn spontaneously.

TS227 –UN–23AUG88

DX,FLAME –19–29SEP98–1/1

Service Cooling System Safely

Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

TS281 –UN–23AUG88

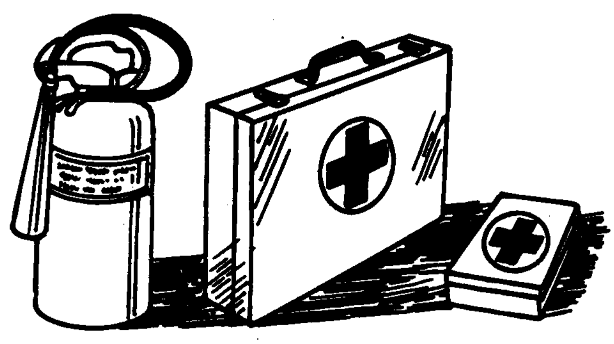
DX,RCAP –19–04JUN90–1/1

Prepare for Emergencies

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.



TS291 –UN–23AUG88

DX,FIRE2 –19–03MAR93–1/1

Handling Batteries Safely

CAUTION: Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.

Always remove grounded (-) battery clamp first and replace it last.

CAUTION: Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid the hazard by:

1. **Filling batteries in a well-ventilated area.**
2. **Wearing eye protection and rubber gloves.**
3. **Avoiding breathing fumes when electrolyte is added.**
4. **Avoiding spilling or dripping electrolyte.**
5. **Use proper jump start procedure.**

If you spill acid on yourself:

1. **Flush your skin with water.**
2. **Apply baking soda or lime to help neutralize the acid.**
3. **Flush your eyes with water for 15—30 minutes. Get medical attention immediately.**

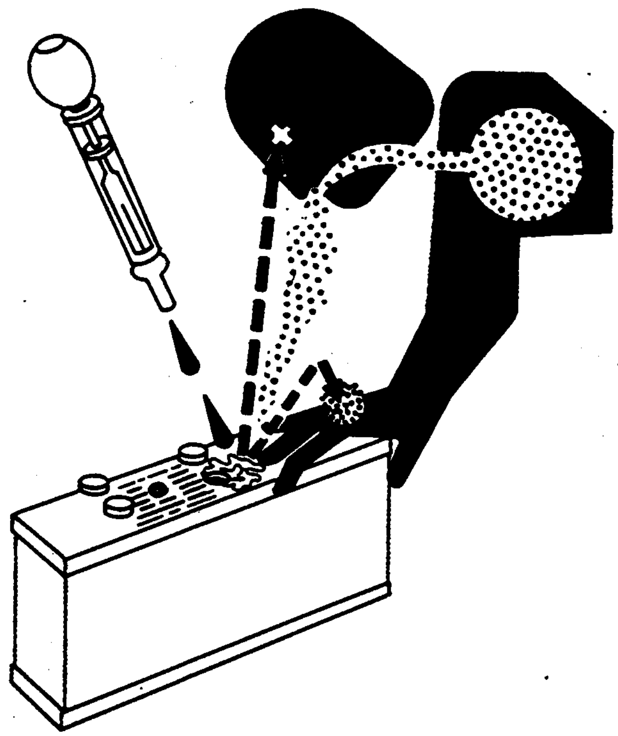
If acid is swallowed:

1. **Do not induce vomiting.**
2. **Drink large amounts of water or milk, but do not exceed 2 L (2 quarts).**
3. **Get medical attention immediately.**

WARNING: Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. **Wash hands after handling.**

TS204 –UN–23AUG88

Explosion

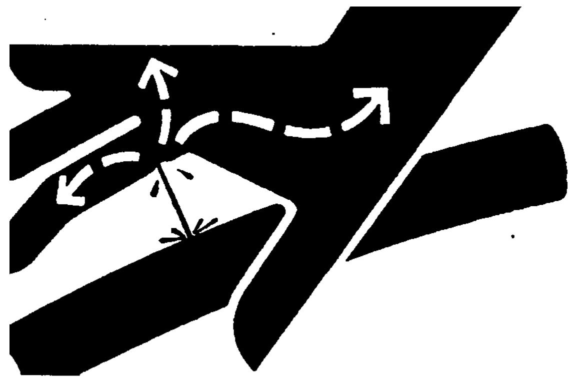


TS203 –UN–23AUG88

Acid

DPSG,OUO1004,2758 –19–11MAY00–1/1

Avoid High-Pressure Fluids



X9811 –UN–23AUG88

Escaping fluid under pressure can penetrate the skin causing serious injury.

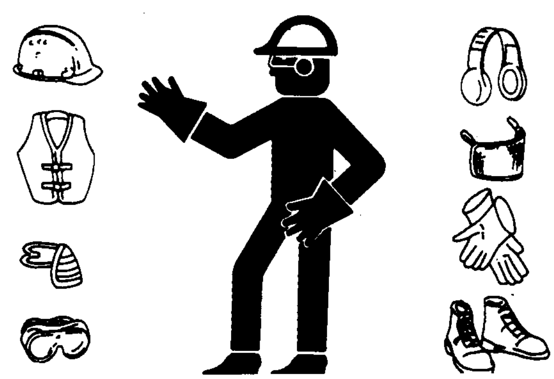
Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A.

DX,FLUID –19–03MAR93–1/1

Wear Protective Clothing



TS206 –UN–23AUG88

Wear close fitting clothing and safety equipment appropriate to the job.

Prolonged exposure to loud noise can cause impairment or loss of hearing.

Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

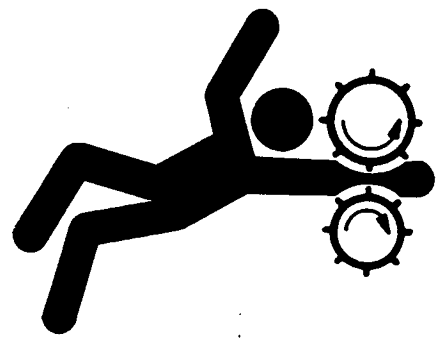
Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.

DX,WEAR –19–10SEP90–1/1

Service Machines Safely

Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.



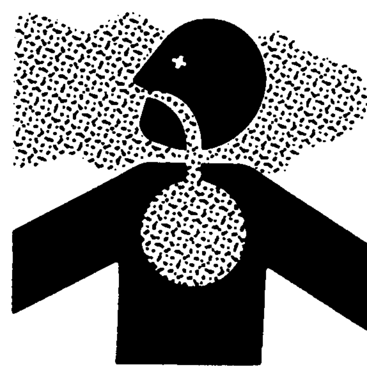
TS228 –UN–23AUG88

DX,LOOSE –19–04JUN90–1/1

Work In Ventilated Area

Engine exhaust fumes can cause sickness or death. If it is necessary to run an engine in an enclosed area, remove the exhaust fumes from the area with an exhaust pipe extension.

If you do not have an exhaust pipe extension, open the doors and get outside air into the area



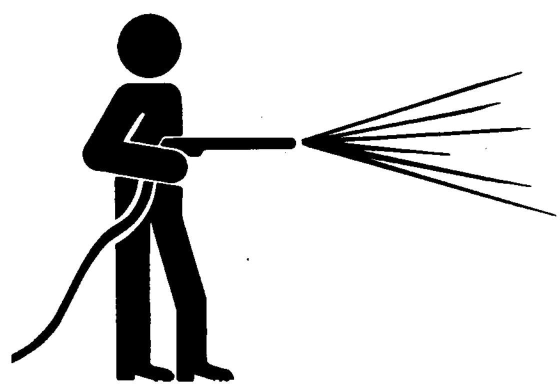
TS220 –UN–23AUG88

DX,AIR –19–17FEB99–1/1

Work in Clean Area

Before starting a job:

- Clean work area and machine.
- Make sure you have all necessary tools to do your job.
- Have the right parts on hand.
- Read all instructions thoroughly; do not attempt shortcuts.



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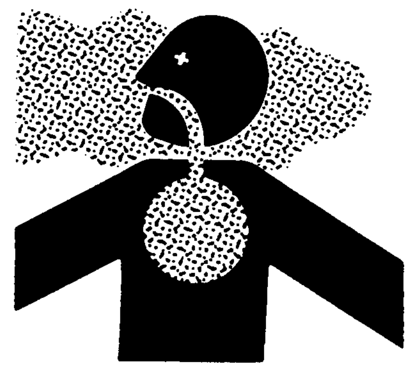
DX,CLEAN –19–04JUN90–1/1

Remove Paint Before Welding or Heating



TS220 –UN–23AUG88

Avoid potentially toxic fumes and dust.

Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch.

Remove paint before heating:

- Remove paint a minimum of 101 mm (4 in.) from area to be affected by heating. If paint cannot be removed, wear an approved respirator before heating or welding.
- If you sand or grind paint, avoid breathing the dust. Wear an approved respirator.
- If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.

Do not use a chlorinated solvent in areas where welding will take place.

Do all work in an area that is well ventilated to carry toxic fumes and dust away.

Dispose of paint and solvent properly.

DX,PAINT –19–24JUL02–1/1

Avoid Heating Near Pressurized Fluid Lines

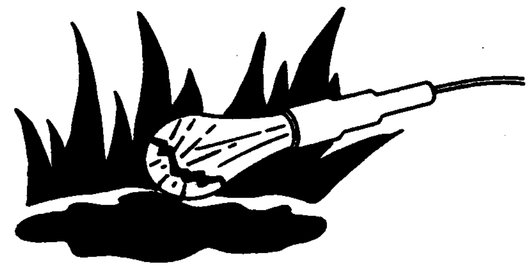
TS953 –UN–15MAY90

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area.

DX,TORCH –19–03MAR93–1/1

Illuminate Work Area Safely

Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.



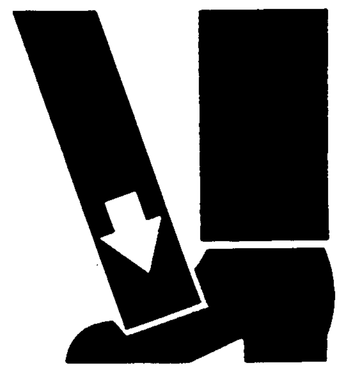
TS223 –UN–23AUG88

DX,LIGHT –19–04JUN90–1/1

Use Proper Lifting Equipment

Lifting heavy components incorrectly can cause severe injury or machine damage.

Follow recommended procedure for removal and installation of components in the manual.



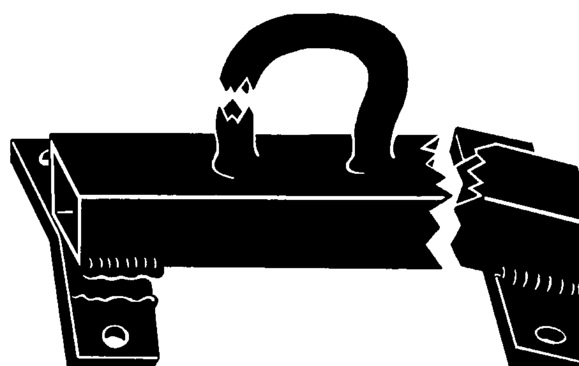
TS226 –UN–23AUG88

DX,LIFT –19–04JUN90–1/1

Construct Dealer-Made Tools Safely

Faulty or broken tools can result in serious injury. When constructing tools, use proper, quality materials and good workmanship.

Do not weld tools unless you have the proper equipment and experience to perform the job.



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Construct Dealer-Made Tools Safely

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Practice Safe Maintenance

Understand service procedure before doing work. Keep area clean and dry.

Never lubricate, service, or adjust machine while it is moving. Keep hands, feet , and clothing from power-driven parts. Disengage all power and operate controls to relieve pressure. Lower equipment to the ground. Stop the engine. Remove the key. Allow machine to cool.

Securely support any machine elements that must be raised for service work.

Keep all parts in good condition and properly installed. Fix damage immediately. Replace worn or broken parts. Remove any buildup of grease, oil, or debris.

On self-propelled equipment, disconnect battery ground cable (-) before making adjustments on electrical systems or welding on machine.

On towed implements, disconnect wiring harnesses from tractor before servicing electrical system components or welding on machine.

TS218 –UN–23AUG88

DX,SERV –19–17FEB99–1/1

Use Proper Tools

Use tools appropriate to the work. Makeshift tools and procedures can create safety hazards.

Use power tools only to loosen threaded parts and fasteners.

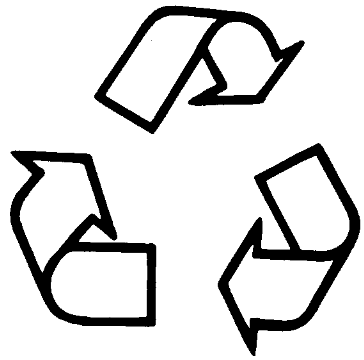
For loosening and tightening hardware, use the correct size tools. DO NOT use U.S. measurement tools on metric fasteners. Avoid bodily injury caused by slipping wrenches.

Use only service parts meeting John Deere specifications.

TS779 –UN–08NOV89

DX,REPAIR –19–17FEB99–1/1

Dispose of Waste Properly



TS1133 –UN–26NOV90

Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries.

Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

Do not pour waste onto the ground, down a drain, or into any water source.

Air conditioning refrigerants escaping into the air can damage the Earth's atmosphere. Government regulations may require a certified air conditioning service center to recover and recycle used air conditioning refrigerants.

Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.

DX,DRAIN –19–03MAR93–1/1

Live With Safety

TS231 –19–07OCT88

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

DX,LIVE –19–25SEP92–1/1

Engine Model Designation

Example: John Deere Engine Model—6105HRW01

John Deere engine model designation includes number of cylinders, displacement in liters, aspiration, user code, and application code. For example:

6105HRW01 Engine

6	Number of cylinders
10.5	Liter designation
H	Aspiration
RW	User code
01	Application Code

Aspiration Code

A	Turbocharged and air-to-coolant aftercooled
H	Turbocharged and air-to-air aftercooled

User Code

DW	Davenport (Construction Equipment) Works
F	OEM (Outside Equipment Manufacturers)[a]
RW	Waterloo (Tractor) Works
T	Dubuque (Construction Equipment) Works
T8	Cameco
Z	Zweibrucken (Forage Harvester) Works

[a]OEM users are non-Deere users of John Deere engines.

Application Code

01, 02, etc.,	Code for specific application

RG8427 –UN–21MAY98

Engine Serial Number Plate

RG,RG34710,23 –19–05SEP02–1/1

01
001
2

Engine Serial Number Plate Information

IMPORTANT: The engine serial number plate can be easily destroyed. Remove the plate or record the information elsewhere, before "hot tank" cleaning the block.

1. Example Engine Serial Number (A)

   Each engine has a 13-digit John Deere engine serial number identifying the producing factory, engine model designation, and a 6-digit sequential number. The following is an example:

RG6105H000000
RG .... Factory code producing engine
6105H .... Engine model designation
000000 .... Sequential number

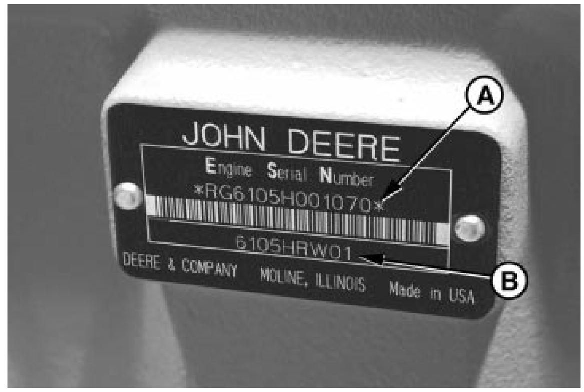
Factory Code Producing Engine
RG .... Waterloo Engine Works

Engine Model Designation
6105H .... See Engine Model Designation on previous page

Sequential Number
000000 .... 6-digit sequential number

2. Engine Application Data (B)

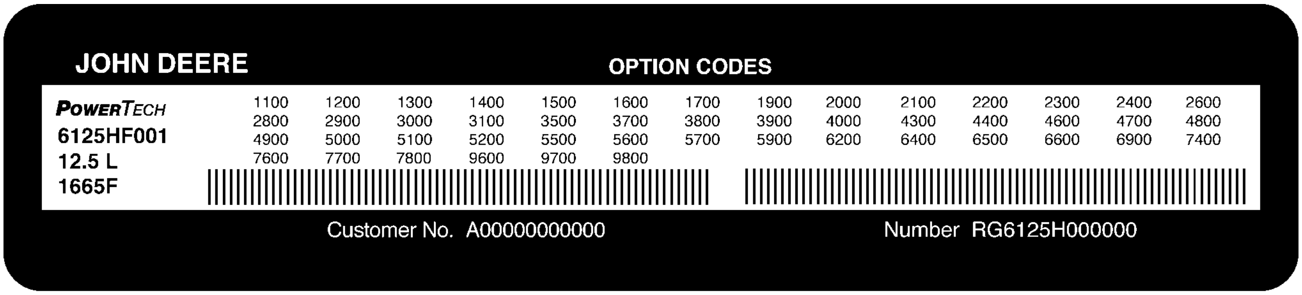
   The second line of information on the engine serial number plate identifies the engine/Deere machine or OEM relationship. See ENGINE APPLICATION CHART later in this group.



Example Engine Serial Number Plate

RG,RG34710,24 –19–07NOV00–1/1

Engine Option Code Label



RG8740 –UN–12JUL99

Option Code Label

In addition to the serial number plate, OEM engines have an engine option code label affixed to the rocker arm cover. These codes indicate which of the engine options were installed on your engine at the factory.

When in need of parts or service, furnish your authorized servicing dealer or engine distributor with these numbers.

DPSG,OUO1004,917 –19–30JUN99–1/1

Engine Application Chart

John Deere Agricultural Equipment Applications

Machine Model No.	Engine Model
WATERLOO TRACTORS—4-WHEEL DRIVE	
9200	6105HRW01, 6105HRW02, 6125HRW05 (30000—)
9220	6125HRW10, 6125HRW13, 6125HRW16
9300	6125HRW01, 6125HRW11, 6125HRW07 (30000—)
9320	6125HRW13, 6125HRW16
9400	6125HRW02, 6125HRW12, 6125HRW09 (30000—)
9420	6125HRW15, 6125HRW17
9520	6125HRW15, 6125HRW17
9620	6125HRW18
WATERLOO TRACTORS—TRACK TYPE	
9300T	6125HRW03, 6125HRW06 (30000—)
9320T	6125HRW13, 6125HRW16
9400T	6125HRW04, 6125HRW08 (30000—)
9420T	6125HRW15, 6125HRW17
9520T	6125HRW15, 6125HRW17
9620T	6125HRW18
HARVESTER—COMBINES	
9860	6125HH003
ZWEIBRUCKEN—COMBINES/FORAGE HARVESTERS	
6750	6125HZ002, 6125HZ006
6850	6125HZ001, 6125HZ005
7300 (Europe)	6125HZ007
7400 (Europe)	6125HZ008
7500 (Europe)	6125HZ009
7700 (Europe)	6125HZ009
7300 (North America)	6125HZ011
7400 (North America)	6125HZ012
7500 (North America)	6125HZ013
7700 (North America)	6125HZ013
9880 STS Combine (Europe)	6125HZ004
CANE HARVESTER (CAMECO—THIBODAUX, LA)	
CH2500	6125AT801

John Deere Construction and Forestry Equipment Applications

Machine Model No.	Engine Model
744H/HMH Loader	6125ADW01, 6125HDW01
LX230 Loader (Hitachi Construction Machinery)	6125ADW70
450C LC Excavator	6125HT001 (30000—)
824J Loader	6125HDW01
844J Loader (production summer 2005)	6125HT003
744J Loader	6125HDW01

Continued on next page

RG,RG34710,25 –19–05SEP02–1/2

Original Equipment Manufacturers (OEM) Applications

Machine Model No.	Engine Model
OEM	6105AF001
	6105HF001
	6125AF001
	6125HF001 (30000—)
	6125HF070 (30000—) Tier II
Marine	6125AFM01, 6125AFM75-Tier II

RG,RG34710,25 –19–05SEP02–2/2

Diesel Fuel

Consult your local fuel distributor for properties of the diesel fuel available in your area.

In general, diesel fuels are blended to satisfy the low temperature requirements of the geographical area in which they are marketed.

Diesel fuels specified to EN 590 or ASTM D975 are recommended.

In all cases, the fuel shall meet the following properties:

Cetane number of 45 minimum. Cetane number greater than 50 is preferred, especially for temperatures below -20°C (-4°F) or elevations above 1500 m (5000 ft).

Cold Filter Plugging Point (CFPP) below the expected low temperature OR **Cloud Point** at least 5°C (9°F) below the expected low temperature.

Fuel lubricity should pass a minimum of 3100 gram load level as measured by the BOCLE scuffing test.

Sulfur content:

- Sulfur content should not exceed 0.5%. Sulfur content less than 0.05% is preferred.
- If diesel fuel with sulfur content greater than 0.5% sulfur content is used, reduce the service interval for engine oil and filter by 50%.
- DO NOT use diesel fuel with sulfur content greater than 1.0%.

Bio-diesel fuels may be used ONLY if the fuel properties meet DIN 51606 or equivalent specification.

DO NOT mix used engine oil or any other type of lubricant with diesel fuel.

OURGP11,000018C –19–12FEB04–1/1

Bio-Diesel Fuel

Consult your local fuel distributor for properties of the bio-diesel fuel available in your area.

Bio-diesel fuels may be used ONLY if the bio-diesel fuel properties meet the latest edition of ASTM D6751, EN 14214, or equivalent specification.

It has been found that bio-diesel fuels may improve lubricity in concentrations up to a 5% blend (also known as B5) in petroleum diesel fuel.

When using a blend of bio-diesel fuel, the engine oil level must be checked daily when the air temperature is –10°C (14°F) or lower. If oil becomes diluted with fuel, shorten oil change intervals accordingly.

IMPORTANT: Raw pressed vegetable oils are NOT acceptable for use as fuel in any concentration in John Deere engines.

These oils do not burn completely, and will cause engine failure by leaving deposits on injectors and in the combustion chamber.

A major environmental benefit of bio-diesel fuel is its ability to biodegrade. This makes proper storage and handling of bio-diesel fuel especially important. Areas of concern include:

- Quality of new fuel
- Water content of the fuel
- Problems due to aging of the fuel

Potential problems resulting from deficiencies in the above areas when using bio-diesel fuel in concentrations above 5% may lead to the following symptoms:

- Power loss and deterioration of performance
- Fuel leakage
- Corrosion of fuel injection equipment
- Coked and/or blocked injector nozzles, resulting in engine misfire
- Filter plugging
- Lacquering and/or seizure of internal components
- Sludge and sediments
- Reduced service life of engine components

Consult your fuel supplier for additives to improve storage and performance of bio-diesel fuels.

DX,FUEL7 –19–05JAN04–1/1

Lubricity of Diesel Fuel

Diesel fuel must have adequate lubricity to ensure proper operation and durability of fuel injection system components.

ASTM D975 and EN 590 specifications do not require fuels to pass a fuel lubricity test.

Sulfur content of diesel fuel for highway use is less than 0.05% (500 ppm) in the United States and Canada, and less than 0.035% (350 ppm) in the European Union.

Experience shows that some low sulfur diesel fuels may have inadequate lubricity and their use may reduce performance in fuel injection systems due to inadequate lubrication of injection pump components. The lower concentration of aromatic compounds in these fuels also adversely affects injection pump seals and may result in leaks.

Use of low lubricity diesel fuels may also cause accelerated wear, injection nozzle erosion or corrosion, engine speed instability, hard starting, low power, and engine smoke.

Fuel lubricity should pass a minimum load level of 3100 grams as measured by ASTM D6078 or maximum scar diameter of 0.45 mm as measured by ASTM D6079 or ISO 12156-1.

If fuel of low or unknown lubricity is used, add John Deere PREMIUM DIESEL FUEL CONDITIONER (or equivalent) at the specified concentration.

DX,FUEL5 –19–19DEC03–1/1

Dieselscan Fuel Analysis

DIESELSCAN™ is a John Deere fuel sampling program to help you monitor the quality of your fuel source. It verifies fuel type, cleanliness, water content, suitability for cold weather operation, and if fuel is within ASTM specifications. Check with your John Deere dealer for availability of DIESELSCAN kits.

DIESELSCAN is a trademark of Deere & Company

DX,FUEL6 –19–06DEC00–1/1

Diesel Engine Break-In Oil

New engines are filled at the factory with John Deere ENGINE BREAK-IN OIL. During the break-in period, add John Deere ENGINE BREAK-IN OIL as needed to maintain the specified oil level.

Change the oil and filter after the first 100 hours of operation of a new or rebuilt engine.

After engine overhaul, fill the engine with John Deere ENGINE BREAK-IN OIL.

If John Deere ENGINE BREAK-IN OIL is not available, use a diesel engine oil meeting one of the following during the first 100 hours of operation:

- API Service Category CE
- API Service Category CD
- API Service Category CC
- ACEA Oil Sequence E2
- ACEA Oil Sequence E1

After the break-in period, use John Deere PLUS-50™ or other diesel engine oil as recommended in this manual.

IMPORTANT: Do not use PLUS-50 oil or engine oils meeting any of the following during the first 100 hours of operation of a new or rebuilt engine:

API CI-4	**ACEA E5**
API CH-4	**ACEA E4**
API CG-4	**ACEA E3**
API CF-4	
API CF-2	
API CF	

These oils will not allow the engine to break-in properly.

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DX,ENOIL4 –19–07NOV03–1/1

Diesel Engine Oil—Non-Certified and Tier I Certified Engines

Use oil viscosity based on the expected air temperature range during the period between oil changes.

The following oil is preferred:

- John Deere PLUS-50®

The following oil is also recommended:

- John Deere TORQ-GARD SUPREME®

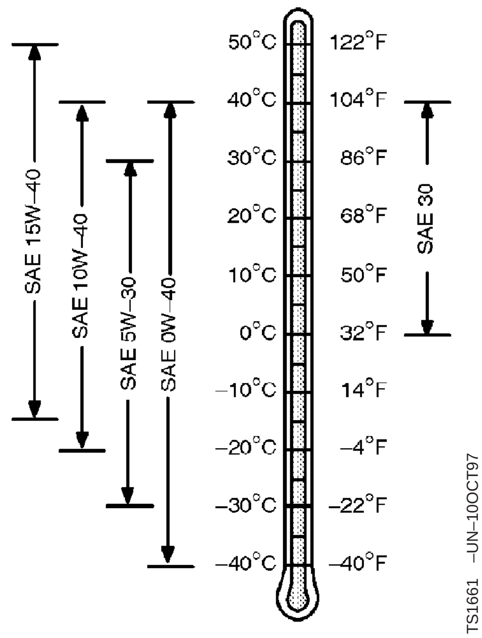
Other oils may be used if they meet one or more of the following:

- API Service Classification CI-4
- API Service Classification CH-4
- API Service Classification CG-4
- API Service Classification CF-4
- ACEA Specification E5
- ACEA Specification E4
- ACEA Specification E3
- ACEA Specification E2

Multi-viscosity diesel engine oils are preferred.

If diesel fuel with sulfur content greater than 0.5% (5000 ppm) is used, reduce the service interval by 50%.

Extended service intervals may apply when John Deere preferred engine oils are used. Consult your John Deere dealer for more information.



PLUS-50 is a registered trademark of Deere & Company.
TORQ-GARD SUPREME is a registered trademark of Deere & Company

OUO1082,0000236 –19–17JAN02–1/1

Diesel Engine Oil—Tier II Engines

Use oil viscosity based on the expected air temperature range during the period between oil changes.

The following oil is preferred:

- John Deere PLUS-50®

The following oils are also recommended:

- John Deere TORQ-GARD SUPREME®
- Oils meeting ACEA Specification E5

Other oils may be used if they meet one or more of the following:

- API Service Classification CI-4
- API Service Classification CH-4
- ACEA Specification E3
- ACEA Specification E4

Multi-viscosity diesel engine oils are preferred.

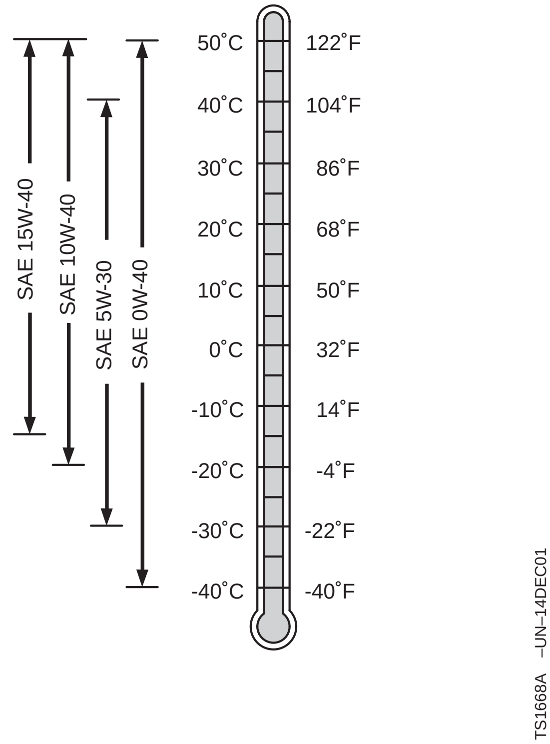
Diesel fuel quality and sulfur content must comply with all existing emissions regulations for the area in which the engine operates.

If diesel fuel with sulfur content greater than 0.05% (500 ppm) is used, reduce the service interval by 100 hours.

If diesel fuel with sulfur content greater than 0.5% (5000 ppm) is used, reduce the service interval by 50%.

Diesel fuel with sulfur content greater than 1.0% (10,000 ppm) is not recommended.

When John Deere PLUS-50® is used along with the specified John Deere filter, the oil change interval may be extended from every 250 hours to every 375 hours of operation.



Diesel Engine Oil

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TORQ-GARD SUPREME is a trademark of Deere & Company

OUOD002,0000172 –19–15MAY02–1/1

Extended Diesel Engine Oil Service Intervals

When John Deere PLUS-50™, ACEA E5, or ACEA E4 oils are used with the specified John Deere filter, the service interval for engine oil and filter changes may be increased by 50% but not to exceed a maximum of 500 hours.

If John Deere PLUS-50, ACEA E5, or ACEA E4 oils are used with other than the specified John Deere filter, change the engine oil and filter at the normal service interval.

If John Deere TORQ-GARD SUPREME™, API CI-4, API CH-4, or ACEA E3 oils are used, change the engine oil and filter at the normal service interval.

DX,ENOIL8 –19–03NOV03–1/1

Alternative and Synthetic Lubricants

Conditions in certain geographical areas may require lubricant recommendations different from those printed in this manual.

Some John Deere brand coolants and lubricants may not be available in your location.

Consult your John Deere dealer to obtain information and recommendations.

Synthetic lubricants may be used if they meet the performance requirements as shown in this manual.

The temperature limits and service intervals shown in this manual apply to both conventional and synthetic oils.

Re-refined base stock products may be used if the finished lubricant meets the performance requirements.

DX,ALTER –19–15JUN00–1/1

Mixing of Lubricants

In general, avoid mixing different brands or types of oil. Oil manufacturers blend additives in their oils to meet certain specifications and performance requirements.

Mixing different oils can interfere with the proper functioning of these additives and degrade lubricant performance.

Consult your John Deere dealer to obtain specific information and recommendations.

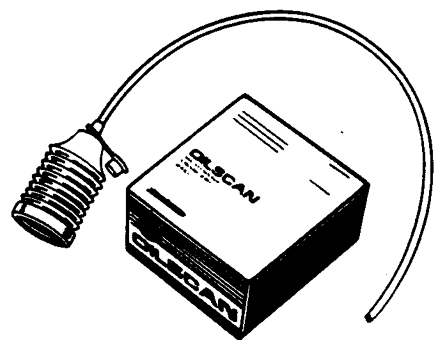
DX,LUBMIX –19–18MAR96–1/1

OILSCAN™and COOLSCAN™

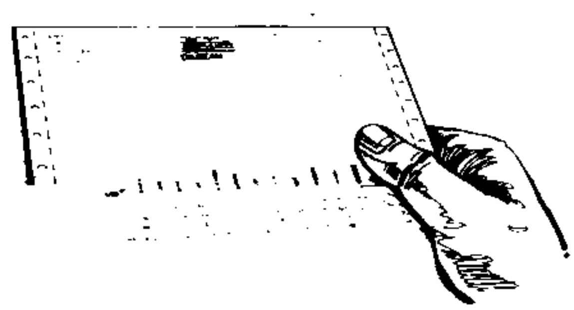
OILSCAN™and COOLSCAN™ are John Deere sampling programs to help you monitor machine performance and identify potential problems before they cause serious damage.

Oil and coolant samples should be taken from each system prior to its recommended change interval.

Check with your John Deere dealer for the availability of OILSCAN™ and COOLSCAN™ kits.



T6828AB –UN–15JUN89



T6829AB –UN–18OCT88

OILSCAN is a registered trademark of Deere & Company.
COOLSCAN is a trademark of Deere & Company.

DX,OILSCAN –19–02DEC02–1/1

Grease

Use grease based on NLGI consistency numbers and the expected air temperature range during the service interval.

The following greases are preferred:

- John Deere SD POLYUREA GREASE

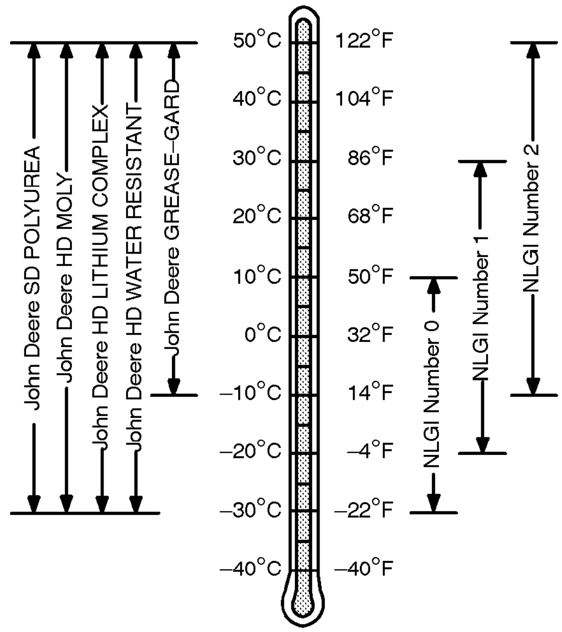
The following greases are also recommended:

- John Deere HD MOLY GREASE
- John Deere HD LITHIUM COMPLEX GREASE
- John Deere HD WATER RESISTANT GREASE
- John Deere GREASE-GARD

Other greases may be used if they meet the following:

- NLGI Performance Classification GC-LB

IMPORTANT: Some types of grease thickener are not compatible with others. Consult your grease supplier before mixing different types of grease.



TS1667 –UN–30JUN99

DX,GREA1 –19–14NOV03–1/1

Diesel Engine Coolant

The engine cooling system is filled to provide year-round protection against corrosion and cylinder liner pitting, and winter freeze protection to -37°C (-34°F). If protection at lower temperatures is required, consult your John Deere dealer for recommendations.

John Deere COOL-GARD™ Prediluted Coolant is preferred for service.

John Deere COOL-GARD Prediluted Coolant is available in either a concentration of 50% ethylene glycol or a 55% propylene glycol.

Additional recommended coolants

The following engine coolant is also recommended:

- John Deere COOL-GARD Coolant Concentrate in a 40% to 60% mixture of concentrate with quality water.

John Deere COOL-GARD coolants do not require use of supplemental coolant additives, except for periodic replenishment of additives during the drain interval.

Other fully formulated coolants

Other fully formulated low silicate ethylene or propylene glycol base coolants for heavy-duty engines may be used if they meet one of the following specifications:

- ASTM D6210 prediluted (50%) coolant
- ASTM D6210 coolant concentrate in a 40% to 60% mixture of concentrate with quality water

Coolants meeting ASTM D6210 do not require use of supplemental coolant additives, except for periodic replenishment of additives during the drain interval.

Coolants requiring supplemental coolant additives

Other low silicate ethylene glycol base coolants for heavy-duty engines may also be used if they meet one of the following specifications:

- ASTM D4985 ethylene glycol base prediluted (50%) coolant
- ASTM D4985 ethylene glycol base coolant concentrate in a 40% to 60% mixture of concentrate with quality water

Coolants meeting ASTM D4985 require an initial charge of supplemental coolant additives, formulated for protection of heavy duty diesel engines against corrosion and cylinder liner erosion and pitting. They also require periodic replenishment of additives during the drain interval.

Other coolants

If a coolant known to meet the requirements of coolant specifications shown in this manual is not available, use either:

- ethylene glycol or propylene glycol base prediluted (40% to 60%) coolant
- ethylene glycol or propylene glycol base coolant concentrate in a 40% to 60% mixture of concentrate with quality water

The coolant concentrate or prediluted coolant shall be of a quality that provides cavitation protection to cast iron and aluminum parts in the cooling system.

Water quality

Water quality is important to the performance of the cooling system. Distilled, deionized, or demineralized water is recommended for mixing with ethylene glycol and propylene glycol base engine coolant concentrate.

COOL-GARD is a trademark of Deere & Company

Continued on next page

DX,COOL3 –19–19DEC03–1/2

IMPORTANT: Do not use cooling system sealing additives or antifreeze that contains sealing additives.

IMPORTANT: Do not mix ethylene glycol and propylene glycol base coolants.

DX,COOL3 –19–19DEC03–2/2

Supplemental Coolant Additives

The concentration of coolant additives is gradually depleted during engine operation. For all recommended coolants, replenish additives between drain intervals by adding a supplemental coolant additive every 12 months or as determined necessary by coolant testing.

John Deere COOLANT CONDITIONER is recommended as a supplemental coolant additive in John Deere engines.

IMPORTANT: Do not add a supplemental coolant additive when the cooling system is drained and refilled with John DeereCOOL-GARD™.

If other coolants are used, consult the coolant supplier and follow the manufacturer's recommendation for use of supplemental coolant additives.

The use of non-recommended supplemental coolant additives may result in additive drop-out and gelation of the coolant.

Add the manufacturer's recommended concentration of supplemental coolant additive. DO NOT add more than the recommended amount.

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DX,COOL4 –19–07NOV03–1/1

Testing Diesel Engine Coolant

Testing Diesel Engine Coolant

Maintaining adequate concentrations of glycol and inhibiting additives in the coolant is critical to protect the engine and cooling system against freezing, corrosion, and cylinder liner erosion and pitting.

Test the coolant solution at intervals of 12 months or less and whenever excessive coolant is lost through leaks or overheating.

Coolant test strips

Coolant test strips are available from your John Deere dealer. These test strips provide a simple, effective method to check the freeze point and additive levels of your engine coolant.

Compare the results to the supplemental coolant additive (SCA) chart to determine the amount of inhibiting additives in your coolant and whether more John Deere COOLANT CONDITIONER should be added.

COOLSCAN™ and COOLSCAN PLUS™

For a more thorough evaluation of your coolant, perform a COOLSCAN or COOLSCAN PLUS analysis, where available. See your John Deere dealer for information.

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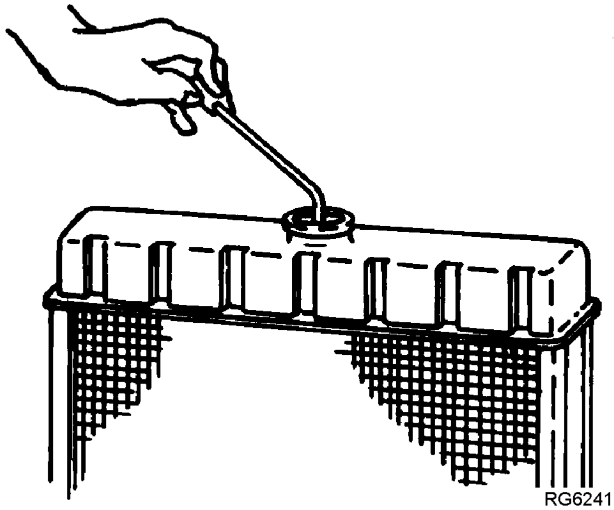
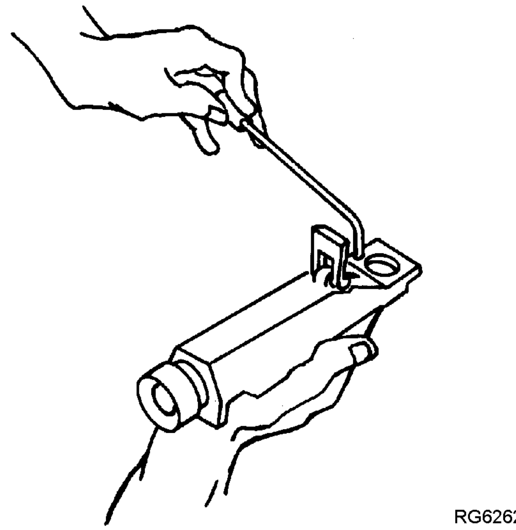
COOLSCAN PLUS is a trademark of Deere & Company

DX,COOL9 –19–19DEC03–1/1

Replenishing Supplemental Coolant Additives (SCAs) Between Coolant Changes



Radiator Coolant Check



JT07298 Refractometer

IMPORTANT: Do not add supplemental coolant additives when the cooling system is drained and refilled with John Deere ANTIFREEZE/SUMMER COOLANT or John Deere COOL-GARD®.

NOTE: If a system is to be filled with coolant that does not contain SCAs, the coolant must be precharged. Determine the total system capacity and premix with 3% John Deere Coolant Conditioner.

Through time and use, the concentration of coolant additives is gradually depleted during engine operation. Periodic replenishment of inhibitors is required, even when John Deere ANTIFREEZE/SUMMER COOLANT is used. The cooling system must be recharged with additional supplemental coolant additives available in the form of liquid coolant conditioner.

Maintaining the correct coolant conditioner concentration (SCAs) and freeze point is essential in your cooling system to protect against rust, liner pitting and corrosion, and freeze-ups due to incorrect coolant dilution.

John Deere LIQUID COOLANT CONDITIONER is recommended as a supplemental coolant additive in John Deere engines.

DO NOT mix one brand of SCA with a different brand.

Test the coolant solution at 600 hours or 12 months of operation using either John Deere coolant test strips or a COOLSCAN® analysis. If a COOLSCAN® analysis is not available, recharge system per instructions printed on label of John Deere Liquid Coolant Conditioner.

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COOLSCAN is a registered trademark of Deere & Company.

Continued on next page RG,01,DT7035 –19–14NOV00–1/2

IMPORTANT: ALWAYS maintain coolant at correct level and concentration. DO NOT operate engine without coolant for even a few minutes.

If frequent coolant makeup is required, the glycol concentration should be checked with JT07298 Coolant/Battery Tester to ensure that the desired freeze point is maintained. Follow manufacturer's instructions provided with refractometer.

Add the manufacturer's recommended concentration of supplemental coolant additive. DO NOT add more than the recommended amount.

The use of non-recommended supplemental coolant additives may result in additive drop-out and gelation of the coolant.

If other coolants are used, consult the coolant supplier and follow the manufacturer's recommendation for use of supplemental coolant additives.

See DIESEL ENGINE COOLANTS AND SUPPLEMENTAL ADDITIVE INFORMATION earlier in this group for proper mixing of coolant ingredients before adding to the cooling system.

RG,01,DT7035 –19–14NOV00–2/2

Operating in Warm Temperature Climates

John Deere engines are designed to operate using glycol base engine coolants.

Always use a recommended glycol base engine coolant, even when operating in geographical areas where freeze protection is not required.

IMPORTANT: Water may be used as coolant *in emergency situations only.*

Foaming, hot surface aluminum and iron corrosion, scaling, and cavitation will occur when water is used as the coolant, even when coolant conditioners are added.

Drain cooling system and refill with recommended glycol base engine coolant as soon as possible.

DX,COOL6 –19–18MAR96–1/1

Flush and Service Cooling System

TS281 –UN–23AUG88

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap completely.

IMPORTANT: Air must be expelled from cooling system when system is refilled. Follow procedure given in your operator's manual.

The ethylene glycol base (antifreeze) can become depleted of SCAs allowing various acids to form that will damage engine components. In addition, heavy metals, such as lead, copper and zinc, accumulate in the ethylene glycol base. The heavy metals come from corrosion that occurs to some degree with in a cooling system. When a coolant is saturated to the point where it can no longer hold heavy metals and other dissolved solids, they settle out and act as abrasives on engine parts.

NOTE: Refer to your operator's manual for a specific service interval.

Flush cooling system as described in your operator's manual. Clean cooling system with clean water and TY15979 John Deere Heavy-Duty Cooling System Cleaner or an equivalent cleaner such as FLEETGUARD® RESTORE™ or RESTORE PLUS™. Follow the instructions provided with the cleaner. Refill cooling system with the appropriate coolant solution. See ENGINE COOLANT SPECIFICATIONS, earlier in this group.

FLEETGUARD is a registered trademark of the Cummins Engine Company.
RESTORE is a trademark of FLEETGUARD.
RESTORE PLUS is a trademark of FLEETGUARD.

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RG,01,DT7033 –19–29OCT97–1/2

IMPORTANT: NEVER overfill the system. A pressurized system needs space for heat expansion without overflowing at the top of the radiator. Coolant level should be at bottom of radiator filler neck.

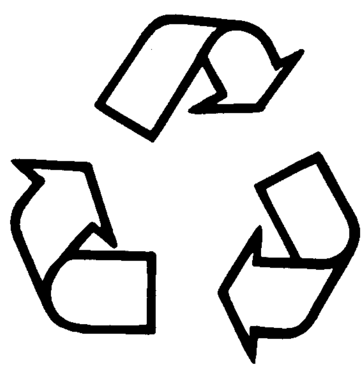
Air must be expelled from cooling system when system is refilled. Loosen plug in side of thermostat housing to allow air to escape when filling system. Retighten plug when all the air has been expelled.

After adding new coolant solution, run engine until it reaches operating temperature. This mixes the coolant solution uniformly and circulates it through the entire system. After running engine, check coolant level and entire cooling system for leaks.

Contact your engine servicing dealer, if there are further questions.

RG,01,DT7033 –19–29OCT97–2/2

Disposing of Coolant



TS1133 –UN–26NOV90

Improperly disposing of engine coolant can threaten the environment and ecology.

Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

Do not pour waste onto the ground, down a drain, or into any water source.

Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your engine servicing dealer.

RG,01,DT7032 –19–29OCT97–1/1

Section 02
Repair and Adjustments

Contents

Continued on next page

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Engine Overhaul Guidelines

Engine life and performance will vary depending on operating conditions and the level of regular engine maintenance. Engines can be brought back to original performance standards through proper overhaul procedure and replacement of parts with genuine John Deere service parts. Overhauling the engine prior to failure can avoid costly repairs and downtime.

Consider installing a John Deere overhaul kit when:

- The engine begins to experience power loss and there are no known engine component failures.
- The engine is hard to start due to low cranking compression.
- The engine begins to smoke and there are no known engine component failures.
- The engine begins to use oil. Refer to Section 04 for acceptable oil consumption.
- The engine has high usage hours and the owner wants to take preventive measure to avoid high-cost repairs and costly downtime.

John Deere overhaul kits have a 1500-hour or 12-month warranty, whichever comes first. Installation labor is covered by warranty if an authorized John Deere dealer installed the overhaul kit and the replacement parts.

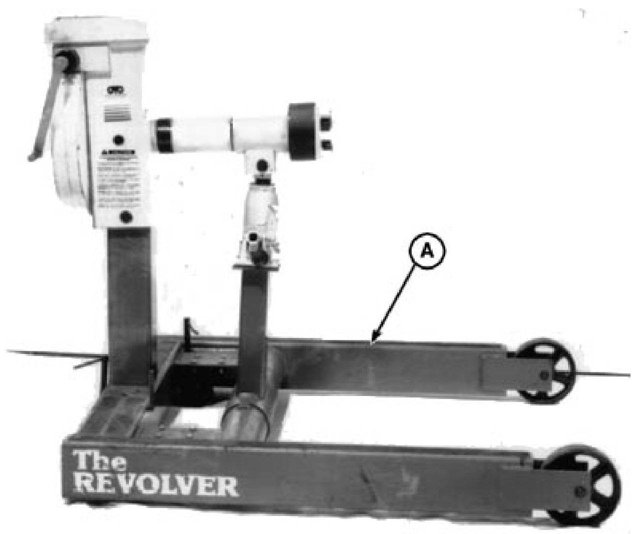
DPSG,OUO1032,3410 –19–15JUN00–1/1

Engine Repair Stand

NOTE: Only the 2722 kg (6000 lb) heavy-duty engine repair stand (A) No. D05223ST manufactured by Owatonna Tool Co., Owatonna, Minnesota is referenced in this manual. When any other repair stand is used, consult the manufacturer's instructions for mounting the engine.

Refer to machine technical manual for steps to remove engine from machine before installing it on repair stand.

A—Engine Repair Stand



RG4929 –UN–05DEC97

Engine Repair Stand

RG,RG34710,1043 –19–23OCT97–1/1

Safety Precautions

The engine repair stand should be used only by qualified service technicians familiar with this equipment.

To maintain shear strength specifications, alloy steel Class 12.9 or SAE Grade 8 or higher cap screws must be used to mount adapters and engine to repair stand. Use LOCTITE® 242 Thread Lock and Sealer on cap screws when installing lifting straps on engine. Tighten cap screws to specifications given.

For full thread engagement, be certain that tapped holes in adapters and engine blocks are clean and not damaged. A thread length engagement equal to 1-1/2 screw diameters minimum is required to maintain strength requirements.

To avoid structural or personal injury, do not exceed the maximum capacity rating of 2722 kg (6000 lb). Maximum capacity is determined with the center of the engine located not more than 330 mm (13 in.) from the mounting hub surface of the engine stand.

The center of balance of an engine must be located within 51 mm (2 in.) of the engine stand rotating shaft.

Engine center of balance is generally located a few millimeters above the crankshaft.

To prevent possible personal injury due to engine slippage, recheck to make sure engine is solidly mounted before releasing support from engine lifting device.

Never permit any part of the body to be positioned under a load being lifted or suspended. Accidental slippage may result in personal injury.

The lifting jack is to be used when it is necessary to lift the engine for rotation. When working on the engine, the jack should be at its lowest position to keep the center of gravity and the possibility of tipping low.

To prevent possible personal injury due to sudden engine movement, lower the engine by operating jack release valve slowly. Do not unscrew release valve knob more than two turns from its closed position.

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RG,RG34710,45 –19–30SEP97–1/1

Disconnect Turbocharger Oil Inlet Line

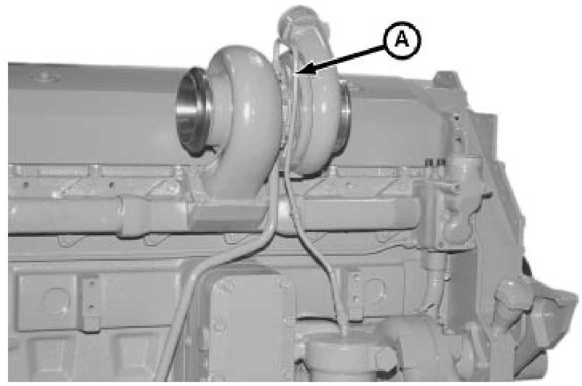
1. Drain all engine oil and coolant, if not previously done.

IMPORTANT: When servicing turbocharged engines on a rollover stand, disconnect turbocharger oil inlet line (A) from oil filter housing or turbocharger before rolling engine over. Failure to do so may cause a hydraulic lock upon starting engine. Hydraulic lock may cause possible engine failure.

Hydraulic lock occurs when trapped oil in the oil filter housing drains through the turbocharger, the exhaust and intake manifolds, and then into the cylinder head.

After starting the engine, the trapped oil in the manifold and head is released into the cylinder(s) filling them with oil causing hydraulic lock and possible engine failure.

2. Disconnect turbocharger oil inlet line at turbocharger or oil filter base.



RG10241 –UN–09JUL99

Turbocharger Oil Inlet Line

A—Turbocharger Oil Inlet Line

DPSG,OUO1004,918 –19–30JUN99–1/1

Install Engine Adapter Onto Repair Stand

Attach the No. 205466 Adapter Assembly to engine repair stand using four 5/8-11 x 2 in. SAE Grade 8 (or higher grade) cap screws. Tighten cap screws to specification.

Specification
Engine Adapter-to-Repair Stand
Cap Screws—Torque .... 135 N•m (100 lb-ft)

RG8183 –UN–08DEC97

D05223ST Repair Stand with 205466 Adapter

RG,RG34710,46 –19–21AUG02–1/1

Engine Lifting Procedure

1. Install R503481 (OEM & AT801 Applications Only) or R128001 Front Lift Strap and R128000 Rear Lift Strap (or attach sling to front plate lift eye) and tighten cap screws to specification.

Specification

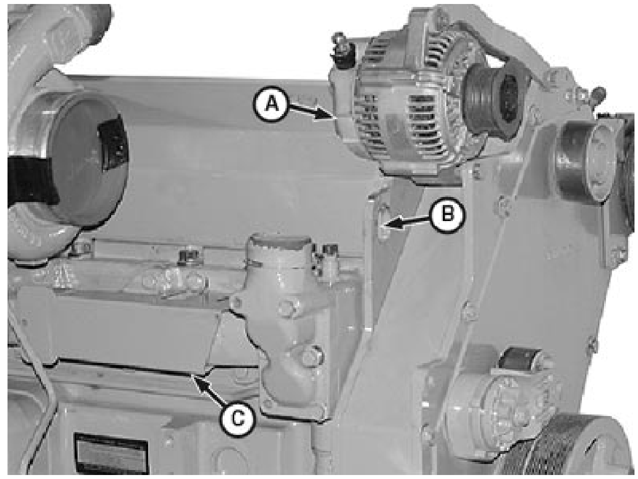
Engine Lift Strap Cap Screws—
Torque .... 90 N•m (66 lb-ft)

NOTE: Lift spacing on sling is adjustable. Position each lifting point so that engine hangs level when lifted.

2. Attach the JDG23 Engine Lifting Sling (D) to lift straps and overhead hoist or floor crane of adequate lifting capacity.

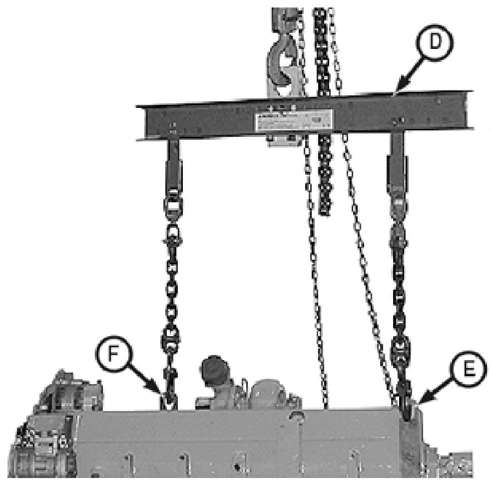
3. Carefully lift engine to desired location.

A—Alternator
B—Front Plate Lift Eye
C—Exhaust Shield
D—JDG23 Lift Sling
E—R128000 Rear Lift Strap[1]
F—R503481 (OEM & AT801 Applications Only) or R128001 Front Lift Strap[1]



RG10349 –UN–13OCT99

Engine Lift Points



RG10350 –UN–13OCT99

Engine Lifting

[1] *Can be ordered from parts catalog.*

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IMPORTANT: Lifting straps are designed to lift the engine and small accessories such as hydraulic pumps and air compressors mounted to the engine auxiliary gear drive, or belt-driven components, such as air conditioning compressors and alternators. If larger components, such as PTO's, transmissions, generators or air compressors, are attached to other locations on the engine, the lift straps provided with the engine are not intended for this purpose. Technician is responsible for providing adequate lifting devices under these situations. See machine technical manual for additional information on removing engine from machine.

CAUTION: The only approved method for lifting the 6105 and 6125 Engine is with the use of JDG23 Lifting Sling (D), R128000 Rear Lift Strap (E) and R503481 (OEM & AT801 Applications Only) or R128001 Front Lift Strap (F). The front plate lift eye (B) can be used as a lifting point instead of R503481 (OEM & AT801 Applications Only) or R128001 Front Lift Strap. Use extreme caution when lifting and NEVER permit any part of the body to be positioned under an engine being lifted or suspended.

Lift engine with longitudinal loading on lift sling and lifting brackets only. Angular loading greatly reduces lifting capacity of sling and brackets.

IMPORTANT: Ensure that engine lifting straps are secured with Class 12.9 (or higher class) cap screws. Apply TY9370 LOCTITE® 242 Thread Lock and Sealer to lift strap cap screws.

NOTE: If lift eye in front plate (B) is used instead of R503481 (OEM & AT801 Applications Only) or R128001 Front Lift Strap, remove alternator (A).

If front lift strap (F) is being used, remove exhaust shield (C) and install lift strap using shield mounting cap screw holes.

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RG,RG34710,47 –19–20AUG02–2/2

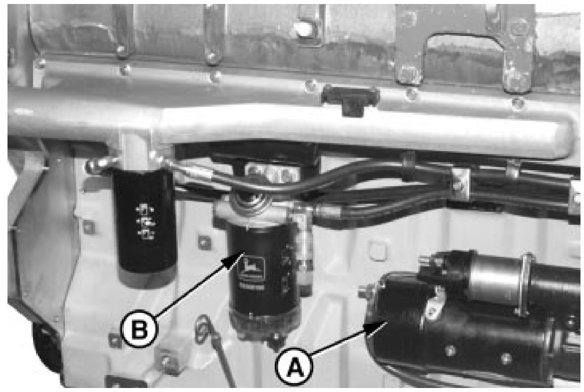
Mount Engine Onto Repair Stand

CAUTION: NEVER remove the overhead lifting equipment until the engine is securely mounted onto the repair stand and all mounting hardware is tightened to specified torque. Always release the overhead lifting equipment slowly.

1. Remove starter motor (A).

2. On engines with primary fuel filter/water separator (B) on left side of engine, remove primary fuel filter/water separator.

   On later engines with large single fuel filter mounted on left side of engine, remove fuel filter assembly.



Component Removal for Repair Stand Mounting

A—Starter Motor
B—Primary Fuel Filter

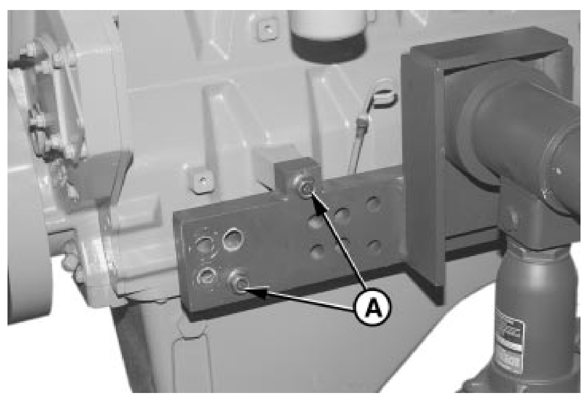
RG,RG34710,48 –19–13SEP02–1/3

IMPORTANT: DO NOT use shorter cap screws than recommended since mounting threads in block bore may be stripped when tightening to specified torque. USE ONLY JDG980 METRIC BOLT KIT for mounting engine to repair stand.

3. Mount engine to front engine adapter using two[1] M16 x 2.0 x 65 mm (Class 12.9) cap screws (A). Tighten cap screws to specification.

Specification

Engine-to-Stand Adapter Cap Screws—Torque .... 400 N•m (300 lb-ft)



Front Repair Stand Cap Screws

A—Cap Screws

[1] *From JDG980 Metric Bolt Kit.*

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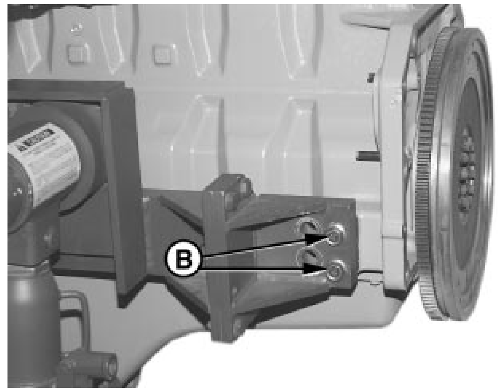
4. Mount engine to rear engine adapter using two[1] M16 x 2.0 x 65 mm (Class 12.9) cap screws (B). Tighten cap screws to specification.

Specification

Engine-to-Stand Adapter Cap Screws—Torque .... 400 N•m (300 lb-ft)

B—Cap Screws



RG8186 –UN–05DEC97

Rear Repair Stand Cap Screws

[1] *From JDG980 Metric Bolt Kit.*

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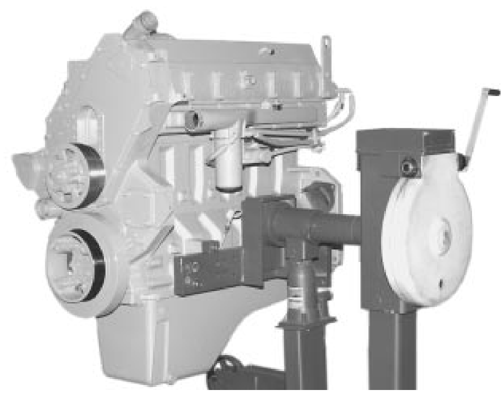
Clean Engine

1. Cap or plug all openings (air intake, exhaust, fuel, coolant, etc.).

2. Remove electrical components (starter, alternator, etc.). Cover electrical components that are not removed with plastic and tape securely to prevent moisture damage.

3. Thoroughly steam clean engine.

IMPORTANT: Never steam clean or pour cold water on an engine while it is still hot. To do so may cause seizure of precision parts.



RG8188 –UN–21MAY98

6125HRW Engine on Repair Stand

RG,RG34710,49 –19–21DEC00–1/1

6105 and 6125 Engine Disassembly Sequence

The following sequence is suggested when complete engine disassembly for overhaul is required. Refer to the appropriate repair group when removing individual components.

NOTE: Remove starter motor and primary fuel filter/water separator before mounting engine onto repair stand.

ENGINE DISASSEMBLY SEQUENCE	
Procedure	**Reference**
Drain all coolant, fuel and engine oil.	See DISPOSING OF COOLANT in Section 01, Group 002.
Perform John Deere COOLSCAN™ and OILSCAN® analysis. Dispose of remaining fluids properly.	See OILSCAN AND COOLSCAN in Section 01, Group 002. See TESTING DIESEL ENGINE COOLANT in Section 01, Group 002.
Remove starter motor.	See REMOVE AND INSTALL STARTER MOTOR in Group 100.
Remove fuel filter assemblies with mounting bases as required (Delphi/Lucas ECU controlled fuel system).	See REPLACING PRIMARY FUEL FILTER/WATER SEPARATOR in CTM115, Section 02, Group 090. See REPLACE FINAL (SECONDARY) FUEL FILTER ELEMENT in CTM115, Section 02, Group 090.
Remove fuel filter assemblies with mounting bases as required (John Deere Level 6 ECU controlled fuel system).	See REPLACING PRIMARY FUEL FILTER/WATER SEPARATOR in CTM188, Section 02, Group 090 (dual rail fuel systems). See REPLACE FINAL (SECONDARY) FUEL FILTER ELEMENT in CTM188, Section 02, Group 090 (dual rail fuel systems). See FUEL FILTER/WATER SEPARATOR ASSEMBLY in CTM188, Section 02, Group 091 (single rail fuel systems).
Mount engine onto recommended safety approved repair stand.	See MOUNT ENGINE ONTO REPAIR STAND in this group.
Remove fan, drive belts, and fan drive assembly.	See Group 070.
Remove alternator.	See REMOVE AND INSTALL ALTERNATOR in Group 100.
Remove compressor.	See CTM67, OEM Engine Accessories.
Remove vibration damper and pulley assembly from crankshaft.	See REMOVE CRANKSHAFT VIBRATION DAMPER AND PULLEY in Group 040.
Disconnect all air intake/exhaust piping and turbocharger oil inlet/drain lines. Remove turbocharger.	See REMOVE TURBOCHARGER in Group 080.
Remove exhaust manifold and gaskets.	See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD in Group 080.
Remove oil filter and oil filter housing.	See REMOVE OIL FILTER AND VALVE HOUSING/OIL COOLER COVER AND VALVE HOUSING in Group 060.
Remove oil cooler assembly.	See REMOVE, CLEAN AND INSPECT ENGINE OIL COOLER in Group 060.
Remove coolant pump assembly.	See REMOVE COOLANT PUMP in Group 070.
Remove water manifold/thermostat housing assembly.	See REMOVE AND INSTALL THERMOSTAT HOUSING in Group 070.
Remove all six piston spray jets.	See REMOVE AND INSTALL PISTON SPRAY JETS in Group 030.
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COOLSCAN is a trademark of Deere & Company.
OILSCAN is a registered trademark of Deere & Company.

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ENGINE DISASSEMBLY SEQUENCE—CONTINUED	
Procedure	**Reference**
On 6105H and 6125H engines, remove air intake manifold.	See REMOVE, INSPECT AND INSTALL INTAKE MANIFOLD in Group 080.
On 6105A and 6125A engines, remove aftercooler assembly.	See REMOVE AND INSTALL AFTERCOOLER ASSEMBLY in Group 080.
Remove fuel supply pump (Delphi/Lucas ECU controlled fuel system).	See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM115, Section 02, Group 090.
Remove fuel supply pump (John Deere ECU controlled fuel system).	See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM188, Section 02, Group 090 (dual rail fuel systems). See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM188, Section 02, Group 091 (single rail fuel systems).
Remove fuel manifold assembly on Delphi/Lucas ECU controlled fuel systems.	See REMOVE AND INSTALL FUEL MANIFOLD in CTM 115, Section 02, Group 090.
Remove fuel manifold assembly on John Deere ECU controlled fuel systems.	See REMOVE AND INSTALL FUEL MANIFOLD in CTM 188, Section 02, Group 090 (dual rail fuel systems).
Remove all remaining fuel lines, identify for reassembly in correct location.	See CTM115, Section 02, Group 090. See CTM188, Section 02, Group 090 or 091.
Remove engine oil pan.	See REMOVE ENGINE OIL PAN in Group 060.
Remove oil pickup tube.	See REMOVE AND INSTALL OIL PICKUP TUBE in Group 060.
Remove front gear train access cover and timing gear cover.	See REMOVE TIMING GEAR COVER in Group 040.
Remove rocker arm cover.	See REMOVE AND INSTALL ROCKER ARM COVER in Group 020.
NOTE: Identify valve train components and electronic unit injectors for reassembly in same location as removed. Remove front and rear rocker arm and shaft assembly and EUI wiring harness.	See REMOVE ROCKER ARM ASSEMBLY in Group 020.
Remove electronic unit injectors on Delphi/Lucas ECU controlled fuel systems.	See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM115, Section 02, Group 090.
Remove electronic unit injectors on John Deere ECU controlled fuel systems.	See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM188, Section 02, Group 090 (dual rail fuel systems). See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM188, Section 02, Group 091 (single rail fuel systems).
Remove camshaft gear and idler gear assembly. Remove camshaft position sensor and remove camshaft.	See REMOVE AND INSTALL CAMSHAFT in Group 050.
Remove oil pump drive gear and remove oil pump assembly.	See REMOVE ENGINE OIL PUMP in Group 060.
Remove cylinder head and gasket.	See REMOVE CYLINDER HEAD in Group 020.
Remove flywheel.	See REMOVE FLYWHEEL in Group 040.
Remove flywheel housing.	See REMOVE AND INSTALL FLYWHEEL HOUSING in Group 040.
Remove rear crankshaft seal and seal housing.	See REMOVE REAR CRANKSHAFT OIL SEAL AND HOUSING ASSEMBLY in Group 040.
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ENGINE DISASSEMBLY SEQUENCE—CONTINUED	
Procedure	**Reference**
Remove cylinder block front plate.	See REMOVE AND INSTALL CYLINDER BLOCK FRONT PLATE in Group 030.
Perform wear checks on connecting rod bearing surfaces using PLASTIGAGE®. Remove piston and connecting rod assemblies.	See REMOVE PISTONS AND CONNECTING RODS in Group 030.
Check crankshaft end play.	See CHECK CRANKSHAFT END PLAY in Group 040.
Remove main bearing caps with bearings. Perform wear checks on main bearing surfaces with PLASTIGAGE®.	See REMOVE CRANKSHAFT MAIN BEARINGS in Group 040. See CHECK MAIN BEARING-TO-JOURNAL OIL CLEARANCE in Group 040.
Remove crankshaft.	See REMOVE CRANKSHAFT in Group 040.
Remove cylinder block plugs and serial number plate if block is to be put in a hot tank.	See COMPLETE DISASSEMBLY OF CYLINDER BLOCK in Group 030.
Inspect and repair individual components.	See appropriate repair groups.

PLASTIGAGE is a registered trademark of the DANA Corp.

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Sealant Application Guidelines

Listed below are sealants which have been tested and are used by the John Deere factory to control leakage and ensure hardware retention. ALWAYS use the following recommended sealants when assembling your John Deere Diesel Engine to ensure quality performance.

LOCTITE® thread sealants are designed to perform to sealing standards with machine oil residue present. If excessive machine oil or poor cleanliness quality exist, clean with solvent. Refer to John Deere Merchandise and Parts Sales Manual for ordering information.

IMPORTANT: LOCTITE® gasket materials are NOT designed to work with oil residue present. Oil residues must be cleaned from surfaces before applying gasket material.

LOCTITE® **242 Thread Lock & Sealer (Medium Strength) (blue):**

TY9370 6 mL (0.2 oz) tube

- Threaded plugs and fittings: cylinder block (oil galley).
- Cap screws: coolant pump, timing gear cover, camshaft gear access cover, oil pump.
- Oil pressure sending unit.
- Turbocharger oil inlet fitting.
- Fuel filter check valve or elbow (filter header end) dual rail fuel system.
- Piston spray jets.
- Timing gear cover gasket and camshaft gear access cover gasket on earlier engines using Fel-Pro gaskets.
- Idler gear carrier cap screws, camshaft gear retainer cap screws and fuel supply pump drive coupler cap screws.
- EUI hold-down clamp cap screws.

LOCTITE® **271 Thread Lock & Sealer (High Strength) (clear):**

TY9371 6 mL (0.2 oz) tube

- Oil filter adapter-to-base.

LOCTITE® **277 Thread Lock & Sealer (High Strength) (red):**

T43514 50 mL (1.7 oz) bottle

- Expansion plugs in cylinder head and block.

LOCTITE® **515 Flexible Sealant (General Purpose) (purple):**

TY6304 50 mL (1.7 oz) bottle

- Timing gear cover and camshaft gear access cover gasket on earlier engines using Fel-Pro gasket.

LOCTITE® **592 Pipe Sealant with** TEFLON® **(white):**

TY9374 6 mL (0.2 oz) tube

- Pipe plugs: cylinder block (water manifold), thermostat housing, air intake manifold, and coolant pump.
- Temperature sending unit.
- Coolant heater.
- Oil pan drain valve/hose.

LOCTITE® **680 Maximum Strength Retaining Compound (green):**

TY15969 6 mL (0.2 oz) tube

- Crankshaft flange and ID of front wear sleeve for front and rear oil seal/wear sleeve installation.
- Steel cup plugs on cylinder head and block.

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TEFLON is a registered trademark of Du Pont Company

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PT569 NEVER-SEEZ® **Compound**

PT569 227 g (8 oz) Brush

PT506 453 g (16 oz) Spray

- Cap Screws: exhaust manifold, intake manifold, aftercooler, turbocharger oil return line, and turbocharger cap screws/nut.

LOCTITE® **222 Small Screw Threadlocker (Removable) (Purple)**

TY24311 0.5 mL (0.02 oz) tube

- EUI solenoid terminal nuts.

LOCTITE® **17430 High Flex Form-in-Place Gasket**

T43514 50 mL (1.7 oz) bottle

- Oil pan-to-cylinder block (timing gear cover and rear seal housing T-joints).

LOCTITE® **7649, TY16285 Clean-and-Cure Primer**

- Clean mating gasket surfaces on timing gear cover, camshaft gear access cover, oil pan, and block sealing surfaces.

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NEVER-SEEZ is a registered trademark of Emhart Chemical Group

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6105 and 6125 Engine Assembly Sequence

The following assembly sequence is suggested when engine has been completely disassembled. Be sure to check runout, clearance, and all critical physical part specifications prior to assembling engine. Replace parts as necessary and tighten retaining hardware to specifications given. Refer to the appropriate repair group when assembling engine.

IMPORTANT: ALWAYS replace vibration damper whenever crankshaft is replaced or after a major engine overhaul.

ENGINE ASSEMBLY SEQUENCE	
Procedure	**Reference**
Install all plugs in cylinder block that were removed to service cylinder block.	See COMPLETE DISASSEMBLY OF CYLINDER BLOCK in Group 030.
IMPORTANT: If new piston and liner kits are being installed, install them as an assembly after crankshaft has been installed. Install cylinder liners without O-rings and measure liner stand-out. Install liners with packing.	See INSTALL CYLINDER LINERS in Group 030.
Install crankshaft.	See INSTALL CRANKSHAFT in Group 040.
Install main bearings.	See INSTALL MAIN BEARING INSERTS IN BLOCK in Group 040.
Rotate crankshaft by hand to ensure correct assembly. Check crankshaft end play.	See CHECK CRANKSHAFT END PLAY in Group 040.
Install pistons and connecting rods. Rotate crankshaft by hand to ensure correct assembly.	See in INSTALL PISTONS AND CONNECTING RODS in Group 030.
Install crankshaft rear oil seal housing.	See INSTALL CRANKSHAFT REAR OIL SEAL HOUSING in Group 040.
Install rear oil seal and wear sleeve assembly.	See INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE ASSEMBLY in Group 040.
Install flywheel.	See INSTALL FLYWHEEL in Group 040.
Install flywheel housing.	See REMOVE AND INSTALL FLYWHEEL HOUSING in Group 040.
Install cylinder block front plate.	See REMOVE AND INSTALL CYLINDER BLOCK FRONT PLATE in Group 030.
Install engine oil pump and drive gear.	See INSTALL ENGINE OIL PUMP in Group 060.
Install cylinder head using a new gasket.	See INSTALL CYLINDER HEAD in Group 020.
Install camshaft and camshaft drive gear.	See REMOVE AND INSTALL CAMSHAFT in Group 050.
Install timing gear cover.	See INSTALL TIMING GEAR COVER in Group 040.
Install oil pickup tube.	See REMOVE AND INSTALL OIL PICKUP TUBE in Group 060.
Install engine oil pan.	See INSTALL ENGINE OIL PAN in Group 060.
Install idler gear. Pin camshaft and crankshaft. Adjust idler gear-to-camshaft gear and idler gear-to-oil pump gear backlash.	See ADJUST FRONT TIMING GEAR BACKLASH in Group 050.
Install **new** crankshaft vibration damper and pulley assembly (with oil seal).	See INSTALL CRANKSHAFT VIBRATION DAMPER AND FRONT OIL SEAL in Group 040.
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ENGINE ASSEMBLY SEQUENCE—CONTINUED	
Procedure	**Reference**
Install electronic unit injectors on Delphi/Lucas ECU controlled fuel systems.	See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM115, Section 02, Group 090.
Install electronic unit injectors on John Deere ECU controlled fuel systems.	See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM188, Section 02, Group 090 (dual rail fuel systems). See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM188, Section 02, Group 091 (single rail fuel systems).
Install valve bridges and push tubes. Install front and rear rocker arm shaft assemblies. Install EUI wiring harness.	See INSTALL ROCKER ARM ASSEMBLY in Group 020.
Preload unit injectors and adjust valve clearance.	See CHECK AND ADJUST VALVE ASSEMBLY CLEARANCES AND INJECTOR PRELOAD in Group 020.
Install front camshaft gear access cover.	See INSTALL TIMING GEAR COVER in Group 040.
Install fuel supply pump (Delphi/Lucas ECU controlled fuel system).	See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM115, Section 02, Group 090.
Install fuel supply pump (John Deere ECU controlled fuel system).	See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM188, Section 02, Group 090 (dual rail fuel systems). See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM188, Section 02, Group 091 (single rail fuel systems).
Install fuel manifold assembly on Delphi/Lucas ECU controlled fuel systems.	See REMOVE AND INSTALL FUEL MANIFOLD in CTM 115, Section 02, Group 090.
Install fuel manifold assembly on John Deere ECU controlled fuel systems.	See REMOVE AND INSTALL FUEL MANIFOLD in CTM 188, Section 02, Group 090 (dual rail fuel systems).
Install all remaining fuel lines, identify for reassembly in correct location.	See CTM115, Section 02, Group 090. See CTM188, Section 02, Group 090 or 091.
On 6105H and 6125H engines, install air intake manifold.	See REMOVE, INSPECT AND INSTALL INTAKE MANIFOLD in Group 080.
On 6105A engines, install aftercooler assembly.	See REMOVE AND INSTALL AFTERCOOLER ASSEMBLY in Group 080.
Install fuel filter assemblies with mounting bases as required (Delphi/Lucas ECU controlled fuel system).	See REPLACING PRIMARY FUEL FILTER/WATER SEPARATOR in CTM115, Section 02, Group 090. See REPLACE FINAL (SECONDARY) FUEL FILTER ELEMENT in CTM115, Section 02, Group 090.
Install fuel filter assemblies with mounting bases as required (John Deere Level 6 ECU controlled fuel system).	See REPLACING PRIMARY FUEL FILTER/WATER SEPARATOR in CTM188, Section 02, Group 090 (dual rail fuel systems). See REPLACE FINAL (SECONDARY) FUEL FILTER ELEMENT in CTM188, Section 02, Group 090 (dual rail fuel systems). See FUEL FILTER/WATER SEPARATOR ASSEMBLY in CTM188, Section 02, Group 091 (single rail fuel systems).
Install all six piston spray jets.	See REMOVE AND INSTALL PISTON SPRAY JETS in Group 030.
Install coolant pump assembly.	See INSTALL COOLANT PUMP in Group 070.
(Continued on next page)	

Continued on next page RG,RG34710,52 –19–21AUG02–2/3

ENGINE ASSEMBLY SEQUENCE—CONTINUED	
Procedure	**Reference**
Install water manifold/thermostat housing assembly.	See REMOVE AND INSTALL THERMOSTAT HOUSING in Group 070.
Install oil filter housing/oil cooler assembly.	See INSTALL OIL COOLER/OIL FILTER VALVE HOUSING ASSEMBLY OR OIL COOLER COVER/VALVE HOUSING ASSEMBLY in Group 060.
Install exhaust manifold assembly.	See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD in Group 080.
Install turbocharger. Connect all turbocharger oil lines and intake/exhaust piping.	See INSTALL TURBOCHARGER in Group 080.
Install alternator.	See REMOVE AND INSTALL ALTERNATOR in Group 100.
Install compressor.	See CTM67, OEM Engine Accessories.
Install fan drive, fan and fan belt.	See Group 070.
Mount engine into vehicle.	See vehicle repair manual.
Flush cooling system. Fill engine systems with recommended fuel, lubricant, and coolant.	See FLUSH AND SERVICE COOLING SYSTEM in Section 01, Group 002.
Perform engine break-in and normal standard performance checks.	See PERFORM ENGINE BREAK-IN in this group.

RG,RG34710,52 –19–21AUG02–3/3

Engine Break-In Guidelines

Engine break-in should be performed after overhaul or when the following repairs have been made:

Main bearings, rod bearings, crankshaft, or any combination of these parts have been replaced.

Pistons, rings, or liners have been replaced.

Rear crankshaft oil seal and wear sleeve have been replaced. (Primary objective is to see if oil seal still leaks).

Cylinder head has been removed.

Electronic unit injectors have been removed or critical adjustments have been made while they are on the engine. (Primary objective of break-in is to check power).

RG,RG34710,1053 –19–05DEC00–1/1

Perform Engine Break-In

IMPORTANT: If engine has a PTO, break-in can be performed at the PTO if it is done as specified below. To prevent possible damage to the PTO gear box, DO NOT apply full load through the PTO for any longer than the specified 10 minutes below.

Use a dynamometer to perform the following preliminary break-in procedure. If necessary, preliminary engine break-in can be performed without a dynamometer if under controlled operating conditions.

IMPORTANT: DO NOT use John Deere PLUS-50 oil or engine oils meeting API CG4, API CF4, ACEA E3 or ACEA E2, performance levels during break-in period of an engine that has had a major overhaul. These oils will not allow an overhauled engine to properly wear during the break-in period.

Do not add makeup oil until the oil level is BELOW the add mark. John Deere Break-In Oil should be used to make up any oil consumed during break-in period.

DO NOT fill above the crosshatch pattern or FULL mark. Oil levels anywhere within the crosshatch are acceptable.

1. Fill engine crankcase to proper level with John Deere ENGINE BREAK-IN OIL during break-in operation. Use break-in oil regardless of ambient temperature. This oil is specifically formulated to enhance break-in of John Deere diesel engines. Under normal conditions, do not exceed 100 hours with break-in oil.

   If John Deere Engine Break-In Oil is not available, use diesel engine oil meeting API Service Classification CE or ACEA Specification E1.

IMPORTANT: During preliminary break-in, periodically check engine oil pressure and coolant temperature. Also check for signs of fuel, oil, or coolant leaks.

2. Start engine, run at loads and speeds shown in following chart for time limits given.

PRELIMINARY ENGINE BREAK-IN AFTER MAJOR OVERHAUL

Time	Load	Engine Speed
1 minute	No load	850 rpm
2 minutes	No load	Fast Idle
10 minutes	1/2—3/4 load	2000 rpm to rated speed
10 Minutes	Full load	Rated speed

3. After preliminary break-in, run engine 1—2 minutes at 1500 rpm, with no load before shut-down.

4. Check and readjust valve clearance as necessary. Cylinder head retorque is not required.

NOTE: During the first 20 hours, avoid prolonged periods of engine idling or sustained maximum load operation. If engine will idle longer than 5 minutes, stop engine.

5. Operate the engine at heavy loads with minimal idling during the break-in period.

If the engine has significant operating time at idle, constant speeds, and/or light load usage, an additional 100 hour break-in period is recommended using a new change of John Deere ENGINE BREAK-IN OIL and new John Deere oil filter.

Continued on next page

RG,100,JW7645 –19–05NOV99–1/2

Check engine oil level more frequently during engine break-in period. As a general rule, makeup oil should not need to be added during 100-hour break-in period. However, if makeup oil is required in the first 100-hour break-in, an additional 100-hour break-in period is required. Use a new change of John Deere ENGINE BREAK-IN OIL and a new John Deere oil filter.

After 100 hours maximum, drain break-in oil and change oil filter. Fill crankcase with John Deere TORQ-GARD SUPREME® OR PLUS-50® or other heavy-duty diesel engine oil within the same service classification as recommended in this manual. See DIESEL ENGINE OIL in Group 002, Fuels, Lubricants, and Coolant.

NOTE: Some increase in oil consumption may be expected when low viscosity oils are used. Check oil levels more frequently.

If air temperature is below -10° C (14° F), use an engine block heater.

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TORQ-GARD SUPREME is a registered trademark of Deere & Company.
PLUS-50 is a registered trademark of Deere & Company.

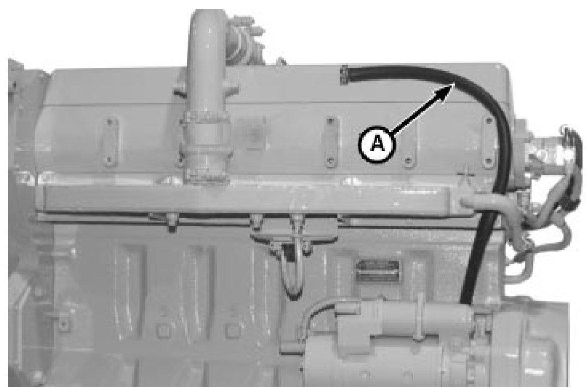
RG,100,JW7645 –19–05NOV99–2/2

Check Crankcase Ventilation System

1. Inspect crankcase ventilation system for restrictions. Lack of ventilation causes sludge to form in crankcase. This can lead to clogging of oil passages, filters, and screens, resulting in serious engine damage.

2. Clean crankcase vent tube (A) with solvent and compressed air if restricted. Install and tighten hose clamps securely.

A—Crankcase Vent Tube



RG10239 –UN–09JUL99

Crankcase Vent Tube

DPSG,OUO1004,919 –19–30JUN99–1/1

Check Air Intake System

1. Replace air cleaner primary filter element. Replace secondary element if primary element has holes in it. (See REPLACING AIR CLEANER FILTER ELEMENTS in operator's manual.)

2. Check condition of air intake hose(s). Replace hoses that are cracked, split, or otherwise in poor condition.

3. Check hose clamps for tightness. Replace clamps that cannot be properly tightened. This will help prevent dust from entering the air intake system which could cause serious engine damage.

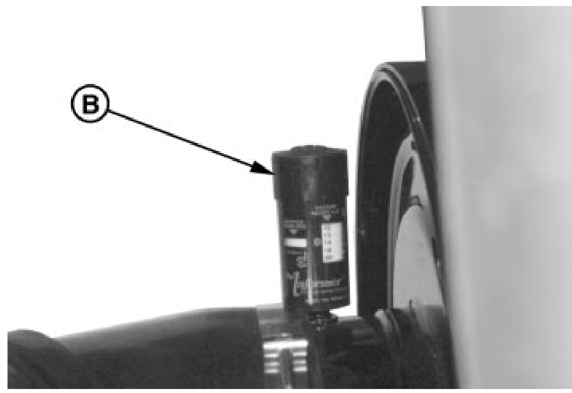
4. If air cleaner has an automatic dust unloader valve (A), inspect valve for dust buildup or restrictions.

5. Check air intake restriction indicator gauge (B) (if equipped) to determine if air cleaner needs to be serviced.

A—Unloader Valve
B—Restriction Indicator Gauge

RG8717A –UN–12JUL99

Unloader Valve



RG8719A –UN–12JUL99

Restriction Indicator Gauge

DPSG,OUO1004,920 –19–09JUL99–1/1

Check Exhaust System

1. Inspect exhaust system for leaks or restrictions. Check manifold for cracks. Repair or replace as necessary.

2. Check that turbocharger-to-exhaust elbow adapter clamps are securely tightened and do not leak.

3. Check exhaust stack for evidence of oil leakage past valve stem seals.

   Oil in exhaust stack may be caused by excessive valve stem-to-guide clearance or excessive light load engine idling.

RG,RG34710,1057 –19–23OCT97–1/1

Check and Service Cooling System

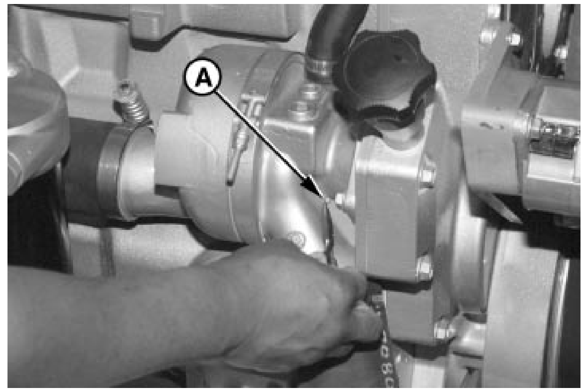
1. Remove trash that has accumulated on or near radiator.

2. Visually inspect entire cooling system and all components for leaks or damage. Repair or replace as necessary.

3. Remove the foam filter from weep hole (A, shown removed) located on the side of timing gear cover and discard filter. Inspect the weep hole for any restrictions.

4. Insert a heavy gauge wire deep into weep hole to make sure hole is open.

5. Install new foam filter flush with bore opening.

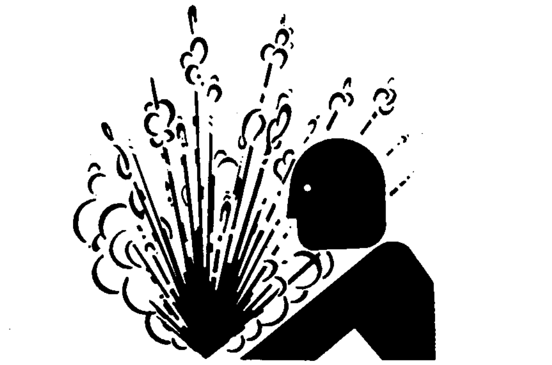


Weep Hole with Foam Filter

A—Weep Hole

Continued on next page DPSG,OUO1004,922 –19–01JUL99–1/2

CAUTION: Do not drain coolant until the coolant temperature is below operating temperature. Always loosen coolant drain valve (A) slowly to relieve any excess pressure.

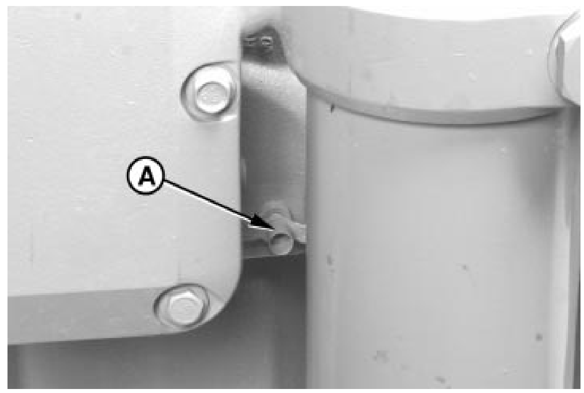

TS281 –UN–23AUG88

Service Cooling System Safely

6. Remove and check thermostat(s). (See REMOVE AND TEST THERMOSTATS in Group 025.)

7. Drain and flush cooling system. (See FLUSH AND SERVICE COOLING SYSTEM in Group 002.)

IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen temperature sending unit fitting at rear of cylinder head, bleed plug at top front of cylinder head, or plug in thermostat housing to allow air to escape when filling system. Retighten fitting or plug when all the air has been expelled.



RG8246 –UN–06DEC97

Coolant Drain Valve

A—Coolant Drain Valve

8. Fill cooling system with coolant. Follow recommendations in Group 002. (See DIESEL ENGINE COOLANT RECOMMENDATIONS in Group 002.)

9. Run engine until it reaches operating temperature. Check entire cooling system for leaks.

10. After engine cools, check coolant level.

NOTE: Coolant level should be even with bottom of radiator filler neck.

11. Check system for holding pressure. (See PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP in Section 04, Group 150.)

DPSG,OUO1004,922 –19–01JUL99–2/2

Check Electrical System


Prevent Battery Explosions

TS204 –UN–23AUG88

CAUTION: Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.

Always remove grounded (-) battery clamp first and replace it last.

1. Clean batteries and cables with damp cloth. If corrosion is present, remove it and wash terminals with a solution of ammonia or baking soda in water. Then flush area with clean water.

2. Coat battery terminals and connectors with petroleum jelly mixed with baking soda to retard corrosion.

3. Test batteries. If batteries are not near full charge, try to find out why.

4. On low-maintenance batteries, check level of electrolyte in each cell of each battery. Level should be to bottom of filler neck. If water is needed, use clean, mineral-free water.

   If water must be added to batteries more often than every 250 hours, alternator may be overcharging.

NOTE: Water cannot be added to maintenance-free batteries.

5. If batteries appear to be either undercharged or overcharged, check alternator and charging circuit.

6. Check tension of drive belts. See operator’s manual.

7. Check operation of starter motor and gauges.

NOTE: For test and repair of alternators and starter motors, see CTM77, Alternators and Starter Motors.

RG,RG34710,1059 –19–23OCT97–1/1

Preliminary Engine Testing Before Tune-Up

Before tuning-up an engine, determine if a tune-up will restore operating efficiency. If in doubt, the following preliminary tests will help determine if the engine can be tuned-up. Choose from the following procedures only those necessary to restore the unit.

1. After engine has stopped for several hours, loosen crankcase drain plug and watch for any water to seep out. A few drops could be due to condensation, but any more than this would indicate problems which require engine repairs rather than just a tune-up.

2. With engine stopped, inspect engine coolant for oil film. With engine running, inspect coolant for air bubbles. Either condition would indicate problems which require engine repairs rather than just a tune-up.

3. Perform a dynamometer test and record power output. (See DYNAMOMETER TEST in Section 04, Group 150.) Repeat dynamometer test after tune-up. Compare power output before and after tune-up.

DPSG,OUO1004,921 –19–07NOV00–1/1

General Tune-Up Recommendations

As a general rule, an engine tune-up is not necessary if ALL recommended operator's manual hourly service procedures are performed on schedule. If your engine performance is not within the rated application guidelines, the following service procedures are recommended to help restore engine to normal operating efficiency.

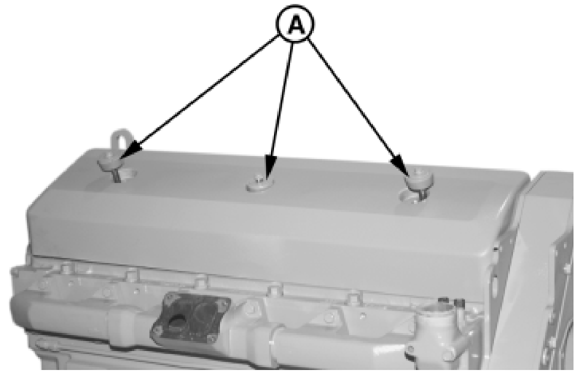
IMPORTANT: These engines are equipped with electronically-controlled governors which have a diagnostic feature that will display detailed codes to alert operator of specific performance problems. Refer to CTM115 for Delphi/Lucas ECU controls, and refer to CTM188 for later John Deere ECU controls.

Operation	Detailed Reference
Check for and correct any diagnostic trouble codes.	CTM115 or CTM188
Change engine oil and filters.	Operator's Manual
Lubricate PTO clutch internal levers and linkage, if equipped.	Operator's Manual
Replace fuel filter.	CTM115 or CTM188, Operator's Manual
Clean crankcase vent tube.	This Group/Operator's Manual
Check air intake system. Replace air cleaner elements.	This Group/Operator's Manual
Check exhaust system.	This Group
Check and service engine cooling system.	This Group/Operator's Manual
Check and adjust fan and alternator belts.	Operator's Manual
Check electrical system.	This Group
Check crankshaft vibration damper.	Group 040/Operator's Manual
Inspect turbocharger and check turbocharger boost pressure.	Section 04, Group 150 of CTM115 or CTM188
Check fuel injection system: Check electronic unit injectors.	Section 04, Group 150 of CTM115 or CTM188
Check engine valve clearance and EUI preload. Adjust if necessary.	Section 02, Group 020 of CTM115 or CTM188
Check engine oil pressure. Correct as necessary.	Section 04, Group 150
Check engine speeds. Correct as necessary.	Authorized Servicing Dealer
Check engine performance on dynamometer.	Section 04, Group 150

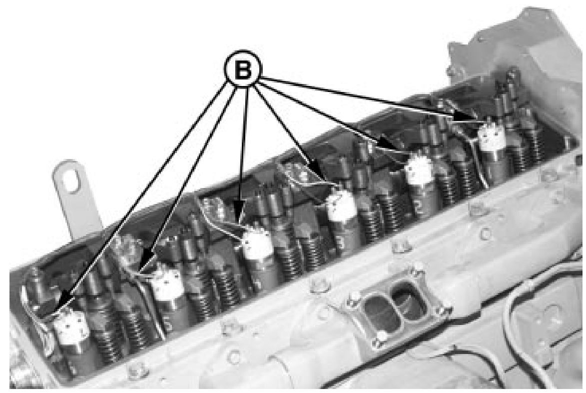
DPSG,OUO1004,923 –19–30AUG02–1/1

Remove and Install Rocker Arm Cover

Remove Rocker Arm Cover



Isolators



Unit Injector Wiring

A—Isolators
B—Unit Injector Wiring

1. Remove air intake cross-over tube (shown removed).

NOTE: Turbocharger is removed for photographic purposes only. It is not necessary to remove turbocharger for rocker arm cover removal.

2. Remove center hold-down cap screw with isolator.

3. Remove two outside cap screws with isolators (A), and thread cap screws into rocker arm cover as shown.

NOTE: Rocker arm cover gasket is reusable if no visible damage is detected. Do not store cover resting on gasket surface.

4. Lift rocker arm cover off engine.

Install Rocker Arm Cover

IMPORTANT: Always check routing of unit injector wiring (B) before installing rocker arm cover. Wiring should be positioned so that rocker arms never contact wire.

1. Inspect rocker arm cover gasket to ensure that gasket is properly seated in groove and that contact face is clean.

2. Position rocker arm cover onto two locating dowels in cylinder head.

3. Install center hold-down cap screw with isolator. Tighten to specifications.

Specification
Rocker Arm Cover Hold-Down
Cap Screws[1]—Torque .... 30 N•m (22 lb-ft)

4. Install two outside hold-down cap screws with isolators. Tighten to specifications.

[1] *Tighten center cap screw first, then tighten sides.*

Continued on next page
RG,RG34710,60 –19–03NOV99–1/2

Specification

Rocker Arm Cover Hold-Down
Cap Screws[1]—Torque .... 30 N•m (22 lb-ft)

5. Install air intake cross-over tube and tighten connections securely.

[1]Tighten center cap screw first, then tighten sides.

RG,RG34710,60 –19–03NOV99–2/2

Clean and Inspect Crankcase Ventilation Assembly

1. Remove ventilation outlet tube from rocker arm cover (shown removed).

NOTE: *Ventilator assembly-to-rocker cover self-tapping cap screws have been replaced by flange head cap screws with pre-applied sealant. Discard old self-tapping cap screws and replace with new cap screws.*

2. Remove two cap screws securing ventilator assembly (B) to cover and remove.

3. Clean ventilator assembly in solvent and dry with compressed air.

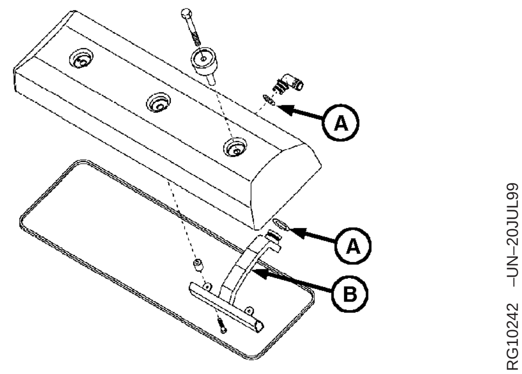
4. Install ventilator assembly in reverse order of removal. Replace O-rings (A) as necessary.

5. Tighten ventilator assembly-to-rocker arm cover cap screws to specifications.

Specification

Crankcase Vent Baffle-to-Rocker
Arm Cover Cap Screws—Torque .... 15 N•m (11 lb-ft) (133 lb-in.)

6. Install ventilator outlet tube onto elbow attached to rocker arm cover.



Crankcase Ventilation Assembly

A—O-Rings
B—Ventilator Assembly

RG,RG34710,61 –19–03SEP02–1/1

Replace Rocker Arm Cover Gasket

1. Remove rocker arm cover. (See REMOVE AND INSTALL ROCKER ARM COVER earlier in this group.)

2. Remove existing gasket from cover and discard. Clean gasket groove as needed.

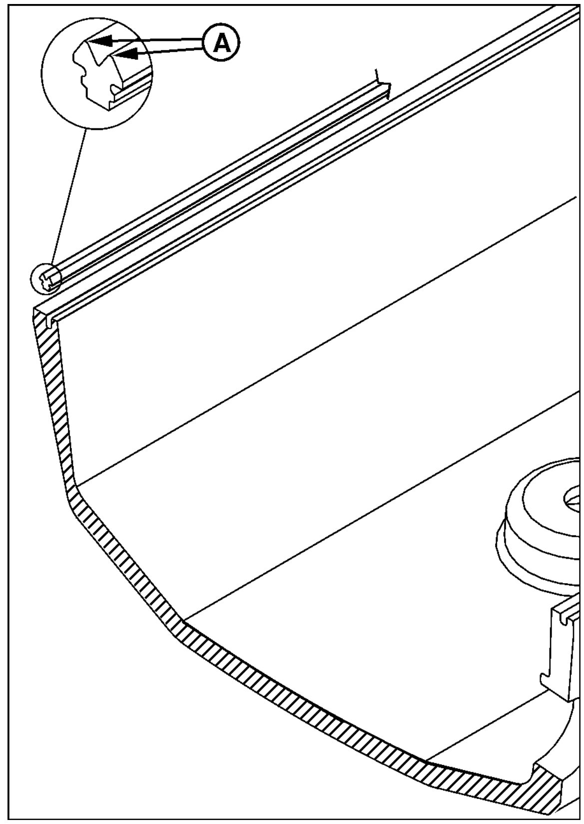
3. Position new gasket at two front corners of cover with double lips (A) of gasket facing up.

IMPORTANT: DO NOT stretch gasket while seating in groove of cover.

4. Seat gasket on front side of cover and proceed around entire cover gasket groove using a deep-well socket.

5. Re-seat gasket again (especially in corners) after entire gasket is installed in groove.

A—Gasket Double Lips



Replacing Rocker Arm Cover Gasket

RG,RG34710,62 –19–30SEP97–1/1

Check and Adjust Valve Assembly Clearances and Injector Preload

Rocker arm assembly adjustments consist of intake and exhaust valve clearance (lash) and electronic unit injector preload adjustment.

CAUTION: To prevent accidental starting of engine while performing rocker arm adjustment, ALWAYS disconnect NEGATIVE (–) battery terminal.

IMPORTANT: All rocker arm assembly adjustments MUST BE performed with engine COLD.

1. Remove rocker arm cover. (See REMOVE AND INSTALL ROCKER ARM COVER earlier in this group.)

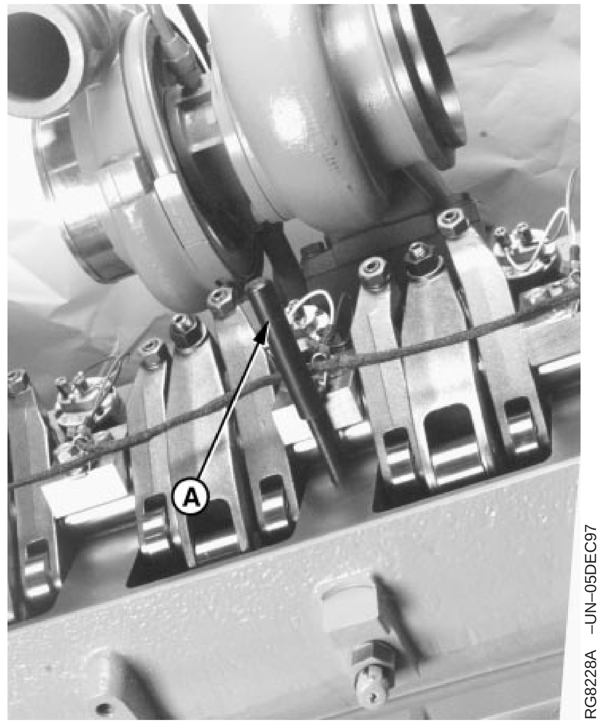
2. Remove plug from cylinder block and install JDG820 Flywheel Turning Tool (B).

3. Remove threaded plug from timing hole below oil cooler and filter housing assembly.

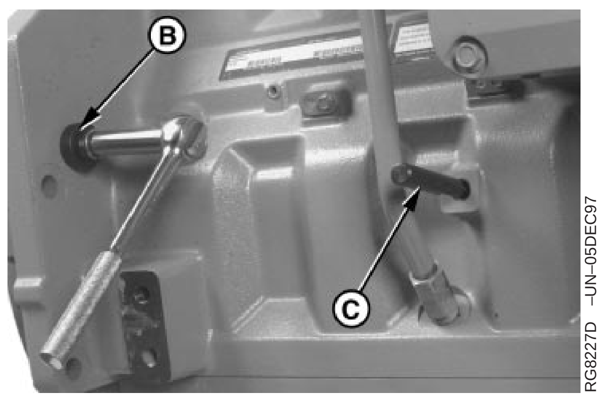
IMPORTANT: Timing pin MUST BE installed in slot of camshaft first, then install second timing pin in crankshaft slot by carefully rocking flywheel back and forth.

4. Rotate engine flywheel in running direction (counterclockwise as viewed from rear) until JDG971 Timing Pin (A) engages single timing slot (D) in camshaft. The proper timing slot can be found by viewing camshaft timing lobe through camshaft timing pin bore while rotating engine. The double timing slot (E) will be at approximately 11 o'clock (viewed from rear of engine) when pin is installed in slot (D).This ensures that engine is locked at TDC of No. 1 cylinder's compression stroke. Intake and exhaust rocker arms on No. 1 cylinder should be loose.

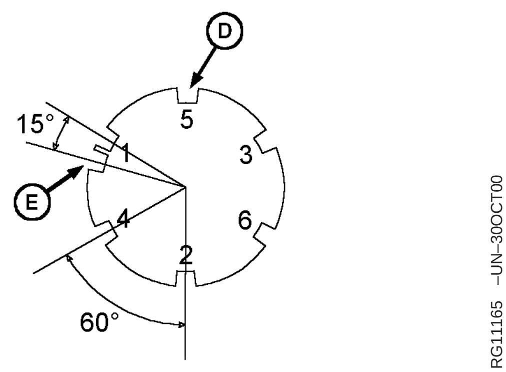
A—JDG971 Timing Pin
B—JDG820 Flywheel Turning Tool
C—JDG971 Timing Pin
D—Single Timing Slot
E—Double Timing Slot



JDG971 Timing Pin in Camshaft



JDG971 Timing Pin in Crankshaft



Camshaft Timing Slot

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RG,RG34710,63 –19–16OCT00–1/6

IMPORTANT: DO NOT insert timing pin full depth into cylinder block crankshaft timing hole when rotating engine flywheel until double slot on camshaft timing lobe is at approximately 11 o'clock (viewed from rear of engine) to avoid crankshaft counterweight bending timing pin.

5. Slightly move engine flywheel back and forth with turning tool until a second JDG971 Timing Pin (C) can be installed in slot in crankshaft. This ensures that camshaft and crankshaft are in sync (properly timed).

   If timing pin does not enter crankshaft timing slot, crankshaft is not properly timed with camshaft. Crankshaft MUST BE timed to camshaft. (See CHECK AND ADJUST CAMSHAFT-TO-CRANKSHAFT TIMING in Group 050.)

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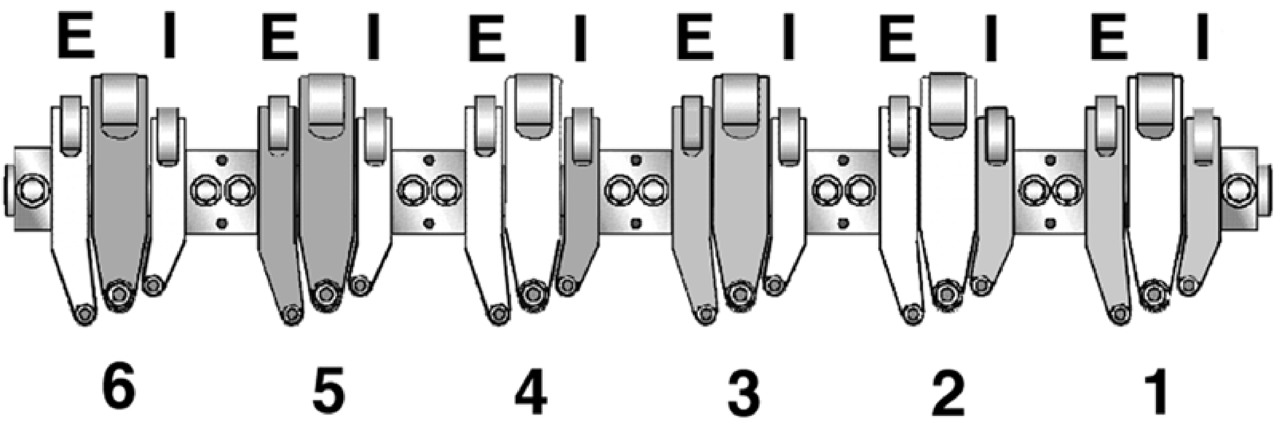
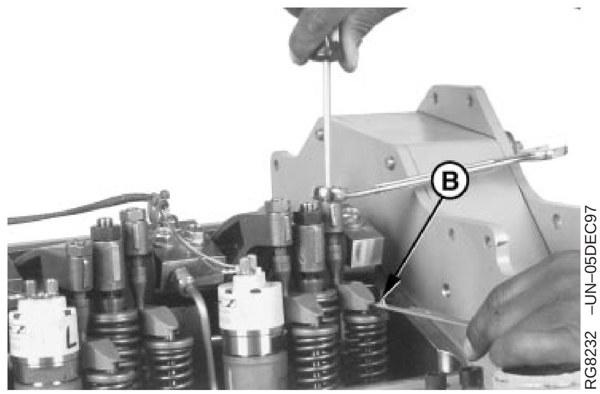


Rocker Arm Assembly Identification

6. Check and adjust (as needed) valve stem-to-bridge clearance (lash) on intake valves Nos. 1, 2, and 4, and exhaust valves Nos. 1, 3, and 5 (shaded locations). Adjust preload on electronic unit injectors Nos. 3, 5, and 6 (shaded locations).

   Valve clearance is adjusted using JDG1333 Feeler Gauge Set or equivalent 1/4 inch (6.0 mm) wide automotive ignition point-type feeler gauge installed at the joint between the valve bridge and valve stem tip (B) that is near the exhaust (right) side of engine. Loosen lock nuts, set clearance with adjusting screw and tighten lock nut to specified torque while holding adjusting screw stationary.



Adjusting Valve Lash/Clearance

B—Valve Stem Tip

Valve Stem-to-Bridge Clearance (Engine Cold)—Specification

Intake Valve—Clearance.......................... 0.58 ± 0.05 mm (0.023 ± 0.002 in.)

Exhaust Valve—Clearance....................... 1.08 ± 0.05 mm (0.043 ± 0.002 in.)

7. Tightten intake and exhaust valve adjusting screw lock nuts to specifications.

Specification

Intake and Exhaust Valve
Adjusting Screw Lock Nuts—
Torque .... 50 N•m (37 lb-ft)

Continued on next page RG,RG34710,63 –19–16OCT00–3/6

8. Set electronic unit injector preload by turning the EUI rocker arm adjusting screw in until there is zero clearance between the rocker arm roller and camshaft lobe. Next, turn the adjusting screw in an additional one-half turn (180°). Hold adjusting screw stationary while tightening lock nut to specified torque. Tighten EUI adjusting screw lock nuts to specifications.

Specification

Electronic Unit Injector—Preload .... 0.00 mm (in.) clearance plus 1/2 turn in (180°)

Electronic Unit Injector Adjusting Screw Lock Nuts—Torque .... 65 N•m (48 lb-ft)

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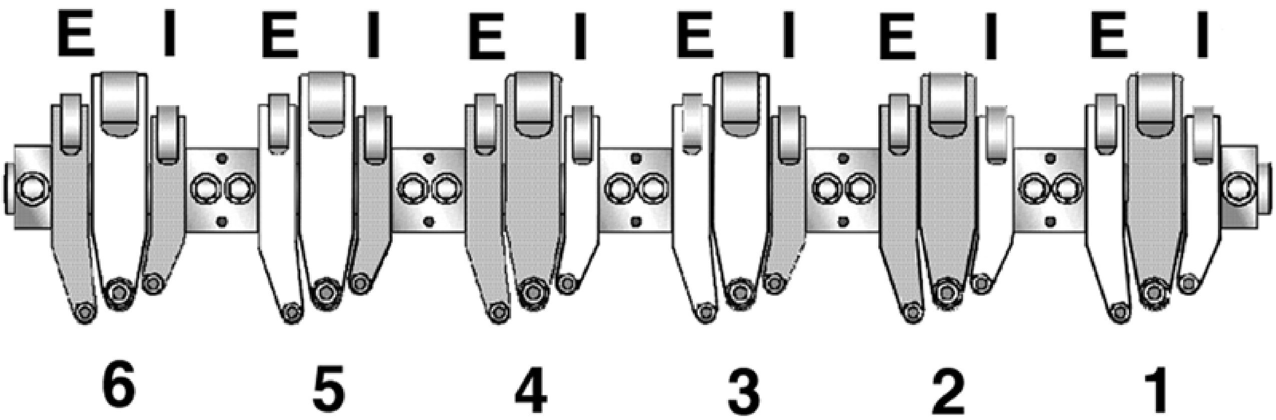
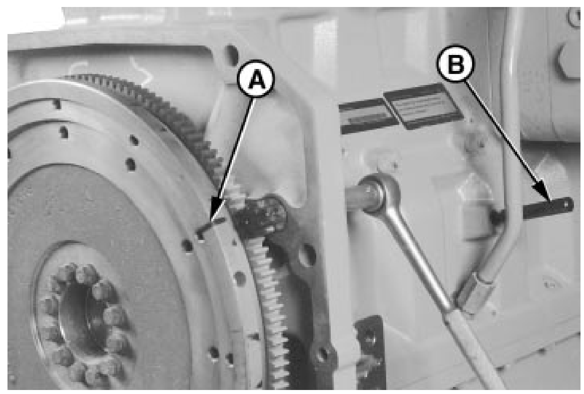


Rocker Arm Assembly Identification



Locking Engine at No.6 TDC

A—Flywheel Reference Mark
B—Timing Pin

9. Reference mark flywheel (A) as shown with engine locked at No.1 TDC compression stroke.

IMPORTANT: DO NOT insert timing pin full depth into cylinder block when rotating engine flywheel until reference mark is within a few degrees of a full crankshaft revolution to eliminate possibility of crankshaft counterweight bending timing pin.

10. Remove both timing pins and rotate engine flywheel one full revolution (360°) until timing pin (B) enters slot in crankshaft again. Engine will now be locked at No. 6 TDC compression stroke.

11. Check and adjust, as needed, valve clearance (lash) on intake valves Nos. 3, 5, and 6 and exhaust valves Nos. 2, 4, and 6 (shaded locations). Adjust preload on injectors Nos. 1, 2, and 4 (shaded locations).

12. Tighten intake and exhaust valve adjusting screw lock nuts to specifications.

Specification
Intake and Exhaust Valve
Adjusting Screw Lock Nuts—
Torque .... 50 N•m (37 lb-ft)

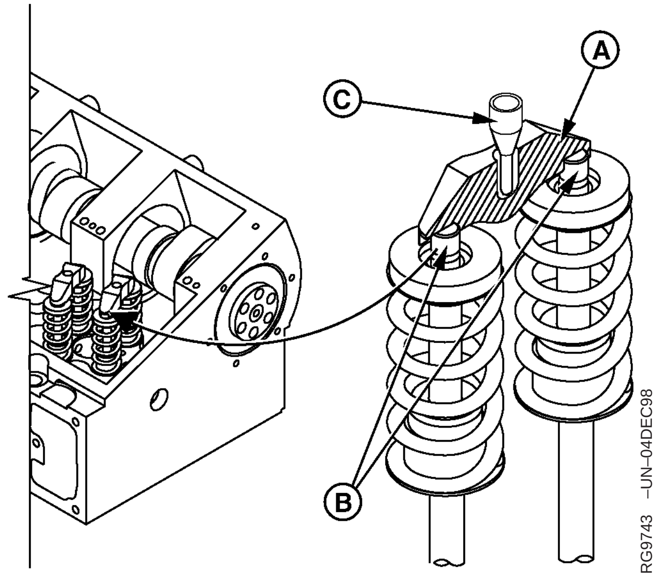
Tighten EUI adjusting screw lock nuts to specifications.

Specification
Electronic Unit Injector Adjusting
Screw Lock Nuts—Torque .... 65 N•m (48 lb-ft)

Continued on next page RG,RG34710,63 –19–16OCT00–5/6

IMPORTANT: Thoroughly inspect ALL intake and exhaust valve bridges (A) for proper seating on valve stems (B) from both sides of engine. Also, be sure that push tubes (C) are properly seated in top of valve bridge.

Use a flashlight and carefully check each bridge (for proper seating on valve stems) from both sides of the engine, by lifting up on each bridge to verify proper seating. VALVE BRIDGES THAT ARE NOT PROPERLY SEATED ON VALVE STEMS WILL RESULT IN MAJOR ENGINE VALVE TRAIN FAILURE.



Inspect Valves

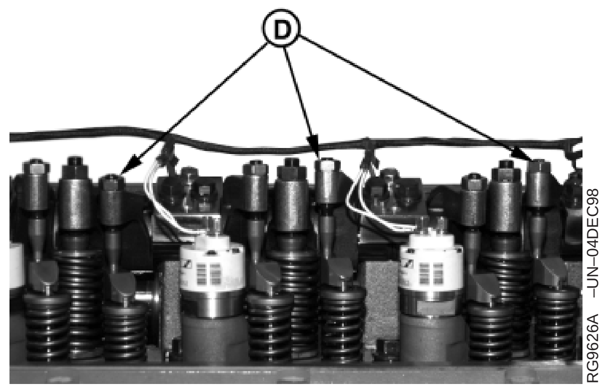
13. Check that all intake rocker arm adjusting screws (D) have approximately the same number of threads visible above lock nut. Normally flush to maximum of two threads.

    If the number of threads above lock nut at any location is visually different, verify bridge seating and readjust valve clearance to ensure everything is within specification at this location.

14. Install plug in timing pin hole below oil cooler and tighten to specifications.

Specification

Timing Pin Plug (Below Oil Cooler)—Torque .... 33 N•m (24 lb-ft)



Adjusting Screws

A—Valve Bridges
B—Valve Stems
C—Push Tubes
D—Adjusting Screws

RG,RG34710,63 –19–16OCT00–6/6

Remove Rocker Arm Assembly

CAUTION: After operating engine, allow exhaust system to cool before servicing engine.

1. Remove rocker arm cover.

2. Lock camshaft and crankshaft at TDC of No.1 cylinder's compression stroke.

3. Remove electronic unit injector wiring harness from rocker arm shaft clamps.

IMPORTANT: ALWAYS loosen all intake, exhaust and EUI rocker arm adjusting screws before removal or installation of rocker arm assembly to relieve pressure. This allows for a more uniform rocker arm cap screw clamp load and reduces the possibility of damage to valve train components.

Remove push tubes and valve bridges immediately after relieving rocker arm pressure. Push tubes can fall into oil drain opening of cylinder head causing oil pan removal to retrieve tubes.

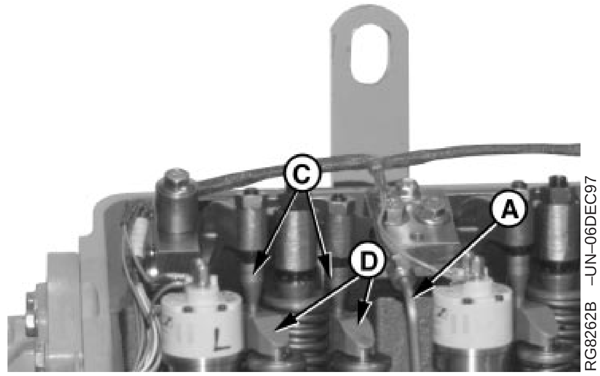
4. Loosen EUI, intake, and exhaust valve rocker arm adjusting screw lock nut and relieve pressure at all locations.

5. Remove push tubes (C) and valve bridges (D) from all valve stems.

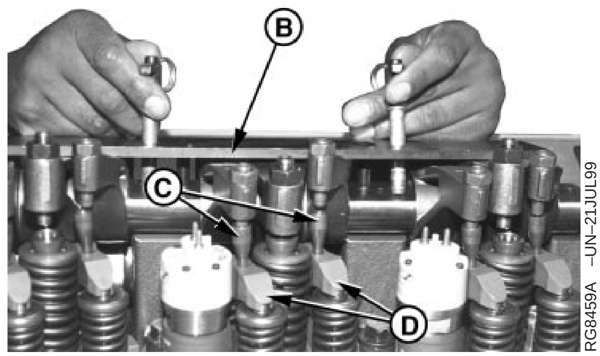
6. Remove two rocker arm shaft oil tubes (A) (dual rail system only). Remove rocker arm shaft hold-down clamps.

IMPORTANT: Rocker arm shaft hold-down clamp cap screws can not be reused. Use new cap screws for reassembly.

7. Install shaft clamp cap screw in end hole of each rocker arm shaft so that rocker arms do not slide off shaft when lifted.



Removing Valve Bridge and Push Tubes



Removing Rocker Arm Assembly with JDG970A

A—Rocker Arm Shaft Oil Tubes (Dual Rail Fuel System Only)
B—Rocker Arm Lifting Fixture
C—Push Tubes
D—Valve Bridges

Continued on next page
RG,RG34710,64 –19–21DEC00–1/2

CAUTION: A second set of pins has been added to JDG970A tool. With 6125 Tier II engines (engine serial no. 030000—), the holes for the pins in the rocker arm shaft are smaller. The new pins have a smaller diameter shaft and are marked “JDG1847”. To safely handle the rocker arm shaft assembly, BE CERTAIN to verify the engine serial number, then use the correct pins for that engine.

8. Depress actuator (ball) pins and install JDG970A Rocker Arm Lifting Fixture (B) into rocker arm shaft cap screw holes as shown. Replace pins to seat ball locks.

9. Remove both front and rear rocker arm and shaft assemblies using JDG970A Rocker Arm Lifting Fixture.

10. Discard rocker arm shaft hold-down clamp cap screws.

RG,RG34710,64 –19–21DEC00–2/2

Remove Cylinder Head

On some applications, it may be necessary to remove engine from machine to service cylinder head. Refer to your Machine Technical Manual for engine removal procedure.

CAUTION: After operating engine, allow exhaust system to cool before servicing engine.

DO NOT drain coolant until the coolant is below operating temperature. Only remove radiator filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

1. Drain all oil and coolant.

2. Remove intake manifold (6105H and 6125H engines). (See REMOVE, INSPECT AND INSTALL INTAKE MANIFOLD in Group 080.)

3. Remove turbocharger (A). (See REMOVE TURBOCHARGER in Group 080.)

4. Remove exhaust manifold (B). (See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD in Group 080.)

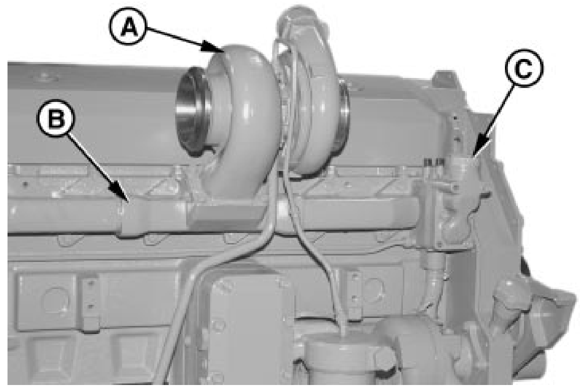
5. On 6105A and 6125A engines, remove aftercooler assembly. (See REMOVE AND INSTALL AFTERCOOLER ASSEMBLY in Group 080.)

6. Remove thermostat housing/water manifold (C). (See REMOVE AND INSTALL THERMOSTAT HOUSING in Group 070.)

7. Remove rocker arm assembly. (See REMOVE AND INSTALL ROCKER ARM ASSEMBLY, earlier in this group).

8. Remove electronic unit injectors and wiring harness. Refer to the appropriate fuel system repair manual.

   Delphi/Lucas ECU controlled fuel systems:



Removing Turbocharger and Exhaust Manifold

A—Turbocharger
B—Exhaust Manifold
C—Thermostat Housing/Water Manifold

Continued on next page

RG,RG34710,65 –19–13AUG99–1/5

- See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM115, Section 02, Group 090.

John Deere Level 6 ECU controlled fuel systems:

- See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM188, Section 02, Group 090 (dual rail fuel systems).
- See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM188, Section 02, Group 091 (single rail fuel systems).

9. Remove fan drive hub and camshaft gear access cover.

Continued on next page RG,RG34710,65 –19–13AUG99–2/5

10. Remove six cap screws securing camshaft gear retaining washer (A) and remove camshaft gear (B).

NOTE: Later engines: 10.5 L S.N. (003764—) and 12.5 L S.N. (010967—) with single rail fuel systems do not have a fuel manifold. Return fuel line is connected to port of single rail in back of cylinder head. Inlet line and port are on left side of head up by No.1 cylinder.

11. Remove fuel manifold block (C) on engines with dual rail systems, or disconnect fuel inlet and return lines on single rail systems. Refer to the appropriate fuel system repair manual.

    Delphi/Lucas ECU controlled fuel systems:

    - See REMOVE AND INSTALL FUEL MANIFOLD in CTM115, Section 02, Group 090.

    John Deere Level 6 ECU controlled fuel systems:

    - See REMOVE AND INSTALL FUEL MANIFOLD in CTM188, Section 02, Group 090.

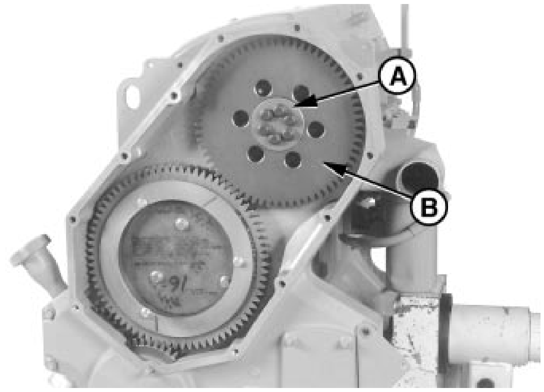
12. Remove fuel supply pump. Refer to the appropriate fuel system repair manual.

    Delphi/Lucas ECU controlled fuel systems:

    - See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM115, Section 02, Group 090.

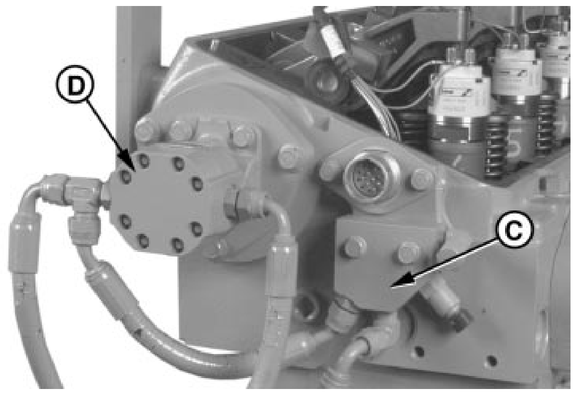
    John Deere Level 6 ECU controlled fuel systems:

    - See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM188, Section 02, Group 090 (dual rail fuel systems).
    - See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM188, Section 02, Group 091 (single rail fuel systems).



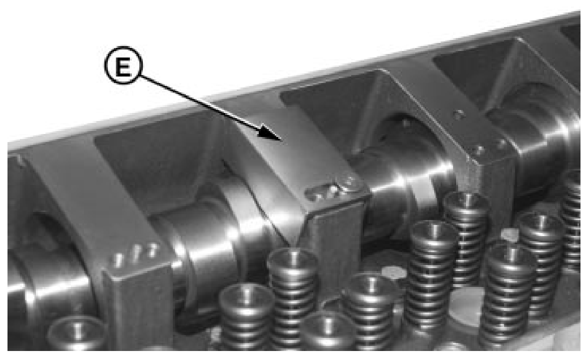
RG8251A –UN–06DEC97

Removing Camshaft Gear



RG8264B –UN–06DEC97

Removing Supply Pump and Fuel Manifold (Early Engine Shown)



RG8544B –UN–10DEC97

DFRG4 Camshaft Locking Tool

A—Gear Retaining Washer
B—Camshaft Gear
C—Fuel Manifold
D—Fuel Supply Pump
E—DFRG4 Camshaft Locking Tool

Continued on next page RG,RG34710,65 –19–13AUG99–3/5

NOTE: Cylinder head can be removed without removing camshaft.

IMPORTANT: If cylinder head is removed with camshaft installed, secure camshaft in bushings with DFRG4 Camshaft Locking Tool (E) so that camshaft journals and bushings are not damaged by camshaft sliding out of bushings. (See DFRG4-CAMSHAFT LOCKING TOOL in Section 05, Group 190 for details on this dealer fabricated tool.)

Camshaft position sensor MUST BE removed from air intake side of cylinder head when removing or installing camshaft to prevent camshaft binding on sensor.

13. Remove camshaft front thrust ring. Remove camshaft position sensor and remove camshaft if desired (see REMOVE AND INSTALL CAMSHAFT in Group 050).

Continued on next page RG,RG34710,65 –19–13AUG99–4/5

NOTE: If removing head with camshaft installed, camshaft will have to be rotated to remove two of the cylinder head cap screws.

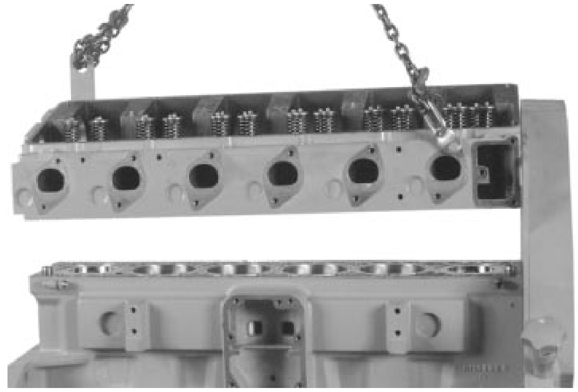
14. Remove 26 cylinder head cap screws with washers and discard.

IMPORTANT: DO NOT use screwdrivers or prybars between cylinder block and head to loosen gasket seal. Screwdrivers and prybars can damage head and block gasket surfaces.

15. Carefully lift cylinder head from block using an overhead hoist or floor crane. Place head on a clean, flat surface.

16. Remove cylinder head gasket. Inspect gasket for any manufacturing imperfections. Inspect head, gasket, and check for possible oil, coolant, or combustion chamber leakage.

NOTE: DO NOT rotate engine crankshaft with cylinder head removed unless all cylinder liners are secured with cap screws and large, flat washers. (See REMOVE PISTONS AND CONNECTING RODS in Group 030.)


RG8285 –UN–21MAY98

Removing Cylinder Head

RG,RG34710,65 –19–13AUG99–5/5

Diagnosing Head Gasket Joint Failures

Head gasket failures generally fall into three categories:

- Combustion seal leakage.
- Coolant seal leakage.
- Oil seal leakage.

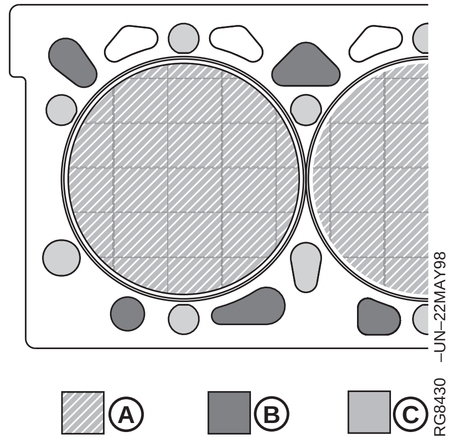
Combustion seal leakage failures occur when combustion gases escape between cylinder head and head gasket combustion flange, or between combustion flange and cylinder liner. Leaking combustion gases may vent to an adjacent cylinder, to a coolant or oil passage, or externally.

Coolant or oil seal failures occur when oil or coolant escapes between cylinder head and gasket body, or between cylinder block and gasket body. The oil or coolant may leak to an adjacent coolant or oil passage, or externally.

Follow these diagnostic procedures when a head gasket joint failure occurs or is suspected:

1. Before starting or disassembling engine, conduct a visual inspection of machine, and note any of the following:

    - Oil or coolant in head gasket seam, or on adjacent surfaces, especially right rear corner of gasket joint.
    - Displacement of gasket from normal position.
    - Discoloration or soot from combustion gas leakage.
    - Leaking radiator, overflow tank, or hoses.
    - Leaking coolant from coolant pump weep hole.
    - Damaged or incorrect radiator, fan, or shroud.
    - Obstructed air flow or coolant flow.
    - Worn or slipping belts.
    - Damaged or incorrect pressure cap.
    - Presence of oil in coolant.
    - Low coolant levels or improper coolant.
    - Unusually high or low oil levels.
    - Oil degradation, dilution, or contamination.
    - Correctly specified electronic unit injectors.
    - Indications of fuel delivery or gear train not properly timed.
    - Unburned fuel or coolant in exhaust system.



Cylinder Head Gasket Sealing Area

A—Combustion Sealing Areas
B—Coolant Sealing Areas
C—Cylinder Head Cap Screws

Continued on next page

2. Obtain coolant and oil samples for further analysis.

3. Start and warm up engine if it can be safely operated. Examine all potential leakage areas again as outlined previously. Using appropriate test and measurement equipment, check for the following:

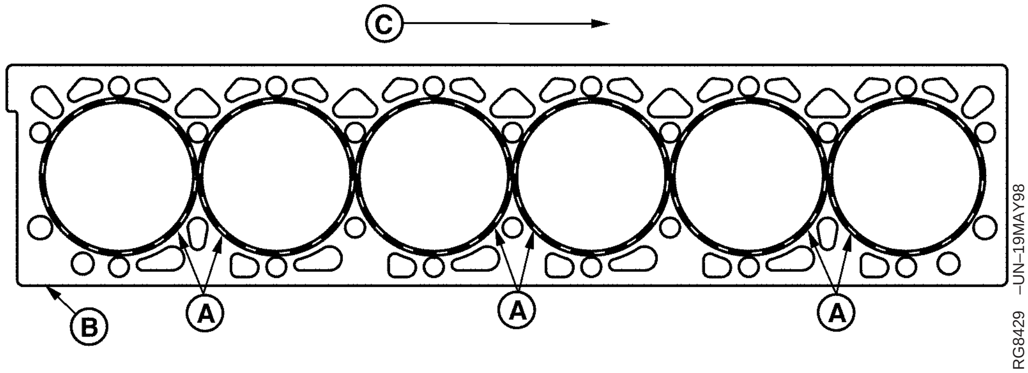
   - White smoke, excessive raw fuel, or moisture in exhaust system.
   - Rough, irregular exhaust sound, or misfiring.
   - Air bubbles, gas entrainment in radiator or overflow tank.
   - Loss of coolant from overflow.
   - Excessive cooling system pressure.
   - Coolant overheating.
   - Low coolant flow.
   - Loss of cab heating (air lock).

4. Shut engine down. Recheck crankcase, radiator, and overflow tank for any significant differences in fluid levels, viscosity, or appearance.

5. Compare your observations from above steps with the appropriate diagnostic procedures in Section 04, Group 150. If diagnostic evaluations and observations provide conclusive evidence of combustion gas, coolant, or oil leakage from head gasket joint, the cylinder head must be removed for inspection and repair of gasket joint components.

RG,RG34710,69 –19–01NOV00–2/2

Head Gasket Inspection and Repair Sequence



Cylinder Head Gasket Inspection

A—Combustion Seals (Flanges) **B—Gasket Body** **C—Front of Engine**

The following inspection procedures are recommended whenever a head gasket joint failure occurs or when joint disassembly takes place.

1. Review historical data relating to machine operation, maintenance and repair, along with diagnostic observations. Note all areas requiring further inspection and analysis.

2. Remove rocker arm cover and check for presence of coolant in the oil.

3. Record head cap screw torques prior to removal. Upon removal, check cap screw length differences.

4. Remove cylinder head using appropriate lifting devices to prevent handling damage to head gasket. (See REMOVE CYLINDER HEAD in this group.)

5. Observe surfaces of removed head gasket.

   Examine combustion seals (A) for the following:

   - Flange severed/expanded/cracked/deformed.
   - Adjacent body area burned/eroded.
   - Fire ring severed/displaced/missing.
   - Flange sealing pattern eccentric/contains voids.
   - Discoloration of flange and adjacent body areas.
   - Flange surfaces rough/abraided/channelled.

   Examine gasket body (B) for the following:

   - Combustion gas erosion paths or soot deposits originating at combustion seals.
   - Extreme discoloration/hardening/embrittlement in localized areas.
   - Oil or coolant paths from port areas.
   - Localized areas of low compression.

6. Before cleaning components, inspect head, block, and liners for evidence of combustion gas and fluid leakage. Inspect cylinders and valve ports for unusual deposits.

7. Clean cylinder block. (See INSPECT AND CLEAN CYLINDER BLOCK in Group 030.) Clean cylinder head. (See CLEAN AND INSPECT CYLINDER HEAD in this group.) Clean liners. (See CLEAN CYLINDER LINERS in Group 030.)

8. Proceed with the following dimensional checks and visual inspections:

   - Cylinder Head (this group)
     – Check surface flatness/finish.
     – Inspect for surface damage.
     – Check cylinder head thickness, if resurfacing.
   - Cylinder Block and Liners (assembled and clamped) (Group 030)

Continued on next page

RG,RG34710,70 –19–30SEP97–1/2

- – Check liner standout at four places on each liner.
- – Check liner standout difference between cylinders.
- Cylinder Block (Group 030)
  - – Check surface flatness/finish.
  - – Inspect for surface damage.
  - – Check liner counterbore depth (if liner is removed).
  - – Check top deck to crankshaft centerline dimension.
  - – Inspect cap screw bosses; must be clean/intact.
- Cylinder Liner (Group 030)
  - – Check liner flange flatness/finish.
  - – Check liner flange thickness (if liner is removed).
  - – Inspect flange for damage.
- Cylinder Head Cap Screws (this group)
  - – Inspect condition of threads.
  - – Check length.

9. When inspections and measurements have been completed, determine most probable causes of joint failure. Make all necessary repairs to joint components, cooling system, and fuel injection system.

10. Reassemble the engine according to procedures and specifications in the appropriate repair groups of this manual.

RG,RG34710,70 –19–30SEP97–2/2

Disassemble and Inspect Rocker Arms and Shaft Assembly

1. Remove rocker arms from shaft and identify for installation in same position as removed.

2. Inspect rocker arm shaft for scoring and excess wear at rocker arm contact points. Roll on a flat surface and check for bends or distortion.

3. Check rocker arm adjusting screws and lock nuts for thread damage.

4. Check valve bridges and push tubes for contact wear.

5. Clean all parts with clean solvent. Dry with compressed air.

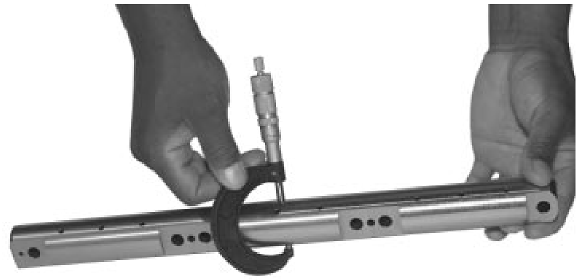
6. Measure rocker arm shaft OD and rocker arm bushing ID. Compare measurements with specifications below.

7. Inspect rocker arm roller for uneven wear. Measure roller OD and compare with specifications below.

Specification

Rocker Arm Bushing—ID	38.064 ± 0.013 mm (1.4986 ± 0.0005 in.)
Rocker Arm Shaft—OD	38.000 ± 0.013 mm (1.4961 ± 0.0005 in.)
Rocker Arm Shaft-to-Bushing—Oil Clearance	0.064 ± 0.026 mm (0.0025 ± 0.0010 in.)
Rocker Arm Shaft Intake and Exhaust Roller—OD	39.995—40.045 mm (1.5746—1.5766 in.)
Rocker Arm Shaft Unit Injector Roller—OD	37.995—38.045 mm (1.4959—1.4978 in.)

Replace parts as necessary.



RG8395 –UN–21MAY98

Measure Rocker Arm Shaft

RG8392 –UN–21MAY98

Measure Rocker Arm Bushing

RG8390 –UN–21MAY98

Measure Rocker Arm Roller

RG,RG34710,71 –19–30SEP97–1/1

Preliminary Cylinder Head and Valve Checks

Make preliminary inspection of cylinder head and valve assembly during disassembly.

Look for the following conditions:

Sticking Valves:

- Carbon deposits on valve stem.
- Worn valve guides.
- Scored valve stems.
- Warped valve stems.
- Misaligned or broken valve springs.
- Worn or distorted valve seats.
- Insufficient lubrication.

Warped, Worn, or Distorted Valve Guides:

- Lack of lubrication.
- Cylinder head distortion.
- Excessive heat.
- Unevenly tightened cylinder head cap screws.

Distorted Cylinder Head and Gasket Leakage:

- Loss of cylinder head cap screw torque.
- Broken cylinder head cap screw.
- Overheating from low coolant level operation.
- Insufficient liner standout.
- Coolant leakage into cylinder causing hydraulic failure of gasket.
- Leaking aftercooler.
- Cracked cylinder head.
- Cracked cylinder liner.
- Damaged or incorrect gasket.
- Overpowering or overfueling.
- Damaged cylinder head or block surfaces.
- Improper surface finish on cylinder head.
- Improperly tightened cylinder head cap screws or faulty gasket installation (misaligned).

Worn or Broken Valve Seats:

- Misaligned valves.
- Distorted cylinder head.
- Carbon deposits on seats due to incomplete combustion.
- Valve spring tension too weak.
- Excessive heat.
- Improper valve clearance.
- Improper valve timing.
- Incorrect valve or seat installed.

Burned, Pitted, Worn, or Broken Valves:

- Worn or distorted valve seats.
- Loose valve seats.
- Worn valve guides.
- Insufficient cooling.
- Cocked or broken valve springs.
- Improper engine operation.
- Improper valve train timing.
- Faulty valve rotators.
- Warped or distorted valve stems.
- “Stretched” valves due to excessive spring tension.
- Warped cylinder head.
- Carbon build-up on valve seats.
- Rocker arm failure.
- Incorrect valve or seat installed.
- Incorrect piston-to-valve clearance.

Improper Valve Clearance:

- Inefficient use of fuel.
- Engine starts harder.
- Maximum engine power will not be achieved.
- Shorter service life of valve train.
- Greater chance for engine to overheat.

Excessive Valve Recession:

- Worn valve seats.
- Bent valves.
- Debris passed through valve train.

RG,RG34710,72 –19–30SEP97–1/1

Assemble Rocker Arms and Shaft Assembly

1. Make sure that rocker arm shaft end plugs are firmly seated in each shaft end bore.

2. Assemble parts on rocker arm shaft in reverse sequence as removed.

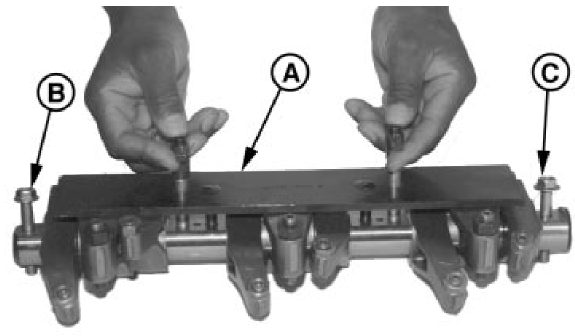
3. Install cap screws (B) and (C) in holes at each end of rocker arm shaft to keep rocker arms from sliding off shaft during installation.

4. Install JDG970A Rocker Arm Lifting Fixture (A) onto rocker arm and shaft assembly.

A—JDG970A Rocker Arm Assembly Lifting Fixture
B—Cap Screw
C—Cap Screw


RG8460 –UN–21MAY98

Rocker Arm and Shaft Assembly



RG8304 –UN–06DEC97

Lifting Rocker Arm Assembly

RG,RG34710,73 –19–13AUG99–1/1

Check Valve Height in Relation to Head Surface (Valve Recess)

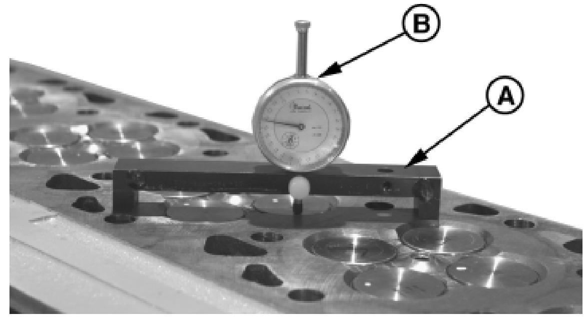
1. Thoroughly clean all gasket material from cylinder head combustion face.

2. Measure and record valve recess using JDG451 (English) or KJD10123 (Metric) Height Gauge (A) along with D17526CI (English, in.) or D17527CI Dial Indicator (Metric) (B). Measurements must be made a maximum of 3.0 mm (0.12 in.) in from edge of valve head.

Specification

Intake and Exhaust Valves—	
Recess	1.85—2.35 mm (0.073—0.093 in.)

Install new valves, inserts, or grind existing valves and inserts (as necessary) to obtain specified valve recess.



RG8330A –UN–09DEC97

Measure Valve Recess

A—Height Gauge
B—Dial Indicator

RG,RG34710,74 –19–03NOV99–1/1

Remove Valve Assembly

NOTE: A small magnet may be used to aid removal of valve retainer locks (D).

1. Place cylinder head on a clean flat surface with combustion face down.

2. Using JDG982 Valve Spring Compressor (A), compress valve spring far enough to remove retainer locks as shown.

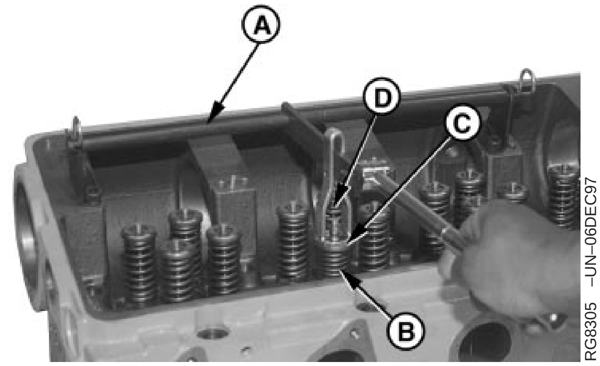
3. Release spring tension, remove valve rotator (C) and valve spring (B).

4. Remove valve stem seals (E) from valve guide tower.

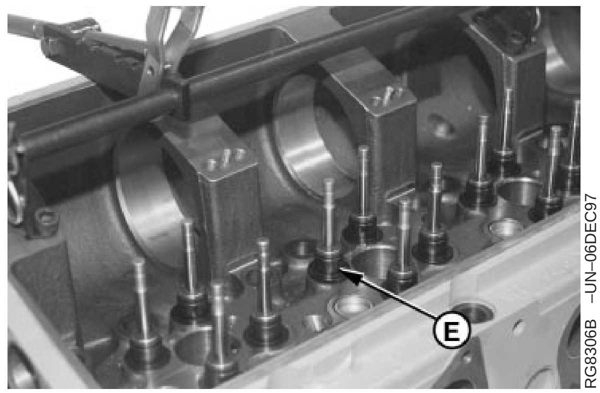
5. Lay cylinder head on air intake side using a 1016 x 51 x 102 mm (40 x 2.0 x 4.0 in.) block of wood.

6. Remove valves and identify for assembly in same location.

A—JDG982 Valve Spring Compressor
B—Valve Springs
C—Valve Rotators
D—Valve Retainer Locks
E—Valve Stem Seals



Removing Valve Springs



Removing Valve Stem Seals

RG,RG34710,75 –19–30SEP97–1/1

Inspect and Measure Valve Springs

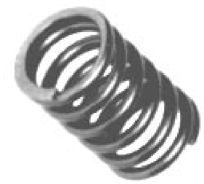
IMPORTANT: Replacement valve springs (R133891) have higher working loads than older springs (R116585). Newer valve springs (R133891) have two green paint stripes for identification. Valve springs must be replaced in sets of two with new rotators. DO NOT intermix springs across valve bridges.

1. Inspect valve springs for alignment, wear, and damage.

2. Using D01168AA Spring Compression Tester, check valve spring tension. Compressed height must be within specification given below.

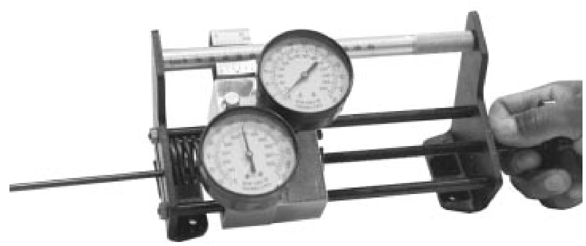
Specification

Intake and Exhaust Valve Springs (All)[1]—Height at 0 N (0 lb-force) Free Length	67.9—72.1 mm (2.67—2.84 in.)
Intake and Exhaust Valve Springs (R116585)—Height at 352—396 N (79—89 lb-force) (Valve Closed)	59.4 mm (2.34 in.)
Intake and Exhaust Valve Springs (R116585)—Height at 845—935 N (190-210 lb-force) (Valve Open)	45.5 mm (1.79 in.)
Intake and Exhaust Valve Springs (R133891)—Height at 527—593 N (118—133 lb-force) (Valve Closed)	59.4 mm (2.34 in.)
Intake and Exhaust Valve Springs (R133891)—Height at 1187—1313 N (267—295 lb-force) (Valve Open)	46.4 mm (1.83 in.)



RG2732 –UN–04DEC97

Valve Spring



RG7427 –UN–21MAY98

Measuring Valve Spring Compression

02
020
25

[1] *Free length of springs may vary slightly between springs.*

RG,RG34710,76 –19–13AUG99–1/1

Inspect Valve Rotators

Valve rotators cannot be repaired. Replace valve rotators when valves are replaced or reground.

Ensure that valve rotators turn freely in both directions. Replace if defective.

Inspecting Valve Rotator

RG,RG34710,77 –19–30SEP97–1/1

Clean, Inspect, and Measure Valves

1. Hold each valve firmly against a soft brass or copper wire wheel on a bench grinder.

IMPORTANT: Any carbon left on the stem will affect alignment in valve refacer. DO NOT use a wire wheel on plated portion of valve stem. Polish the valve stem with steel wool or crocus cloth to remove any scratch marks left by the wire brush.

2. Make sure all carbon is removed from valve head, face, and unplated portion of stem.
3. Inspect valve face, stem, tip, and retainer lock groove.
4. Measure valve stem OD Record measurements and compare with valve guide ID. (See MEASURE VALVE GUIDE ID, later in this group.)

Specification

Intake and Exhaust Valve
Stems—OD... 8.999 ± 0.013 mm (0.3543 ± 0.0005 in.)

5. Using a valve inspection center, determine if valves are out of round, bent, or warped.

Specification

Intake and Exhaust Valve
Face[1]—Maximum Runout...................................... 0.038 mm (0.0015 in.)

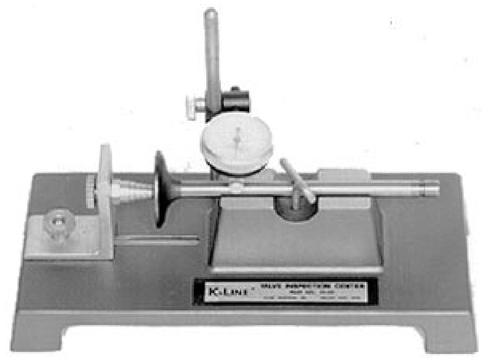
6. Measure valve head OD.

Specification

Intake and Exhaust Valve Head—
OD .... 46.35—46.61 mm (1.825—1.835 in.)


RG8322 –UN–21MAY98

Measuring Valve Stem



RG4234 –UN–05DEC97

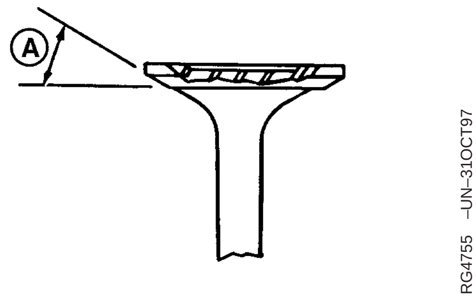
Measuring Valve Face Runout

[1]*Maximum runout measured at 44 mm (1.73 in.) diameter.*

RG,RG34710,78 –19–13AUG99–1/1

Grind Valves

Reface serviceable valves to specified angle (A). Face angle on intake and exhaust valves is as follows:



Valve Face Angle

Specification

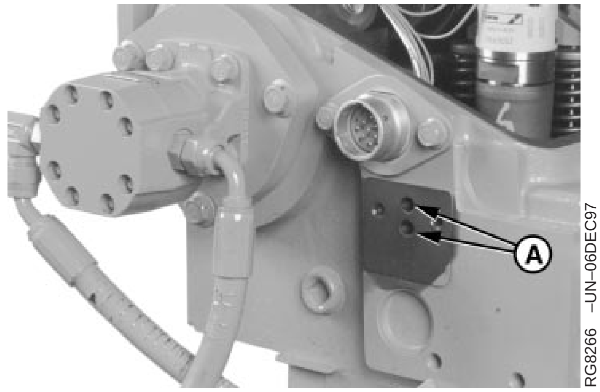
Intake and Exhaust Valve Face—
Angle .... 29.25° ± 0.25°

IMPORTANT: DO NOT nick valve head-to-stem radius when grinding valves. A nick could cause the valve to break. Break all sharp edges after grinding.

A—Valve Face Angle

RG,RG34710,79 –19–30SEP97–1/1

Clean and Inspect Cylinder Head



Fuel Rail

A—Supply Rails (Dual Rail System Shown)

IMPORTANT: DO NOT USE scouring pads or wire brush to clean gasket sealing surface (combustion face). Doing so may affect sealing ability of gasket joint.

DO NOT "hot tank" clean cylinder head unless all plugs and valve guides are removed for replacement. Hot tank solution will destroy lubricating properties of valve guides.

1. Inspect combustion face for evidence of physical damage, oil or coolant leakage, or gasket failure prior to cleaning the cylinder head. Repair or replace cylinder head if there is evidence of physical damage such as cracking, abrasion, distortion, or valve seat "torching." Inspect all cylinder head passages for restrictions.

2. Inspect around injector sleeve for evidence of fuel or coolant leakage.

3. Scrape gasket material, oil, carbon, and rust from head. Use a powered brass or copper (soft) wire brush to clean sealing surfaces. DO NOT use a steel wire brush.

4. Clean valve guides using a plastic brush.

IMPORTANT: During engine repair or overhaul, cleanliness of fuel supply rail(s) (A) is extremely important due to fuel flow through passages. Think of the fuel rails as internal passages of an injection pump; therefore, same cleanliness must be maintained.

5. Remove fuel rail expansion plugs in front of cylinder head and thoroughly clean fuel rail passages using a rifle-type cleaner (solvent). All debris must be removed from fuel rail.

6. Dry with compressed air and blow out all passages.

Continued on next page

7. Final dry fuel rail passages with clean lint-free cloth and rifle cleaner or suitable push rod.

8. Coat new expansion plug with LOCTITE® 277 Plastic Gasket and install in front face of head.

LOCTITE is a registered trademark of Loctite Corp.

RG,RG34710,80 –19–03SEP02–2/2

Check Cylinder Head Flatness


RG8309 –UN–21MAY98

Measuring Cylinder Head Flatness

Check cylinder head flatness using D05012ST Precision Straightedge and feeler gauge. Check lengthwise, crosswise, and diagonally in several places.

Specification

Cylinder Head—Maximum Acceptable Out-of-Flat for Entire Length of Head .... 0.10 mm (0.004 in.)
Maximum Acceptable Out-of-Flat for Every 305 mm (12.0 in.) .... 0.025 mm (0.0009 in.)

If out-of-flat exceeds specifications, the cylinder head must be resurfaced or replaced. (See MEASURE CYLINDER HEAD THICKNESS later in this group.)

RG,RG34710,81 –19–30SEP97–1/1

Measure Cylinder Head Thickness

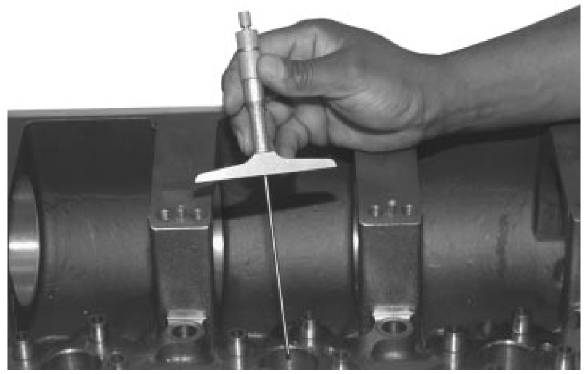
Measure cylinder head thickness from rocker cavity-to-combustion face.

If cylinder head thickness is less than wear limit, DO NOT attempt to resurface. Install a new cylinder head.

If cylinder head thickness is greater than wear limit, a MAXIMUM of 0.15 mm (0.006 in.) can be ground from new part dimension for a minimum overall thickness. (See RESURFACE CYLINDER HEAD COMBUSTION FACE, later in this group.)

Specification

Cylinder Head (Rocker Arm Cover-to-Combustion Face)—	
New Part Thickness	124.975—125.025 mm (4.9203—4.9222 in.)
Minimum Acceptable Thickness	124.840 mm (4.9150 in.)



RG8324 –UN–21MAY98

Using Depth Gauge

RG8325 –UN–21MAY98

Measuring Cylinder Head Thickness

RG,RG34710,82 –19–30SEP97–1/1

Resurface Cylinder Head Combustion Face

IMPORTANT: DO NOT grind cylinder head combustion face or block top deck. Surface mill only.

After surface milling, check flatness (see CHECK CYLINDER HEAD FLATNESS in this group). Check surface finish on combustion face of head.

Measure valve height (recess) after grinding. (See CHECK VALVE HEIGHT IN RELATION TO HEAD SURFACE earlier in this group.) Valve seat or valve face may be ground to bring within specifications.

NOTE: If necessary to resurface cylinder head, a MAXIMUM of 0.15 mm (0.006 in.) can be milled from minimum new part dimension. Remove ONLY what is necessary to restore flatness.

Specification	
Cylinder Head (Rocker Arm Cavity-to-Combustion Face)—Minimum Overall Thickness	124.840 mm (4.9150 in.)
Cylinder Head Combustion Face Surface Finish (Surface Mill Only) (AA)—Surface Finish	1.5—2.8 micrometers (60—110 micro-in.)
Cylinder Head—Maximum Wave Height	0.008 micrometers (0.0002 micro-in.)
Maximum Wave Width	2.0 micrometers (79 micro-in.)

RG,RG34710,83 –19–30SEP97–1/1

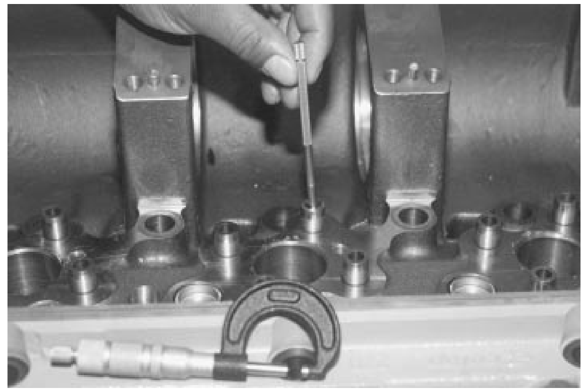
Measure Valve Guide ID

1. Measure valve guides ID using a telescopic gauge.

2. Record measurements and compare readings with valve stem OD to determine stem-to-guide clearance.

Specification

Valve Guide—ID .... 9.045 ± 0.013 mm (0.3583 ± 0.0005 in.)
Valve Stem—OD .... 8.999 ± 0.013 mm (0.3543 ± 0.0005 in.)
Valve Stem-to-Guide—Clearance .... 0.077—0.129 mm (0.0030—0.0050 in.)


RG8308 –UN–21MAY98

Measuring Valve Guide ID

Replacement valve guides are available if valve guide ID is not within specification for specified guide-to-stem clearance (See REPLACE VALVE GUIDES, later in this group).

RG,RG34710,84 –19–01NOV00–1/1

Replace Valve Guides

Remove Valve Guides

1. Position cylinder head with combustion face facing up.

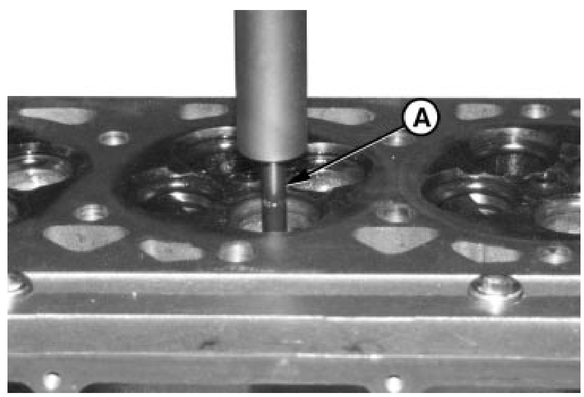
2. Drive valve guides from combustion face side of cylinder head using JDG164A Driver (A) and a press.

3. Inspect valve guide bore for cracking or excessive metal transfer. Thoroughly clean valve guide bore.

4. Measure valve guide bore in cylinder head. Replace cylinder head if valve guide bore is not within specification.

Specification

Valve Guide Bore in Head—ID .... 14.94 ± 0.02 mm (0.5882 ± 0.0008 in.)



RG8823 –UN–11DEC97

Removing Valve Guide with JDG164A

A—JDG164A Valve Seat Pilot Driver

Continued on next page

RG,RG34710,85 –19–16OCT00–1/2

Install Valve Guides

1. Assemble JDG1167 Valve Guide Installation Adapter (A) and JDG164A Driver (B) onto replacement valve guide (C).

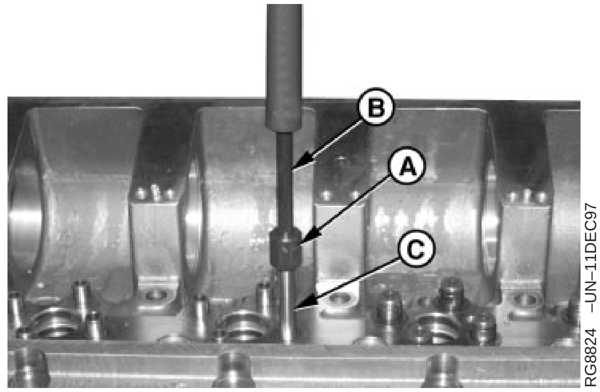
2. Position cylinder head resting on combustion face.

3. Position valve guide over bore in cylinder head and press guide in head until adapter bottoms on machined surface.

4. Measure valve guide installed height. Installed height should be as follows:

Specification	
Valve Guide—Installed Height	14.5—15.5 mm (0.57—0.61 in.)

5. Insert a valve stem through valve guide to check for adequate clearance. Valve stem should move freely in valve guide.



Installing Valve Guide

A—JDG1167 Valve Guide Installation Adapter
B—JDG164A Valve Seat Pilot Driver
C—Replacement Valve Guide

RG,RG34710,85 –19–16OCT00–2/2

Clean and Inspect Valve Seats

1. Use an electric hand drill with copper or brass (soft) wire brush to remove all carbon on valve seats.

2. Inspect seats for excessive wear, cracks, or damage.

3. Check entire combustion face for rust, scoring, pitting, or cracks.

RG,RG34710,86 –19–30SEP97–1/1

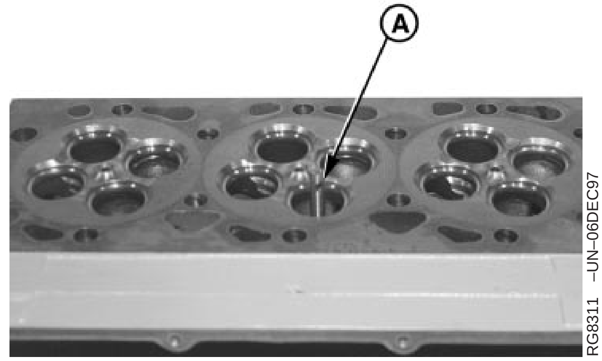
Grind Valve Seats

IMPORTANT: Valve seat grinding should only be done by experienced personnel familiar with equipment and capable of maintaining required specifications. ALWAYS keep valve guides and work area clean when grinding valve seats to maintain valve guide bore-to-seat runout.

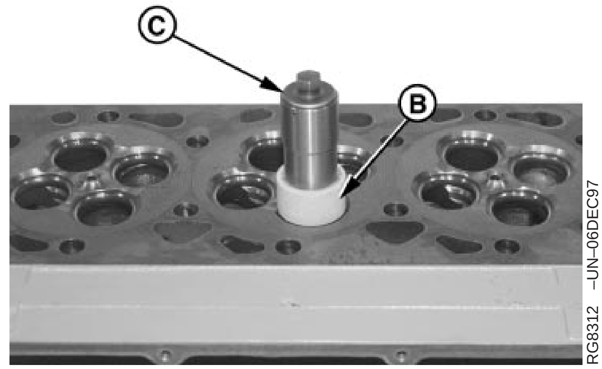
Grinding valve seats increases seat width and valve recess in cylinder head. DO NOT grind excessively. Only a few seconds are required to recondition the average valve seat. Dress grinding stone as necessary to maintain specified seat angle.

Support the weight of grinder to avoid excessive pressure on the stone.

Blend or radius all sharp edges 0.50 mm (0.02 in.) maximum corner break to eliminate burrs after grinding valve seats.



Valve Seat Grinding Pilot



Valve Seat Arbor and Grinding Stone

Grinding Valve Seat

A—Pilot
B—Grinding Stone
C—Arbor

1. Install appropriate pilot (A) in valve guide bore.

2. Install appropriate grinding stone (B) on arbor (C) and position onto valve seat and pilot.

3. Using drill from JT05893 Heavy-Duty Seat Grinder Set, grind valve seats to the following specifications:

Specification

Valve Seat Grinding—Contact	
Angle	30°
Width	1.50—2.00 mm (0.059—0.079 in.)
Maximum Runout	0.16 mm (0.006 in.)

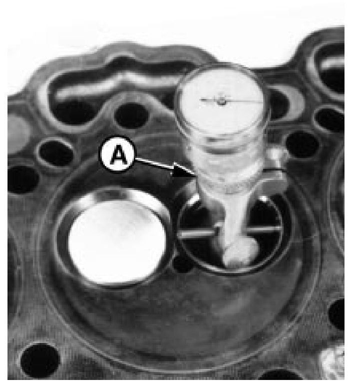
Continued on next page RG,RG34710,87 –19–28NOV00–1/2

4. Use a vernier caliper or scale to measure seat width. If valve seat is too wide, reduce the width with a narrowing stone.

NOTE: A narrowing stone will change the top angle of the seat and reduce the outer diameter of the valve seating area. Varying the width changes the fine contact between valve face and seat. If seat width is too narrow, valve may burn or erode.

5. If valve does not seat properly, use an eccentrimeter (A) to check valve seat runout. Use a new or refaced valve and blueing to check contact between valve seat and face. If necessary, lap the valve onto its seat using a lapping tool and lapping compound. Replace valves and inserts as necessary.

6. Install new or refaced valve and check valve recess in cylinder head after grinding. (See CHECK VALVE HEIGHT IN RELATION TO HEAD SURFACE earlier in this group.)



RG6318 –UN–03NOV97

Measuring Valve Seat Runout

A—Eccentrimeter

RG,RG34710,87 –19–28NOV00–2/2

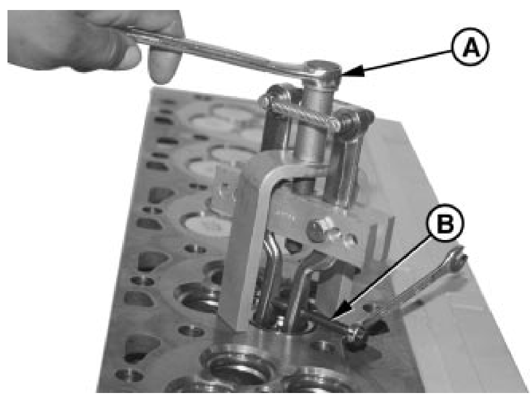
Remove Valve Seat Inserts

IMPORTANT: Be careful not to damage cylinder head when removing valve seats.

Use JDE41296 Valve Seat Puller (A). Adjusting screw (B) may need to be retightened during removal of inserts.

After removal of inserts, thoroughly clean area around valve seat bore and inspect for damage or cracks. Measure bore ID. (See MEASURE VALVE SEAT BORE IN CYLINDER HEAD in this group.)

A—JDE41296 Valve Seat Puller
B—Adjusting Screw

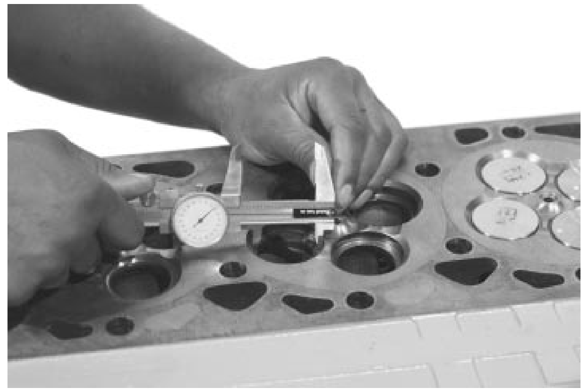


RG8314 –UN–06DEC97

Removing Valve Seat Insert

RG,RG34710,88 –19–30SEP97–1/1

Measure Valve Seat Bore in Cylinder Head



Measuring Valve Seat Bore

1. Measure valve seat bores in cylinder head and compare with specifications given below.

Specification

Intake and Exhaust Valve Seat Bore—ID	49.424 ± 0.013 mm (1.9458 ± 0.0005 in.)
Bore Depth	11.50 mm (0.443 in.)
Radius at Lower Bore	0.64 ± 0.25 mm (0.025 ± 0.001 in.)
Standard Intake and Exhaust Valve Seat—OD	49.487—49.513 mm (1.9483—1.9493 in.)

2. If valve seat bores are not within specification, oversize seat inserts are available. Have a qualified machine shop bore the valve seat to specification for installation of oversize valve seat inserts. (See INSTALL VALVE SEAT INSERTS, later in this group.)

RG,RG34710,89 –19–13AUG99–1/1

Install Valve Seat Inserts

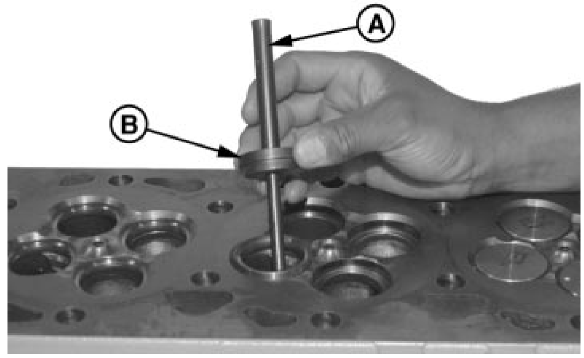
1. Use JDG164A Pilot Driver (A) and JDG1166 Valve Seat Insert Installing Adapter (B) to install valve seat inserts in cylinder head.

2. Install valves and measure valve recess. (See CHECK VALVE HEIGHT IN RELATION TO HEAD SURFACE, earlier in this group.)

3. Grind valve seats as required to maintain correct valve recess and valve face-to-seat seal. (See GRIND VALVE SEATS earlier in this group.)

IMPORTANT: A common practice is to chill valve seat inserts in a freezer before installing. This chilling process allows for less interference when pressing in valve seats. Once inserts heat up to room temperature, original press-fit is restored.

A—JDG164A Pilot Driver
B—JDG1166 Adapter



RG8319 –UN–06DEC97

Valve Seat Pilot Driver

RG8318 –UN–21MAY98

Installing Valve Seat Insert

RG,RG34710,90 –19–03NOV99–1/1

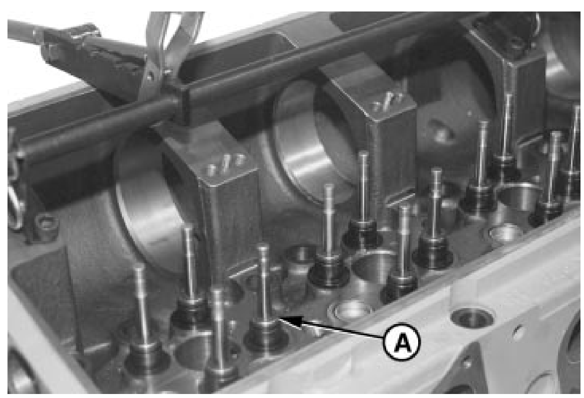
Install Valves

1. Lubricate valve stems and guides with AR44402 Valve Stem Lubricant or clean engine oil.

NOTE: Valve must move freely in guide and seat properly with inserts to form an effective seal.

2. Insert valves in head (if valves are reused, install in same location from which removed).

3. Slide valve stem seals (A) over valve stems and onto intake and exhaust valve guide tower until firmly seated.



RG8306A –UN–06DEC97

Installing Valve Stem Seals

A—Valve Stem Seals

Continued on next page

RG,RG34710,91 –19–13AUG99–1/2

IMPORTANT: Replacement valve springs (R133891) have higher working loads than older springs (R116585). Newer valve springs (R133891), have two green paint stripes for identification. Valve springs must be replaced in sets of two with new rotators. DO NOT intermix springs across valve bridges.

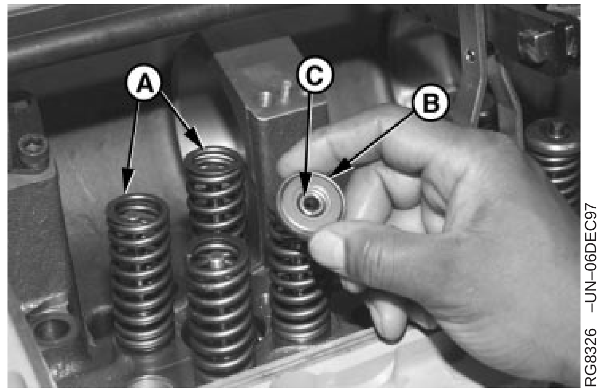
4. With cylinder resting on combustion face, install valve springs (A) and rotators (B) with retainer locks (C).

5. Compress valve springs using JDG982 Valve Spring Compressor and install retainer locks on valve stems.

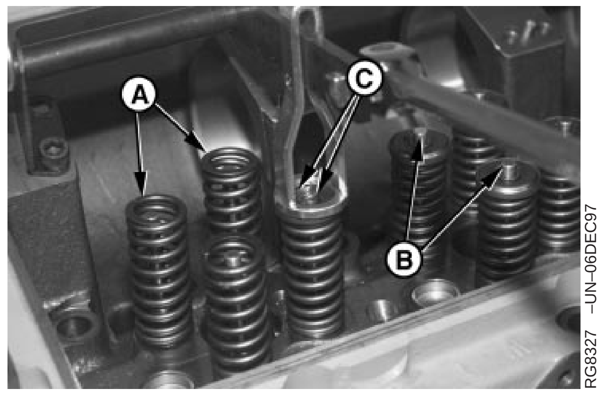
6. Strike end of each valve several times with a soft, (non-metallic) hammer to ensure retainer locks are properly seated.

7. Recheck valve recess. (See CHECK VALVE HEIGHT IN RELATION TO HEAD SURFACE, earlier in this group.)

A—Valve Springs
B—Rotators
C—Retainer Locks



Installing Valve Rotators



Installing Valve Retainer Locks

Seating Valve Retainer Locks

RG,RG34710,91 –19–13AUG99–2/2

Replace Unit Injector Sleeve in Cylinder Head Using JDG981

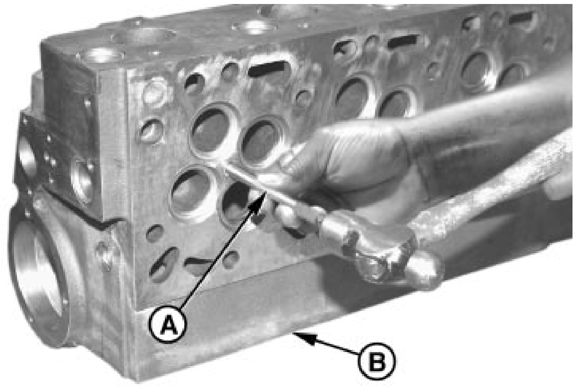
Remove Unit Injector Sleeve

NOTE: Cylinder head must be removed to replace EUI sleeve using JDG981 Unit Injector Sleeve Installation Set. To replace EUI sleeve with head installed refer to REPLACE UNIT INJECTOR SLEEVE IN CYLINDER HEAD USING JDG1184 later in this group.

IMPORTANT: Whenever EUI is replaced, sleeve in cylinder head must be replaced also.

JDG981-2 Swedge is obsolete. Disgard this tool and replace with JDG1184-2-1 Swedge Rod and 8132 Adapter.

1. Remove cylinder head from engine. (See REMOVE CYLINDER HEAD, earlier in this group.)
2. Remove valves from cylinder head. (See REMOVE VALVE ASSEMBLY, earlier in this group.)
3. Using a 51 mm by 102 mm (2.0 in. by 4.0 in.) block of wood (B) at least 914.4 mm (36.0 in.) long, lay cylinder head on its side with air intake manifold mounting surface resting on block of wood.
4. Drive injector sleeve from combustion face side of cylinder head using MAY-25010 Punch (A) from JDG981 Unit Injector Sleeve Installation Set and hammer.
5. Remove square packing from injector sleeve bore. Thoroughly clean sleeve bore and inspect sleeve tip seating area for damage.



RG8151 –UN–05DEC97

Removing Injector Sleeve

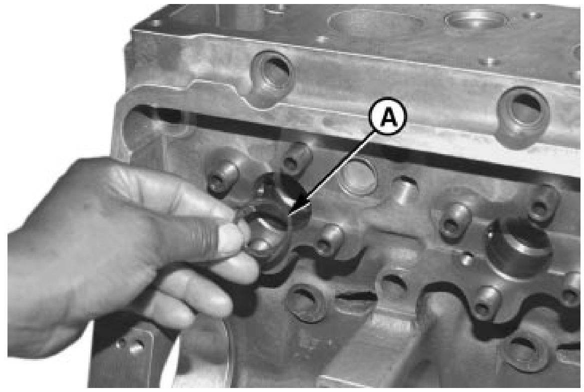
A—MAY-25010 Punch
B—Wood Block

Continued on next page RG,RG34710,92 –19–28NOV00–1/6

Install Unit Injector Sleeve

1. Grease square packing (A) and sleeve bore in head with JDT405 High Temperature Grease and install in packing seat area of injector sleeve bore. Take care that packing is not twisted during installation.

A—Square Packing



RG8152 –UN–05DEC97

Installing Injector Sleeve Packing

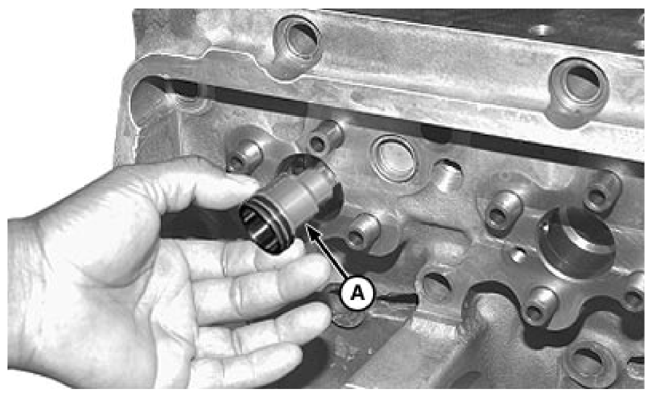
RG,RG34710,92 –19–28NOV00–2/6

IMPORTANT: Old injector sleeve (B) with one O-ring MUST be replaced with new injector sleeve (C) with two O-rings.

IMPORTANT: DO NOT use engine oil or any petroleum based product as a lubricant for the injector sleeve o-rings. A chemical reaction will occur, leading to o-ring failure. Instead use a soap based solution to lubricate the packing.

2. Lubricate injector sleeve (A) with clean engine oil and push into sleeve bore with minimal pressure until tightly seated.

A—Injector Sleeve
B—Old Injector Sleeve
C—New Injector Sleeve



RG12417 –UN–04SEP02

Installing Injector Sleeve

RG12415 –UN–04SEP02

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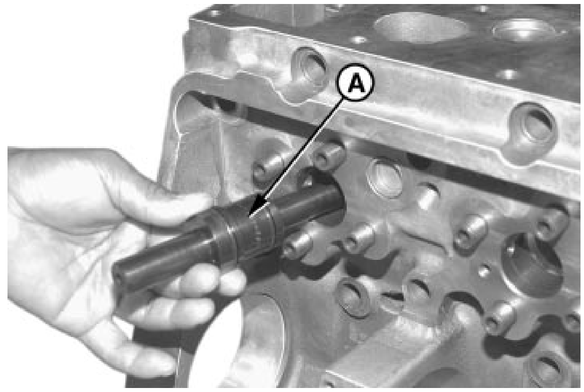
RG,RG34710,92 –19–28NOV00–3/6

3. Grease polished tip of JDG981-1 Guide Sleeve (A) and install inside injector sleeve.

A—JDG981-1 Guide Sleeve



Installing Injector Sleeve Guide

Continued on next page RG,RG34710,92 –19–28NOV00–4/6

NOTE: Carefully inspect threads on 8 mm cap screw prior to use to avoid damaging injector hold-down clamp threads in cylinder head. Replace cap screw as needed.

4. Install JDG981-3 Guide Sleeve Holding Bar (A) as shown. Install 220213 (8 mm) cap screw (B) finger tight.

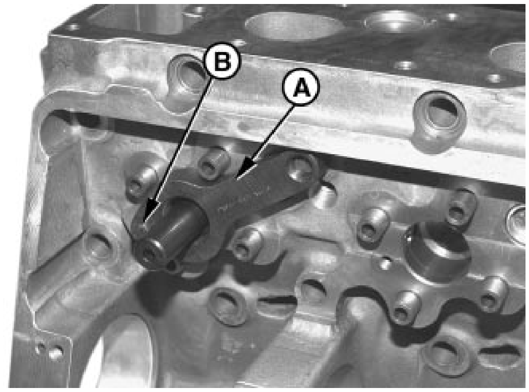
5. Install 220089 (16 mm) cap screw (C) from combustion face side of head using a phosphate washer from cylinder head mounting cap screw finger tight.

6. Install JDE131-2 Driver Nut (D) finger tight.

7. Tighten cap screws and nut in following order to specification given:

- 16 mm Cap Screw (C) to 115 N•m (85 lb-ft)
- 8 mm Cap Screw (B) to 47 N•m (35 lb-ft)
- Guide Sleeve Nut (D) to 150 N•m (110 lb-ft)

A—JDG981-3 Guide Sleeve Holding Bar
B—220213 (8 mm) Cap Screw
C—220089 (16 mm) Cap Screw
D—JDE131-2 Driver Nut

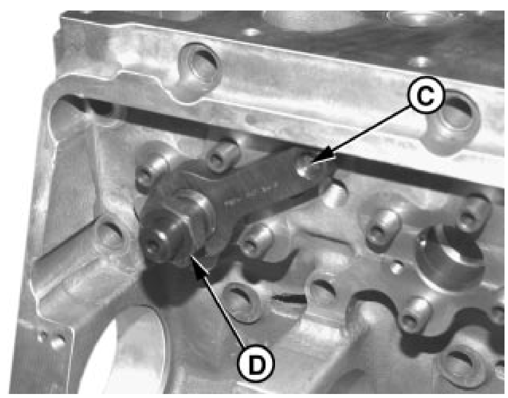


RG8155 –UN–05DEC97

Installing Guide Support Bar

RG8157 –UN–05DEC97

Guide Support Bar Cap Screw



RG8156 –UN–05DEC97

Guide Sleeve Arbor Nut

Continued on next page RG,RG34710,92 –19–28NOV00–5/6

8. Clean and inspect JDG1184-2-1 Swedge Arbor (A) for raised or foreign material.

IMPORTANT: DO NOT use JDG981-2 Swedge, this tool is obsolete. Use only JDG1184-2-1 Swedge and 8132 Adapter.

9. Assemble small end of 8132 Adapter (B) onto swedge arbor (A).

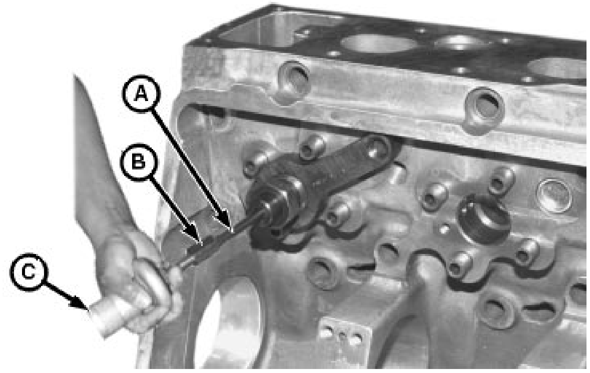
10. Assemble large end of adapter onto D01300AA 2.2 kg (5 lb) Slide Hammer (C).

11. Position tip of swedge into guide sleeve and drive swedge through sleeve tip. Withdraw swedge with slide hammer.

12. Remove injector sleeve replacement tool set from cylinder head and inspect for proper installation of injector sleeve.

13. Repeat procedure on remaining injector sleeves.

A—JDG1184-2-1 Swedge Arbor
B—8132 Adapter
C—D01300AA Slide Hammer



RG10279 –UN–13AUG99

Using Expansion Arbor

RG8159 –UN–21MAY98

Installed Injector Sleeve

RG,RG34710,92 –19–28NOV00–6/6

Replace Unit Injector Sleeve in Cylinder Head Using JDG1184

Remove Injector Sleeve

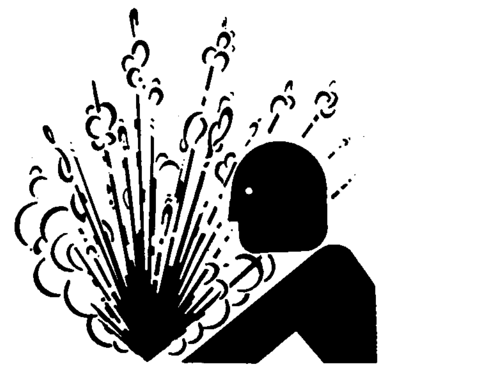
NOTE: EUI sleeve can be removed from the cylinder head with head removed or installed on engine using JDG1184 Nozzle Sleeve Replacement Set.

IMPORTANT: Whenever EUI is replaced, sleeve in cylinder head must be replaced also.

CAUTION: Do not drain coolant until the coolant temperature is below operating temperature. Always loosen coolant drain valve (A) slowly to relieve any excess pressure.

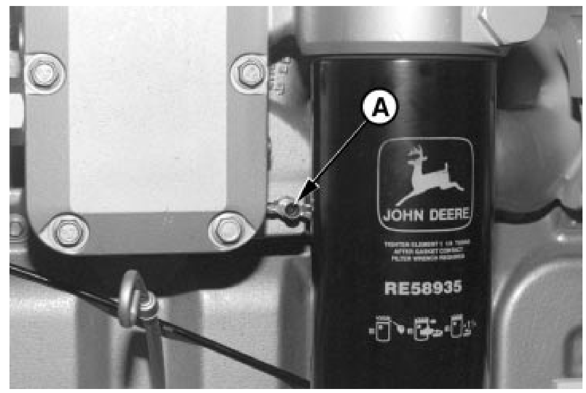
1. Attach a long hose to drain valve (A). Drain coolant into a clean container to a level below cylinder head.

A—Coolant Drain Valve



TS281 –UN–23AUG88

Service Cooling System Safely



RG8708A –UN–21JUL99

Drain Coolant

Continued on next page DPSG,OUO1004,929 –19–16JUL99–1/15

2. **On dual rail fuel systems**, disconnect secondary (final) filter outlet line (A) and place in a clean container to collect fuel.

   Loosen fuel temperature sensor (B) in fuel manifold block and drain all fuel from fuel rail into a clean container.

3. **On single rail fuel systems**, loosen fuel rail inlet line (C). Disconnect outlet line (D) and drain fuel into a clean container.

4. Tighten temperature sensor to specifications.

Specification

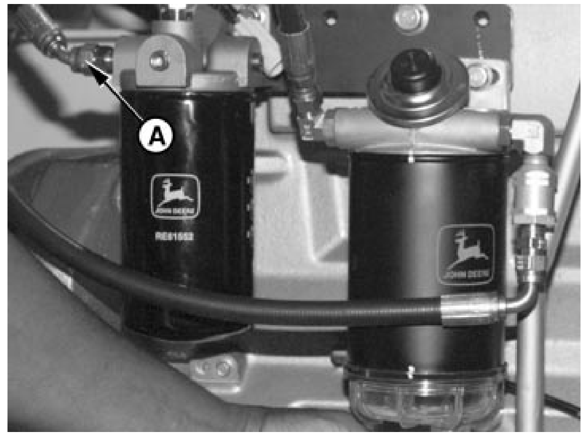
Fuel Temperature Sensor—
Torque .... 10 N•m (7.5 lb-ft)

5. Reconnect fuel lines and tighten to specifications.

Specification

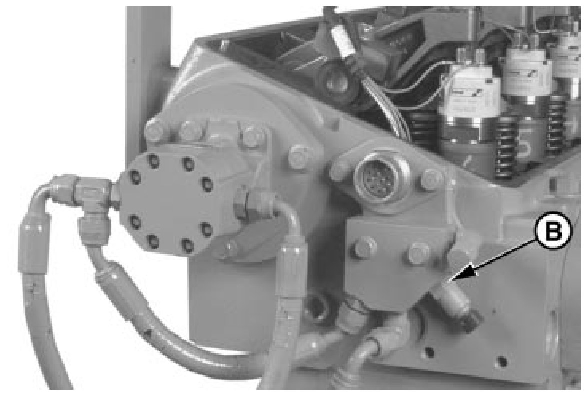
Fuel Lines—Torque .... 24 N•m (18 lb-ft)

A—Fuel Outlet Line
B—Fuel Temperature Sensor
C—Fuel Rail Inlet Line
D—Fuel Rail Outlet Line



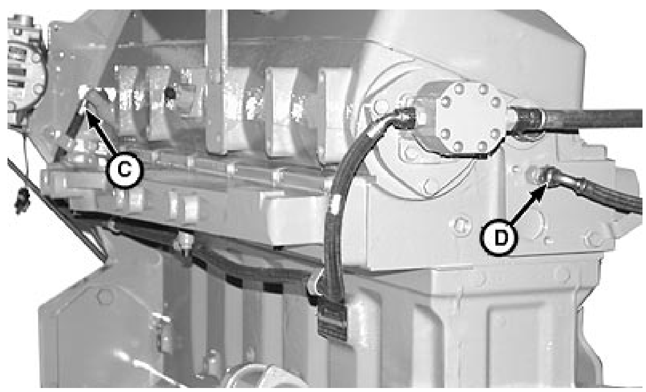
RG9159A –UN–21JUL99

Fuel Outlet Line (Dual Rail System)



RG8264C –UN–21JUL99

Fuel Temperature Sensor (Dual Rail System)



RG10291 –UN–24AUG99

Fuel Lines (Single Rail System)

Continued on next page DPSG,OUO1004,929 –19–16JUL99–2/15

6. Plug oil drain cavities in cylinder head with clean, lint-free shop towels to prevent debris and hardware from falling into drain cavity.

7. Remove rocker arm cover. (See REMOVE AND INSTALL ROCKER ARM COVER in this group.)

8. Remove appropriate rocker arm assembly:

   - Remove front rocker arm assembly for replacement of injector sleeves 1 and 2.
   - Remove both front and rear rocker arm assemblies for replacement of injector sleeve 3.
   - Remove rear rocker arm assembly for replacement of injector sleeves 4, 5, and 6.

   (See REMOVE ROCKER ARM ASSEMBLY in this group.)

NOTE: If all six injector sleeves are to be replaced, replace sleeves for cylinders 1 and 6, 2 and 5, 3 and 4 at the same time so crankshaft has to be rotated only three times.

9. Remove electronic unit injector from injector sleeve that is to be replaced. Refer to the appropriate fuel system repair manual.

   Delphi/Lucas ECU controlled fuel systems:

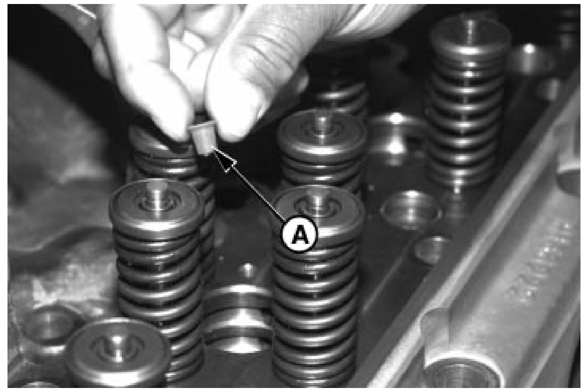
   - See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM115, Section 02, Group 090.

   John Deere Level 6 ECU controlled fuel systems:

   - See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM188, Section 02, Group 090 (dual rail fuel systems).
   - See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM188, Section 02, Group 091 (single rail fuel systems).

IMPORTANT: Injector sleeve tip MUST BE plugged to keep debris out of power cylinder while tapping (threading) sleeve for removal.

10. Install small red cap plug (A) into injector sleeve tip. Be sure plug is firmly seated in tip of sleeve.



RG9160A –UN–21JUL99

Cap Plug

A—Cap Plug

Continued on next page

IMPORTANT: DO NOT attempt to tap threads in injector sleeve (for removal) unless JDG1184-1-3 Protector Sleeve (A) is anchored against injector sleeve with EUI hold-down clamp. This will eliminate injector sleeve turning in swedged bore of cylinder head.

11. Thoroughly clean and dry JDG1184-1-3 Protector Sleeve as needed. Install protector sleeve into EUI bore until it is seated with injector sleeve.

A—JDG1184-1-3 Protector Sleeve

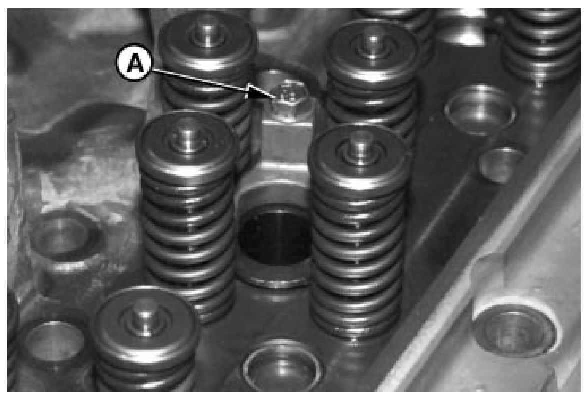
RG9161A –UN–21JUL99

JDG1184-1-3 Protector Sleeve

DPSG,OUO1004,929 –19–16JUL99–4/15

12. Install EUI hold-down clamp and cap screw (A) over protector sleeve. Tighten cap screws to 40 N•m (30 lb-ft).

A—Hold-Down Cap Screw



RG9162A –UN–21JUL99

Hold-Down Cap Screw

Continued on next page

DPSG,OUO1004,929 –19–16JUL99–5/15

13. Apply a generous amount of all-purpose grease to JDG1184-1-1 Tap (A).

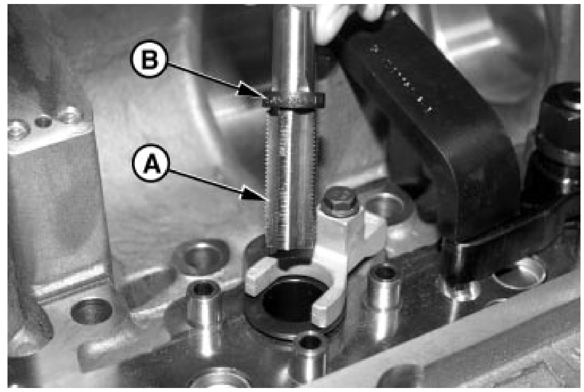
14. Position JDG1184-1-5 Tap Guide (B) over shaft of tap to center tap in protector sleeve.

15. Tap at least five full threads in ID of injector sleeve using a 5/8 in., 12-point socket and extension with a ratchet or T-handle.

16. Once resistance increases on tap, reverse direction and remove tap.

IMPORTANT: DO NOT remove protector sleeve from nozzle sleeve after tapping screw threads. Sleeve MUST BE removed as an assembly with JDG1184-1-2 Screw Adapter and JDG1184-1-4 Spacer to contain shavings and protect fuel rail in head.

17. Remove cap screw and EUI hold-down clamp from protector sleeve. Do not remove sleeve at this time.



RG9163A –UN–21JUL99

JDG1184-1-1 Tap

A—JDG1184-1-1 Tap
B—JDG1184-1-5 Tap Guide

DPSG,OUO1004,929 –19–16JUL99–6/15

18. Thread JDG1184-1-2 Screw Adapter (A) with JDG1184-1-4 Spacer (B) into threaded injector sleeve finger tight. This will keep shavings out of fuel rail.

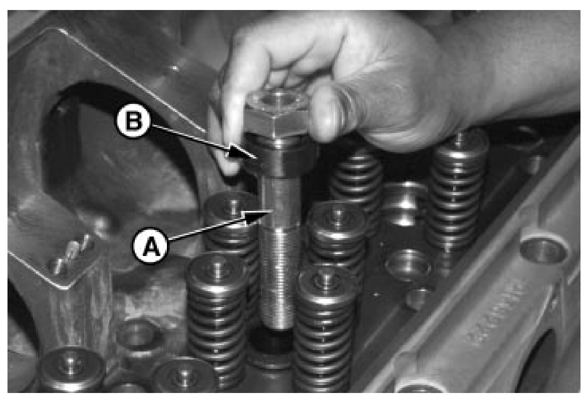
19. Thread D01300AA 2.2 kg (5 lb) Slide Hammer into screw adapter.

20. Pull injector sleeve from cylinder. Remove puller attachments from injector sleeve.

21. Remove injector sleeve packing from groove in cylinder head using O-ring pick.

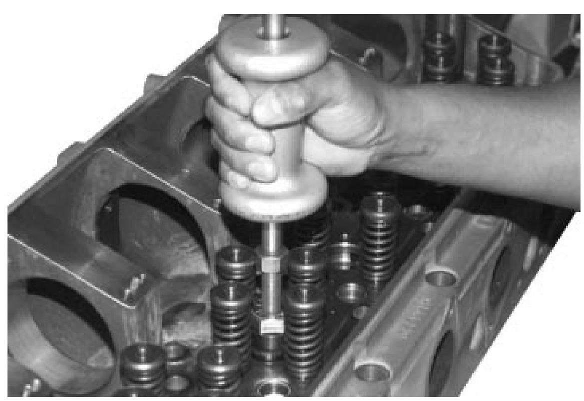
22. Thoroughly clean and dry protector sleeve for future use. Clean remaining components as necessary.

A—JDG1184-1-2 Screw Adapter
B—JDG1184-1-4 Spacer



RG9164A –UN–21JUL99

Adapter and Spacer



RG9165 –UN–21JUL99

Remove Sleeve

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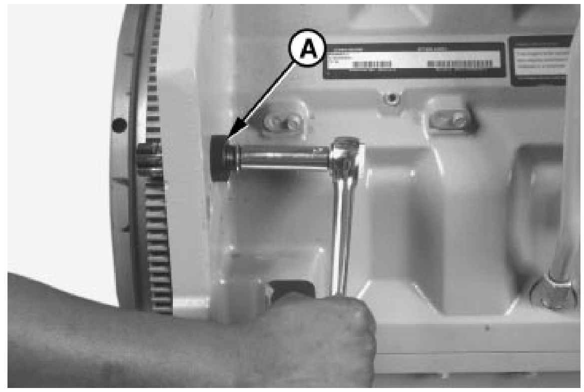
DPSG,OUO1004,929 –19–16JUL99–7/15

Check Piston Position in Liner

1. After injector sleeve is removed, look into sleeve bore of cylinder head to be sure that piston is at or near bottom of its stroke.

2. If piston is not near bottom, rotate engine flywheel using JDG820 Flywheel Rotation Tool (A).

A—JDG820 Flywheel Rotation Tool



RG8226 –UN–05DEC97

Rotate Engine Flywheel

DPSG,OUO1004,929 –19–16JUL99–8/15

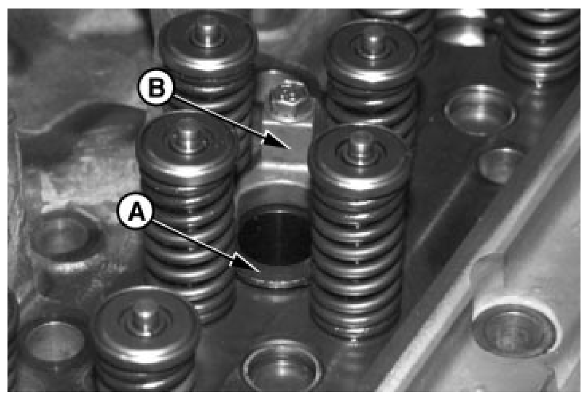
Install Injector Sleeve

1. Install JDG1184-1-3 Protector Sleeve (A) into injector sleeve bore (without injector sleeve).

2. Install EUI hold-down clamp (B) and cap screw over protector sleeve. Tighten cap screw to 40 N•m (30 lb-ft).

3. Thoroughly clean injector sleeve bore with a small brush.

4. Remove protector sleeve.



RG9162B –UN–21JUL99

Install Protector Sleeve

A—JDG1184-1-3 Protector Sleeve
B—Hold-Down Clamp

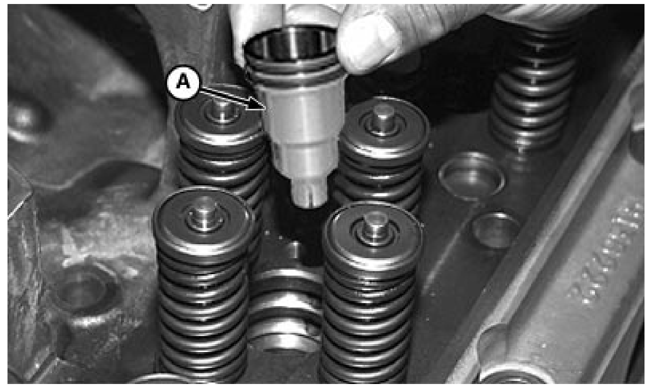
Continued on next page DPSG,OUO1004,929 –19–16JUL99–9/15

5. Lubricate new square packing with clean engine oil or grease and install into packing bore in cylinder head.

IMPORTANT: Old injector sleeve (B) with one O-ring MUST be replaced with new injector sleeve (C) with two O-rings.

6. Lubricate O-rings with engine oil and install injector sleeve (A) into cylinder bore.

A—Injector Sleeve
B—Old Injector Sleeve
C—New Injector Sleeve



RG12418 –UN–04SEP02

Installing Sleeve

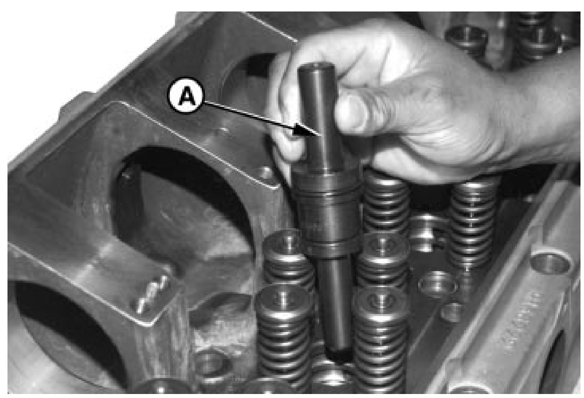
RG12415 –UN–04SEP02

DPSG,OUO1004,929 –19–16JUL99–10/15

7. Lubricate O-rings with clean engine oil and position JDG981-1 Guide Sleeve (A) into injector sleeve and seat sleeve using a plastic or rubber hammer. Be careful not to cut O-rings.

NOTE: When injector sleeve is fully seated, top of JDG981-1 Guide Sleeve should be slightly lower than top of valve rotators.

A—JDG981-1 Guide Sleeve



RG9167A –UN–21JUL99

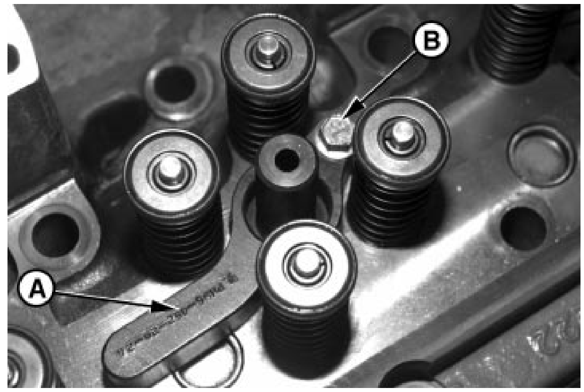
Seat Sleeve

Continued on next page

DPSG,OUO1004,929 –19–16JUL99–11/15

8. Position JDG1184-2-2 Guide Sleeve Holding Bracket (A) over guide sleeve and tighten cap screw (B) finger tight.

A—JDG1184-2-2 Guide Sleeve Holding Bracket
B—Cap Screw



RG9168A –UN–21JUL99

Guide Sleeve Holding Bracket

DPSG,OUO1004,929 –19–16JUL99–12/15

9. Thread JDG1184-2-4 Drive Nut (A) into holding bracket but do not tighten.

A—Drive Nut

RG9169A –UN–21JUL99

Drive Nut

Continued on next page

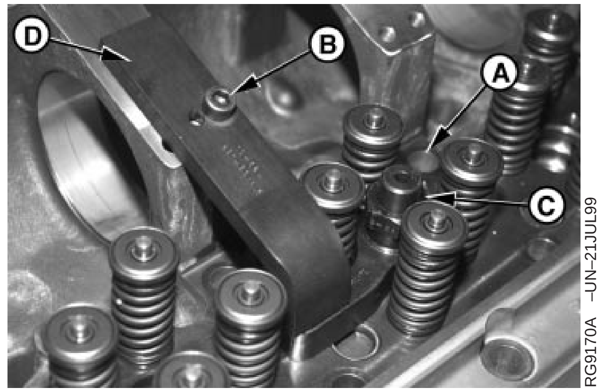
DPSG,OUO1004,929 –19–16JUL99–13/15

10. Install JDG1184-2-3 Bracket Clamp (D) onto rocker arm rail as shown, and tighten cap screw (B) finger tight.

IMPORTANT: Use only the 10 mm cap screw (B) that is provided in JDG1184 Nozzle Sleeve Replacement Set. Cap screws exceeding 35 mm (1.375 in.) can damage the camshaft bushings.

11. Tighten cap screws and nut to the following specifications.

- Guide screw holding bracket cap screw (A) to 40 N•m (30 lb-ft.).
- Bracket clamp cap screw (B) to 68 N•m (50 lb-ft).
- Driver nut (C) to 115 N•m (85 lb-ft).



Tighten Hardware

A—Guide Sleeve Holding Bracket Cap Screw
B—Bracket Clamp Cap Screw
C—Driver Nut
D—JDG1184-2-3 Bracket Clamp

Continued on next page DPSG,OUO1004,929 –19–16JUL99–14/15

12. Assemble small end of 8132 Adapter (A) onto JDG1184-2-1 Swedge Arbor (B).

13. Assemble large end of adapter onto D01300AA 2.2 kg (5 lb) Slide Hammer (C).

14. Position tip of swedge into guide sleeve and drive swedge through sleeve tip. Withdraw swedge with slide hammer.

15. Remove all tooling. After all required sleeves are replaced, refill cooling system and pressure test for leakage.

16. Install electronic unit injector and wiring harness. Refer to the appropriate fuel system repair manual.

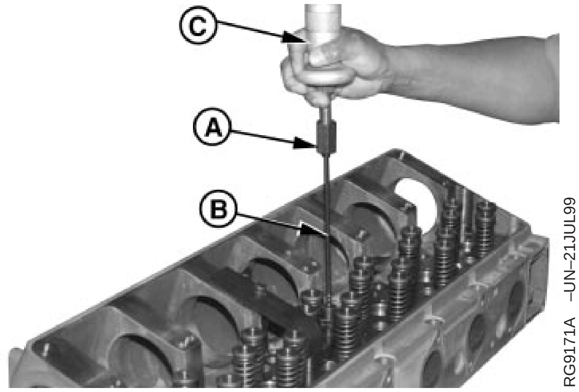
    Delphi/Lucas ECU controlled fuel systems:

    - See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM115, Section 02, Group 090.

    John Deere Level 6 ECU controlled fuel systems:

    - See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM188, Section 02, Group 090 (dual rail fuel systems).
    - See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM188, Section 02, Group 091 (single rail fuel systems).

17. Install rocker arm assembly. (See INSTALL ROCKER ARM ASSEMBLY in this group.)



Remove Swedge

A—8132 Adapter
B—JDG1184-2-1 Swedge Arbor
C—D01300AA Slide Hammer

DPSG,OUO1004,929 –19–16JUL99–15/15

Clean and Inspect Top Deck of Cylinder Block

1. Remove gasket material, rust, carbon, and other foreign material from top deck using a powered brass or copper (soft) wire brush. DO NOT use a steel wire brush.

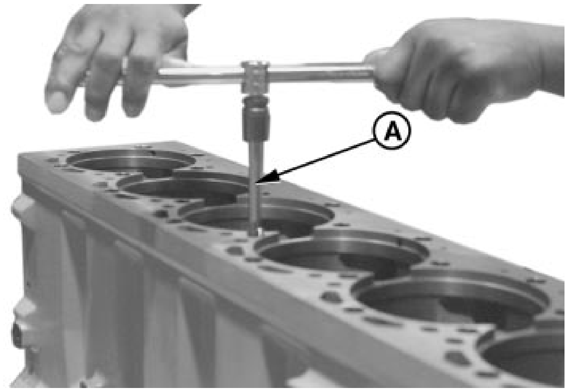
2. Clean threaded holes in cylinder block using JDG978 Special Tap (A) or an equivalent M16 x 2.0 x 140 mm (5.50 in.) long tap.

3. Use compressed air to remove debris and fluids from cap screw holes. Replace block if thread damage is detected.

4. Inspect and measure top deck for flatness. Service as required. (See MEASURE CYLINDER BLOCK, in Group 030.)

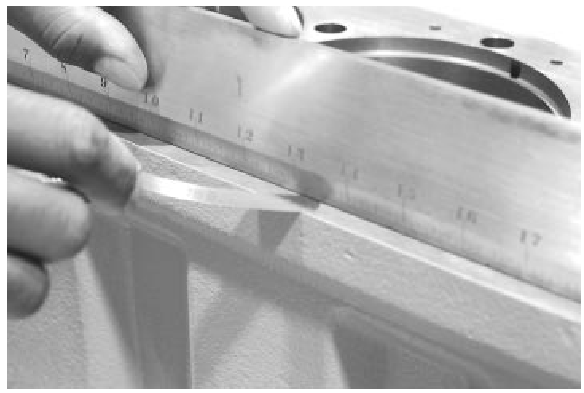
5. Clean all oily residue and dirt from top deck before installing head gasket.

A—JDG978 Special Tap



RG8210A –UN–05DEC97

Cleaning Head Bolt Threads



RG8208 –UN–21MAY98

Measuring Block Top Deck Flatness

RG,RG34710,93 –19–16OCT00–1/1

Measure Cylinder Liner Standout (Height Above Block)

1. Secure liners using cap screws and flat washers. Flat washers should be at least 3.18 mm (1/8 in.) thick. Tighten cap screws to 68 N•m (50 lb-ft).

2. Using JDG451 or KJD10123 Height Gauge (B) and D17526CI or D17527CI Dial Indicator (C), measure liner height (A) at approximately 1, 5, 7, and 11 o'clock positions as viewed from flywheel end of engine. Record all measurements by cylinder number.

Specification

Cylinder Liner—Height Above Block (Standout).. 0.030—0.117 mm (0.0012—0.0046 in.)

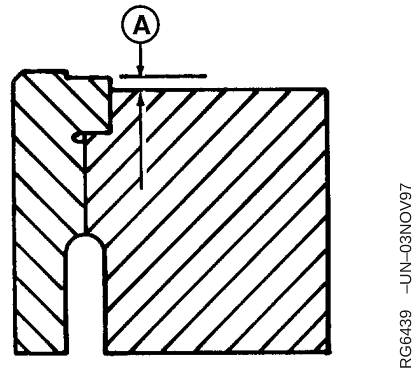
Cylinder Liner—Max. Height Difference at Nearest Point of Two Adjacent Liners or Within One Liner.. 0.051 mm (0.0020 in.)

IMPORTANT: ONE LINER SHIM ONLY may be installed under any given liner flange.

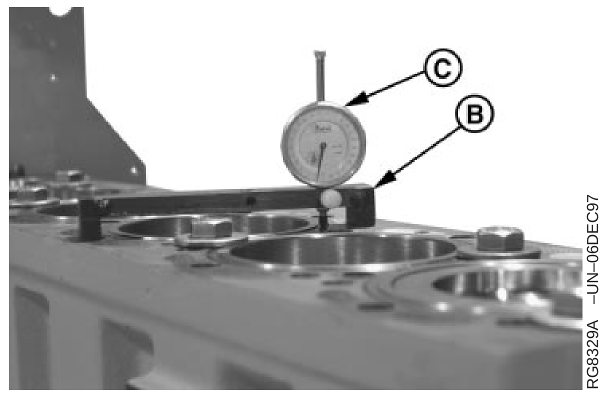
3. Remove liner, add shims or replace any liner that does not fall within allowable standout specification.

   Two sizes of shims are available:

R81276 .... 0.05 mm (0.002 in.)
R87277 .... 0.10 mm (0.004 in.)



Liner Standout



Measuring Liner Standout

A—Liner Height
B—Height Gauge
C—Dial Indicator

RG,RG34710,94 –19–30SEP97–1/1

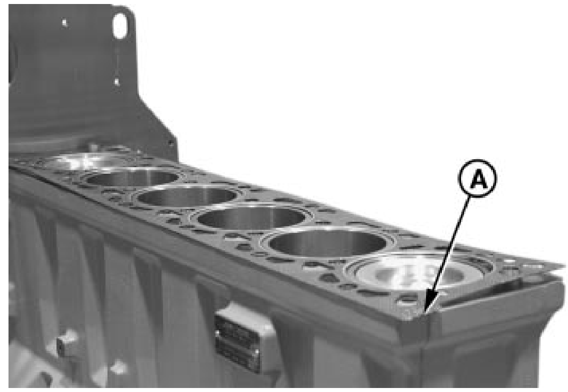
Install Cylinder Head

IMPORTANT: Be sure cylinder head and block gasket surfaces are clean, dry, and free of any oily residue. ALWAYS thoroughly inspect new cylinder head gasket for possible manufacturing imperfections. Return any gasket that does not pass inspection.

1. Place a new head gasket on top of cylinder block. Do not use sealant on gasket. Tab (A) on gasket goes to left rear corner of cylinder block (as viewed from flywheel end).

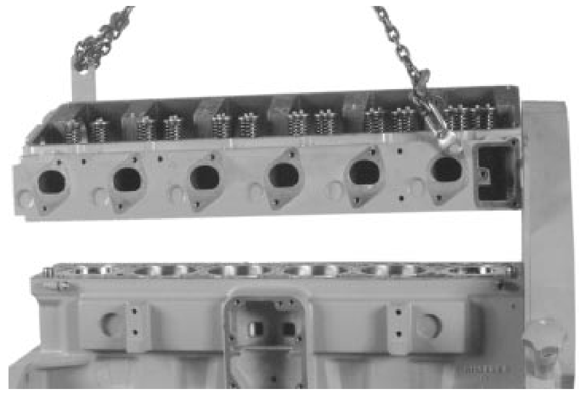
IMPORTANT: If cylinder head is lowered onto cylinder block and you discover that the head is not positioned correctly on locating dowels, remove cylinder head and install a new gasket. DO NOT try to reposition cylinder head on the same gasket again since the fire ring will possibly be damaged.

2. Lower cylinder head in correct position on block using lifting straps and a hoist. Make sure that head is positioned correctly over dowels and that it is all the way down on gasket.



RG8189 –UN–05DEC97

Installing Cylinder Head Gasket



RG8285 –UN–21MAY98

Installing Cylinder Head

A—Tab

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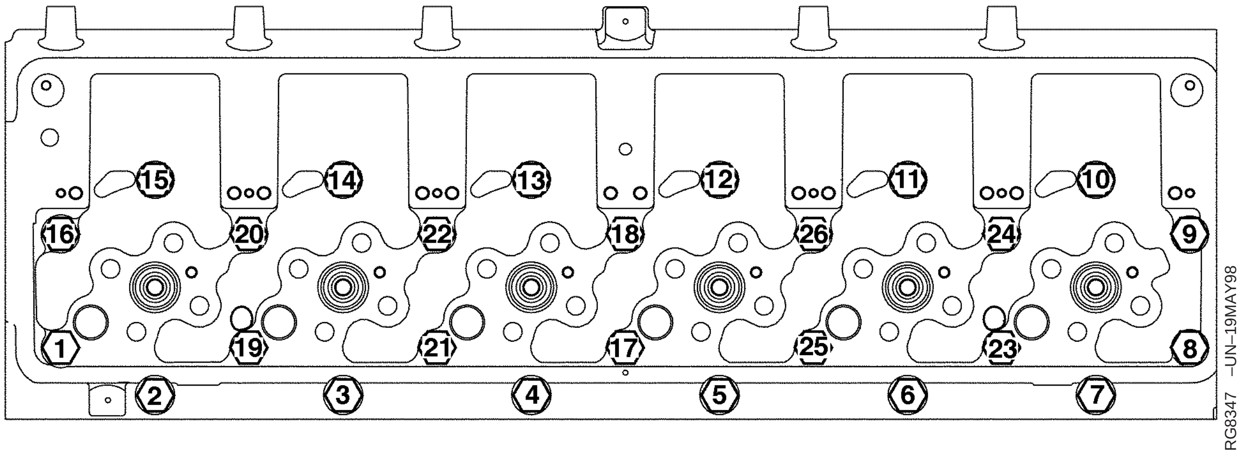


Cylinder Head Cap Screw Torque Sequence

IMPORTANT: Whenever cylinder head is removed for service, all cap screws MUST BE replaced when head is installed. These cap screws can only be used one time.

NOTE: All 26 cylinder head cap screws are the same length.

3. Dip new cap screws and washers in clean SAE 30 engine oil. Allow excess to drain off threads.

4. Initially tighten No. 17 cap screw to specifications.

Specification

Step 1—Cylinder Head No. 17
Cap Screw—Initial Torque..................................... 100 N•m (74 lb-ft)

This prevents head from tipping during tightening sequence.

5. Use torque-turn method to tighten all cylinder head cap screws to specifications. (See TORQUE-TURN CYLINDER HEAD CAP SCREWS next in this Group.)

RG,RG34710,95 –19–27NOV00–2/2

Torque-Turn Cylinder Head Cap Screws

Arrow (A) points toward front of engine.

IMPORTANT: DO NOT use multi-viscosity oils to lubricate cap screws.

1. Lubricate cap screws with clean SAE 30 engine oil and install in their proper locations as outlined previously.

2. If not done, initially tighten cap screw No. 17 to specification to prevent head from tipping during tightening sequence.

Specification

Step 1—Cylinder Head No. 17 Cap Screw—Initial Torque	100 N•m (74 lb-ft)

Following figure on previous page, sequentially start at cap screw No. 1 and proceed through cap screw No. 26 and tighten all cap screws to 163 N•m (120 lb-ft).

Specification

Step 2—All Cap Screws (Nos. 1—26)—Initial Torque	163 N•m (120 lb-ft)

3. Wait 5 minutes and verify above torque.

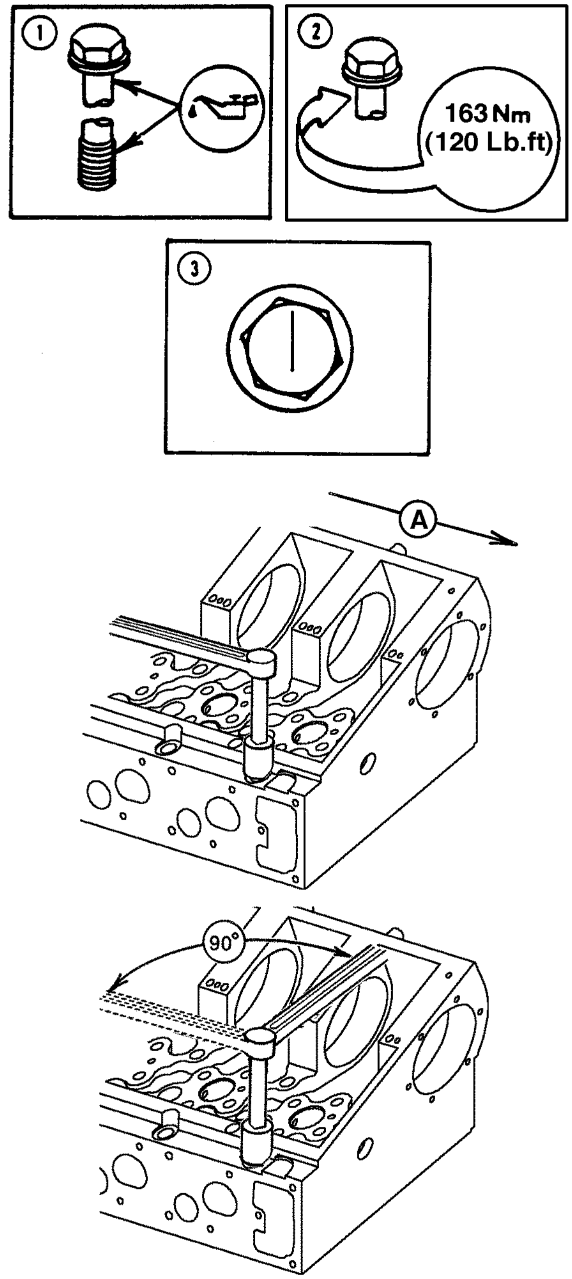
Specification

Step 3—Verify All Cap Screws (Nos. 1—26)—Torque	163 N•m (120 lb-ft)

4. Using an oil-proof pen, pencil, or marker, draw a line parallel to the crankshaft across the entire top of each cap screw head. This line will be used as a reference mark.

IMPORTANT: If a cap screw is accidentally tightened more than 90° in first sequence, DO NOT loosen cap screw but make adjustments in the next tightening sequence.

5. Sequentially (start at cap screw No. 1 and proceed through cap screw No. 26) turn each cap screw 90°. Line on top of cap screw will be perpendicular to crankshaft.



RG8346 –UN–09DEC97

Torque-Turn Cylinder Head Cap Screws

A—Front of Engine

02
020
59

Continued on next page

RG,RG34710,96 –19–28NOV00–1/2

Specification

Step 4—All Cap Screws (Nos. 1—26)—Initial Torque-Turn	90°

IMPORTANT: Cap screws MUST NOT be tightened more than a total of 180°—190°.

6. Finally, sequentially (start at cap screw No. 1 and proceed through cap screw No. 26) turn each cap screw an additional 90°, SO THAT LINE ON TOP OF CAP SCREW IS AS CLOSE AS POSSIBLE TO BEING PARALLEL TO THE CRANKSHAFT. It is not necessary to obtain the final turn in one swing of the wrench. TOTAL AMOUNT OF TURN FROM STEPS 5, and 6, is 180°—190°.

Specification

Step5—All Cap Screws (Nos. 1—26)—Final Torque-Turn	90°

Cylinder head torque procedure summarized as follows:

Cylinder Head—Specification

Step 1—No. 17 Cap Screw—Initial Torque	100 N•m (74 lb-ft)
Step 2—All Cap Screws (Nos. 1—26)—Initial Torque	163 N•m (120 lb-ft)
Step 3—Wait 5 Minutes and Verify All Cap Screws (Nos. 1—26)—Torque	163 N•m (120 lb-ft)
Step 4—All Cap Screws (Nos. 1—26)—Initial Torque-Turn	90°
Step 5—All Cap Screws (Nos. 1—26)[1]—Final Torque-Turn	90°

[1] *Total torque-turn for steps 4 and 5 is 180°.*

RG,RG34710,96 –19–28NOV00–2/2

Install Rocker Arm Assembly

1. Make sure crankshaft and camshaft are locked at No. 1 cylinder TDC with timing pins (A) installed.

A—Timing Pin

Timing Pin in Crankshaft

RG,RG34710,97 –19–01NOV00–1/9

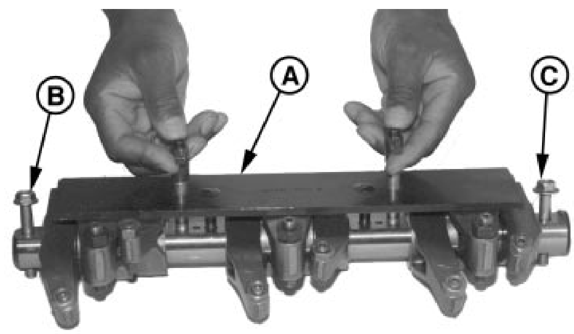
IMPORTANT: Later 12.5 L engines S.N. (30000—) use different rocker arm assembly parts. Refer to parts catalog for correct applications.

2. With rocker arms properly spaced on shaft and cap screws (B) and (C) on each end, install JDG970A Rocker Arm Assembly Lifting Fixture (A) onto rocker arm and shaft assembly.

3. Firmly depress buttons on two lifting arms, install lifting plate with two locator pins and lifting arms positioned in holes of rocker arm shaft. Release buttons so that ball actuating pins lock onto shaft and can be safely lifted.

IMPORTANT: ALWAYS loosen all intake, exhaust and EUI rocker arm adjusting screws before removal or installation of rocker arm assembly to relieve pressure. This allows for a more uniform rocker arm cap screw clamp load and reduces the possibility of damage to valve train components.

4. Install front and rear rocker arm and shaft assembly onto locating roll pins of cylinder head. Make sure all push rods are aligned properly.



Lifting Rocker Arm Assembly

A—JDG970A Rocker Arm Lifting Fixture
B—Cap Screw
C—Cap Screw

Continued on next page

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IMPORTANT: DO NOT reuse rocker arm shaft hold-down clamp cap screws. Ensure that new cap screws are used for reassembly.

NOTE: On early engines with dual rail fuel system, install hold-down clamps (A) with oil tube (B) at second clamp location from front and rear of engine.

5. Install rocker arm hold-down clamps. Install cap screws finger tight.

6. Install twelve valve bridges (D) with slots (E) facing exhaust manifold side of engine. Be sure each bridge is properly seated onto two respective intake and exhaust valves within a given cylinder.

7. Install twelve push tubes (C) on top of bridges.

8. Make sure intake, exhaust, and injector rocker arm adjusting screws are loose to eliminate binding shaft as clamps are tightened.

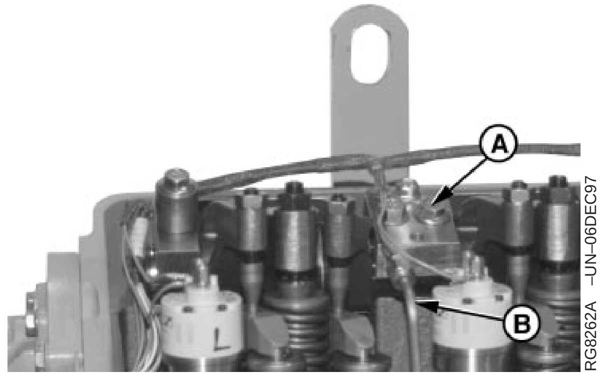
9. Initially tighten rocker arm hold-down cap screws in the end of each shaft to pull shaft down onto locking roll pins. Next, going from front-to-rear of engine, tighten hold-down clamp cap screws to the following specification:

Specification	
Rocker Arm Shaft Hold-Down Clamp Cap Screws (All Engines)—Initial Torque	30 N•m (22 lb-ft)

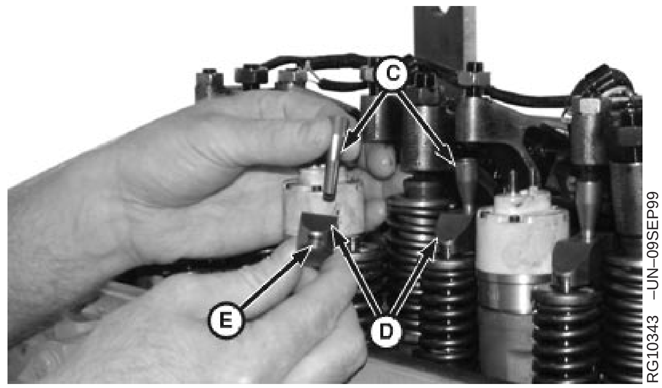
Make an additional pass from front-to-rear and verify torque specification above.

IMPORTANT: Torque-Turn procedures for rocker arm shaft clamp cap screws differ between engines with dual rail and single rail fuel systems. Use proper procedure for engine application.

10. Torque-Turn rocker arm shaft clamp cap screws using proper procedure for type of fuel system as detailed on following pages.



Rocker Arm Oil Tube



Valve Bridges and Push Tubes

A—Hold-Down Clamps
B—Oil Tube (Early Engines with Dual Rail Fuel System)
C—Push Tubes
D—Valve Bridges
E—Slots

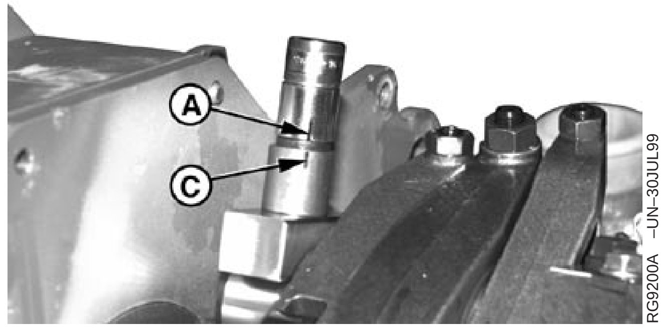
Continued on next page

Torque-Turn Rocker Arm Hold-Down Clamp Cap Screws on Engines with Dual Rail Fuel Systems

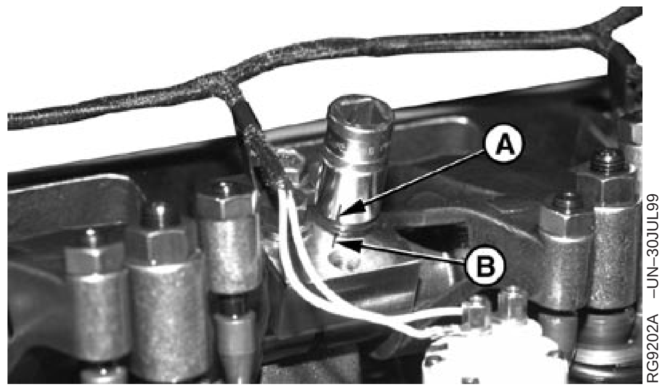
1. After applying initial torque of 30 N•m (22 lb-ft), start at front cap screw and proceed to the rear and torque-turn each cap screw 60° ± 5° as follows:

   - Position a **six point** socket onto rocker arm shaft clamp cap screw.
   - With clockwise tension on socket (viewed from rear of engine), mark a line (A) on socket and another aligning mark on shaft clamp (B) [or spacers (C) at each end location)].

A—Line on Socket
B—Line on Shaft Clamp
C—Line on Spacer



Torque-Turn Clamp Cap Screws



Torque-Turn Clamp Cap Screws

Continued on next page RG,RG34710,97 –19–01NOV00–4/9

- Remove socket from cap screw and rotate socket counterclockwise (viewed from rear of engine) one flat and reinstall on cap screw. Marks should now be 60° apart.
- Tighten cap screws (clockwise) until marks on socket (A) and shaft clamp [or spacers (C) at each end location] are aligned.

NOTE: If cap screw is tightened beyond aligning mark, loosen cap screw and repeat procedure starting with initial torque of 30 N•m (22 lb-ft).

2. Repeat procedure on remaining cap screws and torque-turn cap screws to the following specifications.

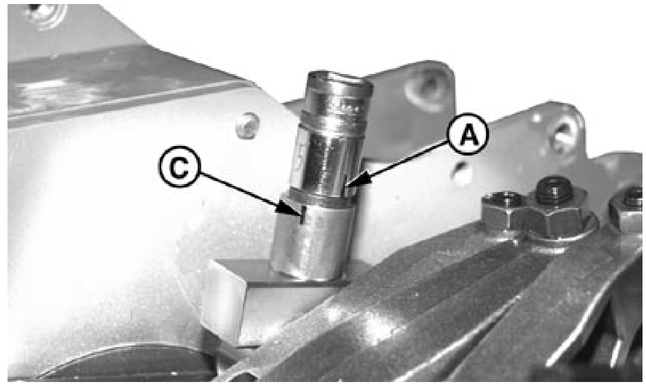
Specification	
Rocker Arm Shaft Hold-Down Clamp Cap Screws (Dual Rail Fuel System)—Final Torque-Turn	60° ± 5°

IMPORTANT: Position electronic unit injector wiring harness so that wires DO NOT touch rocker arms.

3. Install unit injector wiring harness. Apply LOCTITE® 222 (TY24311) Thread Lock and Sealer (Low Strength) to harness cap screws. Tighten cap screws to specifications below.

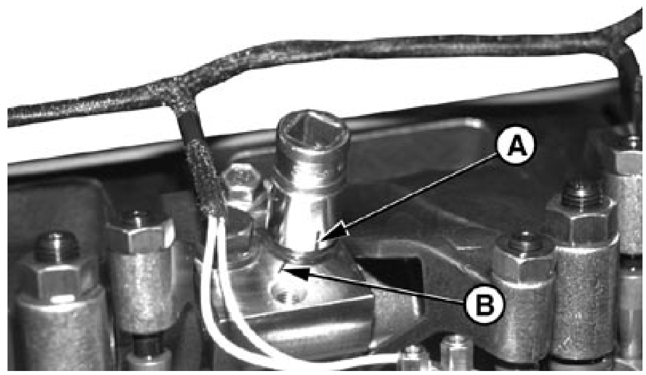
Specification	
Unit Injector Wiring Harness Bracket-to-Rear of Head—Torque	25 N•m (18 lb-ft)
Unit Injector Wiring Harness Solenoid Wire Retaining Nut[1]—Torque	3.0 N•m (27 lb-in.)
Unit Injector Harness Clips-to-Rocker Arm Shaft Clamps—Torque	35 N•m (26 lb-ft)

4. Adjust valve-to-bridge clearance and injector preload. (See CHECK AND ADJUST VALVE ASSEMBLY CLEARANCES AND INJECTOR PRELOAD, earlier in this group.)



RG9201A –UN–30JUL99

Torque-Turn Clamp Cap Screws



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Torque-Turn Clamp Cap Screws

A—Line on Socket
B—Line on Shaft Clamp
C—Line on Spacer

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[1]Apply LOCTITE 222 (TY24311) Thread Lock and Sealer (Low Strength) to nut only.

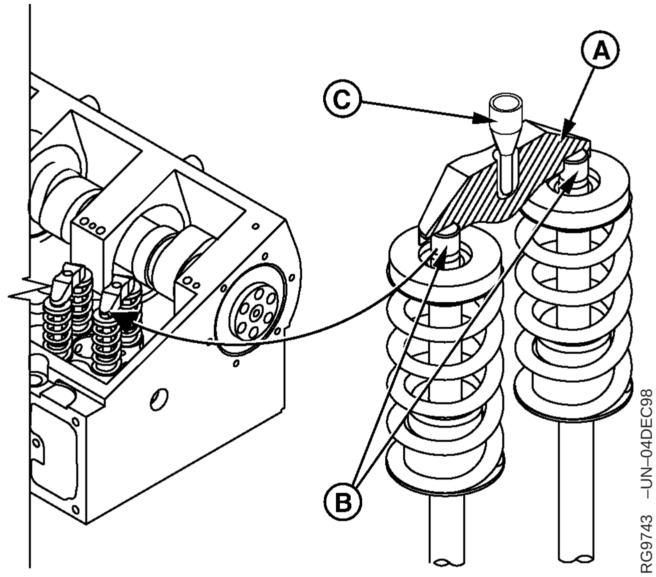
Continued on next page

IMPORTANT: Thoroughly inspect intake and exhaust valve bridges (A) for proper seating on valve stems (B) from both sides of engine. Also, make sure that push tubes (C) are properly seated in top of valve bridges.

Use a flashlight and carefully check each bridge (for proper seating on valve stems) from both sides of the engine. Lift up on each bridge to verify proper seating. Valve bridges that are not properly seated on valve stems will result in major engine failure.

Before installing rocker arm cover, make sure that all EUI wires are positioned so that rocker arm will not contact wires when engine is running.

5. Install rocker arm cover. (See REMOVE AND INSTALL ROCKER ARM COVER, earlier in this group.)



Inspect Bridges and Push Tubes

A—Valve Bridge
B—Valve Stems
C—Push Tube

Continued on next page RG,RG34710,97 –19–01NOV00–6/9

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66

Torque-Turn Rocker Arm Hold-Down Clamp Cap Screws on Engines with Single Rail Fuel Systems

1. After applying initial torque of 30 N•m (22 lb-ft), start at front cap screw and proceed to the rear and torque-turn each cap screw 90° + 10° — 0° as follows:

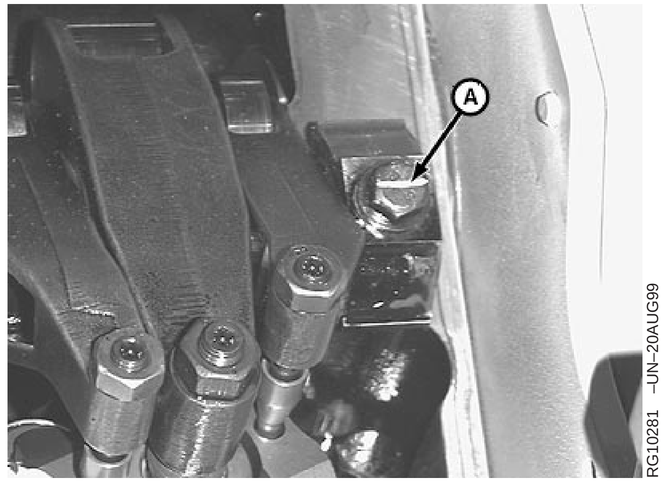
   - Using an oil proof pen, pencil, or marker, draw a line (A) parallel to the crankshaft across the entire top of each cap screw head. This line will be used as a reference mark.
   - Install ratchet/socket on cap screw with ratchet handle parallel (B) to crankshaft.
   - Tighten each cap screw 90° so ratchet handle is perpendicular (C) to crankshaft. Remove ratchet/socket from cap screw and verify line on top of cap screw is perpendicular to crankshaft.

NOTE: If cap screw is tightened beyond aligning mark, loosen cap screw and repeat procedure starting with initial torque of 30 N•m (22 lb-ft).

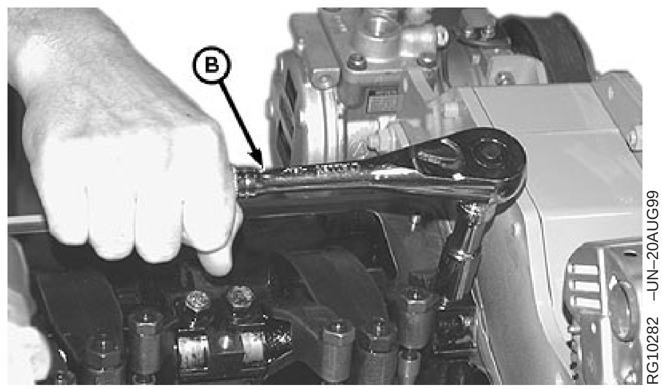
   - Repeat procedure on remaining cap screws and torque-turn cap screws to the following specifications.

Specification

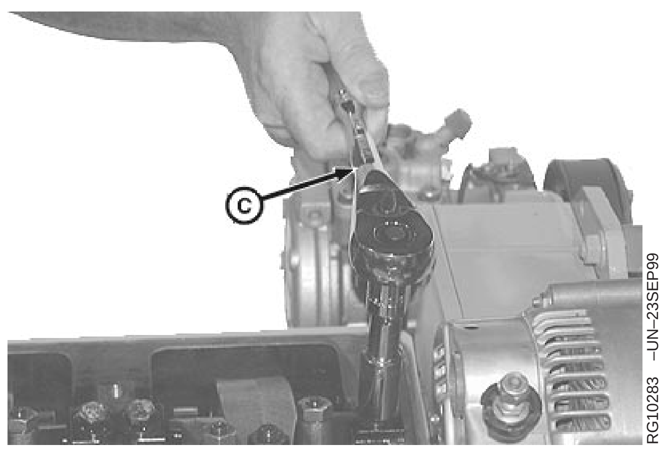
Rocker Arm Shaft Hold-Down Clamp Cap Screws (Single Rail Fuel System)—Final Torque-Turn.................................... 90° + 10° — 0°



Index Rocker Cap Screw



Ratchet Parallel to Crankshaft



Ratchet Perpendicular to Crankshaft

A—Line on Rocker Cap Screw Head
B—Ratchet Parallel to Crankshaft
C—Ratchet Perpendicular to Crankshaft

IMPORTANT: Position electronic unit injector wiring harness so that wires DO NOT touch rocker arms.

2. Install unit injector wiring harness. Apply LOCTITE® 222 (TY24311) Thread Lock and Sealer (Low Strength) to harness cap screws. Tighten cap screws to specifications below.

Specification

Unit Injector Wiring Harness Bracket-to-Rear of Head—Torque .... 25 N•m (18 lb-ft)

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Specification

Unit Injector Wiring Harness Solenoid Wire Retaining Nut[1]—Torque	3.0 N•m (27 lb-in.)
Unit Injector Harness Clips-to-Rocker Arm Shaft Clamps—Torque	35 N•m (26 lb-ft)

3. Adjust valve-to-bridge clearance and injector preload. (See CHECK AND ADJUST VALVE ASSEMBLY CLEARANCES AND INJECTOR PRELOAD, earlier in this group.)

[1]Apply LOCTITE 222 (TY24311) Thread Lock and Sealer (Low Strength) to nut only.

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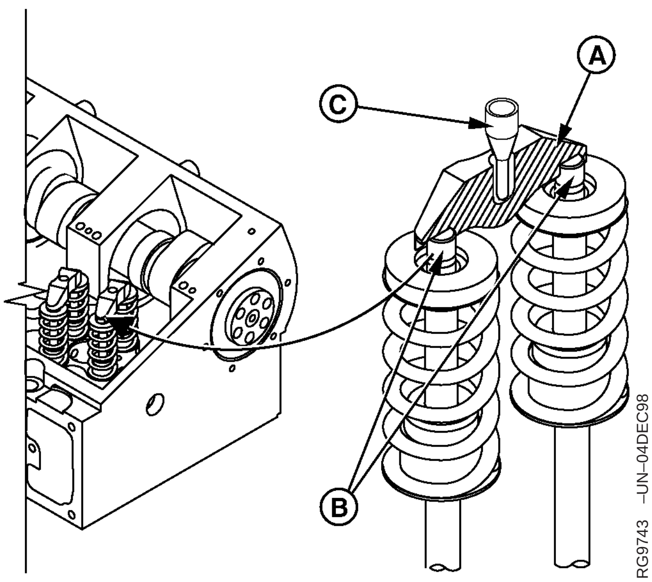
IMPORTANT: Thoroughly inspect intake and exhaust valve bridges (A) for proper seating on valve stems (B) from both sides of engine. Also, make sure that push tubes (C) are properly seated in top of valve bridges.

Use a flashlight and carefully check each bridge (for proper seating on valve stems) from both sides of the engine. Lift up on each bridge to verify proper seating. Valve bridges that are not properly seated on valve stems will result in major engine failure.

Before installing rocker arm cover, make sure that all EUI wires are positioned so that rocker arm will not contact wires when engine is running.

4. Install rocker arm cover. (See REMOVE AND INSTALL ROCKER ARM COVER, earlier in this group.)



Inspect Bridges and Push Tubes

A—Valve Bridge
B—Valve Stems
C—Push Tube

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Complete Final Assembly for Cylinder Head Installation

1. Install camshaft gear access cover. (See INSTALL TIMING GEAR COVER in Group 040.)

2. Install thermostat housing/water manifold assembly. (See REMOVE AND INSTALL THERMOSTAT HOUSING in Group 070.)

3. Install intake manifold. (See REMOVE, INSPECT AND INSTALL INTAKE MANIFOLD in Group 080.) Install exhaust manifold. (See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD in Group 080.) Install turbocharger. (See INSTALL TURBOCHARGER in Group 080.)

4. Install fuel supply pump. Refer to the appropriate fuel system repair manual.

   Delphi/Lucas ECU controlled fuel systems:

   - See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM115, Section 02, Group 090.

   John Deere Level 6 ECU controlled fuel systems:

   - See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM188, Section 02, Group 090 (dual rail fuel systems).
   - See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM188, Section 02, Group 091 (single rail fuel systems).

5. Install fuel manifold assembly (if equipped) from rear of cylinder head. See the appropriate fuel system repair manual.

   Delphi/Lucas ECU controlled fuel systems:

   - See REMOVE AND INSTALL FUEL MANIFOLD in CTM115, Section 02, Group 090 (dual rail fuel system).

   John Deere Level 6 ECU controlled fuel systems:

   - See REMOVE AND INSTALL FUEL MANIFOLD in CTM188, Section 02, Group 090 (dual rail fuel system).

6. Install and securely tighten all fuel lines and fuel filter. (CTM115, Section 02, Group 090 or CTM188, Section 02, Group 090 or 091.)

7. Fill engine with proper fuel and coolant. (Section 01, Group 002.)

8. Perform engine break-in. (See PERFORM ENGINE BREAK-IN in Group 010.)

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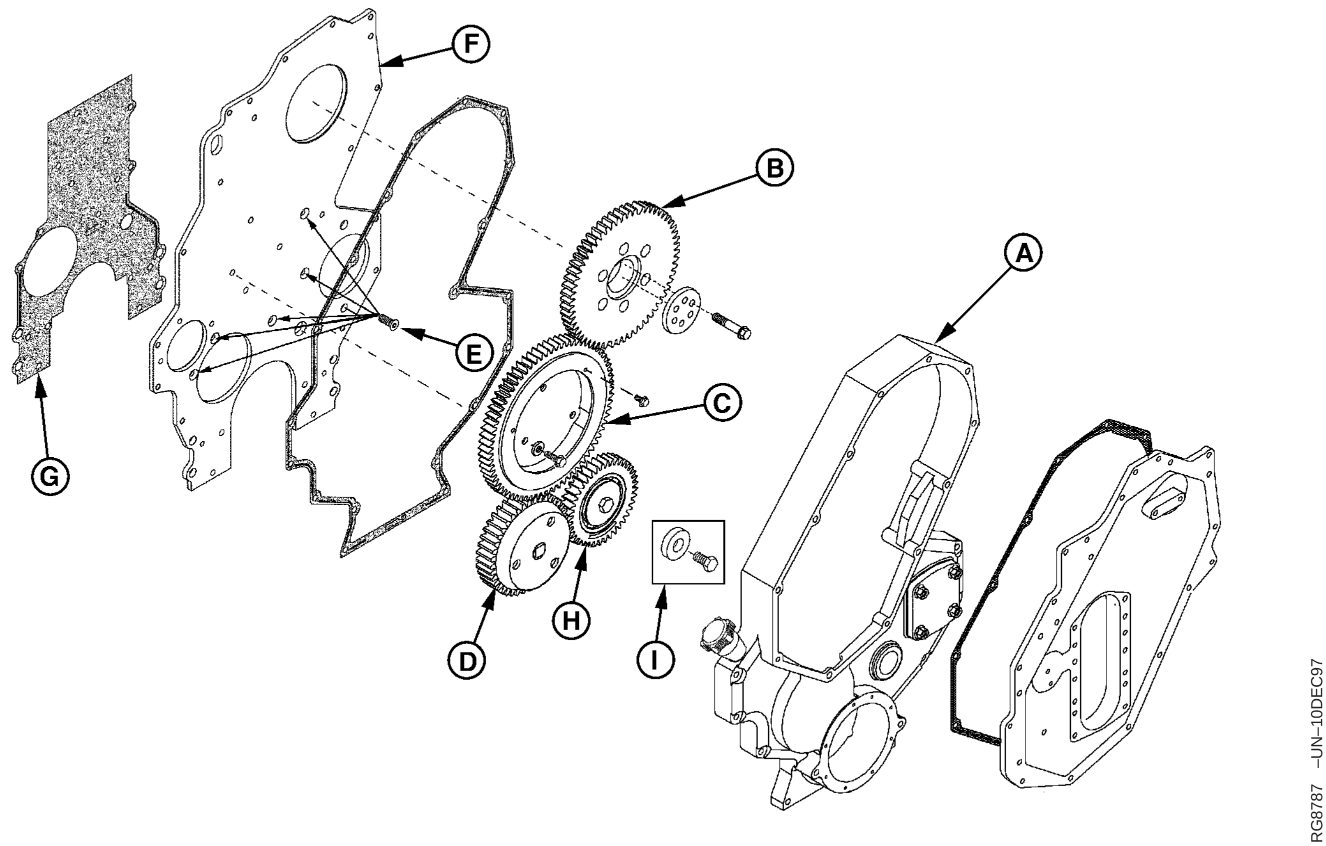
Remove and Install Cylinder Block Front Plate



Front Plate and Timing Gear Cover Exploded View

A—Timing Gear Cover
B—Camshaft Gear
C—Idler Gear
D—Oil Pump Gear
E—Screws (5 Used)
F—Front Plate
G—Front Plate Gasket
H—Auxiliary Drive Gear
I—Without Auxiliary Drive Gear

Remove Front Plate

1. Lock engine at No.1 TDC compression stroke by installing JDG971 Timing Pins in camshaft and crankshaft. (See CHECK AND ADJUST CAMSHAFT-TO-CRANKSHAFT TIMING in Group 050.)

2. Remove timing gear cover (A). (See REMOVE TIMING GEAR COVER in Group 040.)

3. Remove camshaft gear (B) and idler gear assembly (C). (See CHECK AND ADJUST CAMSHAFT-TO-CRANKSHAFT TIMING in Group 050.)

4. Remove engine oil pump assembly (D). (See REMOVE ENGINE OIL PUMP in Group 060.)

5. Remove auxiliary drive gear (H) if equipped. (See REMOVE AND INSTALL AUXILIARY DRIVE IDLER GEAR AND BEARING in CTM67, OEM Engine Accessories, Group 54.)

IMPORTANT: Tap head of countersunk cap screws sharply with a brass punch and use an Allen-head adapter that does not have corners rounded off.

6. Remove five countersunk screws (E) and remove front plate (F) from dowels.

Continued on next page

NOTE: *Older front plate gaskets required the use of sealant on some of the upper threaded cap screw holes. New service gaskets are rubberized in these locations, so sealant is no longer required.*

7. Remove gasket (G) and discard. Thoroughly clean gasket surfaces on cylinder block and front plate. If present, ensure all sealant is removed.

Continued on next page

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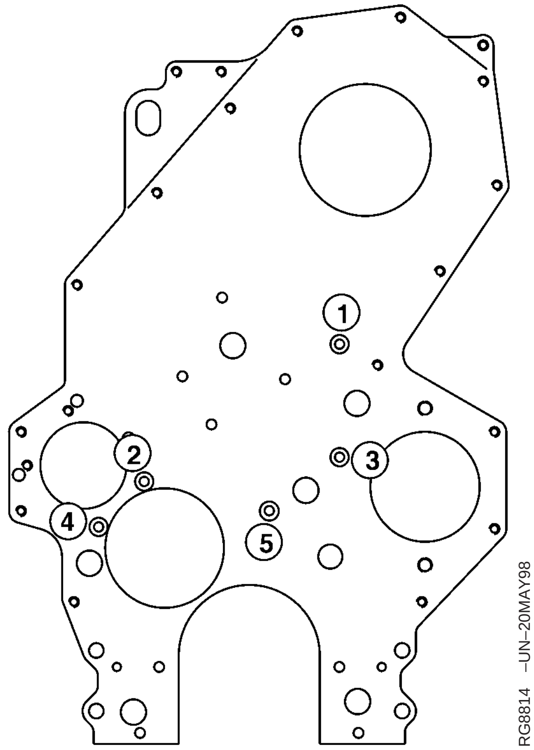
Install Front Plate

IMPORTANT: All gasket contact surfaces MUST BE clean, dry, and free of sealant and oil. Earlier service front plate gaskets used sealant. New gaskets DO NOT require sealant.



Front Plate Torque Sequence

1. Install new gasket onto dowels in cylinder block.
2. Install front plate onto front face of block.
3. Install five countersunk screws and tighten to specifications, following sequence in illustration.

Specification	
Front Plate-to-Cylinder Block Cap Screws—Torque	50 N•m (37 lb-ft)

4. Install engine oil pump assembly. (See INSTALL ENGINE OIL PUMP in Group 060.)
5. Install idler gear and camshaft gear. Adjust gear backlash. (See CHECK AND ADJUST CAMSHAFT-TO-CRANKSHAFT TIMING in Group 050.)
6. Install auxiliary drive gear (if equipped). (See REMOVE AND INSTALL AUXILIARY DRIVE IDLER GEAR AND BEARING in CTM67, OEM Engine Accessories, Group 54.)
7. Install timing gear cover. (See INSTALL TIMING GEAR COVER in Group 040.)
8. Install engine oil pan. (See INSTALL ENGINE OIL PAN in Group 060.)
9. Install crankshaft vibration damper and pulley. (See INSTALL CRANKSHAFT VIBRATION DAMPER AND FRONT OIL SEAL in Group 040.)
10. Remove JDG971 Timing Pins and install rocker arm cover. (See REMOVE AND INSTALL ROCKER ARM COVER in Group 020.)
11. Install crankshaft timing pin plug and tighten to specifications.

Continued on next page

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Specification

Crankshaft Timing Pin Plug—
Torque .... 33 N•m (24 lb-ft)

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Preliminary Liner, Piston, and Rod Checks

Scuffed or Scored Pistons:

- Overheating.
- Overfueling.
- Insufficient lubrication.
- Insufficient cooling.
- Improper piston-to-liner clearance.
- Coolant leakage into crankcase.
- Misaligned or bent connecting rod.
- Improperly installed piston.
- Low oil level.
- Improper operation.
- Incorrect connecting rod bearing clearance.
- Carbon build-up in ring groove.
- Improper engine break-in.
- Worn piston.
- Contaminated oil.
- Distorted cylinder liner.
- Plugged piston cooling orifice.
- Ingestion of dust through air intake.

Worn or Broken Compression Rings:

- Insufficient lubrication.
- Insufficient cooling.
- Improper ring installation.
- Improper timing.
- Abrasives in combustion chamber.

Clogged Oil Control Ring:

- Improper oil.
- Excessive blow-by.
- Contaminated oil.
- Improper periodic service.
- Low operating temperature.

Stuck Rings:

- Improper oil classification.
- Improper periodic service.
- Poor operating conditions.
- Coolant leakage into crankcase.
- Excessive cylinder liner taper.

Mottled, Grayish or Pitted Compression Rings:

- Internal coolant leaks.

Dull Satin Finish and Fine Vertical Scratches on Rings:

- Dirt and abrasives in air intake system.

Piston Pin and Snap Ring Failure:

- Misaligned connecting rod.
- Excessive crankshaft end play.
- Incorrect snap rings.

Broken Connecting Rod:

- Inadequate piston-to-liner clearance.
- Worn connecting rod bearing.
- Distorted cylinder liner.
- Piston pin failure.

Cylinder Liner Wear and Distortion:

- Incorrectly installed compression rings.
- Insufficient lubrication.
- Uneven cooling around liner.
- Inadequate piston-to-liner clearance.
- Liner bore damage.

Warped Cylinder Block:

- Insufficient cooling.

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Connecting Rods—General Information

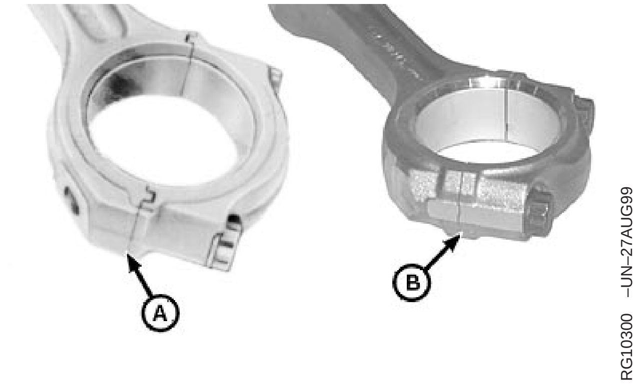
Earlier engines have the traditional tongue-and-groove between the connecting rod and cap (A). Later engines have the PRECISION JOINT™ rod and cap (B).

To create the PRECISION JOINT™, the connecting rod is notched with a laser beam. Then a precision mandrel in the rod bore is powered to separate the cap from the rod at the joints (C).

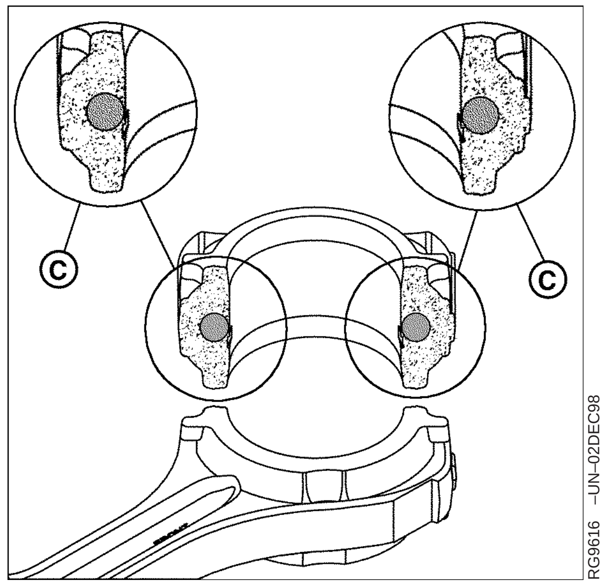
Both types of rods provide a strong joint. Removal and installation is similar, with differences noted, including different torque specifications for cap screws.

IMPORTANT: Replace rods with the same type. Do Not mix tongue-and-groove with PRECISION JOINT™ rods in the same engine. See parts catalog for recommendations.

A—Tongue-and-Groove Rod (Early Engines)
B—PRECISION JOINT™ Rod (Later Engines)
C—PRECISION JOINT™ Details



Connecting Rods



PRECISION JOINT™ Rod (Later Engines)

PRECISION JOINT is a trademark of Deere & Company

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Remove Pistons and Connecting Rods

The engine does not always have to be removed from the machine to service the pistons and connecting rods. If engine is to be removed, see your Machine Technical Manual.

NOTE: The piston and liner sets on later 12.5 L engines are different from earlier engines. Do not mix sets in engines. See parts catalog for correct applications.

CAUTION: DO NOT drain engine coolant until it cools below operating temperature. Then slowly loosen block drain valve to relieve any pressure.

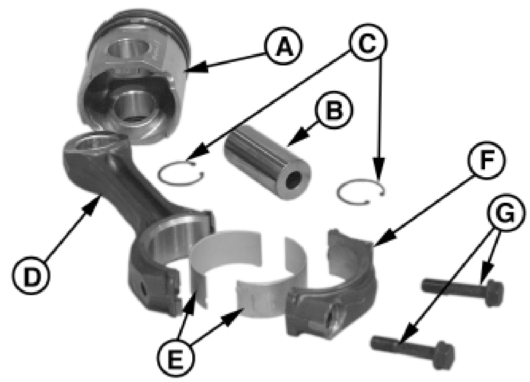
1. Drain all coolant and engine oil.

2. Remove all piston spray jets.

NOTE: If engine is to be completely disassembled, follow ENGINE DISASSEMBLY SEQUENCE in Group 010.

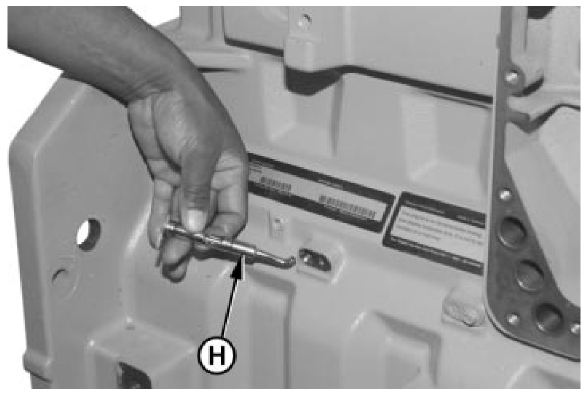
3. Remove cylinder head. (See REMOVE CYLINDER HEAD in Group 020.)

4. Remove oil pan. (See REMOVE ENGINE OIL PAN in Group 060.) Remove oil pick-up tube. (See REMOVE AND INSTALL OIL PICKUP TUBE in Group 060.)



RG8203 –UN–05DEC97

Piston and Rod Exploded View



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Removing Piston Spray Jets

A—Piston with Rings
B—Piston Pin
C—Snap Ring (2 used)
D—Connecting Rod with Bushing
E—Rod Bearings
F—Connecting Rod Cap
G—Special Cap Screws
H—Piston Spray Jet

Continued on next page RG,RG34710,107 –19–01NOV00–1/4

IMPORTANT: Do not rotate crankshaft with cylinder head removed unless liners are bolted down. Bolt liners down before removing piston.

Cap screws and washers must be tightened to 68 N•m (50 lb-ft) to achieve an accurate reading when checking liner standout (height above block), as detailed later in this group.

5. Use seven M16 x 2.0 x 55 mm (2.17 in.) long cap screws (A) and 5/8 in. ID x 1-3/4 in. OD x 3.18 mm (1/8 in.) thick washers (B) to bolt down cylinder liners (C) in the seven locations as shown. Tighten cap screws to specifications.

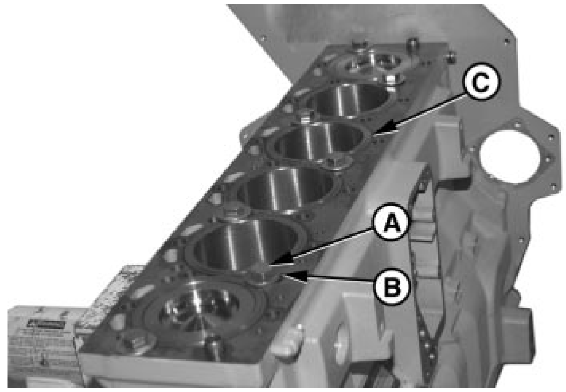
Specification

Cylinder Liner Cap Screws (For Checking Liner Standout)—
Torque .... 68 N•m (50 lb-ft)

6. Before removing pistons, visually inspect condition of cylinder liners with pistons at bottom dead center "BDC". Liners will require replacement if:

   - The crosshatch honing pattern is not visible immediately below the top ring turn-around area.
   - Liners are pitted or contain deep vertical scratches that can be detected by the fingernail.

   No further inspection is required if any one of the above conditions is found.



RG8302 –UN–06DEC97

Bolting Liners Down

A—Long Cap Screws
B—Thick Washers
C—Bolt Down Cylinder Liners

Continued on next page

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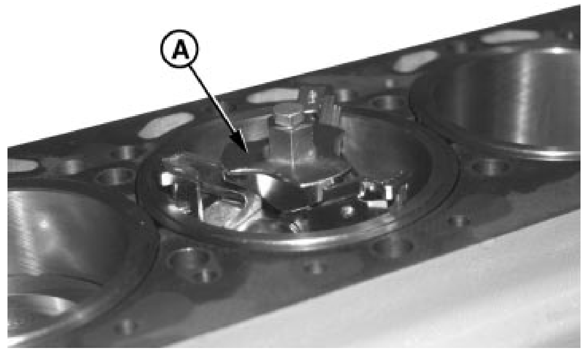
NOTE: Always follow manufacturer's directions provided with ridge reamer.

7. Remove carbon ridge from liner bore with a scraper or JT07277 Ridge Reamer (A). Use compressed air to remove loose carbon from cylinders.

A—JT07277 Ridge Reamer



RG8364 –UN–09DEC97

Using Liner Ridge Reamer

Continued on next page RG,RG34710,107 –19–01NOV00–3/4

8. Mark rods, pistons, and caps to ensure correct assembly in same location.

IMPORTANT: Keep bearing inserts with their respective caps for rod and main bearings.

9. Remove all rod caps (A) with bearings.

NOTE: Use PLASTIGAGE® to determine bearing-to-journal oil clearance as directed by the manufacturer. PLASTIGAGE® will determine bearing-to-journal oil clearance, but will not indicate the condition of either surface.

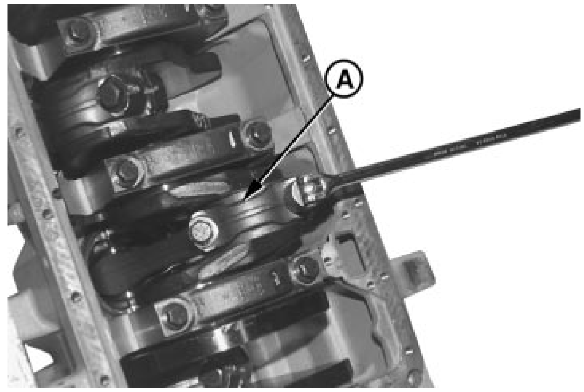
10. Measure rod bearing-to-journal oil clearance with PLASTIGAGE® before removing piston and rod assembly. Record measurements. (See INSPECT AND MEASURE CONNECTING ROD BEARINGS, later in this group.)

IMPORTANT: Hold on to piston to prevent piston from dropping. Piston will drop once piston rings have cleared cylinder liner bore.

If liners are to be reused, be extremely careful not to let connecting rod hit liner bore when removing piston and rod assembly.

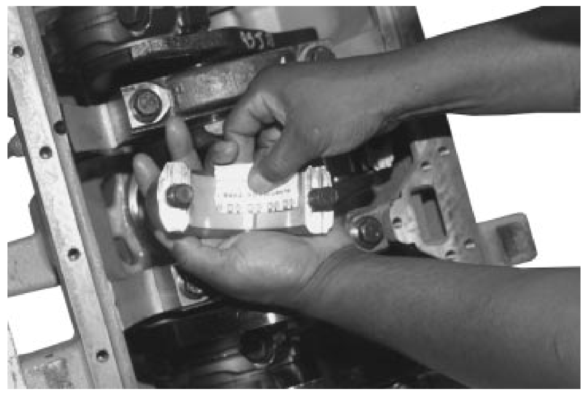
11. Gently tap piston through top of cylinder block from the bottom.

12. Remove remaining pistons and rods from engine.



RG8396A –UN–09DEC97

Removing Rod Caps



RG8398 –UN–21MAY98

Measuring Rod Bushing Oil Clearance

A—Rod Caps

PLASTIGAGE is a registered trademark of DANA Corp.

RG,RG34710,107 –19–01NOV00–4/4

Measure Cylinder Liner Standout (Height Above Block)

IMPORTANT: Remove all gasket material, rust, carbon and other foreign material from top deck of cylinder block. Use compressed air to remove all loose foreign material from cylinders and top deck.

NOTE: Liners having obvious defects must be replaced as a matched piston and liner set.

1. Bolt liners down in seven locations using cap screws and washers. (See REMOVE PISTONS AND CONNECTING RODS, earlier in this group.) Tighten cap screws to 68 N•m (50 lb-ft).

Specification

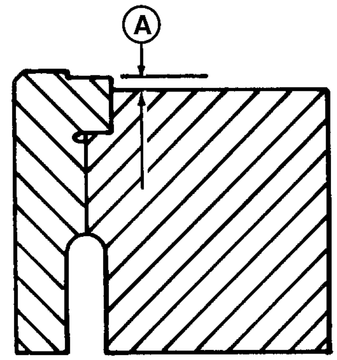
Cylinder Liner Cap Screws (For Checking Liner Standout)—
Torque .... 68 N•m (50 lb-ft)

2. Using JDG451 Gauge (B) along with D17526CI (English scale) or D17527CI (metric scale) Dial Indicator or KJD10123 Gauge (C), measure liner height (A) for all cylinders.

3. Measure each liner in four places at approximately 1, 5, 7, and 11 o'clock positions as viewed from rear of engine (flywheel end). Record all measurements by cylinder number.

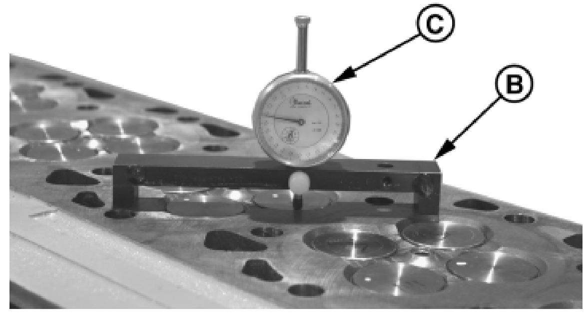
NOTE: Variations in measurement readings may occur within one cylinder and/or between adjacent cylinders.

4. If liner standout is below specification, measure liner flange thickness. (See MEASURE LINER FLANGE THICKNESS later in this group.) Measure liner counterbore depth in cylnder block. (See INSPECT AND CLEAN CYLINDER BLOCK, later in this group.)



RG6439 –UN–03NOV97

Liner Standout



RG8330B –UN–09DEC97

Measuring Liner Standout

A—Liner Height
B—JDG451 Gauge
C—KJD10123 Gauge

Continued on next page

RG,RG34710,108 –19–13AUG99–1/2

Specification

Cylinder Liner Height (Standout)—Height Above Block	0.030—0.117 mm (0.0012—0.0046 in.)
Maximum Permissible Height Difference at Nearest Point of Two Adjacent Liners or Within One Liner	0.05 mm (0.002 in.)
Cylinder Liner Shims Available—Thickness	0.05 mm (0.002 in.)
Thickness	0.10 mm (0.004 in.)

IMPORTANT: ONE LINER SHIM ONLY may be installed under any given liner flange.

5. Add shims or replace any liner that does not meet standout specification at any location.

RG,RG34710,108 –19–13AUG99–2/2

Remove Cylinder Liners Using D01062AA or D01073AA Cylinder Liner Puller

1. Remove cap screws and washers securing liners to cylinder block.

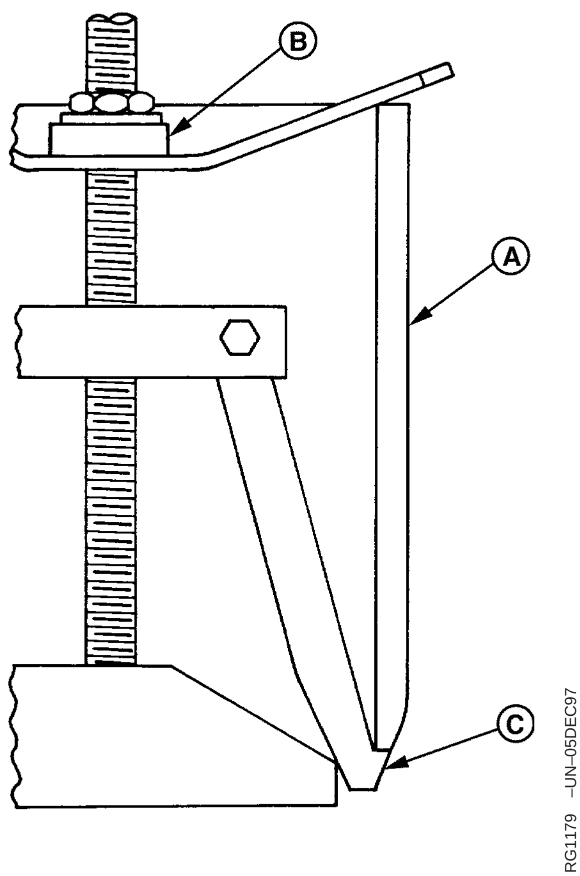
2. Number cylinder liners and mark fronts to ensure correct assembly.

NOTE: Each cylinder liner must be reinstalled in same cylinder bore from which removed. Always keep matched pistons and liners together.

3. Use D01062AA or D01073AA Cylinder Liner Puller (B) with a 2.27 kg (5.0 lb) slide hammer to remove cylinder liner (A).

IMPORTANT: When using D01062AA (or D01073AA) Cylinder Liner Puller (B) to remove liner (A), be sure jaw (C) of puller is correctly positioned before attempting to remove liner.

DO NOT over-tighten liner puller to remove liners. Doing so could easily break liners.



Removing Cylinder Liners

A—Liner
B—Cylinder Liner Puller
C—Jaw

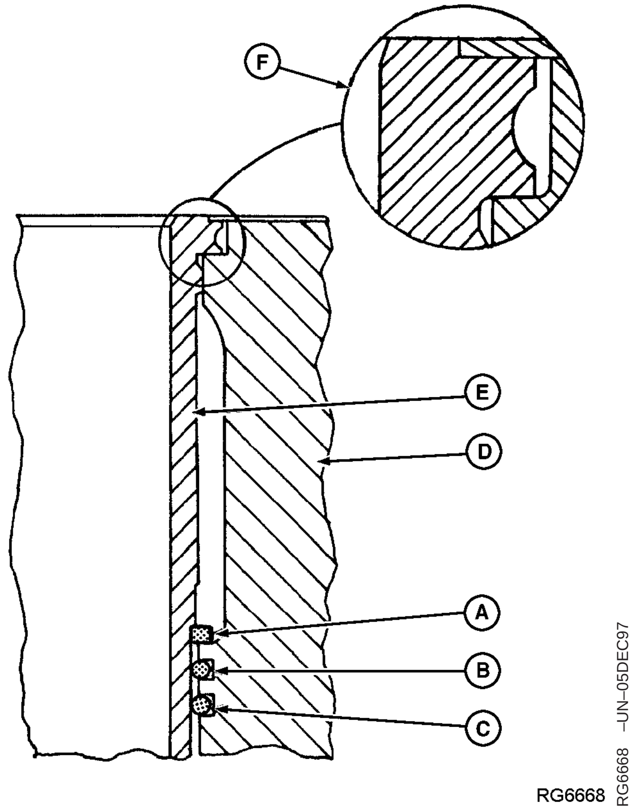
Continued on next page

RG,RG34710,109 –19–13AUG99–1/2

4. Remove the cylinder liner square packing (A) from liner (E).

5. Remove red O-ring (B) and black O-ring (C) from cylinder block (D).

A—Square Packing (Neoprene)
B—Red O-Ring (Silicone)
C—Black O-Ring (Viton)
D—Cylinder Block
E—Cylinder Liner
F—Coolant Passage



Cylinder Liner Packing

RG,RG34710,109 –19–13AUG99–2/2

Remove Cylinder Liners Using JDG1145 Cylinder Liner Service Set

NOTE: JDG1145 Liner Puller (A) shown with liner removed to illustrate proper assembly of tool.

1. Remove cap screws and washers securing liners to cylinder block.

2. Number cylinder liners and mark fronts to ensure correct assembly.

NOTE: Each cylinder liner must be reinstalled in same cylinder bore from which removed. Always keep matched pistons and liners together.

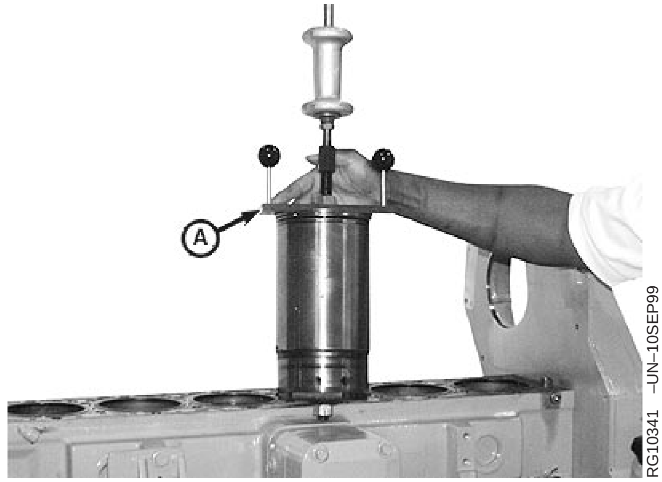
3. Use JDG1145 Cylinder Liner Service Set (A) with a 2.27 kg (5.0 lb) slide hammer (B) to remove cylinder liner.

IMPORTANT: When using JDG1145 as shown (A) to remove liners, make sure puller is properly assembled before attempting to remove liners. Step in bottom plate of puller assembly should fit in ID of liner.

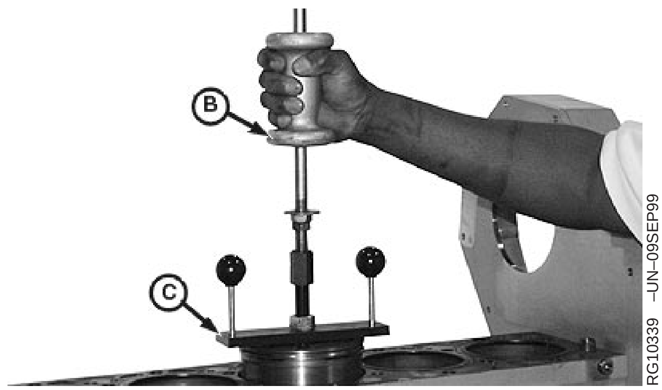
DO NOT over-tighten liner puller to remove liners. Doing so could easily break liners.

4. Install liner puller (C) in liner.

5. Attach a 2.27 kg (5.0 lb) slide hammer (B) to liner puller as shown and remove liner.



JDG1145 Installation



Remove Cylinder Liner

A—JDG1145
B—Slide Hammer
C—Liner Puller

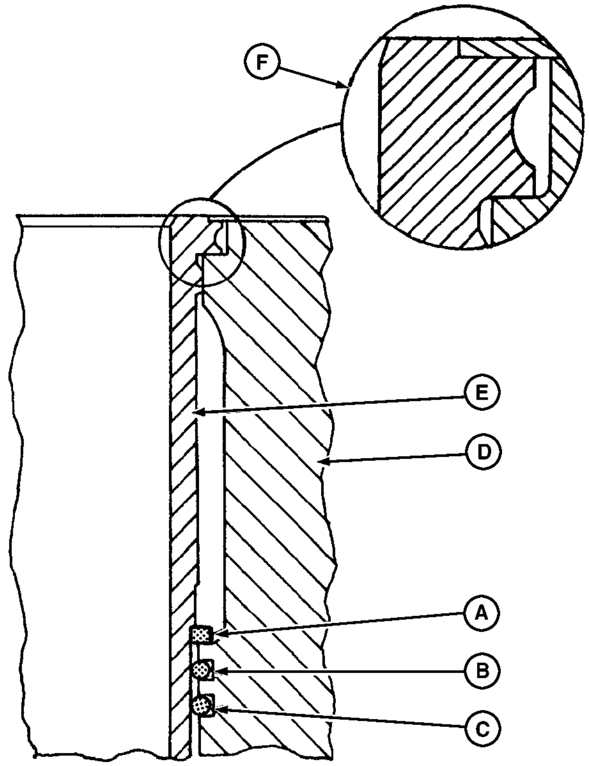
Continued on next page

DPSG,OUO1004,1026 –19–09SEP99–1/2

6. Remove the cylinder liner square packing (A) from liner (E).

7. Remove red O-ring (B) and black O-ring (C) from cylinder block (D).

A—Square Packing (Neoprene)
B—Red O-Ring (Silicone)
C—Black O-Ring (Viton)
D—Cylinder Block
E—Cylinder Liner
F—Coolant Passage



Cylinder Liner Packing

DPSG,OUO1004,1026 –19–09SEP99–2/2

Visually Inspect Cylinder Liners

IMPORTANT: If pitting has occurred, check condition of coolant.

1. Inspect exterior length of liner for pitting (A). Check packing step for erosion (B). If pitting or erosion is observed, measure the depth of pits and erosion with a fine wire or needle.

   Replace piston and liner if:

   - Pitting depth is one-half liner thickness (C) or more.

Specification

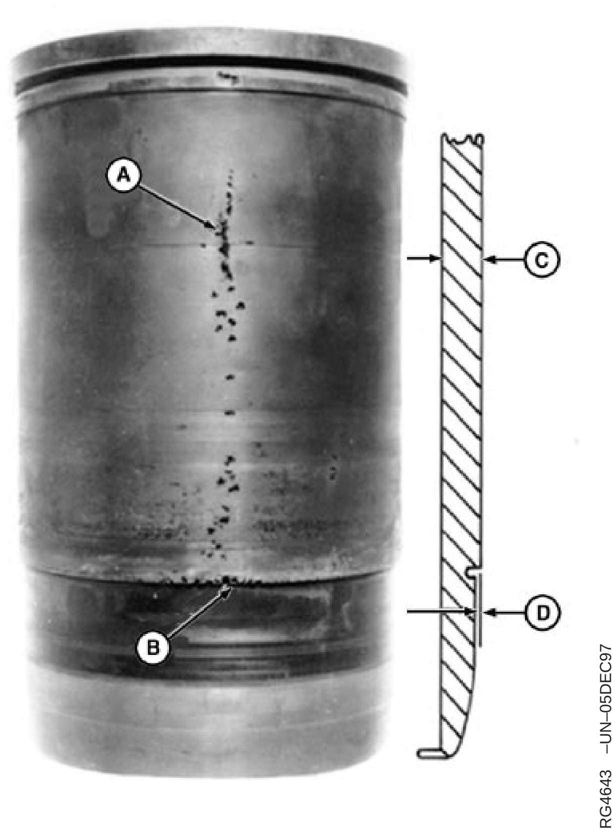
Cylinder Liner Wall—Thickness	9.39—9.43 mm (0.370—0.371 in.)

   - Erosion depth is one-half packing step (D) or more.

Specification

Cylinder Liner Packing Step—Dimension	2.14—2.30 mm (0.084—0.090 in.)

NOTE: Liners are reusable if the depth of pits or erosion is less than one-half the amount specified. When installing these liners, rotate 90° from original position. The liners should be deglazed and ring sets installed on pistons.



Liner Visual Inspection

A—Liner Pitting
B—Erosion
C—Pitting Depth Is One-Half Liner Thickness
D—Erosion Depth Is One-Half Packing Step

Continued on next page RG,RG34710,110 –19–03AUG99–1/2

2. Visually examine liner ID. Replace piston and liner if:

   - The crosshatch honing pattern is not visible immediately below the top ring turn-around area.
   - Liners are pitted or contain deep vertical scratches that can be detected by the fingernail.

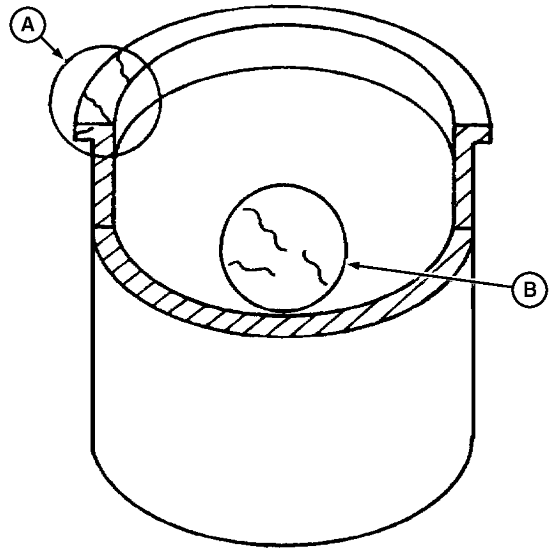
3. Carefully examine liner for signs of fatigue, such as fine cracks in the flange area (A) and cracks in the ring travel area (B).

NOTE: Inspect block for cracks or erosion in the O-ring packing areas. (See INSPECT AND CLEAN CYLINDER BLOCK, later in this group.)

4. Measure liner OD and compare to following specifications.

Cylinder Liners—Specification

Flange Area—OD	151.565—151.615 mm (5.9671—5.9691 in.)
Upper OD for Seating Liner—OD	145.795—145.845 mm (5.7400—5.7419 in.)
Water Jacket Area—OD	144.73—144.99 mm (5.698—5.708 in.)
Lower OD for Seating with O-Rings—OD	140.397—140.447 mm (5.5274—5.5294 in.)



Liner ID Inspection

A—Cracks In The Flange Area
B—Cracks In The Ring Travel Area

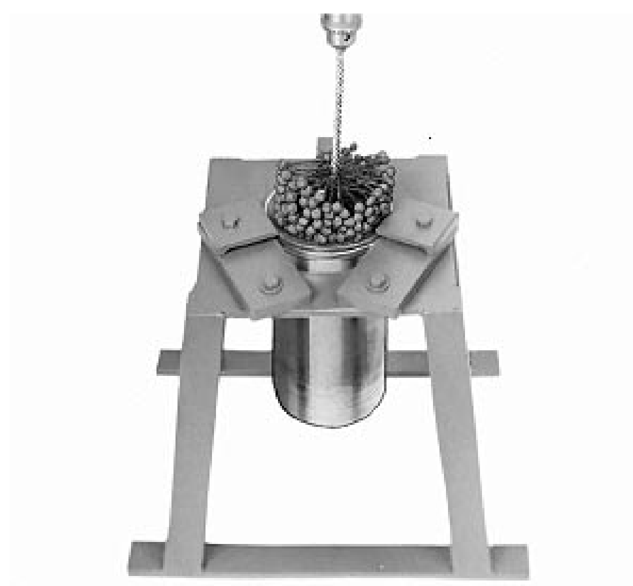
RG,RG34710,110 –19–03AUG99–2/2

Deglaze Cylinder Liners

1. Secure cylinder liner in a holding fixture. See DFRG3—CYLINDER LINER HOLDING FIXTURE, in Section 05, Group 190 for assembly of holding fixture.

2. Use D17006BR Flexible Cylinder Hone to deglaze cylinder liner.

NOTE: Use honing oil along with flex hone when deglazing liners.



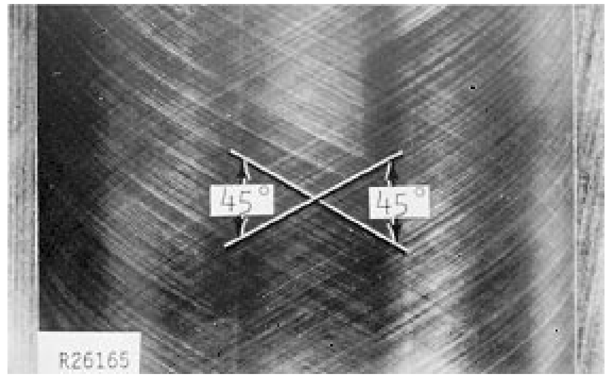
Deglazing Liners

Continued on next page

RG,RG34710,111 –19–30SEP97–1/2

3. Use D17006BR Hone according to instructions supplied with tool to obtain a 45° cross-hatch pattern.

Thoroughly clean liners after deglazing. (See CLEAN CYLINDER LINERS, next in this group.)



R26165 –UN–13DEC88

Liner Cross-hatch

RG,RG34710,111 –19–30SEP97–2/2

Clean Cylinder Liners

1. Use a stiff bristle brush to remove all debris, rust, and scale from OD of liners, under liner flange, and in O-ring packing areas. Make certain there are no nicks or burrs in areas where packings will seat.

IMPORTANT: Do not use gasoline, kerosene, or commercial solvent to clean liners. Solvents will not remove all the abrasives from liner walls.

2. Thoroughly clean liner ID with a 50 percent solution of hot water and liquid detergent.

3. Rinse thoroughly and wipe dry with a clean rag.

4. Swab out liner as many times as necessary with clean SAE 10W oil.

5. Clean liner until a white rag shows no discoloration.

RG,RG34710,112 –19–30SEP97–1/1

Cylinder Liner Manufacturing Date Code Explanation

A manufacturing four-digit date code will appear on each liner. For example, SJ96 15 means the liner has a non-hardened bore and was manufactured on the 15th day of October 1996.

Liner Date Code

SJ96 15

S .... Liner Material Type
J .... Month Liner was Manufactured
96 .... Year Liner was Manufactured
15 .... Day of Month Liner was Manufactured

Liner Material Specification:

S .... Non-Hardened Liner Bore
H .... Hardened Liner Bore

Month Liner was Manufactured

A .... January
B .... February
C .... March
D .... April
E .... May
F .... June
G .... July
H .... August
I .... September
J .... October
K .... November
L .... December

Year Liner was Manufactured:

96 1996
97 1997
etc.

RG,RG34710,113 –19–01NOV00–1/1

Disassemble Piston/Rod Assembly and Clean Piston

NOTE: Piston and ring sizes differ between engines. Piston part numbers are marked on top of pistons for identification.

Early Engines		
Engine	**Piston**	**Ring Size**
10.5 L	RE52836, RE504801	4 mm
12.5 L	RE66125	4 mm
Later Engines		
10.5 L	RE504343	3 mm
12.5 L	RE503969, RE505901	3 mm

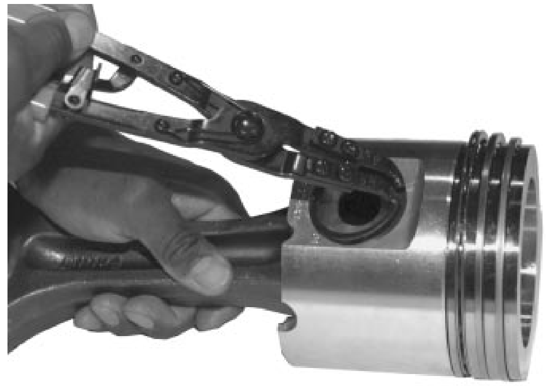
1. If necessary, check piston ring end gap prior to removing rings.

Specification

No. 1 Piston Compression Ring (4-mm Rings)—End Gap..................... 0.43—0.69 mm (0.017—0.027 in.)
No. 2 Piston Compression Ring (4-mm Rings)—End Gap..................... 1.01—1.27 mm (0.040—0.050 in.)
No. 1 Piston Compression Ring (3-mm Rings)—End Gap..................... 0.48—0.74 mm (0.019—0.029 in.)
No. 2 Piston Compression Ring (3-mm Rings)—End Gap..................... 1.35—1.65 mm (0.053—0.065 in.)

2. Remove piston snap rings. Remove piston pin and connecting rod from piston.

NOTE: Discard snap rings. DO NOT reuse.



RG8400 –UN–22MAY98

Removing Piston Pin Snap Ring

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RG,RG34710,114 –19–01NOV00–1/2

3. Remove piston rings (B) using the JDG967 Piston Ring Expander (A). Discard rings.

CAUTION: Always follow manufacturer's instructions, and safety steps exactly.

4. Clean piston ring grooves using a piston ring groove cleaning tool.

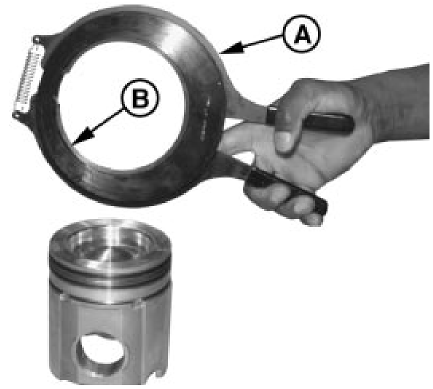
IMPORTANT: When washing pistons, always use a stiff bristle brush—NOT A WIRE BRUSH—to loosen carbon residue.

DO NOT bead blast ring groove areas.

5. Clean pistons by any of the following methods:

   - Immersion-Solvent "D-Part".
   - Hydra-Jet Rinse Gun.
   - Hot water with liquid detergent soap.

   If cleaning with hot water and liquid detergent, soak pistons in a 50 percent solution of liquid household detergent and hot water for 30 to 60 minutes. Use a stiff bristle brush—NOT A WIRE BRUSH—to loosen carbon residue. Dry with compressed air.



RG8367 –UN–09DEC97

Removing Piston Rings

A—JDG967 Piston Ring Expander
B—Piston Ring

RG,RG34710,114 –19–01NOV00–2/2

02
030
22

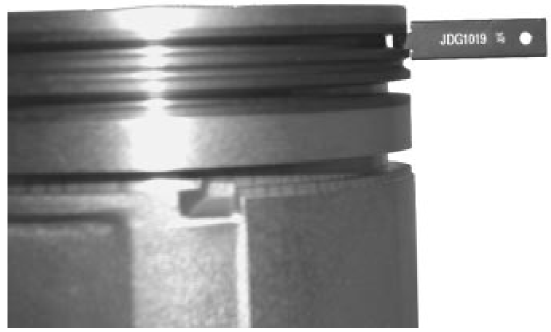
Check Piston Compression Ring Groove Wear—6105 Engines

NOTE: Earlier engines with RE52836 and RE504801 pistons have 4-mm compression rings. Later engines with RE504343 pistons have 3-mm compression rings. Piston part numbers are marked on top of pistons for identification.

Use the JDG1019 Ring Groove Wear Gauge on RE52836 and RE504801 pistons (early engines) to check wear of top two compression ring grooves. Use the JDG1335 Ring Groove Wear Gauge on RE504343 pistons (later engines) to check wear of top two compression ring grooves.

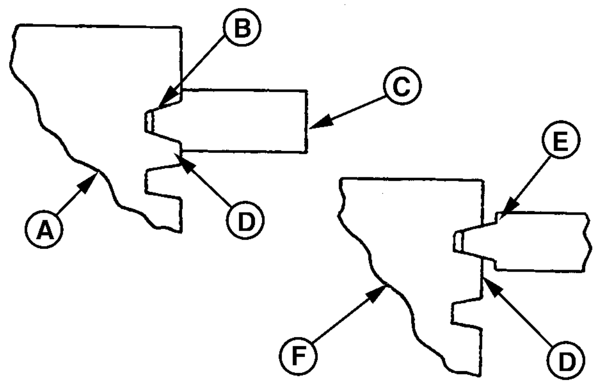
Check each groove at several locations.

Gauge shoulders should not contact ring land (D) of piston. If ring grooves are worn, replace piston and liner as a set. If ring grooves are good, proceed with piston inspection.



RG8373 –UN–21MAY98

Checking 6105 Piston Ring Groove (JDG1019 Shown on RE52836 Piston)



RGR24201 –UN–19NOV97

JDG1019 Ring Groove Wear Gauge Shown

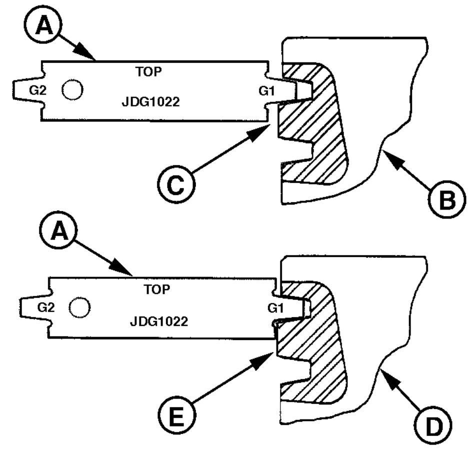
A—Piston with Worn Ring Groove
B—Keystone Ring Groove
C—JDG1019 Ring Groove Wear Gauge
D—Ring Land
E—Gauge Shoulder
F—Piston with Good Ring Groove

RG,RG34710,115 –19–01NOV00–1/1

Check Piston Compression Ring Groove Wear—6125 Engines

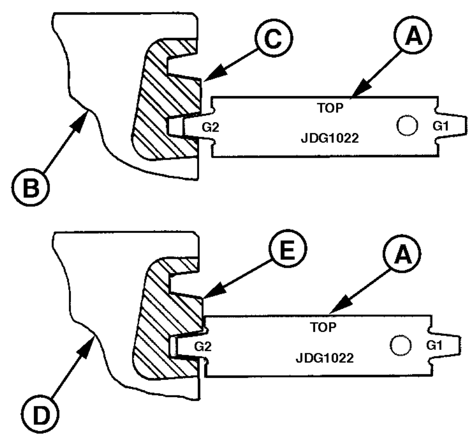
NOTE: *Earlier engines with and RE66125 pistons have 4-mm compression rings. Later engines with RE503969 and RE505901 pistons have 3-mm compression rings. Piston part numbers are marked on top of pistons for identification.*

The illustrations to the right shows use of JDG1022 Wear Gauge on earlier pistons. Use of JDG1335 on later pistons is similar except the two compression ring grooves are the same on these pistons and only one side of the gauge is used to check both.



RG8522 –UN–10DEC97

Using JDG1022 - Top Groove



RG8523 –UN–10DEC97

Using JDG1022 - Second Groove

A—JDG1022 Ring Groove Wear Gauge
B—Piston with Good Ring Groove
C—Acceptable Clearance
D—Piston with Worn Ring Groove
E—Gauge Shoulder Contacting Piston Ring Land

Check grooves at several locations around the circumference of piston crown. The word “TOP” on gauge should always face top of piston.

Earlier RE66125 Pistons with 4-mm Rings:

Use the JDG1022 Ring Groove Wear Gauge (A), end marked “G1”, to check wear of top compression ring groove.

Use end marked “G2” of JDG1022 Ring Groove Wear Gauge to check wear of middle compression ring groove.

If gauge shoulder contacts ring land of piston, ring groove is worn. Replace piston and liner as a set.

If ring grooves are good (B), proceed with piston inspection.

Later RE503969 and RE505901 Pistons with 3-mm Rings:

Use JDG1335 Ring Groove Wear Gauge to check wear of top two compression rings.

If gauge shoulder contacts ring land of piston, ring groove is worn. Replace piston and liner as a set.

If ring grooves are good (B), proceed with piston inspection.

RG,RG34710,116 –19–01NOV00–1/1

Check Piston Oil Control Ring Groove Wear—6105 and 6125 Engines

NOTE: Piston and ring sizes differ between engines. Piston part numbers are marked on top of pistons for identification.

Early Engines		
Engine	**Piston**	**Oil Control Ring Size**
10.5 L	RE52836, RE504801	4.8 mm
12.5 L	RE66125	4.8 mm
Later Engines		
10.5 L	RE504343	4 mm
12.5 L	RE503969, RE505901	4 mm

1. Check oil control ring-to-groove clearance by installing a new ring in groove.

2. Measure clearance with a feeler gauge at several points. Compare measurements with specifications given below.

Specification

Oil Control Ring-to-Groove (RE52836, RE504801, RE66125 Pistons)—Clearance.. 0.064—0.114 mm (0.0025—0.0045 in.)
Maximum Clearance.. 0.165 mm (0.0065 in.)
Oil Control Ring-to-Groove (RE504343, RE503969 and RE505901 Pistons)—Clearance................................... 0.041—0.091 mm (0.0016—0.0036 in.)
Maximum Clearance.. 0.132 mm (0.0052 in.)

NOTE: Replace piston and liner (as a set) if oil control ring clearance exceeds specifications given.

Measuring Oil Control Ring Groove Wear

RG,RG34710,117 –19–01NOV00–1/1

Inspect Piston Pin and Pin Bore in Piston

NOTE: Piston pin must be in good condition and not worn beyond specification given below.

1. Dip piston pin in clean engine oil.

NOTE: On 6125 engines, assemble piston crown and skirt.

2. Install pin (A) through piston.

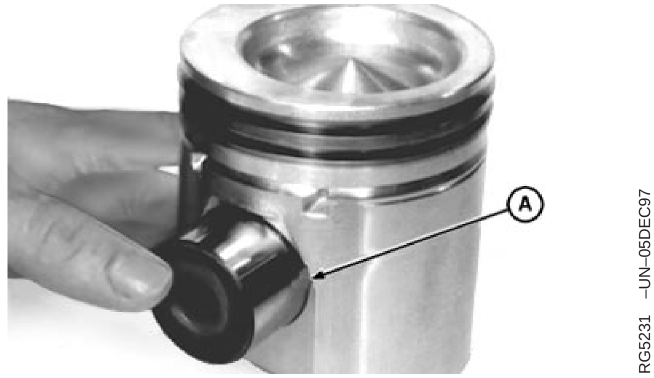
   Pin should pass through piston using only light thumb pressure.

3. Check taper in piston pin bore by inserting pin from both sides. If pin enters freely, but binds in the center, the bore could be tapered (B).

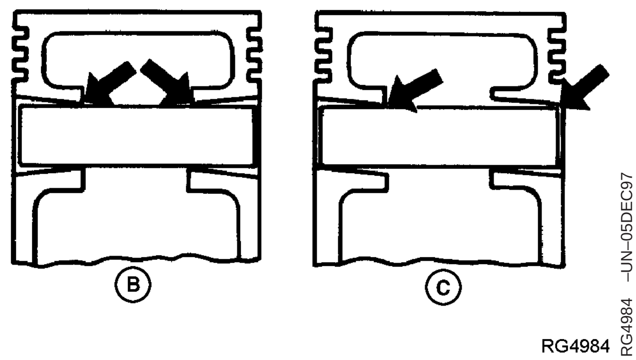
4. Insert pin in piston to check for bore alignment. Pin should not “click” or need to be forced into bore on opposite side (C).

5. Measure piston pin and piston bore and compare to specifications. If either are not within specification, replace pin, piston, and liner.

Specification	
Piston Pin—OD	50.772—50.787 mm (1.9989—1.9995 in.)
Piston Pin Bore in Piston (6105)—ID	50.795—50.805 mm (1.9998—2.0002 in.)
Piston Skirt Bushing (6125)—ID	50.798—50.808 mm (1.9999—2.0003 in.)
Piston Crown Bushing (6125)—ID	50.810—50.825 mm (2.0004—2.0010 in.)



Installing Piston Pin



Piston Pin Bore Inspection

A—Pin
B—Tapered Bore
C—Opposite Side of Bore

RG,RG34710,118 –19–13AUG99–1/1

Determine Piston-to-Liner Clearance

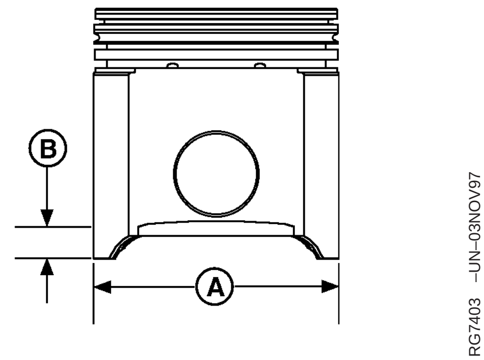
1. Measure 6105 skirt OD (B) at right angles to piston pin bore, 29.97 mm (1.180 in.) from the bottom of the piston (A).

2. Measure 6125 engine skirt OD at right angles to piston pin bore, 35.0 mm (1.38 in.) from bottom of skirt.

3. Record measurement and compare measurement obtained from matching liner.

Specification

Piston Skirt (6105)—OD 29.97 mm (1.180 in.) from Bottom of Piston	126.872—126.898 mm (4.9950—4.9960 in.)
Piston Skirt (6125)—OD 35.0 mm (1.380 in.) from Bottom of Skirt	126.910—126.930 mm (4.9965—4.9972 in.)



Measuring Piston Skirt

A—Bottom of Piston Dimension
B—6105 Skirt OD

Continued on next page

RG,RG34710,119 –19–13AUG99–1/2

IMPORTANT: ALWAYS measure liners at room temperature.

4. Measure liner bore parallel to piston pin at top end of ring travel (A).

5. Measure bore in same position at bottom end of ring travel (B).

6. Measure bore at right angle to piston pin at top end of ring travel (C).

7. Measure bore in same position at bottom end of ring travel (D).

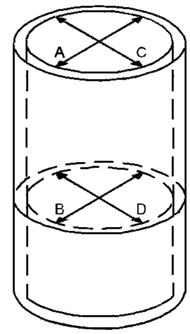
8. Compare measurements A, B, C, and D to determine if liner is tapered or out-of-round.

9. Compare liner ID with matched piston OD.

Specification

Cylinder Liner—ID	126.990—127.010 mm (4.9996—5.0004 in.)
Max. Out of Round	0.020 mm (0.0008 in.)
Max. Wear or Taper (Ring Travel Area)	0.030 mm (0.0012 in.)
Piston-to-Liner Clearance (New Part 6105)—Clearance	0.092—0.138 mm (0.0036—0.0054 in.)
Max. Acceptable Wear	0.152 mm (0.0060 in.)
Piston-to-Liner Clearance (New Part 6125)—Clearance	0.060—0.100 mm (0.0024—0.0039 in.)
Max. Acceptable Wear	0.152 mm (0.0060 in.)

Replace piston and liners (as a set) if they exceed wear specifications given.



Measuring Liner ID

RG10049 –UN–07JAN03

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030
27

RG,RG34710,119 –19–13AUG99–2/2

Measure Liner Flange Thickness

Measure cylinder liner flange thickness at several locations and compare with specification given below.

If liner flange is not within specification, use liner shims or replace piston and liner as a set.

Specification

Cylinder Liner Flange—Thickness .... 9.525—9.575 mm (0.3750—0.3770 in.)


RG8199 –UN–21MAY98

Measuring Liner Flange Thickness

RG,RG34710,120 –19–30SEP97–1/1

Inspect and Measure Connecting Rod Bearings

Inspect rod bearings for damage of wear.

IMPORTANT: Never use new connecting rod cap screws when checking rod bearing ID. Use new cap screws only for final assembly of connecting rods.

Rod bearing-to-journal oil clearance can be checked with PLASTIGAGE®, if rod is connected to crankshaft. If rod is out of engine, measure ID of connecting rod bearings and compare with OD of crankshaft journal.

NOTE: Use PLASTIGAGE® as directed by the manufacturer. The use of PLASTIGAGE® will determine bearing journal clearance, but will not indicate the condition of either surface.

1. With crankshaft removed, measure connecting rod journal OD at several points.

2. Install connecting rod cap (A) on rod (B) with bearings (C) in correct position.

3. **On tongue-and-groove connecting rods**: Initially tighten blind-hole cap screw, then, tighten open-hole cap screw to the following specifications.

Specification

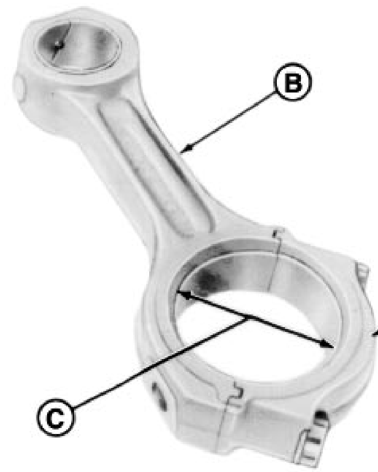
Tongue-and-Groove Connecting Rod Cap Screw—Initial Torque	27 N•m (20 lb-ft)

Next, tighten rod cap screws to the following specifications.

Specification

Tongue-and-Groove Connecting Rod Cap Screw—Final Torque	75 N•m (55 lb-ft) plus 90—100° turn clockwise

(See TORQUE-TURN CONNECTING ROD CAP SCREWS, later in this group.)



Assembled Rod with Bearing

A—Rod Cap
B—Rod
C—Bearings

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Continued on next page

4. **On PRECISION JOINT™ connecting rods**: Initially tighten rod cap screw closest to piston end, then tighten other cap screw to the following specifications.

Specification

PRECISION JOINT™ Connecting
Rod Cap Screw—Torque .... 140 N•m (103 lb-ft) plus 90—100° turn clockwise

(See TORQUE-TURN CONNECTING ROD CAP SCREWS, later in this group.)

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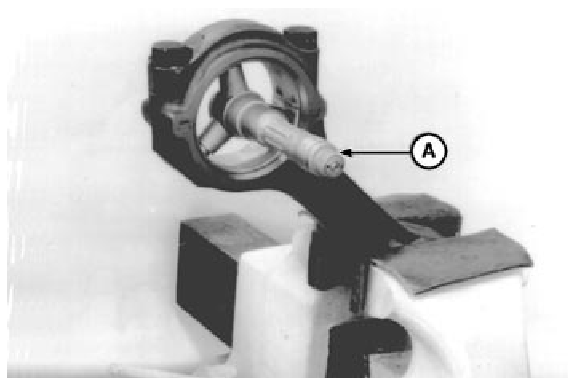
RG,RG34710,121 –19–13AUG99–2/3

5. Using an inside micrometer (A), measure assembled ID of bearing.

6. Subtract OD of each crankshaft journal from ID of each respective rod bearing to obtain oil clearance.

7. Compare measurements with the specifications given.



RG3824 –UN–04DEC97

Measuring Assembled Rod Bearing ID

A—Inside Micrometer

Specification

Crankshaft Rod Journal—OD.................................... 88.844—88.874 mm (3.4980—3.4990 in.)
Connecting Rod Bearing for Crankshaft Journal (Assembled)—ID .... 88.93—88.98 mm (3.501—3.502 in.)
Connecting Rod Bearing-to-Journal (New Part)—
Oil Clearance....................................... 0.06—0.13 mm (0.002—0.005 in.)
Max. Oil Clearance... 0.15 mm (0.006 in.)

8. Inspect connecting rod bearings for wear or damage. If bearings are worn or not within specification, replace both connecting rod bearing and rod pin bearing.

RG,RG34710,121 –19–13AUG99–3/3

Inspect Connecting Rod and Cap

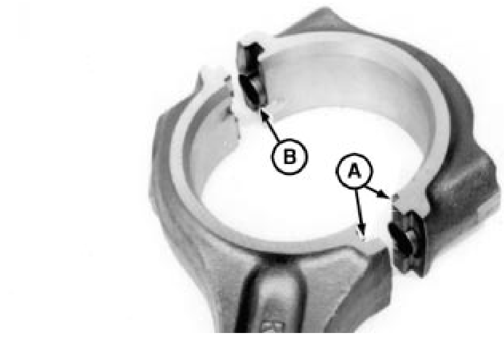
1. Inspect rod and cap for wear or damage, such as chips or nicks in the joint areas (A).

IMPORTANT: DO NOT nick the joint surfaces of rod and cap. This is very critical on PRECISION JOINT™ rods to ensure proper seating. Never scrape joint surfaces (C) with a wire brush or other tool; the interlocking mating surfaces must be preserved, and remain free of any debris.

Rod cap MUST be kept with parent rod.

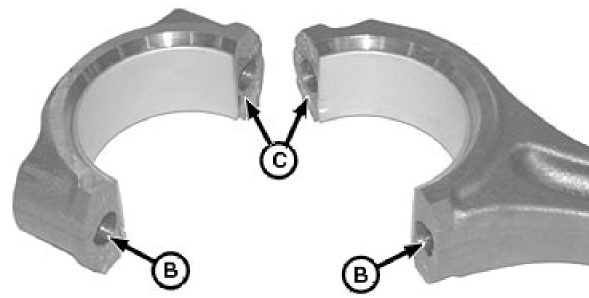
2. Inspect in and around cap screw holes (B) in cap. If any defects are found, replace rod and cap.

IMPORTANT: If replacing a connecting rod, use the same type of joint design. DO NOT intermix PRECISION JOINT™ rods and tongue-and-groove rods on the same engine. See parts catalog for recommendations.



RG3749 –UN–04DEC97

Tongue-and-Groove Rod and Cap



RG10301 –UN–27AUG99

PRECISION JOINT™ Rod and Cap

A—Tongue-and-Groove Joints
B—Cap Screw Hole
C—PRECISION JOINT™ Mating Surfaces

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Continued on next page RG,RG34710,122 –19–02AUG99–1/4

3. Carefully clamp rod in a soft-jawed vise (cap end upward).

IMPORTANT: Never use new connecting rod cap screws when checking rod bearing ID. Use new cap screws only for final assembly of connecting rods.

4. Install cap WITHOUT bearing inserts.

5. **On tongue-and-groove connecting rods**: Initially tighten blind-hole cap screw, then, tighten open-hole cap screw to the following specifications.

Specification

Tongue-and-Groove Connecting
Rod Cap Screw—Initial Torque...................................... 27 N•m (20 lb-ft)

Next, tighten rod cap screws to the following specifications.

Specification

Tongue-and-Groove Connecting
Rod Cap Screw—Final Torque .... 75 N•m (55 lb-ft) plus 90—100° turn clockwise

(See TORQUE-TURN CONNECTING ROD CAP SCREWS, later in this group.)

6. **On PRECISION JOINT™ connecting rods**: Initially tighten rod cap screw closest to piston end, then tighten other cap screw to the following specifications.

Specification

PRECISION JOINT™ Connecting
Rod Cap Screw—Torque .... 140 N•m (103 lb-ft) plus 90—100° turn clockwise

(See TORQUE-TURN CONNECTING ROD CAP SCREWS, later in this group.)

RG4982 –UN–05DEC97

Assembled Rod Without Bearings

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RG,RG34710,122 –19–02AUG99–2/4

7. Using an inside micrometer, measure rod bore at center of bore and record measurements as follows:

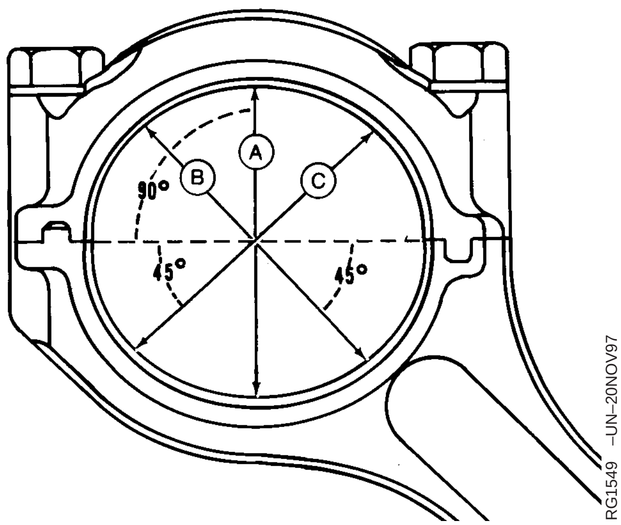
   - (A) At right angle to rod/cap joint.
   - (B) At 45 degrees left of measurement (A).
   - (C) At 45 degrees right of measurement (A).

8. Compare the measurements.

Specification

Connecting Rod Bore (For Crankshaft Journal Bearing)—ID .... 93.76—93.79 mm (3.6915—3.6925 in.)

If difference between the greatest and least measurement is more than 0.038 mm (0.0015 in.), the rod and cap are out of round. Replace both connecting rod and cap.



Measuring Assembled Rod Bore

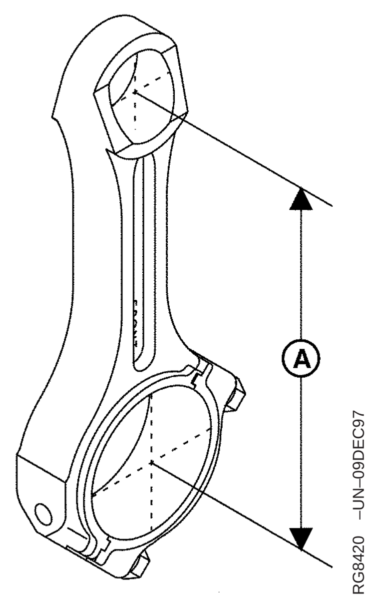
RG,RG34710,122 –19–02AUG99–3/4

9. Measure rod's piston pin bore-to-crankshaft bore center-to-center dimension (A) and compare with specification given. If measurement is not within specification, replace rod.

Specification

Connecting Rod Centerline of Piston Pin Bore-to-Crankshaft Bore (New Part)—Dimension.................................... 263.95—264.05 mm (10.392—10.396 in.)

A—Rod's Piston Pin Bore-to-Crankshaft Bore Center-to-Center Dimension



Measuring Rod Center-to-Center Bores

RG,RG34710,122 –19–02AUG99–4/4

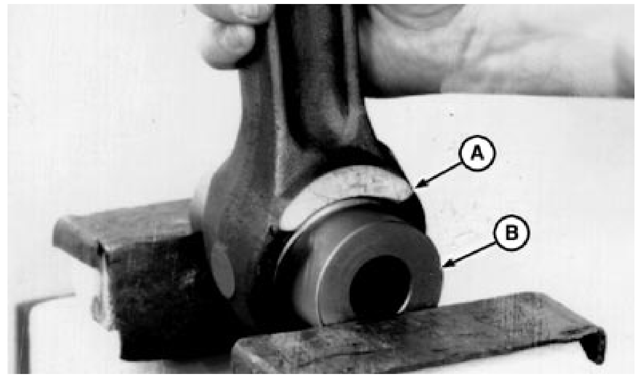
Inspect Piston Pins and Rod Bushings

1. Insert piston pin (B) through piston pin bushing and carefully clamp in a soft-jawed vise.

2. Rotate connecting rod (A) back and forth several times to make sure connecting rod moves freely on piston pin.

3. Remove piston pin from connecting rod.

A—Connecting Rod
B—Piston Pin



Installing Piston Pin in Rod Bushing

Continued on next page RG,RG34710,123 –19–13AUG99–1/2

4. Insert pin from either side of rod bushing. If pin is free on one end, but tight on the other, the bore could be tapered (A). If pin enters freely from both sides, but is tight in the center, bore is bell-mouthed (B).

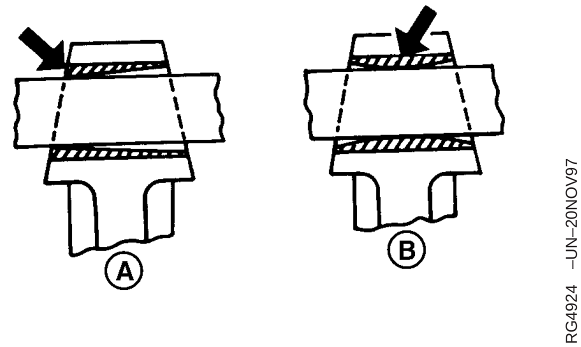
5. Inspect piston pin bushing lubrication hole in rod for damage, excessive wear or contaminants.

6. Measure pin bushing ID for specified clearance.

Specification

Piston Pin—OD	50.772—50.787 mm (1.9989—1.9995 in.)
Rod Pin Bore Without Bushing—ID	55.529—55.555 mm (2.1862—2.1872 in.)
Installed Rod Pin Bushing (Before Boring)—ID	50.729—50.781 mm (1.9972—1.9992 in.)
Installed Rod Pin Bushing (After Boring)—ID	50.805—50.830 mm (2.0002—2.0012 in.)
Piston Pin Bushing Bore—Out-of-Round	0.038 mm (0.0015 in.)
Piston Pin-to-Bushing—Oil Clearance	0.017—0.059 mm (0.0007—0.0023 in.)
Max. Acceptable Wear	0.076 mm (0.0030 in.)
Press Fit of Bushing in Rod Pin Bore—Press Fit	0.100—0.163 mm (0.0039—0.0064 in.)

7. If necessary, remove and replace piston pin bushing. (See REMOVE PISTON PIN BUSHING, CLEAN, AND INSPECT BUSHING BORE in this group.)



Inspecting Rod Piston Pin Bushing Bore

A—Tapered Bore
B—Bell-Mouthed Bore

RG,RG34710,123 –19–13AUG99–2/2

Remove Piston Pin Bushing, Clean, and Inspect Bushing Bore

IMPORTANT: Do not use pneumatic tools to remove or install piston pin bushing.

Use care to properly align the JDE98-10 Bushing Remover/Installer (B) with bushing so that the connecting rod is not damaged.

1. Remove the used bushing with JDE98-8 Cup (A), JDE98-10 Bushing Remover/Installer, and STD36104 Forcing Screw (C) from the JDE98A Connecting Rod Bushing Service Set.

2. Clean rod bushing bore using a medium grit emery cloth, as burrs will distort bushing. Install bushing on side opposite rod burr.

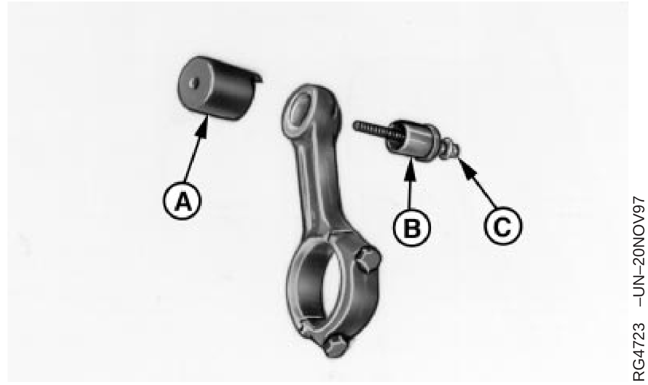
3. If necessary, file a slight chamfer around bushing bore to remove any sharp edges. Chamfer will also aid in bushing installation.

4. Measure rod bushing bore in three or more places approximately 45° apart.

Specification

Connecting Rod Pin Bushing Bore (Without Bushing)—ID	55.529—55.555 mm (2.1862—2.1872 in.)
Connecting Rod Pin Bushing—Press Fit in Rod Pin Bore	0.100—0.163 mm (0.0039—0.0064 in.)

IMPORTANT: If piston pin bushing bore diameter is not within specification or bushing has spun in rod, discard rod and replace with a new one.

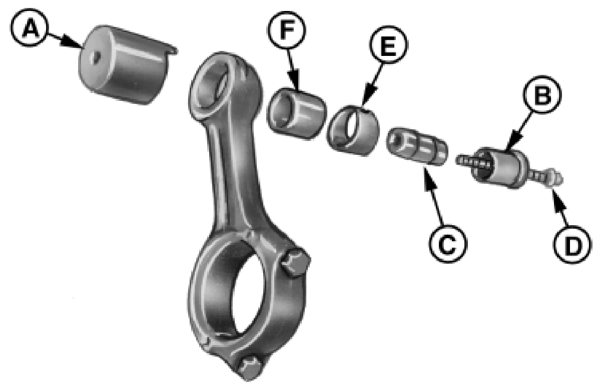


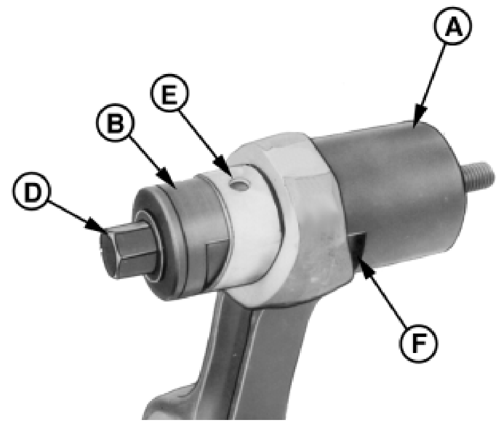
Removing Rod Piston Pin Bushing

A—JDE98-8 Cup
B—JDE98-10 Bushing Remover/Installer
C—STD36104 Forcing Screw

RG,RG34710,124 –19–30SEP97–1/1

Install Piston Pin Bushing





Installing Rod Piston Pin Bushing

A—JDE98-8 Cup[1]
B—JDE98-10 Bushing Remover/Installer[1]
C—JDE98-9 Pilot[1]
D—STD36104 Forcing Screw[1]
E—Bushing
F—JDE98-6 Pilot[1]

1. Lubricate connecting rod bore with clean engine oil.

IMPORTANT: Do not use power tools to install bushing.

2. Assemble JDE98-10 Bushing Remover/Installer (B) with JDE98-9 Pilot (C). Install new bushing (E) onto driver. Lubricate OD of bushing. Install and lubricate STD36104 Forcing Screw threads (D).

3. Assemble JDE98-6 Pilot (F) onto driver.

4. Engage forcing screw heads with threads in JDE98-8 Cup (A) and install new bushing.

IMPORTANT: Boring the connecting rod bushing should be done ONLY by experienced personnel on equipment capable of maintaining bushing finish specification.

5. Precision bore new bushing to specification to obtain pin-to-bushing clearance. Remove all debris from boring operation.

Specification

Piston Pin Bushing (After Boring)—ID	50.805—50.830 mm (2.0002—2.0012 in.)
Piston Pin—OD	50.772—50.787 mm (1.9989—1.9995 in.)
Piston Pin-to-Bushing—Clearance	0.017—0.059 mm (0.0007—0.0023 in.)

[1] *From JDE98A Connecting Rod Bushing Service Set.*

RG,RG34710,125 –19–30SEP97–1/1

Complete Disassembly of Cylinder Block (If Required)

If complete inspection and “Hot Tank” cleaning of cylinder block is required, refer to the appropriate group for removal of all external and internal mounted components listed below:

1. Remove crankshaft and pulley if not previously removed. (See REMOVE CRANKSHAFT in Group 040.)

2. Remove coolant pump and all remaining cooling system components. (See REMOVE COOLANT PUMP in Group 070.)

3. Remove timing gear cover. (See REMOVE TIMING GEAR COVER in Group 040.). Remove front plate. (See REMOVE AND INSTALL CYLINDER BLOCK FRONT PLATE earlier in this group.)

4. Remove engine oil pump and all remaining lubrication system components. (See REMOVE ENGINE OIL PUMP in Group 060.)

5. Remove all components (water gallery plugs, oil gallery plugs, bushings, and engine serial number plate) before inspecting and cleaning cylinder block. Use JDG782 Oil Gallery Plug Tool to remove and install gallery plugs.

RG,RG34710,126 –19–02AUG99–1/1

Inspect and Clean Cylinder Block

NOTE: All components, water gallery plugs, and oil gallery plugs must be removed from the cylinder block for inspection and cleaning. Refer to the proper group for removal of all external and internal mounted components.

1. Use D17015BR O-Ring Groove Cleaning Brush or an equivalent brush to thoroughly clean all debris from cylinder liner O-ring bores.

2. Remove cylinder head locating dowels, if not previously removed. Clean out all threaded holes for cylinder head mounting cap screws in top deck of cylinder block. Use JDG978 Tap or an equivalent M16 x 2.0 tap approximately 152.4 mm (6.0 in.) long. Use compressed air to remove any debris or fluid which may be present in the cap screw hole.

IMPORTANT: If cylinder block is cleaned in a hot tank, be sure to remove any aluminum parts. Aluminum parts can be damaged or destroyed by hot tank solutions. Remove all serial number plates.

3. Clean block thoroughly using cleaning solvent, pressure steam, or a hot tank.

Cleaning Head Bolt Threads in Block

Continued on next page RG,RG34710,127 –19–09SEP99–1/2

NOTE: JDG1145 Cylinder Liner Service Set (D) can be used with lapping compound, as shown, to lap liner flange to block counterbore.

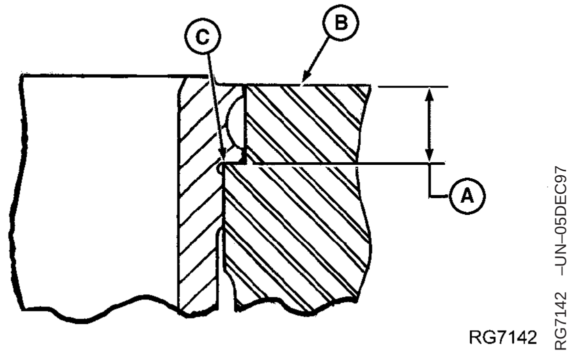
4. Inspect liner support flange (C) for burrs. If burrs are present, use respective liner with lapping compound to remove burrs.

5. Measure liner flange counterbore depth (A) in block (B) and flange thickness on liner. Compare with specification given below.

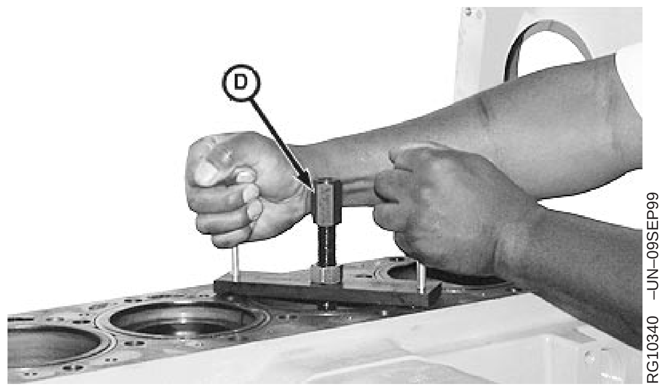
Specification

Cylinder Liner Flange Counterbore—Depth in Block	9.461—9.512 mm (0.3725—0.3745 in.)
Cylinder Liner Flange—Thickness	9.525—9.575 mm (0.3750—0.3770 in.)

6. Carefully inspect block for cracks or any other physical damage. If a cracked block is suspected, pressure-test the block. A procedure for pressure testing is outlined in FOS (Fundamentals of Service) Manual—Engines. Replace block if there is evidence of a crack or physical damage.



Liner Counterbore Depth



Lap Liner Flange

A—Liner Flange Counterbore Depth
B—Block
C—Liner Support Flange
D—JDG1145 Liner Service Set

RG,RG34710,127 –19–09SEP99–2/2

Measure Cylinder Block

Refer to the appropriate groups for a more detailed description of the features being measured. Compare measurements with specifications given below.

1. Assemble and measure main and thrust bearing bores. Compare measurements with specifications given below:

Specification

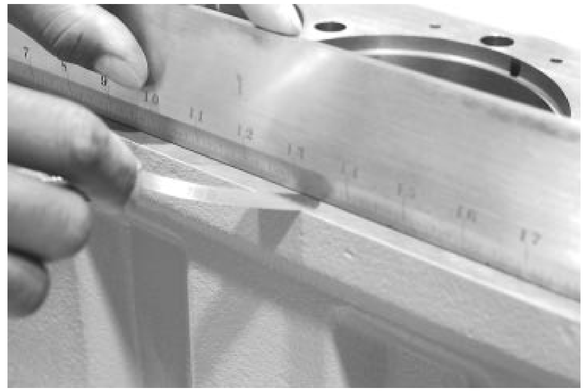
Main and Thrust Bearings—
Assembled ID Without Bearings .... 133.097—133.123 mm (5.2400—5.2410 in.)
Main Bearing Surface Width .... 37.77—38.03 mm (1.487—1.497 in.)
Thrust Bearing Surface Width
(No. 5 Main) .... 37.51—38.29 mm (1.476—1.507 in.)
Overall Thrust Bearing Cap Width .... 43.25—43.75 mm (1.703—1.722 in.)

If any main or thrust bearing cap assembled ID is not within specification, blank (generic) bearing caps are available and must be line bored to specification by a qualified machine shop. (See MEASURE ASSEMBLED ID OF MAIN BEARING CAPS in Group 040.)

2. Measure cylinder block top deck flatness using D05012ST Precision Straightedge and feeler gauge. Resurface as required.

Specification

Cylinder Block Top Deck Surface
Finish—Surface Finish (Surface
Mill Only)... 3.2 micrometers (125 micro-in.)
Max. Wave Height... 0.008 micrometers (0.0002 micro-in.)
Max. Wave Depth....................................... 2.0 micrometers (79 micro-in.)
Main Bearing Bore
Centerline-to-Top Deck—
Minimum Distance... 429.92—430.07 mm (16.926—16.932 in.)


RG8208 –UN–21MAY98

Measuring Block Top Deck Flatness

Continued on next page RG,RG34710,128 –19–03AUG99–1/2

IMPORTANT: The centerline of the main bearing bore-to-top deck of cylinder block MUST be 429.92–430.07 mm (16.926–16.932 in.). If not, replace cylinder block.

3. Measure cylinder liner bores in block and compare to the following specifications.

Cylinder Block Bore for Seating Liner—Specification

Liner Flange Counterbore—ID	153.57—153.77 mm (6.046—6.054 in.)
Upper Block Bore for Seating Liner—ID	145.845—145.895 mm (5.7419—5.7439 in.)
Lower Block Bore for Seating Liner—ID	140.465—140.515 mm (5.5301—5.5321 in.)

RG,RG34710,128 –19–03AUG99–2/2

Recheck Cylinder Liner Standout (Height Above Block)

NOTE: If a new liner assembly is being installed in a new or used cylinder block, liner standout must be checked.

Be sure liner bore in cylinder block (B) and top deck of cylinder block are clean.

1. Install liners without O-rings and square packing. Secure with cap screws and washers, as outlined earlier in this group. (See REMOVE PISTONS AND CONNECTING RODS in this group.)

NOTE: Install liner with the identifying mark toward the front of the engine. Rotate 90° if pits or erosion exceed limits outlined during liner inspection.

2. Measure liner standout. (See MEASURE CYLINDER LINER STANDOUT earlier in this group.)

Specification

Cylinder Liner Standout—Height
Above Block .... 0.030—0.117 mm (0.0012—0.0046 in.)

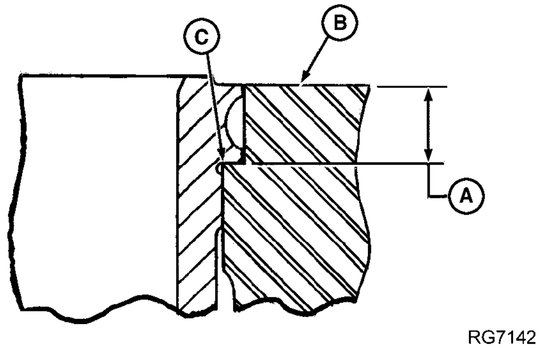
If liner standout is above specification, recheck liner support flange (C) for possible remaining burrs or incorrect counterbore depth (A) in block. If burrs are present, use respective liner and lapping compound to remove burr. Completely clean cylinder liner bore after lapping.

IMPORTANT: ONE LINER SHIM ONLY may be installed under any given liner flange.

If liner standout is below specifications, remove liner and install shim as needed to bring liner standout to within specification.

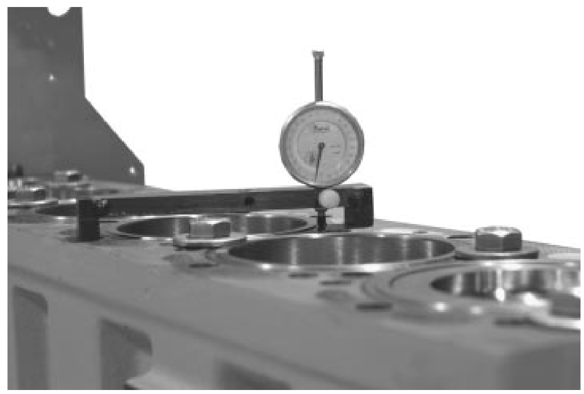
Specification

Cylinder Liner Shims Available—
Thickness.. 0.05 mm (0.002 in.)
Thickness.. 0.10 mm (0.004 in.)



RG7142 –UN–05DEC97

Liner Counterbore Depth



RG8329 –UN–21MAY98

Measuring Liner Standout

A—Liner Flange Counterbore Depth
B—Block
C—Liner Support Flange

RG,RG34710,129 –19–30SEP97–1/1

Install Cylinder Liner O-Rings and Packings

NOTE: Piston and liner sets differ between engines. DO NOT mix piston and liner sets. See parts catalog for correct applications.

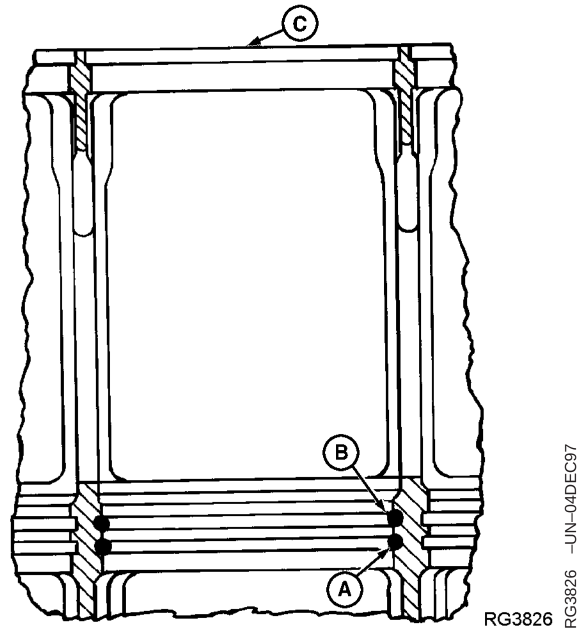
IMPORTANT: DO NOT use oil on cylinder liner packing or O-rings. Oil can cause the red packing to swell, which squeezes liner and could possibly cause a scored piston.

1. Pour AR54749 Soap Lubricant into a suitable container.

2. Dip new packings and O-rings in soap before installation. Do not leave packings or O-rings in soap to soak.

3. Install the black viton O-ring (A) in the lower O-ring groove of the cylinder block (C).

4. Install the red silicone O-ring (B) in the upper O-ring groove of the cylinder block.



Liner O-Rings and Packing

A—Black Viton O-Ring
B—Red Silicone O-Ring
C—Cylinder Block

RG,RG34710,130 –19–01NOV00–1/2

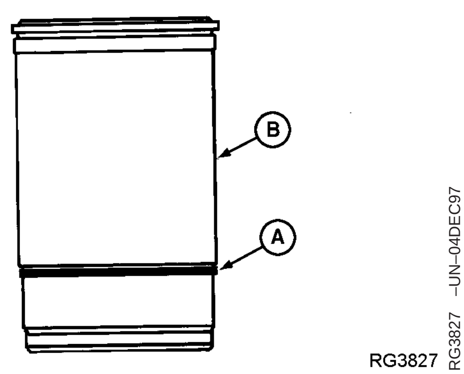
5. Turn cylinder liner (B) upside-down and install the neoprene square packing (A) over outside of liner.

6. Slide packing down firmly against second shoulder on the liner.

NOTE: Make sure the packing is not twisted.

7. Coat the liner packings, sealing area of the cylinder liner, and cylinder block O-rings with liquid soap.

A—Neoprene Square Packing
B—Cylinder Liner



Install Square Packing on Liner

RG,RG34710,130 –19–01NOV00–2/2

Install Cylinder Liners

NOTE: Piston and liner sets differ between engines. DO NOT mix piston and liner sets. See parts catalog for correct applications.

IMPORTANT: Install cylinder liner into same cylinder block bore as removed. DO NOT scuff the packing across the upper bore.

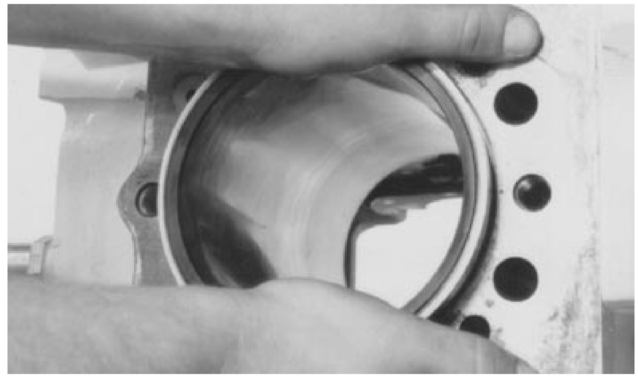
When liner ODs are pitted or eroded and are under one-half the liner thickness, rotate liners 90° from their removed position. Rotate the pitted section of the liner toward either the front or rear of the engine.

If liners are not pitted or eroded, rotation will not be necessary. Install liners with the identifying mark (stamped on flange), toward the front of the engine.

1. Carefully place the cylinder liner, with packing installed, into the cylinder block bore.

NOTE: A resistance will be felt when cylinder liner is aligned in pilot bore.

2. Using only the pressure of both palms, the cylinder liner should drop to a point nearly flush at the upper flange of the cylinder liner and cylinder block.



RG2772 –UN–04DEC97

Installing Liner

Continued on next page

RG,RG34710,131 –19–01NOV00–1/2

NOTE: Cylinder liner will protrude over top of cylinder block more than normal due to uncompressed packings and O-rings.

3. Finish seating cylinder liners using a clean hardwood block and hammer as shown in top figure or by using JDG1145 Liner Service Set (B) and a 2.27 kg (5 lb) slide hammer (A) shown in lower figure.

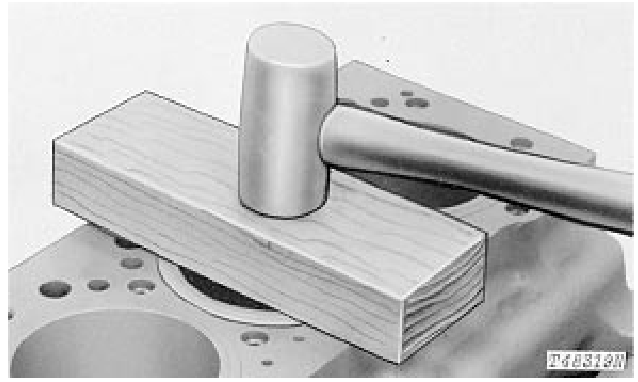
   Using either method, apply only enough force as necessary to seat liners.

IMPORTANT: If you suspect that a packing may have sheared or displaced during liner installation, remove liner and packing assembly. If no damage is found, check packing and O-rings for proper position. Resoap packings and reinstall liner assembly.

4. Hold liners in place with large flat washers and cap screws. Turn cap screws snug, but do not tighten.

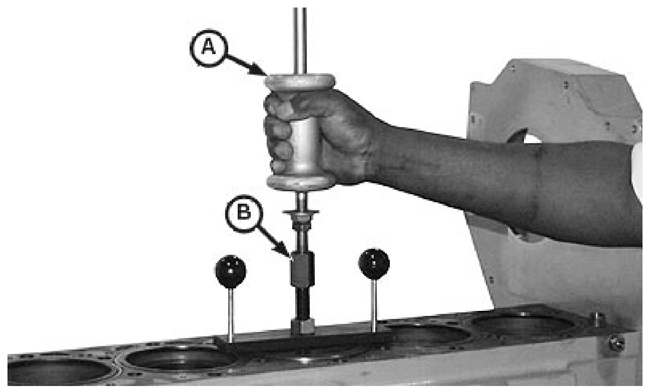
5. Clean cylinder liner bores with waterless hand cleaner after installation. Wipe dry with clean towels.

6. Apply clean engine oil to liner bores immediately to prevent corrosion.



T48319 –UN–23FEB89

Seating Liner



RG10342 –UN–10SEP99

JDG1145 Liner Service Set

A—Slide Hammer
B—Liner Service Set

RG,RG34710,131 –19–01NOV00–2/2

Assemble Pistons and Connecting Rods

NOTE: Piston and liner sets differ between engines. DO NOT mix piston and liner sets. See parts catalog for correct applications.

IMPORTANT: Pistons must be installed on same connecting rods from which they were removed and NEW piston pin snap rings must be used.

If a new piston and liner assembly is to be installed, DO NOT remove piston from liner. Push piston out of liner bottom only far enough to install piston pin.

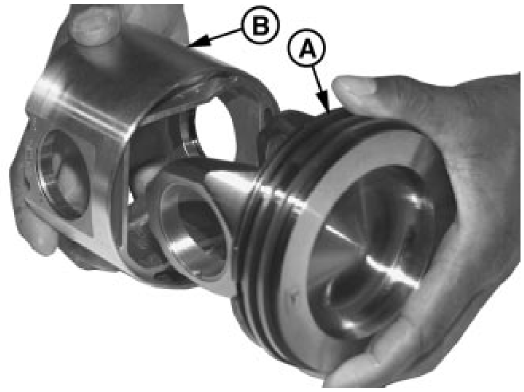
1. On 6125 engines, assemble piston crown (A) and skirt (B) so that connecting rod pin bushings are aligned.

2. Lubricate piston pin and bushings with clean engine oil.

NOTE: Pistons are symmetrical; new pistons can be installed either way. If pistons are being reused, align front reference mark made during disassembly with front of connecting rod.

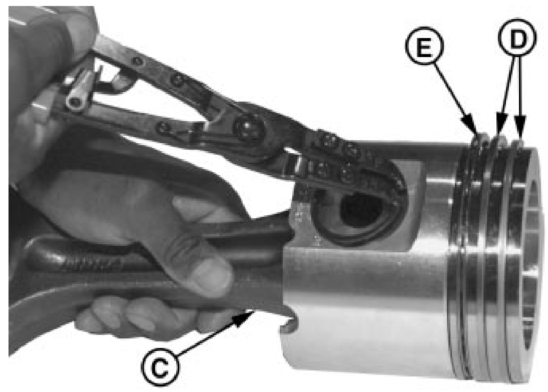
3. Install piston pin through piston and connecting rod (C).

4. Install NEW piston pin snap rings in grooves. Make certain snap rings have completely expanded in grooves of piston. Sharp edge of snap ring MUST face toward outside of piston.



RG8401 –UN–09DEC97

6125 Piston Crown and Skirt



RG8400A –UN–22MAY98

Assembling Piston and Rod

A—Piston Steel Crown (6125 Engine)
B—Piston Skirt (6125 Engine)
C—Connecting Rod
D—Compression Rings (2 used)
E—Oil Control Ring

Continued on next page RG,RG34710,132 –19–01NOV00–1/2

NOTE: Keystone compression ring with one "Pip" mark goes in top piston ring groove and keystone ring with two "Pip" marks goes in second ring groove of piston. "Pip" mark(s) must face top of piston.

IMPORTANT: Pistons and ring sets differ between engines. Piston part numbers are marked on top of pistons for identification. Ensure correct size rings are installed on appropriate pistons. DO NOT intermix rings.

Early Engines			
Engine	**Piston**	**Compression Ring Size**	**Oil Control Ring Size**
10.5 L	RE52836, RE504801	4 mm	4.8 mm
12.5 L	RE66125	4 mm	4.8 mm
Later Engines			
10.5 L	RE504343	3 mm	4 mm
12.5 L	RE503969, RE505901	3 mm	4 mm

5. Use the JDG967 Ring Expander to install compression rings (D) and oil control ring with expander ring (E).

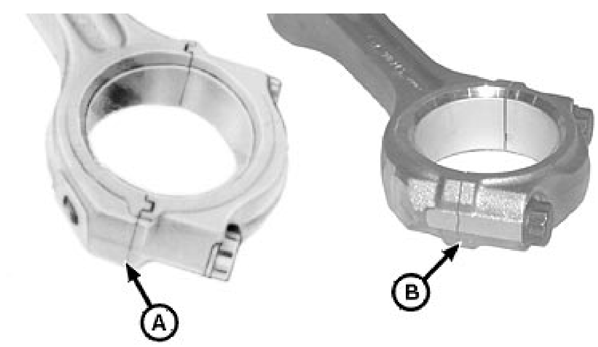
RG,RG34710,132 –19–01NOV00–2/2

Install Pistons and Connecting Rods

IMPORTANT: Replace rods with the same type. Do Not mix tongue-and-groove with PRECISION JOINT™ rods in the same engine. See parts catalog for recommendations.

Earlier engines have the traditional tongue-and-groove between the connecting rod and cap (A). Later engines have the PRECISION JOINT™ rod and cap (B).

Both types of rods provide a strong joint. Installation is similar, with differences noted, including different torque specifications for cap screws.



RG10300 –UN–27AUG99

Connecting Rods

A—Tongue-and-Groove Rod (Early Engines)
B—PRECISION JOINT™ Rod (Later Engines)

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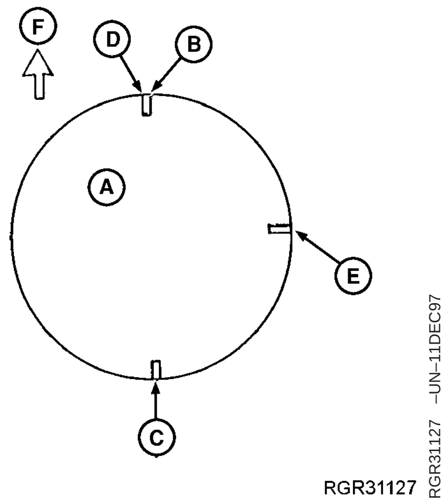
Continued on next page

RG,RG34710,133 –19–26AUG02–1/6

1. Stagger ring gaps on pistons as shown.

A—Piston Head
B—Top Compression Ring Gap
C—Oil Control Ring Gap
D—Expander Ring Gap
E—Bottom Compression Ring Gap
F—Front of Engine



Staggering Piston Ring Gaps

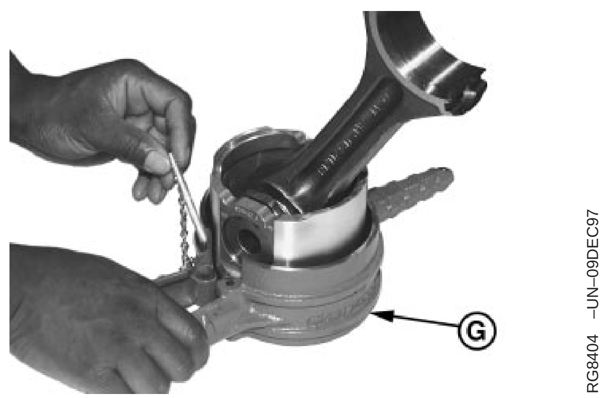
RG,RG34710,133 –19–26AUG02–2/6

2. Coat pistons, liners, and inside of JDG1017 Piston Ring Compressor (G) with clean engine oil.

3. Lay piston rod assembly on piston's top and compress rings with compressor. Squeeze handles together and install pin to full depth to secure.

4. Lubricate rod bearing half and install onto rod with notches on bearing seated with notch in rod.

G—JDG1017 Ring Compressor



Compressing Piston Rings

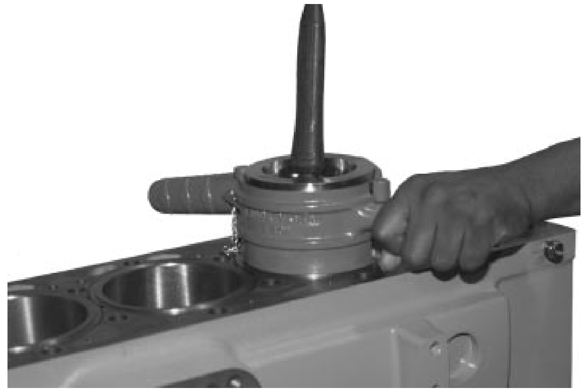
Continued on next page RG,RG34710,133 –19–26AUG02–3/6

5. Carefully place ring compressor with piston and rod over liner.

IMPORTANT: Be sure crankshaft journals and liner walls are not damaged when installing piston and rod liner.

NOTE: Be sure the word "FRONT" on connecting rod faces toward the front of the engine.

6. With piston centered in ring compressor and rings staggered correctly, push piston into liner.



RG8366 –UN–21MAY98

Installing Piston and Rod Assembly

RG,RG34710,133 –19–26AUG02–4/6

7. Apply clean engine oil to bearing inserts (B) and crankshaft rod journals (A).

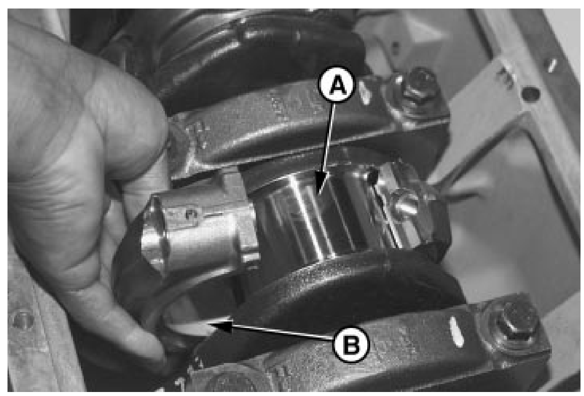
IMPORTANT: On PRECISION JOINT™ rods, make sure bearings are properly centered in the cap and rod. Make sure cap is properly aligned on rod, with interlocking surfaces sealing tightly and edges aligned. DO NOT reverse cap on rod. Match pads on side of rod and cap.

When installing caps, make sure stamped numbers on rod and cap are positioned on the same side.

NEVER use connecting rod cap screws more than once for final engine assembly. Once rod cap screws have been tightened to final torque-turn specifications, they cannot be reused for final assembly.

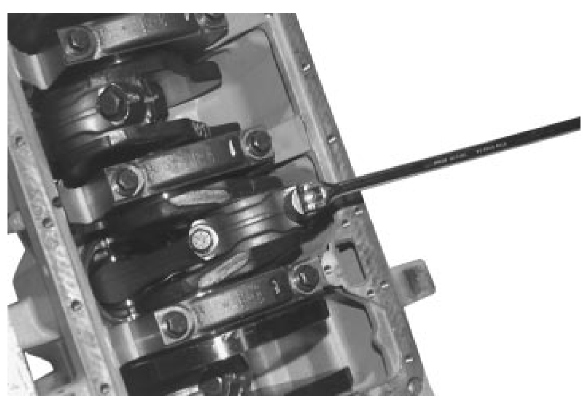
8. Install connecting rod caps.

A—Crankshaft Rod Journals
B—Bearing Inserts



RG8409B –UN–09DEC97

Installing Rod Caps



RG8396 –UN–21MAY98

Tightening Rod Caps

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Continued on next page

RG,RG34710,133 –19–26AUG02–5/6

9. Dip new cap screws and washers in clean engine oil. Make sure tops of cap screws have oil on them also.

IMPORTANT: DO NOT use pneumatic wrenches to install connecting rod cap screws. Doing so may damage threads. Use speed-handle wrench instead.

10. **On tongue-and-groove connecting rods**: Initially, tighten blind-hole cap screw (A) to specifications. Next, tighten the other cap screw. Feel rod-to-cap joint to check for proper alignment.

Specification

Tongue-and-Groove Connecting
Rod Cap Screw—Initial Torque...................................... 27 N•m (20 lb-ft)

Second, tighten all cap screws to the following specifications, then torque-turn all cap screws 90—100°.

Specification

Tongue-and-Groove Connecting
Rod Cap Screw—Final Torque .... 75 N•m (55 lb-ft) plus 90—100° turn clockwise

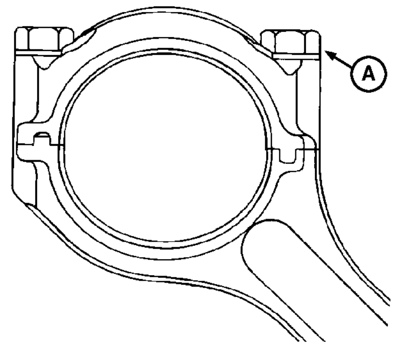
(See TORQUE-TURN CONNECTING ROD CAP SCREWS, next in this group.)

11. **On PRECISION JOINT™ connecting rods**: Initially, tighten cap screw closest to piston end to specifications. Next, tighten the other cap screw. Feel rod-to-cap joint to check for proper alignment.

Specification

PRECISION JOINT™ Connecting
Rod Cap Screw—Torque .... 140 N•m (103 lb-ft) plus 90—100° turn clockwise

(See TORQUE-TURN CONNECTING ROD CAP SCREWS, next in this group.)



Tightening Rod Cap Screws

A—Blind-Hole Cap Screw

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RG,RG34710,133 –19–26AUG02–6/6

Torque-Turn Connecting Rod Cap Screws

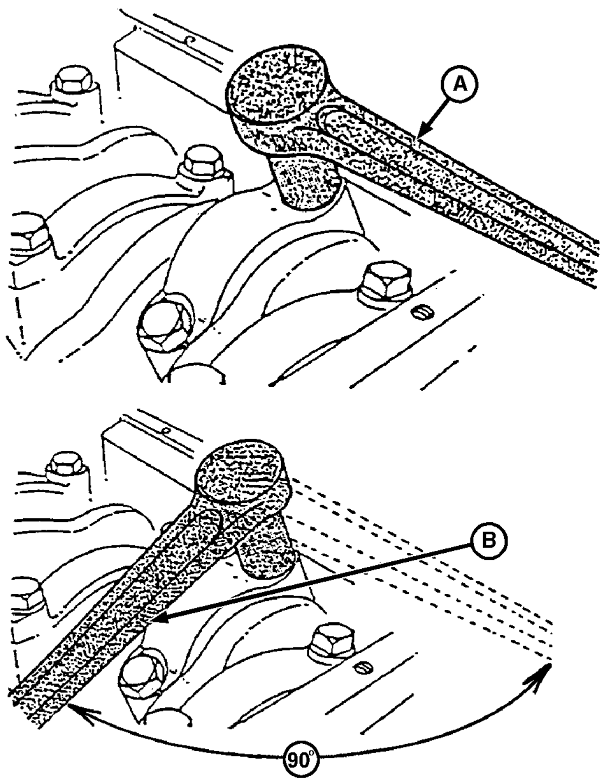
Using Engine Axis Method to Torque-Turn Connecting Rod Cap Screws

1. After tightening cap screws to torque values, mark connecting rod cap and socket.

2. Position handle of wrench parallel to centerline of engine crankshaft axis (A).

3. Tighten 1/4 turn (90—100°) clockwise until handle of wrench is perpendicular to centerline of engine crankshaft axis (B) as shown.

A—Wrench Parallel to Centerline of Engine Crankshaft Axis
B—Wrench Perpendicular to Centerline of Engine Crankshaft Axis

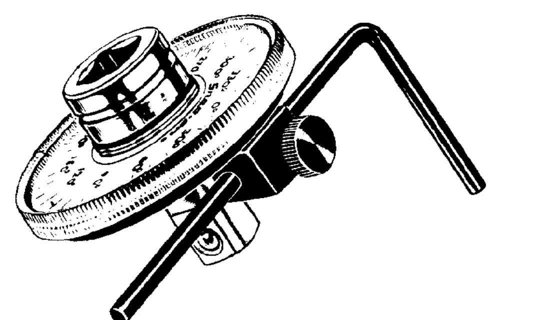


Torque-Turn Rod Cap Screws

RG,RG34710,134 –19–03AUG99–1/2

Using JT05993 Torque Angle Gauge to Torque-Turn Connecting Rod Cap Screws

After tightening cap screws to torque values, follow directions provided with gauge and torque-turn each cap screw 90°—100°.



JT05993 Torque Angle Gauge

RG,RG34710,134 –19–03AUG99–2/2

Check Engine Rotation for Excessive Tightness

1. Rotate crankshaft several revolutions to be sure engine rotates without excessive tightness.

2. Check liners for deep scratches caused by an improperly installed or broken piston ring.

3. Check side clearance of rods; must have slight side-to-side movement.

RG,RG34710,135 –19–30SEP97–1/1

Measure Piston Protrusion

1. Press down on top of piston to remove oil clearances.

2. Use JDG451 Gauge along with D17526CI (English scale) or D17527CI (Metric scale) Dial Indicator, or use KJD10123 Gauge to measure piston protrusion. Place gauge on top of cylinder block so dial indicator can be set to “zero” (0.000) with top of block.

3. Position gauge across top of piston. While pressing gauge downward, rotate crankshaft until piston is at “TDC.”

4. Measure and record piston height at several positions around top OD of piston.

5. Piston protrusion must be within the following specification to prevent piston-to-exhaust valve contact.

Specification

Piston (Early Engines)—Protrusion Above Block Deck	0.229—0.787 mm (0.009—0.031 in.)
Piston (RE505901) (Later 12.5 L Engines)—Protrusion Above Block Deck	0.079—0.637 mm (0.003—0.025 in.)

6. Repeat procedure on remaining pistons and record measurements.

If protrusion does not meet specification, check dimensions of piston, connecting rod, cylinder block, crankshaft, and bearings to determine the cause.

RG,RG34710,136 –19–01NOV00–1/1

Remove and Install Piston Spray Jets

1. Remove piston spray jets.

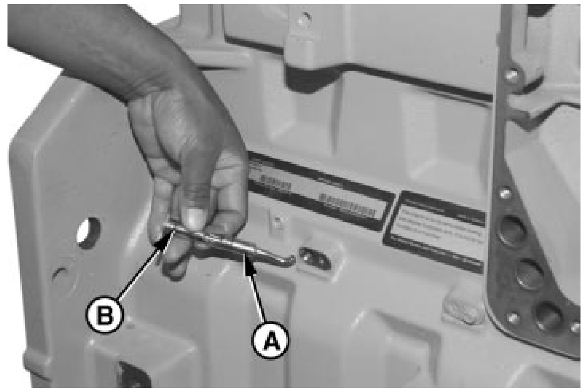
2. Coat O-ring (B) with JDT405 High Temperature Grease.

3. Install piston spray jets (A) at each of the six locations on right side of block.

4. Tighten cap screws to specifications.

Specification

Piston Spray Jet Cap Screws—
Torque .... 15 N•m (11 lb-ft)



Installing Piston Spray Jets

A—Piston Spray Jets
B—O-Ring

RG,RG34710,137 –19–13AUG99–1/1

Complete Final Assembly

NOTE: Refer to the proper group for installation of components.

1. Coat threads of oil gallery plugs with LOCTITE® 242 Thread Lock and Sealant. Install plugs and tighten to specifications.

Specification

Oil Gallery Plug—Torque	20 N•m (15 lb-ft)
Main Oil Gallery (Front) Expansion Plug—Installed Depth	Flush—1.5 mm (0.059 in.) Below Surface

2. Install oil pickup tube. (See REMOVE AND INSTALL OIL PICKUP TUBE in Group 060.) Install oil pan. (See INSTALL ENGINE OIL PAN in Group 060.)

3. Install the cylinder head using new head gasket. (See INSTALL CYLINDER HEAD in Group 020.)

4. Install camshaft and valve train. (See REMOVE AND INSTALL CAMSHAFT in Group 050.) Install timing gear cover. (See INSTALL TIMING GEAR COVER in Group 040.)

5. Install electronic unit injectors. Refer to the appropriate fuel system repair manual.

   Delphi/Lucas ECU controlled fuel systems:

   - See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM115, Section 02, Group 090.

   John Deere Level 6 ECU controlled fuel systems:

   - See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM188, Section 02, Group 090. (Dual rail fuel systems)
   - See REMOVE AND INSTALL ELECTRONIC UNIT INJECTORS in CTM188, Section 02, Group 091. (Single rail fuel systems)

6. Adjust clearances, preloads, and gear backlash. (Groups 020, 040, 050.)

7. Install remaining fuel injection system components. (CTM115 Section 02, Group 090 or CTM188 Section 02 Group 090 and 091.)

8. Install the coolant pump and water piping. (See INSTALL COOLANT PUMP in Group 070.)

9. Install lubrication system components. (Group 060.)

10. Install crankshaft pulley. (See INSTALL CRANKSHAFT VIBRATION DAMPER AND FRONT OIL SEAL in Group 040.)

11. Install the exhaust manifold. (See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD in Group 080.) Install intake assembly. (See REMOVE, INSPECT AND INSTALL INTAKE MANIFOLD in Group 080.)

12. Install starter motor. (See REMOVE AND INSTALL STARTER MOTOR in Group 100.)

13. Install alternator. (See REMOVE AND INSTALL ALTERNATOR in Group 100.)

14. Install fan and fan belts. (See Machine Technical Manual.)

15. Fill engine with clean oil. (See DIESEL ENGINE OIL in Section 01, Group 002.) Service engine with coolant. (See DIESEL ENGINE COOLANT RECOMMENDATIONS in Section 01, Group 002.)

16. Perform engine break-in. (See PERFORM ENGINE BREAK-IN in Group 010.)

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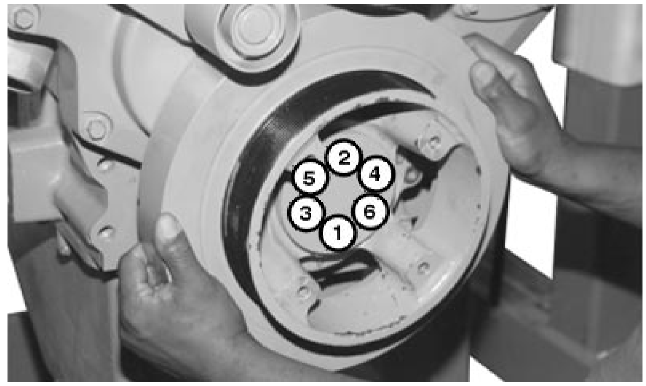
RG,RG34710,138 –19–30AUG02–1/1

Crankshaft Vibration Damper Torque Sequence



Vibration Damper Torque Sequence

DPSG,OUO1004,940 –19–26JUL99–1/1

Inspect Crankshaft Vibration Damper

Refer to your machine operator's manual for recommended vibration damper inspection frequency.

1. Remove V-belt (shown removed).

IMPORTANT: The vibration damper assembly is not repairable and should be replaced every 5 years or 4500 hours, whichever occurs first.

ALWAYS replace vibration damper whenever crankshaft is replaced and at major engine overhaul. Also replace damper when a short block, complete block, or remanufactured basic engine is installed.

2. Carefully inspect vibration damper for torn or split rubber protruding from front and back of assembly.

3. Grasp vibration damper with both hands and attempt to turn it in both directions. If rotation is felt, damper is defective and should be replaced.

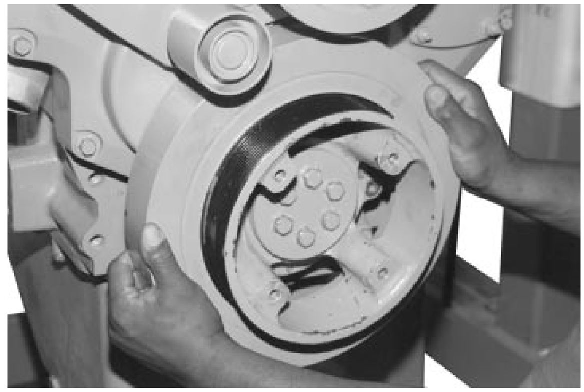
4. Check vibration damper radial runout by positioning a dial indicator so probe (A) contacts damper OD.

5. With engine at operating temperature, rotate crankshaft using JDG820 Flywheel Turning Tool.

6. Note dial indicator reading. Replace vibration damper if radial runout exceeds specifications.

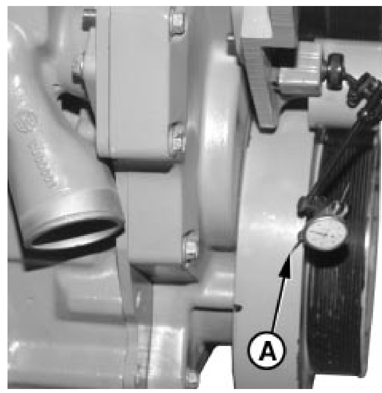
Specification

Vibration Damper—Maximum
Radial Runout.. 0.76 mm (0.030 in.)



RG8536 –UN–20MAY98

Checking Damper Rotation



RG8537 –UN–10DEC97

Measuring Damper Radial Runout

A—Probe

RG,RG34710,149 –19–23OCT00–1/1

Check Crankshaft End Play


RG8538 –UN–20MAY98

Checking Crankshaft End Play

1. Position dial indicator on end of crankshaft as shown.
2. Push crankshaft as far to rear of engine as possible.
3. Zero the dial indicator.

IMPORTANT: Do not apply too much pressure with bar, as this could damage thrust bearings.

4. Using a bar, gently pry the crankshaft as far forward as possible and record end play.

Specification

Crankshaft—End Play .... 0.038—0.380 mm (0.0015—0.0150 in.)

NOTE: If end play is not within specifications, new thrust bearings will usually restore proper end play.

RG,RG34710,150 –19–30SEP97–1/1

Remove Crankshaft Vibration Damper and Pulley

CAUTION: Damper and pulley are very heavy. Plan proper handling procedures to avoid injury. ALWAYS use an assistant when removing and installing pulley.

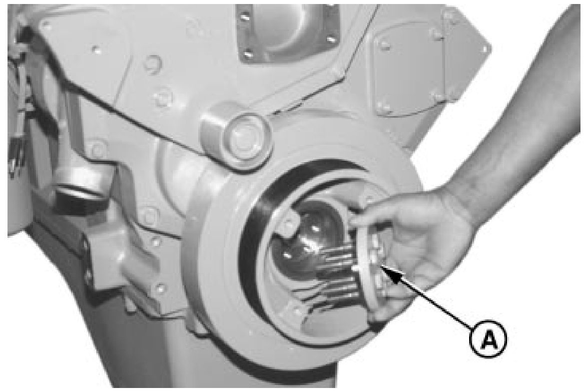
IMPORTANT: DO NOT immerse damper assembly in petroleum products (such as gasoline, oil, solvent, etc.). Doing so can damage the rubber portion of the assembly. Never apply thrust on outer ring of damper. The damper is sensitive to impact damage from being dropped or struck with a hammer.

NOTE: Remove front bolt-on pulley from vibration damper assembly for access to front nose of crankshaft, if equipped.

1. Remove six cap screws and large washer (A) from front nose of crankshaft.

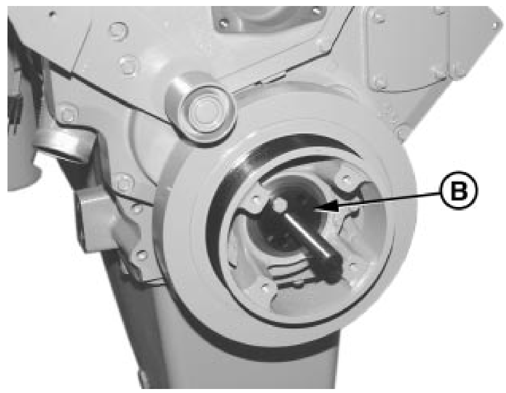
2. Install JDG973-1 Remover/Installer Hub (B) onto nose of crankshaft with two hex socket head cap screws provided in kit. Tighten cap screws until they bottom on hub.

3. Lubricate threads of remover/installer with multi-purpose grease.



RG8175A –UN–05DEC97

Removing Damper Retaining Ring



RG8176 –UN–05DEC97

Installing JDG973-1 Hub

A—Large Washer
B—JDG973-1 Remover/Installer Hub

Continued on next page RG,RG34710,151 –19–30SEP97–1/2

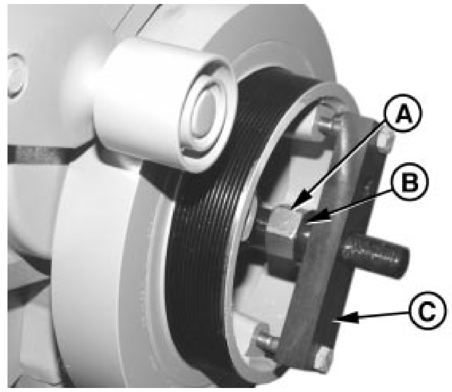
4. Thread large hex nut (A) onto hub and install thrust washer (B). Grease both sides of thrust washer.

5. Install JDG973-2 Cross Block (C) and secure with two hex head cap screws provided in kit. Thread cap screws into vibration damper deep enough to allow clearance for wrench on large nut.

6. Remove damper from crankshaft flange. Remover/installer hub will support damper after it is removed from crankshaft flange.

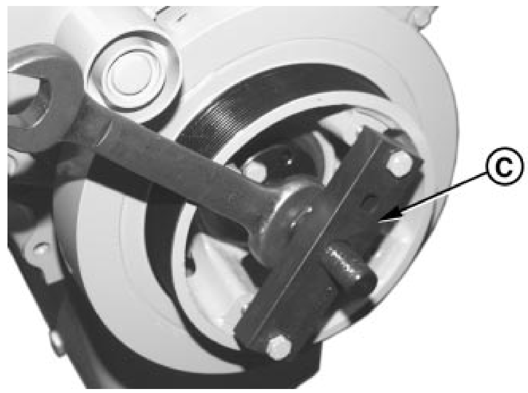
7. Remove hub from front nose of crankshaft.

A—Large Hex Nut
B—Thrust Washer
C—JDG973-2 Cross Block



RG8168 –UN–05DEC97

Installing JDG973-2 Cross Block



RG8169 –UN–05DEC97

Removing Vibration Damper

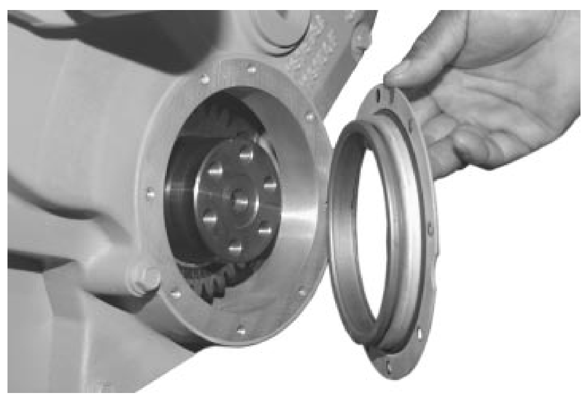
RG,RG34710,151 –19–30SEP97–2/2

Remove Crankshaft Front Oil Seal

1. Remove vibration damper and pulley. (See REMOVE CRANKSHAFT VIBRATION DAMPER AND PULLEY, earlier in this group.)

2. Remove eight cap screws and remove front seal from timing gear cover.

   For front crankshaft oil seal replacement, oil seal must be installed onto vibration damper prior to damper installation. (See INSTALL CRANKSHAFT VIBRATION DAMPER AND FRONT OIL SEAL, later in this group.)



RG8119 –UN–21MAY98

Removing Crankshaft Front Oil Seal

RG,RG34710,152 –19–30SEP97–1/1

Remove Timing Gear Cover

1. If not previously done, remove vibration damper and pulley (A). (See REMOVE CRANKSHAFT VIBRATION DAMPER AND PULLEY, earlier in this group.)

2. Drain engine oil if not previously done and remove engine oil pan (B). (See REMOVE ENGINE OIL PAN in Group 060.)

3. Disconnect crankshaft position sensor.

NOTE: On engines with fixed fan drive assembly, the fan drive housing is cast into the camshaft gear access cover.

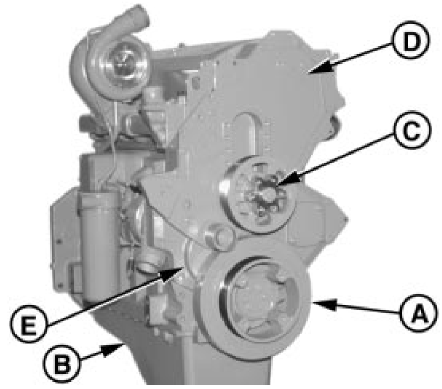
4. Remove fan drive assembly (C). (See REPLACE BEARINGS IN FAN DRIVE ASSEMBLY in Group 070.)

NOTE: Mark location of cap screws to aid in reassembly.

5. Remove camshaft gear access cover (D) from timing gear cover. Mark location of cap screws to aid in reassembly.

6. Remove remaining cap screws and remove timing gear cover. Mark location of cap screws to aid in reassembly.

NOTE: On engines with fixed fan drive, the lower right cap screw (under pulley) will have to be reinstalled in camshaft gear access cover bore prior to installing pulley. Once pulley is installed, it interferes with the installation of this cap screw.



RG8178 –UN–05DEC97

Removing Timing Gear Cover

A—Vibration Damper
B—Oil Pan
C—Fan Drive Assembly
D—Camshaft Gear Access Cover
E—Timing Gear Cover

RG,RG34710,153 –19–12SEP02–1/1

Check Flywheel Housing Face Runout

1. Mount dial indicator on flywheel. Set pointer to contact PTO mounting surface on flywheel housing at right angles (A). Pointer should not contact holes in flywheel housing.

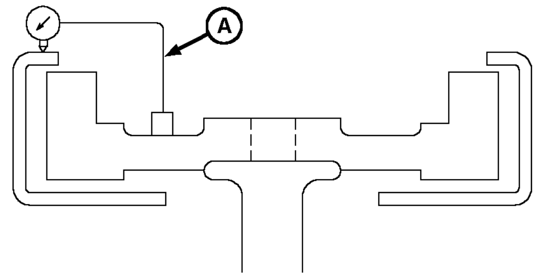
IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel housing face runout.

2. Rotate flywheel by turning crankshaft. Read total dial indicator movement and compare to specifications.

3. Remount set pointer to contact flywheel housing inner bore (B).

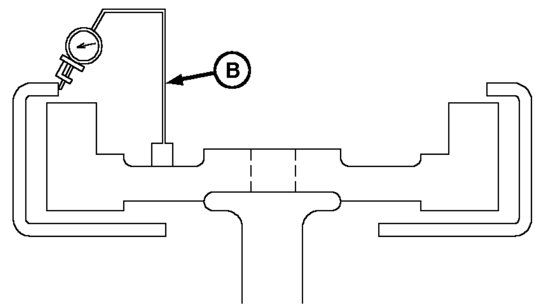
4. Rotate flywheel by turning crankshaft. Read total dial indicator movement and compare to specifications.

Specification	
SAE 1 Flywheel Housing—	
Maximum Face Deviation (A)	0.30 mm (0.012 in.)
Maximum Bore Eccentricity (B)	0.30 mm (0.012 in.)
SAE 2 Flywheel Housing—	
Maximum Face Deviation (A)	0.28 mm (0.011 in.)
Maximum Bore Eccentricity (B)	0.28 mm (0.011 in.)
SAE 0 Flywheel Housing—	
Maximum Face Deviation (A)	0.41 mm (0.016 in.)
Maximum Bore Eccentricity (B)	0.41 mm (0.016 in.)



RG10271 –UN–02AUG99

Face Deviation



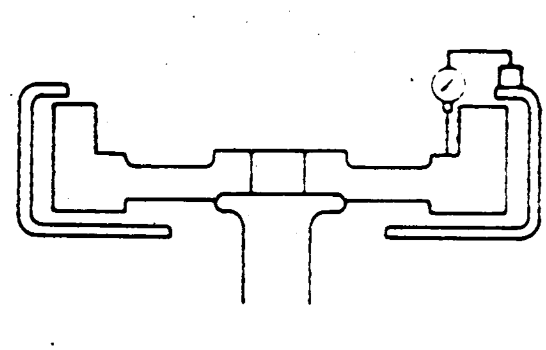
RG10272 –UN–02AUG99

Bore Eccentricity

A—Measure Face Deviation
B—Measure Bore Eccentricity

RG,RG34710,154 –19–12SEP02–1/1

Check Flywheel Face Flatness



Measuring Flywheel Face Flatness

1. Mount dial indicator base on flywheel housing. Position pointer to contact driving ring mounting surface. Do not allow pointer to contact driving ring mounting holes.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel face flatness.

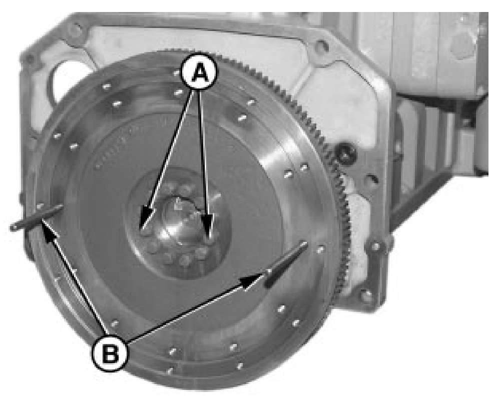
2. Rotate flywheel by turning crankshaft. Read total dial indicator movement. Resurface flywheel face or replace as required.

Specification

Flywheel Face Flatness—
Maximum Variation .... 0.23 mm (0.009 in.)
Maximum Variation per 25 mm
(1.0 in.) of Travel .... 0.013 mm (0.0005 in.)

RG,RG34710,155 –19–05SEP02–1/1

Remove Flywheel



Removing Flywheel

A—Cap Screws
B—Threaded Guide Pins

CAUTION: Flywheel is heavy. Use proper lifting procedures to avoid personal injury.

NOTE: SAE 1 flywheel housing must be removed before flywheel can be removed from engine. (See REMOVE AND INSTALL FLYWHEEL HOUSING, later in this group.)

1. Remove two flywheel attaching cap screws (A), and install two guide pins in their place.

2. Remove remaining cap screws, and carefully pull flywheel from crankshaft.

NOTE: Threaded guide pins (B) may also be used to ease handling of flywheel.

Once flywheel is removed, JDG976 Crankshaft Front Rotation Adapter can be used to rotate crankshaft if necessary.

RG,RG34710,156 –19–27JUL99–1/1

Inspect and Repair Flywheel

1. Inspect the clutch contact face for scoring, overheating or cracks.

2. Resurface clutch contact face, as necessary, to restore flatness for proper clutch contact.

3. Replace a defective flywheel.

4. Examine ring gear for worn or broken teeth. If ring gear is damaged, replace gear. (See REPLACE FLYWHEEL RING GEAR later in this group.)

RG,RG34710,157 –19–05SEP02–1/1

Replace Flywheel Ring Gear

CAUTION: Oil fumes or oil can ignite above 193°C (380°F). Do not allow a flame or heating element to be in direct contact with the oil. Heat the oil in a well ventilated area. Plan a safe handling procedure to avoid burns.

1. Place the flywheel on a solid flat surface.

2. Drive ring gear off with a brass drift and hammer.

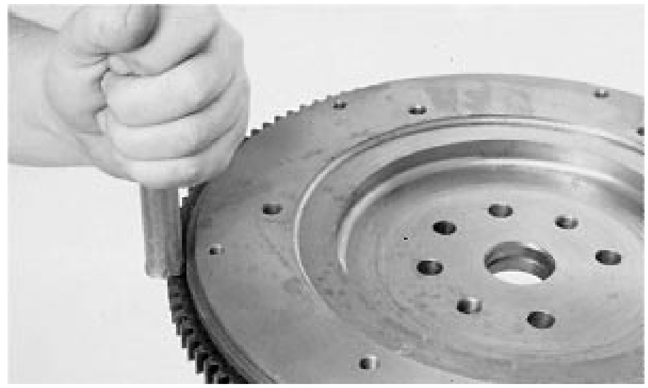
IMPORTANT: If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT above 232°C (450°F). SEE CAUTION. Overheating may also destroy original heat treatment of gear.

3. Heat new ring gear sufficiently to allow gear to fit flywheel hub without interference, but do not heat above 232°C (450°F) maximum, using either heated oil or oven heat.

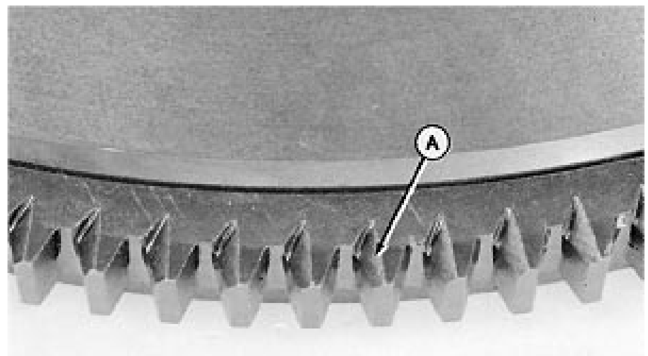
4. Turn gear so side with chamfer (A) is toward engine with flywheel installed.

5. Install ring gear flush within 0.25 mm (0.010 in.) against shoulder of flywheel.

   Ring gear will shrink to required fit as it cools.



Removing Flywheel Ring Gear



Flywheel Ring Gear

A—Chamfer

RG,RG34710,158 –19–17DEC00–1/1

Remove and Install Flywheel Housing

Remove Flywheel Housing

CAUTION: Flywheel housing is heavy. Plan a proper lifting procedure to avoid personal injury.

NOTE: *Flywheel must be removed before removing SAE 0 and SAE 2 flywheel housings. (See REMOVE FLYWHEEL earlier in this group.)*

1. Remove attaching cap screws.

2. Remove flywheel housing.

3. Inspect dowel pins for damage. Replace pins as needed.

Install Flywheel Housing

CAUTION: Flywheel housing is heavy. Plan proper lifting procedures to avoid personal injury.

1. Scrape off all old gasket material. Install a new gasket without sealant between block and flywheel housing, if equipped.

2. Install flywheel housing on cylinder block.

NOTE: *ALWAYS use new cap screws when installing flywheel housing.*

3. Dip threads of cap screw in engine oil before installing. Install and tighten cap screws to specifications.

Specification

Flywheel Housing-to-Cylinder Block Cap Screws (SAE 1 With Rear PTO)—Torque .... 325 N•m (240 lb-ft)
Flywheel Housing-to-Cylinder Block Cap Screws (SAE 0, 1 and 2 Without Rear PTO)—Torque.. 365 N•m (270 lb-ft)

4. Install flywheel housing front plate and timing hole covers, if removed. Tighten cap screws to specifications.

Specification

Flywheel Housing Front Plate Cap Screws—Torque .... 50 N•m (37 lb-ft)
Flywheel Housing Timing Hole Cover Cap Screws—Torque..................................... 5 N•m (44 lb-in.)

5. If removed, install starter motor and tighten cap screws to specifications.

Specification

Starter Motor Cap Screws—Torque.. 125 N•m (92 lb-ft)

RG,RG34710,159 –19–23OCT00–1/1

Install Flywheel

CAUTION: Flywheel is heavy. Plan proper handling procedures to avoid injuries.

NOTE: SAE 0 and SAE 2 flywheel housings must be installed before installing flywheel. (See REMOVE AND INSTALL FLYWHEEL HOUSING earlier in this group.)

NOTE: ALWAYS use new cap screws when installing flywheel.

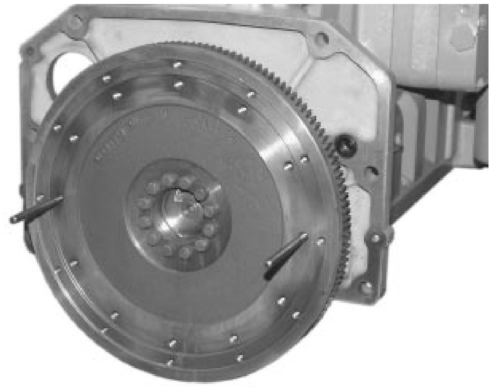
1. Install two pilot studs in crankshaft to aid in assembly. Position flywheel over pilot studs.

2. Install flywheel attaching cap screws. Remove pilot studs and install remaining two cap screws.

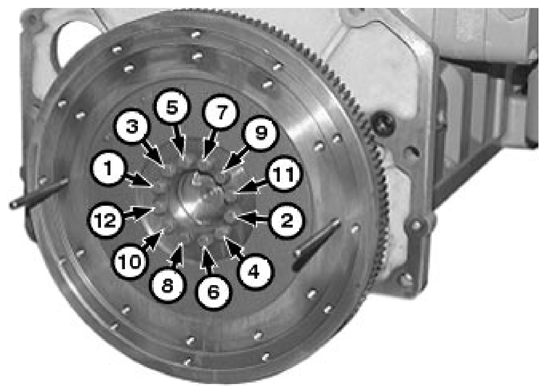
3. Tighten flywheel attaching cap screws in the sequence shown to the following specifications.

Specification	
Flywheel-to-Crankshaft Cap Screws—Torque	130 N•m (96 lb-ft)

4. After flywheel and housing are installed, perform flywheel-to-housing runout checks. (See CHECK FLYWHEEL HOUSING FACE RUNOUT earlier in this group.)


RG8134 –UN–21MAY98

Installing Flywheel



RG10248 –UN–30JUL99

Flywheel Tightening Sequence

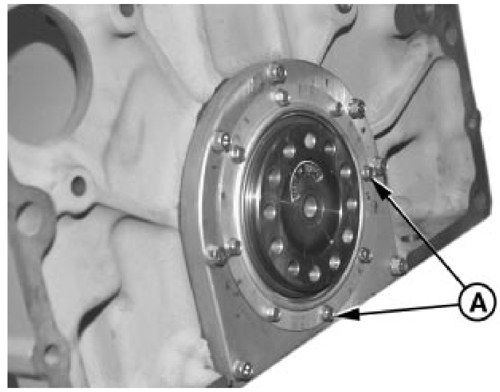
RG,RG34710,160 –19–27JUL99–1/1

Remove Rear Crankshaft Oil Seal and Housing Assembly

To remove rear crankshaft oil seal, the seal housing MUST BE removed also.

1. Remove engine oil pan, if not previously removed. (See REMOVE ENGINE OIL PAN, in Group 060.) Remove flywheel, if not previously removed. (See REMOVE FLYWHEEL earlier in this group.)

2. Remove eight cap screws (A) securing rear seal to housing.



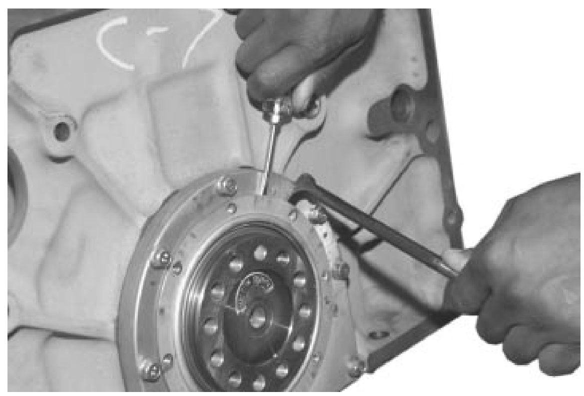
RG8291 –UN–06DEC97

Removing Rear Oil Seal and Housing

A—Cap Screws

RG,RG34710,161 –19–13AUG99–1/4

3. Separate seal from housing using a small flat screwdriver and heel-type prybar as shown.



RG8293 –UN–21MAY98

Separating Rear Seal From Housing

Continued on next page RG,RG34710,161 –19–13AUG99–2/4

02
040
14

4. Remove all cap screws securing rear seal housing to cylinder block except top cap screw and two bottom cap screws (A) as shown.

NOTE: Position split in collet halves at 12:00 o'clock position (C).

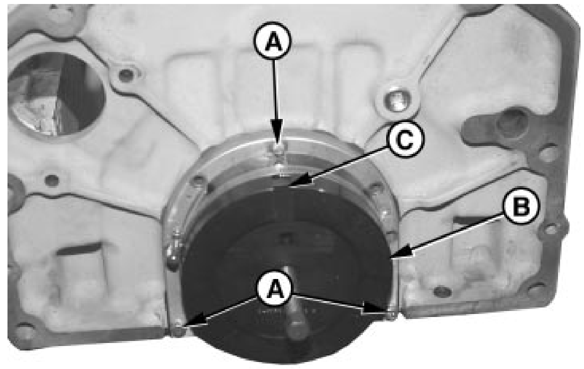
5. Install JDG1020 Rear Seal and Housing Remover (B) using knife-edge jaws with larger ID. Install puller jaws between seal carrier and seal housing.

6. Secure assembly by tightening band clamp securely.

NOTE: Always lubricate forcing screw with multi-purpose grease prior to using.

7. Tighten forcing screw until rear seal and remover is free from seal housing. Wear sleeve portion of seal assembly should remain on crankshaft flange.

8. Remove three remaining cap screws securing seal housing to block and remove housing with gasket.



RG8344 –UN–09DEC97

Removing Rear Seal Carrier

A—Cap Screw
B—JDG1020 Rear Seal and Housing Remover
C—12:00 O'clock Position

RG,RG34710,161 –19–13AUG99–3/4

9. If necessary, push wear sleeve portion of seal assembly (A) away from block to allow collet halves to be installed behind wear sleeve.

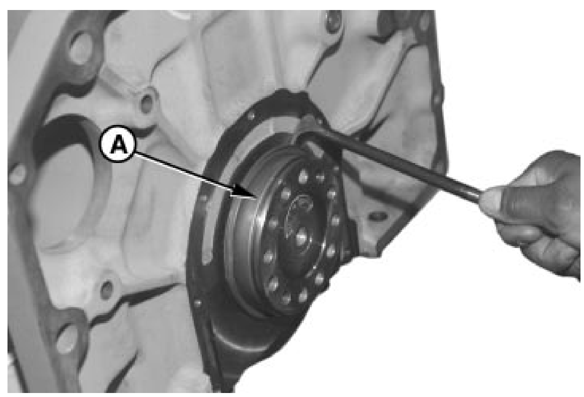
10. Install JDG1020 Remover (B) behind wear sleeve using smaller ID knife-edge jaws. Tighten band clamp securely.

11. Lubricate threads and tighten forcing screw until wear sleeve is removed from crankshaft flange.

12. Inspect crankshaft flange for burrs and nicks.

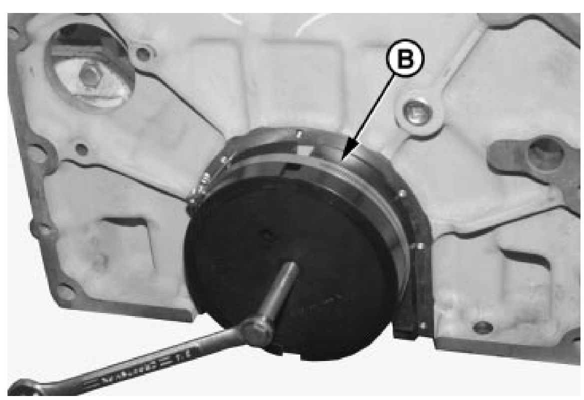
13. Clean all oil and sealant from crankshaft flange using Brake Kleen or ignition cleaner. Polish burrs with fine emery cloth.

A—Seal Assembly
B—JDG1020 Remover



RG8295 –UN–06DEC97

Prying Rear Wear Sleeve



RG8345 –UN–09DEC97

Removing Rear Wear Sleeve Using JDG1020

RG,RG34710,161 –19–13AUG99–4/4

Crankshaft and Main Bearing Failure Analysis

Scored Main Bearing (Diagnosis also applies to connecting rod bearing.):

- Oil starvation.
- Contaminated oil.
- Engine parts failure.
- Excessive heat.
- Poor periodic service.

Galled or “Wiped” Bearings:

- Fuel in lubricating oil (incomplete combustion).
- Coolant in lubrication system (cracked block, liner seal failure, or leaking coolant pump seal with plugged hole).
- Insufficient bearing oil clearance.
- Parts not lubricated prior to engine operation.
- Wrong bearing size.

Inconsistent Wear Pattern:

- Misaligned or bent connecting rod.
- Warped or bowed crankshaft.
- Distorted cylinder block.

Broken Main Bearing Caps:

- Improper installation.
- Dirt between bearing and crankshaft journal.
- Low oil pressure.
- Oil pump failure.

Cracked, Chipped or Broken Bearings:

- Overspeeding.
- Excessive idling.
- Lugging.
- Excessive oil clearance.
- Improper installation.

RG,15,DT7461 –19–18MAY00–1/1

Remove Crankshaft Main Bearings

NOTE: A drop in oil pressure, engine knock, or excessive crankshaft end play are indications of main bearing and main thrust bearing washer failures.

IMPORTANT: Before removing main bearing caps, check for proper torque on all main bearings. Also, check each bearing cap to make sure they are numbered for reassembly on the same numbered main bearing web. Keep matched bearing inserts with their respective main bearing caps for comparison with corresponding crankshaft journal to check surface wear.

NOTE: When removing main bearings and caps for crankshaft removal, leave No. 1 and 7 main bearing caps installed until all connecting rod caps have been removed.

1. Remove engine oil pan and pick-up tube. (See REMOVE ENGINE OIL PAN in Group 060.)

2. Remove front timing gear cover. (See REMOVE TIMING GEAR COVER in this group.)

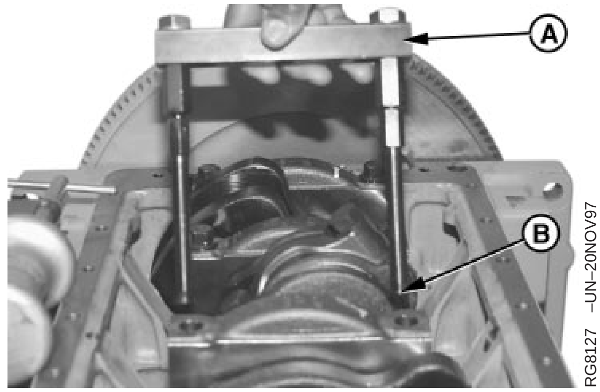
3. Remove rear oil seal and housing. (See REMOVE REAR CRANKSHAFT OIL SEAL AND HOUSING ASSEMBLY in this group.)

4. Remove main bearing cap screws.

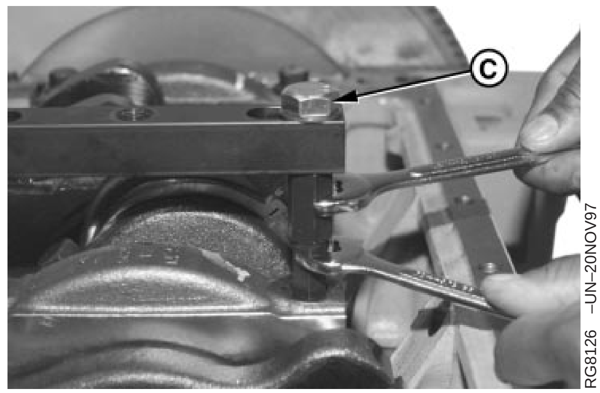
5. Install JDG996 Puller (A) so that tip (B) of blind hole puller legs are below bearing cap half.

6. Tighten hex of actuator pin securely while holding collet portion of puller leg with second wrench.

7. Tighten both cap screws (C) on cross block finger tight.



JDG996 Main Bearing Cap Puller



Installing JDG996 Puller

A—JDG996 Puller
B—Tip
C—Cap Screws

Continued on next page

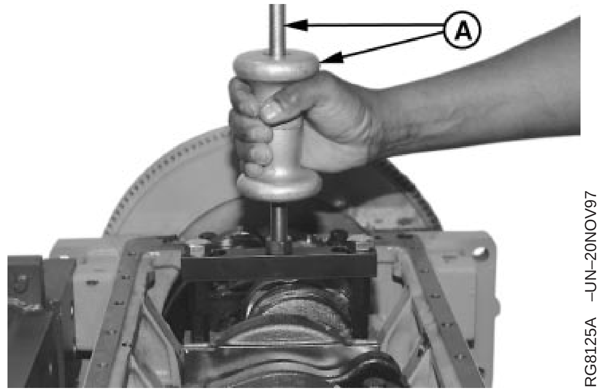
RG,RG34710,162 –19–13AUG99–1/2

8. Attach D01300AA Slide Hammer (A) to cross block, tighten nut securely.

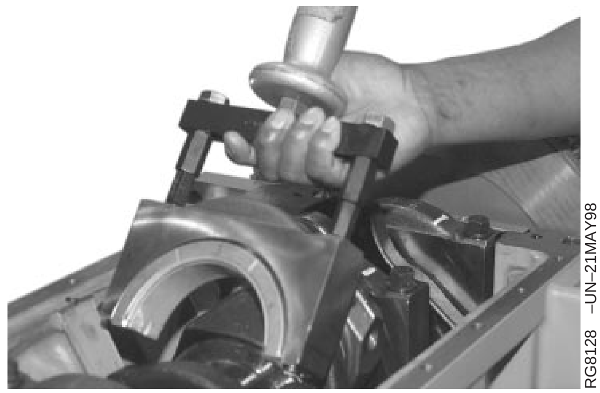
9. Remove main bearing cap by sliding up on hammer weight.

10. Use PLASTIGAGE® to measure journal-to-bearing oil clearance on each main bearing as they are removed. (See CHECK MAIN BEARING-TO-JOURNAL OIL CLEARANCE, later in this group.)

A—D01300AA Slide Hammer



Bearing Cap Puller and Slide Hammer



Main Bearing Cap Assembly Removed

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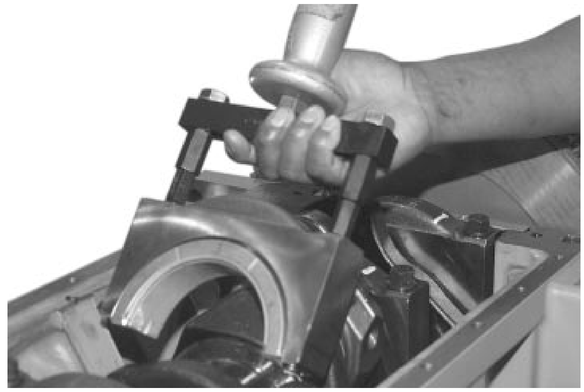
RG,RG34710,162 –19–13AUG99–2/2

Check Main Bearing-to-Journal Oil Clearance

NOTE: The use of PLASTIGAGE® will determine wear (crankshaft-to-bearing oil clearance) but will not determine condition of either bearing or journal surface.



Checking Oil Clearance

1. Place a strip of PLASTIGAGE® in the center of the main bearing cap about three-fourths of the width of the bearing.

2. Use clean SAE 30 engine oil on PLASTIGAGE® to prevent sticking.

3. Install cap and tighten cap screws to specification.

Specification

Crankshaft Main Bearing Cap Screws—Final Torque .... 320 N•m (236 lb-ft)

4. Remove cap and compare width of PLASTIGAGE® with specifications below to determine clearance.

Specification

Crankshaft Main Bearings—Main Bearing-to-Journal Clearance.. 0.046—0.122 mm (0.0018—0.0048 in.)

Maximum Acceptable Oil Clearance .... 0.152 mm (0.0060 in.)

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RG,RG34710,163 –19–12SEP02–1/1

Remove Crankshaft

1. Remove timing gear cover. (See REMOVE TIMING GEAR COVER, earlier in this group.)

2. Remove flywheel. (See REMOVE FLYWHEEL, earlier in this group.)

3. Remove flywheel housing. (See REMOVE AND INSTALL FLYWHEEL HOUSING, earlier in this group.)

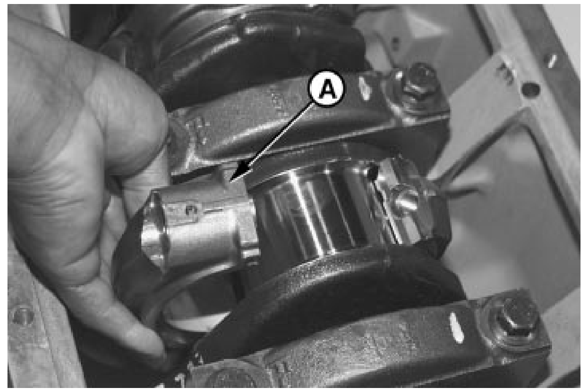
4. Remove rear oil seal housing. (See REMOVE REAR CRANKSHAFT OIL SEAL AND HOUSING ASSEMBLY, earlier in this group.)

5. Remove all six piston spray jets to avoid damage. (See REMOVE AND INSTALL PISTON SPRAY JETS in Group 030.)

6. Remove main bearings 2 through 6. (See REMOVE CRANKSHAFT MAIN BEARINGS, earlier in this group.)

7. Rotate crankshaft using the JDG820 Flywheel Turning Tool until connecting rod caps can be removed easily. You will be able to remove two rod caps at each position.

8. Remove all connecting rod caps with bearings (A), then remove No. 1 and 7 main bearing caps and bearings. (See REMOVE PISTONS AND CONNECTING RODS in Group 030.)



RG8409A –UN–09DEC97

Removing Rod Caps

A—Bearings

Continued on next page

RG,RG34710,164 –19–13AUG99–1/2

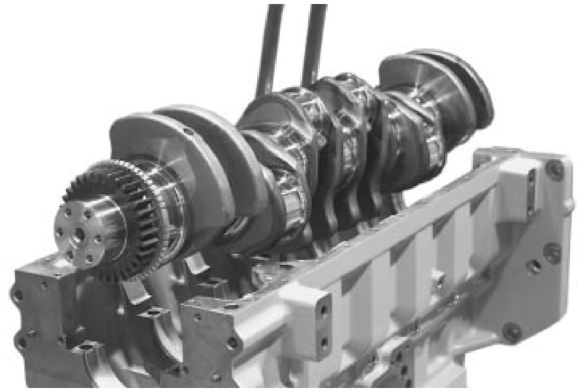
CAUTION: Crankshaft is very heavy. Plan a proper handling procedure to avoid injury.

9. Attach a lifting strap to crankshaft. Protect machined journals from damage with clean shop towels.

10. Using proper lifting equipment, carefully raise crankshaft out of cylinder block.

11. Clean crankshaft, especially oil passages, using solvent and compressed air.

12. Put crankshaft on clean V-blocks for inspection.



Removing Crankshaft from Block

RG,RG34710,164 –19–13AUG99–2/2

Inspect Crankshaft

NOTE: If crankshaft damper damage was discovered during teardown, it is recommended that the crankshaft be magna-fluxed. This will verify whether or not it has microscopic cracks or fissures. (See INSPECT CRANKSHAFT VIBRATION DAMPER, earlier in this group.)

1. Thoroughly clean crankshaft. Clear restrictions from all oil passages.

2. Inspect crankshaft for signs of load stress, cracks, or scratches on journals. Also check each journal for evidence of excessive overheating or discoloration. If either condition exists, replace crankshaft, since heat treatment has probably been destroyed.

3. Inspect (front) crankshaft gear and timing wheel for cracks, chipped teeth, or excess wear. Inspect keyway and index pin for damage and proper indexing on flange. Replace gear(s) as required. (See REPLACE CRANKSHAFT DRIVE GEAR, later in this group.)

4. Inspect the keyway for evidence of cracks or wear. Replace crankshaft as necessary.

5. Carefully inspect the rear flange of the crankshaft in the area of the oil seal's wear sleeve contact surface for evidence of a rough or grooved condition. Any imperfections in this area will result in oil leakage. Slight ridges may be cleaned up with emery cloth and crocus cloth.

6. Check each journal for evidence of excessive overheating or discoloration. If either condition exists, replace crankshaft, since heat treatment has probably been destroyed.

IMPORTANT: The vibration damper MUST BE replaced whenever the crankshaft is replaced.

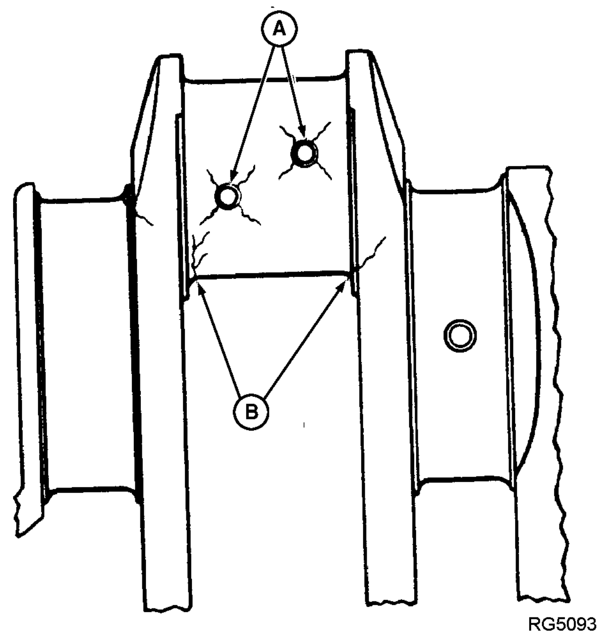
Continued on next page

RG,RG34710,165 –19–13AUG99–1/2

IMPORTANT: Small cracks may not be visible to the eye. Use procedure such as the Fluorescent Magnetic Particle method. This method magnetizes the crank, employing magnetic particles which are fluorescent and glow under “black light”. The crankshaft must be de-magnetized after the test.

7. Carefully check the crankshaft for cracks in the area of rod journal oil holes (A) and at journal fillets (B). Replace crankshaft if any cracks are found.

A—Rod Journal Oil Holes
B—Journal Fillets



Crankshaft Stress Cracks

RG,RG34710,165 –19–13AUG99–2/2

Measure Assembled ID of Bearings and OD of Crankshaft Journals

1. With crankshaft out of cylinder block, install main bearing inserts and caps (be sure inserts are installed correctly).

2. Tighten main bearing cap screws to specification.

Specification

Crankshaft Main Bearing Cap Screws—Final Torque	320 N•m (236 lb-ft)

3. Measure ID of all bearings with an inside micrometer and compare measurements with respective crankshaft main journals.

Specification

Crankshaft Main Bearing—ID With Bearing	125.071—125.127 mm (4.9241—4.9263 in.)
ID Without Bearing	133.097—133.123 mm (5.2400—5.2411 in.)

NOTE: Inspect and measure assembled ID of connecting rod bearings. Compare measurements with connecting rod journal OD on crankshaft. (See INSPECT AND MEASURE CONNECTING ROD BEARINGS in Group 030.)

4. Measure OD of all respective crankshaft journals at several points around journal.

Specification

Crankshaft Main Bearing Journal—OD	124.983—125.017 mm (4.9206—4.9219 in.)

NOTE: If engine has previously had a major overhaul and undersized bearing inserts were used, above listed ID and OD dimensions may not be the same as those recorded. However, oil clearance should be within specifications. Oil clearance is 0.046—0.122 mm (0.0018—0.0048 in.). The maximum serviceable clearance is 0.152 mm (0.0060 in.).

Compare crankshaft journal OD measurements to determine if journal is out-of-round or tapered.

Specification

Crankshaft Main Journal—Max. Out-of-Round	0.025 mm (0.0010 in.)
Max. Taper per 25.4 mm (1.0 in.) of Journal Length	0.0025 mm (0.0001 in.)

RG,RG34710,166 –19–05SEP02–1/1

Measure Assembled ID of Main Bearing Caps (Without Bearings)

1. With crankshaft removed from cylinder block, install main bearing caps without bearing inserts.

2. Tighten main bearing cap screws to specification.

Specification

Crankshaft Main Bearing Cap Screws—Final Torque .... 320 N•m (236 lb-ft)

3. Measure ID of all bearing caps with an inside micrometer. Compare to specifications given.

   If any main bearing cap assembled ID is not within specification, blank (generic) bearing caps are available and must be line bored to specification. Replace individual bearing caps as needed.

Specification

Main Bearing Cap Bore Specifications—ID Without Bearings.. 133.097—133.123 mm (5.2400—5.2411 in.)
Max. Bore Diameter Variation .... 0.013 mm (0.0005 in.)
Max. Bore Diameter Taper .... 0.005 mm (0.0002 in.)
Max. Straightness (Any Bore-to-Adjacent Bore) .... 0.038 mm (0.0015 in.)
Max. Straightness (5 Center Bores-to-Adjacent Bore) .... 0.076 mm (0.0030 in.)
Centerline of Bore-to-Top Deck......................... 429.92—430.07 mm (16.926—16.932 in.)

IMPORTANT: Main bearing cap line boring should be done ONLY by experienced personnel on equipment capable of maintaining bore specifications.

4. Measure main bearing cap surface width and compare to following specifications.

Specification

Crankshaft Main Bearing Cap—Surface Width .... 39.75—40.25 mm (1.565—1.585 in.)

RG,RG34710,167 –19–05SEP02–1/1

Crankshaft Grinding Guidelines

IMPORTANT: Crankshaft grinding should be done ONLY by experienced personnel on equipment capable of maintaining crankshaft size and finish specifications.

If undersize bearings are used, check bearing clearance after bearing caps have been tightened to specified torque. If undersize bearings are too tight and clearance is not within specifications, the journal and bearing will be wiped clean of all oil. This would result in premature wear of parts.

In addition to the standard size main and connecting rod bearings, the following undersize bearings are available.

Specification	
Crankshaft Main Bearings Available—Undersize	0.25, 0.50 mm (0.010, 0.020 in.)

If journals are tapered, out-of-round, scored or damaged, grind the crankshaft and install the proper undersize bearings.

If the crankshaft is to be reground, use the following recommended procedure:

1. Compare the crankshaft journal measurements taken during inspection and determine the size to which the journals are to be reground.

2. If one or more main or connecting rod journals require grinding, then grind all of the main journals or all of the connecting rod journals to the same required size.

3. All journal fillet radii must be free of any sharp grind marks or scratches. The fillet must blend smoothly into the journal and crank cheek. Check the radius with a fillet gauge.

IMPORTANT: Care must be taken to avoid localized heating which often produces grinding cracks.

4. Cool the crankshaft while grinding by using coolant generously. DO NOT crowd the grinding wheel into the work.

IMPORTANT: Grind crankshaft with journals turning clockwise, as viewed from the front end of crankshaft. Lap or polish journals in opposite direction of grinding.

5. Polish or lap the ground surfaces to the specified finish to prevent excessive wear of the journals.

NOTE: Production crankshafts are induction hardened and shotpeened at the factory. Field shotpeening is not recommended due to the equipment required and part geometry.

6. If the thrust surfaces of the crankshaft are worn or grooved excessively, regrind and polish. Maintain the specified radius between each thrust surface and the bearing journal. An oversize thrust washer set containing one standard washer and two 0.18 mm (0.007 in.) oversize washers is available. (See THRUST BEARING NEW PART SPECIFICATIONS, later in this group.)

NOTE: When thrust surfaces are reground and oversize washers used, crankshaft end play specification must be maintained to within 0.038—0.380 mm (0.0015—0.0150 in.). (See CHECK CRANKSHAFT END PLAY, earlier in this group.)

7. Stone the edges of all oil holes in the journal surfaces smooth to provide a radius of approximately 1.50 mm (0.060 in.).

Continued on next page

8. When finished grinding, inspect the crankshaft for cracks with the Fluorescent Magnetic Particle Method, or similar method.

9. De-magnetize the crankshaft.

10. Thoroughly clean the crankshaft and oil passages with solvent. Dry with compressed air.

RG,RG34710,168 –19–13AUG99–2/2

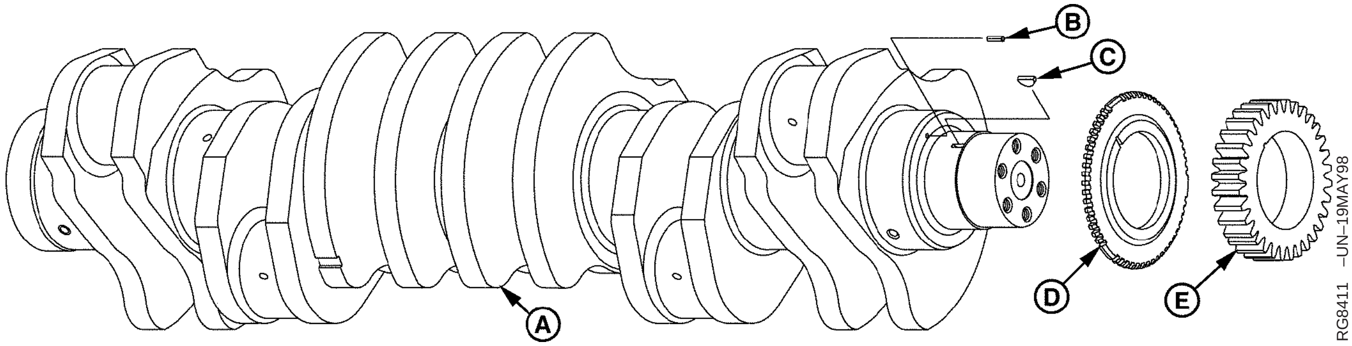
Crankshaft Grinding Specifications

Engine Stroke (6105)	138 mm (5.43 in.)
Engine Stroke (6125)	165 mm (6.50 in.)
Main and Rod Journal Surface Finish	Lap 0.25 Um (9.8 AA)
Thrust Journal and Fillet Radii Surface Finish	Lap 0.4 Um (16 AA)
Rod Journal Fillet Radius	4.49—4.85 mm (0.177—0.191 in.)
Main and Thrust Journal Fillet Radius	3.94—4.44 mm (0.155—0.175 in.)
Thrust Journal Width	48.97—49.07 mm (1.928—1.932 in.)

Bearing Size	Crankshaft Main Journal OD	Crankshaft Rod Journal OD
Standard	124.983—125.017 mm (4.9206—4.9219 in.)	88.844—88.874 mm (3.4980—3.4990 in.)
0.25 mm (0.010 in.)	124.733—124.767 mm (4.9107—4.9121 in.)	88.594—88.624 mm (3.4980—3.4990 in.)
0.50 mm (0.02 in.)	124.473—124.507 mm (4.9005—4.9019 in.)	88.334—88.364 mm (3.4777—3.4789 in.)

RG,RG34710,170 –19–13AUG99–1/1

Replace Crankshaft Drive Gear



Crankshaft, Timing Wheel, Gear

A—Crankshaft
B—Roll Pin
C—Woodruff Key
D—Timing Wheel
E—Crankshaft Drive Gear

IMPORTANT: Crankshaft must be removed before replacing drive gear (E).

NOTE: Remove crankshaft gear for replacement only; it is not necessary to remove gear for crankshaft removal.

1. Protect crankshaft machined wear sleeve surface with masking tape.
2. Remove crankshaft gear using D01074AA 17-1/2 Ton Puller Set.
3. Discard gear after removal.
4. Remove Woodruff key (C), crankshaft timing wheel (D), and roll pin (B) from crankshaft keyway.
5. Remove masking tape.

CAUTION: Oil fumes or oil can ignite above 193°C (380°F). Do not allow a heating element to be in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

IMPORTANT: Crankshaft gear must be installed on crankshaft before crankshaft is installed in engine, otherwise damage to thrust bearings could occur.

6. Heat crankshaft gear to 182°C (360°F) maximum, using either heated oil or oven heat.
7. Install new roll pin in crankshaft and position timing wheel over roll pin for proper indexing.
8. Install Woodruff key in crankshaft keyway.
9. Place gear on crankshaft flange. Be sure key on crankshaft is properly aligned with keyway in gear.

IMPORTANT: When installing gear, do not gouge or nick crankshaft flange.

10. Firmly seat gear and timing wheel against crankshaft flange using a driver.

    No clearance is allowed between gear, timing wheel, and crankshaft after gear cools.

RG,RG34710,171 –19–30SEP97–1/1

Inspect Thrust Bearings

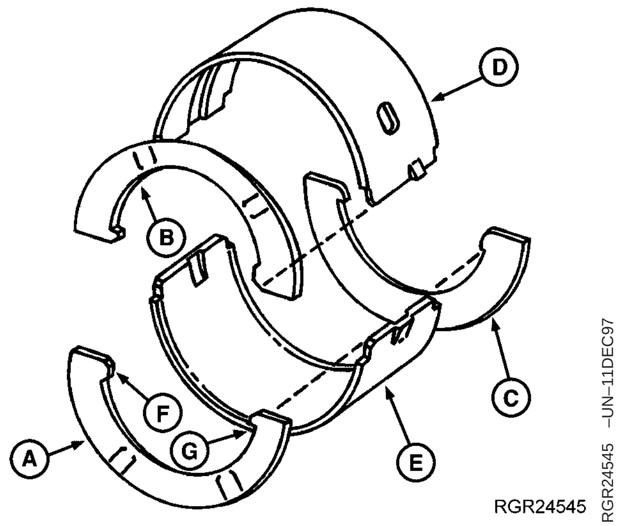
Check thrust surfaces of the thrust bearing and the thrust bearing journal on crankshaft and replace as necessary.

Thrust bearings are available in each of the previously mentioned insert undersizes. An oversize thrust washer set containing one regular size washer and two 0.18 mm (0.007 in.) oversize washers is also available.

Specification

Oversize Thrust Washers
Available—Thickness .... 0.18 mm (0.007 in.)

NOTE: Thrust bearing must be installed with slots facing crankshaft flange. Two halves (A) and (C) go on cap side, not block.



Thrust Bearing Assembly

A—Lower Rear Thrust Washer
B—Upper Rear Thrust Washer
C—Lower Front Thrust Washer
D—Main Bearing Block Thrust Bearing
E—Main Bearing Cap Thrust Bearing
F—Large Tang
G—Small Tang

RG,RG34710,173 –19–13AUG99–1/1

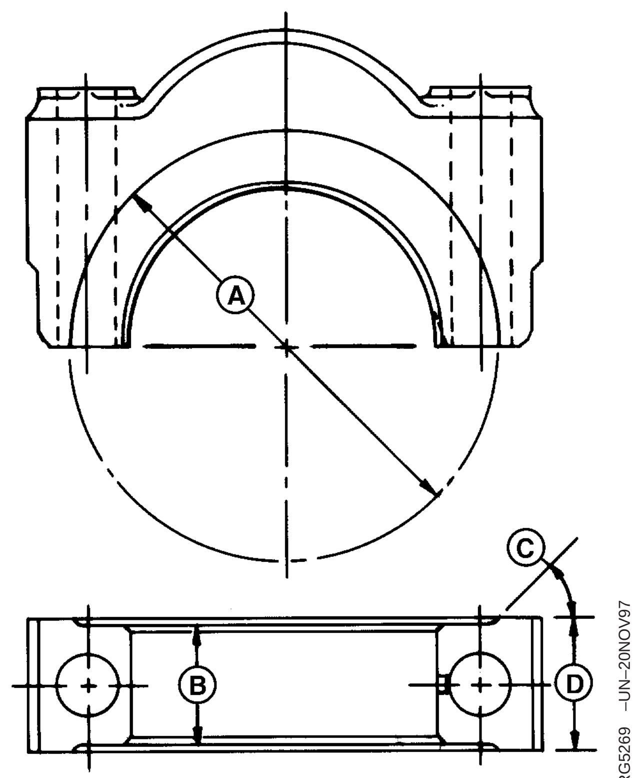
Thrust Bearing New Part Specifications

IMPORTANT: Install thrust bearing in cylinder block and tighten to specification before regrinding or polishing thrust surfaces to ensure that all surfaces on bearing and on block web are correctly aligned.

Specification

Thrust Bearing New Part
Specifications—Thrust Washer
Clearance Base Circle (A).. 162.24—163.76 mm (6.387—6.447 in.)
Thrust Surface Width (B) .... 42.05—42.12 mm (1.656—1.658 in.)
Relief Angle (C).. 45°
Bearing Cap Overall Width (D) .... 43.46 mm (1.711 in.)
Thrust Surface Maximum Runout .... 0.025 mm (0.0010 in.)

A—Thrust Washer Clearance Base Circle
B—Thrust Surface Width
C—Relief Angle
D—Bearing Cap Overall Width



Thrust Bearing Clearance

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Install Main Bearing Inserts in Block

IMPORTANT: If new main or thrust bearing inserts or thrust washers are installed, they must be installed as a matched set.

During assembly, apply a liberal coating of clean engine oil to:

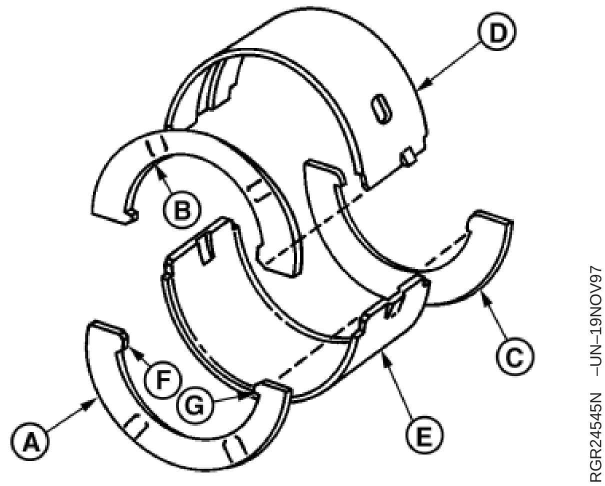
- All main bearing webs in block
- Both sides of main bearing inserts, thrust bearing inserts, and thrust washers
- Entire OD of crankshaft main bearing journals

1. Install six main bearing inserts in block except No. 5 thrust bearing insert. Be sure locating tabs on inserts are properly positioned with slot in block web.

IMPORTANT: Thrust washers (A) and (C) go on both sides of block web only, with the slots facing the crankshaft.

2. Install No. 5 main thrust bearing insert (D) in block. Install upper thrust washer on bearing insert at rear of block web. Be sure tangs on washer are properly positioned on thrust bearing insert.

3. Check to make sure that oil holes in main bearing web are properly aligned with oil holes in bearing inserts.



Thrust Bearing Assembly

A—Lower Rear Thrust Washer
B—Upper Rear Thrust Washer
C—Lower Front Thrust Washer
D—Main Bearing Block Thrust Bearing
E—Main Bearing Cap Thrust Bearing
F—Large Tang
G—Small Tang

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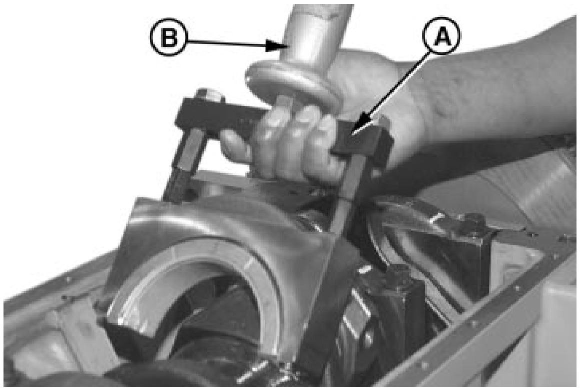
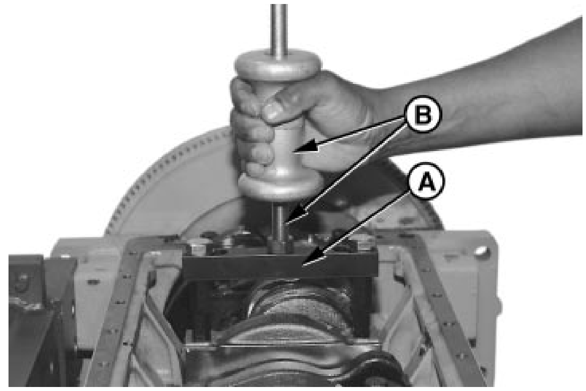
Install Crankshaft



RG8128A –UN–05DEC97

Installing Main Bearing Assembly



RG8125B –UN–20NOV97

Seating Main Bearing Cap

A—JDG996 Main Bearing Cap Puller/Installer
B—D01300AA Slide Hammer

CAUTION: Crankshaft is heavy. Plan a proper lifting procedure to avoid injuries.

NOTE: *If crankshaft is being replaced, vibration damper should be replaced also.*

1. Carefully position crankshaft onto main bearing inserts using a host and lift sling.

2. Dip all main bearing cap screws in clean engine oil. Apply a liberal amount of oil to bearing inserts in caps.

NOTE: *Make sure main bearing caps are installed on the bearing bosses from which they were removed. The numbers stamped on the caps should be on the same side as the numbers on the block. Arrow on cap must point towards front of the engine. If bearing caps have been rebored, make sure bearing caps have numbers stamped on them.*

3. Install each bearing cap and bearings with the recesses and tabs aligned in matching order using JDG996 Main Bearing Cap Puller/Installer (A) and D01300AA Slide Hammer (B). Make sure bearing tabs also match up before tightening cap screws.

NOTE: *Main bearing caps may also be installed by evenly tightening both main bearing cap screws.*

IMPORTANT: Do not use pneumatic wrench to install main bearing cap screws, as damage may occur to threads.

4. Before tightening cap screws on main bearing caps, align upper and lower thrust flanges on main thrust bearings. Using a soft-face hammer, tap crankshaft to the rear and then to the front to line up thrust bearing flanges.

5. Tighten No. 1, 2, 3, 4, 6, and 7 main bearing cap screws to the following specification.

Specification

Crankshaft Main Bearing Cap
Screws—Initial Torque.. 68 N•m (50 lb-ft)

Hand-tighten No. 5 main thrust bearing cap screws.

Continued on next page

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NOTE: DO NOT PRY crankshaft on No. 5 main thrust bearing.

6. Gently pry crankshaft rearward and then forward to align thrust washers on No. 5 main thrust bearing.

7. Tighten No. 5 main thrust bearing cap screws to the following specification.

Specification

Crankshaft Main Bearing Cap
Screws—Initial Torque... 68 N•m (50 lb-ft)

8. Tighten all main bearing cap screws (including No. 5) to the following specification.

Specification

Crankshaft Main Bearing Cap
Screws—Final Torque .... 320 N•m (236 lb-ft)

9. Turn crankshaft by hand. If it does not turn easily, disassemble parts and determine the cause.

Continued on next page

RG,RG34710,176 –19–05SEP02–2/3

10. Install connecting rod caps with bearing using new cap screws. (See INSTALL PISTONS AND CONNECTING RODS in Group 030 for procedure to install and tighten connecting rod cap screws.)

IMPORTANT: Do not use pneumatic wrenches to tighten connecting rod cap screws. Threads can be damaged.

11. Install rear oil seal housing. (See INSTALL CRANKSHAFT REAR OIL SEAL AND HOUSING later in this group.)

12. Install rear oil seal and wear sleeve. (See INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE ASSEMBLY later in this group.)

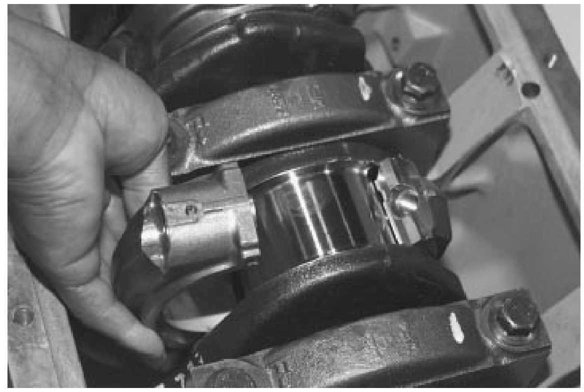
13. Install flywheel. (See INSTALL FLYWHEEL earlier in this group.)

14. Install flywheel housing. (See REMOVE AND INSTALL FLYWHEEL HOUSING earlier in this group.)

15. Install six piston spray jets. (See REMOVE AND INSTALL PISTON SPRAY JETS in Group 030.)

16. Check crankshaft end play. (See CHECK CRANKSHAFT END PLAY earlier in this group.)

17. Install timing gear cover. (See INSTALL TIMING GEAR COVER later in this group.)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Installing Rod Caps

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Install Crankshaft Rear Oil Seal Housing

NOTE: Clean all gasket material and sealant from oil pan gasket rail prior to installing rear seal housing for proper housing alignment.

Ensure that OD of crankshaft flange and ID of rear seal housing is free of nicks and burrs. Restore damaged surfaces with emery cloth and clean surfaces thoroughly.

1. Install JDG977 Pan Rail Aligner (A) onto rear pan rail (as shown) using two cap screws provided. Tighten cap screws securely.

2. Install rear seal housing (B) using a new gasket; bottom edge of gasket should extend through opening in alignment plate. Tighten housing cap screws finger tight.

3. Install larger end of JDG975 Timing Gear Cover/Rear Seal Housing Aligner (C) onto crankshaft rear flange with tapered locators (D) at 3 o'clock and 9 o'clock position.

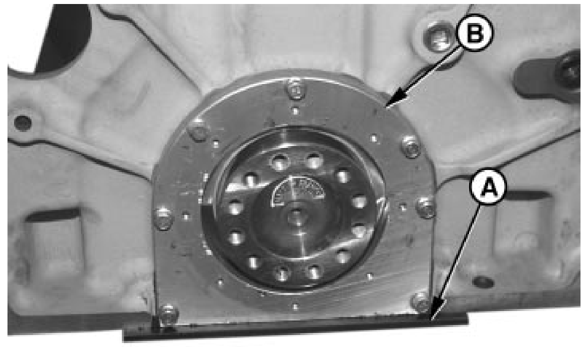
4. Center housing and tighten cap screws to specifications using torque sequence shown in lower illustration.

Specification

Rear Oil Seal Housing Cap Screws—Torque .... 25 N•m (18 lb-ft)

5. Remove alignment tools from engine and trim rear seal housing gasket flush with bottom of seal housing and oil pan gasket surface.

A—JDG977 Front/Rear Pan Rail Aligner
B—Rear Seal Housing
C—JDG975 Timing Gear Cover/Rear Seal Housing Aligner
D—Tapered Locators



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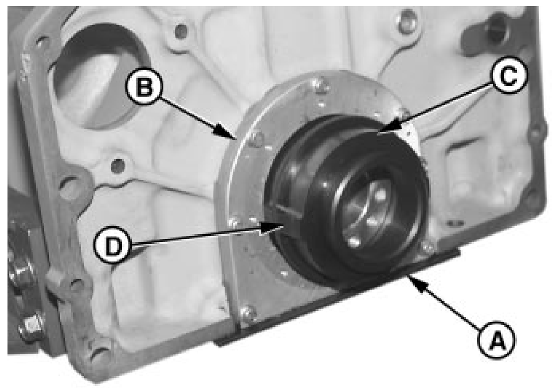
Rear Seal Housing Installed on Aligner



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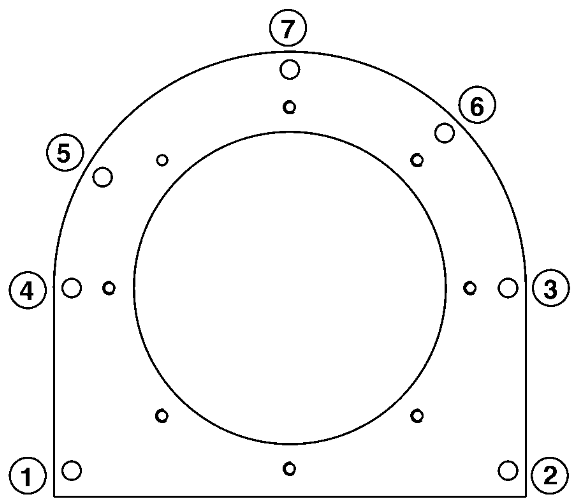
Centering Rear Seal Housing with JDG975



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Rear Seal Housing Torque Sequence

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Install Crankshaft Rear Oil Seal and Wear Sleeve Assembly

1. Thoroughly clean ID of rear seal housing and OD of crankshaft flange. Dry with a clean shop towel.

2. Center JDG974A Forcing Screw (A) rear face of crankshaft and tighten cap screws securely.

3. Apply a light coat of LOCTITE® 680 (TY15969) Retaining Compound around OD of rear crankshaft flange.

4. Position rear seal assembly (B) and JDG974A Seal Installer (C) onto rear crankshaft flange and forcing screw.

NOTE: Align mounting holes in seal casing with holes in rear seal housing as seal assembly is installed.

5. Lubricate forcing screw threads and both sides of friction washer. Install washer and nut; tighten nut until installer bottoms.

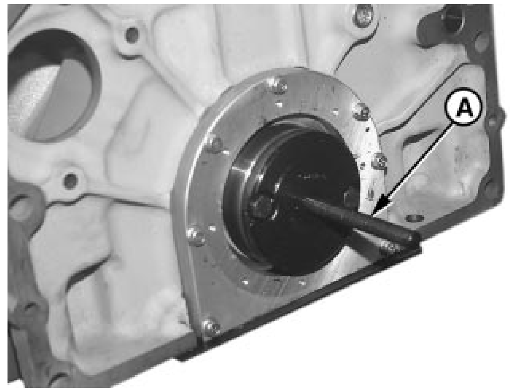
6. Remove seal installation tool set and clean any sealant from tool.

7. Center seal casing and tighten cap screws to specifications following sequence in lower illustration.

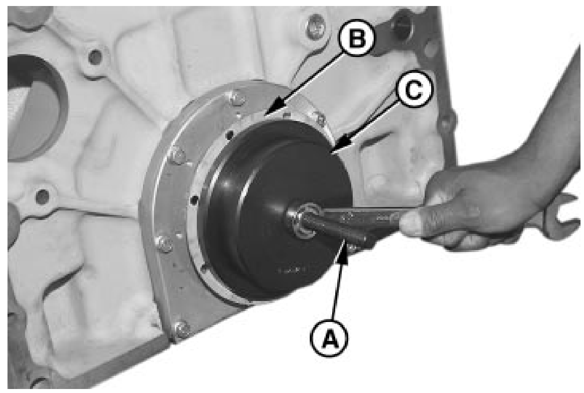
Specification

Rear Oil Seal-to-Housing Cap Screws—Torque .... 15 N•m (11 lb-ft)

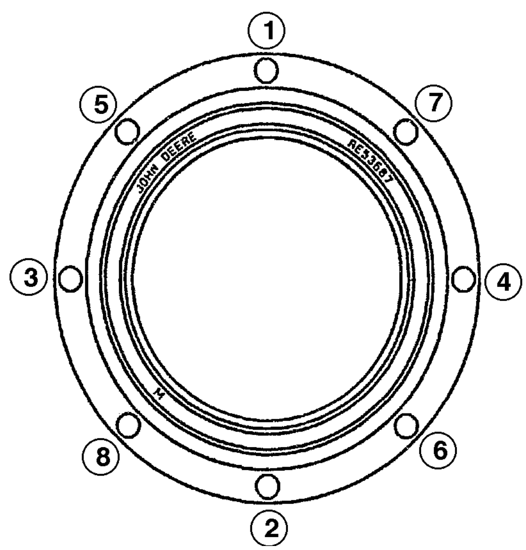
A—JDG974A Forcing Screw
B—Rear Seal Assembly
C—JDG974A Seal Installer



JDG974-2 Forcing Screw Installed



Installing Rear Crankshaft Oil Seal



Rear Seal Torque Sequence

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Install Timing Gear Cover

NOTE: New service timing gear covers and camshaft gear access covers have pressed-in-place gasket grooves. These covers use silicon rubber gaskets. DO NOT apply any sealant to rubber gaskets. Fel-Pro gaskets are still available for service on older covers without gasket grooves.

1. Clean timing gear cover gasket mating surfaces.

2. Clean all gasket material and sealant (if applied) from oil pan gasket rail.

3. Install JDG977 Pan Rail Aligner (A) onto front pan rail (as shown) using cap screws provided. Tighten cap screws securely.

NOTE: If necessary, guide pins may be used to ensure correct gasket (B, earlier engines) and timing gear cover (C) alignment with mounting holes.

IMPORTANT: On earlier engines where sealant was applied, clean front plate and timing gear cover surfaces with TY16285 Clean and Cure Primer prior to assembly. Follow instructions on label.

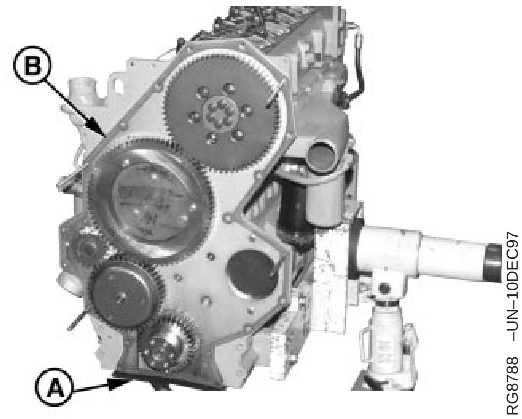
4. **On earlier engines with Fel-Pro gaskets only**, soak both sides of new timing gear cover gasket with LOCTITE® 242 Thread Lock and Sealant and let dry for 15 minutes or until dry to the touch.

   Apply a 3 mm (1/8 in.) wide bead of LOCTITE® 515 Flexible Sealant to timing gear cover side of gasket.

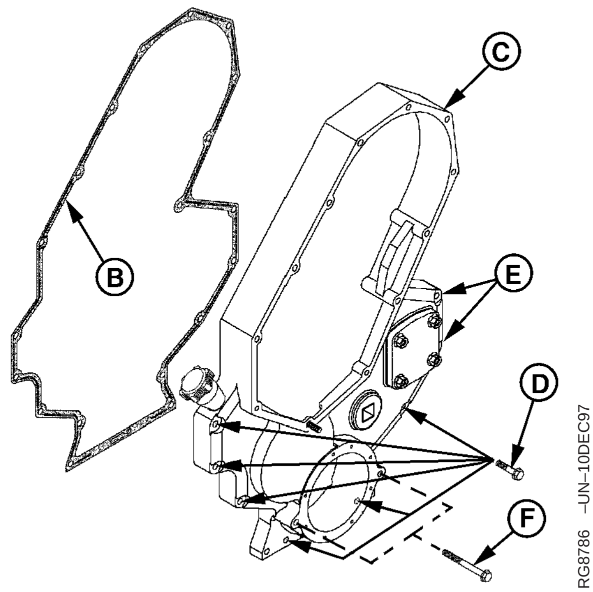
5. Carefully install gasket on timing gear cover.

   On later engines with press-in-place silicon rubber gaskets, ensure gasket is properly seated in grooves of timing gear cover.

6. Install timing gear cover and wipe off excess sealant, if used.



JDG977 Pan Rail Aligner Installed



Timing Gear Cover Cap Screw Locations

A—JDG977 Pan Rail Aligner
B—Gasket (Fel-Pro Gasket Shown)
C—Timing Gear Cover
D—M10 x 55 mm (2.17 in.)—6 Used
E—M10 x 65 mm (2.56 in.)—2 Used
F—M10 x 110 mm (4.33 in.)—2 Used

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7. Install cap screws (D), (E) and (F) at respective locations shown. Tighten cap screws finger tight only so that cover can be correctly centered.

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8. Install, smaller end of JDG975 Timing Gear Cover/Rear Seal Housing Aligner (A) onto front crankshaft flange with tapered locators (B) at 3 o'clock and 9 o'clock position.

NOTE: Earlier engines with Fel-Pro gaskets using sealant require an initial torque and a final torque sequence. Later engines with press-in-place gaskets require only a final torque.

9. Center cover with crankshaft flange and initially tighten cap screws (on earlier engines) to specifications, following sequence in lower illustration. Tighten two longest cap screws located next to crankshaft center line. Then, go to bottom cap screws (alternating from side-to-side) and tighten remaining cap screws to specifications.

Specification

Timing Gear Cover Cap Screws (Early Engines Only)[1]—Initial Torque .... 45 N•m (33 lb-ft)

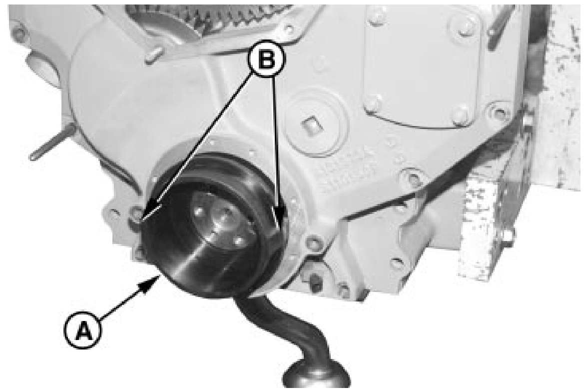
Tighten timing gear cover cap screws following sequence in lower illustration to the following specification.

Specification

Timing Gear Cover Cap Screws—Final Torque .... 63 N•m (46 lb-ft)

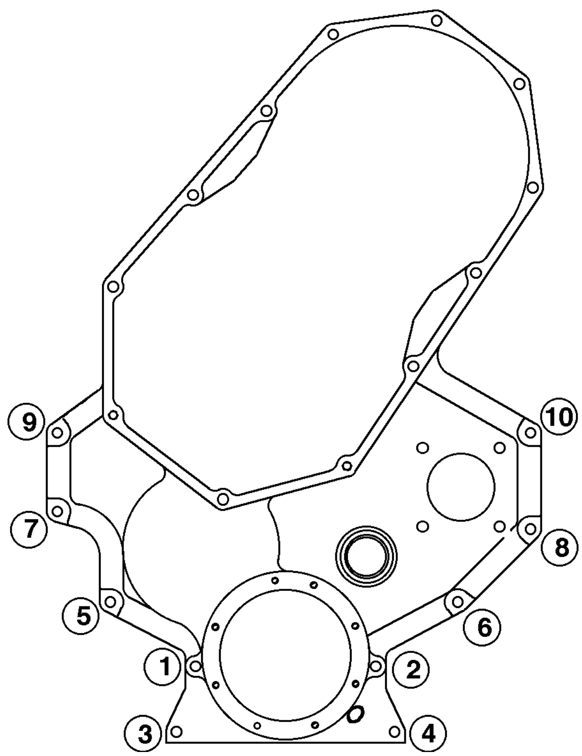
10. Remove alignment tools from engine.

A—Seal Housing Aligner
B—Tapered Locators



RG8790 –UN–11DEC97

Aligning Timing Gear Cover



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Timing Gear Cover Torque Sequence

[1] *Initial torque is required only on early timing gear covers using Fel-Pro gaskets with sealant.*

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NOTE: If fixed fan drive assembly (cast into camshaft gear access cover) was removed, it must be reinstalled before installing access cover. In this case, be sure cap screw (F) is installed in cover before pressing on fan hub/pulley. (See REPLACE BEARINGS IN FAN DRIVE ASSEMBLY in Group 070.)

IMPORTANT: On earlier engines where sealant was applied, clean timing gear cover and camshaft gear access cover gasket surfaces with TY16285 Clean and Cure Primer prior to assembly. Follow directions on label.

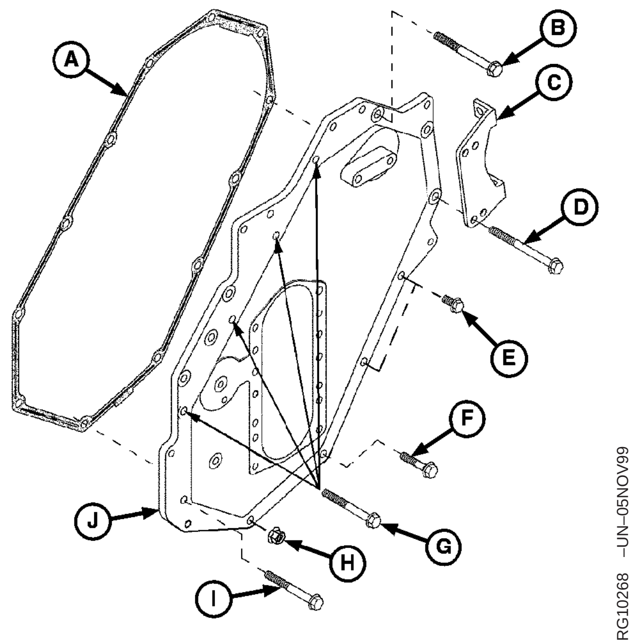
11. **On earlier engines with Fel-Pro gaskets only**, soak both sides of new camshaft gear access cover gasket (A) with LOCTITE®242 Thread Lock and Sealant and let dry for 15 minutes or until dry to the touch.

    Apply a 3 mm (1/8 in.) wide bead of LOCTITE® 515 Flexible Sealant to timing gear cover side of gasket.

12. Carefully install gasket on timing gear cover mounting surface.

    On later engines with press-in-place silicon rubber gaskets, ensure gasket is properly seated in grooves of timing gear cover.

13. Install camshaft gear access cover and wipe off excess sealant, if used.



Installing Camshaft Gear Access Cover

A—Gasket
B—M10 x 110 mm
C—A/C Compressor Bracket
D—M10 x 130 mm (w/Compressor Bracket)
M10 x 110 mm (w/o Compressor Bracket)
E—M10 x 30 mm (005482—)
M10 x 100 mm (—005481)
F—M10 x 100 mm (005482—)
M120 x 30 mm (—005481)
G—M10 x 100 mm
H—Flange Nut
I—M10 x 100 mm (005482—)
M10 x 30 mm (—005481)
J—Camshaft Gear Access Cover

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Continued on next page RG,RG34710,179 –19–05SEP02–4/6

14. Install cap screws (B), (D—G) and (I), and nut (H) in respective locations.

NOTE: Earlier engines with Fel-Pro gaskets using sealant require an initial torque and a final torque sequence. Later engines with press-in-place gaskets require only a final torque.

15. Initially tighten cap screws (and stud nut) to specification, following sequence in lower drawing.

Specification

Camshaft Gear Access Cover
Cap Screws (Early Engines
Only)[1]—Initial Torque .... 50 N•m (37 lb-ft)

Finish tightening camshaft gear access cover cap screws (following sequence in lower drawing) to the following specification.

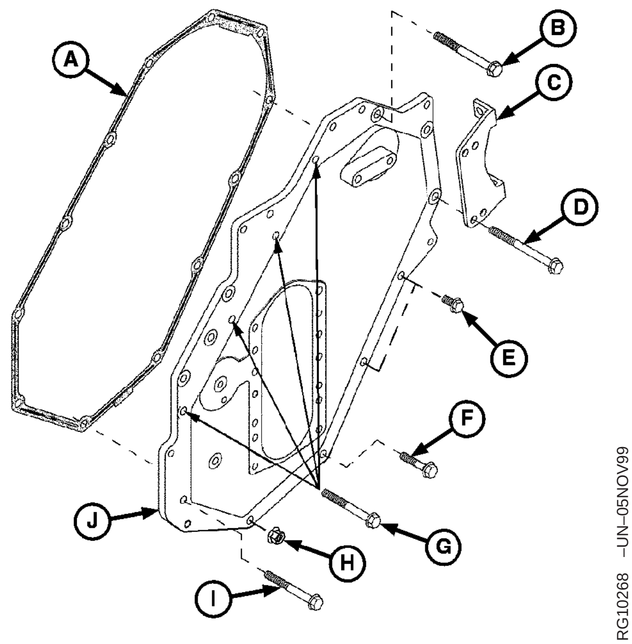
Specification

Camshaft Gear Access Cover
Cap Screws—Final Torque .... 68 N•m (50 lb-ft)

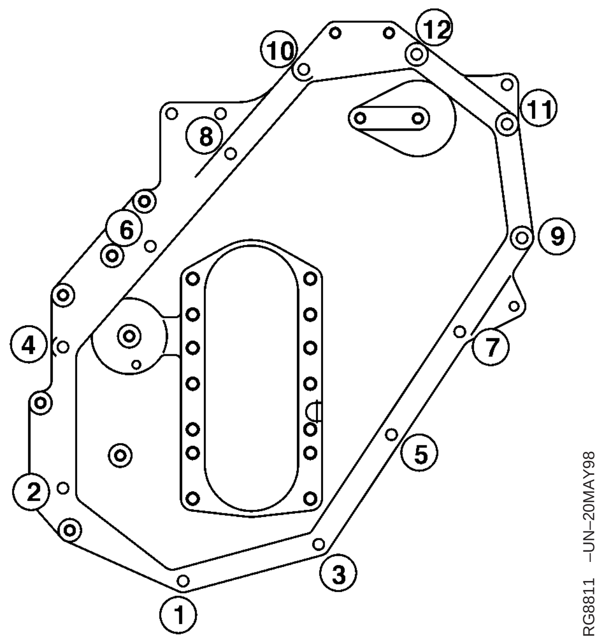
16. Install engine oil pan. (See INSTALL ENGINE OIL PAN in Group 060.)

17. Install crankshaft vibration damper. (See INSTALL CRANKSHAFT VIBRATION DAMPER AND FRONT OIL SEAL next in this group.)

A—Gasket
B—M10 x 110 mm
C—A/C Compressor Bracket
D—M10 x 130 mm (w/Compressor Bracket)
M10 x 110 mm (w/o Compressor Bracket)
E—M10 x 30 mm (005482—)
M10 x 100 mm (—005481)
F—M10 x 100 mm (005482—)
M120 x 30 mm (—005481)
G—M10 x 100 mm
H—Flange Nut
I—M10 x 100 mm (005482—)
M10 x 30 mm (—005481)
J—Camshaft Gear Access Cover



Installing Camshaft Gear Access Cover



Camshaft Gear Cover Torque Sequence

[1] *Initial torque is required only on early timing gear covers using Fel-Pro gaskets with sealant.*

Continued on next page

18. Install adjustable fan drive assembly and tighten cap screws to specifications.

Specification

Adjustable Fan Drive Assembly Mounting Cap Screws—Torque	90 N•m (66 lb-ft)

NOTE: Whenever the timing gear cover has been removed and reinstalled, the crankshaft position sensor must be checked to ensure proper distance from crankshaft timing wheel. This applies even if the sensor was not removed from timing gear cover.

19. Install crankshaft position sensor, if removed, or check sensor-to-crankshaft timing wheel dimension. See REMOVE AND INSTALL CRANKSHAFT POSITION SENSOR in the appropriate fuel systems manual.

    Delphi/Lucas ECU controlled fuel systems:

    - See REMOVE AND INSTALL CRANKSHAFT POSITION SENSOR in CTM 115, Section 02, Group 110.

    John Deere Level 6 ECU controlled fuel systems:

    - See REMOVE AND INSTALL CRANKSHAFT POSITION SENSOR in CTM 188, Section 02, Group 110.

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Install Crankshaft Vibration Damper and Front Oil Seal

IMPORTANT: The vibration damper assembly is not repairable and should be replaced every 5 years or 4500 hours, whichever occurs first.

ALWAYS replace vibration damper whenever crankshaft is replaced and at major engine overhaul. Also replace damper when a short block, complete block, or reman basic engine is installed.

Front crankshaft oil seal (A) must be installed onto vibration damper before installing damper onto engine.

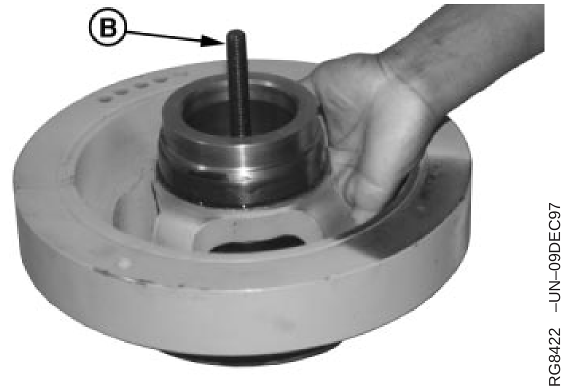
Install Front Seal onto Vibration Damper

1. Apply LOCTITE® 680 (TY15969) Retaining Compound around OD of crankshaft flange. Position front oil seal assembly on flange with rubber seal ring facing up as shown.

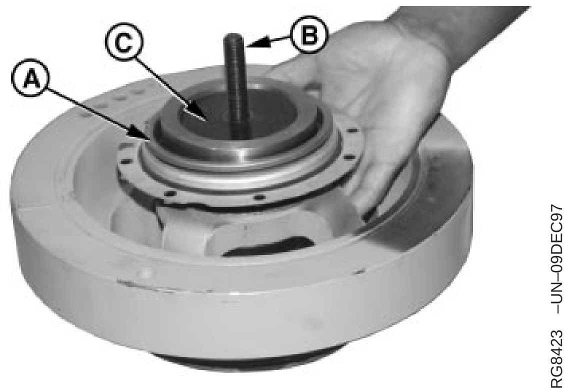
NOTE: Lubricate threads of forcing screw with multi-purpose grease.

2. Lay vibration damper on table (front face down) with JDG974-2 Seal Installer Forcing Screw (B) extending through damper ID.

3. Hold forcing screw against front face of damper and position JDG974-3 Guide Plate (C) in ID of damper as shown.



JDG974-2 Forcing Screw Installed on Damper



Front Seal Positioned on Damper

A—Front Crankshaft Oil Seal
B—JDG974-2 Seal Installer Forcing Screw
C—JDG974-3 Guide Plate

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Continued on next page

RG,RG34710,180 –19–13AUG99–1/4

4. Install JDG974-1 Seal Installer (A) with friction washer and nut.

5. Tighten nut until installer bottoms on rear face of damper.

6. Remove tools and clean any sealant from tools.

A—JDG974-1 Seal Installer

RG8424 –UN–09DEC97

Seating Front Seal on Damper

RG8535 –UN–20MAY98

Front Seal Installed on Damper

Continued on next page RG,RG34710,180 –19–13AUG99–2/4

Install Vibration Damper on Engine

1. Install JDG973-1 Damper Remover/Installer Hub (A) onto front face of crankshaft using two cap screws provided with kit. Tighten cap screws securely.

2. Lubricate forcing screw threads with all purpose grease.

3. Position vibration damper and seal (B) on forcing screw hub as shown.

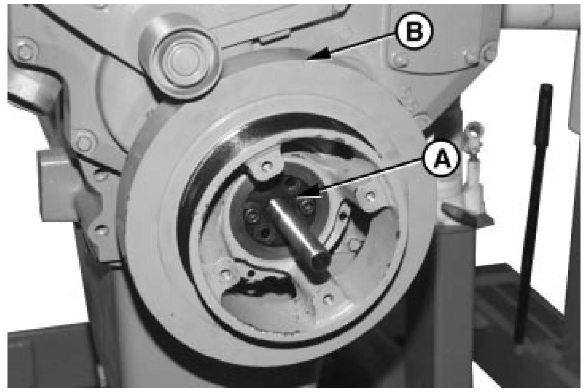
4. Install JDG973-2 Cross Block (C) onto forcing screw. Secure cross block with two cap screws finger tight.

NOTE: Lubricate forcing screw and both sides of friction washer with multi-purpose grease prior to each use.

5. Install friction washer and nut against cross block.

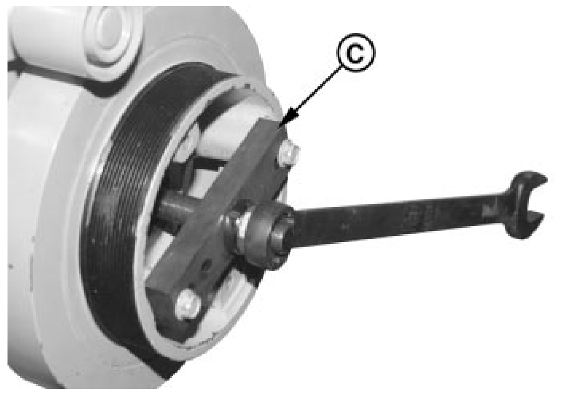
NOTE: Cut-outs in seal casing should be at 3 o'clock and 9 o'clock position for timing gear cover cap screw clearance. Align holes in casing with cap screw holes as damper and seal are installed.

6. Tighten nut until damper bottoms on crankshaft flange. Remove JDG973 tool set from engine.



RG8425 –UN–09DEC97

Installing JDG973-1 Hub



RG8426 –UN–09DEC97

Installing Vibration Damper

A—JDG973-1 Damper Remover/Installer Hub
B—Vibration Damper And Seal
C—JDG973-2 Cross Block

Continued on next page RG,RG34710,180 –19–13AUG99–3/4

7. Install large washer onto front nose of crankshaft to secure damper to crank. Tighten cap screws in sequence shown to specifications.

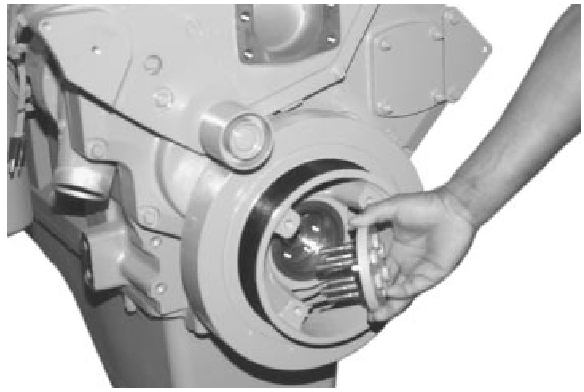
Specification
Damper Hub Cap Screws—
Torque .... 125 N•m (92 lb-ft)

8. If required, install pulley on damper and tighten cap screws to specifications.

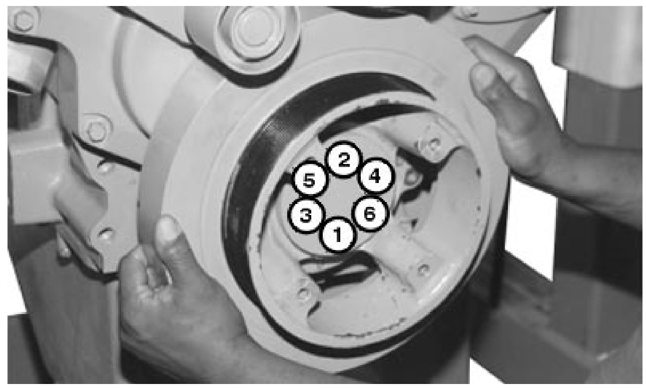
Specification
Pulley-to-Damper Cap Screws—
Torque .... 125 N•m (92 lb-ft)

9. Install front seal-to-timing gear cover cap screws and tighten to specifications following sequence in lower illustration.

Specification
Front Oil Seal Cap Screws—
Torque .... 15 N•m (11 lb-ft)

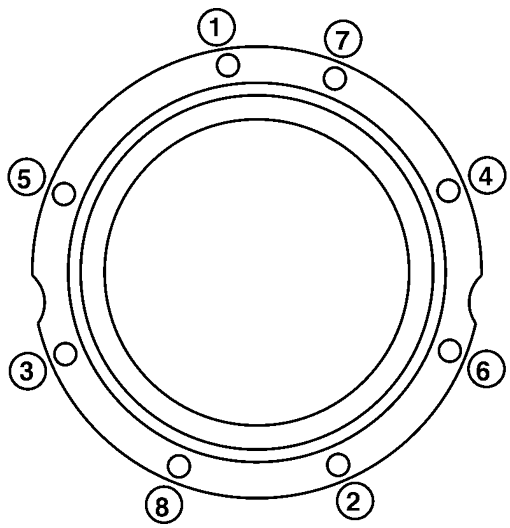

RG8175 –UN–21MAY98

Installing Damper Retainer Cap Screws



RG10247 –UN–30JUL99

Damper Torque Sequence



RG8809 –UN–20MAY98

Front Seal Torque Sequence

RG,RG34710,180 –19–13AUG99–4/4

Complete Final Assembly

1. Install idler pulley assembly. (See REPLACE BELT TENSIONER ASSEMBLY, in Group 070.)

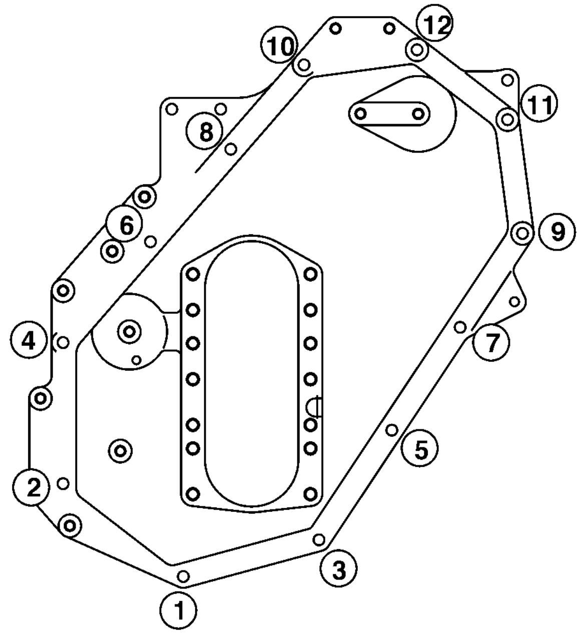
2. Install oil pan and service engine with clean engine oil. (See INSTALL ENGINE OIL PAN, in Group 060.)

3. Fill cooling system with proper coolant (See DIESEL ENGINE COOLANT RECOMMENDATIONS in Section 01, Group 002.)

4. Perform engine break-in. (See ENGINE BREAK-IN GUIDELINES in Group 010.)

RG,RG34710,182 –19–13AUG99–1/1

Camshaft Gear Access Cover Torque Sequence



Camshaft Gear Access Cover Torque Sequence

RG,RG34710,188 –19–30SEP97–1/1

Check and Adjust Camshaft-to-Crankshaft Timing

Check Camshaft-to-Crankshaft Timing

1. Remove rocker arm cover. See (REMOVE AND INSTALL ROCKER ARM COVER in Group 020.)

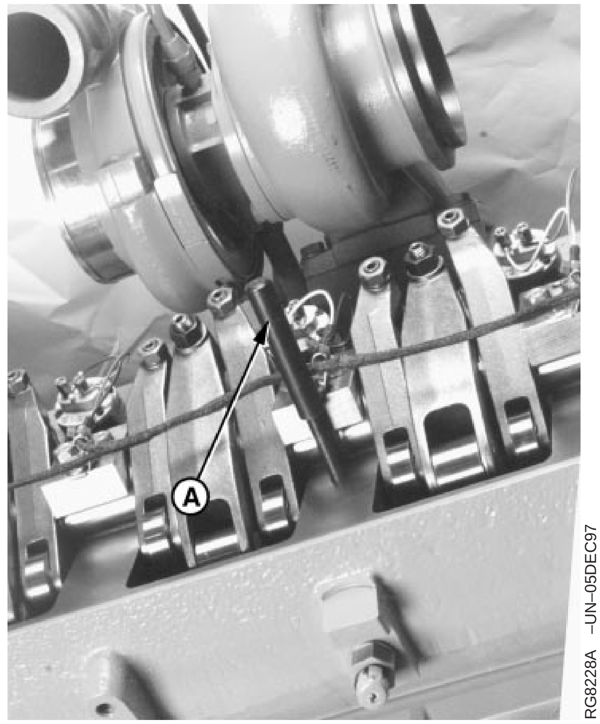
2. Remove plug from cylinder block and install JDG820 Flywheel Turning Tool (B).

IMPORTANT: JDG971 Timing Pin MUST BE installed into camshaft timing slot (A) first before attempting to install second timing pin into crankshaft timing slot (C).

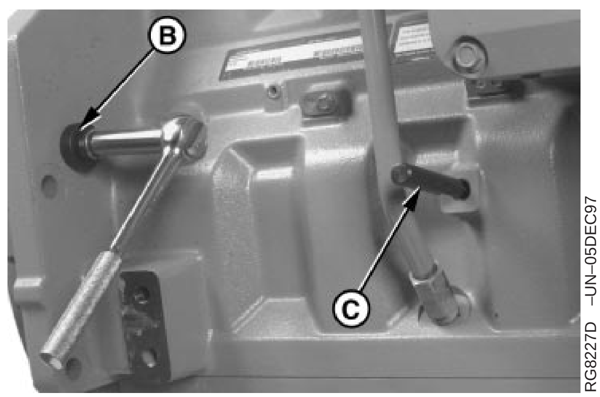
3. Rotate engine flywheel in running direction (counterclockwise as viewed from rear) until JDG971 Timing Pin (A) engages single timing slot (D) in camshaft. The proper timing slot can be found by viewing camshaft timing lobe through camshaft timing pin bore while rotating engine. The double timing slot (E) will be at approximately 11 o'clock (viewed from rear of engine) when pin is installed in slot (D). This ensures that engine is locked at TDC of No. 1 cylinder's compression stoke. Intake and exhaust rocker arms on No. 1 cylinder should be loose.

4. Remove threaded plug from crankshaft timing hole below oil cooler and filter housing assembly.

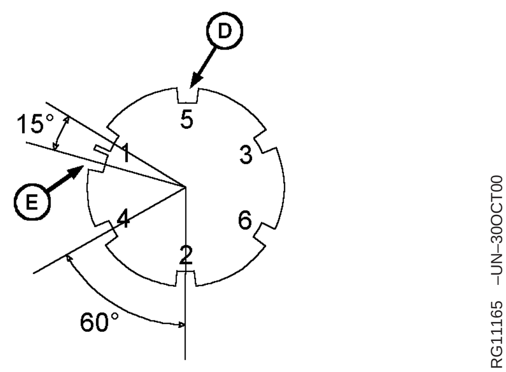
A—JDG971 Timing Pin
B—JDG820 Flywheel Turning Tool
C—JDG971 Timing Pin
D—Single Timing Slot
E—Double Timing Slot



JDG971 Timing Pin in Camshaft



JDG971 Timing Pin in Crankshaft



Camshaft Timing Slot

Continued on next page

IMPORTANT: DO NOT insert timing pin full depth into cylinder block crankshaft timing hole when rotating engine flywheel until double slot on camshaft timing lobe is at approximately 11 o'clock (viewed from rear of engine) to avoid crankshaft counterweight bending timing pin.

5. Slightly move engine flywheel back and forth with turning tool until a second JDG971 Timing Pin (C) can be installed in slot in crankshaft. This ensures that camshaft and crankshaft are in sync (properly timed).

   If timing pin does not enter crankshaft timing slot, crankshaft MUST BE timed to camshaft as detailed next in this group.

RG,RG34710,189 –19–13AUG99–2/3

Adjust Camshaft-to-Crankshaft Timing

1. Leave JDG971 Timing Pin in camshaft timing slot and remove camshaft gear access cover (shown removed) from timing gear cover. (See REMOVE TIMING GEAR COVER in Group 040.)

2. Loosen camshaft gear retainer cap screws (A).

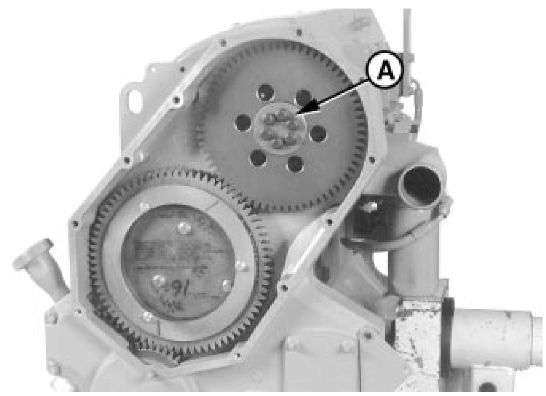
3. Rotate crankshaft with JDG820 Flywheel Turning Tool (B) and install second JDG971 Timing Pin (C) in crankshaft timing slot.

4. Adjust gear train backlash and complete final assembly. (See ADJUST FRONT TIMING GEAR BACKLASH, next in this group.)

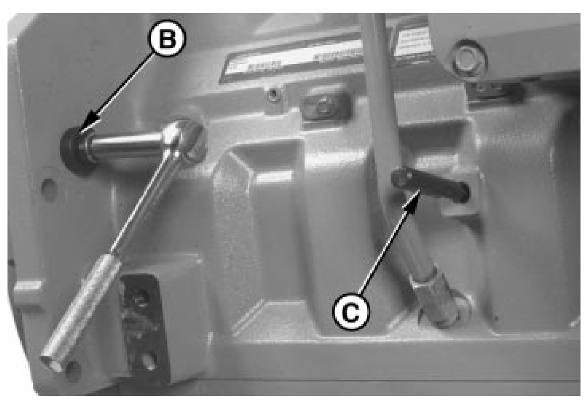
5. Tighten camshaft gear retainer plate to following torque:

Specification

Camshaft Gear Retainer	
Plate-to-Camshaft—Initial Torque	100 N•m (74 lb-ft)
Second Torque	150 N•m (110 lb-ft)
Final Retorque	150 N•m (110 lb-ft)



Camshaft Gear Retainer Cap Screws



JDG971 Timing Pin in Crankshaft

A—Camshaft Gear Retainer Cap Screws
B—JDG820 Flywheel Turning Tool
C—JDG971 Timing Pin

RG,RG34710,189 –19–13AUG99–3/3

Adjust Front Timing Gear Backlash

1. Remove camshaft gear access cover from timing gear cover. (See REMOVE TIMING GEAR COVER in Group 040.)

2. Remove rocker arm cover from cylinder head. (See REMOVE AND INSTALL ROCKER ARM COVER in Group 020.)

IMPORTANT: Rocker arm assembly should be completely installed before adjusting timing gear backlash.

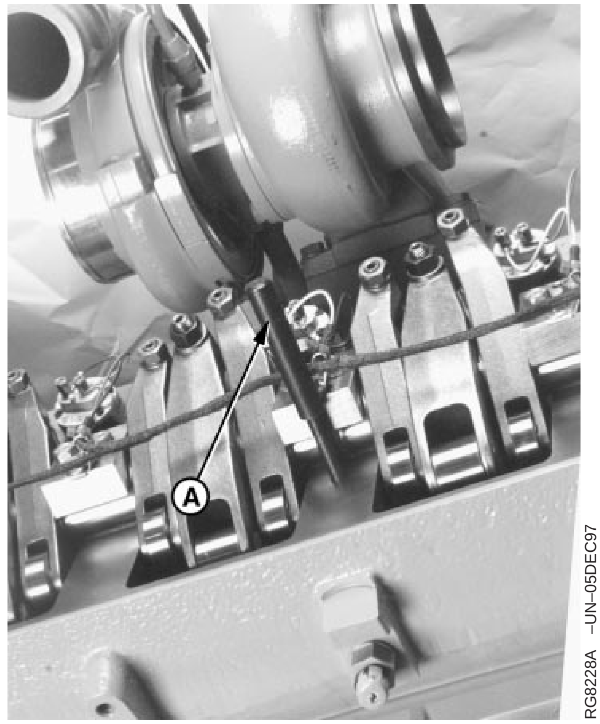
3. Lock camshaft at No. 1 TDC compression stroke by rotating engine with JDG820 Flywheel Turning Tool (B) until JDG971 Timing Pin (A) fully engages timing slot (D) in camshaft. The proper timing slot can be found by viewing camshaft timing lobe through camshaft timing pin bore while rotating engine. The double timing slot (E) will be at approximately 11 o'clock (viewed from rear of engine) when pin is installed in slot (D).

   This ensures that engine is locked at TDC of No. 1 cylinder's compression stoke. Intake and exhaust rocker arms on No. 1 cylinder should be loose.

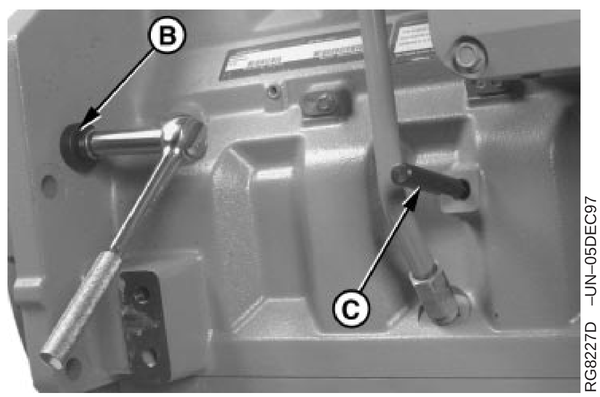
IMPORTANT: DO NOT insert timing pin full depth into cylinder block crankshaft timing hole when rotating engine flywheel until double slot on camshaft timing lobe is at approximately 11 o'clock (viewed from rear of engine) to avoid crankshaft counterweight bending timing pin.

4. Remove plug and install a second JDG971 Timing Pin (C) in crankshaft timing hole on right-hand side of cylinder block. Rotate engine flywheel back and forth with JDG820 Turning Tool until timing pin (C) enters timing slot in crankshaft counterweight.

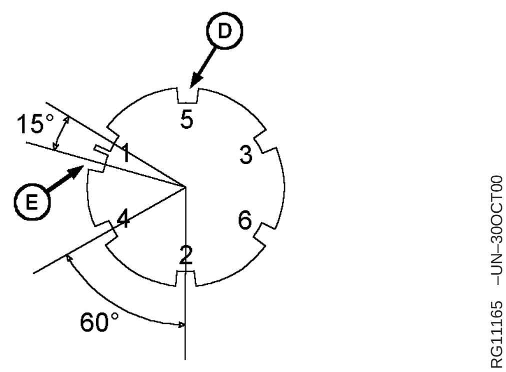
A—JDG971 Timing Pin
B—JDG820 Flywheel Turning Tool
C—JDG971 Timing Pin
D—Single Timing Slot
E—Double Timing Slot



JDG971 Timing Pin in Camshaft



JDG971 Timing Pin in Crankshaft



Camshaft Timing Slot

Continued on next page

At this location the keyway in crankshaft drive gear will be at the 12 o'clock position, visible when vibration damper is removed. This is TDC of No. 1 cylinder's compression stroke. Also, with timing pin installed in camshaft and crankshaft slots, this ensures that camshaft-to-crankshaft timing is within specification.

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5. Loosen all six camshaft gear retainer cap screws.

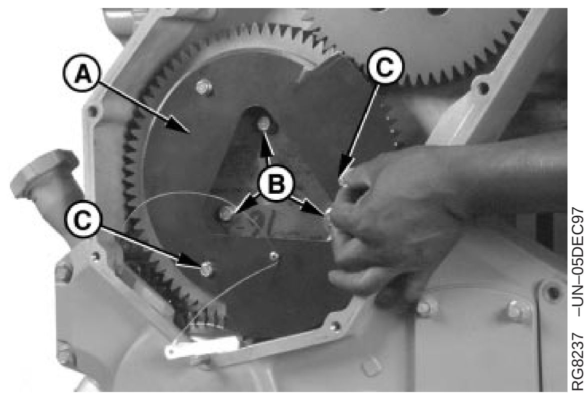
6. Loosen three upper idler gear bearing carrier cap screws (B), so that carrier can be moved by hand. Do not loosen more than required for ease of assembly.

NOTE: Upper hole on template is larger and fits over upper cap screw. This ensures proper placement of template when installed.

7. Remove two lower cap screws (C) from upper idler gear thrust plate and install JDG993 Timing Gear Backlash Template (A) as shown. Re-install two lower cap screws through template and tighten to specification.

Specification

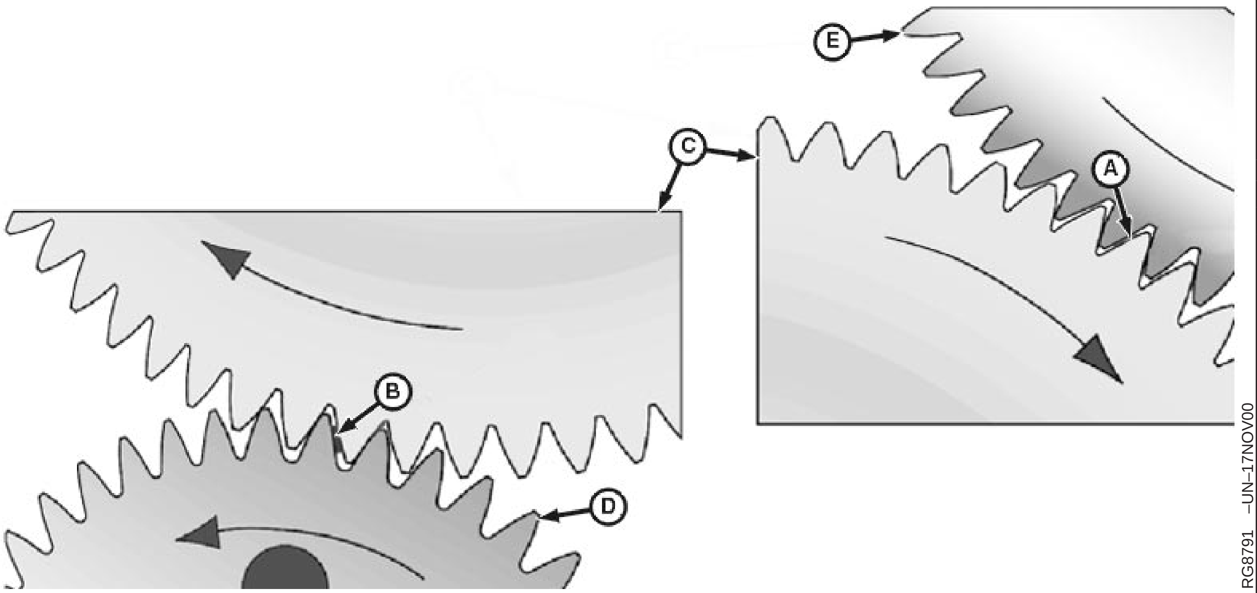
Upper Idler Gear Thrust Plate
Cap Screws—Initial Torque.. 35 N•m (26 lb-ft)



Installing JDG993 Backlash Template

A—JDG993 Timing Gear Backlash Template
B—Upper Idler Gear Bearing Carrier Cap Screws
C—Lower Cap Screws

Continued on next page RG,RG34710,190 –19–19SEP02–3/6



Backlash Adjusting Shim Placement

A—0.13 mm (0.005 in.) Shim
B—0.25 mm (0.010 in.) Shim
C—Idler Gear
D—Oil Pump Gear
E—Camshaft Gear

8. Install shims (A and B) in (non-loaded) side of gear teeth closest to tab on backlash template as shown. Also, shim must be installed between gear teeth that are meshing deepest in the root.

   - 0.13 mm (0.005 in.) shim (A) for idler gear-to-camshaft gear backlash.
   - 0.25 mm (0.010 in.) shim (B) for idler gear-to-oil pump gear backlash.

Specification

Camshaft Gear-to-Upper Idler Gear—Backlash.. 0.13 mm (0.005 in.)
Oil Pump Gear-to-Upper Idler Gear—Backlash.. 0.25 mm (0.010 in.)

Continued on next page RG,RG34710,190 –19–19SEP02–4/6

IMPORTANT: Both shims MUST BE tight between gear teeth before and after tightening idler carrier cap screws.

9. Weight of gear should seat idler gear and carrier assembly between shims (A and B) so that both shims are tight and cannot be removed from gear teeth.

10. Remove three idler gear carrier cap screws (C), one at a time, and apply LOCTITE® 242 Thread Lock and Sealer. Re-install and tighten to specifications.

Specification

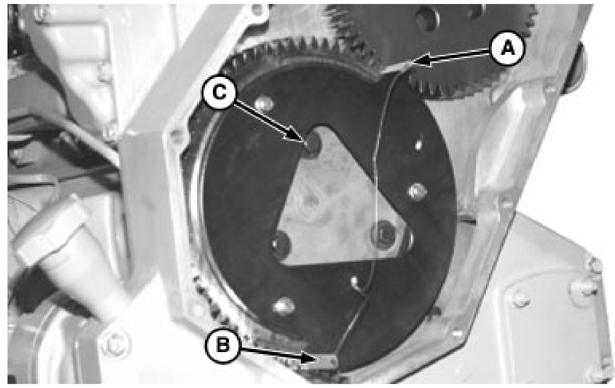
Upper Idler Gear Thrust Plate
Cap Screws—Initial Torque.. 35 N•m (26 lb-ft)

Both shims MUST BE tight between gear teeth.

11. Retorque idler gear carrier cap screws to specifications.

Specification

Upper Idler Gear Thrust Plate
Cap Screws—Final Torque .... 35 N•m (26 lb-ft)



RG12422 –UN–16SEP02

Idler Gear Carrier Cap Screws

A—0.13 mm (0.005 in.) Shim
B—0.25 mm (0.010 in.) Shim
C—Cap Screws

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RG,RG34710,190 –19–19SEP02–5/6

12. Remove six camshaft retainer cap screws, one and a time in sequence shown, and apply LOCTITE® 242 Thread Lock and Sealer. Re-install and tighten to specification.

Specification

Camshaft Gear Retainer
Plate-to-Camshaft—Initial Torque .... 100 N•m (74 lb-ft)

13. Next, retorque cap screws to the following specification in sequence shown.

Specification

Camshaft Gear Retainer
Plate-to-Camshaft—Second
Torque .... 150 N•m (110 lb-ft)

14. Finally, retorque cap screws to the following specification in sequence shown.

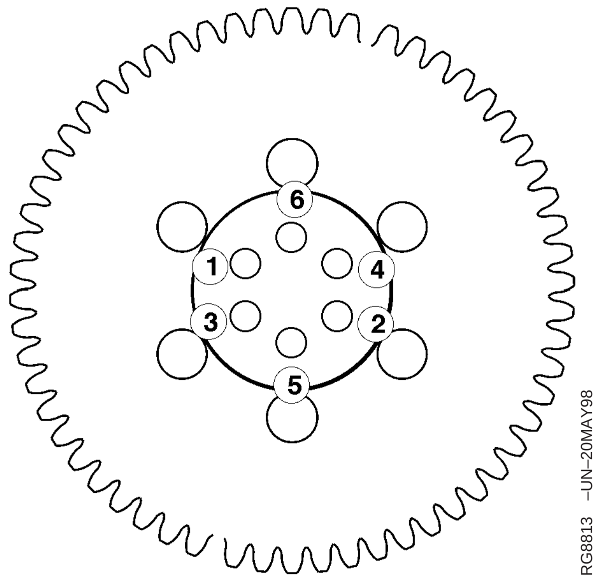
Specification

Camshaft Gear Retainer
Plate-to-Camshaft—Final
Retorque.. 150 N•m (110 lb-ft)

15. Remove two lower idler gear thrust plate cap screws and backlash template and rotate engine flywheel to remove shims. Apply LOCTITE® 242 Thread Lock and Sealer to two cap screws. Re-install and tighten to specifications.

Specification

Upper Idler Gear Thrust Plate
Cap Screws—Final Torque .... 35 N•m (26 lb-ft)



Camshaft Gear Retainer Torque Sequence

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RG,RG34710,190 –19–19SEP02–6/6

Remove and Install Camshaft

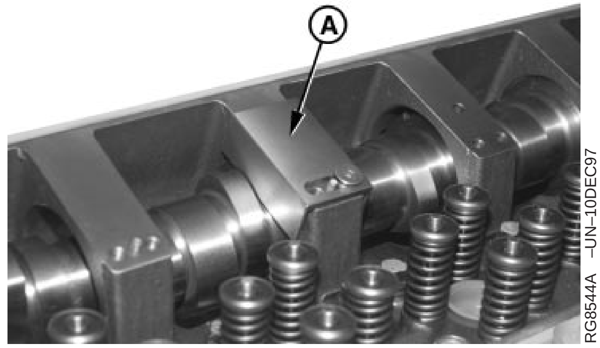
Remove Engine Camshaft

Engine camshaft can be removed with cylinder head installed or removed from engine.

1. Remove rocker arm assembly. (See REMOVE ROCKER ARM ASSEMBLY in Group 020.)

NOTE: See DFRG4—CAMSHAFT LOCKING TOOL in Section 05, Group 190 for instructions on how to fabricate tool.

2. Secure camshaft in bushings with DFRG4 Camshaft Locking Tool (A). Tighten cap screw and secure locking tool to head.



DFRG4 Camshaft Locking Tool

A—Camshaft Locking Tool

RG,RG34710,191 –19–25OCT00–1/14

3. Remove camshaft position sensor from cylinder head.

Removing Camshaft Position Sensor

Continued on next page RG,RG34710,191 –19–25OCT00–2/14

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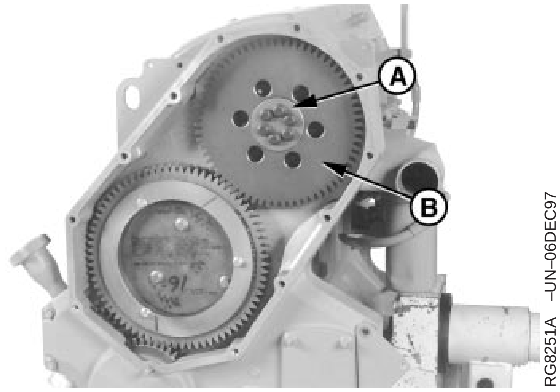
4. Remove camshaft gear access cover. (See REMOVE TIMING GEAR COVER in Group 040.)

5. Remove six cap screws securing camshaft gear retainer washer (A) and remove camshaft gear (B).

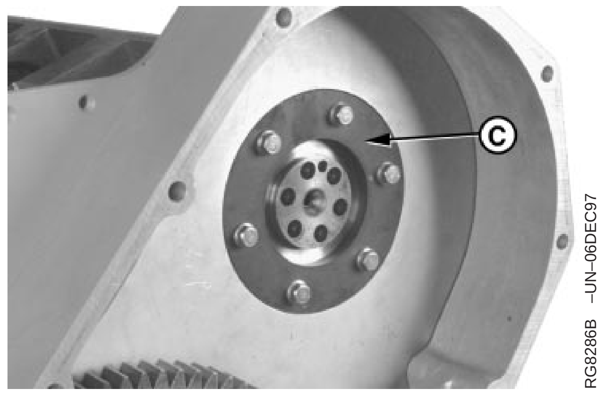
NOTE: Gently bump camshaft forward to remove thrust ring (C).

6. Remove camshaft thrust ring (C).

A—Camshaft Gear Retainer Washer
B—Camshaft Gear
C—Camshaft Thrust Ring



Removing Camshaft Gear

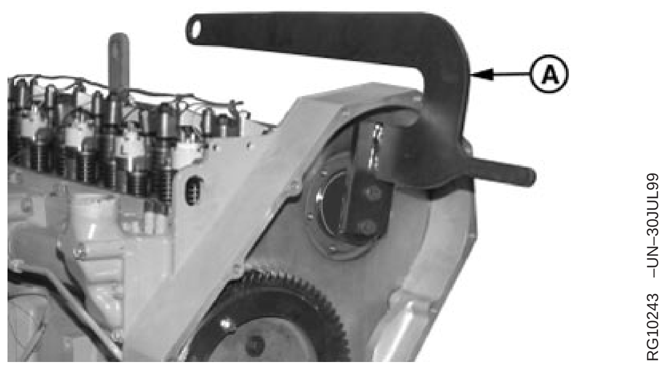


Removing Camshaft Thrust Ring

RG,RG34710,191 –19–25OCT00–3/14

7. Install JDG969A Camshaft Holder (A) onto front face of camshaft using two camshaft gear retainer cap screws. Tighten cap screws securely.

A—Camshaft Holder



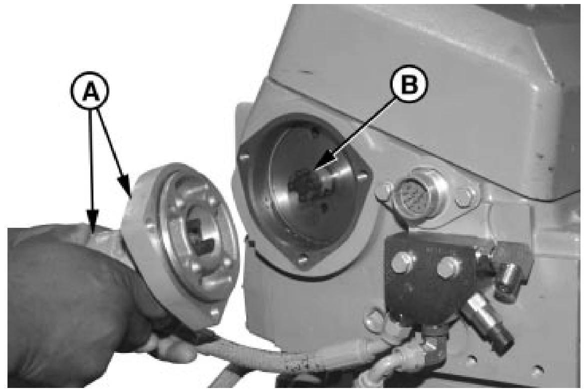
Installing JDG969A Camshaft Holder

Continued on next page RG,RG34710,191 –19–25OCT00–4/14

8. Remove fuel supply pump and mounting bracket (A) from rear of cylinder head.

9. Remove supply pump drive coupler (B) from drive pin in rear of camshaft.

A—Fuel Supply Pump and Mounting Bracket
B—Supply Pump Drive Coupler



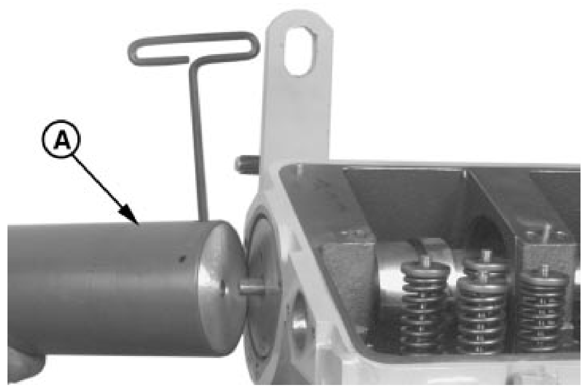
RG8822B –UN–11DEC97

Removing Supply Pump Drive Coupler

RG,RG34710,191 –19–25OCT00–5/14

10. Install JDG972 Camshaft Pilot (A) onto rear face of camshaft. Tighten two set screws securely. Lubricate pilot with clean engine oil or multipurpose grease.

A—Camshaft Pilot



RG8289A –UN–06DEC97

Installing JDG972 Camshaft Pilot

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11. Support camshaft holder with a hoist. Ensure that engine repair stand is level to ease removal of camshaft.

12. Slowly remove camshaft from cylinder head. Traverse hoist (if possible) as camshaft is removed to avoid binding in bushing bores.


RG10244 –UN–30JUL99

Camshaft with Pilot and Holder

Continued on next page RG,RG34710,191 –19–25OCT00–7/14

Install Engine Camshaft

IMPORTANT: Later 12.5 L engines (30000—) have a redesigned camshaft. This camshaft must NOT be installed in earlier engines (—29999) or the ECU's will be overstroked, resulting in severe engine damage. Additionally, DO NOT install early model camshafts in 12.5 L engines (30000—). Consult parts catalog for correct camshaft part numbers.

1. If removed, install fuel supply pump drive pin in end of camshaft. (See REPLACE FUEL SUPPLY PUMP DRIVE PIN later in this group.)

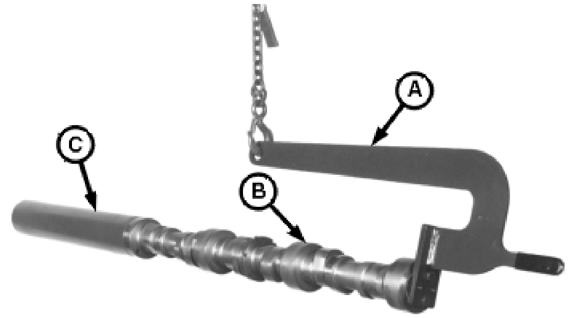
NOTE: Engine repair stand must be level during camshaft installation. Traverse hoist during installation so that camshaft bearings do not bind in bushing.

2. Attach JDG969A Camshaft Holder (A) to front face of camshaft (B). Attach JDG972 Camshaft Pilot (C) to rear face of camshaft. Securely tighten all mounting hardware.

3. Coat camshaft lobes and bearings with TY6333 or TY6347 High Temperature Grease.

4. Generously lubricate camshaft bushings with clean engine oil.

5. Support camshaft with overhead hoist and carefully guide camshaft into bushing bores. Traverse hoist (if possible) as camshaft is installed and keep engine repair stand level to ease installation.



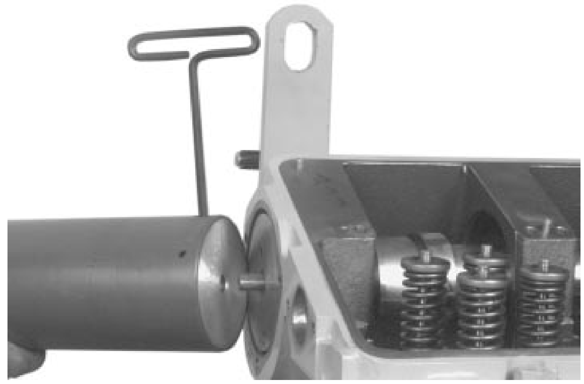
RG10245 –UN–30JUL99

Camshaft with Pilot and Holder

A—JDG969A Camshaft Holder
B—Camshaft
C—JDG972 Camshaft Pilot

Continued on next page RG,RG34710,191 –19–25OCT00–8/14

6. Push camshaft toward rear of engine until pilot set screws can be removed from rear face. Remove pilot from rear face of camshaft.



Removing JDG972 Pilot from Camshaft

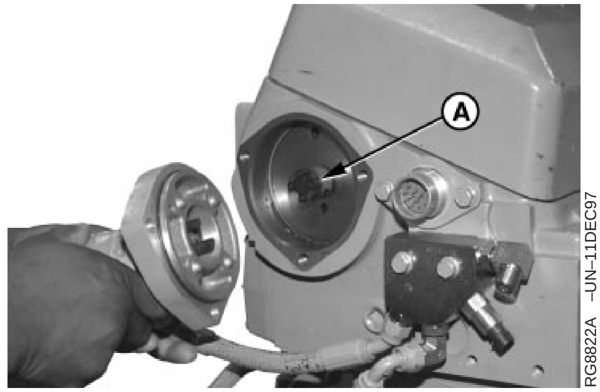
Continued on next page RG,RG34710,191 –19–25OCT00–9/14

7. Install fuel supply pump drive coupler (A) onto camshaft drive pin so that coupler is flush to 0.5 mm (0.020 in.) above pin. Apply LOCTITE® 242 Thread Lock and Sealer to set screws.

   Install set screws with the centerline of one screw perpendicular to flat on drive pin. Tighten set screws to specifications.

Specification

Camshaft and Supply Pump Drive Coupler Set Screw—Torque .... 4 N•m (3 lb-ft)



Installing Supply Pump Drive Coupler

A—Fuel Supply Pump Drive Coupler

8. Install fuel supply pump. Refer to the appropriate fuel system repair manual.

   Delphi/Lucas ECU controlled fuel systems:

   - See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM115, Section 02, Group 090.

   John Deere Level 6 ECU controlled fuel systems:

   - See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM188, Section 02, Group 090 (dual rail fuel systems).
   - See REMOVE AND INSTALL FUEL SUPPLY PUMP in CTM188, Section 02, Group 091 (single rail fuel systems).

Specification

Fuel Supply Pump-to-Cylinder Head—Torque .... 50 N•m (37 lb-ft)

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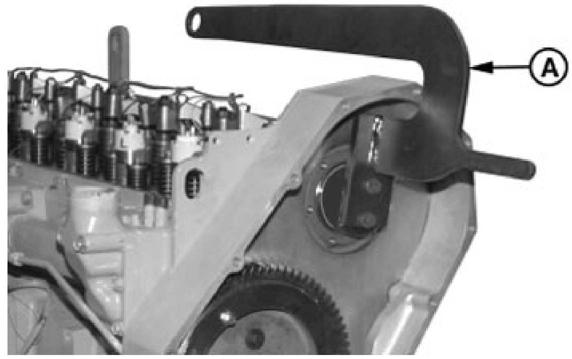
Continued on next page

RG,RG34710,191 –19–25OCT00–10/14

9. Remove JDG969A Camshaft Holder (A) from front face of camshaft.

A—JDG969A Camshaft Holder



RG10243 –UN–30JUL99

Removing JDG969A Camshaft Holder

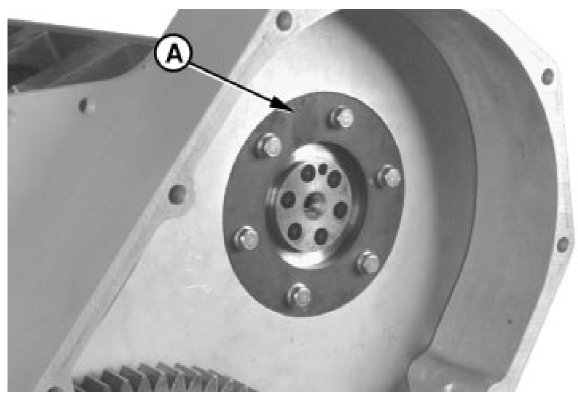
RG,RG34710,191 –19–25OCT00–11/14

10. Install a new thrust ring gasket. Lubricate O-ring with clean engine oil and install camshaft thrust ring (A) and tighten cap screws to specifications.

Specification

Camshaft Thrust Ring-to-Head—
Torque .... 35 N•m (26 lb-ft)

A—Camshaft Thrust Ring



RG8286A –UN–06DEC97

Installing Camshaft Thrust Ring

Continued on next page

RG,RG34710,191 –19–25OCT00–12/14

11. Rotate camshaft in bushings and install JDG971 Timing Pin (A) in camshaft timing slot.

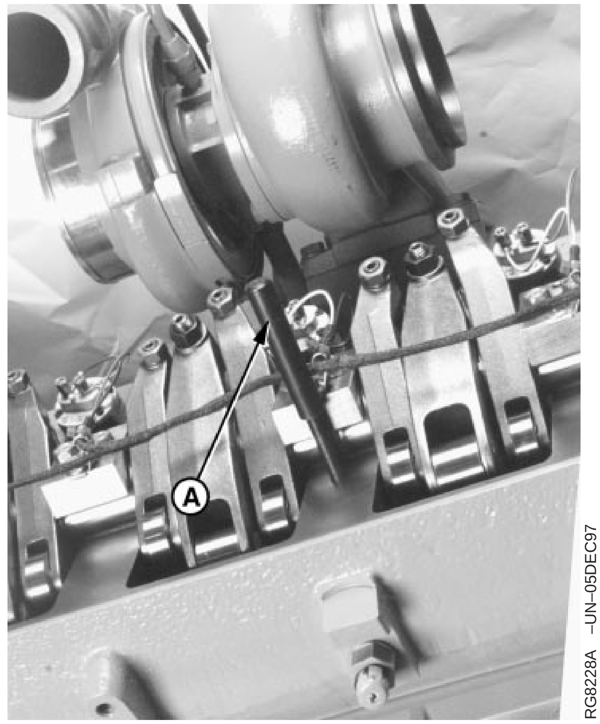
12. Remove camshaft locking tool and install rocker arm assembly. (See INSTALL ROCKER ARM ASSEMBLY in Group 020.)

13. Install camshaft position sensor and tighten to specifications.

Specification

Camshaft Position Sensor—
Torque .... 14 N•m (10 lb-ft)

A—JDG971 Timing Pin

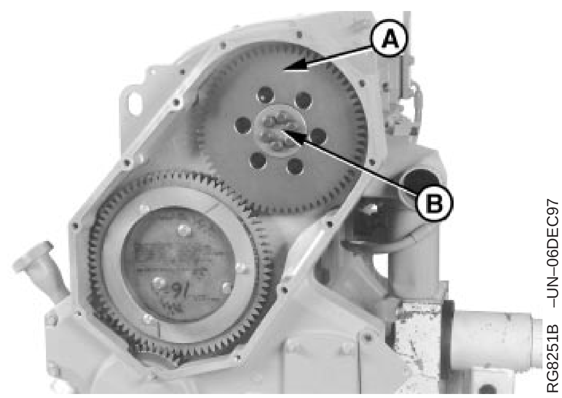


JDG691 Timing Pin in Camshaft

RG,RG34710,191 –19–25OCT00–13/14

14. Install camshaft gear (A) and retainer washer (B) Install retainer cap screws finger tight. Adjust timing gear backlash. See ADJUST FRONT TIMING GEAR BACKLASH, earlier in this group, to set backlash and for torque procedure on camshaft retainer cap screws.

A—Camshaft Gear
B—Retainer Washer



Installing Camshaft Gear

RG,RG34710,191 –19–25OCT00–14/14

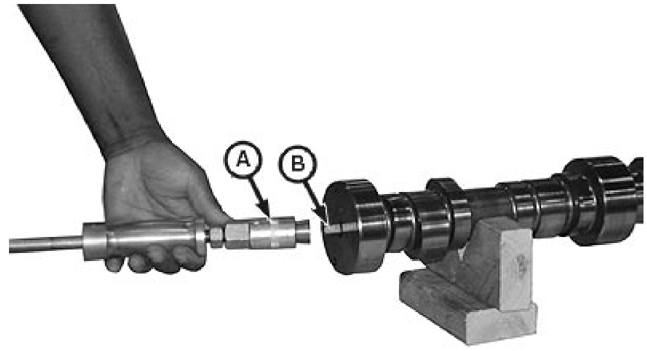
Replace Fuel Supply Pump Drive Pin

1. Remove camshaft. (See REMOVE AND INSTALL CAMSHAFT earlier in this group.)

2. Remove fuel supply pump drive pin (B) using Snap-On CG503 Dowel Pin Puller Set (A) or equivalent tool.

3. Press new drive pin into end of camshaft until it bottoms out. Pin should protrude 15.45—17.45 mm (0.608—0.687 in.) from end of camshaft.

4. Install camshaft. (See REMOVE AND INSTALL CAMSHAFT earlier in this group.)



RG10344 –UN–09SEP99

Fuel Supply Pump Drive Pin

A—Dowel Pin Puller
B—Fuel Supply Pump Drive Pin

DPSG,OUO1004,1021 –19–08SEP99–1/1

Visually Inspect Camshaft and Roller Followers

1. Clean camshaft in solvent. Dry with compressed air.

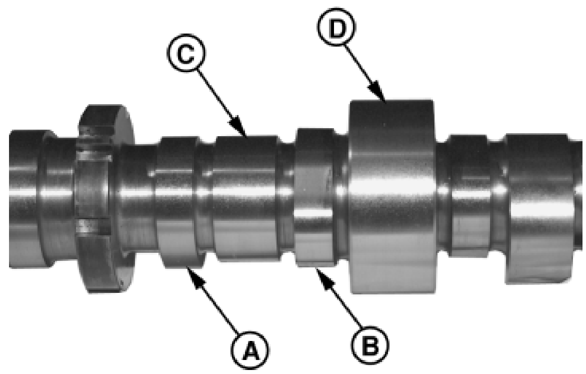
IMPORTANT: Very light score marks may be found on eccentric lobes, but are acceptable if valve lift is within specification. Pitting and galling dictates replacement.

2. Inspect all camshaft eccentric lobes and bushing journals (D) for wear or damage.

3. Inspect all corresponding rocker arm roller followers for uneven wear or damage.

   Replace individual roller followers as necessary.

A—Intake Lobe
B—Exhaust Lobe
C—Unit Injector Lobe
D—Bushing Journal



RG8385B –UN–09DEC97

Inspecting Camshaft Lobes

RG8388 –UN–21MAY98

Inspecting Roller Followers

RG,RG34710,192 –19–30SEP97–1/1

Inspect and Measure Camshaft Bushing ID and Journal OD

1. Measure each camshaft bushing journal OD and compare with specifications below.

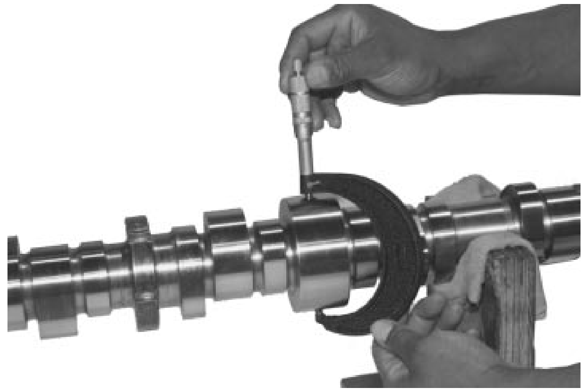
   Replace camshaft if journal OD is not within specification.

2. Measure camshaft bushing ID and compare with specifications below.

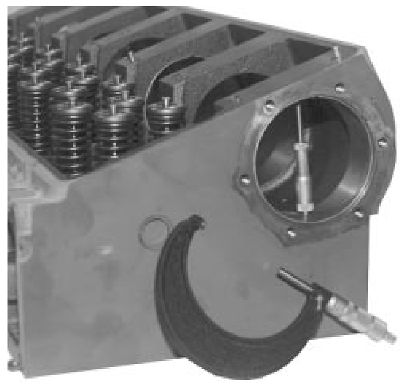
   Replace camshaft bushings if not within specification and if surface wear or scratching is detected.

Specification

Camshaft Journal—OD	101.987—102.013 mm (4.0152—4.0162 in.)
Camshaft Bushing—ID	102.091—102.167 mm (4.0193—4.0223 in.)
Camshaft Journal-to-Bushing—Oil Clearance	0.078—0.180 mm (0.0031—0.0071 in.)
Camshaft Bushing—Bore in Head	105.987—106.013 mm (4.1727—4.1737 in.)


RG8341 –UN–21MAY98

Measuring Camshaft Journal OD


RG8331 –UN–21MAY98

Measuring Camshaft Bushing ID

RG,RG34710,193 –19–13AUG99–1/1

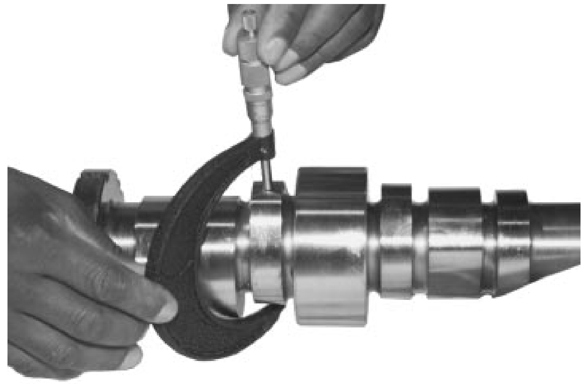
Measure Camshaft Lobe Lift Height

Measure each camshaft lobe at its highest point (lobe lift) and at its narrowest point (base circle). Subtract narrowest from highest height to find cam lobe lift.

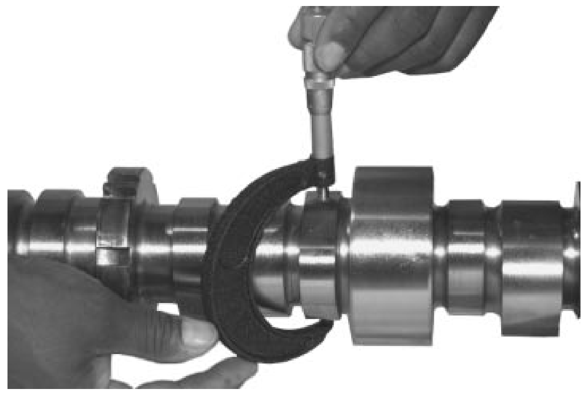
If camshaft lobe lift is not within specification on any one lobe, replace camshaft.

Camshaft Lobe—Specification

Intake Lobe—Lift .... 8.73—8.99 mm (0.343—0.353 in.)
Exhaust Lobe—Lift .... 7.93—8.19 mm (0.312—0.322 in.)
EUI Lobe 10.5 L Engines and
12.5 L Engines (—29999)—Lift .... 14.16—14.42 mm (0.557—0.567 in.)
EUI Lobe 12.5 L Engine S.N.
(30000—)—Lift .... 16.09—16.35 mm (0.633—0.643 in.)


RG8386 –UN–21MAY98

Measuring Camshaft Lobe Base Circle


RG8387 –UN–21MAY98

Measuring Camshaft Lobe Lift

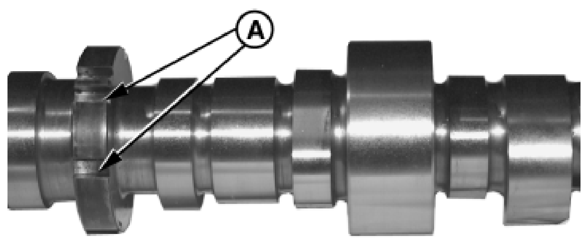
RG,RG34710,194 –19–25OCT00–1/1

Inspect Camshaft Position Sensor Lobe

Visually inspect camshaft position sensor lobe slots (A) for damage or chips that may emit a false reading.

Replace camshaft as necessary.

A—Lobe Slots



RG8385A –UN–09DEC97

Inspecting Camshaft Sensor and Timing Slots

RG,RG34710,195 –19–30SEP97–1/1

Replace Camshaft Bushings

Camshaft bushings MUST BE replaced with cylinder head removed from engine.

IMPORTANT: Use only hand tools for camshaft bushing removal and installation. DO NOT use pneumatic equipment for bushing replacement.

Remove Camshaft Bushings

1. Remove camshaft. (See REMOVE AND INSTALL CAMSHAFT, earlier in this group.)

2. Remove spring pins from camshaft towers 3 and 5 (bushing locations 2 and 3).

3. **No. 1 Bushing:**

   Install JDG968-1 Bushing Remover (A) in front side of No. 1 camshaft tower.

4. Lubricate 313793 Forcing Screw (B) and inset through remover with double nut and washer towards front of engine.

5. Install JDG968-3 Guide (C) in rear side of No. 2 tower with forcing screw through driver. Secure assembly with nut and washer.

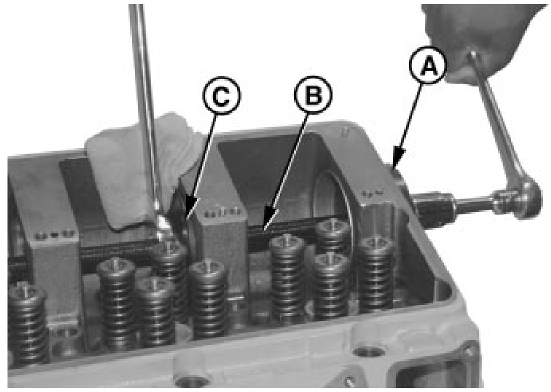
6. Remove bushing from bore using a 1/2-in. drive ratchet wrench with deep-well socket on double nut and a combination wrench to hold single nut. Protect cylinder head with a shop towel on wrench handle.

   Remove remaining bushings using the same procedure as above and by positioning tool set as follows:

7. **No. 2 Bushing:**

   Install JDG968-1 Bushing Remover in rear of No. 3 tower and JDG968-3 Guide in front of No. 2 tower.

8. Install 313793 Forcing Screw with double nut toward front of engine. Use a 152.4 mm (6.0 in.) extension with ratchet to reach double nut.



Removing Camshaft Bushings

A—JDG968-1 Bushing Remover
B—313793 Forcing Screw
C—JDG968-3 Guide

Continued on next page

9. **No. 3 Bushing:**

   Install JDG968-1 Bushing Remover in front of tower No. 5 and JDG968-3 Guide in rear of tower No. 6.

10. Install 313793 Forcing Screw with double nut toward rear of engine.

11. Use a 152.4 mm (6.0 in.) extension with ratchet to reach double nut.

12. **No. 4 Bushing:**

    Install JDG968-1 Bushing Remover in rear of No. 7 tower and JDG968-3 Guide in front of No. 6 tower.

13. Install 313793 Forcing Screw with double nut toward rear of engine. No extension needed.

14. Thoroughly clean bushing bores in cylinder head and inspect for damage. Clean lubricating oil holes as needed.

RG,RG34710,196 –19–25OCT00–2/7

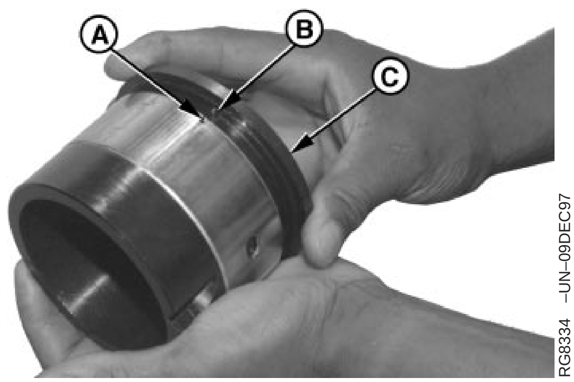
Install Camshaft Bushings

IMPORTANT: ALWAYS install bushings from front side of cylinder head bushing bore and drive toward rear.

1. **No. 1 Bushing:**

   Apply a light coat of TY6333 or TY6347 High Temperature Grease to ID of bushing bore in cylinder head.

2. Align notch (A) in new camshaft bushing with notch in JDG968-4 Alignment Sleeve (B). Position JDG968-2 Bushing Installer (C) onto end of sleeve with index slot engaged in notches in bushing and sleeve.



Positioning Replacement Bushing on Installer

A—Notch Alignment
B—Alignment Sleeve
C—Bushing Installer

Continued on next page RG,RG34710,196 –19–25OCT00–3/7

3. Position installer and sleeve with bushing on the front side of No. 1 tower with alignment groove (A) in guide sleeve positioned approximately as shown.

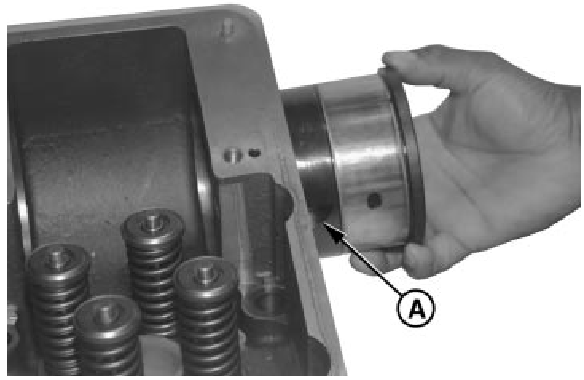
4. Install 313793 Forcing Screw with washer through installer with double nut towards front of engine.

5. Install JDG968-3 Guide (B) in the rear of tower No. 2 with 313793 Forcing Screw through guide. Secure assembly (finger tight) with nut and washer.

6. Install large end of JDG968-5 Alignment Pin (C) into oil hole (spring pin removed) until pin engages groove in alignment sleeve.

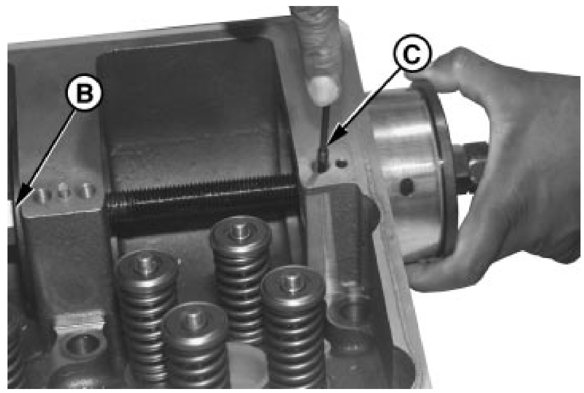
7. Once pin engages groove, rotate sleeve toward valves until you feel a positive stop. This ensures that the oil holes in bushing and cylinder head will be properly aligned after installation.

A—Alignment Groove
B—JDG968-3 Guide
C—JDG968-5 Alignment Pin



RG8335 –UN–09DEC97

Positioning Bushing and Installer in Head



RG8336 –UN–09DEC97

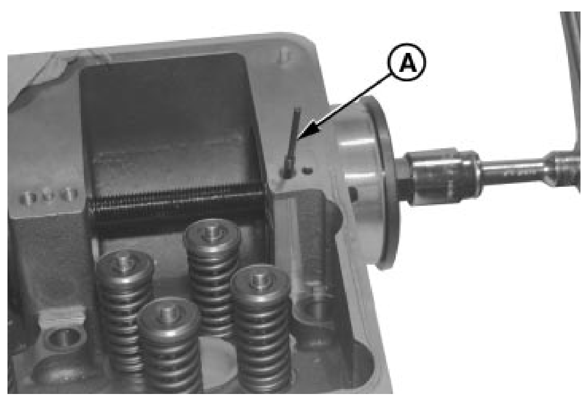
Indexing Bushing in Head

RG,RG34710,196 –19–25OCT00–4/7

8. Slowly install bushing in bore using a 1/2-in. drive ratchet wrench with deep-well socket on double nut and a combination wrench to hold single nut. Protect cylinder head with a shop towel on wrench handle.

9. Remove alignment pin (A) from oil hole once bushing is started in bore. Continue tightening double nut until shoulder of installer contacts tower.

A—Alignment Pin



RG8337 –UN–09DEC97

Bushing Installation Alignment Pin

Continued on next page

RG,RG34710,196 –19–25OCT00–5/7

10. Remove tool set and insert the smaller end of JDG968-5 Alignment Pin from the TOP side of tower oil lube hole. This pin must pass through installed bushing completely to ensure proper lube hole alignment.

    If alignment pin does not pass through bushing oil hole, remove bushing and install a new one.

    Install remaining bushings using the same procedure as above and by positioning tool set as follows:

IMPORTANT: Protect previously installed bushings from tool damage with clean shop towels when installing 313793 Forcing Screw through bores.

11. **No. 2 Bushing:**

    Install JDG968-2 Bushing Installer and JDG968-4 Alignment Sleeve with bushing in front of tower No. 3 and JDG968-3 Guide in rear of tower No. 5.

12. Install 313793 Forcing Screw with double nut toward front of engine.

13. Use a 304.8 mm (12.0 in.) extension with ratchet to reach double nut.

14. **No. 4 Bushing:**

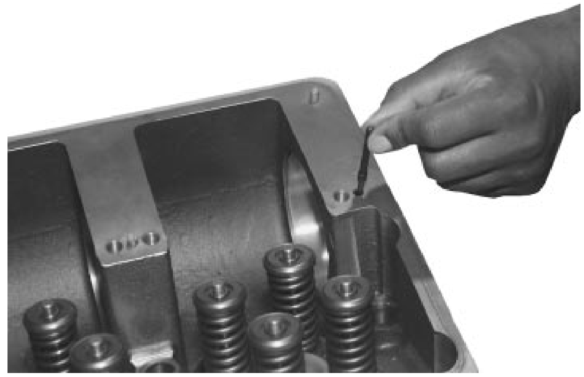
NOTE: Install bushing No. 4 before installing bushing No. 3.

    Adjust double nut position on forcing screw so that double nut is 51 mm (2.0 in.) from end of rod.

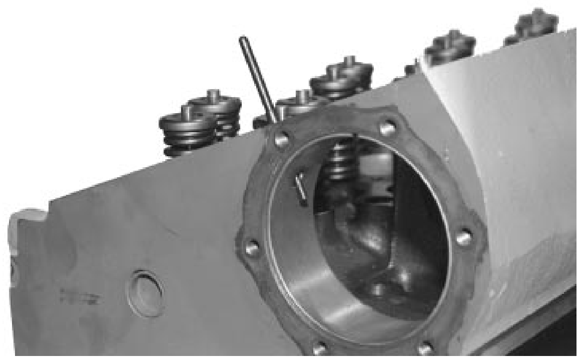
NOTE: JDG968-1 Bushing Remover can be positioned in tower No. 6 as a pilot, if desired.

15. JDG968-2 Bushing Installer and JDG968-4 Alignment Sleeve with bushing in front of tower No. 7 and JDG968-3 Guide in rear of No. 5 tower without bushing.

16. Install 313793 Forcing Screw with double nut and thrust washer against JDG968-3 Guide [51 mm (2.0 in.) with forcing screw extending through guide].



Checking Bushing Oil Hole Alignment



Index Pin Installed through Bushing

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17. Install single nut and washer against JDG968-2 Bushing Installer. Put wrench on double nut and push bushing in with wrench on single nut.

18. **No. 3 Bushing:**

NOTE: Install bushing No. 4 before installing bushing No. 3.

Install JDG968-2 Bushing Installer and JDG968-4 Alignment Sleeve with bushing in front of tower No. 5 and JDG968-3 Guide in rear of No. 6 tower.

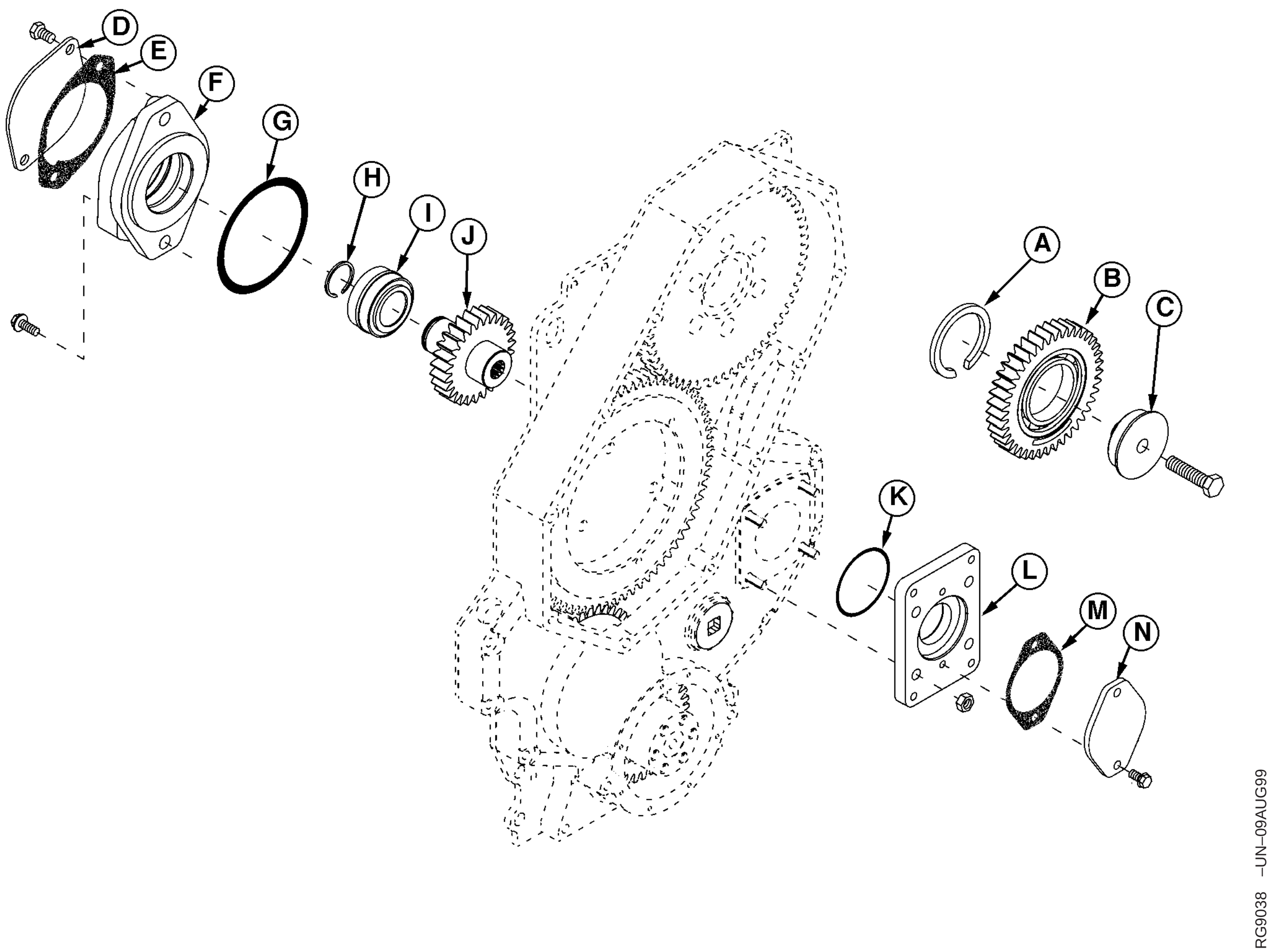
19. Install 313793 Forcing Screw with double nut toward rear of engine.

20. Use a 152.4 mm (6.0 in.) extension with ratchet to reach double nut.

21. Install a new spring pin in towers 3 and 5 (bushing locations 2 and 3).

RG,RG34710,196 –19–25OCT00–7/7

SAE “A” (Front) and SAE “B” (Rear) Auxiliary Drive Assembly



Auxiliary Drive Assembly

A—Snap Ring
B—Auxiliary Drive Idler Gear
C—Support Bushing
D—Cover Plate
E—Gasket
F—"B" Adapter Housing
G—O-Ring
H—Snap Ring[1]
I—Bearing
J—Splined Gear
K—O-Ring
L—"A" Adapter
M—Gasket
N—Cover Plate

NOTE: Refer to CTM67, OEM Engine Accessories, for repair of auxiliary drive assembly.

Torque specifications for adapter housing (F) and support bushing (C) are as follows:

Specification

SAE “A” Front Auxiliary Drive
Adapter Housing Nuts—Torque .... 50 N•m (37 lb-ft)
SAE “A” Front Auxiliary Drive
Idler Gear Support Bushing—
Torque.. 220 N•m (162 lb-ft)

[1] *A shim may be used with snap ring (H) to set gear shaft end play.*

RG,RG34710,197 –19–26OCT00–1/1

SAE “B” Rear Auxiliary Drive

Disassemble Rear Auxiliary Drive Assembly

NOTE: Refer to CTM67, OEM Engine Accessories, for repair of auxiliary drive assembly.

1. Remove rear auxiliary drive assembly (G) from front plate. Discard O-ring (B).

2. Support front face of adapter housing (A). Press gear (F) and bearing (E) out of housing bore.

3. Remove snap ring (C) from gear shaft. Discard snap ring.

4. Remove bearing from gear. Discard bearing.

5. Thoroughly clean and inspect gear and housing.

Assemble Rear Auxiliary Drive Assembly

1. Assemble bearing onto gear shaft. Press bearing flush with shoulder on gear.

2. Determine correct size snap ring (C) and shim (D) (if required) to achieve 0.11 mm (0.004 in.) maximum clearance between bearing cone and snap ring. See parts catalog for snap ring and shim sizes.

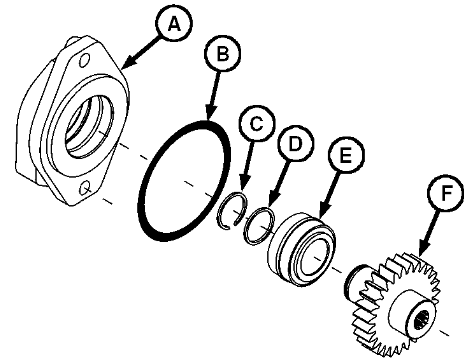
3. Support back side of adapter housing. Press gear and bearing assembly into housing until assembly bottoms.

IMPORTANT: Make sure oil drain port (H) is positioned on bottom as shown.

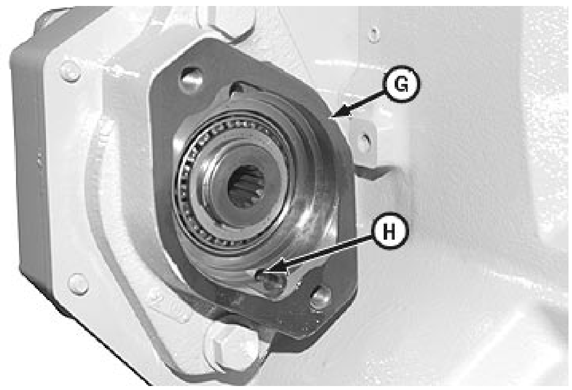
4. Install assembly onto front plate using a new gasket. Tighten cap screws to specifications.

Specification

SAE “B” Rear Auxiliary Drive
Adapter—Torque .... 110 N•m (81 lb-ft)



SAE “B” Rear Auxiliary Drive Assembly



SAE “B” Rear Auxiliary Drive

A—SAE “B” Adapter Housing
B—O-Ring
C—Snap Ring[1]
D—Shim[1]
E—Bearing
F—Splined Gear
G—Rear Auxiliary Drive Assembly
H—Oil Drain Port

[1]*Three snap ring sizes and one shim size are available to set gear shaft end play. See parts catalog for sizes and part numbers.*

Align SAE “A” Front Auxiliary Drive Adapter

IMPORTANT: Front auxiliary drive adapter (A) MUST BE properly aligned with center of gear spline whenever front or rear adapter is removed. Improperly aligned adapter may damage bearing assembly.

1. Install SAE “B” rear auxiliary drive adapter and tighten to specification.

Specification
SAE “B” Rear Auxiliary Drive
Adapter—Torque .... 110 N•m (81 lb-ft)

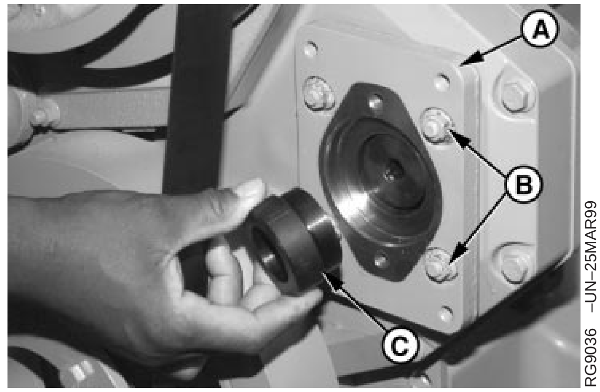
2. Install SAE “A” front adapter and tighten four mounting stud nuts (B) finger tight.

3. Install JDG1144 Alignment Tool (C) onto gear flange and into adapter bore to properly center adapter with gear spline.

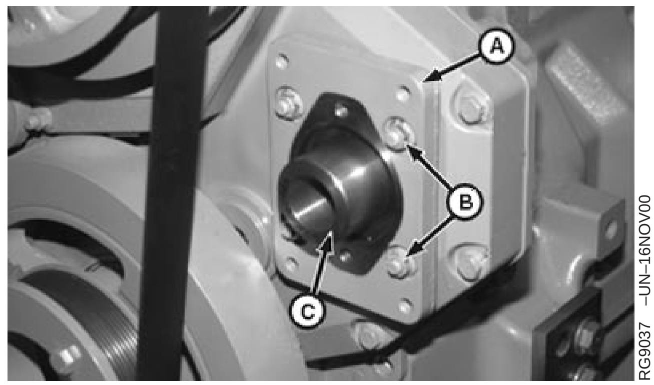
4. Tighten mounting stud nuts to specifications.

Specification
SAE “A” Front Auxiliary Drive
Adapter Housing Nuts—Torque .... 50 N•m (37 lb-ft)

Remove alignment tool.



Installing JDG1144 Alignment Tool

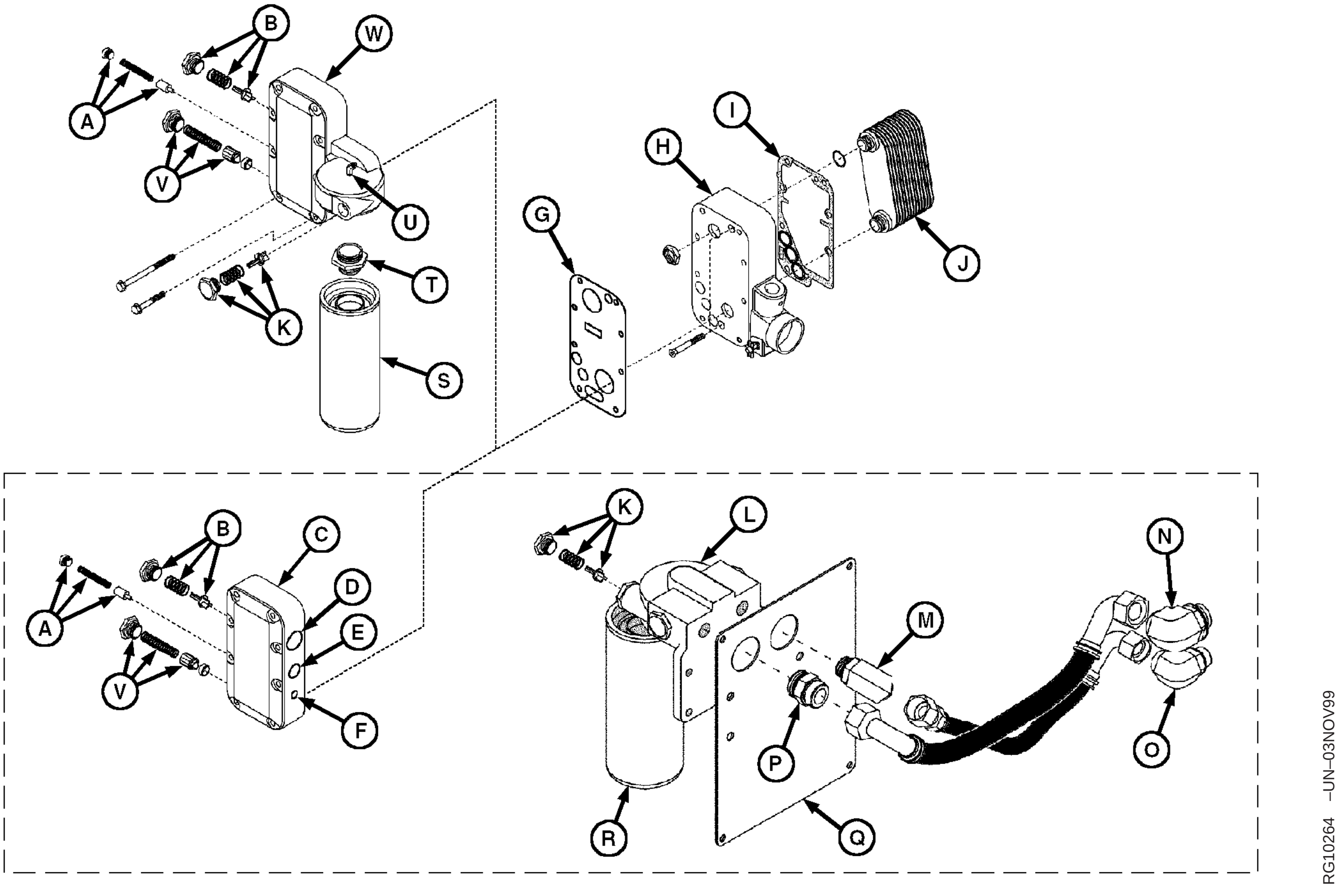


JDG1144 Alignment Tool Installed

A—Auxiliary Drive Adapter
B—Mounting Stud Nuts
C—JDG1144 Alignment Tool

RG,RG34710,199 –19–13AUG99–1/1

Oil Filter and Oil Conditioning Housing Assembly



Oil Filter Base, Oil Cooler, and Valve Assembly (Remote Filter Option Shown on Lower Portion of Figure)

A—Pressure Relief Valve Assembly (If Equipped)
B—Oil Cooler Bypass Valve Assembly
C—Oil Cooler Cover/Valve Housing (Remote Filter Applications)
D—Port to Remote Oil Filter Inlet
E—Port to Remote Oil Filter Outlet
F—Port to Turbocharger Oil Inlet (Remote Oil Filter Applications)
G—Gasket
H—Oil Cooler Housing
I—Gasket
J—Oil Cooler
K—Oil Filter Bypass Valve Assembly
L—Remote Oil Filter Housing
M—1 in. ID Elbow (Remote Oil Filter Applications)
N—1-1/4 in. ID Elbow (To Remote Oil Filter Inlet)
O—1 in. ID Elbow (To Remote Oil Filter Outlet)
P—1-1/4 ID Adapter (Remote Oil Filter Applications)
Q—Access Cover (Remote Oil Filter Applications)
R—Remote Oil Filter
S—Oil Filter
T—Filter Adapter
U—Port to Turbocharger Oil Inlet
V—Pressure Regulating Valve Assembly
W—Oil Filter and Valve Housing

RG,RG34710,206 –19–28JUL99–1/1

Remove Oil Filter and Valve Housing/Oil Cooler Cover and Valve Housing

NOTE: Standard oil filter/valve housing shown. Procedure for removal of remote oil cooler cover and valve housing is the same.

Guide pins (C) may be used as an aid for removing and installing oil filter housing.

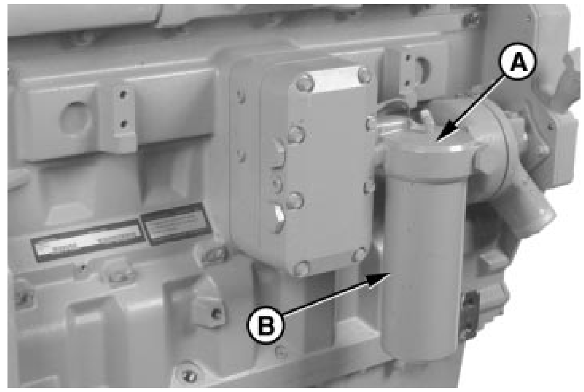
1. Disconnect turbocharger oil inlet line (shown removed) from oil filter and valve housing (A).

2. Turn oil filter (B) counterclockwise using filter wrench and remove filter from housing.

3. Remove eight cap screws securing oil filter and valve housing to cylinder block and remove housing. Remove and discard gasket.

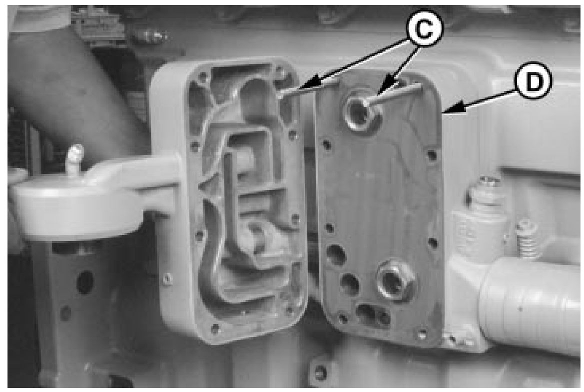
4. Remove valves and thoroughly clean all bores and passages in housing.

A—Oil Filter and Valve Housing
B—Oil Filter
C—Guide Pins
D—Gasket



RG8245A –UN–06DEC97

Removing Filter and Valve Housing



RG8247A –UN–06DEC97

Filter and Valve Housing Removed

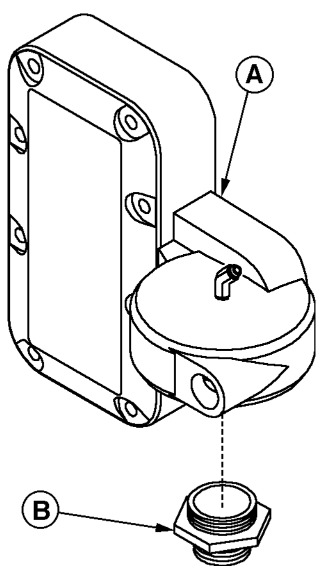
RG,RG34710,207 –19–28JUL99–1/1

Inspect and Replace Oil Filter Adapter

1. Inspect threads on oil filter adapter (B) for damage. Remove adapter from housing (A) and replace as necessary.

2. Coat adapter-to-oil filter housing threads with LOCTITE® 271 (TY9474) Thread Lock and Sealer before installing adapter in housing. Tighten adapter securely.

A—Oil Filter Housing
B—Oil Filter Adapter



RG8433 –UN–19MAY98

Oil Filter Adapter

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RG,RG34710,208 –19–30SEP97–1/1

Remove, Inspect, and Install Oil Pressure Regulating Valve

NOTE: Refer to OIL FILTER AND OIL CONDITIONING HOUSING ASSEMBLY, earlier in this group, for illustrated location of valves.

Oil pressure regulating valve is in same location on oil cooler cover/valve housing for remote filter applications.

1. Remove oil pressure regulating valve assembly (C) from oil filter housing (G). Discard O-ring.

2. Inspect valve and valve bore for damage. Replace if necessary.

3. Clean all parts with a brass or copper wire brush and solvent. Dry with compressed air.

4. Check spring for proper compression.

Specification

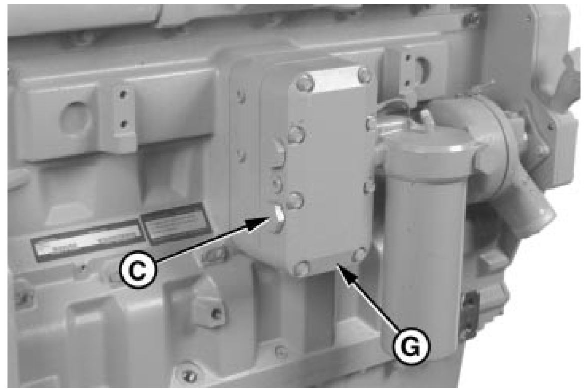
New Oil Pressure Regulating Valve Spring—Free Length .... 86.4 mm (3.40 in.)
Working Load at 76—84 N (17—19 lb-force) .... 42.0 mm (1.65 in.)

5. Dip all parts in clean engine oil. Insert valve and spring assembly in housing.

6. Install plug using a new O-ring and tighten to specifications.

Specification

Oil Pressure Regulating Valve Plug—Torque .... 100 N•m (74 lb-ft)



RG8245B –UN–06DEC97

Removing Pressure Regulating Valve

C—Oil Pressure Regulating Valve Assembly
G—Oil Filter Housing

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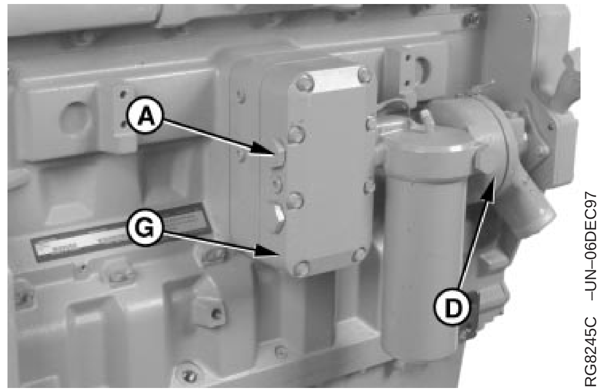
RG,RG34710,209 –19–28JUL99–1/1

Remove, Inspect, and Install Oil Cooler and Oil Filter Bypass Valves

NOTE: Refer to OIL FILTER AND OIL CONDITIONING HOUSING ASSEMBLY, earlier in this group, for illustrated location of valves.

Oil cooler bypass valve is in same location on oil cooler cover/valve housing for remote filter applications. Oil filter bypass valve is in same location on face of remote oil filter housing.



Removing Oil Cooler and Oil Filter Bypass Valve

A—Oil Cooler Bypass Valve Assembly
D—Oil Filter Bypass Valve Assembly
G—Oil Filter Housing

1. Remove oil cooler bypass valve assembly (A) and oil filter bypass valve assembly (D) from oil filter housing (G). Discard O-rings.

2. Clean all parts with a brass or copper wire brush and solvent. Dry with compressed air.

3. Inspect bypass valves and valve bores for damage. Replace if necessary.

4. Check bypass valve springs for proper compression. Replace if not within specification.

Specification

New Oil Cooler Bypass Valve Spring—Free Length	44.0 mm (1.73 in.)
Working Load @ 64—78 N (14—18 lb-force)	30.0 mm (1.18 in.)
New Oil Filter Bypass Valve Spring—Free Length	44.0 mm (1.73 in.)
Working Load @ 64—78 N (14—18 lb-force)	30.0 mm (1.18 in.)

5. Dip all parts in clean engine oil. Insert valve and spring assembly in housing.

6. Install plug using a new O-ring and tighten to specifications.

Specification

Oil Cooler Bypass Valve Plug—Torque	100 N•m (74 lb-ft)
Oil Filter Bypass Valve Plug—Torque	100 N•m (74 lb-ft)

RG,RG34710,210 –19–06NOV00–1/1

Remove, Inspect, and Install Oil Pressure Relief Valve (If Equipped)

NOTE: Refer to OIL FILTER AND OIL CONDITIONING HOUSING ASSEMBLY, earlier in this group, for illustrated location of valves.

Oil pressure relief valve is in same location on oil cooler cover/valve housing on remote filter applications.

1. Remove oil pressure relief valve assembly (B) from oil filter housing (G).

2. Clean all parts with a brass or copper wire brush and solvent. Dry with compressed air.

3. Inspect valve and valve bore for damage. Replace if necessary.

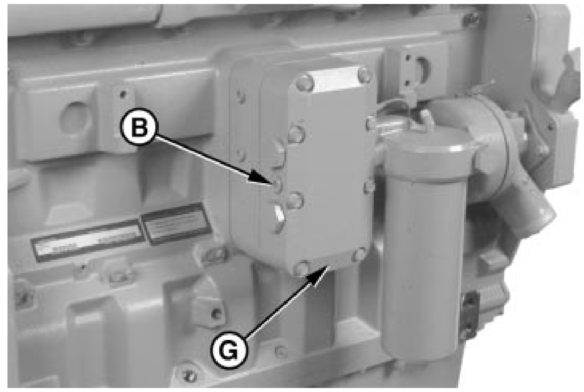
4. Check valve spring for proper compression. Replace if not within specification.

Specification

Oil Pressure Relief Valve Spring—Free Length	79.0 mm (3.11 in.)
Working Load @ 196—222 N (44—50 lb-force)	65.0 mm (2.56 in.)

5. Dip all parts in clean engine oil. Insert valve and spring assembly in housing.

6. Install plug using a new O-ring and tighten securely.



RG8245D –UN–06DEC97

Removing Oil Pressure Relief Valve

B—Oil Pressure Relief Valve Assembly
G—Oil Filter Housing

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RG,RG34710,211 –19–13AUG99–1/1

Remove, Clean, and Inspect Engine Oil Cooler

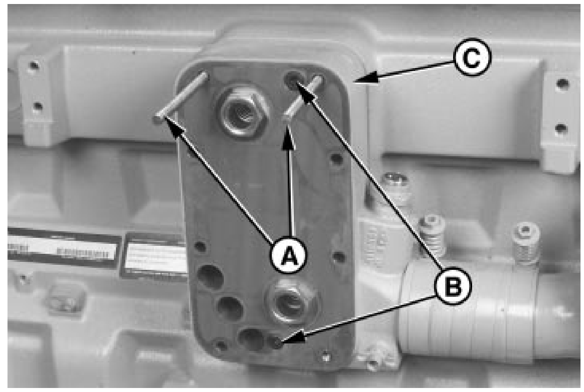
NOTE: Guide pins may be used as an aid for removing and installing oil filter housing.

1. Remove oil filter and valve housing (shown removed). (See REMOVE OIL FILTER AND VALVE HOUSING/OIL COOLER COVER AND VALVE HOUSING, earlier in this group.)

2. Install two guide pins (A) as shown (if desired). Remove two hex socket head cap screws (B) and remove oil cooler housing (C) with oil cooler (D).

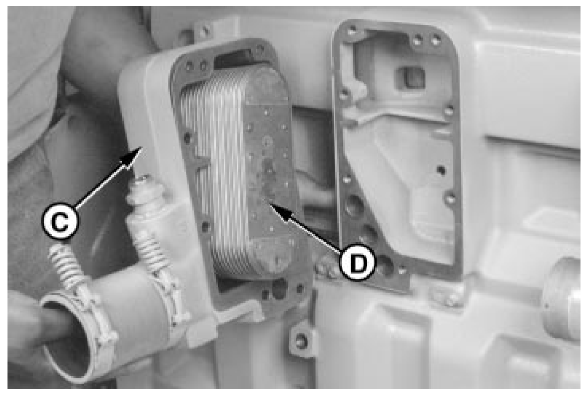
3. Remove and discard oil cooler-to-cylinder block gasket.

A—Guide Pins
B—Hex Socket Head Cap Screws
C—Oil Cooler Housing
D—Oil Cooler



RG8248A –UN–06DEC97

Removing Oil Cooler and Housing Assembly



RG8249B –UN–06DEC97

Oil Cooler and Housing Assembly Removed

Continued on next page RG,RG34710,212 –19–12AUG99–1/3

4. Remove two large hex nuts (D) securing oil cooler (C) to housing (A) and remove cooler from housing. Remove and discard gasket (B) and O-rings (E).

5. Clean all parts and flush oil cooler with solvent. Dry with compressed air.

6. Thoroughly inspect oil cooler for plugging, damage, or leaks.

NOTE: If mixing of oil and coolant is suspected, pressure test oil cooler in liquid and compressed air. Use specified air pressure for testing. Replace oil cooler as necessary.

Specification

Oil Cooler—Test Pressure .... 140—170 kPa (1.4—1.7 bar) (20—25 psi)

IMPORTANT: When installing oil cooler into housing, ensure that face of both mounting nuts is square to threads for proper torque.

7. Apply TY9473 LOCTITE® 242 Thread Lock and Sealer to oil cooler hex nuts.

8. Install oil cooler in housing using a new gasket and two new O-rings. Tighten two large hex nuts to specifications.

Specification

Oil Cooler-to-Housing Nuts—
Torque .... 50 N•m (37 lb-ft)

9. If removed, install oil cooler drain cock handle and tighten to specifications.

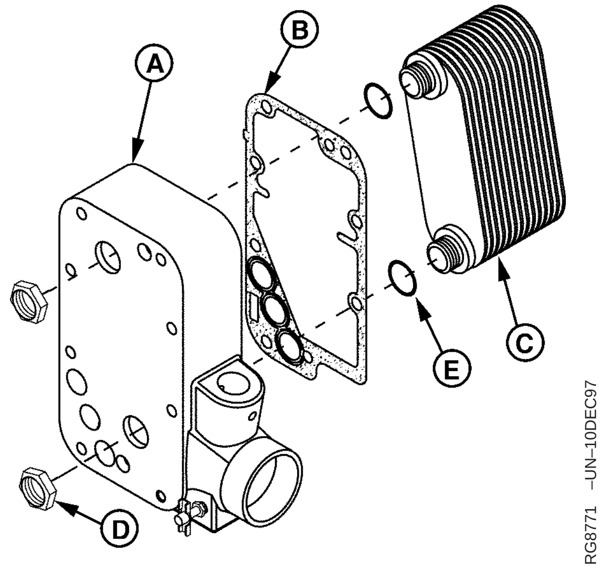
Specification

Oil Cooler Drain Cock Handle—
Torque .... 3 N•m (25 lb-in.)

10. If removed, install oil cooler housing expansion plug and tighten to specified depth.

Specification

Oil Cooler Expansion Plug—
Installed Depth.. Flush to 1.5 mm (0.059 in.) Below Surface



Oil Cooler and Housing Assembly

A—Oil Cooler Housing
B—Gasket
C—Oil Cooler
D—Nut (2 Used)
E—O-Ring (2 Used)

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RG,RG34710,212 –19–12AUG99–2/3

11. If removed, apply LOCTITE® 242 Thread Lock and Sealer to oil pressure sending unit. Install sending unit and tighten securely.

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RG,RG34710,212 –19–12AUG99–3/3

Install Oil Cooler/Oil Filter Valve Housing Assembly or Oil Cooler Cover/Valve Housing Assembly

NOTE: Standard filter/valve housing assembly shown. Procedure for remote filter applications is similar.

1. Remove all gasket material from cylinder block, oil cooler housing, and oil filter/valve housing. All sealing surfaces must be clean and free of oil.

NOTE: Use guide pins as an assembly aid if desired.

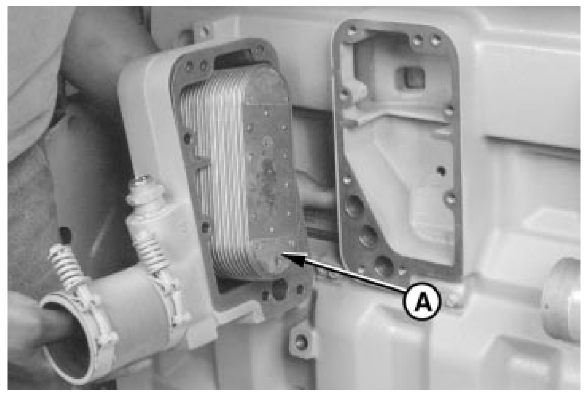
2. Install oil cooler and housing assembly (A) using a new gasket. Position oil cooler housing-to-coolant pump hose on coolant pump outlet elbow.

3. Install two hex socket head cap screws (B) and tighten to specifications.

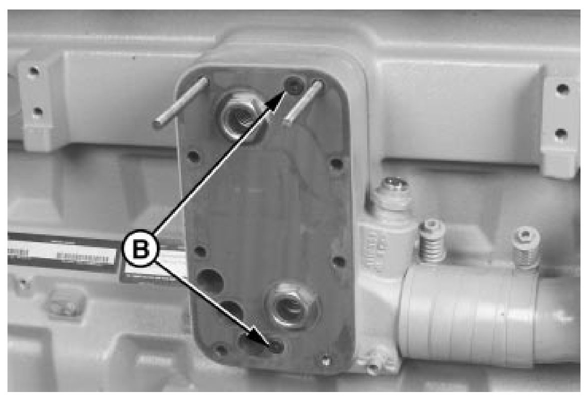
Specification

Oil Cooler Housing-to-Block Cap Screws—Torque .... 68 N•m (50 lb-ft)

A—Oil Cooler and Housing Assembly
B—Hex Socket Head Cap Screws



Installing Oil Cooler and Housing Assembly



Oil Cooler and Housing Assembly Installed

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RG,RG34710,213 –19–24SEP02–1/2

4. Install oil filter/valve housing (or oil cooler cover/valve housing on remote applications) using a new gasket. Tighten cap screws to specifications using sequence shown in lower illustration.

Specification
Oil Filter/Valve Housing or Oil Cooler Cover/Valve Housing[1]—Torque .... 68 N•m (50 lb-ft)

5. Retighten cap screws to specification using same sequence.

Specification
Oil Cooler Housing-to-Block Cap Screws—Retorque........................ 68 N•m (50 lb-ft)

6. Tighten coolant pump-to-oil cooler housing hose clamps securely.

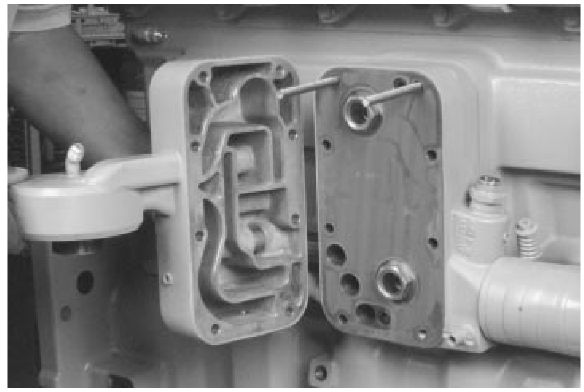
7. Coat oil filter gasket with clean engine oil. Install filter to housing until gasket contacts base, then tighten an additional 1/2—3/4 turn.

8. If equipped with a remote filter: Connect hose or line ends to oil cooler cover/valve housing and tighten hose or line ends to specification.

Specification
Remote Filter Inlet Hose or Line—Torque .... 190 N•m (140 lb-ft)
Remote Filter Outlet Hose or Line—Torque .... 142 N•m (105 lb-ft)

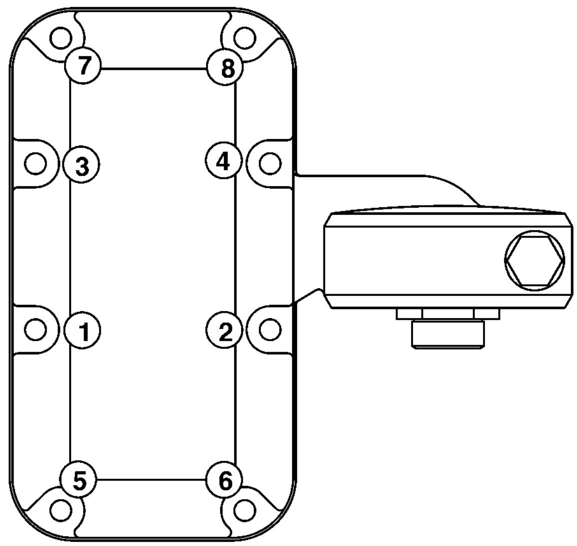
9. Install turbocharger oil inlet line onto housing adapter and tighten to specifications.

Specification
Turbocharger Oil Inlet Line-to-Oil Cooler Housing—Torque........................ 35 N•m (26 lb-ft)



RG8247 –UN–21MAY98

Install Filter and Valve Housing



RG8815 –UN–20MAY98

Oil Filter Housing Torque Sequence

[1] *Torque sequence and specification also applies to oil cooler cover/valve housing on remote filter applications.*

RG,RG34710,213 –19–24SEP02–2/2

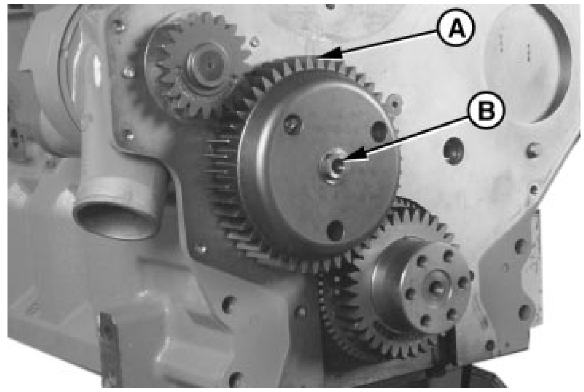
Remove Engine Oil Pump

1. Remove timing gear cover. (See REMOVE TIMING GEAR COVER in Group 040.)

2. Remove external snap ring (B) securing oil drive gear (A) to oil pump drive shaft.

3. Remove drive gear from shaft and oil pump housing.

A—Oil Drive Gear
B—External Snap Ring



RG8256A –UN–06DEC97

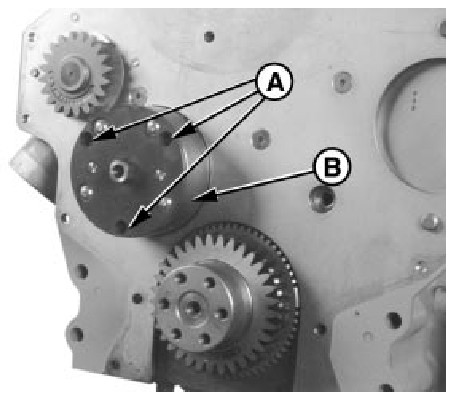
Removing Oil Pump Gear

RG,RG34710,214 –19–25OCT00–1/3

4. Remove three hex socket head cap screws (A) securing oil pump assembly (B) to cylinder block and remove oil pump.

IMPORTANT: DO NOT disassemble oil pump since no repair parts are available. Replace oil pump as a complete assembly as necessary.

A—Hex Socket Head Cap Screws
B—Oil Pump Assembly



RG8257 –UN–06DEC97

Removing Oil Pump

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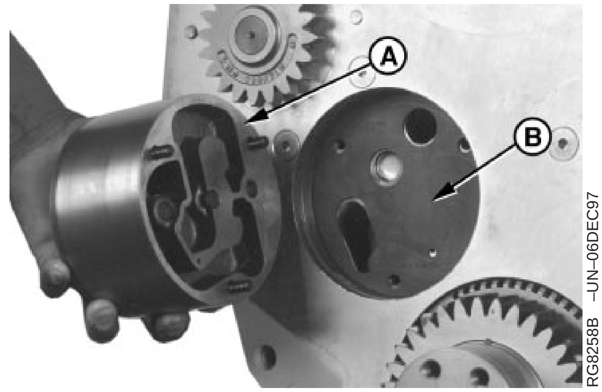
RG,RG34710,214 –19–25OCT00–2/3

5. Remove oil pump-to-cylinder block gasket (B). Discard gasket.

A—Oil Pump Assembly
B—Oil Pump-to-Cylinder Block Gasket



Oil Pump Removed

RG,RG34710,214 –19–25OCT00–3/3

Clean and Inspect Oil Pump and Drive Gear

IMPORTANT: DO NOT disassemble oil pump for repair or inspection. No repair parts are available. Replace pump as a complete assembly as necessary.

1. Completely flush oil pump with solvent while rotating input shaft by hand to clean any debris from housing and gears.

2. Using a good light source, look through rear cavities of pump to inspect all gear teeth for abnormal wear. Replace pump if excess wear is noticed.

3. Inspect back side of oil pump cover through cavities for evidence of gear contact with cover. Replace pump if gear contact is noticed.

4. Inspect oil pump drive gear teeth for wear. Inspect and measure drive gear bushing ID. Bushing ID must be within specifications. Replace drive gear and bushing assembly as necessary.

Specification

Oil Pump Drive Gear Bushing—
ID .... 135.70—135.80 mm
(5.343—5.346 in.)

RG,RG34710,215 –19–13AUG99–1/1

Install Engine Oil Pump

1. Position new gasket (A) in oil pump bore on front face of cylinder block.

2. Apply TY6333 or TY6347 High Temperature Grease to inside cavities of oil pump through openings in back of oil pump.

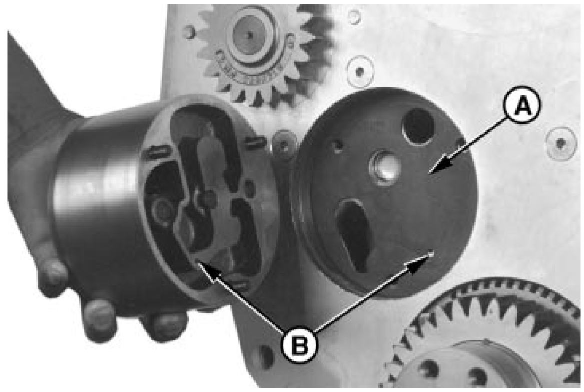
IMPORTANT: Holes (B) in cylinder block, gasket and oil pump housing must align to ensure proper lubrication for oil pump-to-gear bushing.

NOTE: 101.6 mm (4.0 in.) long guide pins may be used to aid oil pump cap screw hole alignment, if desired. Cap screw holes will be aligned only when oil pump is correctly installed.

3. Install oil pump on cylinder block. Apply LOCTITE® 242 (TY9473) Thread Lock and Sealer to oil pump-to-cylinder block cap screw threads and tighten to initial torque specification.

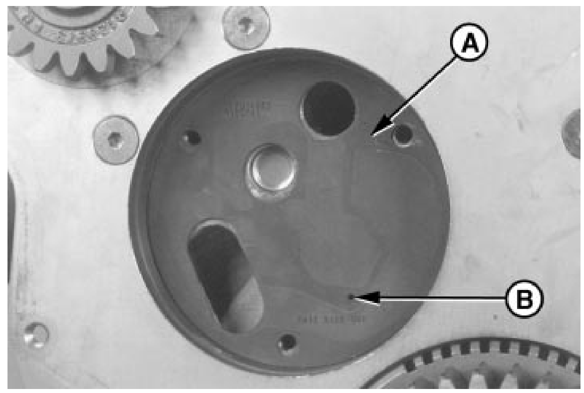
Specification

Oil Pump-to-Block Cap Screws—
Initial Torque.. 20 N•m (177 lb-in.)



RG8258A –UN–06DEC97

Installing Oil Pump



RG8259 –UN–06DEC97

Oil Pump Gasket

A—Gasket
B—Lubrication Holes

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RG,RG34710,216 –19–24SEP02–1/2

4. Second: Starting with first cap screw tightened, apply 90° torque turn to each cap screw.

Specification

Oil Pump-to-Block Cap Screws—
Torque Turn.. 90° (1/4 Turn)

5. Rotate input shaft full 360° after pump installation. If shaft does not turn freely for full 360°, remove pump and determine cause.

6. Apply TY6333 or TY6347 High Temperature Grease to ID of oil pump drive gear bushing.

7. Install oil pump gear with bushing over oil pump housing; align input shaft with opening in gear.

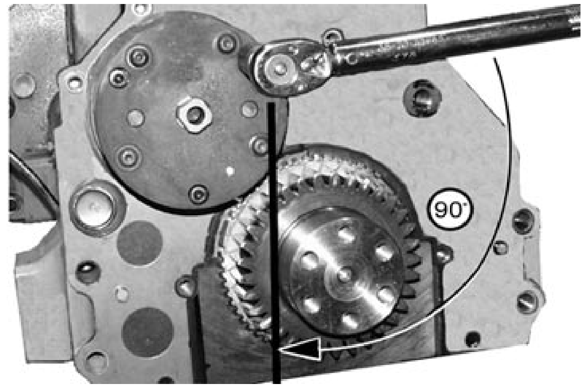
8. Install external snap ring in groove of input shaft.

9. Check oil pump drive gear-to-idler gear backlash.

Specification

Oil Pump Drive Gear-to-Idler
Gear—Backlash.. 0.25 mm (0.010 in.)

10. Install timing gear train cover and complete final assembly. (See INSTALL TIMING GEAR COVER in Group 040.)



RG12611 –UN–30AUG02

90° Torque Turn

RG8256 –UN–21MAY98

Installing Oil Pump Drive Gear

RG,RG34710,216 –19–24SEP02–2/2

Remove Engine Oil Pan

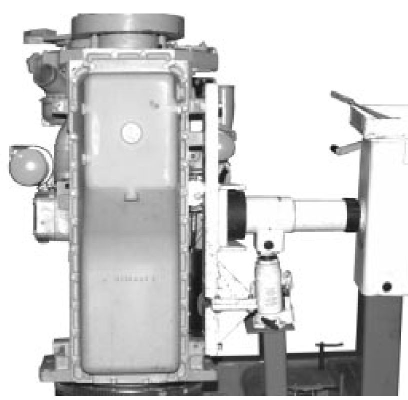
1. Disconnect turbocharger oil inlet line. Remove oil pan drain plug and drain all engine oil.

NOTE: It may be necessary to tap oil pan with a rubber or plastic dead-blow hammer to free oil pan from gasket seal.

2. Remove all 30 oil pan cap screws and remove oil pan from cylinder block.

3. Remove all gasket material from oil pan and cylinder block gasket sealing surfaces.

4. Clean all oil from oil pan and cylinder block sealing surfaces and dry completely.



RG8819 –UN–20MAY98

Removing Oil Pan

RG,RG34710,217 –19–30SEP97–1/1

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Remove and Install Oil Pickup Tube

1. Remove engine oil pan. (See REMOVE ENGINE OIL PAN earlier in this group.)

NOTE: On engine option code 1903, oil pickup tube is mounted on the oil pan with two cap screws.

2. Remove three cap screws securing pickup tube to cylinder block and remove tube assembly with gasket.

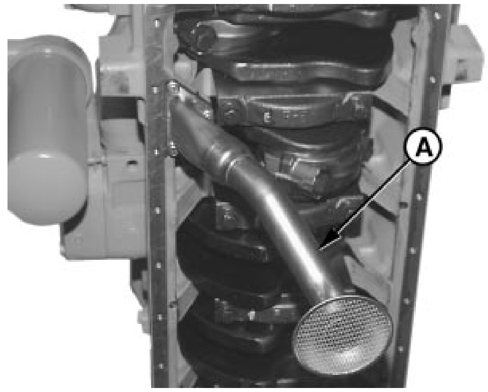
3. Clean pickup tube and screen completely with solvent. Dry with compressed air.

4. Inspect pickup screen for damage or holes. Inspect tube for weld breaks, bends, or any other damage. Replace as necessary.

5. Install pickup tube assembly to cylinder block using a new gasket. Tighten cap screws to specifications.

Specification

Oil Pickup Tube-to-Block Cap Screws—Torque .... 35 N•m (26 lb-ft)
Oil Pickup Tube-to-Oil Pan Cap Screws—Torque .... 25 N•m (18 lb-ft)



RG8122 –UN–20NOV97

Oil Pickup Tube

A—Pickup Tube

RG,RG34710,218 –19–13AUG99–1/1

Install Engine Oil Pan

NOTE: When installing the oil pan gasket and pan, ensure that the oil pan bolts are installed loosely (leave approximately 1/4 inch gap between the pan and block pan rail).This will allow the gasket to center itself to the bolt and block pattern. Once the bolts are installed, follow the torque sequence defined later in this group.

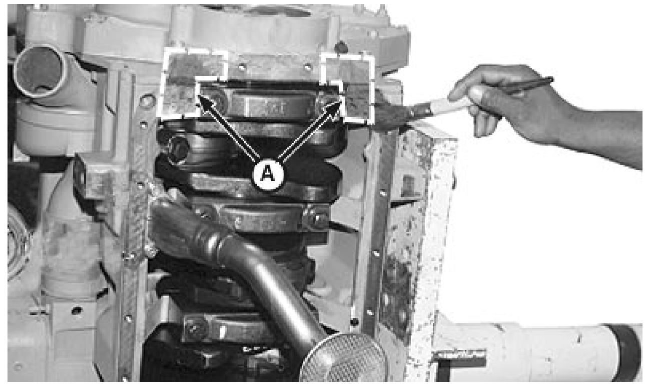
All oil pan and cylinder block gasket sealing surfaces (including timing gear cover and rear seal housing) MUST BE free of gasket material and oil. Surface must be dry.

1. Apply LOCTITE® 7649 Solventless Primer to two front T-joint areas (A). At close to 5 minutes, apply a 3 mm (1/8 in.) bead of LOCTITE® 17430 High Flex Form-In-Place Gasket.

2. Apply a 3 mm (1/8 in.) bead of LOCTITE® 17430 High Flex Form-In-Place Gasket to two rear T-joint areas (C), and on inside edge of both cap screw holes for rear oil seal housing.

3. Position new oil pan gasket on cylinder block.

4. Apply a 3 mm (1/8 in.) bead of LOCTITE® 17430 High Flex Form-In-Place Gasket to face of oil pan gasket at same T-joint locations (A) and (C) on cylinder block in steps 1 and 2 above.



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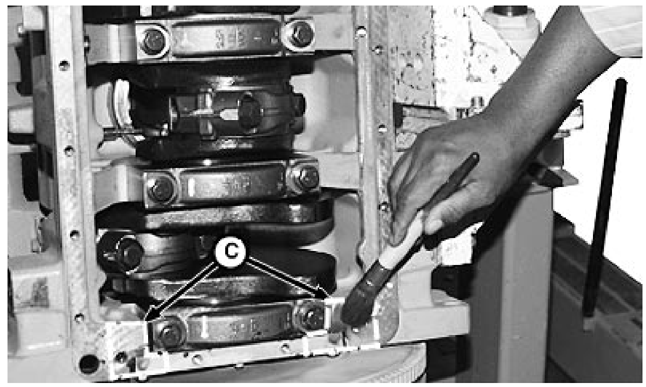

RG10274 –UN–06AUG99

Sealant Applications—Rear Rail

A—Front T-Joints
C—Rear T-Joints

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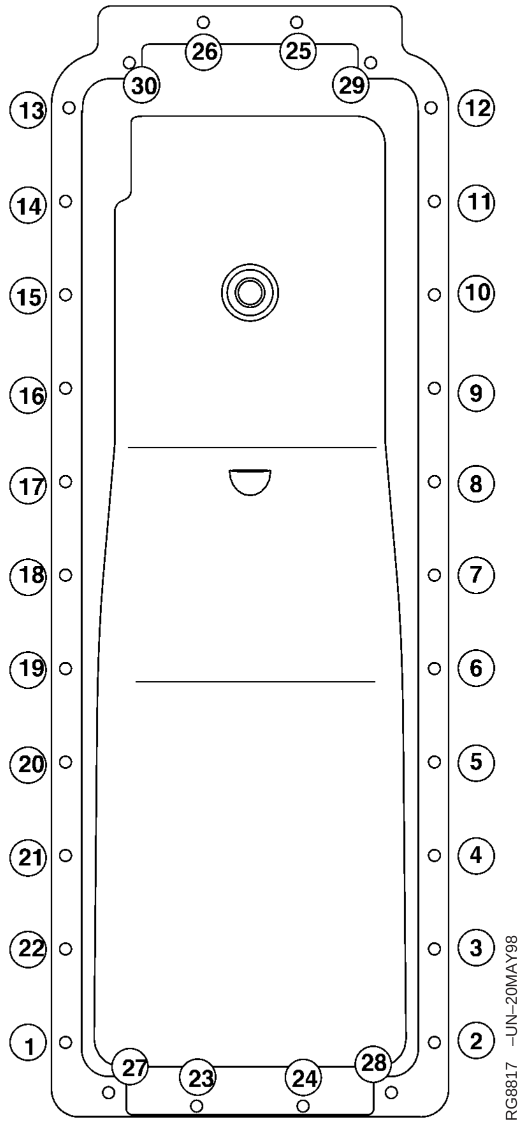
NOTE: Locate rear of oil pan flush to ± 0.05 mm (0.002 in.) with rear face of cylinder block.

5. Carefully install oil pan on cylinder block and tighten all oil pan-to-cylinder block cap screws in sequence shown to specifications. Start at right rear corner of oil pan (facing toward flywheel end) and proceed counterclockwise according to the sequence.



Oil Pan Torque Sequence

Specification

Oil Pan-to-Cylinder Block Cap Screws—Torque .... 25 N•m (18.5 lb-ft) plus 90° Turn Clockwise

6. Tighten oil pan-to-rear oil seal housing and oil pan-to-timing gear cover cap screws to specification.

Specification

Oil Pan-to-Rear Oil Seal Housing Cap Screws—Torque .... 25 N•m (18.5 lb-ft) plus 90° Turn Clockwise

Oil Pan-to-Timing Gear Cover Cap Screws—Torque .... 25 N•m (18.5 lb-ft) plus 90° Turn Clockwise

7. Install oil pan drain plug using a new O-ring and tighten to specifications.

Specification

Oil Pan Drain Plug 1-1/4 in. Hex Plug—Torque.. 46 N•m (34 lb-ft)

Oil Pan Drain Plug 1-1/2 in. Hex Plug—Torque.. 64 N•m (47 lb-ft)

8. If equipped, coat threads of drain hose and drain valve with LOCTITE® 592 Pipe Sealant with TEFLON®. Install and tighten securely.

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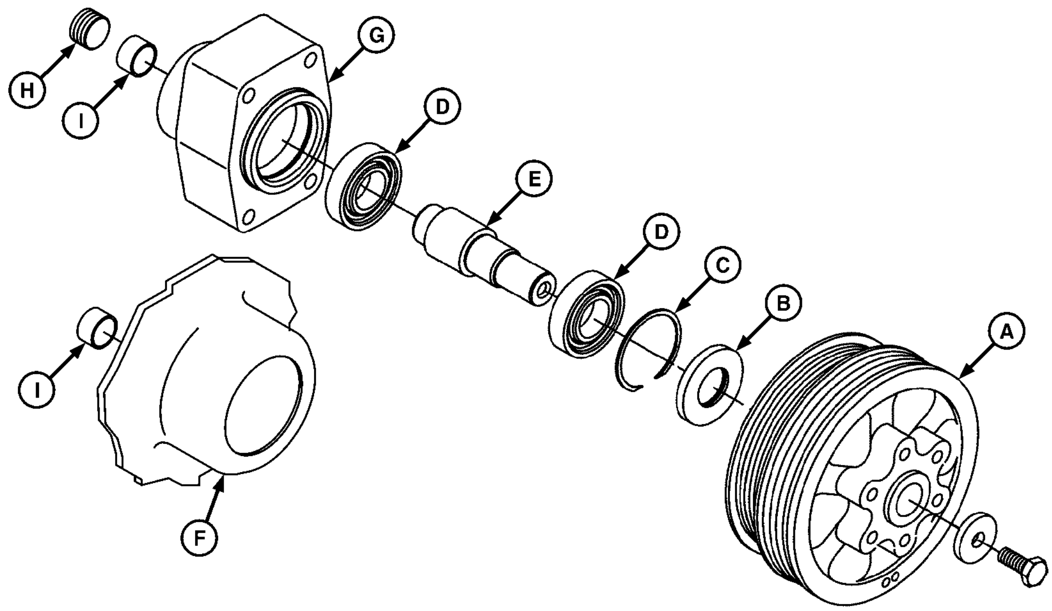
RG,RG34710,219 –19–24SEP02–2/2

Replace Bearings in Fan Drive Assembly



Fan Drive Exploded View

A—Fan Hub/Pulley
B—Grease Seal
C—Snap Ring
D—Ball Bearing (2 used)
E—Shaft
F—Bearing Housing (Fixed)[1]
G—Bearing Housing (Adjustable)
H—Pipe Plug
I—Plug

Disassemble Fan Drive

1. Remove V-belts and remove fan.

2. Using a suitable puller, remove fan hub (A) from shaft (E).

NOTE: ON engines with fixed fan drive assembly cast into camshaft gear access cover, cover must be removed from engine. (See REMOVE TIMING GEAR COVER in Group 040.)

3. Remove fan drive assembly from engine.

NOTE: Early adjustable bearing housings (G) will use threaded type pipe plug (H). Fixed bearing housings (F) and later adjustable bearing housings (G) will use press in type plug (I).

4. Remove pipe plug (H) or plug (I), grease seal (B), and snap ring (C). Discard seal and snap ring.

5. Remove shaft with bearings (D) by lightly tapping end of shaft (through pipe plug opening) with a hammer and brass drift.

6. Remove bearings from shaft using a bearing puller. Discard bearings.

7. Thoroughly clean and inspect shaft and bearing housing (F or G) for cracks or any other damage. Measure parts and compare with specifications given below.

[1] *Bearing housing is cast into camshaft gear access cover.*

Continued on next page

Specification

Heavy Duty Fan Drive—	
Housing ID	71.999—72.025 mm (2.8346—2.8356 in.)
Shaft OD	35.001—35.017 mm (1.3780—1.3786 in.)
Bearing ID	34.987—35.013 mm (1.3774—1.3785 in.)
Bearing OD	71.987—72.013 mm (2.8341—2.8351 in.)

Replace parts that are cracked or not within specification.

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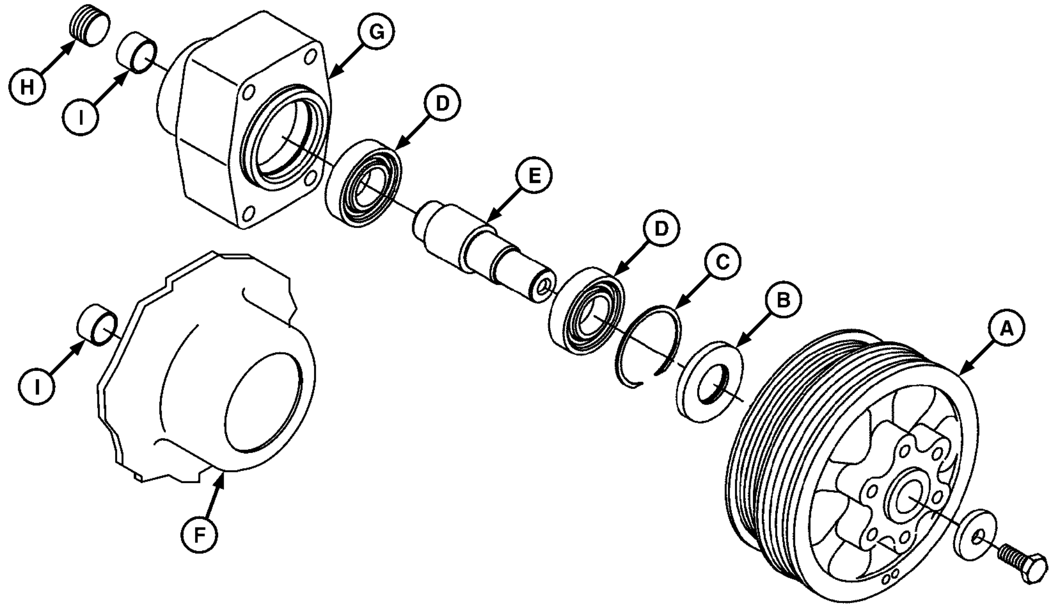


Fan Drive Exploded View

A—Fan Hub/Pulley
B—Grease Seal
C—Snap Ring
D—Ball Bearing (2 used)
E—Shaft
F—Bearing Housing (Fixed)[1]
G—Bearing Housing (Adjustable)
H—Pipe Plug
I—Plug

Assemble Fan Drive

1. Pack inner and outer bearings (D) with TY6333 or TY6347 High Temperature Grease. Apply clean engine oil to bearing ID and shaft OD

2. Support end of shaft (E) and install bearings against shoulder on each end of shaft. Apply force to bearing inner race only.

3. Support bearing housing (F or G) on a firm flat surface with bearing bore in the upward position.

4. Install bearing and shaft assembly into housing using JDG743A Bearing Driver. Small end of shaft should extend through housing.

5. Determine proper snap ring (C) thickness needed to obtain specified end play.

Specification	
Fan Drive Shaft—End Play	0.10 mm (0.004 in.)

6. Install snap ring in housing groove. Visually inspect snap ring installation for proper seating in housing groove.

NOTE: Install grease seal (B) with seal spring toward engine.

7. Apply a thin coat of clean engine oil to OD of seal casing (B) and to seal lips. Using a driver that contacts flat outside case of seal, press seal in housing bore until metal casing is flush to 0.50 mm (0.020 in.) below housing face.

[1] *Bearing housing is cast into camshaft gear access cover.*

Continued on next page

IMPORTANT: On engines with fixed pulleys, be sure the lower right access cover cap screw (3, in diagram on this page) is installed in the camshaft gear access cover before the pulley (A, figure on previous page) is pressed on. Otherwise, pulley will interfere with installation of this cap screw.

8. Apply clean engine oil to ID of fan hub/pulley (A, figure on previous page). Support end of shaft through pipe plug hole in bearing housing. Using a driver that bears on outside finished edge of hub, press hub onto other end of shaft until it bottoms against shoulder. Do not hammer fan hub onto shaft.

9. Install washer and cap screw. Tighten cap screw to specifications.

Specification

Fan Drive Hub-to-Shaft—Torque .... 115 N•m (85 lb-ft)

On engines with dual pulleys, tighten pulley-to-pulley cap screws to the following specifications.

Specification

Fan Pulley-to-Pulley Cap
Screws—Torque .... 61 N•m (45 lb-ft)

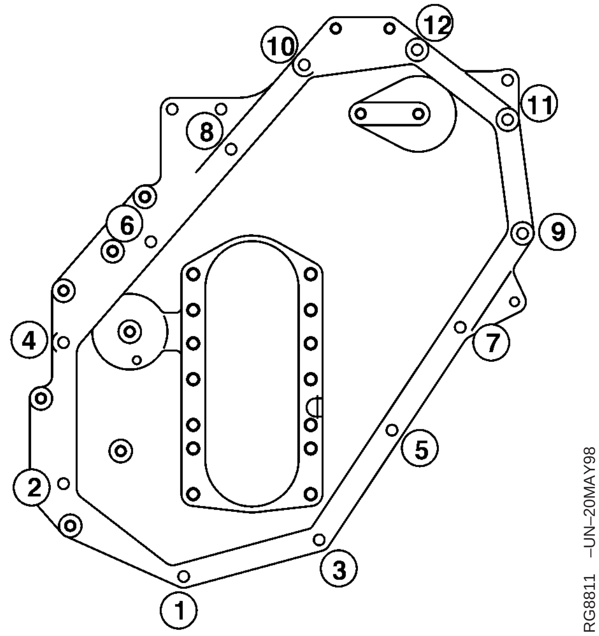
10. On fixed fan drive and later adjustable fan drive assemblies, plug (I, figure on previous page) should be driven in flush to slightly recessed in rear surface of camshaft gear access cover.

11. On early adjustable fan drive assemblies, apply LOCTITE® 592 Pipe Sealant with TEFLON® (TY9480) to threads of pipe plug (H, figure on previous page). Install and tighten plug in bearing housing.

12. Install adjustable fan drive assembly onto engine and tighten cap screws to specifications.

Specification

Adjustable Fan Drive-to-Camshaft
Gear Access Cover Cap
Screws—Torque .... 90 N•m (66 lb-ft)



Camshaft Gear Access Cover

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To install fixed fan drive/camshaft gear access cover assembly, see INSTALL TIMING GEAR COVER in Group 040.

RG,RG34710,224 –19–17SEP02–5/5

Inspect and Check Belt Tensioner Spring Tension

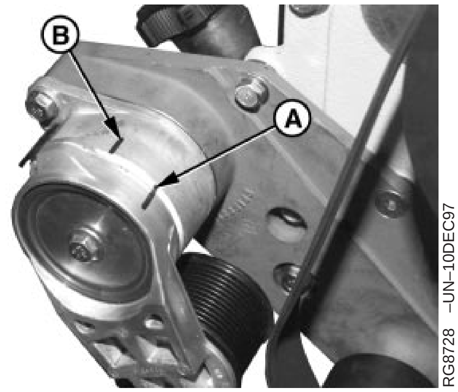
Checking Lower Tensioner Spring Tension

A belt tension gauge will not give an accurate measure of the belt tension when automatic spring tensioner is used. Measure tensioner spring tension using a torque wrench and procedure outlined below:

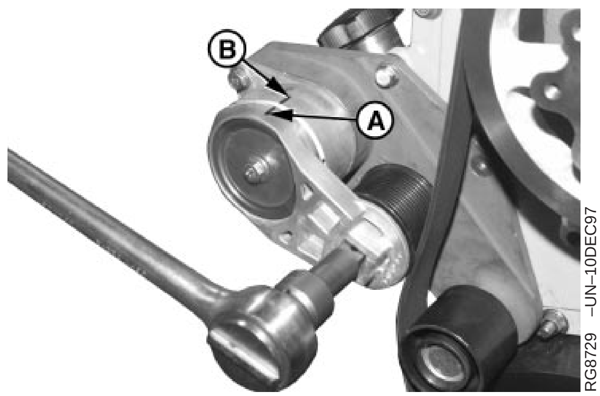
1. Release tension on belt using a long-handle 3/4-in. breaker bar in tension arm. Remove belt from pulleys.
2. Release tension on tension arm and remove breaker bar.
3. Put a mark (A) on swing arm of tensioner as shown.
4. Measure 25 mm (1.0 in.) from first mark (A) and put a second mark (B) on tensioner mounting base.
5. Rotate the swing arm using a torque wrench until marks (A and B) are aligned.
6. Record torque wrench measurement and compare with specification below. Replace tensioner assembly as required.

Specification

Belt Tensioner Lower Spring—
Tension .... 81—99 N•m (60—73 lb-ft)



Marking Lower Belt Tensioner



Testing Lower Tensioner

A—Mark on Swing Arm
B—Mark on Tensioner Base

Continued on next page

RG,RG34710,225 –19–30SEP97–1/2

Checking Upper Tensioner Spring Tension

A belt tension gauge will not give an accurate measure of the belt tension when automatic spring tensioner is used. Measure tensioner spring tension using a torque wrench and procedure outlined below:

1. Release tension on belt using a long handle 1/2-in. breaker bar in tension arm. Remove belt from pulleys.

2. Release tension on tension arm and remove breaker bar.

3. Put a mark (A) on swing arm of tensioner as shown.

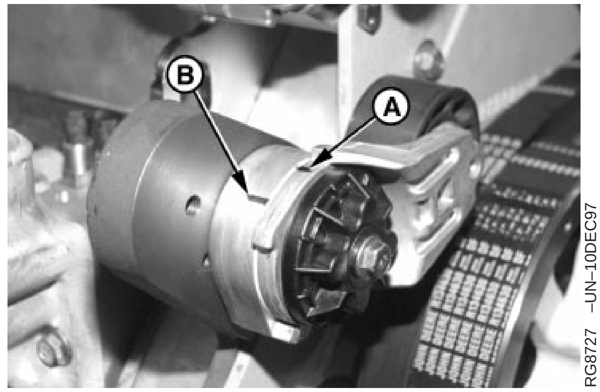
4. Measure 21 mm (0.83 in.) from first mark (A) and put a second mark (B) on tensioner mounting base.

5. Rotate the swing arm using a torque wrench until marks (A and B) are aligned.

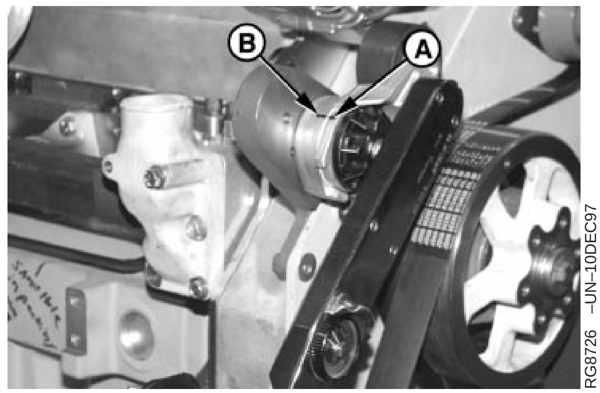
6. Record torque wrench measurement and compare with specification below. Replace tensioner assembly as required.

Specification

Belt Tensioner Upper Spring—
Tension .... 18—23 N•m (13—17 lb-ft)



Marking Upper Belt Tensioner



Testing Upper Tensioner

A—Mark on Swing Arm
B—Mark on Tensioner Base

RG,RG34710,225 –19–30SEP97–2/2

Replace Belt Tensioner Assembly

Follow same procedure for replacement of upper (A) and lower (C) belt tensioner.

1. Release tension on pulley and remove belt.

2. Check spring tension on tensioner. (See INSPECT AND CHECK BELT TENSIONER SPRING TENSION earlier in this group.)

NOTE: Later cam access covers will have two locator holes for positioning of the upper belt tensioner. Mark location of hole being used for ease of installation.

3. Remove cap screw and remove the tensioner assembly.

NOTE: If cam access cover is equipped with two upper tensioner locating holes, reinstall upper tensioner using locating hole previously marked on disassembly.

Apply LOCTITE® 242 Thread Lock and Sealer (TY9473) to tensioner shoulder bolt or cap screw before installing.

4. Install tensioner using locator in upper tensioner only and tighten shoulder bolt or flanged head cap screw to specifications.

Specification

Belt Tensioner Shoulder Bolt or Flanged Head Cap Screw—Torque	50 N•m (37 lb-ft)

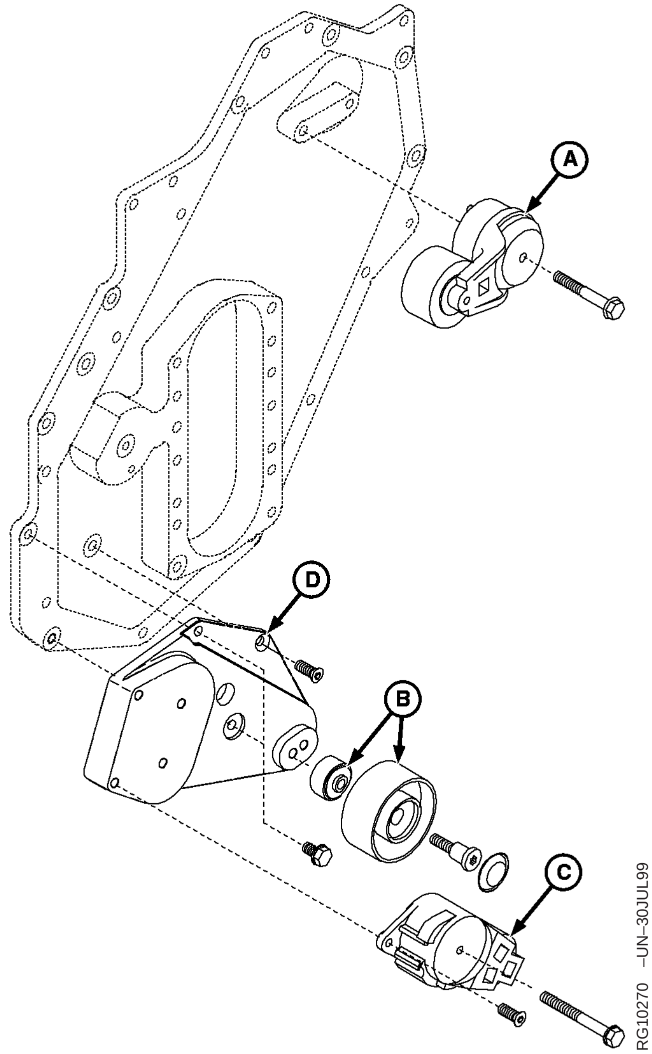
NOTE: Apply LOCTITE® 242 Thread Lock and Sealer (TY9473) to idler pulley mounting cap screw before installing.

5. Install idler pulley assembly.

6. Tighten idler pulley (B) cap screw to specifications.

Specification

Fan Belt Idler Pulley—Torque	68 N•m (50 lb-ft)



Upper and Lower Belt Tensioners

A—Upper Belt Tensioner
B—Belt Idler Pulley Assembly
C—Lower Belt Tensioner
D—Lower Tensioner Bracket

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Continued on next page

RG,RG34710,226 –19–18SEP02–1/2

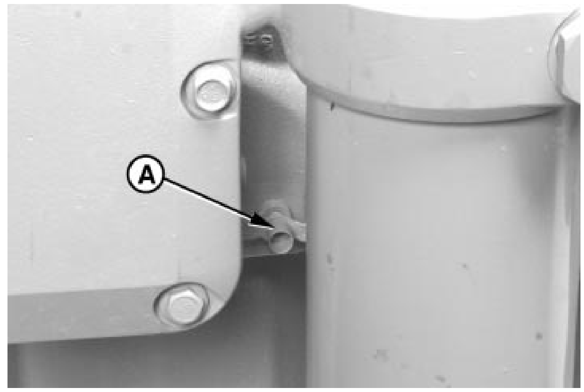
7. Install belt and position onto tensioner.

RG,RG34710,226 –19–18SEP02–2/2

Remove Coolant Pump

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. DO NOT drain coolant until it has cooled below operating temperature. Always loosen radiator pressure cap or drain valve slowly to relieve pressure.

1. Loosen radiator pressure cap and open coolant drain valve (A) on oil cooler housing. Drain all coolant from engine block.



RG8246 –UN–06DEC97

Coolant Drain Valve

A—Coolant Drain Valve

RG,RG34710,227 –19–17SEP02–1/2

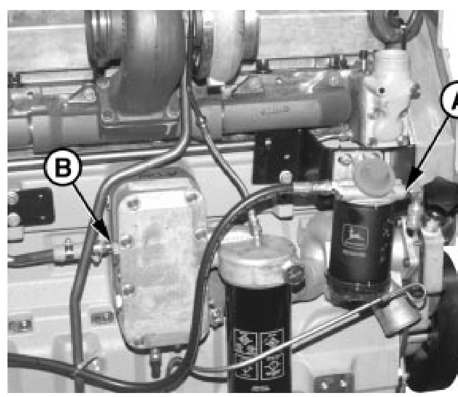
2. On 6125ADW engines, remove primary fuel filter/water separator (A) and mounting bracket.

3. On all engines, remove engine oil cooler and housing assembly (B). (See REMOVE OIL FILTER AND VALVE HOUSING/OIL COOLER COVER AND VALVE HOUSING, in Group 060.)

4. Disconnect coolant pump-to-thermostat housing bypass hose and remove from coolant pump tube fitting.

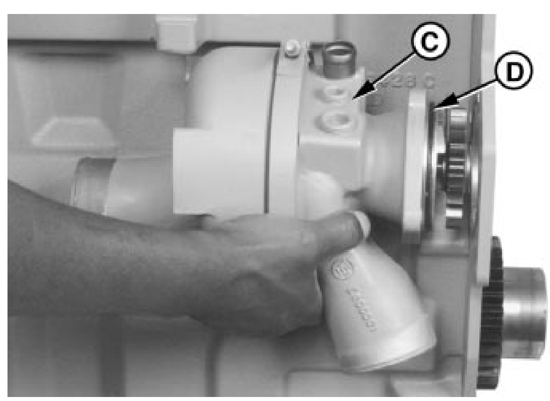
5. Remove three cap screws securing coolant pump-to-front plate and remove coolant pump (C).

6. Remove and discard O-ring (D).



RG8825 –UN–26JUL99

Removing Primary Fuel Filter



RG8261B –UN–06DEC97

Removing Coolant Pump

A—Primary Fuel Filter/Water Separator
B—Oil Cooler and Housing Assembly
C—Coolant Pump
D—O-Ring

RG,RG34710,227 –19–17SEP02–2/2

Clean and Inspect Coolant Pump Parts

NOTE: There are no serviceable parts for the coolant pump. Do not disassemble pump. Replace entire assembly as required. Coolant pump assemblies are available through John Deere service parts as complete remanufactured assemblies.

1. Clean all parts with solvent and dry with compressed air.

2. Inspect coolant pump cover (A) and housing (C) for cracks or damage.

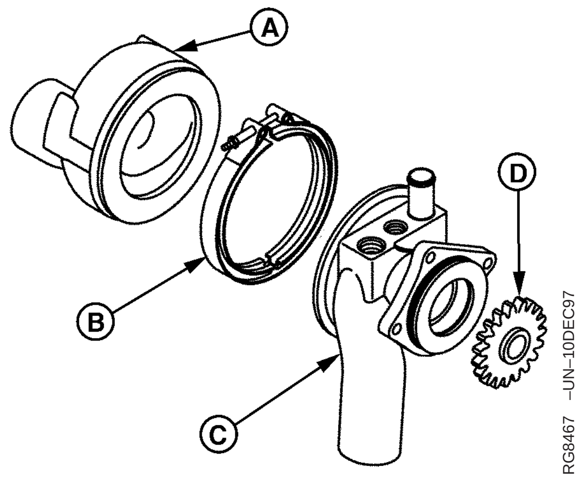
3. Inspect gear (D) for damage.

4. Be sure the “weep hole” in housing is clear and install new foam filter if required.

5. If removed, install coolant pump cover (A) with new O-ring. Tighten band clamp (B) to specifications.

Specification

Coolant Pump Housing-to-Cover
Band Clamp—Torque.. 10 N•m (7.5 lb-ft)

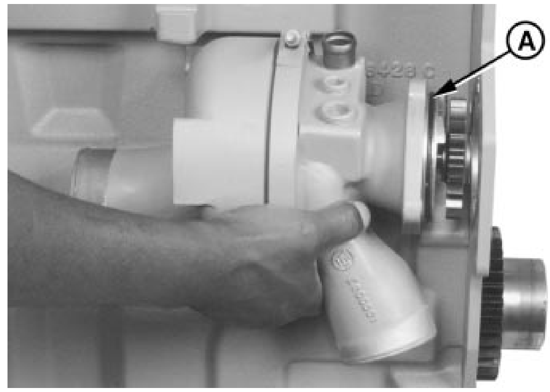


Coolant Pump Part Inspection

A—Coolant Pump Cover
B—Band Clamp
C—Pump Housing
D—Drive Gear

RG,RG34710,229 –19–29NOV00–1/1

Install Coolant Pump



Installing Coolant Pump

A—O-Ring

1. Install a new O-ring (A) on coolant pump mounting flange. Coat O-ring with clean engine oil.

2. Position thermostat housing-to-coolant pump bypass hose onto tube on coolant pump.

3. Install coolant pump to front plate. Be careful not to cut or damage O-ring.

NOTE: Apply LOCTITE® 242 Thread Lock and Sealer (TY9473) to coolant pump cap screws before installing.

4. Install three coolant pump-to-front plate cap screws and tighten to specifications.

Specification

Coolant Pump-to-Front Plate Cap Screws—Torque .... 50 N•m (37 lb-ft)

5. On engines with removable coolant pump inlet elbow, install elbow and tighten cap screws to following specifications.

Specification

Coolant Pump Inlet Elbow to Housing Cap Screws—Torque.. 41 N•m (30 lb-ft)

6. Install oil cooler and housing assembly. (See INSTALL OIL COOLER/OIL FILTER VALVE HOUSING ASSEMBLY OR OIL COOLER COVER/VALVE HOUSING ASSEMBLY in Group 060.)

7. Install all hoses and tighten hose clamps securely.

Specification

Coolant Bypass Hose Clamp—Torque .... 6 N•m (4.5 lb-ft)

Oil Cooler-to-Coolant Pump Hose Clamp—Torque .... 9 N•m (7 lb-ft)

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RG,RG34710,231 –19–29NOV00–1/1

Remove Thermostats

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. DO NOT drain coolant until it has cooled below operating temperature. Always loosen radiator pressure cap or drain valve slowly to relieve pressure.

1. Visually inspect area around thermostat housing for leaks. Partially drain cooling system.

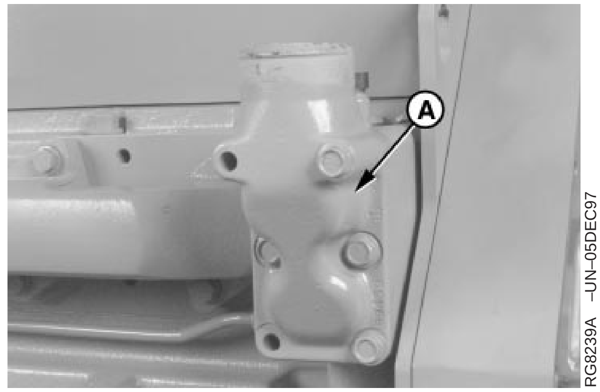
2. Remove cap screws securing thermostat cover (A) to thermostat housing and engine block.

3. Remove thermostat cover from thermostat housing.

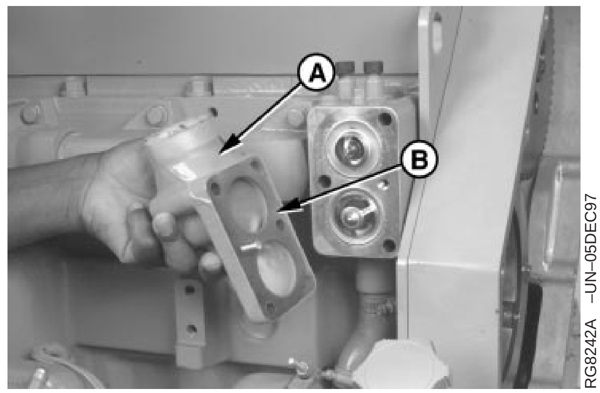
4. Remove gasket or seal (B) and remove both thermostats.

5. Test each thermostat for proper opening temperature. (See TEST THERMOSTAT OPENING TEMPERATURE later in this group.)

A—Thermostat Cover
B—Gasket



Thermostat Cover Installed



Thermostat Cover Removed

RG,RG34710,232 –19–17SEP02–1/1

Install Thermostats

IMPORTANT: Top thermostat has a vent notch with wiggle wire (A) for air bleeding. Bottom thermostat has a blocking poppet that opens passage to radiator when coolant warms.

1. Clean all material from thermostat cover and housing mounting surfaces.

2. Install smaller (non-blocking) thermostat in top position with vent (wiggle wire) at 12 o'clock position. Install larger blocking thermostat in bottom position.

3. Install thermostat cover using a new gasket or seal (B).

4. If equipped, install M10 x 35 cap screw (C) securing thermostat cover-to-housing and tighten to specifications.

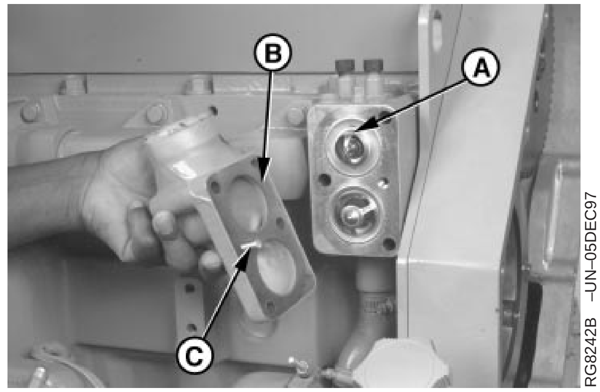
Specification

Thermostat Cover-to-Housing
M10 x 35 Cap Screw—Torque .... 35 N•m (26 lb-ft)

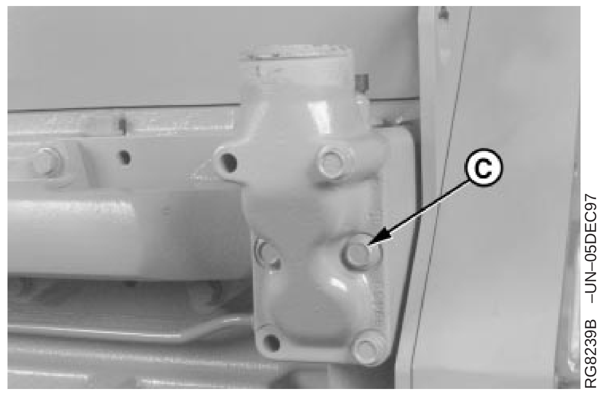
5. Install and tighten thermostat cover/housing assembly-to-block cap screws to specifications.

Specification

Thermostat Cover/Housing
Assembly-to-Block Cap Screws—
Torque .... 50 N•m (37 lb-ft)



Install Thermostats



Thermostat Cover Installed

A—Wiggle Wire
B—Gasket
C—M10 x 35 Cap Screw

RG,RG34710,233 –19–24SEP02–1/1

Test Thermostat Opening Temperature

1. Remove thermostats. (See REMOVE THERMOSTATS earlier in this group.)

CAUTION: DO NOT allow thermostat or thermometer to rest against the side or bottom of container when heating water. Either may rupture if overheated.

2. Visually inspect thermostats for corrosion or damage. Replace thermostats as a matched set as necessary.

3. Suspend thermostats and a thermometer in a container of water.

4. Stir the water as it heats. Observe opening action of thermostat and compare temperatures with specification given in chart below.

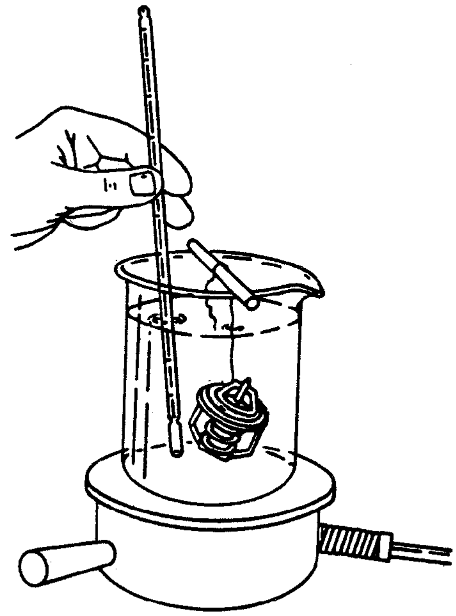
Specification

Thermostat Test—Rating	82°C (180°F)
Initial Opening (Range) Temperature	80—84°C (175—182°F)
Full Open (Nominal) Temperature	94°C (202°F)

NOTE: Due to varying tolerances of different supplies, initial opening and full open temperatures may vary slightly from specified temperatures.

5. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.

6. If any one thermostat is defective, replace both thermostats.



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Testing Thermostats

RG,RG34710,234 –19–30SEP97–1/1

Remove and Install Thermostat Housing

Remove Thermostat Housing

1. Disconnect top liner cooling return line (B) from thermostat housing.

2. Remove three cap screws (A) securing thermostat housing to cylinder block.

3. Pull thermostat housing straight out from engine to free housing from top liner cooling outlet adapter (C).

4. Loosen hose clamp and remove hose from housing nipple.

5. Remove gasket and discard. Clean all gasket material from mounting surfaces.

Install Thermostat Housing

1. Apply clean engine oil to top liner cooling outlet adapter O-ring.

2. Position thermostat housing on engine using a new gasket. Be sure housing is firmly seated on top liner cooling adapter O-ring.

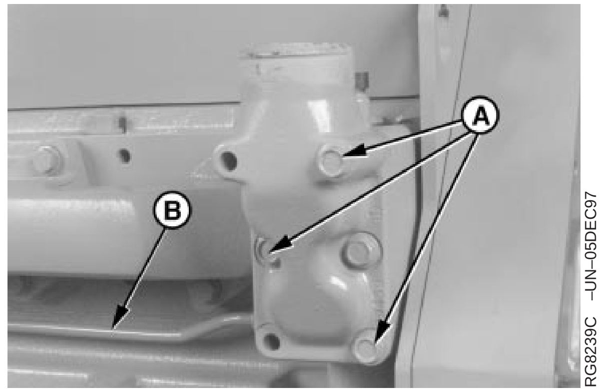
3. Install mounting cap screws and tighten to specifications.

Specification

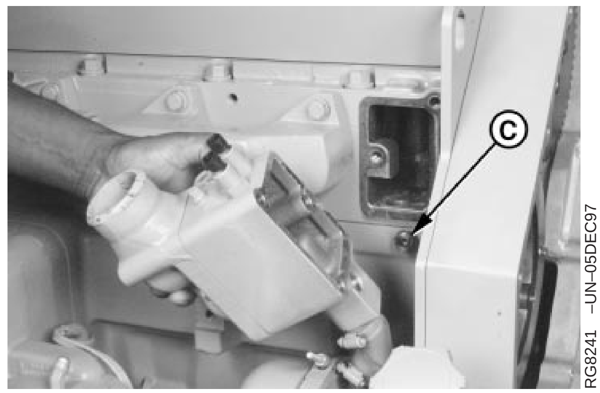
Thermostat Cover/Housing
Assembly-to-Block Cap Screws—
Torque .... 50 N•m (37 lb-ft)

4. Connect top liner cooling return line and tighten securely.

5. If removed, apply LOCTITE® 592 Pipe Sealant with TEFLON® (TY9480) to pipe plugs and temperature sensor and tighten to the following specifications.



Thermostat Housing Installed



Thermostat Housing Removed

A—Cap Screws (3 Used)
B—Return Line
C—Outlet Adapter

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Continued on next page

Specification

Coolant Temperature Sensor—	
Torque	10 N•m (7.5 lb-ft)
Thermostat Housing Pipe Plugs—	
Torque	20 N•m (15 lb-ft)

RG,RG34710,235 –19–17SEP02–2/2

Remove and Install Coolant Heater—if Equipped

TS210 –UN–23AUG88

Testing Coolant Heater

CAUTION: To avoid shock or hazardous operation, always use a three-wire heavy-duty electrical cord. If a two-to-three contact adapter is used at the wall receptacle, always connect green wire to a good ground. Keep electrical connectors clean to prevent arcing.

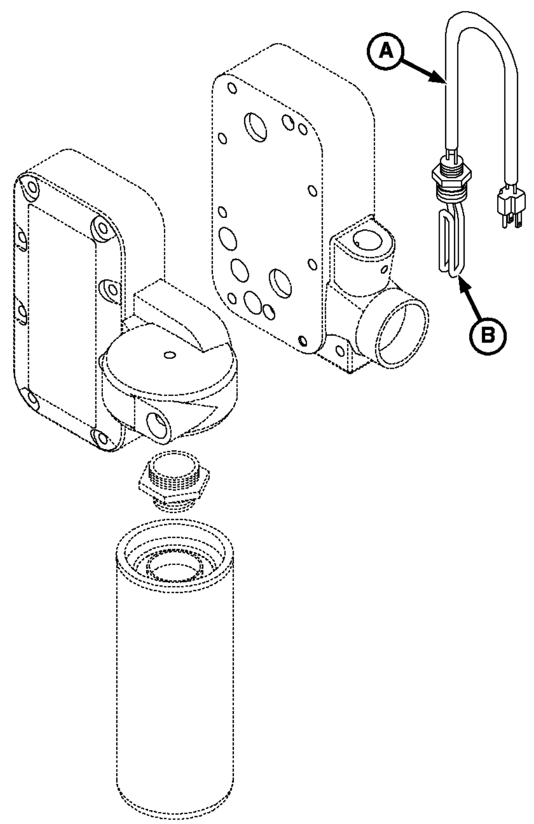
Only plug coolant heater into electrical power if heating element is immersed in coolant. Otherwise sheath could burst, causing personal injury.

1. Unplug heater from electrical power source.
2. Partially drain cooling system.
3. Remove electrical cord (A), loosen nut, and pull heater element (B) out of oil cooler housing.

NOTE: The heater element cannot be repaired. If defective, replace it.

4. Apply LOCTITE® 592 Pipe Sealant with TEFLON® (TY9480) to coolant heater threads.
5. Install heater element in oil cooler housing and tighten hex nut securely.
6. Install cord.

A—Electrical Cord
B—Heater Element



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Engine Coolant Heater

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RG,RG34710,236 –19–30SEP97–1/1

Extending Turbocharger Life

Turbochargers are designed to last the life of the engine, but because they operate at such high speeds (100,000 rpm or more), a moment's carelessness can cause them to fail in seconds.

The major causes of turbocharger failures are attributed to:

- Lack of lube oil (quick starts and hot shutdowns)
- Oil contamination
- Ingestion of foreign objects
- Restricted oil drainage
- Low oil level
- Operation on excessive side slopes
- Abnormally high exhaust temperatures

Lack of Lube Oil

Oil not only lubricates the turbocharger's spinning shaft and bearings, it also carries away heat. When oil flow stops or is reduced, heat is immediately transferred from the hot turbine wheel to the bearings, which are also heating up because of the increased friction due to the lack of oil. This combination causes the turbocharger shaft temperature to increase rapidly.

If oil flow does not increase and the process continues, bearings will fail. Once the bearings fail (which can happen in just seconds), seals, shaft, turbine and compressor wheels can also be damaged.

The principal causes of turbocharger bearing lubrication problems are low oil pressure, a bent, plugged or undersized oil lube supply line, plugged or restricted oil galleries in the turbocharger, or improper machine start-up and shutdown procedures.

Oil levels and pressure should always be closely monitored and all worn hoses and lines should be replaced. The turbocharger oil supply line should be checked frequently to make sure it is not kinked or bent, and it should always be replaced with a line of equal size, length and strength.

The easiest way to damage a turbocharger is through improper start-up and shutdown procedures. Always idle the engine for at least 30 seconds (no load) after start-up and before shutdown. Warming the engine up before applying a load allows oil pressure to build up and lines to fill with oil.

Idling the engine before shutdown allows the engine and turbocharger to cool. "Hot" shutdowns can cause the turbocharger to fail because, after high-speed operation, the turbocharger will continue to rotate long after the engine has been shut off and oil pressure has dropped to zero. This will cause heat to build up and possible bearing damage. It can also cause carbon and varnish deposits to form.

Oil Contamination

A second cause of turbocharger failures is contaminated oil. It can be caused by a worn or damaged oil filter or not changing the lube oil at recommended intervals. Expecting the oil filter to remove dirt, sand, metal chips, etc., from the oil before they reach the engine or turbocharger can be a costly mistake because contaminated oil may completely bypass the engine oil filter if the oil filter or oil cooler is clogged, if the filter element is improperly installed, or if the oil is thick during cold weather.

Four good ways of avoiding oil contamination are:

- Always inspect the engine thoroughly during major overhaul. Look especially for any sludge or debris left in lube oil galleries.
- Change lube oil at recommended intervals. Analysis of oil samples at filter change periods can help identify potentially harmful contaminants in the oil.
- Clean the area around the oil fill cap before adding oil.
- Use a clean container when adding oil.

Continued on next page RG,RG34710,1256 –19–23AUG02–1/2

Ingestion of Foreign Objects

A third cause of turbocharger damage is the ingestion of foreign objects. Foreign objects or particles can be ingested and cause damage to the turbocharger on both compressor and turbine sides. This is easy to avoid.

On the compressor side, foreign objects usually take the form of dust, sand, or shreds of air cleaner element that enter through improperly installed air cleaner elements. Leaky air inlet piping (loose clamps or torn rubber joints) or torn pleats in dry-type air cleaner elements also create problems.

The result is erosion of compressor blades that can cause the delicately balanced wheel to wobble.

IMPORTANT: Whenever an internal engine failure (valve, valve seat, piston) occurs, a thorough inspection of the turbocharger MUST BE performed before returning engine to service.

Restricted Oil Drainage

A fourth cause of turbocharger damage is restricted lube oil drainage. The lubricating oil carries away heat generated by friction of the bearings and from the hot exhaust gases. If drainage back to the sump is impeded, the bearings will overheat with damage that will ultimately lead to failure.

There are two primary reasons for restricted drainage. A blocked drain tube, due to either damage or a buildup of sludged oil, or high crankcase pressure, which can be due to restricted crankcase breather or excessive engine blow-by.

Periodically check both the turbocharger oil drain tube and engine breather tube for damage or restriction. Correction of these conditions leads to longer turbocharger life.

Abnormally High Exhaust Temperatures

A fifth cause of turbocharger damage is abnormally high exhaust temperatures. Elevated exhaust temperatures cause coking of oil which can lead to bearing failure. Extreme over-temperature operation can cause wheel burst.

There are two basic causes of over-temperature. The first is restricted air flow and the second is overpowering the engine. In either case the engine has more fuel than available air for proper combustion; this overfueled condition leads to elevated exhaust temperatures.

Causes of restricted air flow can include damaged inlet piping, clogged air filters, excessive exhaust restriction, or operation at extreme altitudes. Overpowering generally is due to improper fuel delivery or injection timing. If overtemperature operation has been identified, an inspection of the air inlet and exhaust systems should be performed. Also, check the fuel delivery and timing.

RG,RG34710,1256 –19–23AUG02–2/2

Remove Turbocharger

CAUTION: After operating engine, allow exhaust system to cool before removing turbocharger.

Thoroughly clean exterior of turbocharger and surrounding area to prevent entry of dirt into the air intake system during removal.

IMPORTANT: When cleaning turbocharger, do not spray directly into compressor cover or turbine housing. If turbocharger inspection is required, do not clean exterior prior to removal. Doing so may wash away evidence of a potential failure mode. See TURBOCHARGER SEVEN-STEP INSPECTION later in this group.)

1. Refer to your machine technical manual to disconnect air inlet and exhaust piping.

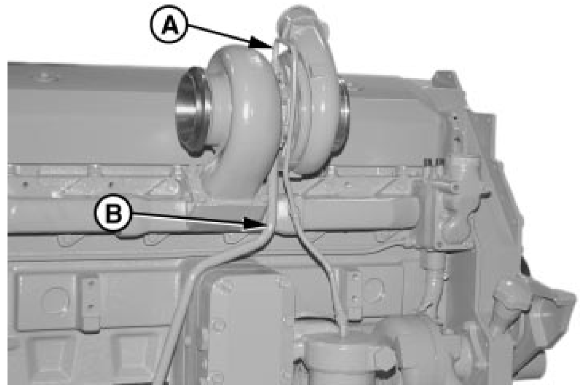
2. Remove turbocharger air intake hose and exhaust elbow. Remove turbocharger air outlet piping (shown removed).

3. Disconnect oil inlet line (A) and oil return pipe (B) from turbocharger.

4. Remove four mounting cap screws and lift turbocharger from exhaust manifold. Remove stainless steel gasket.

5. Place turbocharger on a clean flat surface. Cap or plug all air intake and exhaust openings.

6. Perform turbocharger seven-step inspection, as described later, if failure mode has not yet been determined. See TURBOCHARGER SEVEN-STEP INSPECTION later in this group.



RG8187B –UN–05DEC97

Removing Turbocharger

A—Oil Inlet Line
B—Oil Return Pipe

RG,RG34710,241 –19–30SEP97–1/1

Turbocharger Failure Analysis

The following is a guide for diagnosing the cause of turbocharger failures after removal from the engine.

Problem	Possible Cause	Suggested Remedy
COMPRESSOR HOUSING INLET DEFECTS		
Foreign Object Damage	Objects left in intake system.	Disassemble and inspect intake system for foreign objects (this group). Inspect engine for internal damage.
	Leaking and/or defective intake system.	Inspect air intake system connections including air filter; repair as required (this group). Inspect air intake related engine components.
Compressor Wheel Rub	Bearing failure.	Determine if engine and/or operator contributed to lack of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in progress. Correct as required.
	Manufacturing defects.	Correct as required.
COMPRESSOR HOUSING OUTLET DEFECTS		
Oil and/or Dirt in Housing	Restricted air intake system.	Inspect and clean air cleaner.
	Prolonged periods of low rpm engine idling.	Check with operator to confirm conditions. (See Operator's Manual.)
	Defective oil seal ring.	Repair as required (this group).
	Restricted oil drain line.	Inspect and clear oil drain line as required.
TURBINE HOUSING INLET DEFECTS		
Oil in Housing	Internal engine failure.	Inspect and repair engine as required.
	Oil leaking from compressor housing seal.	Verify that oil is in compressor housing and refer to "Compressor Housing Outlet Defects" as listed earlier in this chart.
Center Wall Deteriorated	Excessive operating temperature.	Check for restricted air intake. Check engine for overfueling.

Continued on next page OUO1004,0000C21 –19–29NOV00–1/2

TURBINE HOUSING OUTLET DEFECTS

Turbine Wheel Rub	Bearing failure.	Determine if engine and/or operator contributed to lack of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in progress. Correct as required.
	Manufacturing defect.	Correct as required (this group).
Foreign Object Damage	Internal engine failure.	Inspect and repair engine as required.
	Objects left in intake system.	Disassemble and inspect air intake system (this group).
	Leaking air intake system.	Correct as required (this group).
Oil and/or Excessive Carbon	Internal engine failure.	Verified by oil in turbine housing. Correct as required.
	Turbine seal failure.	Inspect for excessive heat from overfueling and/or restricted air intake.
	Prolonged periods of low rpm engine idling.	Ask operator to run engine under load or at a higher rpm. (See Operator’s Manual.)
	Restricted oil drain line.	Inspect and clear oil drain line as required.

EXTERNAL CENTER HOUSING AND JOINT DEFECTS

Leaks from Casting	Defective casting.	Replace turbocharger (this group).
	Defective gasket.	Verify if leaks are occurring at gasket joints.
Leaks from Joints	Loose attaching screws.	Tighten to specifications in CTM (this group).
	Defective gasket.	Inspect and repair as required.

INTERNAL CENTER HOUSING DEFECTS

Excessive Carbon Build-Up in Housing or on Shaft	Hot engine shutdown.	Review proper operation with operator as shown in Operator’s Manual.
	Excessive operating temperature.	Restricted air intake; overfueling or mistimed engine.
	Restricted oil drain line.	Inspect and clean oil drain lines as required.
	Operating engine at high speeds and loads immediately after start-up.	Idle engine for a few minutes to allow oil to reach bearings before applying heavy loads.

OUO1004,0000C21 –19–29NOV00–2/2

Turbocharger Seven-Step Inspection

The following inspection procedure is recommended for systematic failure analysis of a suspected failed turbocharger. This procedure will help to identify when a turbocharger has failed and why it has failed, so the primary cause of the failure can be corrected.

Proper diagnosis of a non-failed turbocharger is important for two reasons. First, identification of a non-failed turbocharger will lead to further investigation and repair of the cause of a performance complaint.

Second, proper diagnosis eliminates the unnecessary expense incurred when a non-failed turbocharger is replaced.

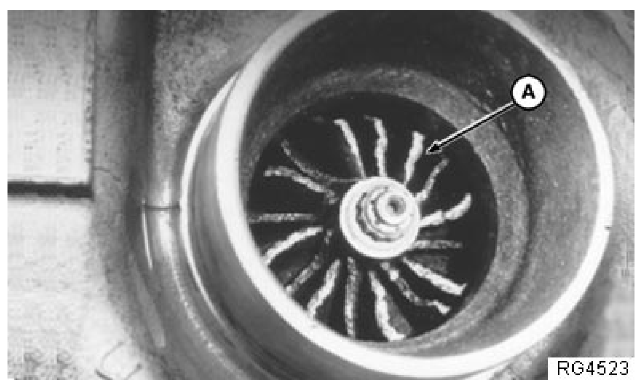
The seven recommended inspection steps, which are explained in detail on the following pages, are:

- Compressor Housing Inlet and Compressor Wheel.
- Compressor Housing Outlet.
- Turbine Housing Inlet.
- Turbine Housing Outlet and Turbine Wheel.
- External Center Housing and Joints.
- Internal Center Housing.
- Turbocharger Bench Test.

NOTE: To enhance the turbocharger inspection, an inspection sheet (Form No. DF-2280 available from Distribution Service Center—English only) can be used that lists the inspection steps in the proper order and shows potential failure modes for each step. Check off each step as you complete the inspection and record any details or problems obtained during inspection. Retain this with the work order for future reference.

DPSG,OUO1004,945 –19–28JUL99–1/13

Compressor Housing Inlet and Compressor Wheel



Checking Inlet and Compressor Wheel

1. Check compressor inlet and compressor wheel (A) for foreign object damage.

NOTE: Foreign object damage may be extensive or minor. In either case, the source of the foreign object must be found and corrected to eliminate further damage.

2. Mark findings on your checklist and continue the inspection.

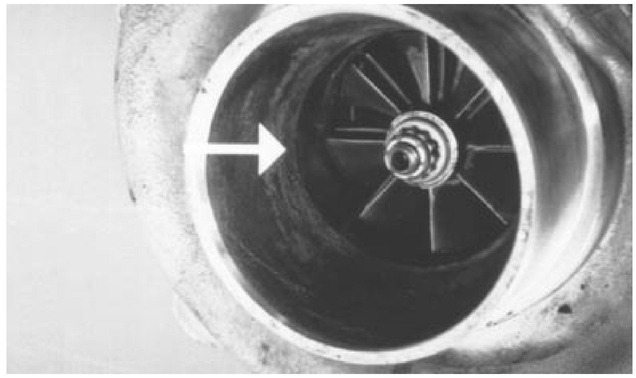
A—Compressor Wheel

Continued on next page

DPSG,OUO1004,945 –19–28JUL99–2/13

NOTE: You will need a good light source for this check.

3. Check compressor inlet for wheel rub on the housing (arrow). Look very closely for any score marks on the housing itself and check the tips of the compressor wheel blades for damage.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Checking Compressor Inlet

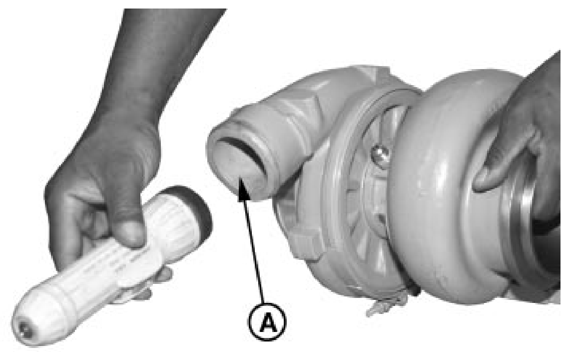
DPSG,OUO1004,945 –19–28JUL99–3/13

Compressor Housing Outlet

1. Check compressor housing outlet (A). The outlet should be clean and free of dirt or oil.

2. Mark it on your checklist if dirt or oil is found and continue the inspection.

A—Compressor Housing Outlet



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Checking Compressor Outlet

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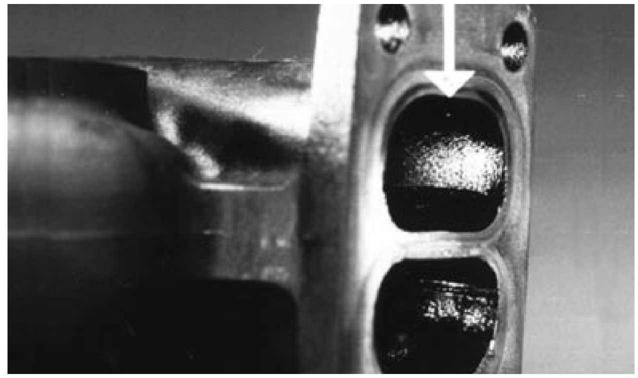
DPSG,OUO1004,945 –19–28JUL99–4/13

Turbine Housing Inlet

Check the turbine housing inlet ports (arrow) for oil in housing, excessive carbon deposit or erosion of center walls.

NOTE: If the inlet is wet with oil, or has excessive carbon deposits, an engine problem is likely. Center wall erosion (cracking or missing pieces), indicates excessive exhaust temperature.



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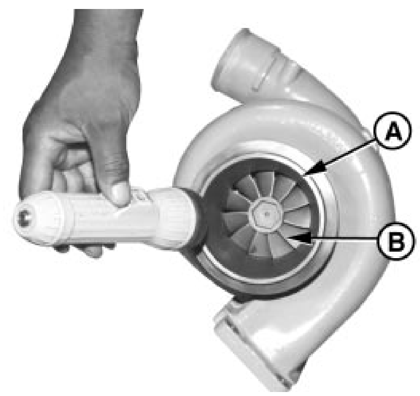
Checking Turbine Housing Inlet Ports

DPSG,OUO1004,945 –19–28JUL99–5/13

Turbine Housing Outlet and Turbine Wheel

1. Use a flashlight to look up inside the turbine housing outlet (A) and check blades (B) for foreign object damage.

A—Turbine Housing Outlet
B—Blades



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Checking Turbine Wheel and Outlet

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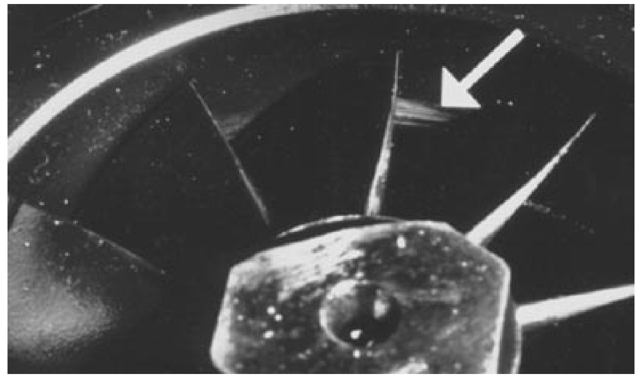
DPSG,OUO1004,945 –19–28JUL99–6/13

2. Inspect the wheel blades and housing for evidence of wheel rub (arrow). Wheel rub can bend the tips of the blades with the housing showing wear or damage.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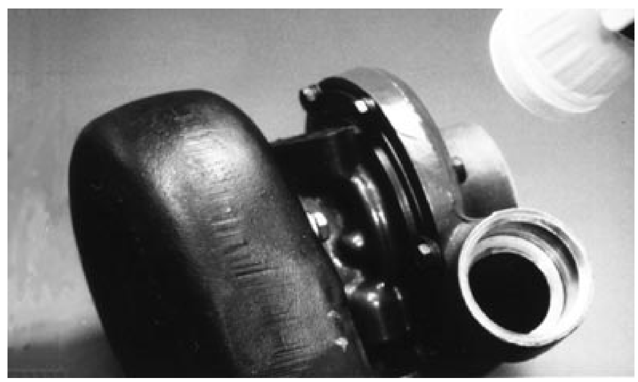
Checking Turbine Wheel Blades

DPSG,OUO1004,945 –19–28JUL99–7/13

External Center Housing and Joints

Visually check the outside of the center housing, all connections to the compressor, and turbine housing for oil.

NOTE: If oil is present, make sure it is not coming from a leak at the oil supply or return line.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Checking Center Housing

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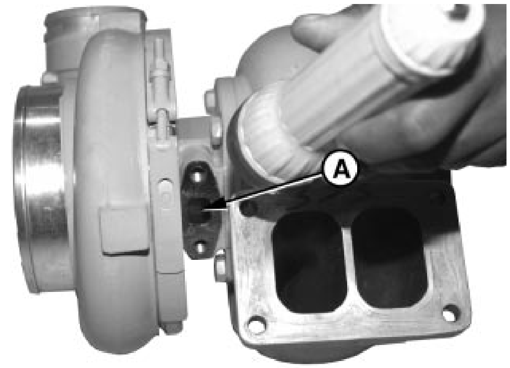
DPSG,OUO1004,945 –19–28JUL99–8/13

Internal Center Housing

1. Using a flashlight, look through the oil return hole (A), to check the condition of the shaft and/or bearings. There should not be excess carbon deposits on the shaft or in the housing.

A—Oil Return Hole



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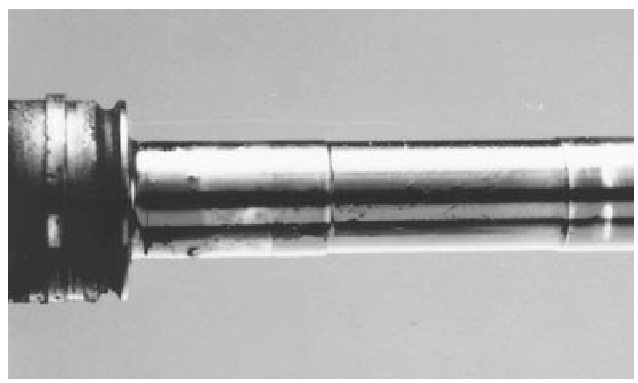
Checking Shaft and Bearings

DPSG,OUO1004,945 –19–28JUL99–9/13

2. Excessive “blueing” or “coking” of oil along the complete length of the shaft indicates a possible lack of lubrication caused by an engine failure, or improper operation, such as hot shutdowns.



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Checking for Oil “Coking” on Shaft

Continued on next page DPSG,OUO1004,945 –19–28JUL99–10/13

Turbocharger Bench Test

1. Mount the turbocharger in a vise.

2. Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely; however, there may be a slight amount of drag.

Checking Shaft Rotation and Clearance

DPSG,OUO1004,945 –19–28JUL99–11/13

IMPORTANT: Use only moderate hand force (3—4 pounds) on each end of shaft.

3. Next, pull up on the compressor end of the shaft and press down on the turbine end while rotating shaft. Neither the compressor wheel nor the turbine wheel should contact the housing at any point.

NOTE: There will be some "play" because the bearings inside the center housing are free floating.

Checking for Contact of Compressor and Turbine Wheels

Continued on next page DPSG,OUO1004,945 –19–28JUL99–12/13

4. Next, check shaft end play by moving the shaft back and forth while rotating. There will be some end play but not to the extent that the wheels contact the housings.

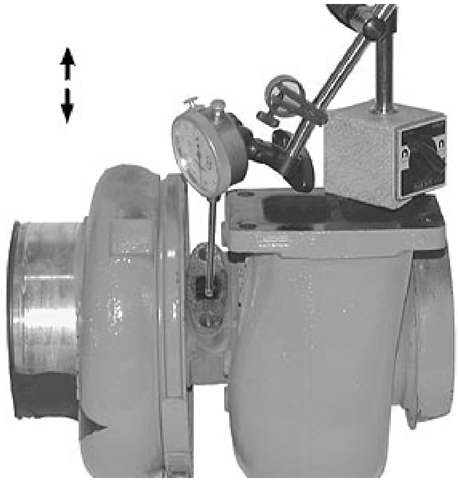
Checking Shaft End Play

NOTE: These diagnostic procedures will allow you to determine the condition of the turbocharger. If the turbocharger has failed, analysis of your inspection notes should direct you to the specific areas of the engine to correct the problems causing the turbocharger failure (See TURBOCHARGER FAILURE ANALYSIS, earlier in this group). It is not unusual to find that a turbocharger has not failed. If your turbocharger passes all the inspections, the problem lies somewhere else.

IMPORTANT: Before you finalize your conclusion that the turbocharger has not failed, it is strongly recommended that the following procedures of checking radial bearing clearance and axial bearing end play with a dial indicator be performed. These procedures are not required if a failure mode has already been identified.

DPSG,OUO1004,945 –19–28JUL99–13/13

Perform Radial Bearing Clearance Test



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Checking Radial Bearing Clearance

This test will give an indication of the condition of the radial bearings within the center housing and rotating assembly.

1. Fasten a magnetic base (plunger-type) dial indicator to the turbocharger mounting base. Assemble an extension adapter and indicator extension rod onto dial indicator.

2. Position indicator tip (through center housing oil return) on center of shaft. Preload indicator tip and zero dial on indicator.

IMPORTANT: Use only moderate hand force (3—4 pounds) on each end of shaft when checking clearance.

3. Grasp rotating shaft at both ends and move the shaft toward the indicator, then away from the indicator (arrows). Use care to move the shaft in the same direction as the dial indicator tip travels and apply equal pressure at both ends of the shaft.

4. Observe and record total indicator movement.

Specification

Garrett Turbocharger Shaft—Radial Bearing Clearance (Allowable Movement) .... 0.076—0.165 mm (0.003—0.0065 in.) (measured on center of shaft)

Borg Warner Turbocharger Shaft—Radial Bearing Clearance (Allowable Movement) .... 0.56—0.81 mm (0.022—0.0.032 in.) (measured on end of shaft)

If total indicator reading is not within specification, install a replacement turbocharger.

DPSG,OUO1004,946 –19–03NOV00–1/1

Perform Axial Bearing End Play Test

This test will give an indication of the condition of the axial bearing within the center housing and rotating assembly.

1. Mount magnetic base dial indicator so that indicator tip rests on end of shaft. Preload indicator tip and zero dial on indicator.

2. Move shaft axially back and forth by hand.

3. Observe and record total dial indicator movement and compare to following specification.

Specification

Garrett Turbocharger Axial Bearing—End Play .... 0.025—0.114 mm (0.0010—0.0045 in.)

Borg Warner Turbocharger Axial Bearing—End Play .... 0.0635—0.1143 mm (0.0025—0.0045 in.)

If bearing end play is not within specification, replace turbocharger.


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Measuring Axial End Play

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Repair Turbocharger

Turbochargers used on the engines covered in this manual are available through service parts as a complete remanufactured assembly only. Individual components for repair are not available.

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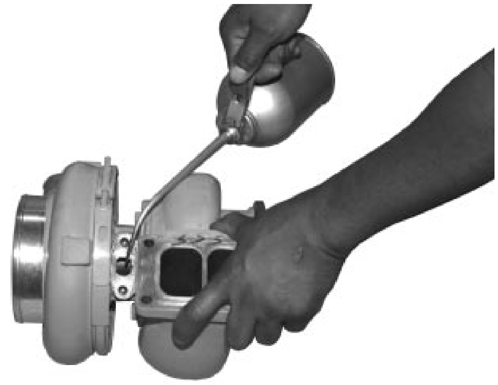
Prelube Turbocharger

IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

Fill oil inlet or drain port with clean engine oil and spin rotating assembly (by hand) to properly lubricate bearings.

If turbocharger is to be stored for an extended period of time, lubricate internally and install protective covers on all openings.



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Prelubing Turbocharger Bearings

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Install Turbocharger

IMPORTANT: If turbocharger failed because of foreign material entering the air intake system, be sure to examine the system and clean as required to prevent a repeat failure.

If not done previously, prime (prelube) the turbocharger rotating assembly prior to mounting turbocharger on engine. Prelube center housing with clean engine oil through the oil drain hole. Turn rotating assembly by hand to lubricate bearings. (See PRELUBE TURBOCHARGER earlier in this group.)

1. Install two guide pins (A) in front turbocharger mounting holes as shown. Install stainless steel gasket (B) over guide pins.

2. Position turbocharger on stainless steel gasket and exhaust manifold.

3. Apply PT569 NEVER-SEEZ® Compound to turbocharger cap screws and tighten to specifications.

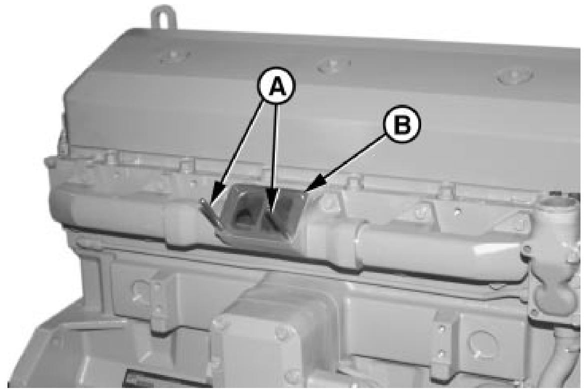
Specification	
Turbocharger-to-Exhaust Manifold—Torque	50 N•m (37 lb-ft)

4. If removed, apply LOCTITE® 242 Thread Lock and Sealant to turbocharger oil inlet fitting and install and tighten to specifications.

Specification	
Turbocharger Oil Inlet Fitting—Torque	50 N•m (37 lb-ft)

5. Apply PT569 NEVER-SEEZ® Compound to oil return pipe cap screws. Install oil return pipe (C) to turbocharger using a new gasket. Tighten oil return pipe cap screws to specifications.

Specification	
Turbocharger Oil Return Pipe-to-Turbocharger—Torque	50 N•m (37 lb-ft)



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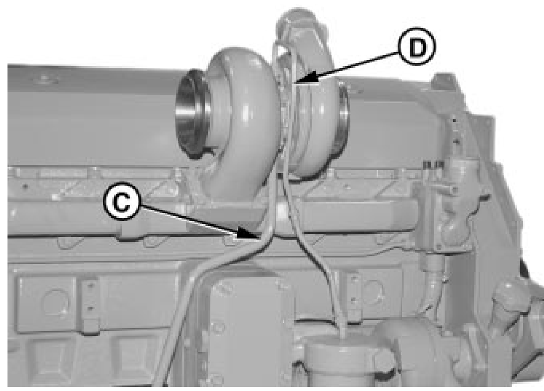
Guide Pins as Assembly Aid



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Installed Turbocharger

A—Guide Pins
B—Gasket
C—Oil Return Pipe
D—Oil Inlet Line

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Connect turbocharger oil inlet line (D) and tighten both ends to specifications.

Specification

Turbocharger Oil Inlet Line (Both Ends)—Torque .... 35 N•m (26 lb-ft)

IMPORTANT: Since the greatest suction force occurs between air cleaner and turbocharger, ensure that hose connections are tight to prevent entry of dirt into system.

6. Connect air inlet hose-to-turbocharger compressor housing.

7. Install air intake and exhaust piping onto turbocharger compressor and turbine ends as detailed in machine technical manual.

RG,RG34710,247 –19–13AUG99–2/2

Turbocharger Break-In

IMPORTANT: A new or repaired turbocharger DOES NOT have an adequate oil supply for immediate start-up of engine. Perform the steps below to prevent damage to turbocharger bearings.

1. Remove ECU power fuse so engine does not start.

IMPORTANT: DO NOT crank engine longer than 30 seconds at a time to avoid damage to starter motor.

2. Crank engine over with starter motor until oil pressure gauge needle registers within the “GREEN” zone of pressure gauge.

3. Install ECU power fuse. Start and run engine at low idle while checking oil inlet and all piping connections for leaks.

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Remove, Inspect, and Install Exhaust Manifold

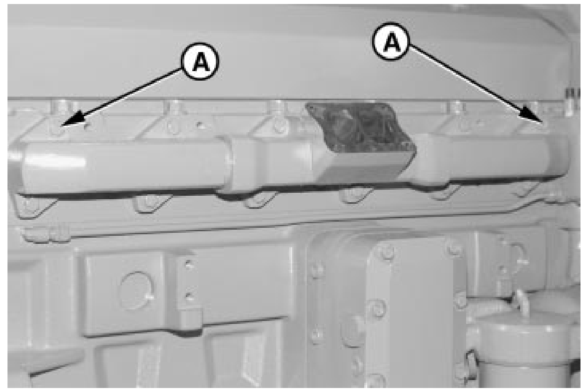
Remove Exhaust Manifold

1. Remove turbocharger (shown removed). (See REMOVE TURBOCHARGER earlier in this group.)

2. Remove upper cap screws (A) from front and rear exhaust manifold sections and install guide pins.

3. Remove remaining exhaust manifold-to-cylinder head cap screws and remove exhaust manifold as an assembly.

4. Separate three exhaust manifold sections. Remove exhaust manifold-to-cylinder head gaskets and discard.



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Removing Exhaust Manifold

A—Upper Cap Screws

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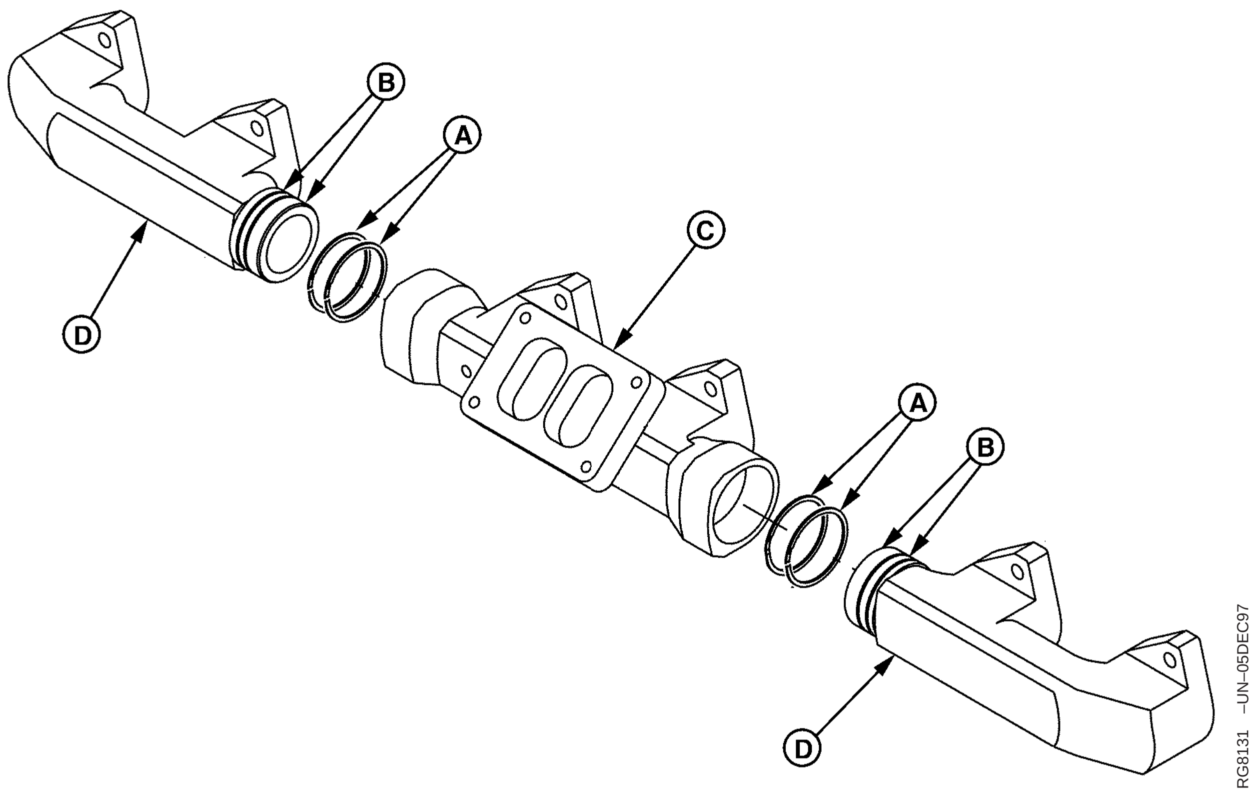


Exhaust Manifold Exploded View

A—Sealing Rings (4 used) **B—Sealing Ring Grooves** **C—Center Manifold Section** **D—End Manifold Sections (2 used)**

Inspect Exhaust Manifold

IMPORTANT: Some early production exhaust manifold end sections (D) may have three sealing ring grooves (B) and may have been assembled with only one sealing ring. ALWAYS use two sealing rings during engine reassembly and use outer grooves on manifold sections with three grooves.

1. Inspect machined mating surfaces (ID and OD) for burrs, cracks or other imperfections which may prevent sealing rings (A) from sealing properly.

2. Inspect area past sealing ring locations for evidence of exhaust leakage. Inspect all sections for cracks.

3. Inspect and clean cylinder head and exhaust manifold machined mounting surfaces.

Continued on next page RG,RG34710,249 –19–13AUG99–2/3

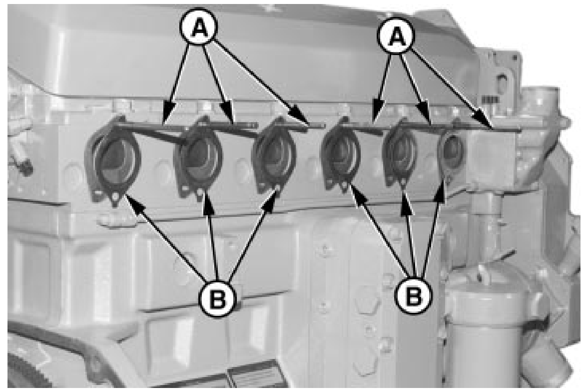
Install Exhaust Manifold

1. Install guide pins (A) at upper threaded hole of each exhaust port as shown.
2. Install gaskets (B) on each guide pin as shown.
3. Install two sealing rings on both exhaust manifold end sections and assemble with center section.
4. Install manifold assembly (C) onto guide pins.
5. Apply PT569 NEVER-SEEZ® Compound to exhaust manifold cap screws and tighten bottom row of cap screws finger tight. Be sure gaskets are properly positioned before installing cap screws.
6. Remove guide pins from top row and install cap screws finger tight.
7. Tighten all cap screws to specifications.

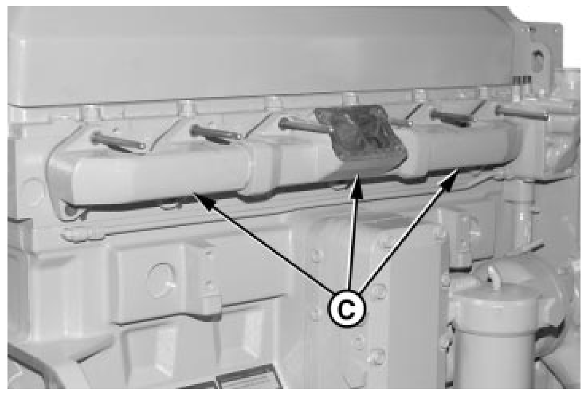
Specification

Exhaust Manifold-to-Head Cap
Screws—Torque .... 70 N•m (52 lb-ft)

8. Install turbocharger. (See INSTALL TURBOCHARGER earlier in this group.)



Exhaust Manifold Gaskets



Installing Exhaust Manifold

A—Guide Pins
B—Gaskets
C—Manifold Assembly

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RG,RG34710,249 –19–13AUG99–3/3

Remove, Inspect, and Install Intake Manifold

NOTE: Intake manifolds differ between engine applications. Manifold shown has inlet on end of manifold. Some manifolds have center inlets.

Remove Intake Manifold

1. If required, remove final fuel filter (A). Disconnect fuel lines (B) from filter mounting base.

2. Refer to your machine technical manual to disconnect intake piping, sensors, and starting aid that is connected to intake manifold.

NOTE: If required, note location of primary fuel filter/water separator bracket (C) for assembly in same location as removed.

3. Remove top cap screw on each end of intake manifold and install guide pins.

4. Remove remaining cap screws and remove intake manifold with gasket. Discard gasket.

Inspect Intake Manifold

1. Check intake manifold for damage or cracks.

2. Thoroughly inspect interior of manifold for dust or debris.

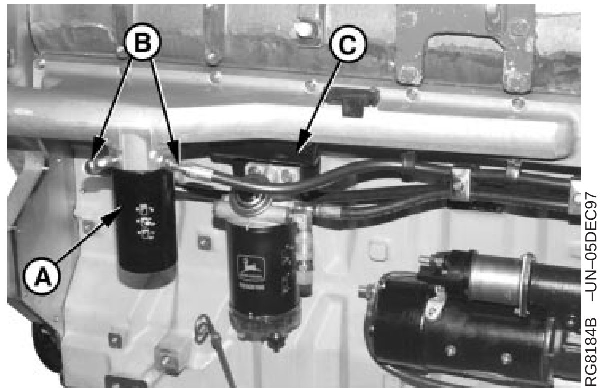
3. Clean all gasket material from intake manifold and cylinder head mounting surfaces.

Install Intake Manifold

1. Install guide pins at each end of top intake manifold cap screw locations.

2. Install a new gasket onto guide pins.

3. Install intake manifold onto guide pins. If required, install primary fuel filter/water separator in same location as removed.



Intake Manifold Assembly (6105HRW and 6125HRW Engines with Dual Rail Fuel Systems Shown)

A—Final Fuel Filter
B—Fuel Lines
C—Primary Fuel Filter/Water Separator Bracket

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Continued on next page

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4. Apply PT569 NEVER-SEEZ® Compound to intake manifold cap screws. Starting at center cap screws, alternating top to bottom and front to rear, tighten intake manifold-to-cylinder head cap screws to specifications.

Specification

Intake Manifold-to-Cylinder Head Cap Screws—Torque	35 N•m (26 lb-ft)

5. If required, connect fuel lines to final fuel filter mounting base. Install final fuel filter.

6. Reconnect intake piping, sensors, and starting aid detailed in machine technical manual.

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Remove and Install Aftercooler Assembly (6105A and 6125A Engines)

Remove Aftercooler Assembly

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Wait until engine coolant is below operating temperature before draining. Slowly loosen radiator filler cap to first stop to relieve pressure.

1. Drain engine coolant.

2. Clean area surrounding aftercooler intake piping to prevent debris from entering intake system as parts are removed.

3. Remove coolant inlet hose (A) and outlet hose (B) from aftercooler end connections.

4. Remove air inlet adapter (C) from aftercooler inlet.

5. Refer to machine technical manual to disconnect all sensors and starting aid.

6. Remove aftercooler assembly (D) with gasket using two guide pins at upper outside cap screw locations. Discard gasket.

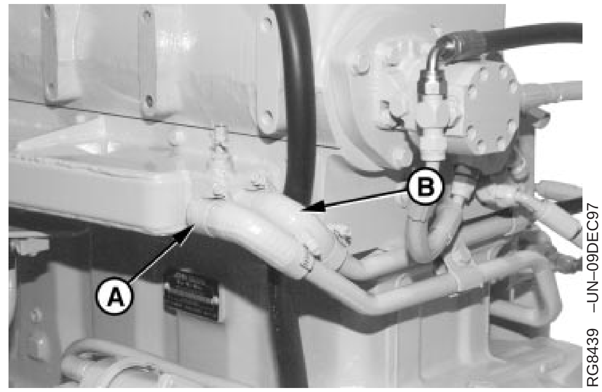
Install Aftercooler Assembly

1. Install aftercooler assembly using a new gasket and two guide pins at upper outside cap screw locations.

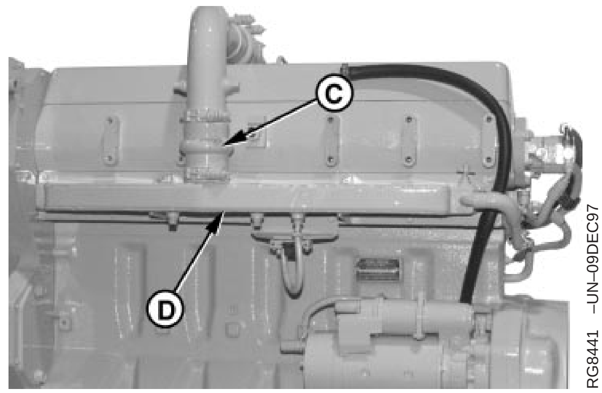
2. Apply PT569 NEVER-SEEZ® Compound to aftercooler-to-cylinder head cap screws. Install cap screws and tighten to specifications.

Specification	
Aftercooler-to-Cylinder Head Cap Screws—Torque	35 N•m (26 lb-ft)

3. Install coolant inlet and outlet hoses and tighten clamps securely.



Aftercooler Coolant Piping



Removing Aftercooler

A—Coolant Inlet Hose
B—Coolant Outlet Hose
C—Air Inlet Adapter
D—Aftercooler Assembly

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4. If removed, install inlet and outlet tube clamps and tighten cap screws (or cap screw with nut) to specifications.

Specification

Aftercooler Tube Clamp Cap Screw (or Cap Screw with Nut)—Torque .... 50 N•m (37 lb-ft)

5. Install air inlet adapter onto aftercooler inlet and tighten securely.

6. Fill cooling system with proper coolant solution.

7. Refer to machine technical manual to connect sensors and starting aid.

RG,RG34710,251 –19–13AUG99–2/2

Inspect and Repair Aftercooler (6105A and 6125A Engines)

Aftercooler Assembly

A—Inlet Tube
B—Outlet Tube

1. Inspect aftercooler for overall condition. The fins should be reasonably straight, and cross straps should be free of cracks.

2. Inspect aftercooler inlet and outlet hoses. Replace either hose if cracked or damaged.

3. Test the aftercooler for leaks by plugging outlet tube (B).

4. Apply compressed air to the inlet tube (A) while unit is submerged under water. Use specified air pressure for testing.

Specification
Aftercooler—Test Pressure .... 140—170 kPa (1.4—1.7 bar) (20—25 psi)

A minor leak that is accessible may be repaired.

However, if the condition of the core is questionable, replace aftercooler.

IMPORTANT: Coolant leakage from the aftercooler may cause severe engine damage.

5. Inspect air intake cover for cracks or damage. Replace as necessary.

RG,RG34710,252 –19–13AUG99–1/1

Fuel System

NOTE: Repair, operation, diagnostic, and testing procedures on fuel systems and electronic controls have been moved to the following manuals:

- CTM115—Delphi/Lucas Electronic Fuel Systems With Delphi/Lucas EUIs
- CTM188—Level 6 Electronic Fuel Systems With Delphi/Lucas EUIs

Later Tier II 12.5 L engines with dual- or single-rail fuel systems are covered in CTM188.

OUO1004,0000C2D –19–23AUG02–1/1

Remove and Install Alternator (OEM Engines)

IMPORTANT: The alternator is designed with a Transient Voltage Protector (TVP) to protect the engine electronics. A regular alternator without the TVP could cause extensive damage to the electronics.

NOTE: For test and repair of alternator, refer to CTM 77.

1. Disconnect battery ground (-) cable.

2. Disconnect positive (+) red wire (A) and regulator connector (E) (shown disconnected).

3. Remove alternator belt using a 1/2 in. drive ratchet on the belt tensioner (C).

4. Remove mounting cap screws from adjusting strap (B). Remove cap screw and nut (D) and remove alternator.

5. Install alternator in reverse order.

6. Torque alternator mounting hardware to the following specifications.

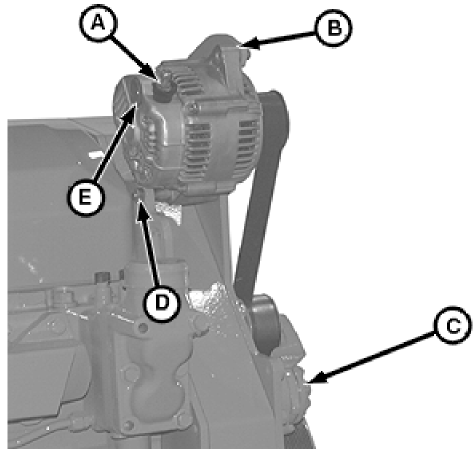
Alternator Strap Mounting Hardware—Specification

M8 Cap Screw—Torque	25 N•m (18 lb-ft)
M10 Cap Screw—Torque	50 N•m (37 lb-ft)
1/2 in. Cap Screw—Torque	61 N•m (45 lb-ft)

Alternator Foot Mounting Hardware—Specification

M10 Cap Screw—Torque	70 N•m (52 lb-ft)
M12 Cap Screw—Torque	60 N•m (44 lb-ft)

7. Inspect alternator belt for cracks and wear.



RG10286 –UN–20AUG99

Alternator

A—Positive Wire Terminal
B—Alternator Strap
C—Belt Tensioner
D—Mounting Cap Screw and Nut
E—Regulator Connector Terminal

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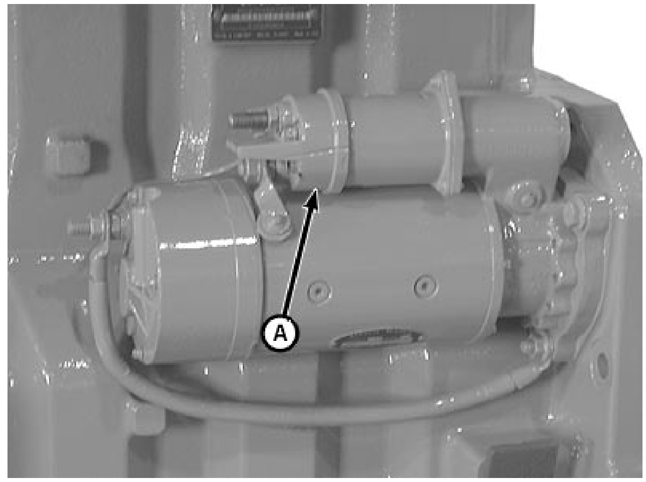
DPSG,OUO1004,1005 –19–23SEP02–1/1

Remove and Install Starter Motor (OEM Engines)

NOTE: For test and repair of starter motor, refer to CTM 77.

1. Disconnect battery ground (-) cable.
2. Disconnect all cables and wires from starter solenoid (A) (shown disconnected).
3. Remove starter motor using JDE80 Starter Wrench.
4. Install starter motor in reverse order.
5. Torque motor mounting hardware to the following specifications.

	Specification
Starter Motor Mounting Hardware—Torque	125 N•m (92 lb-ft)



Starter Motor

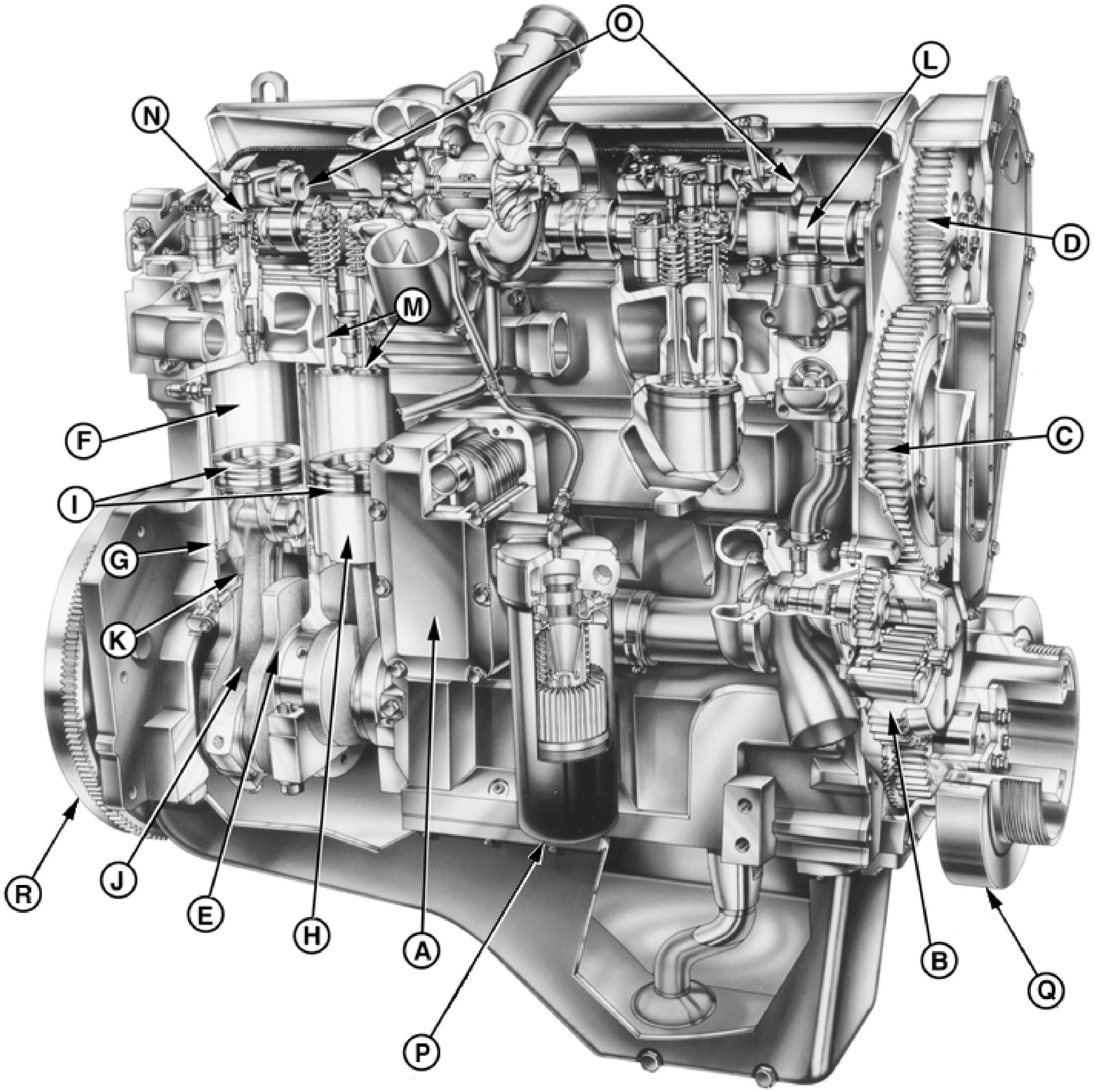
A—Starter Solenoid

DPSG,OUO1004,1006 –19–13AUG99–1/1

Section 03
Theory of Operation

Contents

General Engine Operation



RG12419 –UN–11SEP02

Engine Components

A—Oil Cooler
B—Oil Pump Drive Gear
C—Idler Gear
D—Camshaft Gear
E—Crankshaft
F—Cylinder Liner
G—Cylinder Liner O-rings
H—Piston
I—Piston Rings
J—Connecting Rod
K—Oil Spray Jet
L—Camshaft
M—Valves
N—Electronic Unit Injector
O—Two-Piece Rocker Arm Shaft
P—Oil Filter
Q—Crankshaft Damper
R—Flywheel

The 6105 and 6125 engines include a cam in head, actuating four valves per cylinder and an electronic unit injector (EUI) fuel system. They are vertical stroke, in-line, valve-in-head, 6-cylinder diesel engines. The firing order is 1-5-3-6-2-4.

The cast block has ribbed walls to add strength and rigidity, and to decrease noise and vibration. The 6105 and 6125 use the same block. The crankshafts and pistons are different to produce a long stroke and short stroke engine.

Continued on next page
RG,RG34710,1518 –19–09SEP02–1/3

The engine oil filter (P) mounts to a combination oil filter housing and pressure regulator housing. These items then bolt together with the oil cooler housing (A) located on the right side of the block.

A gear train on the front of the engine consists of four gears connecting the crankshaft with the camshaft. The crankshaft gear drives the oil pump gear (B), which drives the engine coolant pump gear and the idler gear (C). The idler gear then drives the camshaft gear (D). A backlash adjustment is required during assembly. No timing marks are used on the gears.

A timing pin procedure is used to increase the accuracy of the gear train adjustment. To locate top dead center of the crankshaft for number one and number six cylinders, a timing pin is installed through a timing hole on the right side of the block. The pin will engage a slot cut into a counterweight of the crankshaft.

The crankshaft (E) is a heat treated, dynamically balanced steel forging which rotates in replaceable main bearings. Thrust washers are added to the number five main bearing to reduce crankshaft defection and to limit end play during high load operation. A crankshaft damper (Q) is installed on the front of the crankshaft to reduce shock loads during engine operation. The flywheel (R) also dampens load changes.

Cylinder liners (F) are wet sleeve, flanged, and centrifugally cast using a strong durable alloy. O-rings (G) are used to seal the connection between the cylinder block and liners. Liners incorporate top liner cooling passages.

6105 engines use an aluminum piston with a 3 ring configuration (I). The top two rings are compression rings and the lower ring is an oil control ring. Double Ni-Resist ring carriers are cast integrally in the piston to greatly improve the life of the ring grooves.

6125 engines use an articulated or two piece piston (H). The crown of the piston is steel. This adds strength and durability for the higher power output of the 6125 engine. The skirt of the piston is aluminum to reduce the overall weight of the piston.

The 6105 and 6125 pistons have a centered, symmetrical bowl to provide efficient combustion, which allows the engine to produce high power with low exhaust emissions.

The hardened piston pins are highly polished, fully floating, and held in place by snap rings.

Connecting rods (J) are made of forged steel and have replaceable bushing and bearing inserts. They are weight controlled (by machining) on both ends to minimize engine vibration.

WEAR-GARD bearings are used on the connecting rod. These bearing have a lube pocket to provide an extra volume of oil to lubricate and cool the crankshaft.

The engine is equipped with an oil spray jet (K) for each cylinder, installed through the right side of the cylinder block. The spray jets precisely spray a stream of oil directly from the main oil galley onto the bottom of the pistons. This provides piston cooling and lubrication for the piston pin and the connecting rod bushing.

The cylinder head is an air-flow-through design. The exhaust manifold is located on the left side of the head; the intake manifold on the right. Intake and exhaust passages have been optimized for the most efficient air flow, raising the volumetric efficiency of the engine. Intake ports are short to reduce intake air heating. Exhaust ports are short to reduce heat rejection to the head. The head contains the camshaft (L), 4 valves per cylinder (M), the rocker arm assemblies, and the electronic unit injectors (N). The head has replaceable powdered metal or cast iron valve guides and valve seats.

Continued on next page

The camshaft turns in the head on four replaceable bushings. The camshaft directly actuates the rocker arms for the valves and the rocker arm for the electronic unit injectors. Rocker arms rotate on a two-piece rocker arm shaft (O). The rocker arms for cylinders 1, 2, and 3 rotate on one half of the two piece shaft; the rocker arms for cylinders 4, 5, and 6 rotate on the other half. Rollers built in to each rocker arm ride on the camshaft lobes.

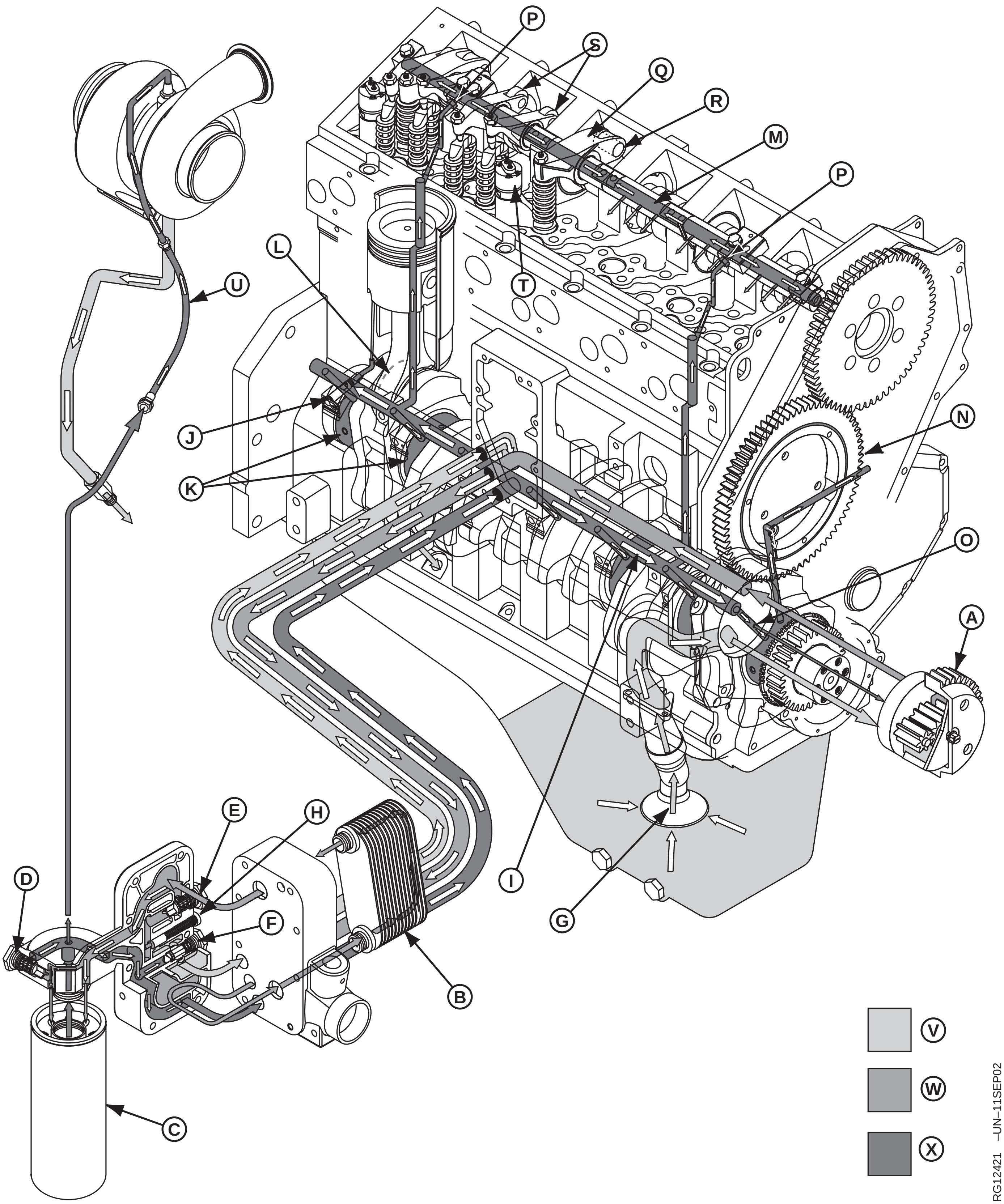
The electronic unit injector rocker arm directly actuates an injector for each cylinder. The injectors are located so that they spray fuel directly into the center of the cylinder. The injectors deliver fuel at a much higher pressure (approximately 23,200 psi) than what is achievable with an in-line or rotary injection pump.

The valve rocker arms push on a short push rod. The push rod actuates a bridge that will then operate two valves.

Four valves per cylinder increases engine air flow compared to using one large intake and one large exhaust valve. The intake valves for each cylinder are located towards the front of engine. The exhaust valves are located towards the rear. The intake valves and exhaust valves are the same size. The difference between the two can be determined by the fact that the intake valves are all magnetic. The head of the exhaust valves are a stellite alloy and are not magnetic.

RG,RG34710,1518 –19–09SEP02–3/3

Lubrication System Operation



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RG,RG34710,1519 –19–16SEP02–1/3

A—Oil Pump
B—Oil Cooler
C—Oil Filter
D—Oil Filter Bypass Valve
E—Oil Cooler Bypass Valve
F—Oil Pressure Regulating Valve
G—Pick-up Tube
H—Oil Cooler Relief Valve
I—Main Oil Galley
J—Piston Spray Jets
K—Crankshaft Main Bearing
L—Connecting Rod Bearing
M—Rocker Arm Shaft Assemblies
N—Idler Gear Bushing
O—Oil Pump Drive Gear Bushing Lube
P—Rocker Arm Shaft Oil Supply
Q—Unit Injector Rocker Arm
R—Unit Injector Rocker Arm Roller Bushing
S—Valve Rocker Arm Rollers
T—Electronic Unit Injector
U—Turbocharger Lube Line
V—Return Oil
W—Pressurized-Nonfiltered Oil
X—Pressurized-Filtered Oil

The lubrication system consists of a crankshaft driven oil pump (A), oil cooler (B), oil filter (C), oil filter bypass valve (D), oil cooler bypass valve (E), and oil pressure regulating valve (F).

Oil is drawn from the sump via a pick-up tube (G) and an internal passage in the cylinder block. The oil pump sends the oil to the pressure regulating valve housing and then to the oil cooler through an internal passage in the cylinder block. An oil cooler relief valve (H) protects the oil cooler during cold oil starting by returning oil to sump. The cooler bypass valve allows oil to bypass the cooler and flow to the filter if the oil cooler is restricted. From the oil cooler oil flows to the oil filter housing and into the filter. If the filter becomes restricted, the oil filter bypass valve will open sending oil to the main oil galley.

Oil flow from the filter is sensed by the oil pressure regulating valve. This valve regulates the pressure in the main oil galley (I). Excess oil is returned to sump.

Clean cool oil is routed directly from the top of the filter base (U) to the turbocharger. Turbocharger return oil is routed through a steel line to the cylinder block and then to sump.

The remaining oil is routed to the main oil galley then distributed to the piston spray jets (J), crankshaft main bearings (K), connecting rod bearings (L), the two rocker arm shaft assemblies (M), upper idler gear bushing (N), and auxiliary drive.

The piston spray jets receive oil directly from the main oil galley. These spray jets allow for precise targeting of the oil spray onto the bottom of the piston.

Drilled passage in the block route oil directly to each crankshaft main journal. The main bearing is slotted to allow oil to flow to the crankshaft cross-drilled passages. The crankshaft cross drilled passages route oil flow from a main journal to each connecting rod bearing.

A drilled passage (O) at the front of the block routes lubrication oil to the oil pump. A cross drilled passage in the pump housing routes this oil to the outside edge of the pump. This oil lubricates the oil pump gear bushing.

A drilled passage from the number one main bearing routes oil to the upper idler gear hub. A drilled passage in the hub routes oil to the outside edge of the hub. This oil lubricates the upper idler gear bushing.

A drilled passage in the cylinder block connects with the upper idler passage. This oil is available to lubricate auxiliary drive components.

Two drilled passages route oil from the main oil galley through the cylinder block towards the head. At the head gasket, oil flows into head bolt holes 19 and 23. Oil flows around these bolts and into a cross-drilled passage at the top of the head. Steel lines (P) connect with the cross drilled passages and routes oil to a rocker arm shaft hold down clamp for each rocker arm shaft.

At the rocker arm hold down clamp, oil flows around a cap screw and enters the rocker arm shaft assemblies (M). The rocker arm shaft is hollow and is sealed on each end. A hollow roll pin connects with each rocker arm shaft drilled passage and routes oil to the two center camshaft bushings.

Continued on next page

The front and rear camshaft bushings receive oil from a hole in the respective rocker arm shaft. A drilled passage lines up with a drilled passage in the head to route oil to the bushings.

The rocker arm shaft is cross-drilled to provide lubrication to each rocker arm bushing.

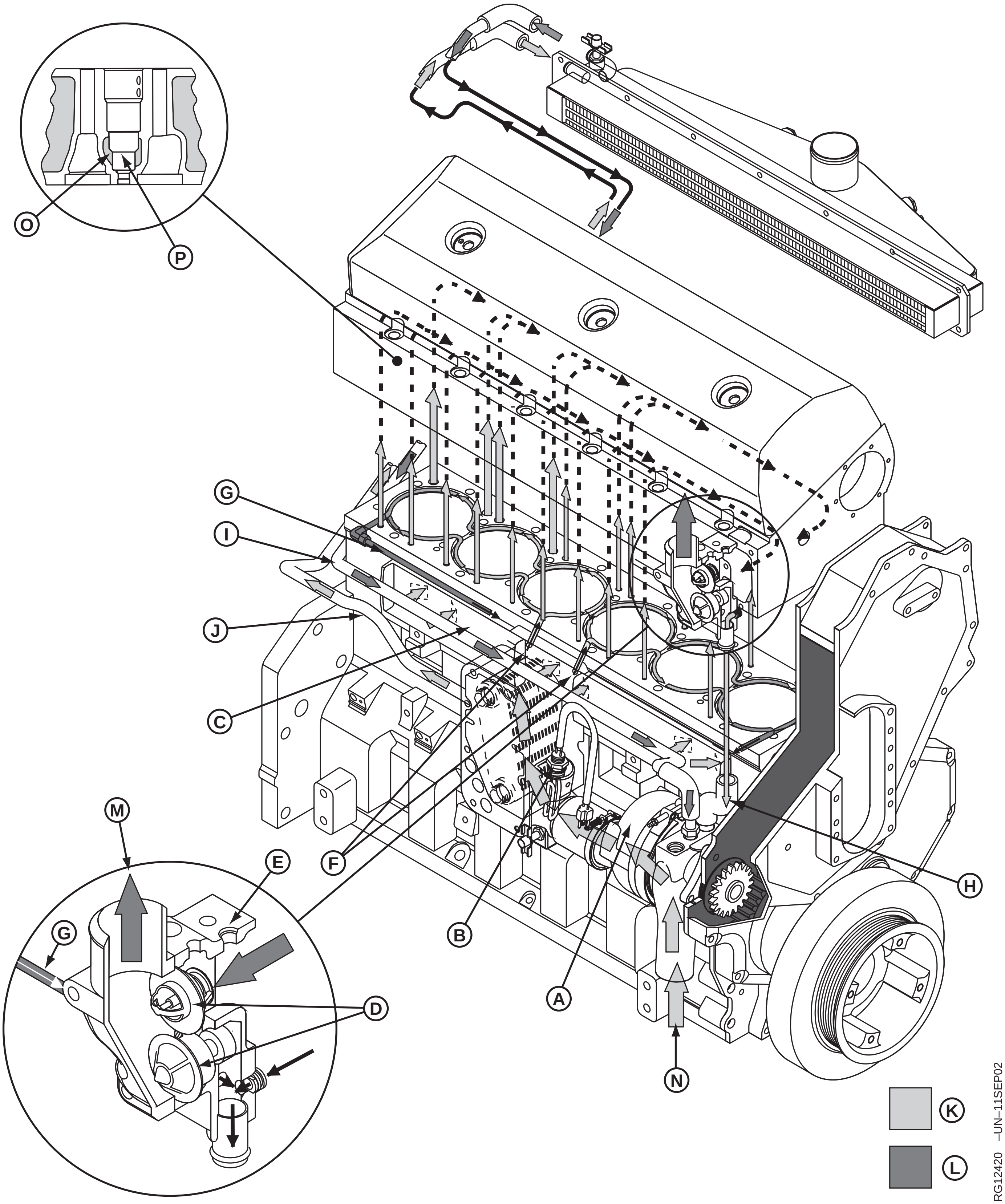
The unit injector rocker arms (Q) are cross-drilled to route oil from the bushing to each end of the rocker arm. At the roller end, oil flows through the roller bushing (R) and out to spray and lubricate the adjacent valve rocker arm rollers (S). Oil then sprays on to the camshaft lobes.

At the front of the unit injector rocker arms, oil sprays out the adjusting screw to lubricate the unit injector (T) and the adjacent valves and adjusting screws.

Some oil is routed from the top of the oil filter base through an external line to the turbocharger and is returned to the cylinder block crankcase through another external line.

RG,RG34710,1519 –19–16SEP02–3/3

Cooling System Operation



Cooling System

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A—Coolant Pump
B—Coolant Heater
C—Coolant Manifold
D—Thermostats
E—Thermostat Housing
F—Directed Top Liner Cooling Passages
G—Directed Top Liner Cooling Return Line
H—Coolant Bypass Tube
I—Water-to-Air Aftercooler Supply
J—Water-to-Air Aftercooler Return
K—Low Temperature Coolant
L—High Temperature Coolant
M—To Radiator Top Tank
N—From Radiator
O—Coolant Passage
P—Unit Injector Sleeve

The pressurized cooling system consists of a radiator (not shown), coolant pump (A), coolant heater (B), coolant manifold (C), coolant passages in block and the cylinder head, thermostats (D), and thermostat housing (E).

The coolant pump draws coolant from the radiator through the lower radiator hose. Flow then goes past a coolant heater and into the oil cooler housing. Coolant flows around the oil cooler and then flows into one of two circuits.

The main circuit flows coolant from the oil cooler into the coolant manifold. The coolant manifold extends the length of the right side of the block. From the coolant manifold, coolant flows into each liner cavity. From the liners, coolant flows up into the cylinder head.

The coolant flow through the block and cylinder head is optimized to provide ample flow around each liner and to provide more flow to the rear of the cylinder head than into the front. To achieve this, the coolant passages from the block to the cylinder head vary in size and in number.

The holes on the right side of the block are smaller than the holes on the left side. Therefore, as coolant flows out of the coolant manifold on the right side of the block, it is forced to flow around the liners to escape through larger holes on the left of the block. This assures that each liner is surrounded by coolant flow.

In addition, there are more holes and larger holes at the rear of the cylinder head than at the front. Cylinders 1 and 2 have one 6.3 mm (0.25 in.) and one 9 mm (0.35 in.) hole. Cylinders 3 and 4 have two 6.3 mm (0.25 in.) and two 10 mm (0.39 in.) holes. Cylinders 5 and 6 have two 10 mm (0.39 in.) and two 16 mm (0.63 in.) holes.

The larger and higher number of coolant flow holes around cylinders 5 and 6 force more coolant to flow to the back of the cylinder head than to the front.

Once coolant is in the cylinder head, all flow is towards the front. Coolant from cylinder 6 flows forward and accumulates with flow from other cylinders. All coolant flow then exits out the head at number 1 cylinder to the thermostat housing.

The second circuit is called the “directed top liner cooling” system. Two drilled passages (F) at the top of the oil cooler cavity in the cylinder block route coolant to cylinders 3 and 4 liners for top liner cooling.

Coolant will flow around the top of cylinder 3 liner, then flow forward to cylinder 2 liner and then to cylinder 1 liner. Coolant will leave cylinder 1 through a drill passage to the thermostat housing. Coolant entering number 4 cylinder will flow rearward to number 5 and then to number 6. Coolant leaves number 6 cylinder through a drilled passage and flows though an external steel line (G) to the thermostat housing.

When the engine is cold, the thermostats will be closed. Coolant will flow through the bypass tube (H), into the inlet of the coolant pump.

When the engines warms to operating temperature, the thermostats will open and coolant will flow past the open thermostats to the radiator (M).

The thermostat housing contains two thermostats. The bottom thermostat has a blocking poppet. When the engine gets to operating temperature, this thermostat will open and allow flow to the radiator. The blocking will close off the bypass path to the coolant pump inlet.

Continued on next page
RG,RG34710,1521 –19–09SEP02–2/3

The top thermostat is a non-blocking type. When it opens, coolant will flow to the radiator. The non-blocking type has a vent notch to provide an air bleed when the cooling system is filled.

On water-to-air aftercooled engines, coolant is routed through an external line (I) to the aftercooler, then back to the oil cooler housing through a second external line (J).

Coolant also flows in passages (O) around the unit injector sleeves (P). This helps to regulate the temperature of injected fuel.

RG,RG34710,1521 –19–09SEP02–3/3

Fuel System Theory of Operation

NOTE: Fuel system operation is now covered in the following companion manuals:

- *CTM115—Lucas Electronic Fuel Systems With Lucas EUIs*
- *CTM188—Level 6 Electronic Fuel Systems With Lucas EUIs*

CTM115 covers earlier Tier I engines, while CTM188 covers later Tier II engines (with either dual-rail or single-rail fuel systems.)

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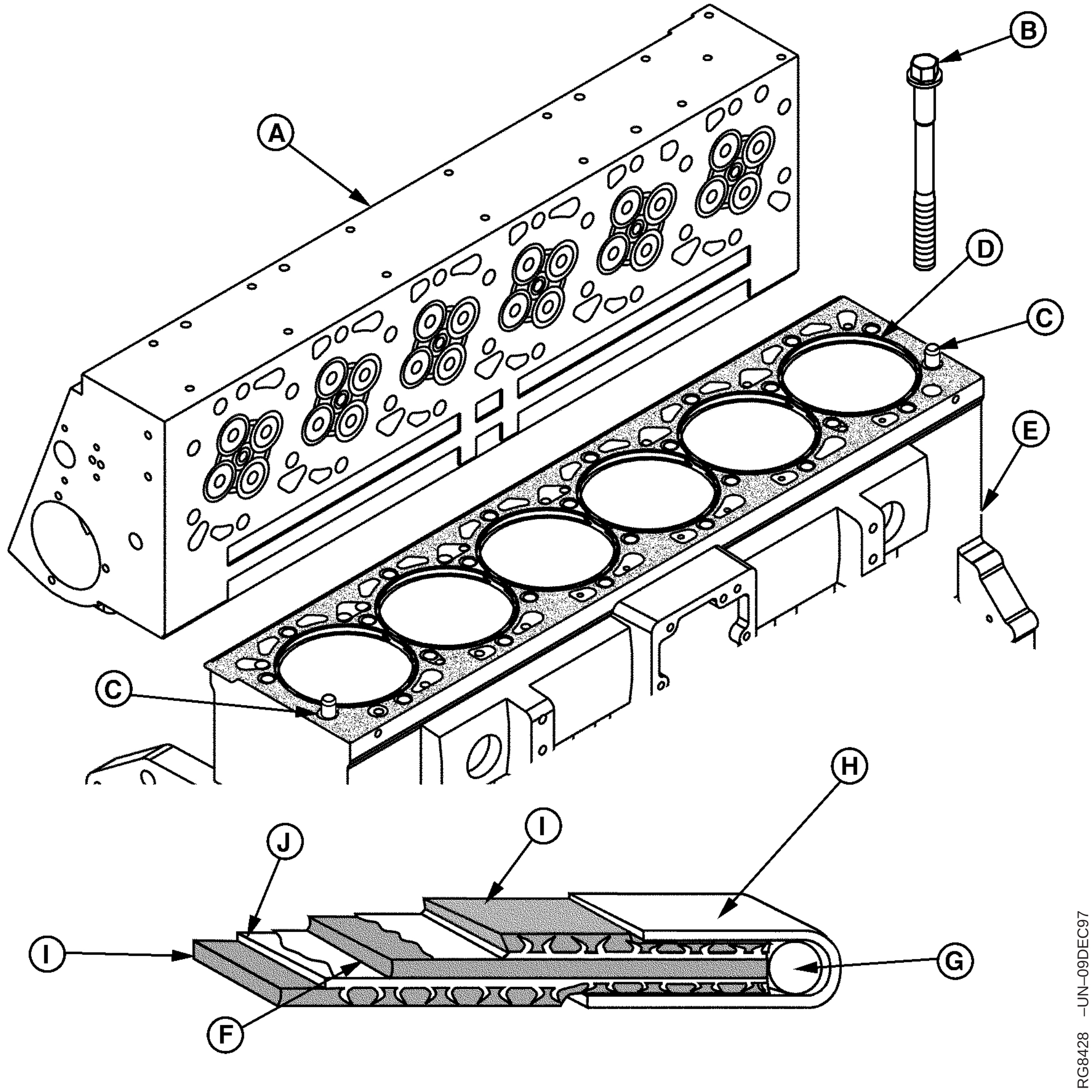
Head Gasket Joint Construction and Operation



Cylinder Head Gasket Construction

A—Cylinder Head
B—Cylinder Head Cap Screws
C—Dowel Pins
D—Cylinder Liners
E—Cylinder Block
F—Solid Steel Core
G—Fire Ring Combustion Seal
H—Stainless Steel Flange
I—Graphite Gasket Body
J—Perforated Steel Core

The head gasket joint consists of:

- Cylinder head gasket body (I)
- Cylinder head (A)
- Cylinder block (E)
- Cylinder liners (D)
- Cylinder head cap screws (B)

Continued on next page

RG,RG34710,67 –19–30SEP97–1/2

The head gasket must form an air-tight seal between cylinder liners and cylinder head that can withstand the temperatures and pressures of the combustion process. The gasket must also form a liquid-tight seal between the cylinder head and cylinder block to retain coolant and oil in their respective passages. The gasket is constructed of a solid steel core (F) covered by perforated steel core (J) and graphite body (I). The surface of gasket is treated to improve liquid sealing and anti-stick characteristics. A fire ring combustion seal (G) is located at each cylinder bore and is held in place by a U-shaped stainless steel flange (H).

The cylinder head and block must be flat to provide an even clamping pressure over the entire surface of gasket, and must have the proper surface finish to keep gasket material form moving in the joint. Dowel pins (C) are used to properly locate head gasket on block.

The cylinder liners (D) must protrude evenly from top of cylinder block the specified amount to provide adequate clamping force on fire ring of each cylinder.

The cap screws (B) must be proper length, made of proper material, and be tightened to proper torque in order to provide an adequate clamp load between other joint components.

Each of the above components contributes to the integrity of the head gasket joint. If any of these components do not conform to specification, gasket joint may fail resulting in combustion leaks, coolant leaks, or oil leaks.

Operating conditions such as coolant, oil, and combustion temperatures, and combustion pressures can reduce the ability of the head gasket joint to function properly. Failure of head gasket and mating parts may occur when coolant and oil temperatures become excessive, or when abnormally high combustion temperatures and pressure persist.

RG,RG34710,67 –19–30SEP97–2/2

Intake and Exhaust System Operation

Engine suction draws dust-laden outside air through an air inlet stack into the air cleaner. Air is filtered through dry-type primary and final filter elements in the air cleaner canister. Clean air travels through the intake air hose to the turbocharger, through the air-to-air aftercooler, through the air/fuel mixing elbow, and into the intake manifold.

Exhaust, as it is expelled out of the exhaust manifold, drives the turbocharger to deliver a larger quantity of air to meet the engine requirements than what could be delivered under naturally aspirated (non-turbocharged) conditions.

On some engines, an air-to-air aftercooler cools the turbocharger compressor discharge air by routing it through a heat exchanger before it enters the engine. The heat exchanger uses no liquid coolant but relies on air flow to cool the charge air.

On some engines, the aftercooler functions as a heat exchanger. Engine coolant circulates through the aftercooler core and carries heat out of the aftercooler.

RG,RG34710,1522 –19–30SEP97–1/1

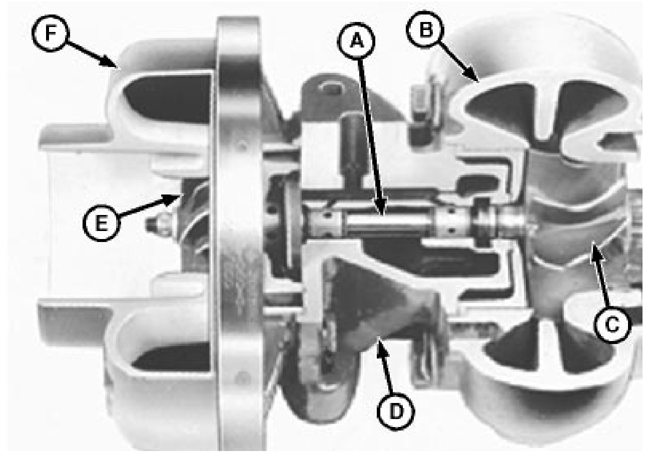
Turbocharger Operation

The turbocharger, which is basically an air pump that is driven by exhaust gases, allows the engine to produce added power without increasing displacement. Turbochargers are specially matched for the power ratio requirements of each specific application.

The turbine wheel (C) is driven by the hot engine exhaust gases. These gases flowing through the turbine housing (B) act on the turbine wheel causing shaft (A) to turn.

Compressor wheel (E) brings in filtered air and discharges the compressed air into the intake manifold where it is then delivered to engine cylinders.

Engine oil under pressure from the engine lubrication system is forced through passages in center housing (D) to bearings.



Turbocharger Components

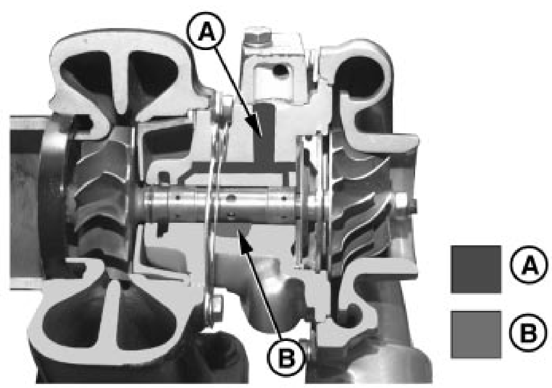
A—Shaft
B—Turbine Housing
C—Turbine Wheel
D—Center Housing
E—Compressor Wheel
F—Compressor Housing

RG,RG34710,1523 –19–30SEP97–1/1

How the Turbocharger is Lubricated

Engine oil under pressure from the engine lubrication system is pumped through a passage in the bearing housing and directed to the bearings, thrust plate, and thrust sleeve. Oil is sealed from the compressor and turbine by a piston ring at both ends of the bearing housing.

The turbocharger contains two floating bearings. These bearings have clearance between the bearing OD and the housing bore as well as clearance between the bearing ID and the shaft OD. These clearances are lubricated by the oil supply (A) and the bearings are protected by a cushion of oil. Discharge oil (B) drains by gravity from the bearing housing to the engine crankcase.



Turbocharger Lubrication

A—Pressure Oil
B—Discharge Oil

RG,RG34710,1524 –19–30SEP97–1/1

Section 04
Diagnostics

Contents

04

About this Section of the Manual

This section of the manual contains necessary information to diagnose problems with the base engine lubrication and cooling systems. This section is divided into two areas: diagnosing malfunctions and testing procedures. The diagnosing malfunction areas are further divided into the following headings, containing the following symptoms:

- **(L)** Diagnosing Lubrication System Malfunctions:
  - L1 - Excessive oil consumption
  - L2 - Engine oil pressure high
  - L3 - Engine oil pressure low
- **(C)** Diagnosing Cooling System Malfunctions
  - C1 - Coolant temperature above normal
  - C2 - Coolant temperature below normal
  - C3 - Coolant in oil or oil in coolant

Procedures for diagnosing some of the above symptoms are formatted such that a test or repair is recommended, then based on the results another test or repair is recommended. Other symptoms are formatted in a symptom - problem - solution format. In these symptoms, the problems are arranged in the most likely or easiest to check first. Symptoms arranged in both formats refer to testing procedures in the second part of this section. The second part of this section of the manual contains the following testing procedures:

- Lubrications System Testing Procedures:
  - Check engine oil pressure
  - Check for excessive crankcase pressure (blow-by)
  - Check for turbocharger oil seal leak
- Cooling System Testing Procedures:
  - Inspect thermostat and test opening temperature
  - Pressure test cooling system and radiator cap
  - Check for head gasket failures
- Air Supply and Exhaust Systems Testing Procedures
  - Measure intake manifold pressure (turbo boost)
  - Check for intake and exhaust restrictions
  - Test for intake air leaks
  - Check for exhaust air leaks

OUO1004,0000BE7 –19–06NOV00–1/1

10.5L/12.5L - L1 - Excessive Oil Consumption

DPSG,RG40854,345 –19–27NOV00–1/1

10.5L/12.5L - L1 - Excessive Oil Consumption

Before using this diagnostic procedure:
Check for too low or too high engine oil level.
Check for too low viscosity, coolant in oil, or fuel diluted in engine oil.
Check for excessive external oil leaks.

– – –1/1

❶ **Oil in Coolant Test**	Check the coolant for signs of oil.	**No oil found in coolant:** GO TO ❷ **Oil found in coolant:** See C3 - COOLANT IN OIL OR OIL IN COOLANT later in this Group.

– – –1/1

❷ **Excessive Crankcase Pressure Check**	Check for excessive crankcase pressure. See CHECK FOR EXCESSIVE ENGINE CRANKCASE PRESSURE (BLOW-BY) in this Group.	**No fumes and no dripping oil observed:** GO TO ❸ **Excessive fumes or dripping oil observed; appears to be caused by boost pressure:** Check the turbocharger, repair/replace as needed. See TURBOCHARGER FAILURE ANALYSIS in Section 02, Group 080. **Excessive fumes or dripping oil observed; does not appear to be caused by boost pressure:** Excessive blow-by, not caused by boost pressure is most likely caused by faulty piston rings/cylinder liners not providing an adequate combustion seal. Perform a compression test to verify this. See DST ENGINE TEST INSTRUCTIONS - RELATIVE COMPRESSION TEST in CTM115, Section 04, Group 160. OR See DST ENGINE TEST INSTRUCTIONS - RELATIVE COMPRESSION TEST in CTM188, Section 04, Group 160 – – –1/1

❸ **Turbocharger Oil Seal Leak Test**	Check for turbocharger oil seal leaks. See CHECK FOR TURBOCHARGER OIL SEAL LEAK in this Group.	**No signs of oil leakage:** GO TO ❹ **Signs of oil leakage present:** Investigate problems associated with oil leakage as outlined in the test procedure, perform necessary repairs and retest. – – –1/1

❹ **Pistons, Rings, and Cylinder Liners Test**	At this point, the most likely cause of the excessive oil consumption is one of the following failures in the pistons, rings, and/or cylinder liners or in the valve guides. Check the most likely item as needed: • Oil control rings worn or broken • Scored cylinder liners or pistons • Piston ring groves excessively worn • Piston rings stuck in ring groves • Insufficient piston ring tension • Piston ring gaps not staggered • Cylinder liners glazed (insufficient load during break-in) • Worn valve guides or stems	**Problem found with pistons, rings, and/or liners or valve guides:** Repair problem as necessary. – – –1/1

10.5L/12.5L - L2 Engine Oil Pressure High

Symptom	Problem	Solution
10.5L/12.5L - L2 - Engine Oil Pressure High	Improper oil classification	Drain crankcase and refill with correct oil.
	Oil pressure regulating valve bushing loose (wanders)	Remove and inspect oil pressure regulating valve. See REMOVE, INSPECT, AND INSTALL OIL PRESSURE REGULATING VALVE in Section 02, Group 060.
	Improperly operating regulating valve	Remove and inspect oil pressure regulating valve. See REMOVE, INSPECT, AND INSTALL OIL PRESSURE REGULATING VALVE in Section 02, Group 060.
	Plugged piston spray jet	Replace piston spray jet. See REMOVE AND INSTALL PISTON SPRAY JETS in Section 02, Group 030.
	Stuck or damaged filter bypass valve	Remove and inspect filter bypass valve. See REMOVE, INSPECT, AND INSTALL OIL COOLER AND OIL FILTER BYPASS VALVES in Section 02, Group 060.
	Stuck or damaged oil cooler bypass valve	Remove and inspect oil cooler bypass valve. See REMOVE, INSPECT, AND INSTALL OIL COOLER AND OIL FILTER BYPASS VALVES in Section 02, Group 060.

OUO1004,0000C30 –19–12DEC00–1/1

10.5L/12.5L Engines - L3 - Engine Oil Pressure Low

Symptom	Problem	Solution
10.5L/12.5L - L3 - Engine Oil Pressure Low	Low crankcase oil level	Fill crankcase to proper oil level.
	Clogged oil cooler or filter	Remove and inspect oil cooler. See REMOVE, CLEAN, AND INSPECT ENGINE OIL COOLER in Section 02, Group 060. Replace oil filter.
	Excessive oil temperature	Remove and inspect oil cooler. See REMOVE, CLEAN, AND INSPECT ENGINE OIL COOLER in Section 02, Group 060.
	Defective oil pump	Remove and inspect oil pump. See CLEAN AND INSPECT OIL PUMP AND DRIVE GEAR in Section 02, Group 060.
	Incorrect oil	Drain crankcase and refill with correct oil.
	Oil pressure regulating valve failure	Remove and inspect oil pressure regulating valve. See Group REMOVE, INSPECT, AND INSTALL OIL PRESSURE REGULATING VALVE in Section 02, Group 060.
	Broken piston spray jet	Replace piston spray jet. See REMOVE AND INSTALL PISTON SPRAY JETS in Section 02, Group 030.
	Clogged oil pump screen or cracked pick-up tube	Remove oil pan and clean screen. Replace pick-up tube. See REMOVE AND INSTALL OIL PICKUP TUBE in Section 02, Group 060.
	Excessive main or connecting rod bearing clearance	Determine bearing clearance. See CHECK MAIN BEARING-TO-JOURNAL OIL CLEARANCE in Section 02, Group 040.

RG,RG34710,1542 –19–27NOV00–1/1

10.5L/12.5L - C1 - Engine Coolant Temperature Above Normal

Symptom	Problem	Solution
10.5L/12.5L - C1 - Engine Coolant Temperature Above Normal	Lack of coolant in cooling system	Fill cooling system to proper level.
	Radiator core and/or side screens dirty	Clean radiator as required.
	Engine overloaded	Reduce engine load.
	Too low crankcase oil level	Fill crankcase to proper oil level.
	Loose or defective fan belt	Replace/tighten fan belt as required.
	Defective thermostat(s)	Test thermostat opening temperature; replace thermostats as required. See REMOVE THERMOSTATS in Section 02, Group 070.
	Damaged cylinder head gasket	Replace cylinder head gasket. See CHECK FOR HEAD GASKET FAILURES in this group.
	Defective coolant pump	Replace coolant pump. See REMOVE COOLANT PUMP in Section 02, Group 070.
	Defective radiator cap	Replace radiator cap as required.

RG,RG34710,1543 –19–27NOV00–1/1

10.5L/12.5L - C2 - Engine Coolant Temperature Below Normal

Symptom	Problem	Solution
10.5L/12.5L - C2 - Engine Coolant Temperature Below Normal	Defective thermostat(s)	Test thermostats; replace thermostats as required. See REMOVE THERMOSTATS in Section 02, Group 070.

OUO1004,0000C4C –19–21DEC00–1/1

10.5L/12.5L Engines - C3 - Coolant in Oil or Oil in Coolant

Symptom	Problem	Solution
10.5L/12.5L - C3 - Coolant in Oil or Oil in Coolant	Faulty cylinder head gasket	Look for signs of head gasket failure. See CHECK FOR HEAD GASKET FAILURES in this group.
	Faulty oil cooler	Remove and inspect engine oil cooler. See REMOVE, CLEAN, AND INSPECT ENGINE OIL COOLER in Section 02, Group 060.
	Leaking cylinder liner seals	Remove and inspect cylinder liners. See VISUALLY INSPECT CYLINDER LINERS in Section 02, Group 030.
	Cracked cylinder head or block	Locate crack, repair/replace components as required.

OUO1004,0000C4B –19–21DEC00–1/1

Dynamometer Test

1. Connect engine to dynamometer using manufacturer's instructions.

2. Operate engine at one-half load until coolant and crankcase oil temperatures are up to normal.

3. Run engine at fast idle.

4. Gradually increase load on engine until speed is reduced to rated speed rpm.

5. Read horsepower on dynamometer and record reading.

6. Compare readings taken with power rating level for your engine application in Section 06, Group 210.

NOTE: Refer to appropriate machine technical manual for average power ratings of vehicle applications. Allow ± 5% for minimum and maximum power. Altitude and temperatures can also affect power levels. (See DYNAMOMETER TEST SPECIFICATIONS in Section 06, Group 210.)

RG,RG34710,1062 –19–13OCT00–1/1

Engine Oil Consumption

All engines consume some oil. The consumption rate depends on loading, design of key parts and engine condition. Since fuel consumption is an indicator of operating power levels, fuel used versus oil consumed is a critical factor in analyzing oil consumption. Oil consumption should be measured over a 100-hour period.

Long-term oil consumption (three oil drain intervals after the engine is broken in) with consumption rates poorer than 400:1 (100 gallons of fuel and 1 quart of oil) indicates a need to monitor/investigate. Suggested steps would be:

- Check for signs of ingested dust or perform an OILSCAN® test to check for silicon.
- Check for proper crankcase oil fill level.
- Remove head and inspect for glazed or worn liners.
- Inspect pistons for carbon deposits in the ring land grooves.
- Measure valve stem OD and valve guide ID to determine clearance.

NOTE: Ring gap alignment does not identify the leak source.

Intake valves do not have valve stem seals, and some oil deposits on the valve stem tulip are normal.

When changing to a premium oil such as TORQ-GARD SUPREME® PLUS-50®, little oil consumption change is expected, although a small percentage of engines may experience a noticeable change in consumption rates. This may be due to the following:

- The previous oil may have left deposits on internal components. Use of PLUS-50® oil will cause different chemical reactions in those deposits. The time required for the engine to regain the previous oil consumption rate will vary from one to three normal drain intervals.
- TORQ-GARD SUPREME® PLUS-50® contains a high-performance anti-oxidant along with other additives resulting in the oil remaining in the specified viscosity grade throughout the recommended drain interval. API oil grades CD, CE, and CF-4 universal engine oils do not provide this oxidation resistance which results in more rapid thickening. Increased oil viscosity can reduce oil consumption.

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TORQ-GARD SUPREME is a registered trademark of Deere & Company
PLUS-50 is a registered trademark of Deere & Company

OUO1004,0000C2A –19–05DEC00–1/1

Check Engine Oil Pressure

1. Remove pipe plug from main oil galley using JDG782 Oil Galley Plug Tool.

2. Attach pressure gauge to oil galley.

IMPORTANT: To achieve an accurate oil pressure reading, warm engine oil to 105°C (220°F).

3. Start engine, run at speeds given below, measure oil pressure, and compare readings.

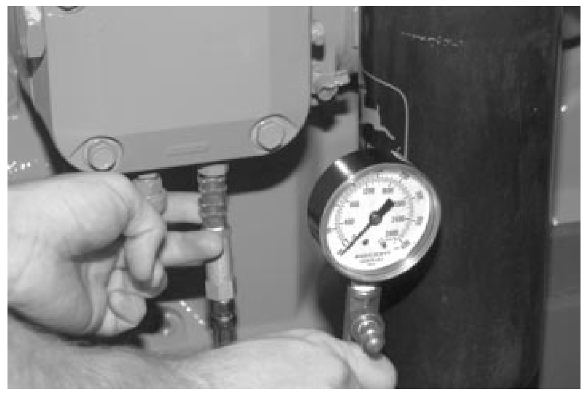
Specification

Engine Oil—Minimum Pressure at No Load (Idle)... 138 kPa (1.38 bar) (20 psi)
Maximum Pressure at Full Load (Rated Speed) .... 310 kPa (3.1 bar) (45 psi)

NOTE: The oil pressure regulating valve is designed so that adjustment of oil pressure should not be required.


RG8531 –UN–26NOV97

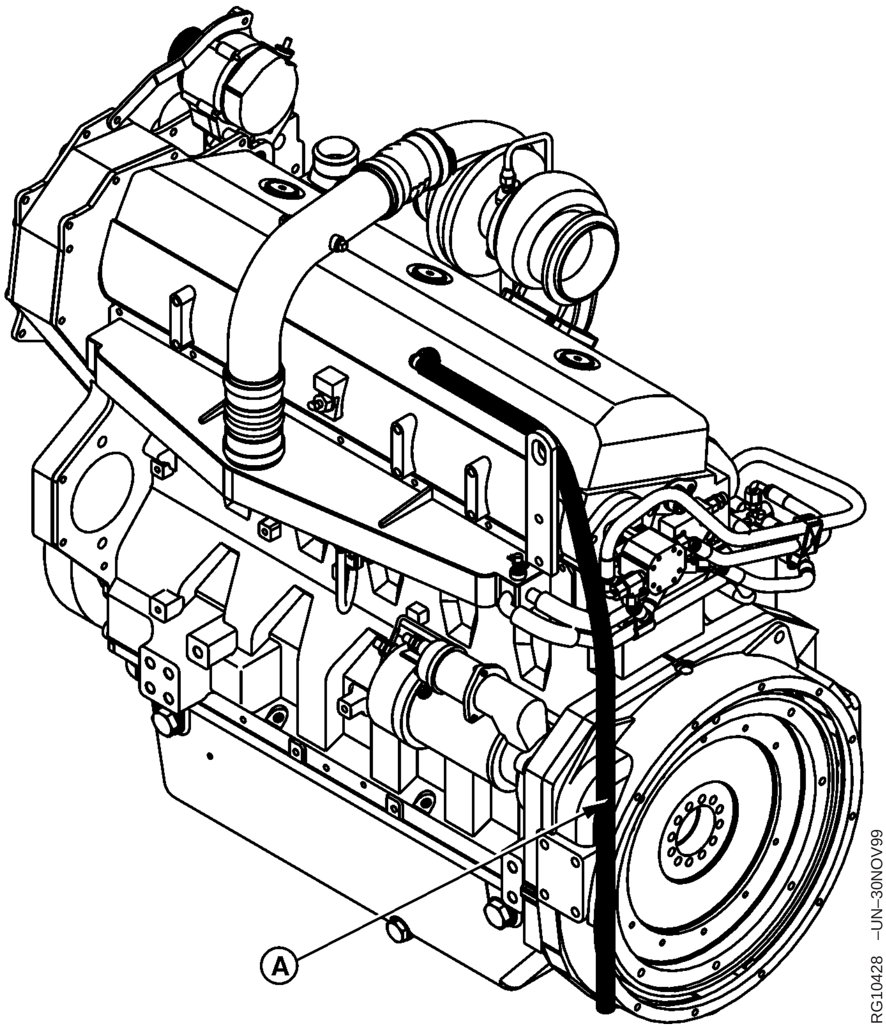
Oil Pressure Gauge at Main Oil Galley


RG10633 –UN–30NOV99

Oil Pressure Gauge at Quick Disconnect on Oil Cooler

RG,RG34710,1547 –19–27NOV00–1/1

Check for Excessive Engine Crankcase Pressure (Blow-By)



Breather Tube

A—Breather Tube

Excessive blow-by coming out of the crankcase breather tube (A) indicates that either the turbocharger seals are faulty or the piston rings and cylinder liners are not adequately sealing off the combustion chamber. This is a comparative check that requires some experience to determine when blow-by is excessive.

Run engine at high idle and check crankcase breather tube. Look for significant fumes and/or dripping oil coming out of the breather tube at fast idle, with no load.

If excessive blow-by is observed, perform the following to determine if the turbocharger is causing the blow-by:

1. Remove the turbocharger oil drain line where it connects to the engine block and run the line into a bucket.

2. Run engine at high idle, slightly loaded and determine if boost pressure is forcing oil through the drain line, and check crankcase breather tube to determine if blow-by has decreased.

Continued on next page

3. If it appears that boost pressure is forcing oil through the drain line, and/or blow-by decreases with the drain line disconnected from the block, replace the turbocharger and retest.

DPSG,RG40854,282 –19–10AUG99–2/2

Check for Turbocharger Oil Seal Leak

Seals are used on both sides of the turbocharger rotor assembly. The seals are used to prevent exhaust gases and air from entering the turbocharger housing. Oil leakage past the seals is uncommon but can occur.

A restricted or damaged turbocharger oil return line can cause the housing to pressurize causing oil to leak by the seals. Additionally, intake or exhaust restrictions can cause a vacuum between the compressor and turbocharger housing causing oil to leak by the seals.

1. Remove intake tube (A) and exhaust pipe (B).

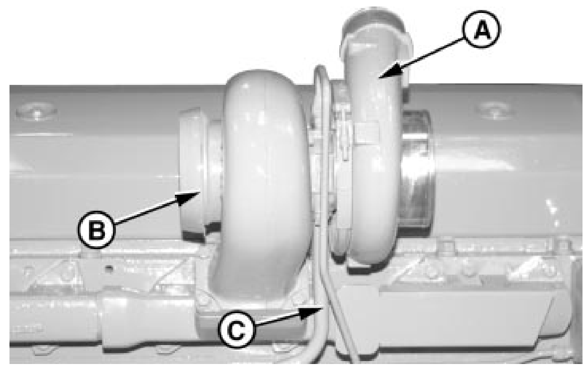
NOTE: The intake tube from the air cleaner (not included in picture) would not have to be removed for this test.

2. Inspect the intake tube and turbocharger turbine casing for evidence of oil leakage.

   If oil leakage is present, perform the following:

   - Inspect turbocharger oil return line (C) for kinks or damage. Replace if necessary.
   - Check the air intake filter, hoses, and crossover tube for restrictions.
   - Check the exhaust system for restrictions to include position of exhaust outlet.

3. Perform necessary repairs and retest.



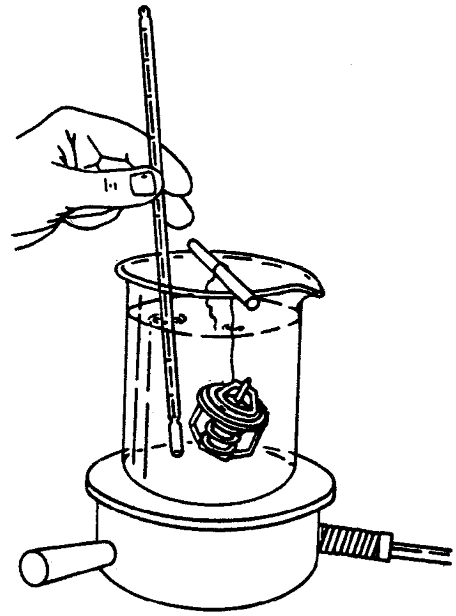
RG10634 –UN–30NOV99

Turbocharger Oil Seal Leak

A—Intake Hose
B—Exhaust Flange
C—Oil Return Line

DPSG,RG40854,283 –19–10AUG99–1/1

Inspect Thermostat and Test Opening Temperature



RG5971 –UN–23NOV97

Testing Thermostat Opening Temperature

Visually inspect thermostat for corrosion or damage. Replace as necessary.

Test thermostat as follows:

CAUTION: DO NOT allow thermostat or thermometer to rest against the side or bottom of container when heating water. Either may rupture if overheated.

1. Remove thermostats. See REMOVE THERMOSTATS in Section 02, Group 070.

2. Suspend thermostat and a thermometer in a container of water.

3. Stir the water as it heats. Observe opening action of thermostat and compare temperatures with specification given in chart below.

NOTE: Due to varying tolerances of different suppliers, initial opening and full open temperatures may vary slightly from specified temperatures.

THERMOSTAT TEST SPECIFICATIONS

Rating	Initial Opening (Range)	Full Open (Nominal)
71°C (160°F)	69–72°C (156–162°F)	84°C (182°F)
77°C (170°F)	74–78°C (166–172°F)	89°C (192°F)
82°C (180°F)	80–84°C (175–182°F)	94°C (202°F)
89°C (192°F)	86–90°C (187–194°F)	101°C (214°F)
90°C (195°F)	89–93°C (192–199°F)	103°C (218°F)
92°C (197°F)	89–93°C (193–200°F)	105°C (221°F)
96°C (205°F)	94–97°C (201–207°F)	100°C (213°F)
99°C (210°F)	96–100°C (205–212°F)	111°C (232°F)

4. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.

5. If any thermostat is defective on a multiple thermostat engine, replace all thermostats.

RG,RG34710,1548 –19–24SEP02–1/1

Pressure Test Cooling System and Radiator Cap

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

Test Radiator Cap:

1. Remove radiator cap and attach to D05104ST Tester using appropriate adaptor as shown.

2. Verify with the applications specification manual that the correct cap is being used.

3. Pressurize cap to cap's specified pressure.[1] Gauge should hold pressure for 10 seconds within normal range if cap is acceptable.

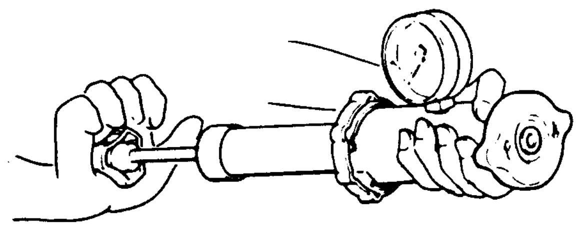
4. Remove the cap from gauge, turn it 180°, and retest cap. This will verify that the first measurement was accurate.

Test Cooling System:

NOTE: Engine should be warmed up to test overall cooling system.

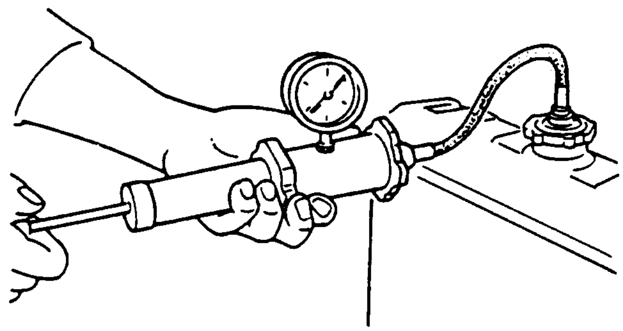
1. Allow engine to cool, then carefully remove radiator cap.

2. Fill radiator with coolant to the normal operating level.



RG6557 –UN–20JAN93

Pressure Testing Radiator Cap



RG6558 –UN–20JAN93

Pressure Testing Cooling System

[1] *If gauge does not hold pressure, replace radiator cap.*

Continued on next page

DPSG,RG40854,284 –19–24SEP02–1/2

IMPORTANT: DO NOT apply excessive pressure to cooling system, doing so may damage radiator and hoses.

3. Connect gauge and adapter to radiator filler neck. Pressurize cooling system to specified pressure for application.[2].

4. With pressure applied, check all cooling system hose connections, radiator, and overall engine for leaks.

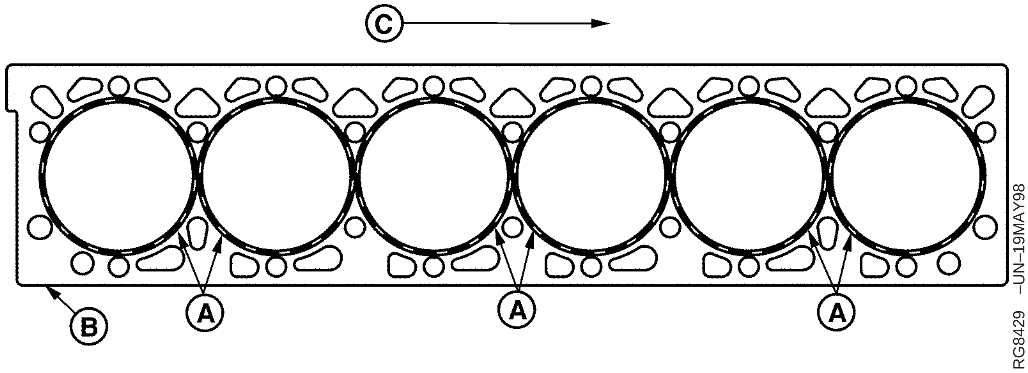
If leakage is detected, correct as necessary and pressure test system again.

If no leakage is detected, but the gauge indicated a drop in pressure, coolant may be leaking internally within the system or at the block-to head gasket. See CHECK FOR HEAD GASKET FAILURES in this group.

[2] *Test pressures recommended are for all Deere OEM cooling systems. On specific vehicle applications, test cooling system and pressure cap according to the recommended pressure for that vehicle.*

DPSG,RG40854,284 –19–24SEP02–2/2

Check for Head Gasket Failures



Head Gasket

A—Combustion Seals (Flanges) **B—Gasket Body** **C—Front of Engine**

Head gasket failures generally fall into three categories:

- Combustion seal failures
- Coolant seal failures
- Oil seal failures

Combustion seal failures occur when combustion gases escape between cylinder head and head gasket combustion flange, or between combustion flange and cylinder liner. Leaking combustion gases may vent to an adjacent cylinder, to a coolant or oil passage, or externally.

Coolant or oil seal failures occur when oil or coolant escapes between cylinder head and gasket body, or between cylinder block and gasket body. The oil or coolant may leak to an adjacent coolant or oil passage, or externally. Since oil and coolant passages are primarily on right hand (camshaft) side of the engine, fluid leaks are most likely to occur in that area.

Follow these diagnostic procedures when a head gasket joint failure occurs, or is suspected.

1. Start and warm up engine if it can be safely operated. Examine all potential leakage areas again as outlined previously. Using appropriate test and measurement equipment, check the following:
   - White smoke, excessive raw fuel, or moisture in exhaust system.
   - Rough, irregular exhaust sound, or misfiring.
   - Air bubbles, gas trapped in radiator/overflow tank.
   - Loss of coolant from overflow.
   - Excessive cooling system pressure.
   - Coolant overheating.
   - Low coolant flow.
   - Loss of cab heating (air lock)
2. Shut engine down. Recheck crankcase, radiator, and overflow tank for any significant differences in fluid levels, viscosity, or appearance.
3. Compare your observations from above steps with the diagnostic charts on the following pages. If diagnostic evaluations provide conclusive evidence of combustion gas, coolant, or oil leakage from head gasket joint, the cylinder head must be removed for inspection and repair of gasket joint components.

COMBUSTION SEAL LEAKAGE

Symptoms:

- Exhaust from head gasket crevice.
- Air bubbles in radiator/overflow tank.
- Coolant discharge from overflow tube.

Continued on next page

- Engine overheating.
- Power loss.
- Engine runs rough.
- White exhaust smoke.
- Loss of cab heat.
- Gasket section dislodged, missing (blown).
- Coolant in cylinder.
- Coolant in crankcase oil.
- Low coolant level.

Possible Causes:

- Insufficient liner standout.
- Excessive liner standout differential between cylinders.
- Low head bolt clamping loads.
- Rough/damaged liner flange surface.
- Cracked/deformed gasket combustion flange.
- Out-of-flat/damaged/rough cylinder head surface.
- Missing/mislocated gasket firing ring.
- Block cracked in liner support area.
- Excessive fuel delivery.
- Hydraulic or mechanical disturbance or combustion seal.

NOTE: Cracked cylinder head or liners may also allow combustion gas leakage into coolant.

If above symptoms are found, see HEAD GASKET INSPECTION AND REPAIR SEQUENCE in Section 02, Group 020.

COOLANT SEAL LEAKAGE

Symptoms:

- Coolant discharge from head gasket crevice.
- Coolant in crankcase oil.
- Low coolant level.
- High oil level.
- Coolant discharge form crankcase vent.

Possible Causes:

- Excessive liner standout.
- Excessive liner standout differential between cylinders.
- Low head bolt clamping loads.
- Out-of-flat/damaged/rough block surface.
- Out-of-flat/damaged/rough cylinder head surface.
- Oil or coolant overheating.
- Cracks/creases in gasket body surfaces.
- Damage/voids in elastomer beading.

If above symptoms are found, see HEAD GASKET INSPECTION AND REPAIR SEQUENCE in Section 02, Group 020.

OIL SEAL LEAKAGE

Symptoms:

- Oil discharge from head gasket crevice.
- Oil in coolant.
- Low crankcase oil level.
- Reduced oil to rocker arms (noisy).

Possible Causes:

- Excessive liner standout
- Excessive liner standout differential between cylinders.
- Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface.
- Out-of-flat/damaged/rough cylinder head surface.
- Oil or coolant overheating.
- Cracks/creases in gasket body surfaces.
- Damage/voids in elastomer beading.
- Damaged/missing O-ring seal at oil port to rocker arms.

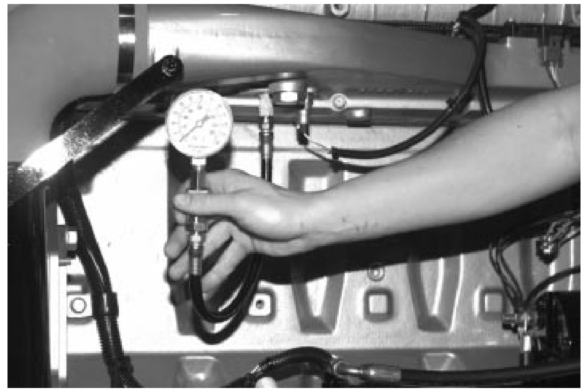
If above symptoms are found, see HEAD GASKET INSPECTION AND REPAIR SEQUENCE in Section 02, Group 020.

NOTE: Defective oil cooler may also allow oil leakage into coolant.

DPSG,RG40854,281 –19–27NOV00–2/2

Check Intake Manifold Pressure (Turbo Boost)

The preferred method of measuring intake manifold pressure (turbo boost) is to use the Diagnostic Scan Tool (DST) and read the Manifold Air Pressure (MAP) parameter when engine is developing rated power at full load rated speed. If the DST is not available, use the procedure below to manually test intake manifold pressure.


RG8800 –UN–26NOV97

Measuring Intake Manifold Pressure

1. Remove ether starting aid assembly adapter or plug from intake manifold cover, as equipped. Connect pressure gauge to intake manifold using JT05412 Universal Pressure Test Kit. Be sure all connections are tight.

2. Before checking boost pressure, warm up engine to allow the lubricating oil to reach operating temperature.

IMPORTANT: Engine speed and load should be stabilized before taking a gauge reading. Be sure that gauge works properly and familiarize yourself with the use of the gauge.

3. Observe pressure reading on gauge. Compare reading to the specifications when engine is developing rated power at full load rated speed. See INTAKE MANIFOLD PRESSURE (TURBOCHARGER BOOST) SPECIFICATIONS in Section 06, Group 210 of this manual.

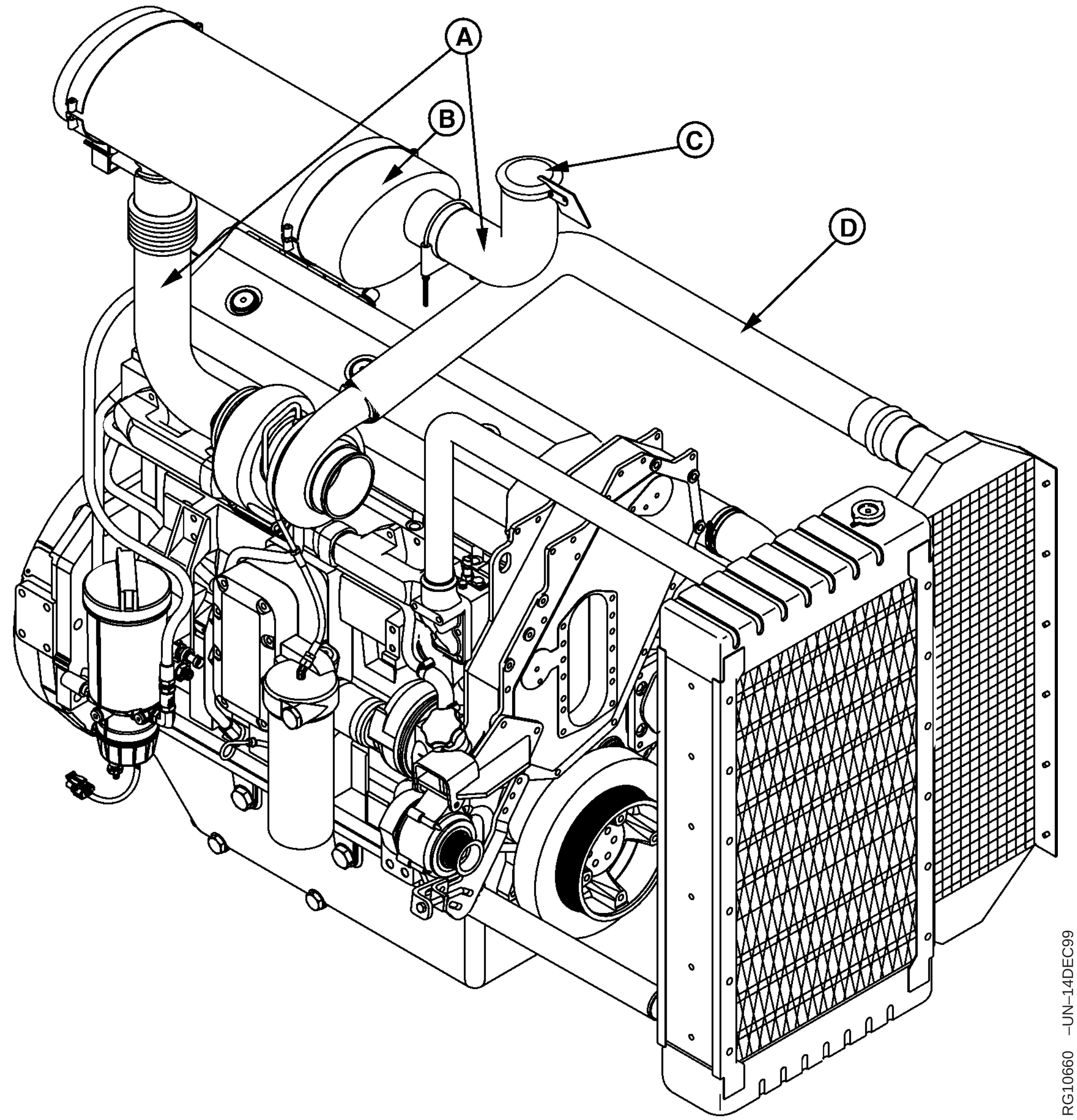
   If boost pressure is too low, check for the following:

   - Restricted air filter elements.
   - Incorrect fast idle adjustment.
   - Exhaust manifold leaks.
   - Intake manifold leaks.
   - Low compression pressure.
   - Carbon build-up in turbocharger.
   - Turbocharger compressor or turbine wheel rubbing housing.
   - Restricted exhaust.

4. After completing test, remove test equipment and reinstall plug. Tighten securely.

RG,RG34710,1549 –19–24SEP02–1/1

Check for Intake and Exhaust Restrictions



Check for Intake and Exhaust Restrictions

A—Exhaust piping **B—Muffler** **C—Rain Cap** **D—Intake Piping**

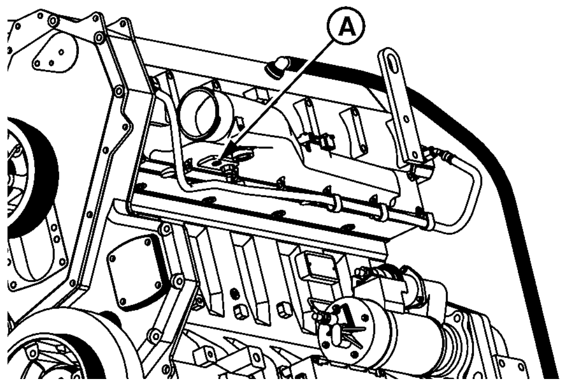
Low power, low boost pressure, and excessive black exhaust smoke can be caused by an intake air or exhaust restriction.

1. Inspect exhaust piping (A), the muffler (B), and the rain cap (C) for damage or any possible restrictions.
2. Inspect the intake piping (D), elbows, and any connections. Look for collapsed pipes, dented pipes and loose connections. Replace components as needed.

DPSG,RG40854,285 –19–10AUG99–1/1

Check for Intake Air Leaks

Air Filter



Intake Plug

A—Intake Plug

Loose connections or cracks in the suction side of the air intake pipe can allow debris to be ingested into the engine causing rapid wear in the cylinders. Additionally, on turbocharged engines, compressor damage may occur and cause an imbalance resulting in bearing failure. Air leaking form loose connections or cracks on the pressure side of the turbocharger can cause excessive smoke and low power.

NOTE: The following test procedure requires that the air intake be sealed off to pressurize the system. Using a plastic bag to seal the intake air filter is used as an example.

CAUTION: Do not start engine during this test procedure. Plastic bag (or whatever material/object is used to seal intake) can be sucked into the engine.

1. Remove air cleaner cover and main filter element.
2. Put a plastic bag over secondary filter element and install main element cover.
3. Remove plug from manifold and using a suitable adapter, connect a regulated air source.
4. Pressurize air intake system to the following specification.

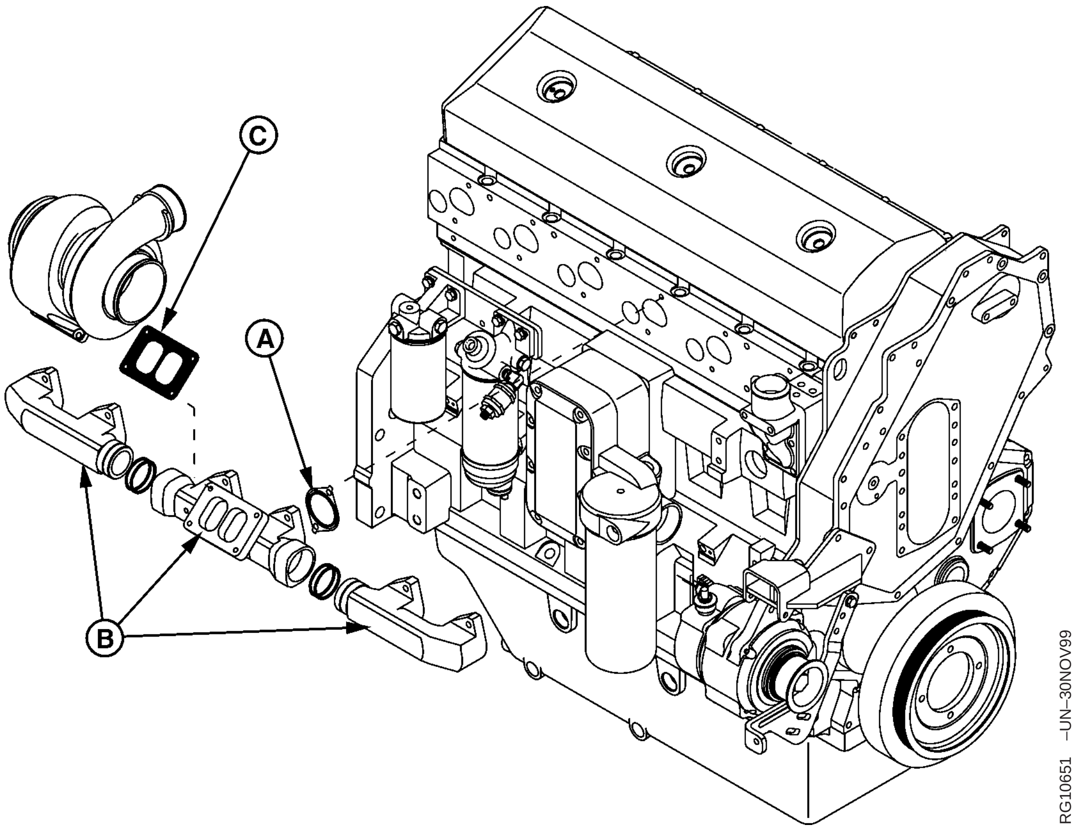
Specification

Intake Manifold—Test Pressure .... 13.8—20.8 kPa (0.13—0.21 bar)
(2—3 psi)

5. Spray soap and water solution over all connections from the air cleaner to the turbocharger or air inlet to check for leaks. Repair all leaks.
6. Remove plastic bag from filter element and reinstall element and cover.

DPSG,RG40854,286 –19–07NOV00–1/1

Check for Exhaust Air Leaks



Check for Exhaust Leaks

A—Exhaust Manifold Gasket **B—Exhaust Manifold** **C—Turbocharger Gasket**

Exhaust leaks, upstream of the turbocharger will cause the turbocharger turbine to rotate at reduced speed resulting in low boost pressure, low power, and excessive black smoke.

Inspect the exhaust manifold gasket, the exhaust manifold, and turbocharger gasket for damage and any signs of leakage. Replace components as needed. (See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD in Section 02, Group 080.)

DPSG,RG40854,287 –19–10AUG99–1/1

Check Camshaft-to-Crankshaft Timing

Check Camshaft-to-Crankshaft Timing

1. Remove rocker arm cover. See (REMOVE AND INSTALL ROCKER ARM COVER in Group 020.)

2. Remove plug from cylinder block and install JDG820 Flywheel Turning Tool (B).

IMPORTANT: JDG971 Timing Pin MUST BE installed into camshaft timing slot (A) first before attempting to install second timing pin into crankshaft timing slot (C).

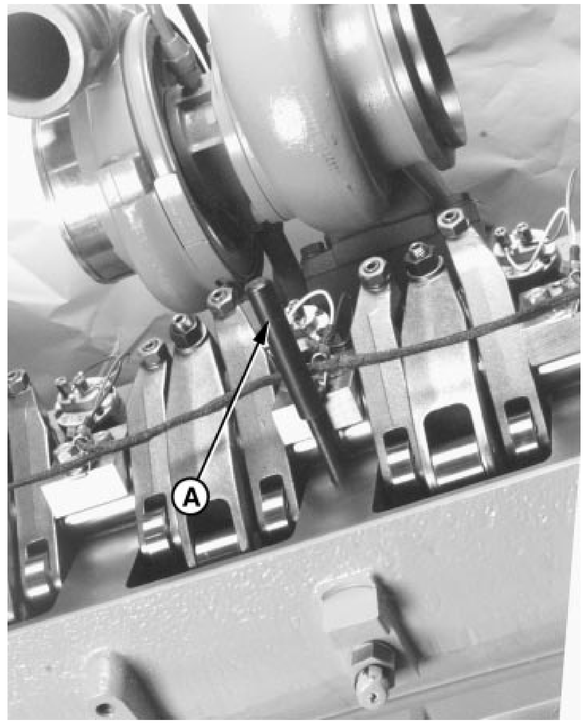
3. Rotate engine flywheel in running direction (Counter-clockwise as viewed from rear) until JDG971 Timing Pin (A) engages single timing slot (D) in camshaft. The proper timing slot can be found by viewing camshaft timing lobe through camshaft timing pin bore while rotating engine. The double timing slot (E) will be at approximately 11 o'clock (viewed from rear of engine) when pin is installed in slot (D). This ensures that engine is locked at TDC of No. 1 cylinder's compression stoke. Intake and exhaust rocker arms on No. 1 cylinder should be loose.

4. Remove threaded plug from crankshaft timing hole below oil cooler and filter housing assembly.

IMPORTANT: DO NOT insert timing pin full depth into cylinder block crankshaft timing hole when rotating engine flywheel until double slot on camshaft timing lobe is at approximately 11 o'clock (viewed from rear of engine) to avoid crankshaft counterweight bending timing pin.

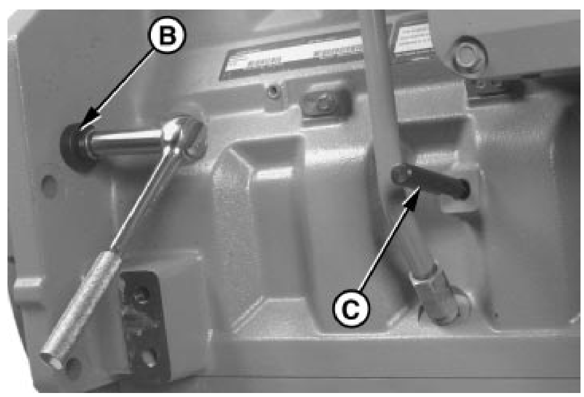
5. Slightly move engine flywheel back and forth with turning tool until a second JDG971 Timing Pin (C) can be installed in slot in crankshaft. This ensures that camshaft and crankshaft are in sync (properly timed).

A—Timing Pin
B—Flywheel Turning Tool
C—Timing Pin
D—Single Timing Slot
E—Double Timing Slot



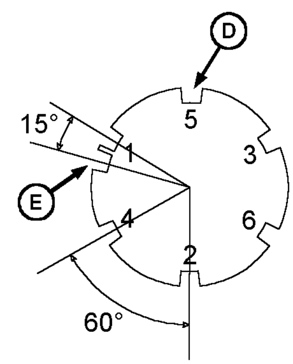
RG8228A —UN–05DEC97

JDG971 Timing Pin in Camshaft



RG8227D —UN–05DEC97

JDG971 Timing Pin in Crankshaft



RG11165 —UN–30OCT00

Camshaft Timing Slot

Continued on next page

DPSG,RG40854,357 –19–06NOV00–1/2

If timing pin does not enter crankshaft timing slot, crankshaft MUST BE timed to camshaft. See CHECK AND ADJUST CAMSHAFT-TO-CRANKSHAFT TIMING in Section 02, Group 050.

DPSG,RG40854,357 –19–06NOV00–2/2

Check Crankshaft Position Sensor Depth

NOTE: Crankshaft vibration damper and front seal shown removed

The ECU monitors the position of the crankshaft and camshaft to determine piston position and the optimum time to start and stop injecting fuel. This crank sensor sends the crank position to the ECU.

1. Disconnect crankshaft position sensor wiring connector.

2. Remove sensor (B) from timing gear cover.

3. Install JDG1334 Tool (C) in sensor bore in timing gear cover until the tool is hand tight within the timing gear cover.

4. Push in on pin (C) until it contacts crankshaft timing wheel (H).

5. Check position of pin end in relation to end of tool as shown in (D, E, F)

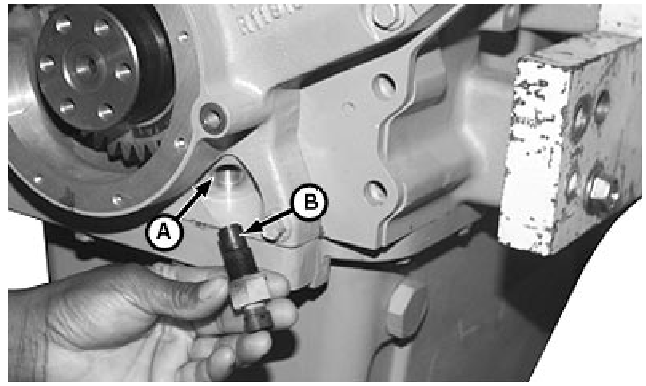
   - If pin's lower shoulder extends above end of tool (D), add one R60756 shim to sensor.
   - If pin's lower shoulder is within range of marks (E), no shim is required on sensor.
   - If pin is below end of tool (F), call DTAC for assistance.

6. Grease O-ring with JDT405 High Temperature Grease

7. Install sensor in timing gear cover and tighten to specification.

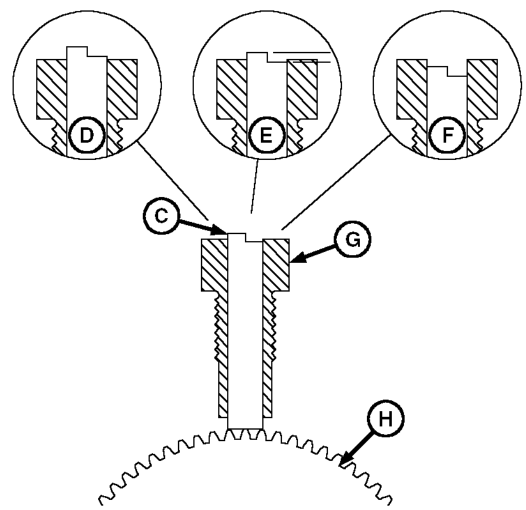
Specification

Crankshaft Position Sensor—
Torque .... 14 N•m (10 lb-ft)



RG10290 –UN–24AUG99

Crankshaft Position Sensor



RG10380 –UN–19OCT99

Using JDG1334 Depth Checking Tool

A—Machined Mounting Surface (Spotface)
B—Crankshaft Position Sensor
C—Pin (In JDG1334 Depth Tool)
D—Sensor Depth Low (Shim Required)
E—Sensor Depth Correct (No Shim Required)
F—Sensor Depth too High (Requires Investigation)
G—JDG1334 Depth Checking Tool
H—Crankshaft Timing Wheel

DPSG,RG40854,466 –19–07NOV00–1/1

Section 05
Tools and Other Materials

Contents

05

Engine Rebuild Guide, Break-In and Tune-Up (Group 010) Other Material

Number	Name	Use
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to engine lift strap cap screws.

LOCTITE is a registered trademark of Loctite Corp.

OUO1082,0000251 –19–19SEP02–1/1

Cylinder Head and Valves (Group 020) Essential Tools

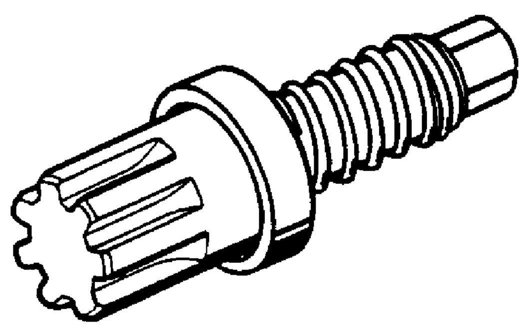
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

SERVICEGARD is a trademark of Deere & Company

OUO1004,0000BC3 –19–01NOV00–1/16

Flywheel Turning Tool JDG820

Used to rotate engine flywheel to check engine timing and adjust valve stem-to-valve bridge clearance. Use with JDG971.



RG7056 –UN–05DEC97

RG7056

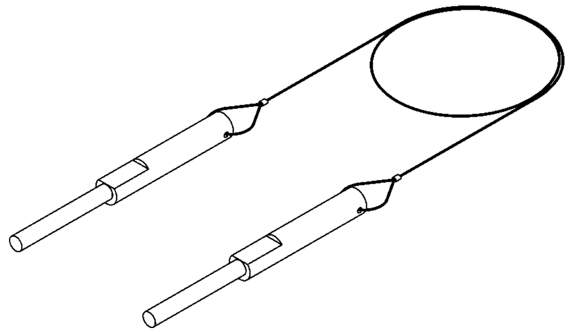
JDG820

Continued on next page

OUO1004,0000BC3 –19–01NOV00–2/16

Cam/Crankshaft Timing Lock Pins JDG971

Set of two. Used to lock camshaft and crankshaft at “Top Dead Center” during timing gear backlash adjustment. Use on crankshaft only for valve clearance adjustments. Set consists of two 313796 Lock Pins.



RG8519 –UN–20MAY98

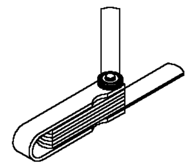
JDG971

OUO1004,0000BC3 –19–01NOV00–3/16

RG10382 –UN–05NOV99

Feeler Gauge Set JDG1333

Used to check intake and exhaust valve stem-to-bridge clearance.

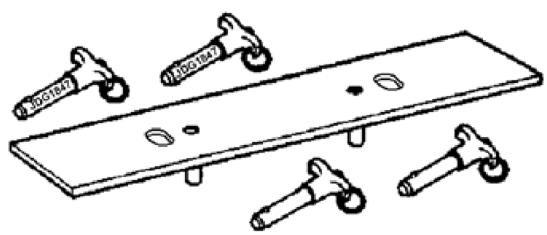


JDG1333

OUO1004,0000BC3 –19–01NOV00–4/16

Rocker Arm Assembly Lifting Fixture JDG970A

Use to correctly position rocker arm assembly during removal and installation. Set consists of a holding plate and two 221808 Ball Locking Pins. **Note: A second set of pins has been added to this tool. With Tier II engines (engine serial no. 030000—), the holes in the rocker arm shaft are smaller. The new pins have a smaller diameter shaft and are marked “JDG1847”. BE CERTAIN to verify the engine serial number, then use the correct pins for that engine.**



RG8502A –UN–10MAR04

JDG970A

Continued on next page OUO1004,0000BC3 –19–01NOV00–5/16

RG6246 –UN–05DEC97

Dial Indicator . . . . . D17526CI (English, in.) or D17527CI (Metric, mm)

Use with JDG451 or KJD10123 to measure valve recess and cylinder liner height-to-cylinder block top deck.

RG6246

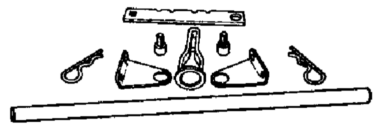
D17526CI/D17527CI

OUO1004,0000BC3 –19–01NOV00–6/16

RG8506 –UN–20MAY98

Valve Spring Compressor JDG982

Use to compress exhaust and intake valve springs for removal and installation.



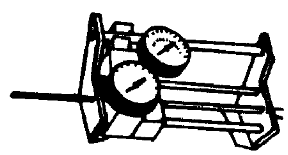
JDG982

OUO1004,0000BC3 –19–01NOV00–7/16

RG5061 –UN–05DEC97

Spring Compression Tester D01168AA

Test valve spring compression.



RG5061

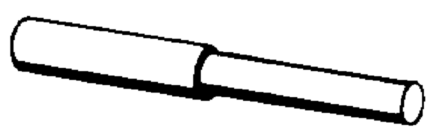
D01168AA

OUO1004,0000BC3 –19–01NOV00–8/16

RG5065 –UN–05DEC97

Valve Seat Pilot Driver JDG164A

Use with JDG1166 Adapter to install intake and exhaust valve seat inserts, and with JDG1167 Adapter to install valve guides.



RG5065

JDG164A

Continued on next page

OUO1004,0000BC3 –19–01NOV00–9/16

RG5067 –UN–06APR89

Valve Guide Installation Adapter. JDG1167

Use with JDG164A Pilot Driver to install valve guides.

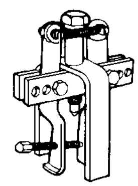
JDG1167

OUO1004,0000BC3 –19–01NOV00–10/16

RG5071 –UN–05DEC97

Valve Seat Puller .JDE41296

Remove valve seat inserts.



RG5071

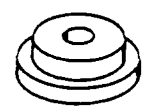
JDE41296

OUO1004,0000BC3 –19–01NOV00–11/16

RG5066 –UN–23AUG88

Valve Seat Insert Installing Adapter. JDG1166

Use with JDG164A Pilot Driver to install intake and exhaust valve seat inserts.

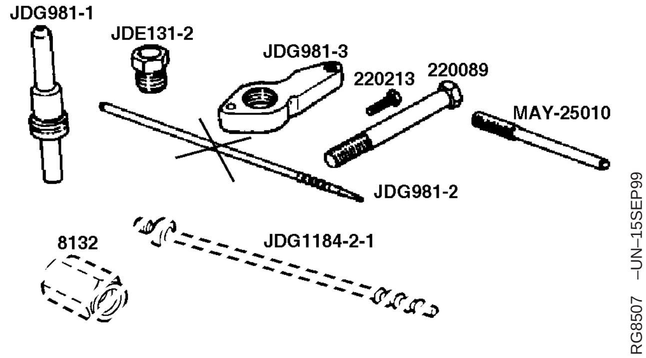


JDG1166

Continued on next page OUO1004,0000BC3 –19–01NOV00–12/16

Unit Injector Sleeve Installation Set. JDG981

Use to replace unit injector sleeve. Unit injector sleeve tip bore must be swedged to seal off coolant passages from cylinder bore. Set consists of JDE131-2 Driver Nut, JDG981-1 Guide Sleeve, JDG981-3 Guide Sleeve Holding Bar, 220213 Hex Head Cap Screw (M8 x 1.25 x 40 mm), 220089 Hex Head Cap Screw (M16 x 2 x 150 mm), and MAY-25010 Punch. JDG981-2 Swedge is obsolete. Use JDG1184-2-1 Swedge Arbor and 8132 Adapter from JDG1184 EUI Nozzle Sleeve Replacement Kit in its place.

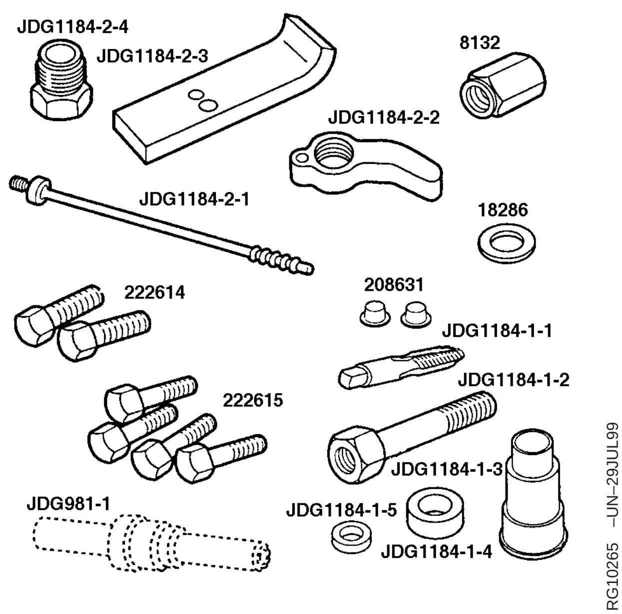


JDG981

OUO1004,0000BC3 –19–01NOV00–13/16

EUI Nozzle Sleeve Replacement Set. JDG1184

Used to install injector sleeves in cylinder head with head installed in engine. Must be used with JDG981-1 Guide Sleeve which can be ordered separately.



JDG1184

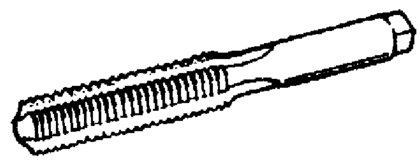
Continued on next page

OUO1004,0000BC3 –19–01NOV00–14/16

RG8508 –UN–20MAY98

Tap JDG978

Used to restore threaded holes in cylinder block for cylinder head cap screws.



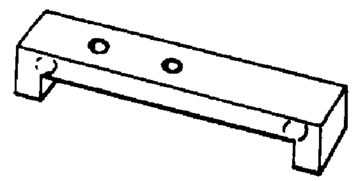
JDG978

OUO1004,0000BC3 –19–01NOV00–15/16

RG7029 –UN–05DEC97

Height Gauge. . . JDG451 (English) or KJD10123 (Metric)

Used with D17526CI or D17527CI Dial Indicator to measure valve recess and cylinder liner height-to-cylinder block top deck.



JDG451

OUO1004,0000BC3 –19–01NOV00–16/16

Cylinder Head and Valves (Group 020) Service Equipment and Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

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OUO1004,0000BC4 –19–01NOV00–1/9

Valve Inspection Center . . . .

Check valves for out of round.

OUO1004,0000BC4 –19–01NOV00–2/9

Plastic Brush . . . .

Clean valve guides.

Continued on next page

OUO1004,0000BC4 –19–01NOV00–3/9

Precision “Bevelled Edge” Straightedge D05012ST

Check cylinder head flatness.

OUO1004,0000BC4 –19–01NOV00–4/9

End Brush D17024BR

Remove carbon on valve seats.

OUO1004,0000BC4 –19–01NOV00–5/9

Heavy-Duty Seat Grinder Set. JT05893

Grind valve seats.

OUO1004,0000BC4 –19–01NOV00–6/9

Eccentrimeter . . . .

Measure valve seat runout.

OUO1004,0000BC4 –19–01NOV00–7/9

Slider Hammer D01300AA

Use with JDG1184-1-2 Adapter to remove EUI sleeve with cylinder head installed in engine.

OUO1004,0000BC4 –19–01NOV00–8/9

Torque Angle Gauge JT05993

Tighten flanged-head cylinder head cap screws.

OUO1004,0000BC4 –19–01NOV00–9/9

Cylinder Head and Valves (Group 020) Other Material

Number	Name	Use
T43514 (U.S.) TY9475 (Canadian) 277 (LOCTITE®)	Plastic Gasket	Apply to expansion plugs in cylinder head and block.
AR44402 (U.S.)	Valve Stem Lubricant	Lubricate valve stems.
JDT405 (U.S.)	High Temperature Grease	Apply to injector sleeve square packing.
TY24311 (U.S.) CXTY24311 (Canadian) 222 (LOCTITE®)	Thread Lock and Sealer (Low Strength)	Apply to EUI solenoid wire retaining nut.

LOCTITE is a registered trademark of Loctite Corp.

OUO1004,0000BC5 –19–01NOV00–1/1

Cylinder Block, Liners, Pistons, and Rods (Group 030) Essential Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

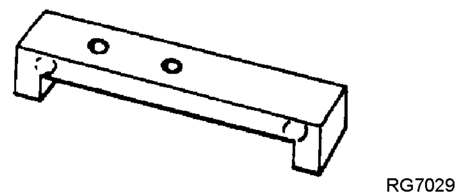
SERVICEGARD is a trademark of Deere & Company

OUO1004,0000BCC –19–02NOV00–1/16

RG7029 –UN–05DEC97

Piston and Liner Height Gauge . . . . JDG451[1]

Measure piston and liner heights.



JDG451

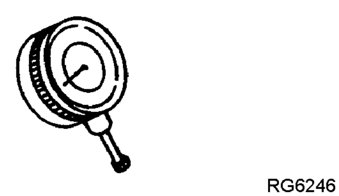
[1]*A dial indicator is not supplied with JDG451. Use D17526CI (English, in.) or D17527CI (Metric, mm) Dial Indicator with JDG451.*

OUO1004,0000BCC –19–02NOV00–2/16

RG6246 –UN–05DEC97

Dial Indicator . . . . . D17526CI (English, in.) or D17527CI (Metric, mm)

Use with JDG451 to measure valve recess and cylinder liner height-to-cylinder block top deck.



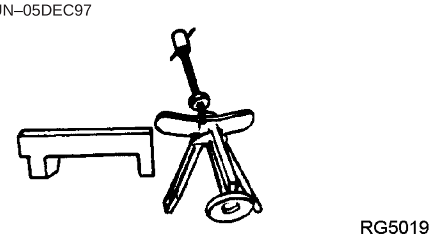
D17526CI/D17527CI

OUO1004,0000BCC –19–02NOV00–3/16

RG5019 –UN–05DEC97

Cylinder Liner Puller . . . . D01062AA, D01073AA, or KCD10001

Use to remove and install cylinder liners.



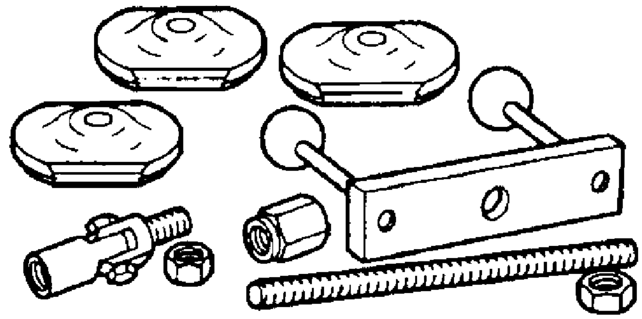
D01073AA

Continued on next page

OUO1004,0000BCC –19–02NOV00–4/16

Cylinder Liner Service Set. JDG1145

Use to remove and install cylinder liners. Use with D01300AA 2.2 kg (5 lb) Slide Hammer. Also used with lapping compound to lap liner flange to block counterbore.


RG10280 –UN–13AUG99

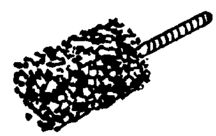
JDG1145

OUO1004,0000BCC –19–02NOV00–5/16

RG5074 –UN–07NOV97

Flexible Cylinder Hone D17006BR

Hone cylinder liners.

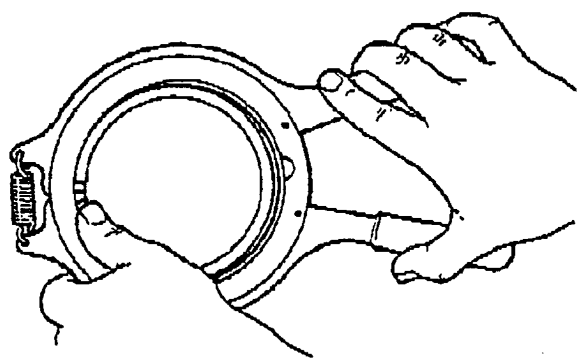

RG5074

D17006BR

OUO1004,0000BCC –19–02NOV00–6/16

Piston Ring Expander JDG967

Use to control the expansion of the piston rings during removal and installation of the pistons. This tool prevents over-expansion and damage to the rings.


RG7406 –UN–21MAY98

JDG967

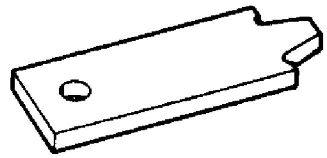
Continued on next page

OUO1004,0000BCC –19–02NOV00–7/16

RG8516 –UN–20MAY98

Piston Ring Groove Wear Gauge JDG1019

Use as a go/no-go gauge to measure wear on the two top compression piston ring grooves on RE52836 and RE504801 aluminum pistons used in 6105 engines with 4-mm piston rings.



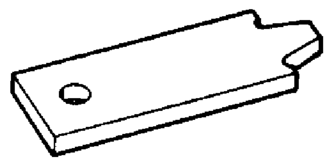
JDG1019

OUO1004,0000BCC –19–02NOV00–8/16

RG8516 –UN–20MAY98

Piston Ring Groove Wear Gauge JDG1335

Use as a go/no-go gauge to measure wear on the two top compression piston ring grooves on later 6105 and 6125 engines with RE504343 (6105), RE503969 (6125) and RE505901 (6125) pistons with 3-mm compression rings.



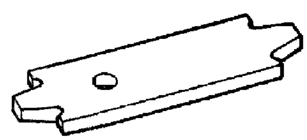
JDG1335

OUO1004,0000BCC –19–02NOV00–9/16

RG8517 –UN–20MAY98

Piston Ring Groove Wear Gauge JDG1022

Use as a go/no-go gauge to measure wear on the two top compression piston ring grooves on RE66125 steel crown pistons used on earlier 6125 engines with 4-mm piston rings.



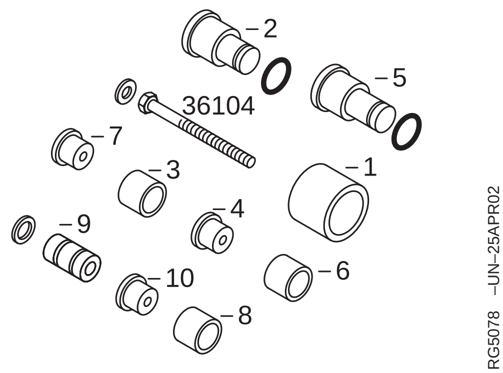
JDG1022

Continued on next page

OUO1004,0000BCC –19–02NOV00–10/16

Connecting Rod Bushing Service Set JDE98A

Remove and install connecting rod bushings. Set consists of JDE98-1 Cup (1), JDE98-2 Driver (2), JDE98-3 Pilot (3), JDE98-4 Driver (4), JDE98-5 Driver (5), JDE98-6 Pilot (6), JDE98-7 Driver (7), JDE98-8 Cup (8), JDE98-9 Pilot (9), JDE98-10 Bushing Remover/Installer (10) and STD36104 Forcing Screw.

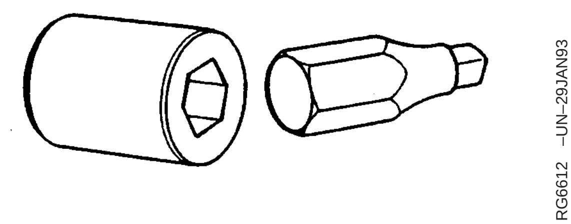


JDE98A

OUO1004,0000BCC –19–02NOV00–11/16

Oil Gallery Plug Tool JDG782

Use to remove and install cylinder block oil gallery plug.

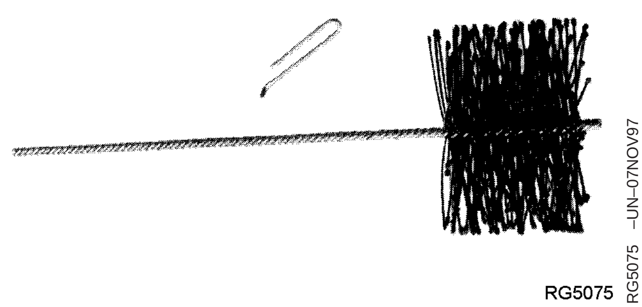


JDG782

OUO1004,0000BCC –19–02NOV00–12/16

O-Ring Groove Cleaning Brush D17015BR

Clean cylinder liner O-ring groove in block.



D17015BR

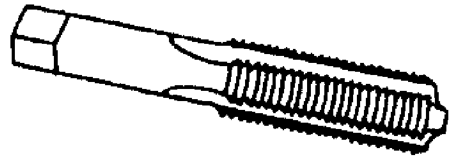
Continued on next page

OUO1004,0000BCC –19–02NOV00–13/16

RG5100 –UN–05DEC97

Tap JDG978

Used to restore threaded holes in cylinder block for cylinder head cap screws.

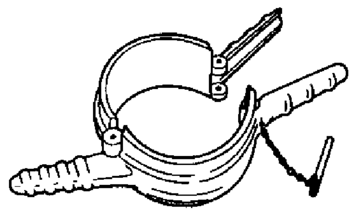


JDG978

OUO1004,0000BCC –19–02NOV00–14/16

Piston Ring Compressor JDG1017

Use to compress piston rings during installation of the piston.



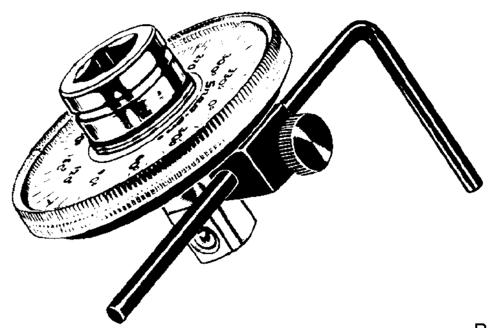
RG8515 –UN–20MAY98

JDG1017

OUO1004,0000BCC –19–02NOV00–15/16

Torque Angle Gauge JT05993

Used to torque-turn cylinder head and connecting rod cap screws.



RG5698 –UN–05DEC97

JT05993

OUO1004,0000BCC –19–02NOV00–16/16

Cylinder Block, Liners, Pistons, and Rods (Group 030) Service Equipment and Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

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OUO1004,0000BC9 –19–01NOV00–1/4

Cylinder Liner Bore Ridge Reamer JT07277

Remove carbon from liner bore prior to piston removal.

OUO1004,0000BC9 –19–01NOV00–2/4

Piston Ring Groove Cleaning Tool

Used to clean piston ring grooves.

OUO1004,0000BC9 –19–01NOV00–3/4

Precision “Bevelled Edge” Straightedge D05012ST

Check cylinder head flatness.

OUO1004,0000BC9 –19–01NOV00–4/4

Cylinder Block, Liners, Pistons, and Rods (Group 030) Other Material

Number	Name	Use
(U.S.)	PLASTIGAGE®	Determine connecting rod bearing-to-journal oil clearance.
AR54749 (U.S.)	Soap Lubricant	Coat O-rings on cylinder liners.
JDT405 (U.S.)	High Temperature Grease	Apply to O-rings for piston spray jets.
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to threads of oil gallery plugs.

05
170
15

PLASTIGAGE is a registered trademark of DANA Corp.
LOCTITE is a registered trademark of Loctite Corp.

OUO1004,0000BCA –19–01NOV00–1/1

Crankshaft, Main Bearings and Flywheel (Group 040) Essential Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

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OUO1004,0000BD0 –19–02NOV00–1/9

RG6246 –UN–05DEC97

Dial Indicator . . . . . D17526CI (English, in.) or D17527CI (Metric, mm)

Use to check vibration damper radial runout, crankshaft end play, flywheel housing runout and flywheel face flatness.

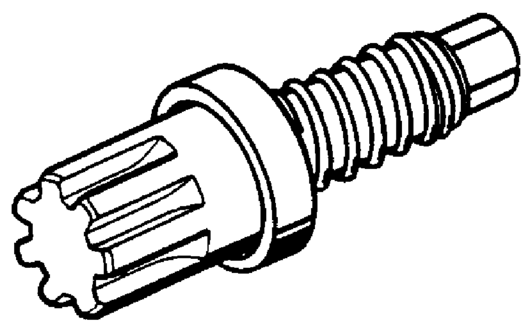
RG6246

D17526CI / D17527CI

OUO1004,0000BD0 –19–02NOV00–2/9

Flywheel Turning Tool JDG820

Use to rotate engine flywheel to check damper radial runout and piston protrusion.



RG7056 –UN–05DEC97

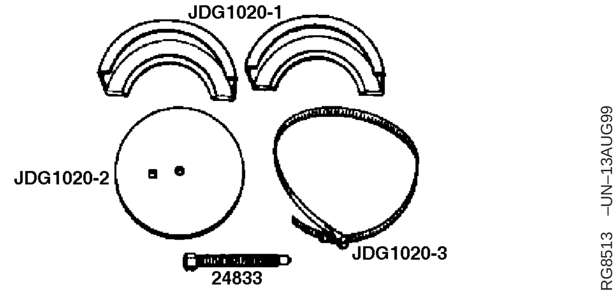
RG7056

JDG820

Continued on next page OUO1004,0000BD0 –19–02NOV00–3/9

Rear Crank Seal Sleeve Remover JDG1020

Use to remove the rear seal assembly and seal housing. Tool helps protect the flange on rear of crankshaft.

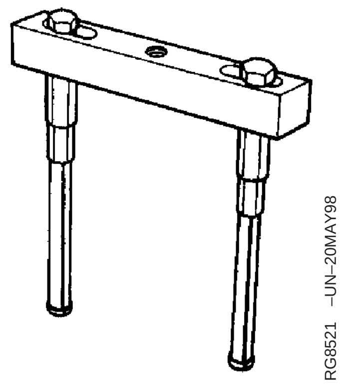


JDG1020

OUO1004,0000BD0 –19–02NOV00–4/9

Main Bearing Cap Puller/Installer JDG996

Use to remove and install the main bearing caps. Due to wider bearing surface, these caps are installed with an increased interference fit.



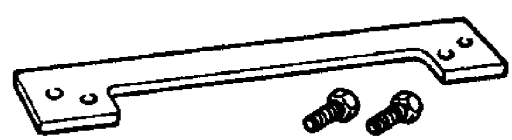
JDG996

OUO1004,0000BD0 –19–02NOV00–5/9

Timing Gear Cover/Rear Seal Housing Oil Pan Rail Aligner JDG977

Use to align the timing gear cover to the engine block oil pan mounting surface and align the rear seal housing to the same surface. When installing the timing gear seal housing, use JDG975 Timing Gear Cover/Rear Crankshaft Housing Centering Tool to center the seal housing bores with the crankshaft flange.

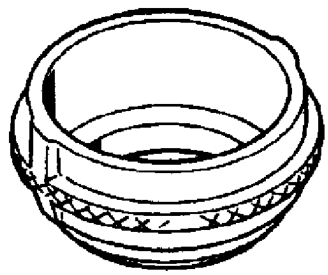
RG8510 –UN–20MAY98


JDG977

Continued on next page OUO1004,0000BD0 –19–02NOV00–6/9

Front Timing Gear Cover/Rear Crankshaft Seal Housing Centering Tool JDG975

Use to center the front/rear seal housing bore with the rear crankshaft flange during installation of the housing. This tool is also used to center the front timing gear cover seal housing bore with the front crankshaft flange during installation of the timing cover. Use with JDG977.



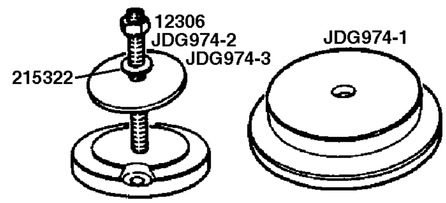
RG8511 –UN–20MAY98

JDG975

OUO1004,0000BD0 –19–02NOV00–7/9

Front/Rear Crankshaft Seal Installer JDG974A

Use to install the front crankshaft seal on damper prior to damper installation and to install rear oil seal in rear seal housing when housing is on engine.



RG8512 –UN–13AUG99

JDG974A

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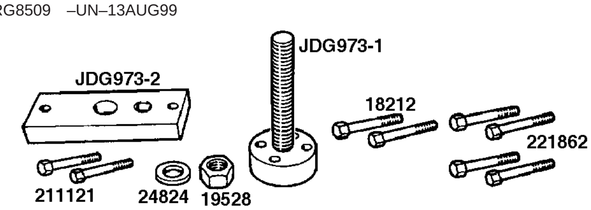
170
18

OUO1004,0000BD0 –19–02NOV00–8/9

RG8509 –UN–13AUG99

Damper Puller/Installer JDG973

Use to safely remove and install engine damper with engine in vehicle chassis. The damper weighs approximately 18 kg (40 lb) and is mounted with an interference press fit.



JDG973

OUO1004,0000BD0 –19–02NOV00–9/9

Crankshaft, Main Bearings and Flywheel (Group 040) Service Equipment and Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

SERVICEGARD is a trademark of Deere & Company

Continued on next page

OUO1004,0000BD1 –19–02NOV00–1/4

Crankshaft Front Rotation Adapter JDG976

Used to rotate crankshaft when flywheel is removed from engine.

OUO1004,0000BD1 –19–02NOV00–2/4

Slide Hammer D01300AA

Use with JDG996 Puller to remove crankshaft main bearing caps.

OUO1004,0000BD1 –19–02NOV00–3/4

17-1/2 and 30-Ton Puller Set. D01047AA

Remove crankshaft gear from crankshaft.

OUO1004,0000BD1 –19–02NOV00–4/4

Crankshaft, Main Bearings and Flywheel (Group 040) Other Material

Number	Name	Use
(U.S.)	Brake Kleen or Ignition Cleaner	Remove sealant from crankshaft flange.
(U.S.)	PLASTIGAGE®	Check main bearing-to-crankshaft journal oil clearance during engine disassembly.
TY15969 (U.S.) TY9479 (Canadian) 680 (LOCTITE®)	Retaining Compound (Maximum Strength)	Coat OD of crankshaft flange for installation of rear oil seal/wear sleeve. Coat ID of front wear sleeve prior to installation.
TY16285 (U.S.)	Clean and Cure Primer	Clean sealant from mating gasket surfaces on timing gear cover and camshaft gear access cover.
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to both sides of timing gear cover gasket and to camshaft gear access cover gasket on earlier engines using Fel-Pro gaskets.
TY6304 (U.S.) TY9484 (Canadian) 515 (LOCTITE®)	Flexible Sealant	Apply to timing gear cover gasket and camshaft gear access cover gasket on earlier engines using Fel-Pro gasket.

PLASTIGAGE is a registered trademark of DANA Corp.
LOCTITE is a registered trademark of Loctite Corp.

OUO1004,0000BD2 –19–02NOV00–1/1

Camshaft and Timing Gear Train (Group 050) Essential Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

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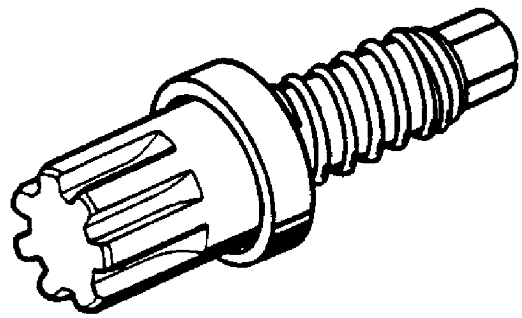
OUO1004,0000BD4 –19–02NOV00–1/8

Flywheel Turning Tool JDG820

Use to rotate engine flywheel to check camshaft-to-crankshaft timing, adjust gear train backlash, and valve stem-to-valve bridge clearance.

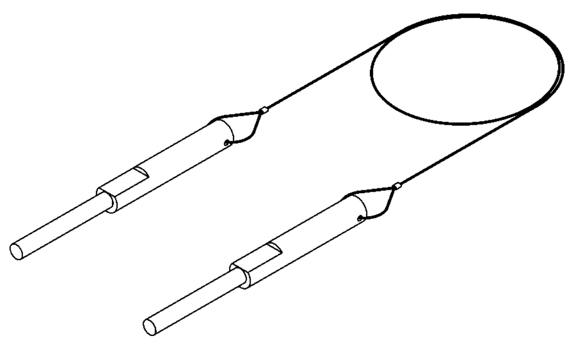


JDG820

OUO1004,0000BD4 –19–02NOV00–2/8

Cam/Crankshaft Timing Lock Pins JDG971

Set of two. Use to lock camshaft and crankshaft at “Top Dead Center” during timing gear backlash adjustment. Use on crankshaft only for valve clearance adjustments. Set consists of Holding Plate and 221808 Ball Locking Pins.



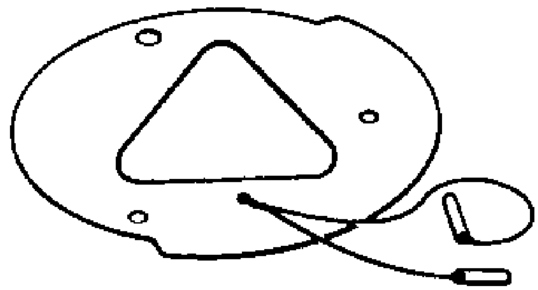
JDG971

Continued on next page

OUO1004,0000BD4 –19–02NOV00–3/8

Gear Train Backlash Template. JDG993

Use to locate correct gear teeth on idler gear for accurate backlash adjustment. This measurement is critical for unit injector timing.



RG8520 –UN–20MAY98

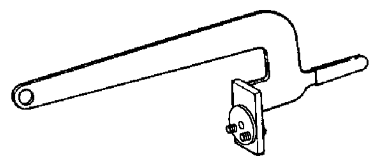
JDG993

OUO1004,0000BD4 –19–02NOV00–4/8

RG10275 –UN–04AUG99

Camshaft Holding Tool JDG969A

Use with overhead hoist to control position of camshaft during removal and installation. Use with JDG972 Camshaft Pilot.



JDG969A

OUO1004,0000BD4 –19–02NOV00–5/8

RG8504 –UN–20MAY98

Camshaft Pilot JDG972

Use with JDG969A Camshaft Holding Tool to remove and install the camshaft.

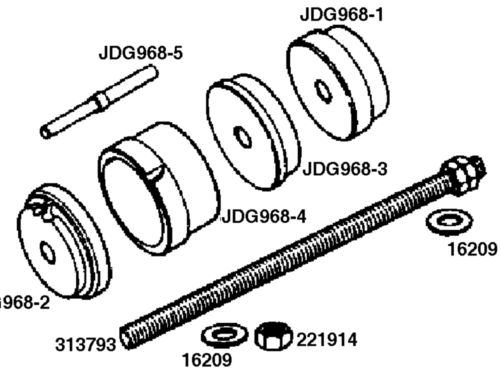
JDG972

Continued on next page

OUO1004,0000BD4 –19–02NOV00–6/8

Camshaft Bushing Service Set. JDG968

Use to remove and install to specification the camshaft bushings. Pilots are designed to protect bushings during installation. Set consists of JDG968-1 Bushing Remover, JDG968-2 Bushing Installer, JDG968-3 Guide, JDG968-4 Alignment Sleeve, JDG968-5 Pin Alignment Checking, 221914 Hex Nut, 16209 Thrust Washers, 313793 Forcing Screw Assembly.



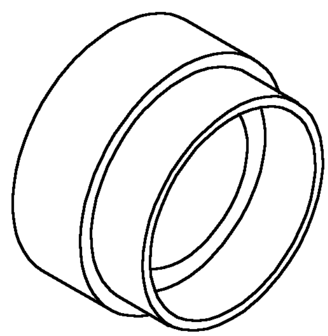
RG8505 –UN–13AUG99

JDG968

OUO1004,0000BD4 –19–02NOV00–7/8

Front Auxiliary Drive Alignment Tool JDG1144

Use to center front SAE “A” auxiliary drive adapter with gear spline.


RG9040 –UN–21MAY98

JDG1144

OUO1004,0000BD4 –19–02NOV00–8/8

Camshaft and Timing Gear Train (Group 050) Service Equipment and Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

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Continued on next page

OUO1004,0000BD5 –19–02NOV00–1/2

Snap-On Dowel Pin Puller Set CG503

Remove fuel supply pump drive pin from end of camshaft.

OUO1004,0000BD5 –19–02NOV00–2/2

Camshaft and Timing Gear Train (Group 050) Other Material

Number	Name	Use
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to idler gear carrier cap screws, camshaft gear retainer cap screws and fuel supply pump drive coupler cap screws.
TY6333 or TY6347 (U.S.)	High Temperature Grease	Coat cam roller followers, camshaft lobes, journals, and bushings during installation. Coat idler gear and bushing during installation.

05
170
24

LOCTITE is a registered trademark of Loctite Corp.

OUO1004,0000BD6 –19–02NOV00–1/1

Lubrication System (Group 060) Essential Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

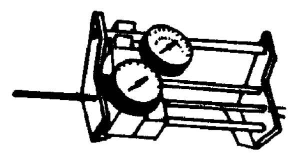
SERVICEGARD is a trademark of Deere & Company

OUO1022,0000008 –19–25OCT00–1/2

RG5061 –UN–05DEC97

Spring Compression Tester D01168AA

Test oil bypass valve spring and oil pressure regulating valve spring compression.



D01168AA

OUO1022,0000008 –19–25OCT00–2/2

Lubrication System (Group 060) Other Material

Number	Name	Use
T43513 (U.S.) TY9474 (Canadian) 271 (LOCTITE®)	Thread Lock and Sealer (High Strength)	Oil filter mounting adapter-to-filter base.
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Oil pump-to-block cap screws and oil pressure sending unit.
TY6333 or TY6347 (U.S.)	High Temperature Grease	Apply to inside cavities of oil pump and ID of oil pump drive gear bushing.
TY16285 (U.S.) CXTY16285 (Canadian) 7649 (LOCTITE®)	Clean and Cure Primer	Apply to oil pan and block sealing surfaces.
TY16021 (U.S.) TY9484 (Canadian) 17430 (LOCTITE®)	High Flex Form-In-Place Gasket	Used to seal oil pan.[1]
TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®)	Pipe Sealant	Apply to oil pan drain hose and drain valve.

LOCTITE is a registered trademark of Loctite Corp.

[1] *See INSTALL ENGINE OIL PAN later in this group for specific locations to apply sealant.*

OUO1022,0000009 –19–25OCT00–1/1

Cooling System (Group 070) Essential Tools

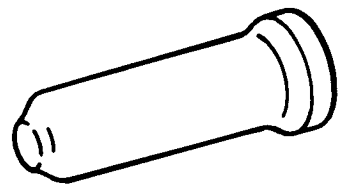
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

SERVICEGARD is a trademark of Deere & Company

OUO1022,000000B –19–26OCT00–1/2

Coolant Pump Bearing Driver JDG743A

Use to install fan drive bearing assembly in fan drive housing.



RG6219 –UN–06MAR92

JDG743A

OUO1022,000000B –19–26OCT00–2/2

Cooling System (Group 070) Other Material

Number	Name	Use
TY6333 or TY6347 (U.S.)	High Temperature Grease	Pack bearings in fan drive and coolant pump.
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Tensioner mounting shoulder bolt or cap screw, idler mounting cap screw and coolant pump mounting cap screws.
TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®)	Pipe Sealant	Oil cooler housing drain valve, coolant heater, temperature sensor and pipe plugs.

LOCTITE is a registered trademark of Loctite Corp.

OUO1022,000000C –19–18SEP02–1/1

Air Intake and Exhaust System (Group 080) Essential Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

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OUO1004,0000C2C –19–06DEC00–1/2

RG6246 –UN–05DEC97

Dial Indicator . . . . . D17526CI (English, in.) or D17527CI (Metric, mm)

Use with magnetic base to measure turbocharger radial bearing clearance and axial bearing end play.

D17526CI/D17527CI

OUO1004,0000C2C –19–06DEC00–2/2

Air Intake and Exhaust System (Group 080) Other Material

Number	Name	Use
PT569 (U.S.)	NEVER-SEEZ® Compound	Apply to turbocharger cap screws, intake manifold-to-cylinder head cap screws, exhaust manifold-to-cylinder head cap screws, aftercooler-to-cylinder head cap screws and turbocharger oil return line cap screws.
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to turbocharger oil inlet fitting.

NEVER-SEEZ is a registered trademark of the Emhart Chemical Group.
LOCTITE is a registered trademark of Loctite Corp.

DPSG,OUO1004,954 –19–29JUL99–1/1

Starting and Charging Systems (Group 100) Essential Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

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DPSG,OUO1004,861 –19–28APR99–1/2

RW17441 –UN–16NOV89

Starter Wrench JDE80

Remove and install starter motor.

JDE80

DPSG,OUO1004,861 –19–28APR99–2/2

Observable Diagnostics and Tests Essential Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

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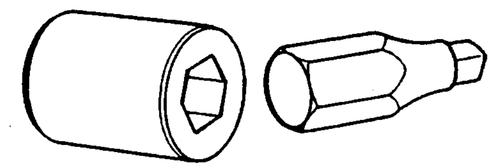
OUO1004,0000C1D –19–27NOV00–1/6

Oil Galley Plug Tool. .JDG782

Used to remove and install oil galley plug.


RG6612 –UN–29JAN93

JDG782

OUO1004,0000C1D –19–27NOV00–2/6

Cooling System Pressure Pump. D05104ST

Used to pressure test radiator cap and cooling system.


R26406N –UN–29NOV88

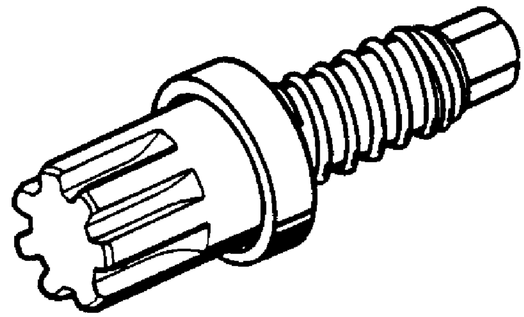
D05104ST

Continued on next page

OUO1004,0000C1D –19–27NOV00–3/6

Flywheel Turning Tool JDG820

Use to rotate engine flywheel to check camshaft-to-crankshaft timing, adjust gear train backlash, and valve stem-to-valve bridge clearance.

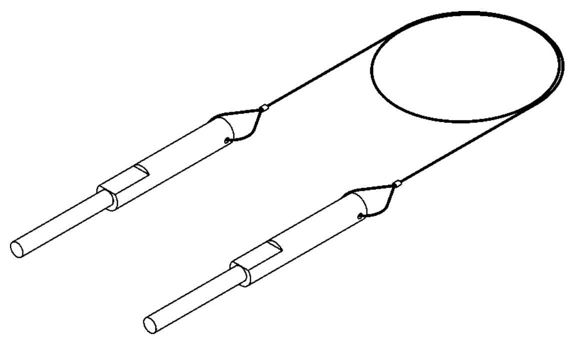


JDG820

OUO1004,0000C1D –19–27NOV00–4/6

Cam/Crankshaft Timing Lock Pins JDG971

Set of 2. Use to lock camshaft and crankshaft at “Top Dead Center” during timing gear backlash adjustment. Use on crankshaft only for valve clearance adjustments. Set consists of Holding Plate and 221808 Ball Locking Pins.

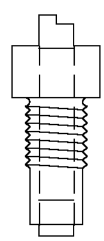


JDG971

OUO1004,0000C1D –19–27NOV00–5/6

Depth Tool. JDG1334

Check crankshaft position sensor depth.



JDG1334

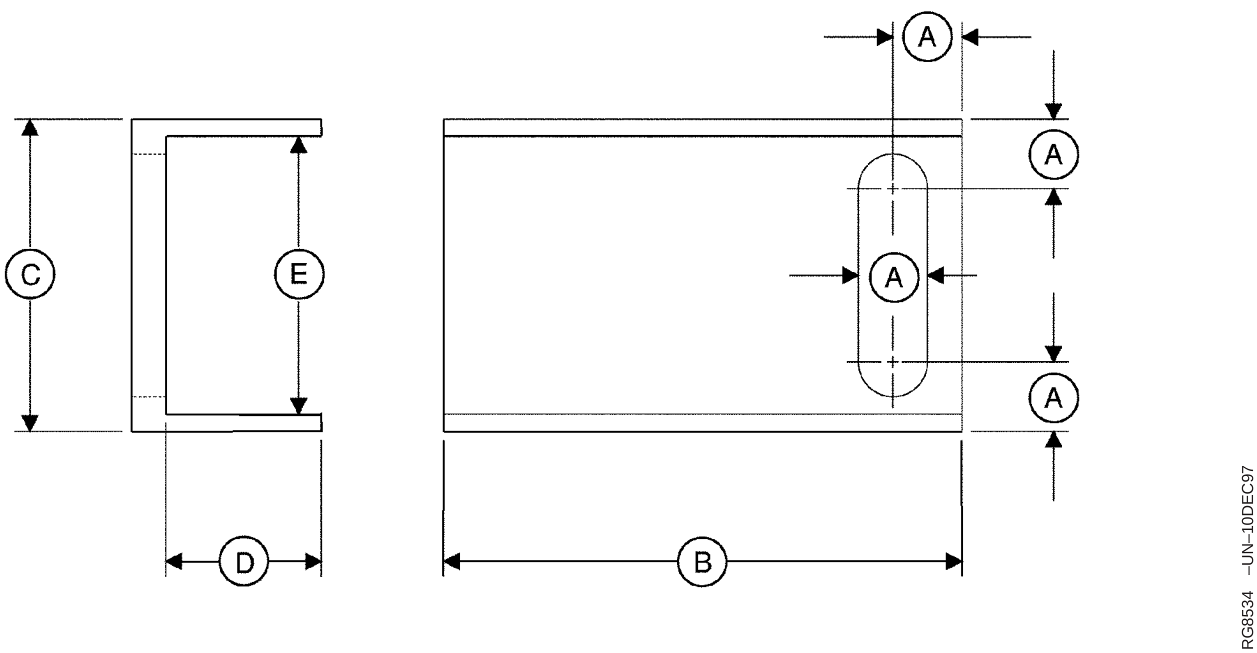
OUO1004,0000C1D –19–27NOV00–6/6

How to Make Tools

These tools can be made in a service shop using common shop tools and locally obtained materials.

RG,RG34710,275 –19–30SEP97–1/1

DFRG4—Camshaft Locking Tool



DFRG4 Camshaft Locking Tool

A—12.7 mm (0.50 in.)
B—95.25 mm (3.75 in.)
C—57.15 mm (2.25 in.)
D—28.57 mm (1.12 in.)
E—50.8 mm (2.00 in.)

RG,RG34710,276 –19–30SEP97–1/1

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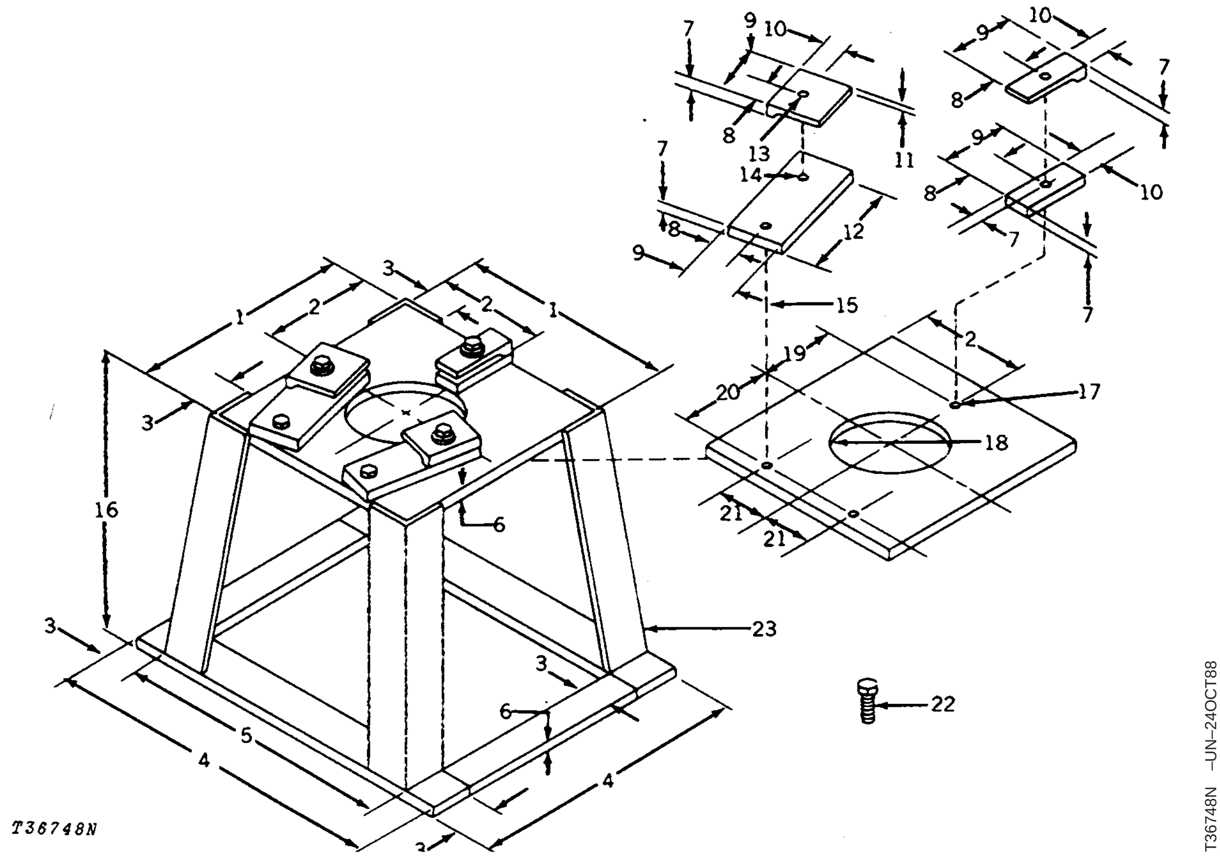
190
1

DFRG3—Cylinder Liner Holding Fixture



DFRG3 Liner Holding Fixture

1—254.0 mm (10 in.)
2—127.0 mm (5 in.)
3—38.1 mm (1.5 in.)
4—405.4 mm (16 in.)
5—330.2 mm (13 in.)
6—9.52 mm (0.38 in.)
7—12.7 mm (0.5 in.)
8—31.8 mm (1.25 in.)
9—63.5 mm (0.25 in.)
10—25.4 mm (1 in.)
11—6.35 mm (0.25 in.)
12—152.4 mm (6 in.)
13—0.328 in. Drill Through
14—5/16 in.–18 Tap
15—2 used
16—304.8 mm (12 in.)
17—5/16 in.–18 Tap
18—69.85 mm (2.75 in.) Radius
19—101.6 mm (4 in.)
20—111.25 mm (4.38 in.)
21—60.45 mm (2.38 in.)
22—5/16 in. [times] 1 in. Cap Screw
23—38.1 mm (1.5 in.) Angle Iron

RG,RG34710,277 –19–30SEP97–1/1

Section 06
Specifications

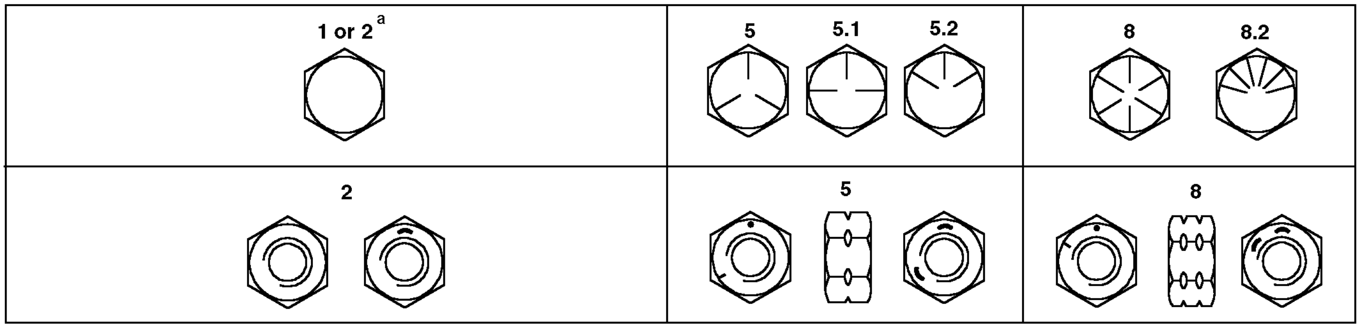
Contents

General OEM Engine Specifications

ITEM	UNIT OF MEASURE	6105AF	6105HF	6125AF	6125HF (—29999)	6125HF (30000—)
Number of Cylinders	——	6	6	6	6	6
Fuel	——	Diesel	Diesel	Diesel	Diesel	Diesel
Stroke	mm (in.)	138 (5.43)	138 (5.43)	165 (6.50)	165 (6.50)	165 (6.50)
Bore	mm (in.)	127 (5.00)	127 (5.00)	127 (5.00)	127 (5.00)	127 (5.00)
Displacement	L (cu in.)	10.5 (640)	10.5 (640)	12.5 (766)	12.5 (766)	12.5 (766)
Compression Ratio	——	16:1	16:1	16:1	16:1	17:1
Physical Dimensions:						
Width	mm (in.)	741 (29.2)	808 (31.8)	741 (29.2)	808 (31.8)	808 (31.8)
Height	mm (in.)	1224 (48.2)	1239 (48.8)	1224 (48.2)	1239 (48.8)	1239 (48.8)
Length	mm (in.)	1326 (52.2)	1326 (52.2)	1326 (52.2)	1326 (52.2)	1326 (52.2)
Basic Dry Weight	kg (lb)	1211 (2665)	1200 (2640)	1216 (2675)	1205 (2650)	1205 (2650)

RG,RG34710,7615 –19–30OCT00–1/1

Unified Inch Bolt and Cap Screw Torque Values



Top, SAE Grade and Head Markings; Bottom, SAE Grade and Nut Markings

	Grade 1 (No Mark)		Grade 2[a] (No Mark)		Grade 5, 5.1 or 5.2		Grade 8 or 8.2	
Size	**Lubricated[b] N•m(lb-ft)**	**Dry[c] N•m(lb-ft)**	**Lubricated[b] N•m(lb-ft)**	**Dry[c] N•m(lb-ft)**	**Lubricated[b] N•m(lb-ft)**	**Dry[c] N•m(lb-ft)**	**Lubricated[b] N•m(lb-ft)**	**Dry[c] N•m(lb-ft)**
1/4	3.8 (2.8)	4.7 (3.5)	6 (4.4)	7.5 (5.5)	9.5 (7)	12 (9)	13.5 (10)	17 (12.5)
5/16	7.7 (5.7)	9.8 (7.2)	12 (9)	15.5 (11.5)	19.5 (14.5)	25 (18.5)	28 (20.5)	35 (26)
3/8	13.5 (10)	17.5 (13)	22 (16)	27.5 (20)	35 (26)	44 (32.5)	49 (36)	63 (46)
7/16	22 (16)	28 (20.5)	35 (26)	44 (32.5)	56 (41)	70 (52)	80 (59)	100 (74)
1/2	34 (25)	42 (31)	53 (39)	67 (49)	85 (63)	110 (80)	120 (88)	155 (115)
9/16	48 (35.5)	60 (45)	76 (56)	95 (70)	125 (92)	155 (115)	175 (130)	220 (165)
5/8	67 (49)	85 (63)	105 (77)	135 (100)	170 (125)	215 (160)	240 (175)	305 (225)
3/4	120 (88)	150 (110)	190 (140)	240 (175)	300 (220)	380 (280)	425 (315)	540 (400)
7/8	190 (140)	240 (175)	190 (140)	240 (175)	490 (360)	615 (455)	690 (510)	870 (640)
1	285 (210)	360 (265)	285 (210)	360 (265)	730 (540)	920 (680)	1030 (760)	1300 (960)
1-1/8	400 (300)	510 (375)	400 (300)	510 (375)	910 (670)	1150 (850)	1450 (1075)	1850 (1350)
1-1/4	570 (420)	725 (535)	570 (420)	725 (535)	1280 (945)	1630 (1200)	2050 (1500)	2600 (1920)
1-3/8	750 (550)	950 (700)	750 (550)	950 (700)	1700 (1250)	2140 (1580)	2700 (2000)	3400 (2500)
1-1/2	990 (730)	1250 (930)	990 (730)	1250 (930)	2250 (1650)	2850 (2100)	3600 (2650)	4550 (3350)

[a] Grade 2 applies for hex cap screws (not hex bolts) up to 6 in. (152 mm) long. Grade 1 applies for hex cap screws over 6 in. (152 mm) long, and for all other types of bolts and screws of any length.

[b] "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings.

[c] "Dry" means plain or zinc plated without any lubrication.

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

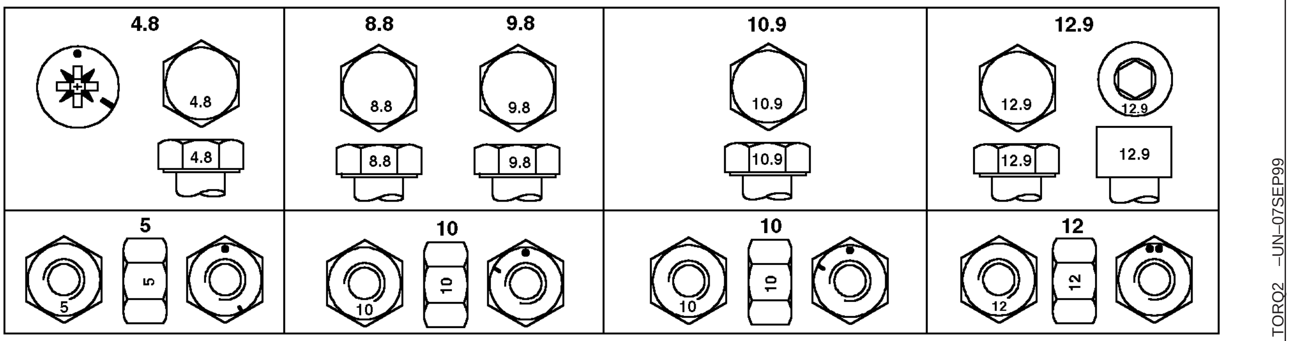
Fasteners should be replaced with the same or higher grade. If higher grade fasteners are used, these should only be tightened to the strength of the original.

Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

DX,TORQ1 –19–01OCT99–1/1

Metric Bolt and Cap Screw Torque Values



Top, Property Class and Head Markings; Bottom, Property Class and Nut Markings

	Class 4.8		Class 8.8 or 9.8		Class 10.9		Class 12.9	
Size	**Lubricated[a] N•m(lb-ft)**	**Dry[b] N•m(lb-ft)**	**Lubricated[a] N•m(lb-ft)**	**Dry[b] N•m(lb-ft)**	**Lubricated[a] N•m(lb-ft)**	**Dry[b] N•m(lb-ft)**	**Lubricated[a] N•m(lb-ft)**	**Dry[b] N•m(lb-ft)**
M6	4.7 (3.5)	6 (4.4)	9 (6.6)	11.5 (8.5)	13 (9.5)	16.5 (12.2)	15.5 (11.5)	19.5 (14.5)
M8	11.5 (8.5)	14.5 (10.7)	22 (16)	28 (20.5)	32 (23.5)	40 (29.5)	37 (27.5)	47 (35)
M10	23 (17)	29 (21)	43 (32)	55 (40)	63 (46)	80 (59)	75 (55)	95 (70)
M12	40 (29.5)	50 (37)	75 (55)	95 (70)	110 (80)	140 (105)	130 (95)	165 (120)
M14	63 (46)	80 (59)	120 (88)	150 (110)	175 (130)	220 (165)	205 (150)	260 (190)
M16	100 (74)	125 (92)	190 (140)	240 (175)	275 (200)	350 (255)	320 (235)	400 (300)
M18	135 (100)	170 (125)	265 (195)	330 (245)	375 (275)	475 (350)	440 (325)	560 (410)
M20	190 (140)	245 (180)	375 (275)	475 (350)	530 (390)	675 (500)	625 (460)	790 (580)
M22	265 (195)	330 (245)	510 (375)	650 (480)	725 (535)	920 (680)	850 (625)	1080 (800)
M24	330 (245)	425 (315)	650 (480)	820 (600)	920 (680)	1150 (850)	1080 (800)	1350 (1000)
M27	490 (360)	625 (460)	950 (700)	1200 (885)	1350 (1000)	1700 (1250)	1580 (1160)	2000 (1475)
M30	660 (490)	850 (625)	1290 (950)	1630 (1200)	1850 (1350)	2300 (1700)	2140 (1580)	2700 (2000)
M33	900 (665)	1150 (850)	1750 (1300)	2200 (1625)	2500 (1850)	3150 (2325)	2900 (2150)	3700 (2730)
M36	1150 (850)	1450 (1075)	2250 (1650)	2850 (2100)	3200 (2350)	4050 (3000)	3750 (2770)	4750 (3500)

[a] *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings.*

[b] *"Dry" means plain or zinc plated without any lubrication.*

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical property class.

Fasteners should be replaced with the same or higher property class. If higher property class fasteners are used, these should only be tightened to the strength of the original.

Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

Engine Rebuild Guide, Break-In and Tune-Up (Group 010) Specifications

Item	Measurement	Specification
Engine Adapter-to-Repair Stand Cap Screws	Torque	135 N•m (100 lb-ft)
Engine Lift Strap Cap Screws	Torque	90 N•m (66 lb-ft)
Engine-to-Stand Adapter Cap Screws	Torque	400 N•m (300 lb-ft)

OUO1082,0000252 –19–19SEP02–1/1

Cylinder Head and Valves (Group 020) Specifications

Item	Measurement	Specification
Rocker Arm Cover Hold-Down Cap Screws[1]	Torque	30 N•m (22 lb-ft)
Crankcase Vent Baffle-to-Rocker Arm Cover Cap Screws	Torque	15 N•m (11 lb-ft) (133 lb-in.)
Valve Stem-to-Bridge Clearance (Engine Cold)		
Intake Valve	Clearance	0.58 ± 0.05 mm (0.023 ± 0.002 in.)
Exhaust Valve	Clearance	1.08 ± 0.05 mm (0.043 ± 0.002 in.)
Intake and Exhaust Valve Adjusting Screw Lock Nuts	Torque	50 N•m (37 lb-ft)
Electronic Unit Injector	Preload	0.00 mm (in.) clearance plus 1/2 turn in (180°)
Electronic Unit Injector Adjusting Screw Lock Nuts	Torque	65 N•m (48 lb-ft)
Timing Pin Plug (Below Oil Cooler)	Torque	33 N•m (24 lb-ft)
Rocker Arm Bushing	ID	38.064 ± 0.013 mm (1.4986 ± 0.0005 in.)
Rocker Arm Shaft	OD	38.000 ± 0.013 mm (1.4961 ± 0.0005 in.)
Rocker Arm Shaft-to-Bushing	Oil Clearance	0.064 ± 0.026 mm (0.0025 ± 0.0010 in.)
Rocker Arm Shaft Intake and Exhaust Roller	OD	39.995—40.045 mm (1.5746—1.5766 in.)
Rocker Arm Shaft Unit Injector Roller	OD	37.995—38.045 mm (1.4959—1.4978 in.)
Intake and Exhaust Valves	Recess	1.85—2.35 mm (0.073—0.093 in.)

[1] *Tighten center cap screw first, then tighten sides.*

Continued on next page

OUO1004,0000BC6 –19–19SEP02–1/4

Item	Measurement	Specification
Intake and Exhaust Valve Springs (All)[2]	Height at 0 N (0 lb-force) Free Length	67.9—72.1 mm (2.67—2.84 in.)
Intake and Exhaust Valve Springs (R116585)	Height at 352—396 N (79—89 lb-force) (Valve Closed)	59.4 mm (2.34 in.)
Intake and Exhaust Valve Springs (R116585)	Height at 845—935 N (190-210 lb-force) (Valve Open)	45.5 mm (1.79 in.)
Intake and Exhaust Valve Springs (R133891)	Height at 527—593 N (118—133 lb-force) (Valve Closed)	59.4 mm (2.34 in.)
Intake and Exhaust Valve Springs (R133891)	Height at 1187—1313 N (267—295 lb-force) (Valve Open)	46.4 mm (1.83 in.)
Intake and Exhaust Valve Stems	OD	8.999 ± 0.013 mm (0.3543 ± 0.0005 in.)
Intake and Exhaust Valve Face[3]	Maximum Runout	0.038 mm (0.0015 in.)
Intake and Exhaust Valve Head	OD	46.35—46.61 mm (1.825—1.835 in.)
Intake and Exhaust Valve Face	Angle	29.25° ± 0.25°
Cylinder Head	Maximum Acceptable Out-of-Flat for Entire Length of Head	0.10 mm (0.004 in.)
	Maximum Acceptable Out-of-Flat for Every 305 mm (12.0 in.)	0.025 mm (0.0009 in.)
Cylinder Head (Rocker Arm Cover-to-Combustion Face)	New Part Thickness	124.975—125.025 mm (4.9203—4.9222 in.)
	Minimum Acceptable Thickness	124.840 mm (4.9150 in.)
Cylinder Head (Rocker Arm Cavity-to-Combustion Face)	Minimum Overall Thickness	124.840 mm (4.9150 in.)
Cylinder Head Combustion Face Surface Finish (Surface Mill Only) (AA)	Surface Finish	1.5—2.8 micrometers (60—110 micro-in.)

[2] *Free length of springs may vary slightly between springs.*

[3] *Maximum runout measured at 44 mm (1.73 in.) diameter.*

Continued on next page

OUO1004,0000BC6 –19–19SEP02–2/4

Item	Measurement	Specification
Cylinder Head	Maximum Wave Height Maximum Wave Width	0.008 micrometers (0.0002 micro-in.) 2.0 micrometers (79 micro-in.)
Valve Guide	ID	9.102 ± 0.013 mm (0.3583 ± 0.0005 in.)
Valve Stem	OD	8.999 ± 0.013 mm (0.3543 ± 0.0005 in.)
Valve Stem-to-Guide	Clearance	0.077—0.129 mm (0.0030—0.0050 in.)
Valve Guide Bore in Head	ID	14.94 ± 0.02 mm (0.5882 ± 0.0008 in.)
Valve Guide	Installed Height	14.5—15.5 mm (0.57—0.61 in.)
Valve Seat Grinding	Contact Angle Width Maximum Runout	30° 1.50—2.00 mm (0.059—0.079 in.) 0.16 mm (0.006 in.)
Intake and Exhaust Valve Seat Bore	ID Bore Depth Radius at Lower Bore	49.424 ± 0.013 mm (1.9458 ± 0.0005 in.) 11.25 mm (0.443 in.) 0.64 ± 0.25 mm (0.025 ± 0.001 in.)
Standard Intake and Exhaust Valve Seat	OD	49.487—49.513 mm (1.9483—1.9493 in.)
Fuel Temperature Sensor	Torque	10 N•m (7.5 lb-ft)
Fuel Lines	Torque	24 N•m (18 lb-ft)
Cylinder Liner	Height Above Block (Standout)	0.030—0.117 mm (0.0012—0.0046 in.)
Cylinder Liner	Max. Height Difference at Nearest Point of Two Adjacent Liners or Within One Liner	0.051 mm (0.0020 in.)
Cylinder Head[4]		
Step 1—No. 17 Cap Screw	Initial Torque	100 N•m (74 lb-ft)

[4] *See INSTALL CYLINDER HEAD later in this group for proper torque sequence.*

Continued on next page

OUO1004,0000BC6 –19–19SEP02–3/4

Item	Measurement	Specification
Step 2—All Cap Screws (Nos. 1—26)	Initial Torque	163 N•m (120 lb-ft)
Step 3—Wait 5 Minutes and Verify All Cap Screws (Nos. 1—26)	Torque	163 N•m (120 lb-ft)
Step 4—All Cap Screws (Nos. 1—26)	Initial Torque-Turn	90°
Step 5—All Cap Screws (Nos. 1—26)[5]	Final Torque-Turn	90°
Rocker Arm Shaft Hold-Down Clamp Cap Screws (All Engines)	Initial Torque	30 N•m (22 lb-ft)
Rocker Arm Shaft Hold-Down Clamp Cap Screws (Dual Rail Fuel System)	Final Torque-Turn	60° ± 5°
Rocker Arm Shaft Hold-Down Clamp Cap Screws (Single Rail Fuel System)	Final Torque-Turn	90° + 10° — 0°
Unit Injector Wiring Harness Bracket-to-Rear of Head	Torque	25 N•m (18 lb-ft)
Unit Injector Wiring Harness Solenoid Wire Retaining Nut[6]	Torque	3.0 N•m (27 lb-in.)
Unit Injector Harness Clips-to-Rocker Arm Shaft Clamps	Torque	35 N•m (26 lb-ft)

[5]Total torque-turn for steps 4 and 5 is 180°.

[6]Apply LOCTITE 222 (TY24311) Thread Lock and Sealer (Low Strength) to nut only.

OUO1004,0000BC6 –19–19SEP02–4/4

Cylinder Block, Liners, Pistons and Rods (Group 030) Specifications

Item	Measurement	Specification
Front Plate-to-Cylinder Block Cap Screws	Torque	50 N•m (37 lb-ft)
Crankshaft Timing Pin Plug	Torque	33 N•m (24 lb-ft)
Cylinder Liner Cap Screws (For Checking Liner Standout)	Torque	68 N•m (50 lb-ft)
Cylinder Liner Height (Standout)	Height Above Block	0.030—0.117 mm (0.0012—0.0046 in.)
	Maximum Permissible Height Difference at Nearest Point of Two Adjacent Liners or Within One Liner	0.05 mm (0.002 in.)
Cylinder Liner Shims Available	Thickness	0.05 mm (0.002 in.)
	Thickness	0.10 mm (0.004 in.)
Cylinder Liner Wall	Thickness	9.39—9.43 mm (0.370—0.371 in.)
Cylinder Liner Packing Step	Dimension	2.14—2.30 mm (0.084—0.090 in.)
Cylinder Liners		
Flange Area	OD	151.565—151.615 mm (5.9671—5.9691 in.)
Upper OD for Seating Liner	OD	145.795—145.845 mm (5.7400—5.7419 in.)
Water Jacket Area	OD	144.73—144.99 mm (5.698—5.708 in.)
Lower OD for Seating with O-Rings	OD	140.397—140.447 mm (5.5274—5.5294 in.)
No. 1 Piston Compression Ring (4-mm Rings)	End Gap	0.43—0.69 mm (0.017—0.027 in.)
No. 2 Piston Compression Ring (4-mm Rings)	End Gap	1.01—1.27 mm (0.040—0.050 in.)

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Item	Measurement	Specification
No. 1 Piston Compression Ring (3-mm Rings)	End Gap	0.48—0.74 mm (0.019—0.029 in.)
No. 2 Piston Compression Ring (3-mm Rings)	End Gap	1.35—1.65 mm (0.053—0.065 in.)
Oil Control Ring-to-Groove (RE52836, RE504801, RE66125 Pistons)	Clearance	0.064—0.114 mm (0.0025—0.0045 in.)
	Maximum Clearance	0.165 mm (0.0065 in.)
Oil Control Ring-to-Groove (RE504343, RE503969 and RE505901 Pistons)	Clearance	0.041—0.091 mm (0.0016—0.0036 in.)
	Maximum Clearance	0.132 mm (0.0052 in.)
Piston Pin	OD	50.772—50.787 mm (1.9989—1.9995 in.)
Piston Pin Bore in Piston (6105)	ID	50.795—50.805 mm (1.9998—2.0002 in.)
Piston Skirt Bushing (6125)	ID	50.798—50.808 mm (1.9999—2.0003 in.)
Piston Crown Bushing (6125)	ID	50.810—50.825 mm (2.0004—2.0010 in.)
Piston Skirt (6105)	OD 29.97 mm (1.180 in.) from Bottom of Piston	126.872—126.898 mm (4.9950—4.9960 in.)
Piston Skirt (6125)	OD 35.0 mm (1.380 in.) from Bottom of Skirt	126.910—126.930 mm (4.9965—4.9972 in.)
Cylinder Liner	ID	126.990—127.010 mm (4.9996—5.0004 in.)
	Max. Out of Round	0.020 mm (0.0008 in.)
	Max. Wear or Taper (Ring Travel Area)	0.030 mm (0.0012 in.)
Piston-to-Liner Clearance (New Part 6105)	Clearance	0.092—0.138 mm (0.0036—0.0054 in.)
	Max. Acceptable Wear	0.152 mm (0.0060 in.)
Piston-to-Liner Clearance (New Part 6125)	Clearance	0.060—0.100 mm (0.0024—0.0039 in.)
	Max. Acceptable Wear	0.152 mm (0.0060 in.)

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OUO1004,0000BCF –19–02NOV00–2/5

Item	Measurement	Specification
Cylinder Liner Flange	Thickness	9.525—9.575 mm (0.3750—0.3770 in.)
Tongue-and-Groove Connecting Rod Cap Screw	Initial Torque	27 N•m (20 lb-ft)
Tongue-and-Groove Connecting Rod Cap Screw	Final Torque	75 N•m (55 lb-ft) plus 90—100° turn clockwise
PRECISION JOINT™ Connecting Rod Cap Screw	Torque	140 N•m (103 lb-ft) plus 90—100° turn clockwise
Crankshaft Rod Journal	OD	88.844—88.874 mm (3.4980—3.4990 in.)
Connecting Rod Bearing for Crankshaft Journal (Assembled)	ID	88.93—88.98 mm (3.501—3.502 in.)
Connecting Rod Bearing-to-Journal (New Part)	Oil Clearance Max. Oil Clearance	0.06—0.13 mm (0.002—0.005 in.) 0.15 mm (0.006 in.)
Connecting Rod Bore (For Crankshaft Journal Bearing)	ID	93.76—93.79 mm (3.6915—3.6925 in.)
Connecting Rod Centerline of Piston Pin Bore-to-Crankshaft Bore (New Part)	Dimension	263.95—264.05 mm (10.392—10.396 in.)
Rod Pin Bore Without Bushing	ID	55.529—55.555 mm (2.1862—2.1872 in.)
Installed Rod Pin Bushing (Before Boring)	ID	50.729—50.781 mm (1.9972—1.9992 in.)
Installed Rod Pin Bushing (After Boring)	ID	50.805—50.830 mm (2.0002—2.0012 in.)
Piston Pin Bushing Bore	Out-of-Round	0.038 mm (0.0015 in.)
Piston Pin-to-Bushing	Oil Clearance Max. Acceptable Wear	0.017—0.059 mm (0.0007—0.0023 in.) 0.076 mm (0.0030 in.)
Press Fit of Bushing in Rod Pin Bore	Press Fit	0.100—0.163 mm (0.0039—0.0064 in.)

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OUO1004,0000BCF –19–02NOV00–3/5

Item	Measurement	Specification
Connecting Rod Pin Bushing Bore (Without Bushing)	ID	55.529—55.555 mm (2.1862—2.1872 in.)
Connecting Rod Pin Bushing	Press Fit in Rod Pin Bore	0.100—0.163 mm (0.0039—0.0064 in.)
Piston Pin Bushing (After Boring)	ID	50.805—50.830 mm (2.0002—2.0012 in.)
Piston Pin	OD	50.772—50.787 mm (1.9989—1.9995 in.)
Piston Pin-to-Bushing	Clearance	0.017—0.059 mm (0.0007—0.0023 in.)
Cylinder Liner Flange Counterbore	Depth in Block	9.461—9.512 mm (0.3725—0.3745 in.)
Cylinder Liner Flange	Thickness	9.525—9.575 mm (0.3750—0.3770 in.)
Main and Thrust Bearings	Assembled ID Without Bearings	133.097—133.123 mm (5.2400—5.2410 in.)
	Main Bearing Surface Width	37.77—38.03 mm (1.487—1.497 in.)
	Thrust Bearing Surface Width (No. 5 Main)	37.51—38.29 mm (1.476—1.507 in.)
	Overall Thrust Bearing Cap Width	43.25—43.75 mm (1.703—1.722 in.)
Cylinder Block Top Deck Surface Finish	Surface Finish (Surface Mill Only)	3.2 micrometers (125 micro-in.)
	Max. Wave Height	0.008 micrometers (0.0002 micro-in.)
	Max. Wave Depth	2.0 micrometers (79 micro-in.)
Main Bearing Bore Centerline-to-Top Deck	Minimum Distance	429.92—430.07 mm (16.926—16.932 in.)
Cylinder Block Bore for Seating Liner		
Liner Flange Counterbore	ID	153.57—153.77 mm (6.046—6.054 in.)
Upper Block Bore for Seating Liner	ID	145.845—145.895 mm (5.7419—5.7439 in.)
Lower Block Bore for Seating Liner	ID	140.465—140.515 mm (5.5301—5.5321 in.)

Continued on next page OUO1004,0000BCF –19–02NOV00–4/5

Item	Measurement	Specification
Cylinder Liner Standout	Height Above Block	0.030—0.117 mm (0.0012—0.0046 in.)
Cylinder Liner Shims Available	Thickness Thickness	0.05 mm (0.002 in.) 0.10 mm (0.004 in.)
Piston (Early Engines)	Protrusion Above Block Deck	0.229—0.787 mm (0.009—0.031 in.)
Piston (RE505901) (Later 12.5 L Engines)	Protrusion Above Block Deck	0.079—0.637 mm (0.003—0.025 in.)
Piston Spray Jet Cap Screws	Torque	15 N•m (11 lb-ft)
Oil Gallery Plug	Torque	20 N•m (15 lb-ft)
Main Oil Gallery (Front) Expansion Plug	Installed Depth	Flush—1.5 mm (0.059 in.) Below Surface

OUO1004,0000BCF –19–02NOV00–5/5

Crankshaft, Main Bearings and Flywheel (Group 040) Specifications

Item	Measurement	Specification
Vibration Damper	Maximum Radial Runout	0.76 mm (0.030 in.)
Crankshaft	End Play	0.038—0.380 mm (0.0015—0.0150 in.)
SAE 1 Flywheel Housing	Maximum Face Deviation Maximum Bore Eccentricity	0.30 mm (0.012 in.) 0.30 mm (0.012 in.)
SAE 2 Flywheel Housing	Maximum Face Deviation Maximum Bore Eccentricity	0.28 mm (0.011 in.) 0.28 mm (0.011 in.)
SAE 0 Flywheel Housing	Maximum Face Deviation Maximum Bore Eccentricity	0.41 mm (0.016 in.) 0.41 mm (0.016 in.)
Flywheel Face Flatness	Maximum Variation Maximum Variation per 25 mm (1.0 in.) of Travel	0.23 mm (0.009 in.) 0.013 mm (0.0005 in.)
Flywheel Housing-to-Cylinder Block Cap Screws (SAE 1 With Rear PTO)	Torque	325 N•m (240 lb-ft)
Flywheel Housing-to-Cylinder Block Cap Screws (SAE 0, 1 and 2 Without Rear PTO)	Torque	365 N•m (270 lb-ft)
Flywheel Housing Front Plate Cap Screws	Torque	50 N•m (37 lb-ft)
Flywheel Housing Timing Hole Cover Cap Screws	Torque	5 N•m (44 lb-in.)
Starter Motor Cap Screws	Torque	125 N•m (92 lb-ft)
Flywheel-to-Crankshaft Cap Screws	Torque	170 N•m (125 lb-ft)
Crankshaft Main Bearings	Main Bearing-to-Journal Clearance Maximum Acceptable Oil Clearance	0.046—0.122 mm (0.0018—0.0048 in.) 0.152 mm (0.0060 in.)
Crankshaft Main Bearing	ID With Bearing ID Without Bearing	125.071—125.127 mm (4.9241—4.9263 in.) 133.097—133.123 mm (5.2400—5.2411 in.)

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OUO1004,0000BD3 –19–19SEP02–1/3

Item	Measurement	Specification
Crankshaft Main Bearing Journal	OD	124.983—125.017 mm (4.9206—4.9219 in.)
Crankshaft Main Journal	Max. Out-of-Round	0.025 mm (0.0010 in.)
	Max. Taper per 25.4 mm (1.0 in.) of Journal Length	0.0025 mm (0.0001 in.)
Main Bearing Cap Bore Specifications	ID Without Bearings	133.097—133.123 mm (5.2400—5.2411 in.)
	Max. Bore Diameter Variation	0.013 mm (0.0005 in.)
	Max. Bore Diameter Taper	0.005 mm (0.0002 in.)
	Max. Straightness (Any Bore-to-Adjacent Bore)	0.038 mm (0.0015 in.)
	Max. Straightness (5 Center Bores-to-Adjacent Bore)	0.076 mm (0.0030 in.)
	Centerline of Bore-to-Top Deck	429.92—430.07 mm (16.926—16.932 in.)
Crankshaft Main Bearing Cap	Surface Width	39.75—40.25 mm (1.565—1.585 in.)
Crankshaft Main Bearings Available	Undersize	0.25, 0.50 mm (0.010, 0.020 in.)
Oversize Thrust Washers Available	Thickness	0.18 mm (0.007 in.)
Thrust Bearing New Part Specifications	Thrust Washer Clearance Base Circle	162.24—163.76 mm (6.387—6.447 in.)
	Thrust Surface Width	42.05—42.12 mm (1.656—1.658 in.)
	Relief Angle	45°
	Bearing Cap Overall Width	43.46 mm (1.711 in.)
	Thrust Surface Maximum Runout	0.025 mm (0.0010 in.)
Crankshaft Main Bearing Cap Screws	Initial Torque	68 N•m (50 lb-ft)
Crankshaft Main Bearing Cap Screws	Final Torque	320 N•m (236 lb-ft)
Rear Oil Seal Housing Cap Screws	Torque	25 N•m (18 lb-ft)
Rear Oil Seal-to-Housing Cap Screws	Torque	15 N•m (11 lb-ft)

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OUO1004,0000BD3 –19–19SEP02–2/3

Item	Measurement	Specification
Timing Gear Cover Cap Screws (Early Engines Only)[1]	Initial Torque	45 N•m (33 lb-ft)
Timing Gear Cover Cap Screws	Final Torque	63 N•m (46 lb-ft)
Camshaft Gear Access Cover Cap Screws (Early Engines Only)[1]	Initial Torque	50 N•m (37 lb-ft)
Camshaft Gear Access Cover Cap Screws	Final Torque	68 N•m (50 lb-ft)
Adjustable Fan Drive Assembly Mounting Cap Screws	Torque	90 N•m (66 lb-ft)
Damper Hub Cap Screws	Torque	125 N•m (92 lb-ft)
Pulley-to-Damper Cap Screws	Torque	125 N•m (92 lb-ft)
Front Oil Seal Cap Screws	Torque	15 N•m (11 lb-ft)

[1] Initial torque is required only on early timing gear covers using Fel-Pro gaskets with sealant.

OUO1004,0000BD3 –19–19SEP02–3/3

Camshaft and Timing Gear Train (Group 050) Specifications

Item	Measurement	Specification
Camshaft Gear Retainer Plate-to-Camshaft	Initial Torque Second Torque Final Retorque	100 N•m (74 lb-ft) 150 N•m (110 lb-ft) 150 N•m (110 lb-ft)
Camshaft Gear-to-Upper Idler Gear	Backlash	0.13 mm (0.005 in.)
Oil Pump Gear-to-Upper Idler Gear	Backlash	0.25 mm (0.010 in.)
Upper Idler Gear Bearing Cup-to-Block	Torque	85 N•m (63 lb-ft)
Upper Idler Gear Thrust Plate Cap Screws	Initial Torque	35 N•m (26 lb-ft)
Upper Idler Gear Thrust Plate Cap Screws	Final Torque	35 N•m (26 lb-ft)
Camshaft and Supply Pump Drive Coupler Set Screw	Torque	4 N•m (3 lb-ft)
Fuel Supply Pump-to-Cylinder Head	Torque	50 N•m (37 lb-ft)
Camshaft Thrust Ring-to-Head	Torque	35 N•m (26 lb-ft)
Camshaft Position Sensor	Torque	14 N•m (10 lb-ft)
Camshaft Journal	OD	101.987—102.013 mm (4.0152—4.0162 in.)
Camshaft Bushing	ID	102.091—102.167 mm (4.0193—4.0223 in.)
Camshaft Journal-to-Bushing	Oil Clearance	0.078—0.180 mm (0.0031—0.0071 in.)
Camshaft Bushing	Bore in Head	105.987—106.013 mm (4.1727—4.1737 in.)
Camshaft Lobe:		
Intake Lobe	Lift	8.73—8.99 mm (0.343—0.353 in.)
Exhaust Lobe	Lift	7.93—8.19 mm (0.312—0.322 in.)

Continued on next page OUO1004,0000BD7 –19–02NOV00–1/2

Item	Measurement	Specification
EUI Lobe 10.5 L Engines and 12.5 L Engine (—29999)	Lift	14.16—14.42 mm (0.557—0.567 in.)
EUI Lobe 12.5 L Engine S.N. (30000—)	Lift	16.09—16.35 mm (0.633—0.643 in.)
SAE “A” Front Auxiliary Drive Adapter Housing Nuts	Torque	50 N•m (37 lb-ft)
SAE “A” Front Auxiliary Drive Idler Gear Support Bushing	Torque	220 N•m (162 lb-ft)
SAE “B” Rear Auxiliary Drive Adapter	Torque	110 N•m (81 lb-ft)
SAE “B” Rear Auxiliary Drive Adapter	Torque	110 N•m (81 lb-ft)
SAE “A” Front Auxiliary Drive Adapter Housing Nuts	Torque	50 N•m (37 lb-ft)

OUO1004,0000BD7 –19–02NOV00–2/2

Lubrication System (Group 060) Specifications

Item	Measurement	Specification
New Oil Pressure Regulating Valve Spring	Free Length Working Load at 76—84 N (17—19 lb-force)	86.4 mm (3.40 in.) 42.0 mm (1.65 in.)
Oil Pressure Regulating Valve Plug	Torque	100 N•m (74 lb-ft)
New Oil Cooler Bypass Valve Spring	Free Length Working Load @ 64—78 N (14—18 lb-force)	44.0 mm (1.73 in.) 30.0 mm (1.18 in.)
New Oil Filter Bypass Valve Spring	Free Length Working Load @ 64—78 N (14—18 lb-force)	44.0 mm (1.73 in.) 30.0 mm (1.18 in.)
Oil Cooler Bypass Valve Plug	Torque	100 N•m (74 lb-ft)
Oil Filter Bypass Valve Plug	Torque	100 N•m (74 lb-ft)
Oil Pressure Relief Valve Spring	Free Length Working Load @ 196—222 N (44—50 lb-force)	79.0 mm (3.11 in.) 65.0 mm (2.56 in.)
Oil Cooler	Test Pressure	140—170 kPa (1.4—1.7 bar) (20—25 psi)
Oil Cooler-to-Housing Nuts	Torque	50 N•m (37 lb-ft)
Oil Cooler Drain Cock Handle	Torque	3 N•m (25 lb-in.)
Oil Cooler Expansion Plug	Installed Depth	Flush to 1.5 mm (0.059 in.) Below Surface
Oil Cooler Housing-to-Block Cap Screws	Torque	68 N•m (50 lb-ft)
Oil Cooler Housing-to-Block Cap Screws	Retorque	68 N•m (50 lb-ft)
Oil Filter/Valve Housing or Oil Cooler Cover/Valve Housing[1]	Torque	68 N•m (50 lb-ft)

[1] *Torque sequence and specification also applies to oil cooler cover/valve housing on remote filter applications.*

Continued on next page

Item	Measurement	Specification
Remote Filter Inlet Hose or Line	Torque	190 N•m (140 lb-ft)
Remote Filter Outlet Hose or Line	Torque	142 N•m (105 lb-ft)
Turbocharger Oil Inlet Line-to-Oil Cooler Housing	Torque	35 N•m (26 lb-ft)
Oil Pump Drive Gear Bushing	ID	135.70—135.80 mm (5.343—5.346 in.)
Oil Pump-to-Block Cap Screws	Initial Torque	20 N•m (177 lb-in.)
Oil Pump-to-Block Cap Screws	Torque Turn	90° (1/4 Turn)
Oil Pump Drive Gear-to-Idler Gear	Backlash	0.25 mm (0.010 in.)
Oil Pickup Tube-to-Block Cap Screws	Torque	35 N•m (26 lb-ft)
Oil Pickup Tube-to-Oil Pan Cap Screws	Torque	25 N•m (18 lb-ft)
Oil Pan-to-Cylinder Block Cap Screws	Torque	25 N•m (18.5 lb-ft) plus 90° Turn Clockwise
Oil Pan-to-Rear Oil Seal Housing Cap Screws	Torque	25 N•m (18.5 lb-ft) plus 90° Turn Clockwise
Oil Pan-to-Timing Gear Cover Cap Screws	Torque	25 N•m (18.5 lb-ft) plus 90° Turn Clockwise
Oil Pan Drain Plug 1-1/4 in. Hex Plug	Torque	46 N•m (34 lb-ft)
Oil Pan Drain Plug 1-1/2 in. Hex Plug	Torque	64 N•m (47 lb-ft)

OUO1022,000000A –19–19SEP02–2/2

Cooling System (Group 070) Specifications

Item	Measurement	Specification
Heavy Duty Fan Drive	Housing ID	71.999—72.025 mm (2.8346—2.8356 in.)
	Shaft OD	35.001—35.017 mm (1.3780—1.3786 in.)
	Bearing ID	34.987—35.013 mm (1.3774—1.3785 in.)
	Bearing OD	71.987—72.013 mm (2.8341—2.8351 in.)
Fan Drive Shaft	End Play	0.10 mm (0.004 in.)
Fan Drive Hub-to-Shaft	Torque	75 N•m (56 lb-ft)
Fan Pulley-to-Pulley Cap Screws	Torque	61 N•m (45 lb-ft)
Adjustable Fan Drive-to-Camshaft Gear Access Cover Cap Screws	Torque	90 N•m (66 lb-ft)
Belt Tensioner Lower Spring	Tension	81—99 N•m (60—73 lb-ft)
Belt Tensioner Upper Spring	Tension	18—23 N•m (13—17 lb-ft)
Belt Tensioner Shoulder Bolt or Flanged Head Cap Screw	Torque	50 N•m (37 lb-ft)
Fan Belt Idler Pulley	Torque	68 N•m (50 lb-ft)
Coolant Pump Housing-to-Cover Band Clamp	Torque	10 N•m (7.5 lb-ft)
Coolant Pump-to-Front Plate Cap Screws	Torque	50 N•m (37 lb-ft)
Coolant Pump Inlet Elbow to Housing Cap Screws	Torque	41 N•m (30 lb-ft)
Coolant Bypass Hose Clamp	Torque	6 N•m (4.5 lb-ft)
Oil Cooler-to-Coolant Pump Hose Clamp	Torque	9 N•m (7 lb-ft)
Thermostat Cover-to-Housing M10 x 35 Cap Screw	Torque	35 N•m (26 lb-ft)

Continued on next page

Item	Measurement	Specification
Thermostat Cover/Housing Assembly-to-Block Cap Screws	Torque	50 N•m (37 lb-ft)
Thermostat Test	Rating Initial Opening (Range) Temperature Full Open (Nominal) Temperature	82°C (180°F) 80—84°C (175—182°F) 94°C (202°F)
Coolant Temperature Sensor	Torque	10 N•m (7.5 lb-ft)
Thermostat Housing Pipe Plugs	Torque	20 N•m (15 lb-ft)

OUO1022,000000D –19–26OCT00–2/2

Air Intake and Exhaust System (Group 080) Specifications

Item	Measurement	Specification
Garrett Turbocharger Shaft	Radial Bearing Clearance (Allowable Movement)	0.076—0.165 mm (0.003—0.0065 in.) (measured on center of shaft)
Borg Warner Turbocharger Shaft	Radial Bearing Clearance (Allowable Movement)	0.56—0.81 mm (0.022—0.0.032 in.) (measured on end of shaft)
Garrett Turbocharger Axial Bearing	End Play	0.025—0.114 mm (0.0010—0.0045 in.)
Borg Warner Turbocharger Axial Bearing	End Play	0.0635—0.1143 mm (0.0025—0.0045 in.)
Turbocharger-to-Exhaust Manifold	Torque	50 N•m (37 lb-ft)
Turbocharger Oil Inlet Fitting	Torque	50 N•m (37 lb-ft)
Turbocharger Oil Return Pipe-to-Turbocharger	Torque	50 N•m (37 lb-ft)
Turbocharger Oil Inlet Line (Both Ends)	Torque	35 N•m (26 lb-ft)
Exhaust Manifold-to-Head Cap Screws	Torque	70 N•m (52 lb-ft)
Intake Manifold-to-Cylinder Head Cap Screws	Torque	35 N•m (26 lb-ft)
Aftercooler-to-Cylinder Head Cap Screws	Torque	35 N•m (26 lb-ft)
Aftercooler Tube Clamp Cap Screw (or Cap Screw with Nut)	Torque	50 N•m (37 lb-ft)
Aftercooler	Test Pressure	140—170 kPa (1.4—1.7 bar) (20—25 psi)

OUO1004,0000BDA –19–03NOV00–1/1

Starting and Charging Systems (Group 100) Specifications

Item	Measurement	Specification
Alternator Strap Mounting Hardware		
M8 Cap Screw	Torque	25 N•m (18 lb-ft)
M10 Cap Screw	Torque	50 N•m (37 lb-ft)
1/2 in. Cap Screw	Torque	61 N•m (45 lb-ft)
Alternator Foot Mounting Hardware		
M10 Cap Screw	Torque	70 N•m (52 lb-ft)
M12 Cap Screw	Torque	60 N•m (44 lb-ft)
Starter Motor Mounting Hardware	Torque	125 N•m (92 lb-ft)

DPSG,OUO1004,959 –19–29JUL99–1/1

Observable Diagnostics and Test Specifications

Item	Measurement	Specification
Engine Oil	Minimum Pressure at No Load (Idle) Maximum Pressure at Full Load (Rated Speed)	138 kPa (1.38 bar) (20 psi) 310 kPa (3.1 bar) (45 psi)
Intake Manifold	Test Pressure	13.8—20.8 kPa (0.13—0.21 bar) (2—3 psi)
Crankshaft Position Sensor	Torque	14 N•m (10 lb-ft)

OUO1004,0000C20 –19–27NOV00–1/1

Dynamometer Test Specifications (OEM Engines)

INDUSTRIAL ENGINE APPLICATIONS					
ENGINE MODEL	FUEL SYSTEM OPTION CODES	INTERMITTENT POWER RATING @ RATED SPEED WITHOUT FAN kW (hp)	RATED SPEED (rpm)	SLOW IDLE (rpm)	FAST IDLE (rpm)
6105AF	1601, 1602, 1603, 1604	224 (300)	2100	850	2225
6105HF	1609, 1610, 1620, 1621	242 (325)	2100	850	2225
	1601, 1602, 1611, 1612	261 (350)	2100	850	2225
6125AF	1610, 1620, 1631, 1641, 1642	242 (325)	2100	850	2225
	1601, 1611, 1622, 1632	261 (350)	2100	850	2225
	1602, 1612, 1623, 1633	280 (375)	2100	850	2225
	1603, 1613, 1624, 1634	298 (400)	2100	850	2225
6125HF (—29999)	1601, 1611, 1621, 1631	317 (425)	2100	850	2225
	1602, 1612, 1622, 1632	336 (450)	2100	850	2225
	1603, 1613, 1623, 1633	354 (475)	2100	850	2225
	1604, 1614, 1624, 1634	373 (500)	2100	850	2225
6125HF (30000—)	16A1, 16A2, 16A3, 16A4	224 (300)	2100	900	2225
	16B1, 16B2, 16B3, 16B4	242 (325)	2100	900	2225
	16C1, 16C2, 16C3, 16C4	261 (350)	2100	900	2225
	16D1, 16D2, 16D3, 16D4	280 (375)	2100	900	2225
	16E1, 16E2, 16E3, 16E4	298 (400)	2100	900	2225
	16F1, 16F2, 16F3, 16F4	317 (425)	2100	900	2225
	16G1, 16G2, 16G3, 16G4	336 (450)	2100	900	2225
	16H1, 16H2, 16H3, 16H4	354 (475)	2100	900	2225
	16J1, 16J2, 16J3, 16J4	373 (500)	2100	900	2225
	16L1, 16L2, 16L3, 16L4	410 (550)	2100		
6125AFM (Marine)	M1	254 (340)	1800	650	1950
	M2	280 (375)	1900	650	2225
	M3	298 (400)	2000	650	2225
	M4, 1601, 1602	336 (450)	2100	650	2225

Continued on next page DPSG,OUO1004,924 –19–13SEP02–1/2

GENERATOR SET (STANDBY) APPLICATIONS					
ENGINE MODEL	FUEL SYSTEM OPTION CODES	STANDBY POWER RATING @ RATED SPEED WITHOUT FAN kW (hp)	RATED SPEED (rpm)	SLOW IDLE (rpm)	FAST IDLE (rpm)
6125AF	1607, 1617, 1628, 1638	233 (312)	1500	900	1550
	1608, 1618, 1629, 1639	254 (341)	1500	900	1550
	1609, 1619, 1630, 1640	277 (371)	1500	900	1550
	1604, 1614, 1625, 1635	280 (375)	1800	900	1850
	1605, 1615, 1626, 1636	300 (402)	1800	900	1850
	1606, 1616, 1627, 1637	330 (442)	1800	900	1850
6125HF (—29999)	1607, 1617, 1627, 1637	302 (405)	1500	900	1550
	1608, 1618, 1628, 1638	352 (472)	1500	900	1550
	1606, 1616, 1626, 1636	360 (483)	1800	900	1850
	1605, 1615, 1625, 1635	420 (563)	1800	900	1850
	1639, 1640, 1641, 1642	460 (616)	1800	900	1850
6125HF (30000—)	164J, 164K, 164L, 164M	300 (402)	1500	900	1550
	163A, 163B, 163C, 163D	330 (442)	1800	900	1850
	165J, 165K, 165L, 165M	350 (469)	1500	900	1550
	164A, 164B, 164C, 164D	360 (483)	1800	900	1850
	166J, 166K, 166L, 166M	387 (519)	1500	900	1550
	165A, 165B, 165C, 165D	420 (563)	1800	900	1850
	166A, 166B, 166C, 166D	460 (617)	1800	900	1850

OEM MARINE APPLICATIONS					
Engine Model	Fuel System Option Codes	Prime Power Rating kW (hp)	Rated Speed (rpm)	Slow Idle (rpm)	Fast Idle rpm
6125AFM	1606, 1616	300 (402)	1800	900	1850
	1609, 1619	252 (338)	1500	900	1550

DPSG,OUO1004,924 –19–13SEP02–2/2

Intake Manifold Pressure (Turbocharger Boost) Specifications

Engine Model	Fuel System Option Codes	Power Rating @ Rated Speed Without Fan kW (hp)	Rated Speed (rpm)	Boost Pressure Specification
OEM INDUSTRIAL APPLICATIONS				
6105AF	1601, 1602, 1603, 1604	224 (300)	2100	134—154kPa (1.3—1.5bar) (19—22 psi)
6105HF	1609,1610, 1620,1621	242 (325)	2100	128—148 kPa (1.3—1.5 bar) (19-21 psi)
	1601, 1602, 1611, 1612	261 (350)	2100	144—166 kPa (1.4—1.7 bar) (21-24 psi)
6125AF	1610, 1620, 1631, 1641, 1642	242 (325)	2100	134—154 kPa (1.3—1.5 bar) (19—22 psi)
	1601, 1611, 1622, 1632	261 (350)	2100	147—168 kPa (1.5—1.7 bar) (21—24 psi)
	1602, 1612, 1623, 1633	280 (375)	2100	159—183 kPa (1.6—1.8 bar) 23—27 psi)
	1603, 1613, 1624, 1634	298 (399)	2100	173—199 kPa (1.7—2.0 bar) 25—29 psi)
6125HF (—29999)	1601, 1611, 1621, 1631	317 (425)	2100	148—170 kPa (1.5—1.7 bar) (21—25 psi)
	1602, 1612, 1622, 1632	336 (450)	2100	162—186 kPa (1.6—1.9 bar) (23—27 psi)
	1603, 1613, 1623, 1633	354 (474)	2100	172—198 kPa (1.7—2.0 bar) (25—29 psi)
	1604, 1614, 1624, 1634	373 (500)	2100	182—210 kPa (1.8—2.1 bar) (26—30 psi)
6125HF (30000—)	16A1, 16A2, 16A3, 16A4	224 (300)	2100	102—116 kPa (1.0—1.2 bar) (15—17 psi)
	16B1, 16B2, 16B3, 16B4	242 (325)	2100	114—130 kPa (1.1—1.3 bar) (16—19 psi)
	16C1, 16C2, 16C3, 16C4	261 (350)	2100	126—145 kPa (1.3—1.4 bar) (18—21 psi)
	16D1, 16D2, 16D3, 16D4	280 (375)	2100	139—159 kPa (1.4—1.6 bar) (20—23 psi)
	16E1, 16E2, 16E3, 16E4	298 (400)	2100	144—165 kPa (1.4—1.6 bar) (21—24 psi)
	16F1, 16F2, 16F3, 16F4	317 (425)	2100	157—180 kPa (1.6—1.8 bar) (23—26 psi)
	16G1, 16G2, 16G3, 16G4	336 (450)	2100	168—193 kPa (1.7—1.9 bar) (24—28 psi)
	16H1, 16H2, 16H3, 16H4	354 (475)	2100	177—203 kPa (1.8—2.0 bar) (26—29 psi)
	16J1, 16J2, 16J3, 16J4	373 (500)	2100	185—212 kPa (1.8—2.1 bar) (27—31 psi)
OEM GENERATOR SET (STANDBY) APPLICATIONS				
6125AF	1607, 1617, 1628, 1638	233 (312)	1500	136—156kPa (1.4—1.6bar) (20—23 psi)
	1608, 1618, 1629, 1639	254 (341)	1500	150—172 kPa (1.5—1.7 bar) (22—25 psi)
	1609, 1619, 1630, 1640	277 (371)	1500	171—197 kPa (1.7—2.0 bar) (25—29 psi)
	1604, 1614, 1625, 1635	280 (375)	1800	182—210 kPa (1.8—2.1 bar) (26—30 psi)
	1605, 1615, 1626, 1636	300 (402)	1800	201—231 kPa (2.0—2.3 bar) (29—33 psi)
	1606, 1616, 1627, 1637	330 (442)	1800	223—257 kPa (2.2—2.6 bar) (32—37 psi)
6125HF (—29999)	1607, 1617, 1627, 1637	302 (405)	1500	184—212 kPa (1.8—2.1 bar) (27—31 psi)
	1608, 1618, 1628, 1638	352 (472)	1500	215—247 kPa (2.1—2.5 bar) (31—36 psi)
	1606, 1616, 1626, 1636	360 (483)	1800	210—242 kPa (2.1—2.4 bar) (30—35 psi)
	1605, 1615, 1625, 1635	420 (563)	1800	250—288 kPa (2.5—2.9 bar) (36—42 psi)
	1639, 1640, 1641, 1642	460 (616)	1800	270—309 kPa (2.7—3.1 bar) (39—45 psi)
6125HF (30000—	164J, 164K, 164L, 164M	300 (402)	1500	Not Available at Time of Printing
	163A, 163B, 163C, 163D	330 (442)	1800	Not Available at Time of Printing
	165J, 165K, 165L, 165M	350 (469)	1500	Not Available at Time of Printing
	164A, 164B, 164C, 164D	360 (483)	1800	Not Available at Time of Printing
	166J, 166K, 166L, 166M	387 (519)	1500	Not Available at Time of Printing

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RG,RG34710,1610 –19–13SEP02–1/4

Engine Model	Fuel System Option Codes	Power Rating @ Rated Speed Without Fan kW (hp)	Rated Speed (rpm)	Boost Pressure Specification
	165A, 165B, 165C, 165D	420 (563)	1800	Not Available at Time of Printing
	166A, 166B, 166C, 166D	460 (617)	1800	Not Available at Time of Printing

OEM MARINE APPLICATIONS				
Engine Model	**Fuel System Option Codes**	**Power Rating @ Rated Speed Without Fan kW (hp)**	**Rated Speed (rpm)**	**Pressure Specification**
6125AFM	M1	254 (340)	1800	124—152 kPa (1.2—1.5 bar) (18—22 psi)
	M2	280 (375)	1900	145—172 kPa (1.4—1.7 bar) (21—25 psi)
	M3	298 (400)	2000	159—187 kPa (1.6—1.9 bar) (23—27 psi)
	M4, 1601, 1602	336 (450)	2100	186—214 kPa (1.9—2.1 bar) (27—31 psi)
	Gen Set (Prime)	300 (402)	1800	165—193 kPa (1.6—1.9 bar) (24—28 psi)
	Gen Set (Prime)	252 (338)	1500	117—145 kPa (1.2—1.5 bar) (17—21 psi)

Continued on next page RG,RG34710,1610 –19–13SEP02–2/4

Engine Model	Deere Model	Rated Speed (rpm)	Pressure Specification
	JOHN DEERE VEHICLE APPLICATIONS		
6125ADW01	744H/MH Loader (4-Wheel Drive) 744H/MH Log Loader	2000	93—107 kPa (0.9—1.1 bar) (14—16 psi)
6125HDW01 (30000—)	744H/MH Log Loader	2000	93—107 kPa (0.9—1.1 bar) (14—16 psi)
6125ADW70	230LC Excavator	2000	93—107 kPa (0.9—1.1 bar) (14—16 psi)
6125HT001 (30000—)	450C LC Excavator	1800	149—170 kPa (1.5—1.7 bar) (22—25 psi)
6105HRW01	9200 (4-Wheel Drive Tractor)	2100	124—142 kPa (1.2—1.5 bar) (18—21 psi)
6125HRW05 (30000—)	9200 (4-Wheel Drive Tractor)	2100	102—117 kPa (1.0—1.2 bar) (15—17 psi)
6125HRW01	9300 (4-Wheel Drive Tractor)	2100	113—130 kPa (1.1—1.3 bar) (16—19 psi)
6125HRW07 (30000—)	9300 (4-Wheel Drive Tractor)	2100	131—150 kPa (1.3—1.5 bar) (1113—130 kPa (1.1—1.3 bar) (16—19 psi)9—22 psi)
6125HRW11	9300 (4-Wheel Drive Tractor)		
6125HRW02	9400 (4-Wheel Drive Tractor) 9200 (4-Wheel Drive Tractor)	2100	144—166 kPa (1.4—1.7 bar) (21—24 psi)
6125HRW09 (30000—)	9400 (4-Wheel Drive Tractor)	2100	153—175 kPa (1.5—1.7 bar) (22—25 psi)
6125HRW12	9400 (4-Wheel Drive Tractor)		
6125HRW03	9300T (Track-Type Tractor)	2100	113—130 kPa (1.1—1.3 bar) (16—19 psi)
6125HRW06 (30000—)	9300T (Track-Type Tractor)	2100	113—130 kPa (1.1—1.3 bar) (16—19 psi)
6125HRW04	9400T (Track-Type Tractor)	2100	144—166 kPa (1.4—1.7 bar) (21—24 psi)
6125HRW08 (30000—)	9400T (Track-Type Tractor)	2100	153—175 kPa (1.5—1.7 bar) (22—25 psi)
6125HZ001	6850 (Forage Harvester)	2100	149—172 kPa (1.5—1.7 bar) (22-25 psi)
6125HZ005	6850 (Forage Harvester)		
6125HZ002	6750 (Forage Harvester)	2100	115—132 kPa (1.1—1.3 bar) (17—19 psi)
6125HZ006	6750 (Forage Harvester)		
6125AT801	CH2500 Sugar Cane Harvester	2100	143—167 kPa (1.4—1.7 bar) (20—24 psi)
6125HRW10	9220 (4-Wheel Drive Tractor)	2100	125 kPa (1.2—1.3 bar) (22 psi)
6125HRW13	9220 (4-Wheel Drive Tractor)	2100	125 kPa (1.2—1.3 bar) (22 psi)
6125HRW16	9220 (4-Wheel Drive Tractor)		125 kPa (1.2—1.3 bar) (18 psi)
6125HRW13	9320 (4-Wheel Drive Tractor)	2100	153 kPa (1.5 bar))22 psi)
6125HRW16	9320 (4-Wheel Drive Tractor)		153 kPa (1.5 bar) (22 psi)
6125HRW14	9420 (4-Wheel Drive Tractor)	2100	173 kPa (1.7 bar) (25 psi)
6125HRW15	9420 (4-Wheel Drive Tractor)		173 kPa (1.7 bar) (25 psi)
6125HRW17	9420 (4-Wheel Drive Tractor)		173 kPa (1.7 bar) (25 psi)
6125HRW15	9520 (4-Wheel Drive Tractor)		175 kPa (1.7—1.8 bar) (25 psi)
6125HRW17	9520 (4-Wheel Drive Tractor)		175 kPa (1.7—1.8 bar) (25 psi)
6125HT001	450LL Forestry Logger/Excavator		See 6125HT001 above for reference
6125HT004	844H Loader		133 - 142 kPa (13.3 - 14.2 bar) (19 - 20.5 psi)

Continued on next page

Engine Model	Deere Model	Rated Speed (rpm)	Pressure Specification
6125HH003	9860 Special Canadian Combine		137 kPa (1.3-1.4 bar) (20 psi)

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